AN EVALUATION OF THE ROLE OF EXTENSION IN ADOPTION OF NEW TECHNOLOGY BY SMALL-SCALE RESOURCE-CONSTRAINED FARMERS: A CASE OF LOWER GWERU COMMUNAL AREA, ZIMBABWE

By

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DECLARATION

I, Tirivashe Phillip Masere, declare that:

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As the candidate's supervisor I have approved this thesis/dissertation for submission.

Prof Steven Worth

Name Signature Date

ABSTRACT

The importance of agricultural extension in small-scale farming systems of developing countries cannot be overemphasised. Extension organisations and their agents play crucial roles in transferring technologies to small-scale farmers for adoption and in fostering development of innovations from among diverse actors including farmers, research institutions, input suppliers, non-governmental organisations (NGOs), and donors. In many developing countries, particularly of Africa, most new agricultural technologies are disseminated by the primary public extension agencies. In Zimbabwe, the Department of Agricultural Technical and Extension Services (AGRITEX) through its agents are tasked with this responsibility. Despite the efforts by AGRITEX and its agents in disseminating new technologies aimed at improving farm production and hence the livelihoods of small-scale farmers, the adoption of most such recommended technology has been poor.

This study was thus driven by the following primary question: What are the main factors influencing small-scale farmer innovation and adoption of recommended technology? The objectives of this study were to:

a) Determine the main factors influencing small-scale farmer innovation and adoption of recommended technology;

b) Evaluate the role and influence that extension has on small-scale farmer innovation and adoption of recommended technology; and

c) Determine key attributes of an appropriate extension system and modes for small-scale farmers that may provide a lasting solution to the technology adoption issue.

The study was conducted in Lower Gweru Communal area, Zimbabwe with a study sample of 256 small-scale farmers. These farmers were selected by means of multi-stage stratified random sampling to eliminate bias and ensure equal representation of male and female farmers from all the eight Wards of Lower Gweru Communal area (Sikombingo, Nyama, Mdubiwa, Chisadza, Madikani, Bafana, Nkawana and Communal ward 16).

Data was solicited from both small-scale farmers and extension agents operating in the study area. Three instruments namely focus group discussions (FGDs), semi-structured interviews (SSIs) and participant observations were used to collect data from farmers. Two focus group discussions (FGDs) were held in each of the eight wards to gather general information about technologies disseminated to farmers over the last several years, sources of technology, and

their perceptions of extension services. Similar, but more specific information was collected using SSIs with 200 farmers (100 men and 100 women) from among the study sample of 256 farmers. Participant observation technique was used to corroborate information gathered in FGDs and SSIs.

Furthermore, a census in the form of SSIs was conducted with extension personnel servicing Lower Gweru Communal area to solicit the extension workers' perspective on factors affecting technology adoption by small-scale farmers including their perceived challenges in offering quality service delivery to their clients. The census was necessitated by the relatively low number of extension workers (21) operating in the study area.

Key findings from FGDs and SSIs included that small-scale farmers are largely constrained in adopting recommended technologies by a number of factors. These factors include small land sizes, high cost of technology, lack of capital to buy technologies, lack of access to both credit facilities and input-output markets and lack of adequate information support (and practical demonstrations of how to utilise technologies to potentially improve production). Furthermore, farmers cited that they are usually excluded by extension and technology developers in problem definition and development of possible solutions (technologies). As a result, extension agents and technology developers often fail to comprehend farmers' problems and priorities leading to poor adoption of technology they recommend. Most of these technologies are disseminated in a "one-size fit-all" approach to different farmer groups with different needs and problems.

Key findings from extension agents included that they were not able to deliver quality services to their clients (farmers) mainly because AGRITEX is poorly funded and this led to poor adoption of recommended technology. This funding challenge cascades into multiple problems including: poorly remunerated and de-motivated workers, high turnover of experienced, competent and skilled staff; high influx of inexperienced and incompetent staff rushed to replace the experienced and competent staff; high agent to farmer ratios; lack of in-service training for the inexperienced workers; and lack of transport for workers to reach many farmers.

The study found a mismatch between technologies that are needed or demanded by farmers and those being recommended or "imposed" on them by extension agents. Unless this discrepancy is addressed the poor adoption of recommended technology issue will persist. As a lasting solution to poor technology adoption, this study proposes and recommends the development of an appropriate extension system and complementary extension modes that promotes building the capacity of extension agents and researchers, and embraces farmers and their indigenous knowledge.

In this proposed extension system, farmers' views, experiences and perspectives are taken into consideration in developing and testing technologies which could improve technology adoption. This extension system should possess six key characteristics: farmer-focused; whose purpose is farmers' empowerment and capacity development; where the role of extension is mainly that of facilitation and brokering as determined by prevailing farmer needs; where farmers have a key role in determining what to learn and how they want learn; it should emphasise social capital and sustainability; and whose nature of learning is experiential, field-based discovery learning aimed at sharpening farmers' analytical, problem solving skills and to demand services. However, for the proposed appropriate extension system for small-scale farmers to work effectively, it must be backed by the availability of committed, highly competent and flexible extension agents to function effectively in offering quality service delivery to meet diverse needs of farmers. Equally important for the effective operation of proposed extension system, is the need for strengthening of linkages between key actors in the innovation and technology development network.

DEDICATION

To the Almighty God

The author and finisher of my faith

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LIST OF ACRONYMS

ADRA	Adventist Development and Relief Agency
AGRITEX	Department of Agricultural, Technical and Extension Services
AIS	Agricultural Information System
CBD	Central Business District
CONEX	Department of Conservation and Extension
DAFF	South African Department of Agriculture, Fisheries and Forestry
DEVAG	Department of Agricultural Development
ECLFLA	Extension Carousel of Learning and the Facilitated Learning Agenda
EMA	Environmental Management Agency
ENRD	European Network for Rural Development
ESA	Eastern and Southern Africa
FAO	Food and Agriculture Organisation
FBS	Farm Business School
FFS	Farmer field School
FGD	Focus Group Discussion
FSRE	Farming Systems Research and Extension
GDA	Group Development Area
GMB	Grain Marketing Board
GTZ	German Development Cooperation
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPM	Integrated Pest Management
ITDG	Intermediate Technology Development Group
MAMI	Ministry of Agriculture Mechanisation and Irrigation

MOFA	Ministry of Food and Agriculture
NDA	South African Department of Agriculture
NGO	Non-Governmental Organisation
NRC	National Research Council
OPVs	Open Pollinated Varieties
RLG	Radio Listening Group
SCF	Seasonal Climate Forecasts
SGMs	Standard Gross Margins
SSI	Semi-Structured Interview
T&V	Training and Visit
TRB	Tobacco Research Board
UNIDO	United Nations Industrial Development Organization
USD	United States Dollar
WCA	World programme of Census of Agriculture
WLZ	Women and Land in Zimbabwe
ZFC	Zimbabwe Fertiliser Company
Zim-AIED	Zimbabwe-Agricultural Income and Employment Development
ZRP	Zimbabwe Republic Police

CHAPTER 1: GENERAL INTRODUCTION

1.1. Background to the study

There is a long history of efforts by scientists to research and develop technologies aimed at increasing farm production which are then transferred by extension agents to farmers for adoption (Rogers, 2004; Swanson and Rajalahti, 2010; Koutsouris, 2012). In this process, extension is also responsible for relaying feedback from farmers to research and technology developers (Rogers, 2004; Zhou, 2008). In Zimbabwe, most new agricultural technologies are disseminated by the primary public extension agency, the Department of Agricultural Technical and Extension Services (AGRITEX) and its agents. AGRITEX mainly services small-scale communal farmers and, until recently, the newly resettled farmers. As the principal dispensers of technologies and information from technology developers and researchers to farmers, AGRITEX extension workers are responsible for technology adoption by their clients. However, most of the technologies recommended by AGRITEX have not been adopted by the small-scale farmers, who have continued to rely primarily on their indigenous knowledge to sustain their farming enterprises, with some success. AGRITEX and the researchers have failed to build on the successful indigenous knowledge and practices when developing new innovations.

Unfortunately, some of the reasons for poor adoption by small-scale farmers can be attributed directly to AGRITEX as an institution, which is facing serious challenges with funding, capacity building and mobility, all of which hinder its service delivery (Hanyani-Mlambo, 2002; Davis, 2008; Mugwisi et al., 2012). Consequently, farmers end up be served compromised extension services from agents who are poorly remunerated and have little or no motivation to do their jobs. Furthermore, AGRITEX have employed ineffective methods of technology dissemination including top-down approaches that fail to take account of farmers' problems and circumstances in looking for solutions; they exclude farmers in problem definition and solving. Employing a 'one-size fit-all' approach, AGRITEX has disseminated the same technologies to farmers in different agro-ecological regions (Masuku, 2011) suggesting that most of the disseminated technologies are actually irrelevant to small-scale farmers. Further, Birner et al. (2009) found that the imposition of standardised "one-size fit-all" extension approaches that have may have been successful in some other different areas, actually contributes to limited technology adoption in small-scale farming systems.

Apart from AGRITEX-related challenges hindering farmer technology adoption, there are three main reasons limiting farmer technology adoption. First is the socio-economic challenges of farmers including their perception of modern technology and unaffordability to purchase desired technologies. Second is the lack of information support on technology as well as lack of credit facilities to help farmers acquire desired technologies. Third is the technological attributes like complexity to use, affordability and relative advantages (Chi and Yamada, 2002; Akudugu et al., 2012; Abdullah and Samah, 2013). Further, farmers' social and biophysical operating environments also influence technology adoption decisions (Chi and Yamada, 2002; Jack, 2013).

It is against this background that this study was conducted in Lower Gweru Communal area, Zimbabwe to determine both farmers and extension agents' perceptions of the factors influencing technology adoption and innovation. Drawing on the Zimbabwe experience, the study sought to shed light on the role of extension in technology adoption by small-scale farmers and to create a framework for a lasting solution to the technology adoption issue.

1.2. Research question

This study was driven by the following primary question: What are the main factors influencing small-scale farmer innovation and adoption of recommended technology? This primary research question gave rise to the following secondary questions:

a) What influence does agricultural extension in Zimbabwe have on technology adoption by small-scale farmers?

b) What are the defining characteristics and circumstances of small-scale farmers?

c) What is the role of extension in small-scale farmers' technology adoption and innovation?

d) What are the appropriate extension approaches and modes for small-scale farmers in developing countries?

e) What is the perception of farmers on the factors influencing adoption and innovation of new technology?

f) What is the perception of extension agents on the factors influencing role adoption and innovation of new technology and decision-making by small-scale farmers?

1.3. Research Objectives

The objectives of this study were to:

d) Determine the main factors influencing small-scale farmer innovation and adoption of recommended technology;

e) Explore the role and influence that extension has on small-scale farmer innovation and adoption of recommended technology; and

f) Determine key attributes of an appropriate extension system and modes for small-scale farmers that may provide a lasting solution to the technology adoption issue.

1.4. Research Design

1.4.1. Study area and Sampling

The study was conducted in Lower Gweru Communal area of Zimbabwe, which is located about 40 km northwest of City of Gweru, and stretches a further 50 km to the west. Lower Gweru is a developed communal settlement in the Midlands province of Zimbabwe. Lower Gweru's climate can be described as semi-arid to arid with summer rainfall ranging from 450mm to 600mm annually but experiences periodic seasonal droughts and severe dry spells (Vincent and Thomas, 1960). Farming is the main occupation of the people in Lower Gweru. Administratively, 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, Nkawana and Communal ward 16. Lower Gweru communal area was chosen for the study for two main reasons. Firstly, it is an area populated with small-scale resource-constrained farmers and secondly the area has seen an increased number of technologies disseminated over the last two decades.

To eliminate bias and ensure representativeness multi-stage stratified random sampling was used to select a study sample of 256 participant farmers from all the eight wards of Lower Gweru Communal area. The eight Wards are: Sikombingo, Nyama, Mdubiwa, Chisadza, Madikani, Bafana, Nkawana and Communal ward 16. This sampling technique was used to cater for equal representation of males and females and to ensure all villages within each ward were represented. The Wards' extension agents assisted in this process. Due to the relatively low number (21) of extension personnel servicing the Lower Communal area, all the extension workers participated in the study.

1.4.2. Data gathering methods

The study used both primary and secondary data (review of relevant literature). Literature reviewed on factors affecting technology adoption by small-scale farmers, characteristics and circumstances of small-scale farmers, extension approaches and modes used in small-scale farming systems, and roles of extension in technology adoption and innovation by farmers provided a benchmark for the primary research that followed. Primary data was solicited using three instruments: focus group discussions (Merton et al., 1956; Krueger, 1994); semi-structured interviews (Barriball and While, 1994; Campion et al., 1988); and participant observation (Marshall and Rossman, 1989, Kawulich, 2005). These methods were used sequentially, each building on the results of the previous data collection exercise; each validating the data of the previous session. Each of the data gathering method is discussed separately:

Focus group discussions: Merton et al. (1956) define focus groups as structured, guided discussions conducted for the primary purpose of gathering data for scientific purposes. Similarly, Wilkinson (2004: 177) define focus group discussions as “a way of collecting qualitative data, which essentially involves engaging a small number of people in an informal group discussion (or discussions), ‘focused’ around a particular topic or set of issues”. It is ideal to have a moderator to facilitate and coordinate the discussions as well as to encourage all members to participate (Krueger, 1994). Further, the moderator or his/her team members are responsible for documenting notes that inform potential emergent questions to ask (Onwuegbuzie et al., 2009). Focus groups offer a socially oriented environment conducive for research participants to discuss perceptions, ideas on a particular topic (Merton et al., 1956; Krueger, 1994; Krueger and Casey, 2000). Focus group discussions have numerous benefits for researchers including that they are quick and cost effective as data is obtained from multiple participants at once.

Semi-structured interviews: It is a form of interview useful in gathering data based on identified predetermined specific research questions or themes which need to be investigated in greater detail (Alexiades, 1996). However, this technique allows for flexibility as interviewers can augment prepared questions with others that emerge from exchanges with the interviewee or may drop some predetermined questions on the guide altogether depending on the ensuing discussions (Campion et al., 1988; Alexiades 1996). This flexibility is what makes semi-structured interviews different from structured interviews where all the predetermined questions are fixed and covered in the same order for all participants (Fylan, 2005). Semi-structured interviews are more appropriate for the exploration of an interviewee's perceptions and opinions regarding complex and sometimes sensitive issues and also enabling probing for more information and clarification of answers (Bariball and While, 1994; Fylan, 2005). In this study, semi-structured interviews were useful in capturing the individual farmer's socio-economic issues and how these issues affect farmers' technology adoption and innovation.

Participant observation: Marshall and Rossman (1989:79) define observation as "the systematic description of events, behaviours, and artefacts in the social setting chosen for study". Thus, participant observation is the process that allows researchers to learn about the activities of the people under study in their natural setting through observing and participating in those activities (Kawulich, 2005). For researchers to learn more from participant observation they need to: have an open, non-judgmental attitude; be interested in learning more about research participants; and be careful observers and good listeners (DeWalt and DeWalt, 1998). Participant observation is useful to researchers in a variety of ways including providing the means to check for non-verbal expression of feelings, determining participants' interactions and communication with each other, as well as checking for amount of time spent on various activities (Schmuck, 1997). Marshall and Rossman (1995) highlighted the importance of participant observation to verify definitions of terms that participants use in interviews and to observe situations described in interviews or focus group discussions. They further posit that participant observation enables researchers to discover events that participants may have intentionally or unintentionally failed to share may be because they consider sharing such events/information to be impolitic, impolite, or insensitive. In this study, participant observation was used for two main reasons: Firstly, to verify findings gathered from focus group discussions and semi-structured interviews; and secondly, to check for potential vital information that may not have come up in both focus group discussions and semi-structured interviews.

Research validity and trustworthiness: Triangulation was used to determine points of similarities and differences in qualitative data collected from participants through focus group discussions, semi-structured interviews (both farmers and extension agents) and participant observations thereby improving the study through enhancing the credibility and veracity of findings and interpretations.

Data analysis: Data gathered through the review of relevant literature was analysed for emerging themes. In addition, the contents of the focus group discussions, semi-structured interviews and participant observation notes were reviewed and coded to identify the emerging concepts and themes.

1.5. Limitations of the study

The research, being a case study, concentrated only on Lower Gweru Communal area of Zimbabwe and AGRITEX officials that service the area, thus making the findings and generated conclusions more specific for Lower Gweru Communal area. While the findings, conclusions and recommendations cannot be generalised, they can nevertheless provide valuable insights that may be applicable to other similar districts of Zimbabwe and other parts of the world experiencing similar issues of technology adoption among small-scale farmers. Thus, despite this limitation, the study adds to the body of knowledge and raise awareness on the role of extension and issues affecting farmer innovation and technology adoption.

1.6. Structure of the Thesis

This thesis is comprised of eight chapters including this introductory chapter. Chapters 2 – 7 are presented as journal articles while Chapter 8 is presented in the form of a summary, discussion and conclusion. Each chapter has its own references. The referencing system used in each chapter varies because each was formatted in compliance with the submission requirements for specific journals. The way the papers are presented in this thesis meant that there will be some unavoidable repetition of information and overlaps of themes. Chapters 2 have been submitted for publication. The chapters are presented as set out below.

Chapter 2 is a paper entitled, "Small-scale farmers: Definition, Characteristics and circumstances". It investigates misconceptions in defining small-scale farmers. The paper also explores the underlying attributes of small-scale farming systems including the strengths and challenges of small-scale farmers. Finally, the paper considers the opportunities of small-scale farming systems in enhancing household food security and livelihood.

Chapter 3: The paper is entitled “Agricultural extension in Zimbabwe and its influence on technology adoption by small-scale farmers”. It explores the relative successes and challenges, regarding technology adoption, of various extension approaches that have been used in the past and those currently being used in Zimbabwe. The paper investigates challenges faced by the primary public extension agency in Zimbabwe, AGRITEX, and how these challenges impacted the agency’s services to the small-scale farming community. This paper has been submitted and currently under review for publication in the *Journal of International Agricultural Extension and Education*.

Chapter 4 presents a paper entitled, “The role of extension in technology adoption and innovation by small-scale farmers”. This paper explores the dynamic role of extension under both a technology adoption-based paradigm and a learning and innovation-based paradigm.

Chapter 5: A paper entitled, “Appropriate extension approaches and modes for small-scale farmers in developing countries”. This paper evaluates the different extension approaches and modes that have been used and are currently in use in developing countries, based on their appropriateness to small-scale farming systems. Subsequently, the paper suggests six key characteristics which constitute an appropriate extension that cut across boundaries of different production and demand-led extension approaches. It provides the overall framework for the research design for the study in Gweru.

Chapter 6 presents a paper entitled, “Factors influencing adoption and innovation of new technology and decision-making by small-scale resource-constrained farmers: the perspective of farmers”. The paper explores farmers’ perception of factors that influence their decision-making processes on innovation and technology adoption. The paper also investigates circumstances where farmers consider learning and adoption of new technologies; challenges they faced in technology adoption as well as the kind of support farmers require in adopting technologies or innovating.

Chapter 7: The paper is entitled, “Factors influencing adoption and innovation of new technology and decision-making by small-scale resource-constrained farmers: the perspective of extension agents”. This paper captures the socio-economic status of extension agents and how it affects service delivery to farmers. It also addresses the reasons why farmers are poorly adopting recommended technology, from the perspective of the extension agents. Further, the paper investigates how extension agents perceive farmers’ indigenous knowledge, farmers' capacity to adopt modern technology as well as possible strategies for improving technology adoption.

Chapter 8: This chapter is entitled, "Defining the role of extension in technology innovation and adoption among small-scale farmers in Zimbabwe". It provides a general summary of key findings, discussion and conclusions based on theoretical investigations and empirical evidence presented in the previous chapters. The chapter concludes with policy implications and recommendations relevant to the Zimbabwean extension system, and suggestions for future research.

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CHAPTER 2: SMALL-SCALE FARMERS: DEFINITION, CHARACTERISTICS AND CIRCUMSTANCES

Abstract

Small-scale farmers account for the majority of farmers across the world. The classifying of farmers into subsectors (small-scale, medium-scale and large-scale) has been mainly based on the size of farm land, geographical location and even on political development of certain countries particularly in Zimbabwe and other African countries. There have also been misconceptions in defining what small-scale farmers really are. This paper attempts to define small-scale farmers and explores their characteristics and circumstances. A desk research was undertaken to investigate small-scale farmers' constraints and strengths as well as to evaluate opportunities offered by the integrated crop-livestock systems attribute of small-scale farming. Key findings included that small-scale farmers are largely constrained by small land sizes, lack of access to both credit facilities and input-output markets, lack of adequate information about modern technologies and the demonstration of how they can potentially benefit these farmers. Strengths of the small-scale farming include use of family labour, low cost inputs, high profitability due to multiple cropping. Integrated crop-livestock production systems enable farmers to spread agricultural risk thus enhance food security and improve farmers' lifestyles. Crops like maize, sunflower and ground nuts and their residues are used to make home mixed feeds to supplement nutrients to the animals while manure from livestock is an important input in crop production as it improves the nutrient status of soils.

Key words: food security; income; integrated crop-livestock systems; small-scale farmers

Small-scale farmers: Definition, characteristics and circumstances with particular reference to Zimbabwe

Worldwide there are approximately 525 million farms, 470 million of which are small-scale farms. The majority (85%) of small-scale farmers in these farms operate in crop lands less than 2 hectares. The location distribution of the farms is anything but uniform as 87% of the farms are located in Asia while eight percent and four percent are located in Africa and Europe, respectively (Nagayets, 2005).

Despite having the overwhelming majority of small farms, according to the FAO (2010) census (Asia also has the smallest average size of landholding among the 114 FAO member countries – 1 hectare compared to the global average size of 5.5 hectares. There are approximately 33 million small-scale farms in Africa, thus constituting 80% of all farms on the continent (Nagayets, 2005; Altieri and Koohafkan, 2008), the majority of which operate in farms less than 2 hectares (Altieri and Koohafkan, 2008).

The challenge for African small-scale farmers is the ever shrinking farm sizes. The major reason for this shrinking is that Africa's rising population is absorbed into farming. For instance, in Ghana, the average size decreased from 1.5 hectares to 0.5 over the 20-year period from 1970 to 1990 due to rising population (Nagayets, 2005; von Braun, 2005). This is similar to findings by Dixon et al. (2003) that small-scale farmers cultivate less than one hectare of land in high population density locations as compared to up to 10 ha or more in sparsely populated semi-arid areas, although the latter may be inclusive of livestock grazing land.

The fragmentation of small-scale farms to accommodate high population growth in Africa confines small-scale farmers to subsistence crop production. Conversely, small-scale farmers in developed regions like Europe, where the fragmentation is minimal, are operating above the subsistence level and are earning as much as USD 50,000 annually (USD137 per day) from their agricultural produce (Dixon et al., 2003). This far exceeds what most small-scale farmers in the developing countries earn which is less than USD 2 per day (Reijntjes, 2009). This shows a great divide between level of production by small-scale farmers in developing and developed countries.

As a result of the low farm outputs from small-scale farmers of Africa compared to small-scale farmers in the developed world or to large-scale farmers in Africa, many misconceptions arose about this farming subsector. Firstly, small-scale farmers are often perceived to be backward and non-productive subsistence farmers located in native lands (Kirsten and van Zyl, 1998). Secondly, in most African countries like South Africa and Zimbabwe, small-scale farmers are generally associated with the black population while large-scale farmers are generally associated with the white population (Kirsten and van Zyl, 1998). The reason for these misconceptions could be the history of land tenure systems under Apartheid regime, and before Independence in South Africa and Zimbabwe respectively where blacks were crowded in rural areas with poor infertile soils as opposed to whites who owned prime extensive agricultural lands. FAO (2006) noted that the political and historical development of the Zimbabwe particularly during the 90 years of colonial and settler government also shaped farming systems.

Before the Zimbabwean government embarked on the fast track land reform in the year 2000, there were three distinct farming subsectors; communal lands, resettlement areas, and large-scale commercial farming (FAO, 2006). The categorisation of farms into these subsectors was based on tenure systems, size, agro-ecological factors, crop and livestock production systems, levels of technology use and income levels (FAO, 2006). Out of the three farming subsectors, communal lands and resettlements areas constituted small-scale farming systems. These small-scale farming systems were mainly established in areas known as Reserves the main purpose of which was to be a labour pool for large-scale commercial farmers; the Reserve areas themselves were not designed to be viable for any meaningful form of agriculture (Mushunje, 2005).

The land reform process brought about two small-scale farm models: A1 (villagised arrangements or small self-contained farms); and A2 (slightly larger scale or medium-scale), focussing on subsistence and more commercial production respectively (Scoones et al., 2011). Thus, after the implementation land reform, a tri-modal structure of Zimbabwe's farming systems ensued namely small-scale farms, medium-scale commercial and large-scale estates (Scoones, et al., 2011). The small-scale farming sector currently comprises old resettlement areas (settled before 2000), communal lands and the A1 farms.

This paper has four objectives:

1) Defining small-scale farmers;
2) Determining the characteristics and circumstances of small-scale farming systems in Zimbabwe and Africa;
3) Exploring constraints and strengths of small-scale farmers; and
4) Evaluating the integrated crop-livestock systems of small-scale farmers based on its contribution to their household food security.

The paper is a review of literature, primarily journals and published technical reports pertaining to small-scale farming systems.

2.1.Definition of small-scale farmers

There is no universally accepted straightforward definition of small-scale farmers. However, there are certain attributes or criteria that have been used to describe or attempt to define small-scale farmers including land size, resources, and income. Farm size is probably the most obvious and easily used criterion to define small-scale farmers (Chamberlin, 2007). However, the World Bank views small-scale farmers as those with cropland sizes less than two hectares and with added condition of having little or no assets (World Bank, 2003). A similar definition for small-scale farmers is given in a study by FAO which emphasises limited/stretched resources in comparison with medium- and large-scale farmers (Dixon et al., 2003). The limited resources include land holding sizes, livestock, access to inputs and markets (Chamberlin, 2007).

Although farm size is the mostly used indicator to identify or define small-scale farmers, it is not a good criterion and has its limitations (Kirsten and van Zyl, 1998; Lund and Price, 1998). In that regard, Kirsten and van Zyl (1998) suggest that small-scale farms should not be generalised as simply scaled down versions of large-scale farms. Lund and Price (1998) reason that the agricultural attributes of land are variable over different types of farms, implying that one may need a vast area of land to get the same output value from a much smaller area of high quality soil fertility. Thus, net farm profitability should be the determinant of farm size categories as opposed to land size (Kirsten and van Zyl, 1998; Lund and Price, 1998).

In Europe, farms are classified on the basis of income generating potential by undertaking standard gross margins (SGMs) of all units (enterprises) on the farm to evaluate how these units contribute to total farm profitability under normal natural conditions (FAO, 2010). The SGM tool thus provides how big or small a farm’s business is as opposed to farm area and intensity of production (FAO, 2010). To cater for farms in different geological locations, different standard coefficients are determined and used in computing SGM for each crop and livestock so as to allow for profit differentials (FAO, 2010).

2.2.Characteristics of small-scale farmers

Worth (2012) suggests that seven factors frame the characteristics of farmers of any scale, five of which are relevant to this study: primary purpose; self-reliance; production paradigm; and technology paradigm. He posits that farmers will fall somewhere on a continuum for each of these factors. Thus, within these factors, small-scale farmers as defined in 3.1. above will have unique characteristics.

2.2.1. Primary purpose

Why a farmer produces is a characteristic of farmers and helps to shape an understanding of the farmer and how extension services should be offered (Worth, 2012). The main objective of small-scale farming systems is for household consumption as opposed to large-scale commercial farming systems that responds to market demand (Delgado, 1999). The farmers normally use local resources in their farming operations although they may occasional make use of external inputs (Chamberlin, 2007; Altieri and Koohafkan, 2008). Moreover, the small-scale farmers employ risk averse strategies and aims to maximise yields from constraining resources (Scoones, 1992).

2.2.2. Land issues

In addition to small land sizes, small-scale farmers are typically located on lands with marginal production potential. This is exacerbated for those farmers living in semi-arid environments with low, erratic rainfall and high temperatures -- further limiting crop productivity (Altieri and Koohafkan, 2008). This latter characteristic pertains to Zimbabwe. FAO (2006) describes these semi-arid environments as marginal agro-ecological regions receiving an average annual rainfall of 400-500mm with high prevalence of severe dry spells during the rainy season and are associated with very shallow infertile soils. These conditions make meaningful crop production very difficult even for drought resistant crops like sorghum (FAO, 2006).

2.2.3. Self-reliance

Self-reliance essentially refers to the extent to which farmers can take command of the factors that influence their farming operations (Worth, 2014). A key aspect of this is the farmers' capacity, which is reflected in their knowledge and skills and the sources of knowledge available to them.

Lack of knowledge and skills, particularly those that enable farmers to enter market-oriented farming is a key factor among small-scale farmers (Rottger, 2004). This holds true for Zimbabwe where the majority of small-scale farmers are not formally trained in agriculture. The only training they have is from the AGRITEX extension workers who have trained over 300 000 master farmers and up to 50 000 advanced master farmers across the country by targeting progressive small-scale farmers and providing them with relevant farming information and technologies, which they are expected to disseminate to other farmers (Pazvakavambwa and Hakutangwi, 2006). The training includes planting methods, and soil and water conservation techniques, among other technologies. Master Farmer certificates and badges were awarded to the small-scale farmers who adopted and practised recommended technologies.

Lack of access to agricultural information, particularly farm management information is a common characteristic of small-scale farmers (FAO, 2004). In Zimbabwe, they are particularly reliant on extension workers, other farmers through their farmers' clubs and, to a small extent, radios (Masere, 2011). Farmers' clubs often organise and conduct field days which offers an informal platform where small-scale farmers exchange experiences and agricultural information through open discussions (Burgers, 1999). This farmer-to-farmer extension can also be an important way to disseminate and encourage adoption of new technology (Burgers, 1999).

2.2.4. Technology paradigm

How farmers produce their enterprises is another factor that characterises small-scale farmers. Most commonly this centres on the reliance on family labour, choices regarding farming technologies, influence of social functions on technology adoption and the use of indigenous knowledge.

Most small-scale farmers rely on their families as the supply of labour for all farm activities including land preparation, cultivation, weeding and harvesting (Chamberlin, 2007; Salami et al., 2010; Masere, 2011). A large family consisting of able-bodied members is thus more likely to be successful compared to a smaller family or families consisting mainly of young children and the aged (Delgado, 1999). This suggests that small-scale farmers are vulnerable on the labour front. This may be a contributing factor to frequent overuse of labour (Mushunje, 2005).

Use of simple farming technologies is common amongst small-scale farmers. Most small-scale in Zimbabwe own hoes, ox-drawn plough, axes, wheelbarrow and cultivators. The better-off farmers additionally own scotch carts, harrows, rippers, and ridgers (Mapiye et al., 2006). Those without essential implements normally hire from others who owns them and thus can only use them after owners have finished using them (Masere, 2011). This often leads to poor crop yields as these farmers usually plough, plant and weed late into the season.

Similarly, cattle are the main source of power for ploughing the land and other farm operations (Mushunje, 2005; Masere, 2011). However, about 40% of the small-scale farmers do not own cattle and must hire them for the required operations (Stonemen and Cliffe, 1989; Masere, 2011). Masere (2011) noted that some farmers owning implements but without cattle enter into reciprocal cooperative arrangements with farmers who have cattle but lack some implements for tillage and cultivation purposes.

Social function (processes and systems) influences farmer decision making around technology adoption. Ghane et al. (2011) suggested that people – in this case farmers, may choose to adopt a technology even if they are not favourable towards it as long as it is favourable to the referent group. Thus 'social influence' can be used to refer to the extent to which members of a reference group influence one another's behaviour and experience social pressure to perform particular behaviours (Kulviwat et al., 2007 as cited in Ghane et al., 2011).

Most small-scale farmers depend on their own indigenous knowledge generated through many years of farming experience in their own communities to guide crop management decisions (Masere, 2011). This reliance on indigenous knowledge-driven methods of farming had been taken to mean that small-scale farmers are mostly uneducated and illiterate (Ortmann, 2000; Makhathini, 2013). However, studies by Francis and Sibanda (2001), Mapiye et al. (2006) and Masere (2011) found small-scale farmers to be literate and educated at least to the basic primary school level. Further, the use of indigenous knowledge by small-scale farmers is mainly because they did not have adequate information and access to modern technologies. These farmers have also shown a willingness to learn about modern farming technologies if given the opportunity (Masere, 2011).

The majority of small-scale farmers are advanced in years as young people usually migrate to urban areas in search of non-agricultural work. Age of the farmers has a bearing on their farm decision-making. Chi and Yamada (2002) found that old farmers prefer to use their own experiences and traditional knowledge to modern technologies. This concurs with findings by Masere (2011) that farmers' age influences their farm management decisions and their perception of outside help (including modern technologies) or changes from their normal farming methods.

2.2.5. Production paradigm

Yields: Small-scale farming systems in sub-Saharan Africa are characterised by low yields as a result of the low level of production they usually operate at. Makhathini (2013) highlighted that small-scale farmers' average crop yields are very low and usually fail to sustain their household consumption and or income needs. The major causes for the low yields include low productivity, droughts, lack of inputs, limited or no access to credit and extension services (Hazell, 2001). Makhathini (2013) added that these major causes of low crop production also constraints small-scale livestock production.

Production and farming systems: Most small-scale farming systems are characterised as mixed farming systems, comprising of both crop production and livestock production (Burgers, 1999). There are numerous advantages of this mixed farming systems including reduction of risk normally prevalent in a monoculture farming system. Small-scale farmers often grow staple crops like maize, sorghum, groundnuts and also rearing cattle, goats and chickens (Burgers, 1999). In Zimbabwe, the most common crops grown by small-scale farmers include maize, sunflower, groundnuts, finger millet and sorghum. (Mapiye et al., 2006). Of these maize is grown on about 70 % of croplands (Ngongoni et al., 2006). These crops are also usually intercropped.

2.3.Challenges facing small-scale farmers

Worldwide small-scale farmers are faced with a plethora of challenges due to their scale of operation. These challenges are most severe in the developing countries including Zimbabwe, where farmers' conditions and circumstances are already dire as a result of geographical locations of these farms as well as economic and political environments they operate in (Salami et al., 2010). Small-scale farmers are usually located in areas with poor road networks and further from the markets. Moyo (2002) suggests that these small-scale farmers are hampered as a result of the scale of operations, lack of capital, increased vulnerabilities to market and natural risks. Some of the more pertinent challenges and how they constrain small-scale farming sector are discussed below:

2.3.1. Land tenure

Insecurity of land tenure and its related constraints like inequitable access to land, lack of clear and sound system of land rights transfer have been noted as one of the causes of food insecurity and under-developed agriculture (Salami et al., 2010). In small-scale farming areas, land is often subdivided into small uneconomic plots resulting in low crop production. Added to this is the continued fragmentation of the already small plots to absorb increasing population (Dixon et al., 2003; Salami et al., 2010).

2.3.2. Lack of access to credit facilities

Lack of access to credit is the most critical resource constraint to small-scale farmers (Mushunje, 2005). The majority of small-scale farmers are unable to access credit from banks and micro-credit firms due to lack of collateral (Salami et al., 2010). As a result, these farmers rely on their own meagre savings and remittances thus thwarting any meaningful attempts to expanding their farm productivity (Salami et al., 2010).

2.3.3. Lack of access to markets

This constraint is twofold; firstly, lack of access to markets to acquire inputs, and, secondly, lack of access markets to sell their produce. Kirsten and van Zyl (1998) described the input and output markets for small-scale farmers as either missing or incomplete, a situation leading to high transaction costs. Small-scale farmers often fail to use quality inputs like hybrid seed and inorganic fertilisers not because of choice, but due to inaccessibility of these inputs on the open market (Masere, 2011). Lack of a ready market to sell small-scale farmers' agricultural produce has resulted in large quantities of agricultural produce rotting away in Africa (Kamara et al., 2009). United Nations Industrial Development Organization (UNIDO) (2007) estimates post-harvest losses in sub-Saharan Africa to amount to more than 40% and is even as high as 70% for perishables.

2.3.4. Poor infrastructure

The infrastructural constraint to small-scale farming systems is closely related to access to markets. A poor road network hinders smooth distribution of inputs to the farms as well as output (agricultural produce) from the farms to the market (Salami et al., 2010). Due to poor road systems in small-scale farming areas of Zimbabwe and most developing sub-Saharan Africa farmers resort to inefficient modes of transportation like animal-drawn scotch carts (Salami et al., 2010).

2.3.5. Agricultural extension and innovation

Small-scale farmers are not getting adequate help from extension services, who are hampered in executing their duties due to low funding from their parent ministries (Salami et al., 2010). Without the social facilitation processes of the extension services farmer development with regards to gaining deeper insight into their problems and their respective causes, and gain new motivation and direction, is hampered (Salomon, no date).

The lack of adequate funding of AGRITEX and poor remuneration led to a number of related challenges including lack of transport to visit farmers, demotivated workers and loss of competent staff to greener pastures leaving behind new and inexperienced staff without practical experience (Mugwisi et al., 2012). Most of these new extension staff are, themselves not familiar with some of the very technologies they are supposed to share with farmers (Masere, 2011). Collectively, this results in poor quality services from the extension workers, which in turn leads to low and poor adoption of some otherwise good innovations (Mngumi, 2010).

2.3.6. Poor technology adoption and unfavourable agricultural policies

The level of operation of small-scale farmers makes it is unsuitable to adopt bulky technologies like combine harvesters and centre pivot irrigation systems which require large land sizes to be viable. This suggests that technology developers and policy makers do not consider the circumstances of small-scale farmers when they develop their technologies. The FAO (2010) postulates that for effective implementation of agricultural policies there is need to incorporate features of small-scale farmers, as agricultural policy and statutory instruments affect different farming sectors differently. Without suitable technologies and the tendency not to adopt relevant technologies encourages farmers to persist with their indigenous technology, which although reliable, keeps them operating at low levels of productivity (Mushunje, 2005).

2.3.7. Vulnerability to climate change and its effects to household food security

African small-scale farmers generally practice rainfed crop and livestock production. This makes them vulnerable to climate change and droughts (Altieri and Koohafkan, 2008; Salami et al., 2010). This often results in crop yield reductions leading to severe food security challenges moreso if household food requirements are not met (Altieri and Koohafkan, 2008; Salami et al, 2010).

2.4.Strengths of small-scale farmers

Small-scale farmers, despite all the challenges they face, still have their strengths which have kept them going for generations. These include use of family labour, low cost of production, spreading of agricultural risk, conservation of natural resources and high profitability per unit output. These are discussed below.

2.4.1. Family labour

Small-scale farmers and their families provide labour requirements to meet all the farm operations. In most cases, small-scale farmers and their family are willing to and actually invest more energy and time in their farms than those justified at standard market wage rates because the rewards accrue directly to the family (Delgado, 1996). In addition, small-scale farmers do not place a monetary value to the labour they put into their own farms because they do not perceive it as a cost (Masere, 2011).

2.4.2. Low cost of production

As a result of their use of family labour, small-scale farmers have lower per unit costs than large-scale farmers (Reijntjes, 2009). Small-scale farmers also make use of local knowledge and practices that accumulated through their experiences with managing their available resources (Altieri and Koohafkan, 2008). Indigenous technologies tend to require little cash outlay, hence the production costs of crop and livestock tend to be low.

2.4.3. Agricultural risk is spread

Through cultivation of a diversity of crops small-scale farmers spread the risks of total crop failure (often associated with mono-cropping) and simultaneously maximising their harvest security in uncertain and marginal environments, under low levels of technology and with limited environmental impact. (Altieri and Koohafkan, 2008).

2.4.4. Conservation of natural resources

Small-scale farmers are usually better at conserving and managing natural resources through their traditional multiple cropping systems (beans, corn, potatoes and fodder) which reduce soil erosion (Altieri, 2008). Management is also used efficiently as multiple cropping results in higher productivity in terms of harvestable products per unit area than under single - enterprise cropping at the same management level. Multiple cropping reduces yield losses caused by weeds, pests and diseases, and utilises water, radiation and nutrients more efficiently thus resulting in yield advantages of between 20 to 60 percent (Altieri, 2008). These traditional multiple cropping systems contribute as much as 20% of global food supply (Altieri, 2008).

2.4.5. High profitability per unit of output

Although large-scale farmers output more crop yields than small-scale farmers, small-scale farmers utilise their fewer resources more intensively thereby making more profit per unit of output (Rosset, 1999). More crops are harvested in croplands where multiple cropping is practised compared to similar cropland where sole cropping is practised.

2.5.Potential of the integrated crop-livestock systems of small-scale farming

One of the major opportunities for small-scale farmers to improve their income and enhance their livelihood is offered through their integrated crop and livestock production systems (Ryan and Spencer, 2001). Although not every small-scale farmer in Zimbabwe owns cattle, the majority of them have goats and sheep. Most of these farmers give priority to the crop production over livestock production (Homann and van Rooyen, 2007). This is mainly because they want to meet their household food security requirement first. This section discusses the advantages and disadvantages of crop-livestock systems to determine their overall potential for small-scale farmers.

2.5.1. Advantages of the integrated crop-livestock system

The major merits of integrated crop-livestock systems include are that livestock provides an important source of income, draft power, food security enhancement, risk-spreading and synergies between crop and livestock enterprises. Each of these is discussed separately**.**

2.5.1.1. Source of income

Livestock offers small-scale farmers opportunities to generate income through products like milk and meat. Further, this income can be generated regularly, augmenting the seasonal income generated by the crop. This improves the cash flow aspect their livelihoods (Ngongoni et al., 2006). Poor small-scale farmers with goats can meet short-term immediate needs for cash and meat. Farmers with cattle can also generate income through hiring out their cattle as draft power to those without for draft power purposes. (Homann and van Rooyen, 2007). Cash from livestock sales is also used for meeting other important household needs including education, family health and acquiring farming inputs.

2.5.1.2. Draft power

Despite the majority of small-scale farmers not having tractors, those with cattle can use their cattle for draft power to pull implements for their farming operations (Homann and van

Rooyen, 2007; Masere, 2011). Farmers without cattle are usually able to hire draft power from those who have cattle. However, cattle often only become available after their owners finish their own farm operations first, which may result in a late start of land preparation and other farming operations.

2.5.1.3. Food security

Livestock also contributes directly to household food security especially for very poor households. Cattle, goats and other stock provide meat and milk, which are particularly important to alleviating seasonal food shortages. As noted earlier, indirect benefits include income, from selling products like meat and milk that can be used to supplement food supplies when necessary. Milk and meat also improve the general nutrition status of households (Homann and van Rooyen, 2007).

2.5.1.4. Spreading agricultural risk

Integrated crop-livestock production systems help small-scale farmers spread the risk of loss and failure, in that if the part or all of the crop production enterprises fails, small-scale farmers have their livestock production to fall back on, and vice versa. This is unlike a situation where farmers are concentrating on one enterprise where if it fails they do not have that sort of insurance offered by having both crop and livestock enterprises.

2.5.1.5. Stringent market standards

Standard of markets for selling products like milk are usually stringent for small-scale farmers to meet, as such they are excluded from commercial markets for milk products. Homann and van Rooyen (2007) propose the development of markets that also suit small-scale farmers so that they can get appropriate rewards from their livestock.

2.6.Conclusions

The paper suggests that small-scale farmers cannot be adequately defined based solely on land size but other attributes like net profitability, standard gross margins and resource endowment should also be incorporated. Further other non-agricultural factors like political and historical development of countries like Zimbabwe also affect how the small-scale farming system is constituted.

The paper highlights the major distinct characteristics of small-scale farming systems as a low cost technology oriented subsector, located in semi-arid regions, low productivity with priority given for ensuring household food security before surplus can be sold. Further, small-scale farmers are in their current circumstances not out of choice but due to challenges including farm size, lack of adequate information about modern technology, lack of input and output markets, poor road networks and lack of credit facilities to help expand their level of productivity.

Small-scale farmers have numerous strengths which they use to improve their food security including family labour and multiple cropping systems which spread risk of complete crop failure while simultaneously conserving natural resources by reducing crop yield losses due to weeds, pests and diseases as well as soil erosion. These strengths mean that small-scale farming is low cost and thus more profitable since more crops can be harvested per unit area under multiple cropping than under sole cropping.

Integrated crop-livestock systems present a great opportunity for small-scale farmers to improve and enhance their household food security directly through meat and milk and indirectly through regular income from selling milk and meat. However, this opportunity should be supported by the availability of adequate information about modern technologies including having their benefits demonstrated to the farmers. The paper also suggests that markets be made available for small-scale farmers to sell their produce in order to realise the best benefits from their animals and crop produce. The paper documents the complimentary attribute of crop and livestock production enterprises including crop residues being used to make home mixed feeds while the livestock by-products like manure and draft power for cultivating croplands are animals benefit crop production.

Small-scale farmers' dependence on traditional indigenous knowledge should not be taken to mean that they are illiterate as some studies reported. The paper showed that most small-scale farmers have been educated to at least primary school level and in Zimbabwe some have been trained informally by extension workers about various aspects of farming. Further, extension and farmer to farmer extension are the most modes of sharing and disseminating relevant information and technologies.

While it is useful to have a working definition of small-scale farmers and to understand the nature of their strengths and weaknesses, it is perhaps more useful to be cognisant of their individual characteristics within a framework of factors including the farmers' primary purpose for farming, their level of self-reliance, their production paradigm, and their technology paradigm. These factors, in the context of the land sizes, and the other constraints they face will enable extension to plan appropriate support.

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CHAPTER 3: Agricultural extension in Zimbabwe and its influence on technology adoption by small-scale farmers

Based on a paper submitted for publication in
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Abstract

This paper presents the findings of a study of Zimbabwe's extension services. It explores the successes and challenges regarding technology adoption and various extension approaches previously and currently used in Zimbabwe. The paper discusses challenges faced by Zimbabwe's primary public extension agency, – the Department of Agricultural, Technical and Extension Services (AGRITEX) – and how these challenges affected services to small-scale farmers. The study found AGRITEX's major challenge to be poor funding. This cascaded into multiple problems including: high turnover of experienced, competent and skilled staff; high influx of inexperienced and incompetent staff rushed to replace the experienced and competent staff; lack of in-service training for the inexperienced workers; and lack of transport for workers to reach many farmers. Consequently, services offered to small-scale farmers were compromised, which led to poor adoption of recommended technologies. Beyond AGRITEX's challenges, the study also determined key factors influencing technology adoption: the farmers' circumstances; the operating environment; and the attributes of technology itself. As a lasting solution to poor technology adoption, an extension system that promotes building the capacity of extensionists and researchers, and embraces farmers and their indigenous knowledge, is proposed. In this extension system, farmers' views, experiences and perspectives are taken into consideration in developing and testing technologies which could improve technology adoption. A key factor in all of this is the trustworthiness of the extension service as it engages with the farmers.

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

3.1. Introduction

Zimbabwe's primary agricultural extension agency, the Department of Agricultural, Technical and Extension Services (AGRITEX) has experienced multiple challenges since its inception. AGRITEX mainly services small-scale communal farmers and, until recently, the newly resettled farmers. 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. AGRITEX failed to build on this knowledge and practices.

Drawing on the Zimbabwe experience, the study sought to shed light on the role of extension (agencies and their workers) in technology adoption by small-scale farmers and to create a framework for a lasting solution to the technology adoption issue. The envisaged framework must incorporate "the collective knowledge of key role players" (Ngomane, 2010, p. 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 & 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.

3.2. Theoretical Framework: Defining Agricultural Extension

The definition of agricultural extension has been much debated over the years. Earlier definitions focused on transfer of agricultural knowledge, information, skills and technology for the purpose of improving farm productivity. Then, definitions began to include a bottom-up flow of information in the form of feedback from farmers to experts; a top-down flow of agricultural technologies or information from technocrats to farmers and a bottom up flow of information from the farmers to technocrats (Pazvakavambwa & Hakutangwi, 2006)

In recent debates, the role of farmers in the extension exchange has been given more prominence in definitions of extension. Birner et al. (2009) and, similarly, Davis (2008) view agricultural extension as a process whereby all stakeholders are involved in problem-solving and acquiring advice in terms of technologies and information for the betterment of farmers' livelihoods.

Adding another dimension, Rivera and Qamar (2003) suggested extension can no longer be viewed as a rigid discipline; but as a knowledge and information support function. They defined extension as a combination of learning methods, facilitation and advisory services which depend on other services such as marketing and credit facilities operating under prevailing economic policies and physical infrastructure for it to be successful (Rivera & Qamar, 2003). Similarly, Worth (2014) frames extension as a “conversation aimed at building the capacity of the farmer to engage in scientific enquiry” (p. 91) around agricultural production, farm management, agricultural economics, and social and environmental sustainability.

3.3. Purpose

This paper presents an overview of extension in Zimbabwe, including extension approaches previously and currently in use, and explores the successes and challenges of each approach. The paper also identifies challenges faced by AGRITEX and discusses reasons for poor adoption of technologies they recommend to small-scale farmers. Thus, the study sought to shed light on extension’s role in technology adoption by small-scale farmers, and to create a framework for a lasting solution to the technology adoption issue.

3.4. Methods

The paper reviewed literature, technical reports, government policy and relevant secondary data. Data were filtered through the extension carousel (Worth, 2014) to distill 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 approach regarding technology adoption. Additional major factors influencing technology adoption were also investigated.

3.5. Findings

3.5.1. Agricultural extension in Zimbabwe

AGRITEX is responsible for public rural agricultural extension. It falls under the Ministry of Agriculture Mechanization and Irrigation (MAMI) and is represented at 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 (Hanyani-Mlambo, 2002). 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 small-scale farming sector and recently on resettled farmers.

3.5.2. Problems and challenges facing agricultural extension agencies

Most extension systems in developing countries are faced with several multifaceted problems. These problems include lack of appropriate technology, top-down approaches, poor remuneration and incentives for extension staff, and weak or no linkages among researchers, farmers and extension staff (Davis, 2008).

Extension services offered in developing countries have been deficient regarding accuracy, relevance and applicability to farmers' problems (Agholor, Monde, & Odeyemi, 2013). There are two main reasons for this. Firstly, extension agencies pursue top-down extension approaches that discourage farmer participation in stages of identifying and defining problems through to developing solutions. Secondly, these agencies, including AGRITEX, recommend outdated technologies – some of which were discovered and developed two decades ago (Hanyani-Mlambo, 2002). It has been observed that this practice has continued to this day.

One of the major challenges confronting most developing countries' extension systems is poor government funding. (Mugwisi, Ocholla, & Mostert, 2012). In Zimbabwe, MAMI, the parent ministry of AGRITEX, is financed from the fiscus which has been restricted over the last 10-15 years due to the country's economic crisis. MAMI also funds other agencies additional to AGRITEX, straining the budgets even further. Thus, allocations to AGRITEX are inadequate. Donor funding previously available to augment budgets, has since been withdrawn due to the 'unstable' political environment experienced by Zimbabwe over the last decade (Mugwisi et al., 2012).

Inadequate funding resulted in several of challenges, particularly, poor remuneration of extension workers and poor operational resources (e.g. transport to reach farmers

(Mugwisi et al., 2012). This de-motivates workers who 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). 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).

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), MAMI acknowledged that some farmers were not willing 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 would be adopted (Mika & Mudzimiri, 2012). In such cases, farmers tended to rely on their own indigenous experiments or advice from other farmers (Hanyani-Mlambo, 2002).

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 IK is multi-dimensional and appear 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 can be summarised into three definitions which are 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 period of 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 (Nyiraruhimbi, 2012).

The Zimbabwean small-scale farmers have useful experience in devising new technologies; this could be tapped provided they have support from research and extension (Hanyani-Mlambo, 2002; Masere & Worth, 2015). However, this has not been the case in

Zimbabwe. AGRITEX have failed to identify and disseminate successful informal technologies developed by farmers or to build on them (Hanyani-Mlambo, 2002). The primary reason for such a poor exchange and flow of information and technologies is lack of communication and poor linkages among researchers, extension workers and farmers (Mugwisi et al., 2012).

3.5.3. 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; at the time 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 (Nhongonhema, 2010). Further, a number of different extension players emerged after independence.

Top-down extension approaches. 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. 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 to construct contour ridges and storm drains, and were prohibited from pulling sleighs. The main objectives were to protect natural resources and minimize soil erosion. 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). 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, 2001; Marume, 2010). It was used as a cost-effective means of increasing coverage of small-scale farmers with extension messages (Chowa, 2010). At its inception, GDA enhanced diffusion of extension messages in previously inaccessible areas (Hanyani-Mlambo, 2001; Marume, 2010). GDA ostensibly included and accommodated large numbers of farmers (Chowa, 2010). However, GDA had two major constraints: channeling 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, 2001, 2002).

Radio listening group (RLG). RLG involves farmers gathering in teams to listen to extension radio programs targeting their specific geographic areas (Mudiwa, 1997). 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 which the farmers were expected to spread to other farmers. 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. These schemes remained at the core of AGRITEX's work Mutimba (1997), and over 300 000 master farmers and up to 50 000 advanced master farmers across Zimbabwe have been trained (Pazvakavambwa & Hakutangwi, 2006).

Despite the general success of the master farmer training schemes, the approach has some notable drawbacks. It appears to favor the few better-off farmers over the majority of poor (communal) farmers, thereby increasing the income gap between the rich and the poor (Mutimba, 1997). 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 (Chowa, 2010) not dissimilar to the approach and outcomes of the Indian Green revolution (Suri, 2006).

The training and visiting (T&V) system. The T&V system was developed for the World Bank by Daniel Benor to improve effectiveness of agricultural extension services through comprehensive, structured training, delivery and administrative systems (Hanyani-Mlambo, 2002). This system involved training frontline extension agents by subject matter specialists; extension agents passed on the new skills, information and technologies to farmers (Anderson, Feder, & Ganguly, 2006). Extension agents were expected to transfer standardized 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 (Anderson et al., 2006; Hanyani-Mlambo, 2001). The T&V system was one of the major approaches used in Sub-Saharan countries, and is still the main extension approach in Mozambique (Alage & Nhancale, 2010). This 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 the resource-constrained (Chowa, 2010).

Commodity based approach. The commodity based approach centralizes all the functions (extension, research, input supply, marketing and pricing) of a particular commodity under one administration and usually comprises an interdisciplinary staff compliment that partner with farmers who grow the crop and sell it to the administration or company. In return, the company supplies extension, inputs, credit, quality management (standards) and marketing services, and loan repayments collection (Owens & Westbrook, 1976).

In Zimbabwe, this approach is usually organized through parastatal organizations or private firms with 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 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. Despite the success of this approach, it had one major disadvantage in that the organizing 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 (Owens & Westbrook, 1976; Hanyani-Mlambo, 2002).

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 analyzing farmers' agricultural systems to identify problems and develop solutions (Hanyani-Mlambo, 2002).

The Kuturaya "Trying" project. The Kuturaya project in Chivi district, Masvingo Province, is one example of the success of participatory approaches in Zimbabwe. It was driven by the UK Intermediate Technology Development Group (ITDG) and the German Development Cooperation (GTZ). It was used mainly for promoting adoption of soil and water conservation techniques. Farmers organized themselves into groups of 70 to 80 which then participated in identifying local soil and water conservation technologies to promote within the project area. 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. Eventually, farmers would adapt 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, 2001). FSRE was developed in response to the limitations of earlier extension approaches such as T&V and master farmer training schemes, which while technically correct, what they offered and the way they offered it was not relevant to small-scale, resource-constrained farmers (Mettrick, 1993 as cited in Hanyani-Mlambo, 2002). FSRE, however, centered 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, 2001). The major drawbacks of this approach included that it was slow in incorporating its findings into actual practice, and that it required more resources (time, funds and effort) to meet the varying specific requirements of different farming systems (Hanyani-Mlambo, 2001).

3.6. Towards an Appropriate Extension Approach for Zimbabwe

The plethora of top-down extension approaches and the few participatory efforts employed by pre- and post-independent Zimbabwe have clearly not lead to effective technology adoption (Marume, 2010). This is explained partly by virtue of the nature of being top-down; that, by design (most notably being centralized), top-down approaches exclude the very farmers they aim to assist (Tuttle et al., 2013). It can also be explained by the resource-endowment differentials and the heterogeneity of the geological locations of farmers, which centralized, top-down approaches cannot easily accommodate because they "tend to include a selected, easily accessible population while neglecting the input of more marginalized communities" (Tuttle et al., 2013, p. 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. Rather, 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. It is further proposed that the conventional separation of extension approaches be abolished. Through integrating theory-based, competence-based, experiential learning, and capacity development paradigms the process can be transformed into a system of extension and research that operates as a complex, but unified adaptive system (Pant, 2012), that draws on the capacity of extension and researchers alike, and uses local knowledge and deliberately includes, rather than marginalizes, farmers (Tuttle et al., 2013). In this way, not only will the objectives of both farmers and researchers be achieved, but, rather than creating dependency, which is often an outcome of top-down approaches, self-reliance and self-confidence are fostered among farmers (Tuttle et al., 2013).

3.6.1. General reasons for poor technology adoption by farmers

Akudugu, Guo, and Dadzie (2012) found that the factors that influence technology adoption can be generally "categorized into economic factors, social factors and institutional factors" (p. 9). Table 1 shows their categorization of these factors.

Table 1

Factors influencing technology adoption

Economic factors	Social factors	Institutional factors
• Farm size • Cost of the technology • Expected benefits from • the technology • Off-farm activities	• Age, • Level of Education • Gender	• Access to information • Access to extension services

Note. Adapted from "Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decision," by M. A. Akudugu, E. Guo, and N. Dadzie, 2012, *Journal of Biology, Agriculture and Healthcare, 2*(3), p. 6.

Similarly, Abdullah and Samah (2013), citing Truong (2008) divided the factors between "Factor related to household conditions" and "Factors outside household conditions" (p. 122). Table 2 captures the 'household' factors. Table 3 captures the 'outside household' factors.

Table 2

Household factors affecting technology adoption

Factor	Influence
Education	Educated farmers want to see the benefits of new technologies Educated farmers are better able to acquire knowledge and information.

Farmers' perception	Preference for traditional methods Concern that new technology may lead to yield losses
Capital/poverty	Cost of technology limits adoption
Age	Young farmers more likely to adopt new technology rather than older farmers
Ethnicity	Often related to poverty and marginalization; poverty limits time needed to learn (and adopt) new technologies
Gender	Women are less exposed to technologies; this leads to disagreements with their husbands over using technologies.
Land size	Farmers with smaller land sizes are less likely to new technologies as smaller farms require less advanced technologies
Family labor	Less family labor limits the use of new technology; particularly relevant to young farmers

Note. Adapted from "Factors impinging farmers' use of agriculture technology," by F. A. Abdullah, and B. A. Samah, 2013, *Asian Social Science, 9*(3), p. 122.

Table 3

Outside household factors affecting technology adoption

Factor	**Influence**
Training	Training offered too far from farmer inhibits adoption
Extension personnel	Poor extension/farmer ratio (numbers and commitments) reduces technology adoption.
Extension's capacity to convince farmers	Weak capacity (personal or resources) inhibits adoption
Infrastructure and ecosystem	Greater infrastructure (e.g. irrigation and roads) improves adoption
Information	Available and suitable (relevant) information encourages adoption
Site of training organization	Location of trainings should be near to the farmers' settlement.
Associations	Working through established farmer associations increases adoption
Market price	Good market prices positively influence adoption
Advertisement and marketing	Use of trusted and reliable media (e.g. radio and television) increases adoption
Neighbors	Farmers tend to imitate one another
Clinics	Availability of clinics leads to increased health awareness in farmers, which positively influences adoption

Note. Adapted from "Factors impinging farmers' use of agriculture technology," by F. A. Abdullah, and B. A. Samah, 2013, *Asian Social Science, 9*(3), p. 122-123.

Chi and Yamada (2002) identified the following reasons for failure by farmers to adopt technologies offered to them by extension:

- Lack of trust in the technologies because they are new to them;
- Concern that the technologies might result in lower than current yields;
- Low education levels;
- Older farmers are reluctant to change from their own ways and experiences of farming;
- Uncertainty of how they must apply technologies;
- Lack of capital and credit facilities to acquire and utilize technologies;
- Lack of credibility of the extension workers introducing the technologies including a good rapport with farmers, intelligence, empathy and ability to communicate;
- Tenure status of the farmer; technologies with a long payback period are less likely to be adopted by farmers with short-term land leases; and
- Social pressures.

3.7. A brief Assessment of Zimbabwe's Extension Service

The framework posited by Worth (2014) in his carousel, suggest that technology adoption should be seen in the context of opportunity, knowledge and skills grouped around farmer capacity relative to the practical aspects of the farm enterprise, the social and economic sustainability context and the overall learning and developmental context within which the farmer operates. The primary issue is not so much the adoption of technology, but the capacity of the farmer to make informed decisions about technology that are appropriate to the farmer's perception of his/her circumstances. Whether the technology is or is not adopted is secondary to ensuring that the farmer has made a conscious, informed decision that reflects the farmer's understanding of his/her farm enterprise in the context of the his/her aspirations and social and environmental circumstances (Worth, 2006; 2014).

Using this framework, information gathered on AGRITEX indicates that it places more importance on technology adoption than the development of farmers' capacity to take charge on factors affecting their operations and livelihoods. Instead of embarking on farmer capacity building interventions and building on the experience and knowledge of farmers, AGRITEX pushed technology adoption by imposing technologies deemed to improve productivity. This is evidenced by the use of blanket recommendations or 'one-size fit-all' approaches they used in disseminating the same technologies to farmers in different agro-ecological regions (Masuku, 2011). For instance, cattle farmers in the dry regions of Matebeleland were prescribed similar intervention programs and technologies (maize seeds and fertilizer) prescribed to crop production farmers in high rainfall areas, where livestock production inputs would have been appropriate (Masuku, 2011). Furthermore, most of the technologies recommended by AGRITEX were developed for conditions which were foreign to farmers' condition. Although AGRITEX embarked on participatory approaches in an attempt to understand farmers' views and perceptions on their problems and potential solutions, the actual level of participation has mostly been confined to mere testing of technologies in their fields. In most cases the technologies are developed without farmers' input.

AGRITEX operates mainly on the premise of pushing for technology adoption if they deem it technically correct or if it has been proven in other areas. In other words, the Zimbabwe's extension service is production oriented and pays less attention to social viability/acceptability (including cultural beliefs) as evidenced by the AGRITEX's dissemination of technology developed in other countries and for different conditions.

Extension agents and researchers generally perceive themselves as instructors, teachers and experts, whereas farmers are considered beneficiaries of technologies, students and, to some extent, minor partners in research. Thus, the nature of learning implemented by AGRITEX and its agents is mostly one-way, with little room for feedback. Thus, AGRITEX failed to build on farmers' indigenous knowledge and successful innovations. This one-way, top-down transfer of knowledge encouraged dependence on the part of farmers as they were not empowered to be self-reliant or to develop critical analytical skills to make their own decisions about adoption.

3.8. Adoption Process

As discussed above, many factors affect technology adoption. It is submitted that, for a technology to be adopted, all these factors have to be considered and the conditions met. These appear to happen in a hierarchical way, determined consciously or unconsciously by the farmer. When the most important adoption factor 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 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 risk. This is an iterative process where 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.

3.9. Conclusions

Zimbabwe's extension service (AGRITEX and its extension workers) has faced and continues to face multiple challenges which resulted in compromised service delivery to farmers. This, in turn, has led to poor uptake of the technology recommended to farmers. In fact, some farmers lost their trust of the extension workers. When farmers deem extension workers as an untrustworthy source of information, they are unlikely to adopt the technologies they recommend – they are unlikely even to be willing to investigate the technology. AGRITEX needs urgently to address the core issues affecting technology adoption by small-scale farmers so they are able to resume playing their crucial role in the process.

Among the core issues to be addressed are understanding and engaging with the specific range of factors influencing technology adoption: farmer circumstances; social and biophysical environment; and the attributes of a technology. Decisions to adopt a technology start with considering what he/she deems to be the most important factor, and once that factor or its conditions are met, he/she moves hierarchically through his/her factors until the last factor. However, the importance given to each of these factors depends on an individual farmer. A critical element is the actual capacity of the farmer (in terms of opportunity, knowledge and skills) to assess the technology recommended in the three-fold context of technical capacity, the sustainability and the learning – something which extension (AGRITEX) should work consciously to build.

AGRITEX also appears to have failed to build on successful indigenous knowledge of farmers. The main reason for this was lack of communication and poor linkages between farmers, extension and researchers. Unless these linkages are improved, technology adoption will remain poor.

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 mean to help, and failed to accommodate all farmers or take account of their unique capacities and circumstances, including knowledge, skills, resource endowments and geographical location. However, where and when implemented, participatory extension approaches resulted in success stories, albeit in small pockets – including development of farmer-driven technologies which led to improved technology adoption. Unfortunately, AGRITEX failed to build on this success through sharing the learning, the processes and their resulting stories with farmers in other parts of the country.

It is thus proposed that the conventional mutually exclusive application of extension approaches, whether they be participatory or top-down, be abolished in favor of a more holistic, competence-based, experiential learning, and capacity development system of extension and research (Pant, 2012). Farmers must be engaged and their capacity built in the context of their practical knowledge and skills, their sustainability and their ability to continue learning. It must also draw on and build the capacity of extension and researchers alike, and deliberately embrace farmers and their local knowledge. Then the issue of technology adoption is appropriately contextualized. 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 a 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. A key factor in all of this is the trustworthiness of the extension service as it engages with the farmers. Without genuine, earned and well-placed trust true extension cannot be achieved.

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CHAPTER 4: Role of extension in technology adoption and innovation by small-scale farmers

This chapter is based on a paper prepared for submission to the South African Journal of Agricultural Extension

ABSTRACT

The importance of agricultural extension in small-scale farming systems of developing countries cannot be overemphasised. Extension organisations and agents play crucial roles in transferring technologies to small-scale farmers for adoption and in fostering development of innovations from among diverse actors including farmers, research institutions, input suppliers, non-governmental organisations (NGOs), and donors. This paper explores the dynamic role of extension under both a technology adoption-based paradigm and a learning and innovation-based paradigm. In both paradigms (technology adoption-based and a learning and innovation-based), key qualities necessary for the role of extension agents to be successful are presented. The major difference in the extension roles under the two paradigms is in approach and main goal to be achieved. For technology adoption the approach is more of persuasion with the ultimate goal of accelerating the rate of adoption. Conversely, in innovation network systems the approach is to facilitate learning and stimulate actors to innovate based on their experiences with the eventual goal being development of innovation. Despite these differences, the key qualities for agents to be successful under both paradigms are similar and they relate to personal attributes, competencies related to training and hands-on practical experiences with farmers.

Keywords: Extension, Innovation, Small-scale farmers, Technology adoption

4.1. Introduction

The roles and objectives of extension have evolved over time. The main roles over the years has centred on the linear transfer of technology and information to farmers, on training, and on advising farmers on better decision making aimed at improving agricultural production (van der Ban & Hawkins, 1996). Oakley and Garforth (1985) added another dimension to extension objectives, focusing on development of the rural farmers and their livelihoods as opposed to purely economic accomplishments. They proposed extension workers engaging rural farmers in discussions about farmers' problems and assisting them in deciding how to tackle them. Similarly, Haug (1999) noted that extension should be centred on human resource and knowledge development.

Anderson and Feder (2003) suggested a dual extension role. On the one hand, extension helps to speed up dissemination of relevant technologies aimed at improving productivity from the farmer's fields, and, on the other hand, extension equips farmers to manage their fields and thus their livelihoods better (Anderson & Feder, 2003). In this way, the extension agent facilitates linkages between farmers and researchers/technology developers which can lead to development of technologies tailor-made for the biophysical circumstances and resource endowment of the farmers (Anderson & Feder, 2003).

The primary principle for any extension program should thus be a two-way flow of information between research, extension and farmers. This way, extension provides avenues for farmers to learn from the researchers and extension workers about alternative methods of increasing their farm production, improving their standard of living, and solving their own problems rather than to depend entirely on solution from the extension and researchers. The traditional classical extension agents' role of top-down technology and knowledge transfer creates dependence among farmers (Chowdhury, Odame & Leeuwis, 2014).

In light of the dynamic and evolving role of extension, there is a need to explore the contribution of extension agents in promoting technology adoption by small-scale farmers as well as their role in innovation systems. This paper is also aimed at identifying key qualities necessary for extension agents to be successful in technology adoption by small-scale farmers and for their role in agricultural innovation networks.

4.2. Theoretical framework

4.2.1. Extension Carousel of Learning and the Facilitated Learning Agenda (ECLFLA)

This is a broad framework that emphasise iterative learning in the form of an engagement in an extension conversation by farmers, extension and enablers (researchers, technology developers, donors) with the main learning areas centred on a range of production, economic and managerial factors (Worth, 2014). Production factors include land, technology, input supply and infrastructure. The economic factors comprise of finance and markets and marketing. The managerial factors comprise organisational capacity and information. The ECLFLA empowers farmers to take charge of issues that impact on their livelihoods by learning along two lines – "practical and command sweeps". The former evaluates the baseline status of the farmers' structures and the strength of farming systems, while the later involves evaluating, on the basis of self-reliance and dependence, issues of knowledge, skills and opportunity to take command of the practical element. Thus, the role of extension in the carousel is to deliberately drive the learning process (using a planned Facilitated Learning Agenda) with the two-fold objective of developing options to address problems and opportunities and of increasing capacity of farmers to command the learning process and to innovate in their farming systems. In this way, the extension plays the role of facilitator rather that the traditional role of transferring technology to farmers (Worth, 2014).

As facilitators in the extension conversation, extension agents should stimulate farmers' thinking and encourage farmers to develop solutions to their problems. Further, this facilitation by extension agents should trigger development of interactive patterns of farmers and other actors to attain certain goals (Ngwenya & Hagmann, 2011). However, Davis (2006) noted that the extension agents, in their role of facilitator, need not lecture the farmers but they should rather promote discovery learning where farmers learn for themselves. Thus the extension agent should be mostly concerned about farmers' personal development by helping them gain confidence in their systems. Similarly, Worth (2014) posits that the ultimate goal of extension in the carousel is not to accelerate technology adoption by small-scale farmers but rather offering a platform for building the capacity of the farmer to engage in scientific enquiry through building the farmer's capacity to learn.

4.1.2. Agricultural innovation systems

Innovations are necessary at all scales of operation, particularly in small-scale farming systems of less economically developed countries (Rivera, 2011). Initially, the concept of an innovation system was seen as the resultant product of interaction among stakeholders in a natural resource or ecosystem services (Rȍl ng & Wagemakers, 1998). Later on, innovation systems broadened to encompass multidisciplinary but relevant players focusing on solving a particular problem (Rivera, 2011). Hence, the World Bank (2007:6) defines an innovation system "as comprising the organizations, enterprises and individuals that together demand and supply knowledge and technology, and the rules and mechanisms by which these different agents interact".

An agricultural information system (AIS) is a "collaborative arrangement bringing together several organizations working toward technological, managerial, organizational, and institutional change in agriculture" (Anandajayasekeram, 2011:7). Similarly, Obiora and Madukwe (2014) defined an AIS as a set of organisations and individuals with capabilities to learn and share experiences resulting in the generation, dissemination and adaption of knowledge for socio-economic significance and scaling up successful strategies.

From these definitions it is clear that the AIS framework does not view innovation merely as a research driven activity culminating in technology adoption, but one centred on interactions of different actors, their ideas, attitudes, practices and learning, thus strengthening their skills to innovate (Hall, Sivamohan, Clark, Taylor & Bockett, 2001; Rivera, 2011). This concurs with Klerkx, Aarts and Leeuwis (2010:390) who noted that "in the AIS approach, innovation is considered the result of a process of networking and interactive learning among a heterogeneous set of actors, such as farmers, input industries, processors, traders, researchers, extensionists, government officials, and civil society organizations."

Agricultural innovation teams or networks are formed to deal with specific challenges and usually disband after the challenges or problems have been dealt with (Daane, 2010). The actors in the innovation systems should possess competencies beyond their professions including problem solving skills and commitment to mutual learning and knowledge exchange (Daane, 2010). The success of the innovation systems stems from interaction, dialogue or communication between innovation team members (Ngwenya & Hagmann, 2011). Agwu, Dimelu & Madukwe (2008) proposes set of assumptions that make up the innovation system concept and as well as the essential elements of an innovation system (Table 1).

Table 1: Assumptions and fundamental elements of an innovation system

Assumptions for an innovation system	**Fundamental elements of an innovation system**
Innovation is an interactive process embedded in the prevailing economic structure and this determines what is to be learnt and where innovation is going to take place.	The actors (organisations and/or individuals) involved are responsible for knowledge generation, dissemination, adoption and using the knowledge.
Innovation includes development, adaptation, imitation and the subsequent adoption of technology or application of new knowledge.	The interactive learning that occurs when organizations engage in generating, diffusing, adapting and using new knowledge and the way in which this leads to innovation (new products, processes or services).
Innovation takes place where there is continuous learning and opportunity to learn is determined by the intensity of interactions among actors.	The institutions (rules, norms, conventions, regulations, traditions) that govern how these interactions and processes occur.

Adapted from Agwu *et al*. (2008)

Both frameworks (AIS and ECLFLA) offer an innovation platform where partners or diverse actors engage in facilitated learning and dialogue to address issues of mutual concern. An innovation platform is defined by (Anandajayasekeram, 2011:11) as "a physical or virtual forum that creates an environment within which to share and discuss ideas, listen and learn, think and talk, and collaborate with a view to innovate". Innovation platforms are useful in exploring socioeconomic, biophysical and environmental strategies aimed at improving production, effective and sustainable management of natural resources (Homann-Kee Tui *et al.*, 2013 cited in Swaans, Cullen, van Rooyen, Adekunle, Ngwenya, Lema & Nederlof, 2013). However, Worth (2006) cautions that the long history of technology transfer has created inequality in the tripartite relationship of farmer, extension and research, with the farmer being the weakest member, thus requiring that extension take an active and deliberate role (through the creation of Facilitated Learning Agenda), in re-establishing equity in the learning partnership and in reinforcing the farmer's capacity to learn.

4.2. Technology adoption by small-scale farmers

Conventionally, extension provision involved a central source, usually a public funded, research centre generating knowledge and developing technologies which the researchers pass on to extension agents, who in turn pass them on to farmers for adoption (Biggs, 1990; Spielman, Ekboir, Davis & Ochieng, 2008; Zhou, 2008). However, adoption of the technologies by farmers is usually not simple, quick or automatic. Guerin (2000) noted that adoption is a process which involves a series of tasks including collection, integration and assessment of new technologies and knowledge on the basis of risk and uncertainty over time.

Role of extension in technology adoption by small-scale farmers

A major role of agricultural extension in developing countries has been to disseminate technologies generated by public sector research organisations to farmers through a plethora of strategies such as demonstrations, field visits, farmers' meetings and the use of media (Zhou, 2008). This was based on the backdrop assertion that increased agricultural productivity primarily depends on adoption of recommended scientific technologies by small-scale farmers to replace their traditional practices (Aphunu & Otoikhian, 2008). This assertion fits a linear model of top-down technology or information transfer designed by technocrats and experts and disseminated by extension agents for adoption by farmers

(Rogers, 2004). To achieve this role, extension agents had to raise awareness of the farmers through promotion of new technologies including new crop and farm management methods (Anderson & Feder, 2003; Pannell, Marshall, Barr, Curtis, Vanclay & Wilkinson, 2006; Aphunu & Otoikhian, 2008). In this way, extension was also trying to accelerate technology adoption by the small-scale farmers. A positive correlation between technology adoption and farmer contact with extension agents have been noted (Aphunu & Otoikhan, 2008; Adesiji, Akinsorotan & Omokore, 2010).

Extension plays the critical role of linking research institutions and technology developers with the farmers. Thus extension agencies are important to bridge the gap between relevant research findings and the information and knowledge requirements of the farmers (Adesiji *et al*., 2010). Further, the extension helps technology developers and researchers to establishing tailor-made technologies suited to farmers' problems, their biophysical environment and resource endowments (Anderson & Feder, 2003). This, in turn, increases the likelihood of adoption of such technologies as they are developed specifically for the farmers' circumstances. This concurs with findings by Asiedu-Darko (2013) that farmers find it easy to adopt technologies with traits associated with their traditional practices.

Key qualities for extension to be successful in technology adoption by farmers

There are a number of qualities that an extension agent should possess in order to be effective in their role in technology adoption by farmers. Aphunu and Otoikhan (2008) identified the main qualities to be an ability to communicate, attitude and commitment to extension work including frequency of contact with farmers. These qualities should be evaluated from the farmers' standpoint.

First and foremost, an extension agent must be formally trained for the position and equipped with technical knowhow to help farmers. Regular training, in the form of workshops, seminars, conferences and in-service training incorporating pertinent adult learning principles for extension agents are ways to enhance extension agents' effectiveness in disseminating technologies to farmers for adoption (Aphunu & Otoikhian, 2008). Anderson and Feder (2003) and Chowdurry *et al*. (2014) also postulate that extension agents require soft skills that transcend formal technical skills to enable them to develop affective domains of learning and influencing how farmers can solve their problems and how they can use their resources efficiently.

In order for extension agents to work well with the small-scale farmers, they must have empathy for the farmers and respect to their knowledge and skills (Guerin, 2000). Some extension agents do not respect small-scale farmers whom they perceive to be illiterate, ignorant of 'progressive' agricultural methods and mere recipients of their information and technologies (Guerin, 2000). This lack of respect for the farmers and their indigenous knowledge or practices often leads to poor adoption of the very technologies disseminated by agents (Asiedu-Darko, 2013). Thus extension agents need to embrace the knowledge of the farmers and have wisdom in communicating and disseminating technologies to them.

Extension agents should have the trust and credibility of the farmers before they can introduce new technologies to the farmers. However, trust and credibility have to be earned, and they are "developed over time through the provision of credible, practical, useful answers that assist farmers in day to day operations" (Vanclay, 2004:221). A trusted extension agent may thus be allowed to help the farmers make certain important decisions including trying out the technologies before actual adoption. Conversely, extension agents who do not usually offer advice to farmers may fail to develop any credibility with the farmers and their ideas or technologies they disseminate are easily dismissed (Pannell *et al*., 2006).

An extension agent should be able to comprehend the cognitive styles of his/her farmers. This is important as it helps the agent decide how to package and disseminate information and different technologies to an individual or group of farmers, thus making the agent more effective in his role (Guerin, 2000). For example, the agents may identify opinion leaders, develop credibility and trust with them and later on provides them with new information and technology to quickly pass on to other farmers.

Extension agents also need to be self-confident and motivated to do their job. In order for agents to sell their technologies to be farmers they have to be convincing and sure of themselves (Oakley and Garforth, 1985). In this way, they can inspire confidence to farmers they are disseminating technologies to. Without faith and confidence in agents meant to advise them, there is little or no chance that farmers would adopt the technologies recommended by such agents (Mika & Mudzimiri, 2012).

4.3. Innovation network system

An innovation network system is centred on a non-linear interactive networking, learning and negotiation among farmers, extension agents, input suppliers and researchers (Davis, Ekboir & Spielman, 2008; Spielman *et al*., 2008; Klerkx, Hall & Leeuwis, 2009). As noted by Fahmid (2013), an innovation system helps in knowledge creation, sharing and accessibility among actors, simultaneously encouraging the learning process. This learning arrangement empower farmers to take a lead in experimentation, communication and organization; and require major changes in the attitudes and roles of researchers and extension workers so that they view farmer innovators as equal partners, possessing different experiences and skill set to theirs (Katanga, Kabwe, Kuntashula, Mafongoya & Phiri, 2007). Thus, the aim the innovation network system, as highlighted by Ngwenya and Hagmann (2011), is one of placing the farmer at a stronger position of creator of knowledge as opposed to the usual weaker position of beneficiary in the technology and knowledge generation process under linear extension systems. This assertion by Ngwenya and Hagmann (2011) meant that researchers and extension officers have to cede some of their power to the farmers. These innovation systems were noted to have led to confident building of the farmers and revival of traditional knowledge in Zimbabwe (Haug, 1999).

Role of extension in innovation network systems

In innovation frameworks (AIS and ECLFLA), someone must take charge of the innovation platform, through facilitating and linking all the multiple diverse actors, for the interactive learning process to be successful. This role is well suited to extension organisation/agents (Navarro, 2006; Hellin, 2012; Swaans *et al*., 2013), who have the ability to maintain an open interactive process where actors engage and learn from one another. In such a setup, the role of extension agents changes from the traditional one of being "bringer of new technology/knowledge" to being the "guide to multi-actor innovation projects" (Beers & Sol, 2009). In other words, the extension plays the role of an innovation broker.

An innovation broker refers to an agent in any aspect of the innovation process between multiple actors (Howells, 2006). Furthermore, Klerkx *et al*. (2009) defined innovation brokers as persons or organisations playing a catalytic role of bringing multiple diverse actors together and facilitating their interactions resulting in the development of innovations. To achieve their role in the innovation process, Swaans *et al*. (2013) proposed a number of important functions the innovation brokers (extension agents) have a number to perform (Table 2).

Table 2: Functions and duties of an innovation broker in an innovation system

Role of innovation broker/extension workers	**Description of duties**
Facilitation	Convenes and manages regular meetings to identify key constraints and strategies and ensures that all members can express their views. The facilitator fosters relations among actors and coordinates interactions and collective learning.
Linking and strategic networking	Links diverse but relevant actors and invites them to collaborate in platform activities including mobilizing support and resources for innovation network activities.
Technical backstopping	Provides technical advice or links the innovation platform to others who can provide that information including soliciting further studies or consultations when the need arises.
Mediation	Prevents and/or addresses possible power struggles that may arise as a result of diverse actors who may perceive each other as competitors wanting to monopolise the innovation process.
Advocacy	Help the platform to advocate for an enabling environment including policy changes, stimulating new relationships among the actors, and getting the support of those who matter to the platform.
Capacity building	Most network members may not be equipped with the technical, organizational and management skills to play their role in the platform effectively. The broker may link the innovation platform to training institutes and organize exchange and exposure visits.
Management	Sometimes the broker may be required to manage the innovation network activities including finances and communication with the donor.
Documenting learning	Documents the learning process and report back to innovation actors and other important parties.

Adapted from Swaans *et al* (2013)

Similarly, Klerkx *et al*. (2009) identified and summarised roles performed by an innovation broker into three main functions namely demand articulation, network composition and innovation process manager (Table 3).

Table 3: Three main functions of an innovation broker

Innovation broker function	Description
Demand articulation or knowledge orchestrator	Articulating innovation needs and visions and the corresponding demands in terms of technology, knowledge, funding and policy.
Network composition or sense maker	Facilitating linkages among relevant actors (scanning, scoping, filtering, and matchmaking of possible cooperation partners).
Innovation process management or mediator	Enhancing alignment in heterogeneous networks of actors with different objectives, institutional norms, values, incentives, and reward systems. This is a continuous activity that involves boundary management, translation, and mediation to build trust, establish working procedures, foster learning, and manage conflict and intellectual property

Adapted from Klerkx *et al*. (2009)

Another similar set of roles played by innovation brokers is provided by Johnson (2008) who identified five vital roles within the innovation network (Table 4).

Table 4: Innovation brokering roles

Innovation broker role	Description of Role
Mediator/arbitrator	This is important when dispute arises. Disputes may stem from the collaborative nature of innovation networks where various actors from different backgrounds may sometimes fail to cooperate or agree on certain issues.
Sponsor/funds provider	Allows for distribution of funding to potential worthy innovation development programs.
Filter	Vetting for feasible innovation developments and also legitimising weaker actors within the innovation network
Technology broker	The broker helps 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 in the innovation network.
Resource/management provider	Management of the collaborative innovation processes and results

Adapted from Johnson (2008)

Extension agents in their role of innovation brokers engage farmers in problem diagnosis and foresight exercises for farmers to clearly identify their knowledge demands (Hermans, Stuiver, Beers & Kok, 2013). Thus, innovation brokers make easy developments of linkages between farmers and other partners which can lead to a healthy exchange of information to develop innovations. In fact, Klerkx and Leeuwis (2009) liken the innovation brokers as the glue holding an innovation team or network together. They achieve this by taking it upon themselves to manage the day to day innovation network issues including dispute resolution and building trust (Kingsley & Malecki, 2004).

The main factor hindering innovation in Europe was found by Klerkx *et al*. (2009) to be lack of coordination. Similarly, African agriculture has a long history of disconnected agricultural innovation systems (Clark 2002; Tesfaye, Puskur, Hoekstra & Azage, 2010). Further, Hellin (2012) noted that farmers rarely self-organise or work collectively. This highlights a need for extension organisations/agents to manage of the innovation systems if meaningful success is to be realised in agricultural innovation systems. As shown in Tables 2-4, all the three sets of roles of innovation brokers concur that the innovation broker must manage the interactive innovation system, strengthening and building the capacity for effective engagement of all the actors. However, Devaux, Andrade-Piedra, Horton, Ordinola, Thiele, Thomann and Velasco (2010) cautions against innovation brokers taking over management and ownership of the innovation process from the actors. Similarly, the European Network for Rural Development (ENRD) (2013) postulates that the broker needs to drive the initiative and support partnership formation in the initial vulnerable steps but gradually the responsibility is to be shared among actors according to the agreed and clearly defined roles for each actor.

All the three sets of roles of innovation brokers indicate several potential benefits the innovation brokers (extension workers) can have in an interactive innovation network system. Firstly, brokers act as catalysts via their demand articulation role of forging connection with all actors involved and facilitating during collaborative innovation process (Howells, 2006; Klerkx & Leewis, 2009). Without effective facilitation tensions are inevitable in innovation networks due to the very nature of innovation involving diverse actors often having conflicting interests. For this reason, Klerkx *et al*. (2009) noted that brokers will forever need to play a balancing role.

Secondly, extension agents as innovation brokers help reduce uncertainty associated with the infancy stages of innovation processes when there is a high risk of failure that could potentially preclude actors from innovating (Johnson, 2008; Madzudzo, 2011; ENRD, 2013). Madzudzo (2011) noted that brokerage is very important during the early stages of innovation where innovation capacity is at the weakest stage as a result of the “inward looking practices” of the actors. Thus an innovation broker should have wider and inclusive perception to enable the creation of platform that warrants conditions for multi-actor interactions (Madzudzo, 2011).

Thirdly, extension agents play an important role of translator in ensuring that all the actors understand each other. This role involves using a language that is understood by farmers and other actors including researchers (ENRD, 2013). Thus the barrier of language or technical jargon will be eliminated as different cultural and educational classes can be able to communicate through the translator (Klerkx, 2012).

Qualities/attributes of extension in innovation

In order for innovation brokers to effectively play their key roles in interactive innovation systems they need to possess particular qualities or skill set. Swaans *et al*. (2013) identified a number of qualities including

- Being flexible and natural networkers;
- Ability to foster cooperation and partnerships among actors;
- A strong and wide personal network;
- Ability to effectively manage relations over time;
- A good sense of power dynamics;
- Conflict management capabilities;
- Good listener;
- Group facilitation skills; and
- The ability to consider broader system dynamics

Similarly, Ingram (2008:414) posits that extension workers, in their role as innovation brokers need to possess good communication skills, ability to empathise, listen and value farmers and other actors' insights, impartial and technically competent. Ngwenya and Hagmann (2011) added that some of the skills required for effective brokering cannot be achieved by modular training but learning by doing.

Another similar set of key qualities for an innovation broker were given by ENRD (2013) and these relate to knowledge in the specific field, technical skills, specific working approach and soft skills related to working attitude and style (Table 5).

Table 5: Key sets of qualities for the success of innovation brokers

Quality set	**Description**
Knowledge in the specific field	Can be acquired through learning or hands-on experience in the field. Brokers should be actively involved in knowledge networks in order to have access to the required information and be able to find actors useful in a specific partnership.
Technical skills	They are acquired through training. They include communication skills which important to effectively communicate to and deal with a range of very different stakeholders including scientists, technicians, manufacturers, farmers. This set of skills includes aspects of external communication like dissemination of information.
Specific working approach	These relate to operational procedures increasing the effectiveness of the brokering process. Innovation brokers should ensure transparency in the innovation process. The partners will need to be well aware in advance of their role. Broker should drive and not dominate the process.
Soft skills related to working attitude and style	They are not easily acquired through learning or training. They include result and action orientation, positive “out of the box” thinking, critical reflection, vision and direction, autonomy, self motivation, empathy, listening, social skills, social awareness, ability of anticipate risky and to handle uncertainty, independent and impartial.

Adapted from ENRD (2013)

The identified key qualities necessary for the innovation broker or extension by Ingram (2008), Swaans *et al.* (2013), and ENRD (2013) can be consolidated and summarised into classified into three broad categories namely personal attributes, competencies related to training and working experience.

Personal attributes are more to do with traits of the individual as opposed to technical training for the job. They include open mindedness to accommodate and learn from diverse views of actors, right attitude towards farmers and work, self-confidence and motivation, humility and respect to farmers and other actors, empathy for the farmers, ability to relate or fit in socially (not a social misfit) with farmers. The agent should also be a good listener, an encourager and someone who takes initiative. Personal attributes of the broker or extension agent alone can determine whether the innovation process is going to be successful or not.

Training related competencies refers to those skills that are obtained mainly through undergoing specialised training. These include technical skills in a specific field, for example skills obtained through a diploma or degree may be sufficient to equip an extension agent with the technical competencies to do his/her job. Some of the skills that the agents are supposed to learn or be trained on include communication skills (including facilitation skills), adult education theories and code of conduct (about professionalism including how to be impartial in his/her work). These are mandatory skills in which any agent must be trained before he can work with farmers. Worth (2006) argues that beyond the facilitation and related skills commonly associated with extension, extension workers require training in the application learning theory implying that, in the same way they broker innovation, they broker farmers' capacity to learn, they broker enhancing their status among role-players and they broker farmers taking conscious command of the factors influencing their farming and livelihood systems.

Work experience often results in agents accumulating certain qualities which they could never have acquired through natural ability or formal training. Hands-on practical experience results in the development of fruitful relationships with farmers and other actors like researchers, input suppliers, NGOs and donors. Such relationships help in building trust and credibility of the extension agents in the eyes of the farmers and other actors. Thus, it will be easier for extension agents to facilitate, drive the innovation process as well as to mediate, if need be, because he/she is trusted by the actors. Further, the agent can thus be able to translate between actors of different cultural backgrounds because of his/her working experiences with network actors. In other words, the extension agent is like the "common denominator" between network actors.

4.4. Conclusions

The role of extension is critical in small-scale farming systems, be it in promoting technology adoption by the farmers or in innovation network systems within a learning paradigm. This paper clearly indicates that the role of extension and, in particular extension workers, is dynamic and changes depending on current situation. If the situation calls for technology adoption, the role is more of technical advisor who use persuasion and links farmers with technology developers to demonstrate their technology to farmers so as to expedite adoption. Conversely, in innovation network process as explored in the AIS and ECLFLA frameworks, extension agents play the key role innovation brokers and facilitators of learning with an emphasis on building farmers' capacity. In this role the main functions include linking diverse actors and acting as a catalyst for collective learning, facilitation, mediation, documenting learning and translating to ensure actors from diverse backgrounds are understanding each other. However, for the extension agents to play these key roles effectively they need to have certain qualities summarised as personal attributes, training-related competencies and skills that accumulate by hands-on working experiences with diverse actors. Extension agencies would be well advised to examine the knowledge and skill set of their agents to ensure they are prepared to operate in both modes of extension (technology transfer and innovation brokering) lest they fall back on the somewhat easier technology transfer only to frustrate themselves and the farmers whom they serve when technologies are not adopted and little learning and capacity building occurs.

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CHAPTER 5: Appropriate extension approaches and modes for small-scale farmers in developing countries

Abstract

Agricultural extension has an important role to play in small-scale farming systems of Africa. However, to successfully play this role, appropriate extension approaches that meet the farmers' needs and circumstances must be developed. Both supply-driven and demand-driven have been tried and used in most developing countries with limited success. Reasons for this includes failure by agents to comprehend farmers' problems and priorities due to limited or no farmer participation in problem definition and solving processes, poor linkages between farmers, extension and research, blanket recommendations for different farmer groups, and issues of coverage. This paper found that there is no single extension approach that can be appropriate for all small-scale farmers due to the different circumstances they operate under. Thus this paper recommends the development of an appropriate extension system - not an appropriate approach – for small-scale farmers. This system will focus on empowering farmers through discovery learning, experiential and field-based learning to sharpen their analytical, problem-solving skills and to demand services. These services may include training from researchers and extension agents on issues they deem important to them, and thus will comprise of some aspects of both supply- and demand-driven approaches as and when necessary to serve the different circumstances of small-scale farmers. In this way each situation can be dealt with by whatever extension approach or a combination of approaches that are suitable – be they demand or supply or a combination of both. An appropriate extension system needs to be complemented with suitable extension modes in order for it to be successful in achieving its intended objectives. There are three main extension modes and these are individual, group and mass media. Key determinants in selecting appropriate extension modes include, intended purpose for which a mode is sought, literacy level of the farmers involved, cost and time effectiveness, number of farmers to be reached.

Keywords: Appropriate extension systems; demand-driven; small-scale farmers; supply-driven

5.1. Introduction

A variety of agricultural extension approaches have been used in small-scale farming systems in developing countries with limited success. Frequent changes in approach emanated from a combination of factors, including a lack of relevant technologies, inability by extension organisations/agents and research to comprehend farmers' problems and how to solve them, excluding farmers in problem definition and solving, lack of incentives for extension agents, and weak farmer-extension-research linkages (MOFA, 2011). In addition to these reasons, Dimelu and Okoro (2011) identified issues of inefficiency, low coverage and equity as arguments for the limited success. Moreover, Birner et al. (2009) noted that the imposition of standardised "one-size fit-all" extension approaches that have may have been successful in some other different areas, played a major role in limited success of extension approaches in small-scale farming systems. This suggests there has been uncertainty about what approach or approaches should be used with small-scale famers.

This uncertainty further suggests if any meaningful success is to be realised in small-scale farming systems, appropriate extension approaches, tailor-made for the farmers' circumstances should be developed. Such circumstances relate to the resources status of the farmers, their needs and priorities, and the biophysical conditions of their farms (Birner et al., 2009; Kibwika et al., 2009; Swanson and Rajalahti, 2010). Due to the diverse circumstances of small-scale farmers, no single extension approach can get the job done. For this reason, Birner et al. (2009) suggest that policymakers should identify a pluralistic agricultural extension framework relevant and flexible enough to meet the demands of different farmer circumstances. Campbell and Barker (1997) postulate that appropriateness of an approach is circumstance-based; what may be appropriate for one farmer (or group of farmers) may not be appropriate for another, even if they farm in the same agro-ecological region. They suggested four criteria against which appropriateness should be determined: technical feasibility, economical feasibility, social acceptability and environmental safety and sustainability.

The development of appropriate extension approaches also hinges on the ability of the extension agents and researchers to adapt to various roles as demanded by different situations. In some situations, they need to be knowledge or innovation brokers, facilitators, co-learners, advisers, trainers or educators. Thus, as noted by Swanson and Rajalahti (2010), extension organisations and agents need to broaden their focus and skills to play different roles under different extension approaches demanded by diverse small-scale farmers and farmer groups. Drawing on this, this paper will review and discuss relevant literature to:

1) Investigate the main characteristics and circumstances of small-scale farmers in developing countries;
2) Characterise the major extension approaches that have been used and are still in use in small-scale farming systems;
3) Determine key attributes of an appropriate extension system for small-scale farmers; and
4) Determine extension modes suitable for an appropriate extension system for small-scale farmers.

5.2.Characteristics and circumstances of small-scale farmers

Small-scale, resource-constrained farmers operating on very small farms comprise the majority of farmers in rural areas of most African countries and the developing world (Swanson, 2006). Small-scale farmers were identified by Swanson and Rajalahti (2010) as the most difficult group to reach for agricultural extension organisations and agents. There are three major reasons for this: low level of education; small scale of operation usually on marginal land; and they are relatively risk averse in trying new technologies (Swanson, 2006; Swanson and Rajalahti, 2010). These circumstances often lead to lack of self-confidence to seek out new opportunities on their own.

Most small-scale farmers lack the necessary technical and management skills probably due to lack of agricultural training and general low education level (Ortmann, 2000; Makhathini, 2013), as well as the resources to try out or to explore new technologies. Thus they opt to continue in their traditional systems even when they are barely meeting household food requirements. However, other studies such as those by Francis and Sibanda (2001), Mapiye et al. (2006) and Masere (2011) have found small-scale farmers to be literate and educated at least to the basic primary school level. Further, these farmers have also shown a willingness to learn about anything that can improve their livelihoods including modern farming technologies if given the opportunity (Masere, 2011). This contrasting understanding further supports the notion that extension approaches need to vary and be adapted to the specific farmer and farmer groups being assisted.

In most developing countries of Africa, the majority of small-scale farmers are advanced in years as young people usually migrate to urban areas in search of non-agricultural work. Chi and Yamada (2002) noted that the older farmers who remain in these rural areas often prefer to use their own experiences and traditional knowledge to modern technologies. Similarly, Masere (2011) found that not only does a farmers' age influence their farm management decisions, but also the way they perceive outside help (including modern technologies recommended by extension and researchers) and changes from their normal farming methods.

Extension agents were identified by small-scale farmers as the most important source of relevant farming information, followed by other farmers within their farmer groups, and, to a small extent, radio broadcasts (Masere, 2011). However, Hazell (2001) and Salami et al. (2010) noted that small-scale farmers rarely get adequate help from publicly funded extension agencies, mainly because the agencies are operating with low budgets which limit extension workers' ability to conduct farm visits to assist farmers (Mugwisi et al., 2012). Consequently, farmers have to look elsewhere for advice to their questions, problems and information needs.

Small-scale farmers have shown that they can learn from their fellow farmers within their communities or from other areas. In this way, farmer awareness is created when they share experiences with their counterparts who have ventured in new enterprises and are enjoying increased productivity or profitability (Swanson and Rajalahti, 2010). This farmer-to-farmer extension can thus be an important way to disseminate and encourage adoption of new technology (Burgers, 1999). Furthermore, small-scale farmers may open up to learn more about the new enterprise including the relevant technical and management skills to utilise that technology. They may even solicit the help of extension agent, if need be, on ways to incorporate such new enterprises into their farming systems, as well as to know more about potential risks associated with new enterprises and how to minimise them (Swanson and Rajalahti, 2010).

5.3. Overview of extension approaches used in small-scale farming systems

Extension approaches can be divided into two classes based on how they are led; production-led and farmer-led (Kokate et al., 2009). Production-led approaches include top-down, commodity based and supply-driven, whose major purpose is dissemination of technology to farmers to enable food self-sufficiency (Kokate et al., 2009). Conversely, farmer-led approaches are participatory, bottom-up and demand-driven, whose objective is building capacity of farmers and strengthening farmer organisations with the ultimate goal of enhancing the sustainability of livelihoods (Kokate et al., 2009).

Using a different framework, Blum (2007) suggested three broad extension models and these are linear, advisory and facilitation. Similarly, Swanson and Rajalahti (2010) classified extension approaches into four models namely technology transfer extension models, participatory extension approaches, market-oriented extension approaches and non-formal education approaches. These are discussed separately below.

5.4. Technology transfer extension approaches

The technology transfer approach was the primary extension model introduced into most colonised countries following independence. This approach was based on the assumption that technologies originate from scientists, are transferred by extension agents, and are adopted by farmers (Rogers, 2004 cited in Koutsouris, 2012). The fundamental characteristic of this approach is that it is based on a linear hierarchical technology transfer concept envisaged to serve as an effective link among research, extension, and farmers (Swanson and Rajalahti, 2010). The main characteristics of technology transfer approaches were given by Swanson and Rajalahti (2010) and Dimelu and Okoro (2011) as follows:

- Linear and research or supply-driven;
- Efficiency-based;
- Production-led, focused on increasing staple food crop yields;
- Highly centralised; and
- Rigidity and high expense

An example of the technology transfer extension approaches is the training and visit (T&V) extension, whose main objective was to strengthen the extension management system (top-down), improve the extension agent–farmer ratio by increasing the number of field staff, and provide basic support services to field extension staff members including offices, housing, transportation and extension materials (Davis and Place, 2003; Swanson and Rajalahti, 2010). Although T&V extension did not have much impact in rainfed areas (due to the lack of relevant technologies), this approach did speed up the dissemination of Green Revolution technologies, especially in irrigated areas, and did have a short-term positive payoff. Singh (2009:6) noted that such 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 technology transfer approaches have three main weaknesses. First, experts usually fail to comprehend farmers’ problems because there is no farmer involvement in this approach. Second, the model fails to respond to complex challenges and rapidly changing contexts, including the shift to sustainable development. Third, the approach does not acknowledge farmers’ experience and knowledge and, that such blanket extension advice often does not match individual farm conditions and the socio-economic context of farmers (Koutsouris, 2012).

5.5. Participatory extension approaches

Participatory extension approaches were promoted to empower farmers and to do away with the passive role of farmers in the technology transfer approaches like T&V approach (MOFA, 2011). Thus, participatory methods were used to better meet farmers’ needs or problems and to develop technologies tailor made to farmers’ system-specific circumstances, risks and cultural preferences (Singh, 2009; MOFA, 2011). Further, farmers are principal decision-makers at all stages of the research processes including problem identification, setting goals, planning and evaluating developing options and strategies (MOFA, 2011). Participatory approaches help raise farmer group consciousness and collective action to define, understand, and address local problems (Swanson and Rajalahti, 2010).

Once farmers have become aware of the causes of their problems and have identified the most critical ones, the extension agents provide technical knowledge and technologies which may be useful to address the problems identified. For this approach to work well, extension agents need not only agricultural expertise, but also good analytical, pedagogical, and facilitation skills (MOFA, 2011). The role of extension agents in this approach is more of facilitators and knowledge brokers, who stimulate farmers to learn how they can attain their defined and perceived goals (Anandajayasekeram et al., 2001; Kokate et al., 2009).

One aspect of participatory approaches includes the focus on the farming systems on of small-scale farmers as found in farming systems research and extension (FSR/E). This approach focused on small-scale resource-constrained farmers' needs within their whole farming system rather than on a single commodity as was the more standard practice. (Davis and Place, 2003). Other participatory approaches include Participatory Rural Appraisal, Participatory Technology Development, Participatory Innovation Development, Participatory Action Research and other forms of Farmer-to-Farmer/Farmer-first extension including Farmer Field Schools (which are discussed in detail in the next section) (Gonsalves et al., 2005). Key characteristics of these approaches included farmer participation through input and on-farm experiments and by farmer-extension-researcher linkages and a systems approach to extension (Davis and Place, 2003).

5.6. Market-oriented extension approaches

These include commodity-based advisory systems and innovative, market-driven extension approaches. These are discussed in detail:

5.6.1. Commodity-based approach

The commodity extension approach for major export crops have been in existence since colonial times and are still common in many developing countries that produce major export crops such as rubber, tobacco, coffee, cocoa, sugar cane, oil palm, bananas, oranges, and cotton (Swanson and Rajalahti, 2010). This approach is generally organized through parastatal organisations or private sector firms. The underlying characteristic of this approach is that the production system is vertically integrated from input supply to the technology adoption and marketing of the produce (MOFA, 2011). It usually focuses on a single one cash crop. Farmers produce a certain quantity and quality of a crop, animal species or animal product, and sell it to the company which is partnering them. In return, the parastatal provides inputs, credit, as well as extension, quality assurance standards and marketing services (MOFA, 2011).

Noted advantages of this approach include high returns on crops, increasing the income of farmers as well as their technical and managerial skills while reducing farmers' risks and uncertainties (MOFA, 2011). It may also provide small-scale farmers with access to profitable competitive markets to agricultural inputs, technology and advice from which they would be excluded otherwise (MOFA, 2011). Swanson and Rajalahti (2010) noted that the commodity extension approach is generally effective and efficient for three reasons. First, they serve specific agro-ecological areas where these export crops can be grown and the advisory personnel work solely with those contract farmers who are growing these particular crops. Second, the focus on just one commodity makes training of both extension agents and farmers they serve to be relatively simple and straightforward. Third, farmers themselves have an economic interest in following these recommended practices so they can sell their respective crops (Swanson and Rajalahti, 2010).

One of the drawbacks of the commodity extension approach is that extension content is limited to technical and administrative or commercial aspect of the particular commodity or crop. Farmers usually become dependent on the commodity organisations for advice, inputs and sale of crops. Farmers also feel they are mostly not involved in the development of extension packages, and this eventually leads to extension offering services that are not of priority to farmers (MOFA, 2011). Its narrow focus on profitable production often leads to overlook environmental issues and to exclude non-commercial producers (Nagel, 1998).

5.6.2. Innovative, market-driven extension approaches

These approaches represent a complete shift in direction from the traditional linear model of linking research to extension to farmers (Swanson and Rajalahti, 2010). They take a holistic approach to farming systems focusing on important causal inter-linkages among a system's parts and on system dynamics, rather than the parts themselves (Koutsouris, 2012). This innovative, market-driven approach is consistent with the agricultural innovation systems (AIS) framework. Rather than being controlled by research, under this emerging new extension approach, innovation is stimulated and driven by markets for high value products. Drawn by marketing opportunities, rural households can consider which market to access and which corresponding innovations to adopt to improve their farm household income (Swanson and Rajalahti, 2010). A key benefit is that a market-driven extension approach helps farmers move incrementally toward agricultural diversification. Farmers who have been producing for home consumption can continue to produce food for their tables, while setting aside small portions of their land to produce the commodity for the market they have selected. It will require them to learn how to produce and market the particular commodity. Starting small, "they begin scaling up the production of these crops or products, based largely on profitability" (Swanson and Rajalahti, 2010: 22).

5.7. Non-formal education approaches

One of the generic definitions of extension is that it is essentially a system of non-formal education (Qamar, 2005). More recently the FAO has identified non-formal education as conceptual approach within extension [technology transfer, advisory services, and facilitation extension being the other main approaches] (Swanson and Rajalahti, 2010). Due to its farmer-engaging nature, non-formal education is also essentially participatory. Thus, the methods used within non-formal educational extension approaches often overlap with those associated with participatory extension approaches. This underscores the essential fluid nature of extension and the inherent danger of attempting to over categorise approaches – beyond an effort to understand the relative value and limitations of the various approaches, methods and tools.

Non-formal education extension primarily uses non-formal education methods to stimulate continued learning and they strengthened the social and political skills of farmers (Swanson and Rajalahti, 2010). These approaches are suggested as important in strengthening a country's extension system in the area of sustainable natural resource management. A preeminent example of these approaches is the Farmer Field Schools (FFS); another is Farm Business Schools (FBS).

5.7.1. Farmer Field Schools (FFS)

A Farmer Field School (FFS) is a learning environment where a group consisting of around 20 to 25 farmers regularly meet with extension agents or any other facilitators throughout a crop or animal cycle (Davis and Place, 2003; Dimelu and Okoro, 2011). The school is an interactive and practical method of training and strengthening farmers' social and technical competencies, thus enabling them to be technical experts on factors affecting their farming systems (Anandajayasekeram et al., 2007; MOFA, 2011). Technical competence of farmers is improved by hands-on learning, experiential learning and integrating indigenous knowledge with scientific ecological knowledge (MOFA, 2011). Additionally, group discussion and reflection processes, presenting and explaining small group decisions to a larger audience and group building exercises were noted to play an important role in fostering the social competence of the farmers (MOFA, 2011).

The FFS is founded on adult learning principles and experiential learning elements - concrete experience, observation and reflection, generalization and abstract conceptualisation and active experimentation (Dimelu and Okoro, 2011). Similarly, Anandajayasekeram et al.

(2007) noted that the defining characteristics of FFS include discovery learning, farmer experimentation, and group action. Specific objectives of FFSs (FAO, 2008 as cited in Ajani and Onwubuya, 2010) are to:

- empower farmers with knowledge and skills to make them experts in their own fields;
- sharpen the farmers' ability to make critical and informed decisions that render their farming profitable and sustainable;
- sensitise farmers in new ways of thinking and solving problems; and
- help farmers learn how to organize themselves and their communities.

Farmers are facilitated to conduct their own research, diagnose and test problems, and come up with solutions. Findings from a study conducted by Anandajayasekeram et al. (2001) in East and South Africa shows that FFS have contributed to changes in attitudes and perceptions of participants, and facilitated the development of new relationships between farmers, researchers, extension workers, and community development personnel. Experience from that study also revealed that there is immediate uptake of technology by participants because trainees discover, learn, then integrate positive ideas into their own production system; and spread information on these technologies in a community (Anandajayasekeram et al., 2001). However, this is not the primary value of FFS.

Numerous advantages of FFS approach have been noted, including that farmers' analytical skills, critical thinking are enhanced leading to better decision making (Kenmore, 1996; 2002). The FFS is responsive to local needs of farmers across a broad range of conditions and farming systems (Simpson and Owens, 2002). A process of learning is mastered rather than a specific set of messages giving famers the confidence and ability to continuously apply their acquired learning skills in different or changing situations (Madukwe, 2006; Ajani and Onwubuya, 2010). Russ (2007) suggested that building farmers' confidence and process mastery as the most important outcomes of their FFS experience. Because of this farmer empowerment, there will be no sustainability issues in the event of FFS coming to an end or when there is no outside funding (Ajani and Onwubuya, 2010).

Despite the successes and numerous advantages of FFS, it has its challenges. There are two major drawbacks of the FFS approach. First, it is very costly. Nalukwago (2004) found FFS to have the highest training costs per farmer compared to other approaches like T & V system. Similarly, MOFA (2011) noted that costs associated with FFS will most likely lead to financial sustainability challenges. This challenges the long-term viability of FFS in developing countries where resources are usually stretched because of multiple competing needs. Although the assumption is that the FFS graduates will spread the knowledge and skills gained to other farmers, there is no guarantee that the graduates will be able to pass significant knowledge or train other farmers in their community (Ebewore, 2013). Second, the FFS does not embrace farmers' local indigenous knowledge and practices due to limited time (Thijssen, 2002 cited Dimelu and Okoro, 2011).) This concurs with Anandajayasekeram et al. (2007) who question whether there is any real participation by the small-scale farmers in the FFS approach. This again highlights the issue that involvement does not equal participation and raises the warning that the pressure to transfer technology is often very great, even when in the guise of being participatory.

5.7.2. Farm Business Schools (FBS)

The Farm Business School (FBS) is a new system developed by the FAO. It has yet to gain much traction, but is another example of non-formal education in extension. FBS is based on principles similar to FFS, but the focus is on building farmer capacity in farm business management rather than agricultural production. According to Kahan and Worth (2015: 2), the FAO created the FBS "to help farmers cope with and, preferably, benefit from the changes taking place internationally in farming" by setting up extension supported farmer-to-farmer informal schools where farmers reside. The educational programme comprises a collection of learning-by-doing lessons on variuos aspects of farm business management that will help them compete in an increasingly market-oriented industry (Kahan and Worth, 2015: 2).

Resembling participatory approaches, in the FBS "Extension officers and lead farmers are trained as facilitators and then organise seasonal training courses, where farmers work in small groups at their own pace using materials that have been specially designed for the schools" (FAO, 2015:7). According to the FAO (2015:7) the school is stated to be comprised of:

- "a program of learning designed to help small holder farmers in producing for the market making their farms work profitably;
- a venue that brings farmers together to carry out collective and collaborative action to address business and marketing problems and opportunities;

- a group of like-minded farmers who want to develop their skills and know more about producing for the market; and
- a forum for sharing knowledge between farmers through discussion, practical exercises and self-study”.

5.8. Towards an appropriate extension system for small-scale farmers in developing countries

The extension approaches discussed above can be placed into two classes; supply-driven or demand-led. Supply-driven extension approaches includes the top-down linear technology transfer approaches like T & V and commodity-based extension where researchers and extension workers are the authority instructing or teaching farmers what to do based on technology developed by researchers, largely in the absence of farmers who are expected to adopt the technologies.

Conversely, demand-led extension approaches are those designed to be appropriate, flexible and responsive to farmers’ needs (Davis and Place, 2003) based on farmers’ active participation. Kibwika et al. (2009) noted that the major objective of demand-led extension is to empower farmers to take charge of a research process that is aimed at generating outputs relevant to their circumstances. For this to happen and to be successful, extension and researchers must build trust and respectful relationships with farmers and change their attitude of perceiving themselves as teachers who farmers should just listen to and obey (Kibwika et al., 2009). Furthermore, extension and researchers should be committed to co-learn with farmers including learning from indigenous knowledge and practices and how they can be integrated with modern scientific knowledge or technologies (Murwira et al., 2001). Thus, the success of demand-led extension approaches depends on extension organisation/agents’ abilities to foster enhance teamwork, and to be good team players themselves, manage group dynamics (self-awareness and self-control are key skills here) as well as play the role of information and knowledge brokers by linking those who have information and knowledge to those who need it. Further, an information and knowledge broker requires critical skills including communication, negotiation, facilitation, lobbying, stimulating co-learning, advocacy and conflict resolution (Kibwika et al., 2009).

However, Pant (2012) postulates that neither demand-driven nor supply-driven approaches focusing on a narrow set of competencies is enough to foster learning and innovation within the small-scale farming sector of developing countries. Further, Pant (2012) argues that while demand-driven approaches, particularly the innovation systems approach, emphasise more systemic interaction between key actors, it neglects how education and training functions within the system. Thus, Pant (2012) recommends crossing the conventional boundaries of competence development through integrating theory-based, competence-based and experiential learning, and capacity development through recognising the systemic nature of agricultural research, education, extension and entrepreneurship as a complex adaptive system.

In light of the arguments presented here for both demand-driven and supply-driven extension approaches, there is no single extension approach that can be appropriate for all small-scale farmers. What may be appropriate for some small-scale farmers may not be appropriate for others. It is submitted that an appropriate extension system - not an appropriate approach - be developed. This system will comprise of some aspects of both supply and demand-driven approaches necessary to serve the different circumstances of small-scale farmers. In this way each situation can be dealt with by whatever extension approach or a combination of approaches is suitable – be they demand or supply or a combination of both.

5.8.1. Key characteristics of an appropriate extension system for small-scale farmers

The appropriateness of an extension system is based on the context-specific circumstances of the farmers. These relates to technical and economical feasibility, social acceptability and environmental sustainability (Campbell and Barker, 1997). For small-scale, resource constrained farmers in Africa the major issue is financial sustainability of an extension approach, especially the usually preferred demand-driven approaches (Davis and Place, 2003). This suggests that the demand-driven extension approach may not appropriate in such circumstances. However, the same approach may be appropriate in better off small-scale farming communities. This further emphasis the development of appropriate extension systems integrating various aspects of both demand and supply-driven approaches which can meet small-scale farmers’ needs at all times.

It is submitted that, an appropriate extension system should be examined on the basis of six key characteristics. These are focus, purpose, role of extension, who determines what to learn, nature of learning and social capital and sustainability.

Focus: An appropriate extension system must focus on farmers and not on technology (Van de Fliert, 2003; Anandajayasekeram et al., 2007). It must be concerned with empowering farmers to make better decisions pertaining to their farming systems, thus enhancing their livelihood sustainability. This include having a voice in issues that concern their challenges and thus demand services that may lead development of solution to these challenges (Davis and Place, 2003; Anandajayasekeram et al., 2007). Such solutions should build on farmers' indigenous knowledge and practices as well as their skills and experiences.

Purpose: The objective should be that of building capacity of farmers. The knowledge, decision making skills may then lead to possible technology adoption or adaptation of the technological guidelines (Van de Fliert, 2003). Further, the ability of the small-scale farmers to adapt technological guidelines as opposed to stick on prescribed standardised recommendations shows improved capacity to study, articulate, appraise their own challenges and technologies using their own criteria without depending entirely on advice from extension and researchers (Van de Fliert, 2003).

Role of extension: Extension organisations and their agents should be flexible, skilled and competent enough to be able to perform different roles as demanded by diverse situations of small-scale farmers. In situations where production-led approaches are appropriate, agents may need to teach and instruct farmers on technology and provide feedback to research systems (Kokate et al., 2009). Conversely, under conditions favouring farmer-led, demand-driven approaches, the agents' role is that of an innovation/knowledge brokers who facilitates interactive learning processes amongst farmers and other key stakeholders (Allahyari et al., 2009; Kokate et al., 2009). In this way extension agents link farmers to support system network in the form of information, knowledge and resources (Allahyari et al., 2009). This support system may include extension agents helping farmers in setting up participatory on-farm experiments where farmers can learn by doing (Van de Fliert, 2003).

Farmers should determine what to learn: Learning or training should be based on farmers' needs, perceptions, analyses and conclusions. Small-scale farmers should actively participate in co-learning interactions especially in issues that affect their livelihoods. Reasons for this include; they understand their biophysical environment better than extension agents and researchers, they have practical experiences of what has worked or not worked for them before, their major challenges and possible solutions to these and aspects of their farming systems they are lacking and which require assistance or training from extension agents and researchers.

Nature of learning: Learning in small-scale farming systems should be more of interactive, experiential, field-based and participatory in nature (Van de Fliert, 2003). Similarly, Worth (2014) proposed an Extension Carousel of Learning and the Facilitated Learning Agenda (ECLFLA) framework which embrace iterative learning in the form of an engagement in an extension conversation by farmers, extension and enablers (researchers, technology developers, donors). The main learning areas encapsulated in the ECLFLA framework centred on a range of production, economic and managerial factors in the context of their social and physical environments. This type of learning has the potential to produce by far the most effective and applicable results which farmers may use to make informed decisions and finding solutions to problems affecting their livelihoods (Van de Fliert, 2003; Worth, 2014).

Social capital and sustainability: It is imperative for agricultural extension systems in developing countries to foster social learning which is important in ensuring sustainability through building social capital, increasing farm income and rural employment in order to alleviate poverty (Swanson, 2006; Allahyari et al., 2009). Further, social learning allows extension agents and researchers to develop skills on how to work with farmers in a participatory way, at the same time creating the social networks for facilitating exchange of knowledge between diverse actors within that network (Allahyari et al., 2009).

Creating an extension that meets all these criteria will require substantial political will (van Niekerk et al., 2011), which is often not forthcoming. As with efforts to introduce private extension models, developing this adaptive system will need “a plan (and budget) for considerable experimentation and flexibility” (Chapman and Tripp, 2003: 10). Further, there will be a tension between the top-down nature of the production-led approach with the dedicated characteristic of the farmers determining what to learn. This suggests agility, wisdom and flexibility on the part of the extension workers as well as on the part of the structures and systems that support them.

5.8.2. Extension modes for an appropriate extension system for small-scale farmers

An extension mode refers to a manner, way, or method of conducting extension activities. As is being discussed in this section, an appropriate extension system – not a single appropriate extension approach – is needed for small-scale farmers in developing countries. Consequently, there is no single extension mode that can satisfy all the different circumstances of small-scale farmers at all times. This paper evaluated the major extension modes that have been used and are still in use. Oakley and Garforth (1985) suggested three broad extension modes: mass media; individual; and group extension modes. Such modes may further be classified according to their form, written, spoken and objective or visual categories. The extension modes are discussed separately.

5.8.2.1. Mass media mode

Mass media are excellent at creating awareness of many farmers at within a short period of time because of their wide coverage (Oakley and Garforth, 1985; Nduru, 2011). Mass media include radios, pamphlets, television, advertising posters, newspapers and brochures. It is appropriate in passing messages that are sensitisation in nature like crop varieties, weather predictions and farm inputs availability (Nduru, 2011). It is cost effective. These methods are however very poor on content, skills acquisition and stakeholder participation (Nduru, 2011). There is no room for discussions and asking questions directly to extension agents.

5.8.2.2.Individual extension mode

These involve the extension agent engaging a farmer on a one-to-one basis. They include farm visits, office calls/visit, telephone calls and informal contacts. Individual meetings are probably the most important aspect of all extension work and invaluable for building confidence, trust and credibility between the agent and the farmer (Oakley and Garforth, 1985). Where individual attention is given to a farmer there is a high chance that farmers will take the advice offered. Similarly, findings by Nduru (2011) noted that one-to-one farm visits are the extension mode most preferred by farmers. In Nduru's study farmers highlighted the opportunity offered by this method to freely ask questions and learn skills interactively on the farm, as the major reason for preferring it. The other reason highlighted was that the individual farm visit is demand-driven, and has no time and cost implications on the farmer (Nduru, 2011).

The major disadvantages are on the extension agents' side. These include that it is time consuming, thus limiting the number of farmers that the agents reach. Second, it can be very costly, as scarce extension resources are reaching limited number of farmers. Third, there is a high likelihood that agents may concentrate on elite or progressive farmer at the expense of the poorer farmers (Nduru, 2011). Finally, the individual extension mode discourages participation of other farmers and other important actors like service providers who would prefer an event that has a large number of clients for time and cost efficiency.

5.8.2.3. Group extension mode

MOFA (2011) noted the group extension mode enhances both technical and social competencies of the farmers as the method allows experiential learning. Experiential learning involves group members observing and learning in the field, reflecting together, deciding together, and observing the results during later meetings (Allahyari et al., 2009; MOFA, 2011). Some of the learning exercises that farmers partake in groups includes "sharing, case study, role play (dramatized sessions), problem solving exercises, panel discussions, group dynamics, small group and large group discussion, brainstorming and simulation games" (Ajani and Onwubuya, 2010: 54).

Group extension modes generally blend well with most farmer-led extension approaches. Possible reasons for this are related to its cooperative, multiplier and cost effective advantages (Dimelu and Okoro, 2011). Similarly, Oakley and Garforth (1985) highlighted several advantages of group extension mode relating to coverage, learning environment and action. First, there is more extension coverage using this method than with the individual mode, thereby making it more cost-effective. Second, the group extension mode offers a reflective learning environment in which farmers can share information and experiences, discuss issues affecting them and how they will make informed decisions, and determine a course of action. The group mode further offers a supportive atmosphere in which individual farmers can gain greater self-confidence by joining others to discuss new ideas and try out new practices (Oakley and Garforth, 1985; Allahyari et al., 2009). Third, the group extension mode can bring together farmers with common similar challenges which usually demand concerted action, thus giving farmers a collective voice to demand extension services, including obtaining funds for development; something individual farmers are less likely to get on their own (Oakley and Garforth, 1985; Davis and Place, 2003).

- Types of group extension methods

The main types of group extension modes are group meetings, demonstrations, field days, and look-and-learn tours. These are briefly discussed.

Group meetings: The group or community meeting is a useful learning forum where the extension agents and farmers can come together, and ideas can be openly discussed and analysed (Oakley and Garforth, 1985; Allahyari et al., 2009; Mashavave et al., 2011). As the most commonly used form of group extension method, the group or community meeting will be most effective if carefully thought out and planned.

Farmers, through their leadership, should consult extension agents and agree on purpose of meetings. The meeting should not resemble a classroom with the agent as teacher and the farmers as pupils. The agent should make every effort to ensure that the proceedings the genuinely reflect that the meeting is their meeting and honour the part they play in it (Oakley and Garforth, 1985). A similar concept to the group meeting is the farmer study circles, where a group of farmers meet regularly to learn and share experiences on any topic of interest including ways to solve problems (MOFA, 2011). These farmer interactions are beneficial to the development of farmers' decision-making, leadership, and management abilities (Van de Fliert, 1993, cited in Anderson and Feder, 2004).

Demonstrations: A demonstration is an invaluable group extension method that offers a learning platform where farmers learn by observing how new innovations work and their effects on improving production (Oakley and Garforth, 1985). Due to the nature of learning it involves, demonstrations are a very powerful method to use even with illiterate or less educated farmers (Oakley and Garforth, 1985; Akinsorotan, 2009). Farmer participation is enhanced when demonstrations are conducted on their (or their fellow farmers') fields rather than on an extension research station (Oakley and Garforth, 1985). Thus, demonstrations are essential in enhancing farmer participation and for introducing and disseminating technologies that need skills acquisition (Oakley and Garforth, 1985; Nduru, 2011) where learning by seeing and observing is helpful.

There are two main types of demonstration; method demonstration, and result demonstration. In the former, farmers observe, step by step, how a technology or new practice works. The later, shows evidence that a technology can be practicable under local conditions (Oakley and Garforth, 1985). Both types bode well with small-scale farmers who are usually risk averse and usually prefer to see tangible results of recommended technologies before considering adoption. However, the major limitation of result demonstrations is that they can take a long time to deliver results (e.g. from planting to harvest) and is thus a costly use of extension resources.

Field days: A field day is an extension mode involving multiple agricultural stakeholders (farmers, extension organisations/agents, researchers and agri-business practitioners) meeting in the field to observe, discuss and interact concerning the impact of a technology or practices being showcased (Akinsorotan, 2009; Nduru, 2011). They are usually conducted in farmers' fields where the host farmer, with the support of an extension agent, explains to other farmers and stakeholders the technology or practices on show. Extension agents will also assist by facilitating the discussions and answering questions and queries. The nature of learning (observation, discussions and sharing experiences) at the field day may convince even the illiterate farmers to try out and, form there consider adopting those technologies which proved appropriate (Akinsorotan, 2009). The main advantages of field days is that it is time and cost effective as large number of farmers and other stakeholders can be reached at once and even with a low budget (Nduru, 2011).

Look-and-learn tours: A look-and learn tour is a series of field demonstrations on different farms in different areas. Such tours afford farmers opportunities to observe and learn what farmers in other areas are doing and to exchange ideas and experiences with them (Oakley and Garforth, 1985). The areas to be visited should be relevant to the agro-ecological conditions prevalent in the visiting farmers' area. In this way, a look and learn tour have potential to stimulate genuine interest in farmers to participate in extension activities. This extension mode involves travelling costs and thus should only be used when resources are permitting.

As mentioned in connection with the proposed adaptive extension system, the foregoing discussion suggests that application of modes and methods needs to be carefully considered in the light of sometimes conflicting factors including high demand for face-to-face engagements, limited budgets, need for farmer interaction to support learning and top-down demands of product-led extension. This again suggests the need for agility, wisdom and flexibility.

5.9. Conclusions

This study evaluated the successes and failures of several extension approaches that have been used and are still in use in developing countries of Africa. Most of these approaches (both supply-driven and demand-driven) had very limited successes. Reasons for this include lack of relevant technologies, failure of extension and research to involve farmers in defining farmers' problems and development of solutions, lack of incentives for extension agents, poor farmer-extension-research linkages, low coverage and imposition of standardised blanket extension approaches and technologies for different farmers (Birner et al., 2009; Dimelu and Okoro, 2011; MOFA, 2011).

There is no single approach that can be appropriate for small-scale farmers at all time. Thus, there is need for an adaptive extension system to be developed to suit the context specific circumstances of different farmers. This extension system will comprise of a combination of both teaching (supply-driven approaches) and learning (demand-driven approaches) paradigms (Swanson and Rajalahti, 2010), which should be adapted and applied as demanded by each unique situation. The combination need not be in equal proportions. Madukwe (2006) suggests that extension system be more inclined to a learning rather than teaching paradigm for one simple reason: farmers have more information or knowledge about their own farms, including the ecological conditions, than extension agents (Madukwe, 2006). This adaptive extension system needs extension agents to be able to play different roles as dictated by situations at hand. In some case they need to be facilitators, knowledge brokers while in other cases they need to be instructors or teachers.

This paper suggests that the key characteristic of an appropriate extension system is its focus on empowering farmers through iterative experiential learning, sharing experiences and discovery learning. Once small-scale farmers are empowered they will be able to demand services, develop analytical and problem solving skills which they will apply in developing solutions to their current and future challenges on their own. Further, they will be able to evaluate technology and make informed decisions on whether to adopt or adapt some aspects of technologies or new practices.

An appropriate and adaptive extension system needs to be complemented with suitable extension modes in order for it to be successful in achieving its intended objectives. There are three main extension modes and these are individual, group and mass media. Key determinants in selecting appropriate extension modes include, intended purpose for which a mode is sought, literacy level of the farmers involved, cost and time effectiveness, number of farmers to be reached and stages of farmers in learning a new technology (awareness, interest, evaluation, trial or adoption).

Figure 1, although using differing terminology depicts the dynamic nature within which this adaptive extension system must operate and frames the nature of choices that the extension practitioner has to make to ensure that the most appropriate extension is provided.

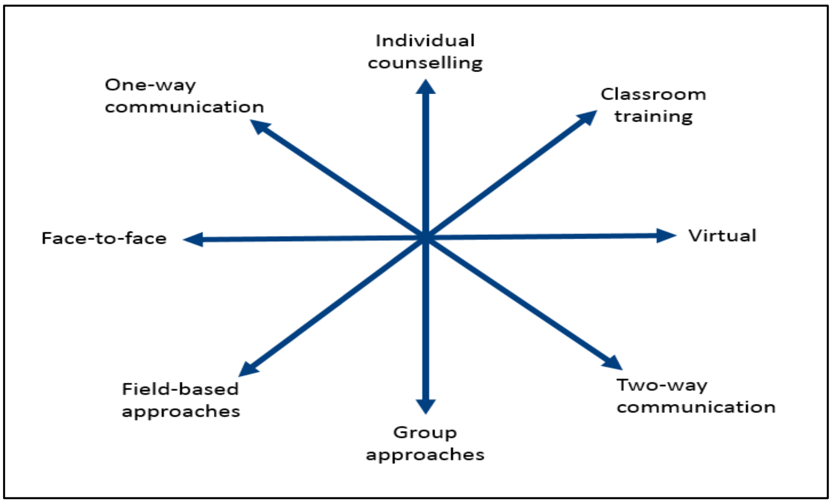

Figure 1: *The dynamic choices of an adaptive extension service* (Source: Helvetas, 2015)

The operative word is adaptive. To make such a system work will require substantial commitment on all fronts. Extension practitioners, research, extension management and support systems will all need to possess both the political will and the concomitant knowledge and skills – technical and social; 'hard' and 'soft' – to make decisions to keep the system adaptive.

Drawing on Figure 1 and data found in this study, in every situation the extension agent should identify where on the dynamic map he is operating. This operating position will always be changing depending on situation at hand. Thus implying a heightened sense of the capacity of extension agent to understand where he/she needs to be at each given time for example when to use one-way or two-way communication approaches or a combination of different extension approaches.

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CHAPTER 6: Factors influencing adoption and innovation of new technology and decision-making by small-scale resource-constrained farmers: The perspective of farmers

Abstract

A study was conducted in Lower Gweru Communal area of Zimbabwe to determine factors affecting small-scale resource-constrained farmers' technology adoption and innovation processes. Specific objectives included determining circumstances when farmers consider learning about and adopting new technologies; documenting challenges faced by farmers in technology adoption; and determining the kind of support farmers require in adopting technologies or innovating. Multistage stratified random sampling was used to select a study sample of 256 farmers. Data was solicited by means of focus group discussions, semi-structured interviews and participant observation. It was found that farmers were mainly hampered by lack of capital to afford certain technologies, lack of support systems including information, credit facilities and markets. Modern technologies with traits similar to farmers' traditional practices showed high adoption rates. Such technologies include conservation agriculture (90%) and thermal composts (78%). Further, farmers highlighted that they readily adopt cheaper, easier/simpler technologies which reduce labour requirements while simultaneously increasing crop yields and animal productivity. Lower Gweru farmers preferred to be involved in problem definition and development of solutions (technologies/innovations) including field-based participatory learning extension and innovation projects as opposed to them being mere beneficiaries of technologies developed without their input.

Keywords: extension; innovation; learning; small-scale farmers; technology adoption

6.1. Introduction

Small-scale farmers of developing countries rarely adopt modern new technology recommended to them. In Zimbabwe, most of the technologies are disseminated by public extension agents from the Department of Agricultural Technical and Extension Services (AGRITEX). AGRITEX is mandated to provide a plethora of services, including technical, advisory and regulatory services, to different farm clientele. Further, AGRITEX is responsible for farmer training on several agronomic practices and for the dissemination of technologies to farmers. In addition to these roles, the AGRITEX extension agents play the important role of taking feedback from farmers to technology developers (including seed houses, fertilizer companies, and research institutes).

Several reasons noted for the poor technology adoption among small-scale farmers include issues of affordability, lack of information support, lack of credit facilities to help farmers purchase the technologies, ineffective methods of dissemination, farmer demographics, perception of technology, and exclusion of farmers in developing technologies aimed at helping solving their problems (Chi and Yamada, 2002; Akudugu et al., 2012; Abdullah and Samah, 2013). Furthermore, farmers' social and biophysical operating environments influence technology adoption decisions (Chi and Yamada, 2002; Jack, 2013). It is against this background that a study was conducted in Lower Gweru Communal area, Zimbabwe to determine farmers' perceptions on technology adoption including main sources of technologies, challenges faced in adopting technology, support needed to promote technology adoption, farmers' perception of extension agents bringing the technologies and to evaluate farmers' participation in innovation and extension projects. Lower Gweru communal area was chosen for the study for two main reasons. First, it is an area populated with small-scale resource-constrained farmers, and, second, the area has seen an increased number of technologies disseminated over the last two decades.

6.2. Methodology

Lower Gweru is a developed communal settlement in the Midlands province of Zimbabwe. The climate of Lower Gweru Communal area is characterised as semi-arid to arid with summer rainfall (October to March) ranging from 450mm to 600mm annually, but experiences periodic seasonal droughts and severe dry spells. Lower Gweru is located about 40 km North West of City of Gweru, and stretches a further 50 km to the West.

To eliminate bias and ensure representativeness, multi-stage stratified random sampling was used to select a study sample of 256 participant farmers from all the eight wards of Lower Gweru Communal area. The eight Wards are: Sikombingo, Nyama, Mdubiwa, Chisadza, Madikani, Bafana, Nkawana and Communal ward 16. This sampling technique was used to cater for equal representation of males and females and to ensure all villages within each ward were represented. The Wards' extension agents assisted in this process.

Data were solicited using three instruments: focus group discussions (Merton et al., 1956; Krueger, 1994); semi-structured interviews (Barriball and While, 1994; Campion et al., 1988); and participant observation (Marshall and Rossman, 1989). These methods were used sequentially, each building on the results of the previous data collection exercise; each validating the data of the previous session. Further, data gathered at each session was reviewed with the relevant extension personnel and key informants to validate the data. The data was found to be consistent with information available to the extension personnel and NGOs personal operating in the area. The use of multiple methods and triangulating as outlined provided the framework for the validity and reliability of the data (Golafshani, 2003).

Two focus group discussions (FGDs) were held in each of the eight wards to gather general information about technologies disseminated to farmers over the last several years, sources of technology, and their perceptions of extension services (Appendix 1). Each FGD comprised 16 farmers (eight men and eight women). Thus, the total number of farmers who participated at all the 16 FGDs held in the eight Wards was 256. Similar, but more specific information was collected using semi-structured interviews (SSIs) with 200 farmers (100 men and 100 women) from among the study sample of 256 farmers (Appendix 2). Hence, 56 farmers who participated in the FGDs were not participants in the SSIs. The data collected included farmer demographics, farmer circumstances and livestock resources, technologies adopted and rating extension services. Participant observation was used to corroborate information gathered in FGDs and SSIs.

6.3. Findings

6.3.1. Farmer demographics and circumstances

The majority (47%) of the interviewed farmers are above 50 years of age, while young farmers (less than 35 years old) accounted for only 9.5% (Table 1). This finding is consistent with Masere (2011) that most of the farmers in rural areas of Zimbabwe are generally older (over 50 years) as most young people migrate from rural farming areas into towns and neighbouring countries in search of non-agricultural work.

Although most farmers (89.5%) have some formal education, only 35% managed to reach the Ordinary Levels or better (Table 1). Only 10.5% of the farmers did not attend any formal educational school. Of these, the majority were the oldest women within the study population. Despite the low level of education of the Lower Gweru farmers, most of them are highly experienced in farming, with 66% having more than 10years of farming experience.

Most of the Lower Gweru farmers (65.5%) are farming on very small farms ranging from 0.5ha to 2ha. Only 33.5% of the respondents have farms greater than 2ha. Furthermore, these farmers have limited resources, particularly livestock. The majority of farmers (44%) have between one to five cattle, while 18.5% do not have any cattle (Table 1). Similar ownership figures are reported for small livestock (goats). Despite the low numbers of livestock ownership among the respondents, only 5% of the farmers do not have any form of livestock (cattle or goats). Cattle are very useful as a source of draft power for various field operations and also for milk and food. Goats are usually used as a form of insurance for income and they are quickly sold in the event that farmers need income quickly.

Table 1: Distribution of Respondents according to their demographics and circumstances

Factor	Category	Frequency	Percentage
Gender	Male	100	50
	Female	100	50
	Total	200	100
Age	Young (≤ 35 years)	20	9.5
	Middle aged (35-50 years)	85	43.5
	Old (50 years and above)	95	47
Formal Education level	Did not attend	25	10.5
	Primary school	75	39
	Zim Junior Certificate	30	15.5
	Ordinary level	65	33
	Advanced level	5	2
Farming experience	Up to 10 years	68	34
	10-30 years	87	43.5
	>30 years	45	22.5
Number of cattle	0	35	18.5
	1-5	90	44
	6-10	40	20
	>10	35	17.5
Goats	0	50	23.5
	1-5	85	43.5
	6-10	45	22.5
	>10	20	10.5
Farmers without cattle and goats		10	5
Farm size (Ha)	<1	30	15.5
	1-2	105	51
	2-3	45	22.5
	>3	20	11

Source: Farmers' SSIs responses.

6.3.2. Crops grown and reasons for growing them

Lower Gweru farmers grow a variety of crops (cereals, legumes, tubers and vegetables) in their fields and gardens (Table 2). These crops are grown in all wards of Lower Gweru by all farmers.

Table 2: Crops grown by Lower Gweru small-scale farmers and reasons for growing them

Crop type	Crop grown	Reasons for growing
Cereals	Maize	Household consumption, income generation from selling surplus. Stock feeding
	Sorghum	Household consumption and income generation from selling surplus. Beer brewing for selling and traditional ceremonies
	Rapoko	Beer brewing for selling and traditional ceremonies
Legumes	Groundnuts	Household consumption, income generation from selling surplus. Fixing nitrogen into the soil.
	Sugar beans	Household consumption, income generation from selling surplus. Fixing nitrogen into the soil.
	Cowpeas	Household consumption, income generation from selling surplus. Fixing nitrogen into the soil.
	Round nuts	Household consumption, income generation from selling surplus. Fixing nitrogen into the soil.
Tubers	Sweet potatoes	Household consumption and income generation from selling surplus.
	Potatoes	Household consumption.
Vegetables	Including butternuts, onions, tomatoes, cabbage, spinach, chomolia, tsunga, pumpkins, carrots, tomatoes.	Income generation and household consumption.

Source: Farmer FGDs and SSIs responses.

The two main purposes of growing crops are household consumption and income generation. Other reasons include stock (cattle and poultry) feeding. Crops like sorghum and rapoko are also grown as important ingredients for beer brewing for traditional functions and for selling. Apart from household consumption and selling surplus, legumes are also grown for improving the soil nutrient status by their ability to fix nitrogen into the soil. The farmers postulate that they view farming as a business and are very serious about it. Further, the income generated is used to buy inputs and for other non-agricultural purposes like paying schools fees for their children and grandchildren.

Apart from these reasons, farmers highlighted that they feel it is their responsibility to contribute to the country’s food security. This is reason why they sell some of their maize yields to the state-controlled Grain Marketing Board (GMB) even though the prices are generally lower than what they get at the market. Although farmers sell their crop produce locally in their communities, their main market is in Gweru city centre. However, they complained that they are facing stiff competition in Gweru CBD due to increased influx of cheaper, similar products from South Africa.

6.3.3. Farmers’ evaluation of extension services

In the FGDs held in all the Wards, farmers highlighted that extension agents visit them at least once a week during the growing season. However, in the SSIs 18.5% of the farmers indicated that agents visit them once every fortnight (Table 3). Most of these farmers come from Nyama and Communal Ward 16. A possible reason for this could be that these two Wards are the largest in terms of land area, thus it takes longer time to cover all villages within the Wards compared to other six Wards. It was also observed that field extension agents actually reside in their respective Wards, thus making it possible to visit or meet farmers frequently particularly those residing closer to them.

Respondent farmers in the FGDs identified several services they expected from extension agents. These included sourcing and distributing inputs, introducing and demonstrating technologies or new practices, training, and advisory services as demanded by farmers. Advisory services include seasonal climate forecasts and agronomic practices like crop protection (herbicides and pesticides), fertiliser placements, and selection of crops and varieties suited to their soil conditions and prevailing weather. Furthermore, farmers expect extension agents to link them with donors and NGOs who bring technologies and sometimes inputs and food aid.

The majority of the farmers interviewed (85.5%) rated extension services to be good while 7.5% percent perceived services to be average (Table 3). Reasons given for rating services as good include: they visit regularly; they respond to farmers’ calls to meet; and advise them. One respondent captured this well by declaring that agents “do not let us down”. The reasoning is that they treat farmers as adults and also because farmers’ yields are improving because the advice and services they get from agents. No farmer rated extension services as excellent. Only six percent (6%) rated services as poor. Reasons for the poor rating include that agents sometimes bring inputs and seasonal climate forecast information late into the season, and they sometimes bring expired seed and outdated technologies.

Farmers perceive extension agents as playing a number of roles within their farming systems. These roles include teacher/instructor, advisor, facilitator and partners in research. All the respondents (100%) viewed extension agents as advisors, while 66.5% and 56% of farmers also perceive extension agents to be teachers/instructors and partners in research, respectively. Conversely, 85% of the farmers perceive that extension agents to view farmers as their students who are eager to learn from them and 82% as partners in research. Reasons for these assertions were based on non-dictatorial tendencies of extension agents and their acknowledgment of farmers' indigenous knowledge and experience in their environment and conditions, which agents do not have, as well as always working together as a team in identifying problems and sharing information. Only 12.5% of the farmers perceived agents to view them as mere beneficiaries of their expertise and technologies. Despite these perceptions, the most preferred and appropriate extension approaches by respondents are the learning (97%) and participatory (89%) models. This corresponds with findings by Swanson and Rajalahti (2010) and Pant (2012) that there is no single extension approach that is appropriate at all time. The learning and participatory extension approaches preferred by Lower Gweru farmers concurs with findings by Van de Fliert (2003) and Worth (2014) who posited that learning in small-scale farming systems should be more of interactive, experiential, field-based and participatory in nature. An extension system consisting of such learning and participatory attributes is most likely to be effective and successful as it provides applicable results which farmers may use to make informed decisions concerning solutions or technologies that enhance their livelihoods (Van de Fliert, 2003).

All farmers interviewed preferred and valued the group extension mode more than the individual farm visits (48%) and mass media (11.5%). The most common examples of group extension modes preferred by farmers during the FGDs were group meetings, demonstrations, field days and on-farm experiments. Similar findings were noted by Zhou (2008), Allahyari et al. (2009) and Mashavave et al. (2011). Reasons given for the preference for group extension mode include learning from other farmers' experiences, it affords farmers opportunities to brainstorm and discuss their problems and possible solutions, and it is easy, better and faster to share ideas and to "spread agricultural gospel". These farmer interactions were noted to be beneficial to the development of farmers' decision-making, leadership, and management abilities (Van de Fliert, 1993, cited in Anderson and Feder, 2004). Further, farmers at the Madikani FGDs highlighted that it easy to demand services as a group compared to doing so individually. Similarly, Davis and Place (2003) noted that the group extension mode brings together farmers with common challenges which usually demand concerted action, thus giving farmer groups a voice to demand extension services. Currently, Madikani farmers are requesting more information about contour ridges as means to control soil erosion against the buffer strips recommended by extension agents.

Despite its relatively lower preference, farmers deemed individual and mass media extension modes to be important. Individual farm visits were noted to be necessary as it complements and affords agents a chance to follow up on what was learnt in groups by offering assistance in implementing technologies in the farming system on a case-by-case basis. This approach is noted for fostering building confidence, trust and credibility between the agent and the farmer (Oakley and Garforth, 1985; Nduru, 2011). Although the mass media mode is useful for creating awareness among many farmers at within a short period of time because of their wide coverage (Nduru, 2011), most of Lower Gweru farmers do not favour it. Their reasons for this include lack of electricity to power radios and televisions (most of them do not have radios and televisions). Second, most of the farmers are old and less literate (and have difficulties in reading pamphlets, newspapers and magazines); they learn better by observing or doing than reading.

Table 3: Farmer perceptions of extension and their preferred extension approaches

Factor	Category	Frequency	Percentage
Frequency of visit	Weekly	163	81.5
	Fortnightly	37	18.5
Extension rating	Poor	12	6
	Average	17	8.5
	Good	171	85.5
Farmer perception of extension agents	Teachers/Trainers	133	66.5
	Advisors	200	100
	Facilitators	74	37
	Partners in research	112	56
How extension agents perceive you	Students	170	85
	Beneficiary of their knowledge and advice only	23	12.5
	Partners in research	164	82

Factor	Category	Frequency	Percentage
Does an agent's personality and conduct influence your technology adoption decision	Yes	172	86
	No	9	4.5
	Indifferent	19	9.5
Preferred extension approach	Advisory	109	54.5
	Participatory	178	89
	Facilitation	49	24.5
	Learning	194	97
Preferred extension modes	Group	200	100
	Individual	96	48
	Mass media	23	11.5

Source: Farmers' SSIs responses.

It is submitted that farmers' rating of the extension agents had a lot do with the agents' personal attributes and working skills (Table 4). This was also evidenced by 86% of the farmers who highlighted that the personality and conduct of an extension agent bringing and/or recommending a new technology may determine the decision to adopt or not (Table 3). Farmers do not like an agent with an "I know it all" attitude, who do not respect them, their knowledge and decisions and who do not sympathize with them. Conversely they desire an agent who is humble, approachable, impartial, honest and mature (Table 4). They even prefer agents who are God-fearing. By this they probably meant someone who fits into their social networks and identifies with them (Lower Gweru is well known as a Christian community where the Seventh Day Adventist Church is the most prominent). These attributes and skills desired by the Lower Gweru farmers are similar to findings by Anderson and Feder (2003), Guerin (2000), Aphunu and Otoikhan (2008), Ingram (2008), Asiedu-Darko (2013) and Chowdhury et al. (2014). Chowdhury et al. (2014) called such attributes soft skills that transcend formal technical skills and are critical for extension agents to effectively help farmers in finding solutions to their problems and gain the trust and credibility of the farmers. Without these soft skills chances are high that technologies and advice recommended or offered are easily dismissed (Pannell et al., 2006).

Table 4: Personal attributes and working skills desired by respondent famers in extension agents

Personal attributes	Work conduct/skills
Humble – should not have an "I know it all" attitude	Ability to communicate effectively including in vernacular/mother language of farmers
Mature	Respectful and values farmers' skills, experiences and decisions– and treat us as elders not children
Technically competent – they should be more advanced than us (farmers)	Committed to farmers and extension work – being time conscious with regards to start of season and all agronomic processes including sourcing inputs, SCF, keeping schedules and
Approachable	Impartiality to all farmers
Patient and good listener	Sympathize with farmers in social problems like funerals (should be part of us and our community)
Honest and God fearing (Christian)	Should be an encourager and motivator
Decent and well behaved (not promiscuous)	Ability to work with our traditional leadership
	Ability to teach us and also to learn from us

Source: Farmers' response from FGDs and SSIs.

6.3.4. Sources of technologies and farmer adoption of recommended technologies

The major sources of technology for Lower Gweru farmers include NGOs, extension and research institutes. NGOs, particularly 'Help Germany' and 'Zimbabwe Agricultural Income and Employment Development' (Zim-AIED) are responsible for most technologies disseminated in Lower Gweru (Table 5). According to farmers interviewed, Help Germany and Zim-AIED provide technologies at subsidized prices, and sometimes they give samples of technology for free at ward level. This is usually done as a means to have farmers test the technology in their environmental conditions. The farmers have two very different perceptions of the NGOs and extension. They explained that extension agents are a trusted source of technology because most of them resides and farm in the same communities (Wards) with farmers. *"They have our best interests at heart and they know our local environment better than NGOs and research institutes. Unlike NGOs which do not stay long after their projects are completed, extension agents are always with us to help us improve our livelihoods"*.

Table 5: Technology adoption by small-scale farmers of Lower Gweru

Source of Technology	Technology	Adoption rate (%)	Reasons for adoption rate
Help Germany	Value addition	100	No costs involved, many products from sweet potatoes
Network providers	Cellphones	93	Useful in conveying messages on time. No information distortions as farmers get message from agents directly.
Help Germany	Conservation agriculture	90	No costs involved. Helpful especially to farmers without draft power as there is no need for ploughing
Met Services /Extension agents	Seasonal climate forecast	84	Farming decisions are influenced by seasonal forecast information
Zim-AIED	Thermal compost	78	Cheap source of fertilizer and highly favoured by farmers without cattle.
Extension agents	Castration of bulls	73	Less painful to cattle, easy to use
Zim-AIED	Livestock feeds (stover rakes	67	Easy to make, reduce wastages
Extension agents	Livestock dehorning	56	Improved health of cattle and reduced injuries due to less fights
Zim-AIED	Seedbed management	54	High quality seeds and it is easy and cheap
Extension agents	Fertility management (application at planting station)	47	It makes efficiently use of resources, improved yields
Extension agents	Raised beds (on wetlands)	43	It has ensured all year production in areas where it was previously not possible
Help Germany	Poultry Layer production	37.5	Relatively high costs of setting up and feeds
Help Germany	Groundnuts roasters	24.5	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
Research Institutes	Crop simulation models/outputs	17	Introduced to fewer farmers. Not easy to use outputs without experts
ICRISAT	Moisture conservation (full stop)	15	Not clearly understood by older farmers and its costly
Zim-AIED	Crop protection/herbicides	15	They are effective and reduce labour for weeding but costs are a major challenge
Zim-AIED	Treadle pump	12	Costly although it eases labour requirements of fetching from long distances. Most farmers cannot afford it
Help Germany	Metal Silos	11	Highly regarded but costly
Zim-AIED	Solar driers	9	Highly regarded but costly
Help Germany	Bee farming	6	Although it is cheap, there is a high risk of getting bitten. Honey is also medicinal and a source of income

Source: Adoption rates were generated from the 200 SSIs responses and verified by researcher where feasible

Table 5 highlights three things. First, there four key factors that influence adoption: cost (both the cost of the technology and the impact it has on income); efficacy (that the technology is useful or creates an efficiency); ease of use; and risk. Of all of these, risk appears to be the most powerful factor. Bee farming is understood to be inexpensive, generates income (and contributes to health), but comes with a risk that outweighs the potential benefits. Similarly, cost is a key negative factor. No matter how highly regarded a technology might be, if the cost of acquisition too high or the added value is low, then the technology will probably not be adopted.

Second, the responses of the farmers interviewed clearly indicate that the farmers are rational in their decision-making. They are not convinced by the technology on its own; they consciously consider it in the light of risk and cost. Third, the source of the technology does not overly influence the decision to adopt. Help Germany offered technology options that saw 100% adoption (value addition) and options that saw only 6% adoption (bee farming).

From another perspective, the data in Table 4 suggest that respondent farmers adopt technologies which require less labour, low initial costs of setting up, time and energy saving, easy to learn, improves yields and easy (feasible in their circumstances) to implement. These findings are consistent with Rogers' diffusion of innovation theory (Rogers, 2003). Another important factor noted was availability of rainfall particularly if the technology is in the form of inputs (crop hybrids, fertilizer) dependent on availability of water to be profitable. In fact, some farmers highlighted that rainfall in their area can often results in recommended technology to fail.

According to the respondents, conservation agriculture was highly adopted (90%) mainly because farmers found it to increase crop yields, reduces soil erosion and ensures more efficient use of resources. More important to the Lower Gweru farmers, it does not require draught power to implement, thus it is very popular among farmers with fewer or no cattle. However, it was noted that even farmers who have cattle for tillage purposes adopted it. Similarly, thermal compost was highly adopted (78%) due to numerous advantages including a cheap and locally available alternative to inorganic fertilizer and cattle manure (particularly for farmers having few or no cattle). According to these farmers, use of compost resulted high crop yields, almost similar to yields they normally obtain when they utilize inorganic fertilizers (this could be also because they normally apply low fertilizer rates of approximately 20kgN/ha). Secondly, compost helps reduce leaching of nutrients from the soil. Thirdly, farmers cited that vegetables taste better when compost (or cattle manure) is applied compared to when inorganic fertilizer is applied. Fourthly, soils are maintained or improved by using composts (and cattle manure) as opposed to using inorganic fertilizer, which some farmers say hardens the soil. Finally, farmers highlighted that compost quickly releases nutrients to the soil thus making it available for plants quicker than cattle manure.

The high adoption percentages of the conservation agriculture and thermal composts can also be attributed to the fact that they are very similar to farmers' own technologies like *gatshombo* and use of grass and crop residues to make composts respectively. Similarly, Asiedu-Darko (2013) found that farmers easily adopt technologies with traits associated with their own traditional practices. According to respondents the main difference between farmers' own technologies like *gatshombo* and composts and the so called conservation agriculture and thermal composts being promoted by NGOs is in standardisation in terms of sizes and how to use them effectively and efficiently. For this reason, they feel they own these technologies although they acknowledge the technologies have been upgraded and improved by experts.

The foregoing speaks directly to the decision-making framework of small-scale farmers. These findings are consistent with the notion that small-scale farmers are essentially rational and are "widely regarded to make rational decisions about their farms and other activities they are engaged in" (Dorward et al., 2007: 348).

6.3.5. Circumstances for considering learning about and adopting new technology

Generally respondent farmers at all the FGDs highlighted that they considered learning about new technology as soon as it is made available to them. Three main reasons were given for this. First, farmers consider their farming operations as a business. They will consider learning any technology disseminated to them to assess if it has potential to improve their production and profitability. Second, farmers cited the need to keep on improving and upgrading the management of their farms, including trying new technologies that come their way. In other words, they do not want to be "left behind" or stuck with old and traditional ways of doing things when they are new or improved alternatives. Third, they stated *"our livelihoods depend on farming and we believe any technology may strengthen our livelihoods* *and our country's economy".* This concurs with findings by Masere (2011) that farmers are keen to learn new or modern technologies if they perceive their livelihoods are at stake.

Farmers in the Chisadza Ward FGDs added that keenness to learn is improved if they perceive that a new technology makes efficient use of resources and/or it adds value to their traditional ways of doing things. At the Mdubiwa Ward FGDs farmers said interest to learn new technology increases if they have a support system, and also when there is a chance for them to first observe how it works and its effect on production. This can be achieved through field-based learning in demonstrations, on-farm trials and field days were results of tested technologies or new practices are reported and farmers can ask more questions and discuss (Akinsorotan, 2009; Nduru, 2011).

Nyama Ward farmers suggested their preferred learning areas including marketing, market prices and innovativeness. Chisadza, Mdubiwa, and Nkawana Ward farmers preferred to learn about processing of raw products, value addition and any other new upcoming technologies that makes their farming easier and more productive. The learning requirements of the Lower Gweru farmers are similar to the learning areas encapsulated in the Extension Carousel of Learning and the Facilitated Learning Agenda framework (Worth, 2014). In the Carousel the major learning areas relates to production, economic and managerial factors.

Beyond learning new technology, farmers make the decision to either adopt or reject a technology. The adoption decision was noted to be based on a technology's relatively advantages against risks like rainfall variability as well as affordability and feasibility of the technology under their biophysical, social and economic circumstances. These findings concur with Rogers' innovation decision process theory (Rogers, 2003).

As shown in Table 6, findings, both from the FGDs and the SSIs, showed that farmers assume different technology 'adoption categories' for different technologies and also under different circumstances. Innovators in one set of circumstances will not automatically be innovators in other circumstances (Rogers, 2003); they might even be laggards in different circumstances. The circumstances identified by the farmers determining when are they innovators, early adopters, late adopters and laggards are set out in Table 6.

Table 6: Circumstances when respondents are innovators, early adopters, late adopters, laggards

Adoption category	Circumstances
Innovator	When a farmer has knowledge, is confident about a technology and its potential for increasing production, resources are not limiting or when they are easily available
Early adopter	When a farmer fully understands the benefits of a technology through demonstration and when the costs involved are minimum
Late adopter	When a farmer is not sure of a technology, when he/she need to see the actual benefits from trials, when the costs are relatively higher and there is a greater risk in adopting the technology
Laggard	When a farmer can neither afford the technology nor understand it. Also where there is no other information support or they doubt the competence of the extension agents recommending the technology

Source: Farmers' responses from FGDs and SSIs.

6.3.6. Challenges faced and support needed by farmers in technology adoption

Three major challenges affecting farmers' adoption of technology were noted. They are lack of capital to acquire some technologies, lack of information and support systems to enable adoption, and the market for most crops they grow is flooded. These market problems often force farmers to sell most of their products at low prices. They also lose a lot of excess produce, especially perishables, as they do not have storage facilities (refrigerators) and they do not have electricity in their homes. Moreover, farmers end up travelling to Gweru city centre to sell their surplus. However, farmers highlighted that, in the city, they are usually targeted by thieves and middlemen who make them sell at lower prices.

The semi-arid climatic conditions of Lower Gweru were also identified as a major challenge as farmers are generally reluctant to adopt technologies that need availability of rainfall to succeed. The riskiness of technology adoption in such a low and erratic rainfall area is too great for these farmers who are generally resource-constrained.

Another challenge noted by farmers who adopted some mechanised technologies, like the treadle pump, was the unavailability of spares locally. The manufacturing industry sector in the Gweru City is non-functional or non-existent, thus placing farmers at a disadvantage (additional costs) as they have to travel long distances to the Capital city, Harare, to purchase spares.

To counter some of their challenges, farmers identified the kind of support they require to adopt some of the recommended technologies. These are information support and training, credit facilities, and input and output markets support. Farmers felt their extension agents are generally competent enough to train them on most technologies and they can facilitate experts and specialists to train them, if and where necessary. This leaves capital/credit facilities and markets as their main areas of concern where farmers really need support and assistance. Consequently, farmers highlighted the need to have access to credit facilities offering loans at low and reasonable interest rates as important for them acquire technology. They prefer to get such services from government or through its initiatives because they believe the government should write off their debts in the event a drought occurs. Alternatively, farmers suggested they would adopt if they get technologies at subsidised prices or when they enter into some form of arrangement with technology developers where they can acquire certain technologies and pay for them later.

Farmers proposed the setting up of value addition companies in their Wards or within Gweru, so as to maximize their crop produce for example through canning and processing some of their raw crops into secondary products. Such products are usually easy to market and sell hence farmers may make more profits, and can store or preserve these products for longer periods of times. Other options identified by farmers include local manufacturing industries to be revived so they can manufacture spares and other technologies like metal silos using locally available and cheaper resources.

These challenges and, more specifically the farmers' proposed solutions are consistent with the findings presented in Table 5. They reaffirm the power of cost and the fear of risk as key factors in technology adoption. Subsidised prices and credit, protection against the risk of drought, and value adding (which all the farmers would adopt) all surfaced again when discussing constraints and solutions. They also reaffirm that it is not generally the technology itself that is the problem, but a range of factors surrounding it that most heavily influence their adoption behaviour.

6.3.7. Farmer organisation and participation in innovation and extension projects

Findings from the FGDs in the eight wards showed that Lower Gweru farmers are generally organised into farmer groups. These groups are formed on the basis of determination and willingness to succeed in farming. Respondent farmers found it easier to work in groups because they have good working and social relationships. This is contrary to findings by Hellin (2012) who noted that farmers rarely self-organise or work collectively, but is consistent with findings by Van An (2006: 98) which found that “farmers prefer to work in homogeneous groups where members have similar resource constraints and interests”. According to respondents, such groups can have a minimum of 10 members, usually residing in the same Ward. The groups select their leaders, usually a chairperson, deputy chairperson, secretary and treasurer. The group leaders are responsible for communicating with extension agents or demanding certain services on behalf of the groups. The main activities of farmer groups include regular meetings to discuss and learn from one another including sharing experiences, and dissemination of innovations and technologies. Secondly, group members help each other in field operations like weeding. Thirdly, they pool their resources (money) to buy inputs which they will later share before the beginning of a season. Other functions include taking care of orphans by contributing food and cooking for them.

Farmers groups also offer an excellent platform which extension agents can use to introduce and disseminate new technologies to a relatively larger number of farmers at once. This was evidenced by the majority of the respondent farmers who preferred to be participants in innovation and extension projects rather than beneficiaries of innovations developed without their input. Lower Gweru farmers noted that this participation is good for their own development. Benefits also include skills to generate income and more informed decision making.

Farmers noted several benefits of participating in innovation or extension projects. Firstly, there is more sharing of information and experiences, thus improving their knowledge of managing their farm businesses. Farmers in Mdubiwa Ward highlighted that experience gained from participatory learning in innovation projects has led to improved crop yields, increased number of calves per cow and improved quality of their livestock. They further highlighted that their livestock is now attracting better grades at the markets when they decide to sell resulting in more income. Secondly, farmers have a sense of ownership of technologies/innovations as they participate in problem definition and developing of solutions rather than having technologies imposed on them as a finished product without their input. This entails development of better understood and desired technologies tailor-made to farmers' biophysical and socio-economic conditions. Thirdly, farmers highlighted that they are empowered to demand services from extension agents and researchers as a result of participatory learning in extension programmes. This concurs with findings by Katanga et al. (2007) and Ngwenya and Hagmann (2011). A current example of this is the farmers in Chisadza Ward demanding assistance and training from extension agents and Agricultural Engineering Department on how to construct contour ridges to minimise soil erosion. This was despite the extension agents recommending them to use buffer strips. Finally, farmers highlighted that they are moving away from dependence on donors, NGOs and Government for handouts, to more self-sufficiency and greater self-reliance.

6.3.8. Technologies developed by and with other farmers

Small-scale farmers have also developed their own small-scale technologies through their farming experiences and those of other farmers. Most of these technologies have been successful and have served and continue to serve them well (Beckford and Barker, 2007; Altieri and Koohafkan, 2008). The main advantages of such technologies include that they are low cost, easy to use and there is farmer ownership entitlement. Some of these small-scale technologies have been upgraded or improved by extension and other modern technology developers. Lower Gweru farmers identified the following successful technologies they have developed or which were developed by other farmers:

- Preservation of seed for main crops like maize and cowpeas. They select maize cobs of high yielding local open pollinated varieties (OPVs), like *bogwe*, which they store in their grass-thatched kitchens where they are continuously treated by smoke from fire. They will use the grains from such cobs as seed for in the next season. They highlighted that this technology is easy to operate and there are no costs involved; instead they save the cost of buying hybrids. For treating and preserving cowpeas seed from weevils, farmers use a mixture of paraffin and ash.

- Pest and disease control in field crops for example control of maize stalk borer using sand and donkey manure.

- Livestock breeding control through castration of bulls using knives. They modified this and are now using the burdizzo and injections which makes the process comfortable.
- Crossbreeding of livestock.
- Rainfall forecasting through studying local indigenous indicators like fruiting of certain indigenous tree species, position of the moon, wind direction and birds.
- Preservation of harvest through burning gumtree leaves and cow dung to repel weevils inside the granaries. The burning is aimed at eliminating oxygen in the granary to ensure no weevils will survive.
- In Madikani Ward farmers developed their own irrigation by flooding in gardens, expanding their gardens as a result - now employing others. It minimises labour requirements, and avoids destruction of environment by doing away with holes. Farmers have also extended this technology to have “showers” for bathing.
- Live fencing for marking homestead and field boundaries and also protecting crops from straying animals.
- Poultry droppings are mixed with water to form what Lower Gweru farmers call “chicken soup” which they use as top dress fertilizers.
- Crop rotation.
- Intercropping, growing cover crops and runner crops like pumpkins to control soil erosion because very little land will not be covered.
- Digging of wells
- Spot irrigation: Applying water to areas around a plant only as opposed to the whole gardens

6.4. Conclusions

Simplicity, availability, low risk and affordability are the major attributes that attracted farmers to adopt technology. Further, new technology with similar traits to farmers’ own indigenous practices or technologies developed by farmers and/or their counterparts are easily adopted for example conservation agriculture and thermal compost. In addition to these technological attributes, technologies that effectively and efficiently make use of locally available resources including potential for all year round production and reduction of wastages as relatively adopted better.

Despite the generally low rates of adoption for many technologies, small-scale farmers appear ready to learn about new technologies if given a chance and the right conditions. A decision on adoption is generally based on affordability, information support, availability of markets and credit facilities offering loans with lower interest rates. Biophysical conditions including availability of rainfall also presents major challenges to adoption as most technologies depend heavily on of rainfall to succeed.

The study documents that farmers prefer to learn new technologies in groups where they can discuss and share experiences and innovate as opposed to be mere recipients of technologies developed without their input. Farmers further highlighted that they perceive themselves as businessmen and women who aim to take their businesses to the next level – which is processing their raw/primary products into products of more value. However, the areas of interest varied by group (Ward), suggesting that it is not wise to assume that even farmers with the same apparent general circumstances are necessarily going to respond uniformly to extension interventions. This is consistent with Worth (2012) who argued that each farmer will fall within a unique point on a continuum of multiple interlinked factors that affect his farming system.

Perhaps most significantly, this study has reaffirmed that small-scale farmers, despite their educational limitations, their age, their constrained circumstances, and their risk profiles – are conscious and deliberate decision-makers. They are rational in their approach to adoption of technology, but are dominated by factors of cost, impact on income, and, of greatest influence, risk.

Extension agents play multiple roles in small-scale resource-constrained farming systems as demanded by circumstances. The roles include training, instructing, facilitating and brokering among different stakeholders within innovation network systems. Understanding the learning, technology adoption and decision-making framework, factors and influences among small-scale farmers – and keeping an eye on the uniqueness of each farmer – will increase the effectiveness of the extension agents in serving the farmers.

6.5. Policy implications

Technology developers must ensure they develop technologies that are affordable, simple to use, and, where possible, should involve farmers in the research and development stages of technology. This often leads to development of desired technology, thereby improving chances of adoption.

Small-scale farmers are conscious and deliberate decision-makers who prefer to be engaged as partners in research and learning, as such AGRITEX and other key extension practitioners should employ learning and facilitation extension approaches. Through such extension approaches there is an exchange of valuable information between actors, particularly the local knowledge, practices and innovations of (successful) farmers which are often ignored in the predominantly top-down technology transfer extension approaches.

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CHAPTER 7: Factors influencing adoption and innovation of new technology and decision-making by small-scale resource-constrained farmers: the perspective of extension

Abstract

This study was conducted in Lower Gweru Communal area of Zimbabwe to determine the views and opinions of extension agents on factors affecting small-scale resource-constrained farmers' technology adoption and innovation processes. The effects of extension agents' working conditions on the quality of service delivery to farmers were also investigated. Data were collected by means of semi-structured interviews conducted with all the 21 extension personnel working in Lower Gweru Communal area. It was found that extension agents perceived the lack of in-service training, transport, poor remuneration and high extension agent to farmer ratios to be main reasons hindering them to offer high quality services to farmers resulting in poor technology adoption. Further, respondents indicated that although farmers have capacity to innovate and to adopt technology in the form of indigenous knowledge, experiences, willingness to learn, commitment and labour, their main challenges include lack of capital to acquire technology, lack of information support on how to use new technology and lack of markets. 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 farmers' needs, resource-endowments and biophysical conditions of their farming communities.

Keywords: AGRITEX, extension; innovation; small-scale farmers; technology adoption

7.1. 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. Extension is also responsible for taking feedback from farmers to research and technology developers (Rogers, 2004; Zhou, 2008). 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. Unfortunately, the primary extension agency in Zimbabwe, the

Department of Agricultural Technical and Extension Services (AGRITEX), is faced with serious challenges hindering its service delivery (Hanyani-Mlambo, 2002; Davis, 2008; Mugwisi et al., 2012). Consequently, farmers are receiving compromised extension services from agents who are poorly remunerated and with little or no motivation to do their job. This has led to poor adoption of recommended technology by farmers. For these reasons, this study was conducted in Lower Gweru Communal area of Zimbabwe to determine the perceptions and assessments of extension agents on factors affecting technology adoption by small-scale farmers and the effect of agents' working conditions on the quality of extension services they render to farmers.

7.2. Methodology

This study is part of a larger study investigating the role of extension in technology adoption by small-scale resource-constrained farmers. The study sought separately the perceptions of farmers and extension agents. Both parts of the study were carried out 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. 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. 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, Nkawana and Communal Ward 16. Each of these Wards is serviced by two extension agents. The study population for this part of the study was composed of 16 field extension agents, two extension supervisors, two agricultural extension officers and the district agricultural extension officer. Thus, the study population was 21 AGRITEX personnel. Due to the relatively low study population, all the 21 extension personnel were part of the study. Data were solicited using semi-structured interviews (Barriball and While, 1994; Campion et al., 1988) (Appendix 3). The data were triangulated for consistency with findings gathered from the farmers in another part of the study.

7.3. Results and Discussion

The key findings are presented and discussed under three major themes: Effect of socio-economic characteristics of extension agents on job performance; Extension agents' perception on farmers' systems and their capacity to adopt technology and innovation; Extension approaches used by respondents in technology dissemination.

7.3.1. Effect of socio-economic characteristics of extension agents on job performance

This section presents and discusses: the demographics of respondents; the quality of extension services rendered to farmers; the job satisfaction of extension agents; the challenges facing AGRITEX and its extension workers; and the training needs and status of in-service training.

7.3.1.1. Demographics of respondents

The extension personnel working servicing the Lower Gweru Communal comprised more females (57.1%) than males (42.9%). 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 (Table 1). Similar findings were noted by Okereke and Onu (2007) who found middle-aged extension agents to be mature and capable to handle the rigours of tedious extension work. The majority (57.1%) of respondents have more than 10 years working experience. However, this group mainly consists of high ranking extension officials who rarely go to the field to work directly with the farmers on a daily basis. Thus, the remaining 42.9% who have less than 10 years working experiences were also the low ranking field extension agents.

The majority of respondents (66.7%) are educated up to diploma level, 23,8% have a Bachelors, and less than 10% having progressed past the Bachelor's degree (Table 1). This finding is similar to findings by Okereke and Onu (2007) and Demenongu et al. (2015) who suggested that agricultural extension agents have the basic educational qualifications to perform their duties effectively.

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
	Honours' Degree	1	4.7

Factor	Category	Frequency	Percentage
	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
Perception of farmers regarding technology adoption	Beneficiary	10	47.6
	Partner in research	4	19.1
	Both beneficiary and partner in research	7	33.3

Source: Extension agents' responses from SSIs.

7.3.1.2. 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.

Average and poor: 19% rated their services to be average and 9.5% rated their services to be poor. The 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. In Zimbabwe the extension worker to farmer ratio is about 1:3000 (Qamar, 2013).

The small sample size prohibits any serious analysis of the statistics. What this does indicate is that the extension agents are relatively conscious of the issues they are facing. While generally confident in their capacity and about their effectiveness, the overwhelming majority (85.7%) observe obvious shortcomings in the service. Lack of transport is a common concern. The extension: farmer ratio is also concerning, even if it was noted only by the minority. South Africa, for example, has set a general ration of 1 extension worker to 500 small-scale farmers (NDA, 2005). The UN (FAO) ratio is 1:500-800 (Issa and Issa, 2013). Inadequate numbers of extension agents and their other commitments, relative to the number of farmers they must serve reduce the adaptive capacity for use of technology (Abdullah and Samah, 2013), which could potentially improve farmer capacity, farm productivity and farmers' livelihoods.

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.

7.3.1.3. Job satisfaction of extension agents

The majority (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 can learn 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. As noted by Okereke and Onu (2007), lack of morale among extension agents impacts negatively on job performance. Similarly, 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.

7.3.1.4. Challenges facing AGRITEX and its extension workers

The main challenge facing the AGRITEX and its workers is poor 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. These challenges are consistent with findings by Hanyani-Mlambo (2002), Davis (2008) and Mugwisi et al. (2012). Similarly, Stevens and Ntai (2011) noted that the majority (78%) of Lesotho extension workers perceived lack of infrastructure and facilities to be the main constraint to efficient extension delivery.

Lack of transport for both agricultural extension officers and field agents limits the coverage of farmers and hence agents are unable to conduct individual farm visits to all the farmers to offer specialised advice to different circumstances of different farmers. Respondents indicated that adoption of most technologies is limited to farmers in the vicinity of agents' houses due to lack of transport to reach far away farmers. This leaves the more distant farmers with very infrequent contact with extension agents. Without adequate contact between these farmers and agents there is little or no chance of considering technology, much less adopting it. As noted by Aphunu and Otoikhan (2008) and Adesiji et al. (2010), there is a positive correlation between technology adoption and farmer contact with extension agents.

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. As noted by Okereke and Onu (2007 citing Agumagu, 1992) for extension agents to be effective, it is important that they reside in their operational areas (Wards) to avoid wasting time travelling, and, more importantly, agent will become part of the farming community thus they will be more readily accepted by the farmers and will always be accessible and available when required by the farmers (Okereke and Onu, 2007).

Despite the poor remuneration and difficult working conditions of the extension agents, respondents indicated that there is still a very low staff turnover. The reason, however, is because there are very few better paying jobs as the country's economy is operating at a very low capacity and there are basically no jobs. Respondents assume that government is taking advantage of the situation knowing there are no ‘greener pastures’ in Zimbabwe.

According to 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, some farmers are better versed with new technologies than the extension agents who are supposed to be bringing technologies to them. Respondents also indicated that they are still using old methods of administration, including handwritten reports and manual filing, due to lack of computers. This impacts negatively on their work as some reports end up being lost, or information is distorted over time.

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. Furthermore, respondents indicated that farmers are more eager to participate in programmes funded and facilitated by donors/NGOs as opposed to AGRITEX-led programmes. Reasons for this include that in donor-funded programmes, farmers get free inputs and other technology, 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 farmers losing their trust and credibility towards agents and the technologies they disseminate. Trustworthiness and credibility of the extension service is very important as it engages with the farmers. Without genuine, earned and well placed trust true extension cannot be achieved (Barr, 2003).

7.3.1.5. Training needs and status of in-service training

As noted earlier, respondents indicated that the in-service training and refresher courses which used to be the strength of AGRITEX have not been conducted over the last decade. The majority of respondents (57.1%) also revealed that some of them were yet to be inducted or undergo in-service training despite joining AGRITEX over ten years ago. This is similar to the findings of Okereke and Onu (2007) who determined that most extension agents (72.3%) in Imo State of Nigeria had not attended any in-service training since they were employed.

Induction courses were previously conducted within the first three years of employment, but due to lack resources, AGRITEX has failed to offer them for many years. These courses covered subjects like extension methods, communication, public speaking, training of trainers, and rural development. They were meant to build competence and confidence among the extension agents. Without these courses, agents perform their duties less adequately. This concurs with findings by Stevens and Ntai (2011) where extension agents perceived lack of appropriate in-service training as a major constraint in equipping them with the essential skills and competence to adequately advise farmers.

One elderly extension supervisor indicated that he often uses his own initiative to train extension agents in areas where they are lacking. Oladele (1999) also found that senior extension officials, through their experience garnered over many years of service, are able to pass on their knowledge to juniors on the job. He indicated further that, without knowledge, extension agents lack confidence and feel intimidated by experienced and competent farmers they are expected to advice. As a result, it becomes difficult to gain credibility and trust of the farmers.

The preferred training areas indicated by respondents include computer literacy skills, geographical information systems (GIS), land use planning, livestock breeding (artificial insemination), training of trainers, climate change forecasting models, crop simulation models and how to apply information outputs in assisting farmers. The main reasons for these preferences were that they need to move with the times in order for them to continue to be relevant. They also need to be more competent and better informed than their clients (farmers). Similarly, Abdullah and Samah (2013) argue that extension workers should update their knowledge and skills and must first be equipped with all the requisite skills and information about new technology before they introduce the technology to farmers. 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.

7.3.2. Extension agents' perception on farmers' systems and their capacity to adopt technology and innovation

The section presents and discusses extension agents' perceptions of farmer capacity to adopt technology and innovate, of farmers' indigenous knowledge/technologies, and their perception of farmers in relation to technology adoption.

7.3.2.1. Farmer capacity to adopt technology and innovate

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, labour, 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.

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

The general perception of extension agents 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, particularly those agents that were fast tracked due to loss of competent staff to alternative, more attractive employment due to the economic challenges that have characterised Zimbabwe over the last 15 years. 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, *zimbani*, *mtuvhiti* 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 specialists. 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.

7.3.2.3. Respondents' perception of farmers in relation to technology adoption

Three broad respondent categories regarding perception of farmers regarding technology adoption emerged (Table 1). The majority (47.6%) saw the farmers as beneficiaries of technology. One third (33.3%) saw farmers as both beneficiary and partner in research. And 19.1% saw the farmers only as partners in research.

Respondents perceiving farmers as beneficiaries of technology cited two reasons. First, farmers have confidence on experts and extension agents to develop and test technologies before they can be disseminated to them for adoption. Secondly most technologies are too complex or beyond farmers' level of knowledge for them to be part of development of those technologies.

Perceiving farmers as partners in research was supported by two reasons. First, farmers contribute to the information needed for development of technologies including their own indigenous technologies which researchers often upgrade and standardise. Second, the respondents acknowledged that they learn a great deal from farmers and vice-versa, and that farmers become partners through their participation in testing technologies in fields, thereby contributing to development of better final products (technology).

The respondents that perceived farmers as both beneficiaries of technologies and partners in research submitted that the type of technology and circumstance determine the role that farmers take in the technology development and adoption process. These respondents noted that there are instances where farmers are innovative and drive the development of a technology, with researchers and extension offering the technical expertise where needed. Similarly, there are times where farmers will be merely beneficiaries of technology developed by experts particularly where there is no opportunity for adequate feedback from extension and researchers. They also argued that the issue is rather how much the farmers are partners (minor, major or equal) in the research development and testing a particular technology.

These findings are consistent with the argument that extension needs to be flexible enough to determine and respond accordingly to the dynamics that surround farmers, their systems and their circumstances. As posited by Koopman and Worth (2015:10-11), "The nature of farmer and extensionist learning suggests that knowledge which flows between individuals can occur dynamically, moving back and forth between them, both horizontally and vertically, making the identification of typologies of learning." Understanding that farmers and their respective households, although outwardly similar, are in reality, unique, and thus "It is within this dynamic context of farmers that extension services must be crafted – both strategically and tactically (Worth, 2012: 5). As noted in the draft South African extension policy, "Flexibility and adaptation to meet situation specific circumstances is important" (DAFF, 2014:11).

7.3.3. Technology dissemination to farmers

This section presents and discusses the extension agents' perceptions in terms of; Technologies disseminated and farmer adoption rate; Extension approaches used by respondents in technology dissemination; and Strategies suggested by extension agents to encourage technology adoption by small-scale farmers.

7.3.3.1. Technologies disseminated and farmer adoption rate

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.

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 fertiliser and highly favoured 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 sceptical 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 minimised 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.

Technology	How disseminated	Adoption rate	Reasons for adoption rate
Fertiliser and manure application rates	On-farm trials, pamphlets and field days	Average	Although yields increased, costs of optimal fertiliser 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.

Source: Extension agents' responses from SSIs. Adoption rate categories were generated from the 21SSIs responses and verified by researcher using data obtained from farmers SSIs

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Technologies disseminated ranged from small-scale to large-scale, simpler to sophisticated, inexpensive to expensive, and those targeting crop production or livestock production (Table 2). While some technologies were highly adopted by farmers, others were not. Technologies with high adoption rates included value addition (sweet potatoes), hybrid seeds, conservation agriculture and soil amendments. 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 Chi and Yamada (2002), Akudugu et al. (2012) and Abdullah and Samah (2013) 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 (Table 2).

The respondents indicated that they use all the three main modes of extension, as suggested by Oakley and Garforth (1985) – individual, group and mass media – to disseminate new technology. These extension modes are used separately and in combination, depending on prevailing circumstances. The group extension mode is the most popular as it saves time and resources for the extension agents. It also offers a platform for discussions, as well as field-based learning for farmers in the form of demonstrations, field days and on-farm trials. Similarly, van de Fliert (2003) proposes 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 (Anderson and Feder, 2004). Respondents also indicated that farmers prefer to learn in groups and that information spreads faster when compared to the individual extension modes. Respondents also noted that field days are useful in converting so-called 'laggards' and encourage late adopters to adopt by showing results of using a certain technology. They noted further that most farmers learn through observation. All of this concurs with Akinsorotan's (2009) finding that 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.

Respondents specified that they use the individual extension mode to follow up on farmers and also when engaging those farmers who are not part of farmer groups. The media extension mode is the least preferred because some farmers are old and cannot read properly, whilst others do not understand English which is the most common language used by seed houses and other technology developers. Respondents also indicated that even the literate farmers have a tendency of not reading the pamphlets. The reason for the general lack of interest by farmers could be, as noted by Nduru (2011), that pamphlets are a poor means for acquiring skills acquisition and they do not offer room for discussion between stakeholders.

7.3.3.2. Extension approaches used by respondents in technology dissemination

Respondents indicated that they have 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 3). This concurs with Campbell and Barker (1997) who postulate that 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 3: Extension approaches used by extension agents

Extension approach	Circumstances	Reasons/Assumptions for using the approach
Linear	Demonstrating a new technology. Training farmers for example 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 they one 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 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.	This approach promotes interactive learning between partners in the innovation network. It usually results in the development of tailor made 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 SSIs.

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 (Rogers, 2004; Spielman et al., 2008; Zhou, 2008). 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 will be given certificates. Despite its 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 3). Similarly, Singh (2009:6) noted 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 also because of the realisation that farmers understand the biophysical conditions of their farms better than extension and researchers. This resulted in an increase in 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.

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 is used when 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 (Anandajayasekeram et al., 2007). 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 have 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 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 is consistent with Stevens and Ntai (2011) who found farmer groups to be one of the most appropriate and effective modes of disseminating new innovations.

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. These projects provide innovation platforms where farmers, extension and other partners learn from each other. As noted by Fahmid (2013), 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 maybe helpful to all partners including technology developers. It is for this reason that Katanga et al. (2007) argued that farmers must be viewed by extension and researchers as equal partners, possessing different, but valuable experiences and skill sets to theirs.

7.3.3.3. Strategies suggested by extension agents to encourage technology adoption by small-scale farmers

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.

Farmer involvement in participatory learning and innovation systems also helps to empower farmers to take initiative, including demanding technologies they deem right for them. As Worth (2002; 2006) and Birner and Anderson (2007) suggest, engagement is the key; farmers genuinely engaged and working within their indigenous framework will create the demand (Birner and Anderson, 2007). 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.

Respondents also suggested that affording farmers ample time to learn new technologies, and the best way to support learning among farmers in Lower Gweru 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 utilised 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. Farmers often lack all the necessary information to make informed decision on technology adoption. Such information includes input and output markets, prices of products produced as result of using technology and how to utilise technologies properly. In addition to understanding the technical efficacy of the technology, Worth (2014) argues that the introduction any technology (or change to a farming system) should also be analysed in terms of how it will affect the management, economic and sustainability aspects of the farming enterprise. The degree to which the technology can be internalised as a 'learning' should also be considered. Akudugu et al. (2012) posit that farmers should have access to technology information and extension services for them to adopt. However, accessibility of extension services alone is not enough, as Chi and Yamada (2002) and, similarly, Abdullah and Samah (2013) argued that extension should have the resources and credibility to convince farmers. A committed extension system may provide farmers such information support to guide decision-making on technology adoption. In addition to a committed extension system, respondents suggested 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. As noted previously, without trust and credibility an agent's recommended technologies are easily dismissed (Chi and Yamada, 2002; Abdullah and Samah, 2013).

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. Findings by Hanyani-Mlambo (2002) indicated that AGRITEX has previously failed to build on successful informal technologies developed by farmers or disseminate them to other farmers. Further, respondents suggested the need for timely feedback (e.g. results of on-farm of tested practices/technologies) from researchers upon completion of research projects. Mugwisi et al. (2012) argue that the main reason for poor exchange and flow of relevant information and technologies is lack of communication and poor linkages between the researchers, extension workers and farmers. Similarly, respondents proposed that documentation and publishing of research findings is essential to ensure continuity of use of this information by farmers after completion of projects.

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. Similarly, Chi and Yamada (2002) found the lack of capital and credit facilities to acquire and utilise 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.

Affordability of technology can also be achieved by downscaling certain technologies to level that can be utilised at the small-scale level. Respondents noted that downscaling of technology can also encourage adoption, as some technologies are just too bulky to be utilised on the generally small farm sizes that characterise small-scale farmers hence small-scale farmers do not even consider them.

7.3.4. Key actors in the agricultural extension system for Lower Gweru Communal area

Respondents identified numerous organisations with which they have worked and with which they are still working in Lower Gweru. They range from research institutions, NGOs and technology developers and other government departments (Table 4). Each of these actors provides services aimed at improving farm production, livelihoods of farmers and conservation of natural resources. The availability of such organisations within Lower Gweru 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, ability to empathise, listen and value farmers and other actors' insights, impartial and technically competent (Ingram, 2008).

Table 4: Partner organizations and technologies they develop or disseminate

Organisation	Technologies developed or disseminated/Main roles
ICRISAT	Water conservation technologies and fertility management techniques
Help Germany	Conservation agriculture, inbuilt silos, treadle pump (giving free or at minimum cost) poultry project, vegetables, sweet potatoes, value addition
Zim-AIED	Improved inputs and training on different technologies and on marketing products
Seed Houses	Development of improved hybrids, offering starter parks for on-farm trials and demonstrations. Sponsoring field days as well as look and learn tours. Specialised information support on different seeds
Marketing boards e.g. Tobacco Research Board (TRB) and Grain Marketing Board (GMB)	Sourcing, marketing and distribution of agricultural inputs and products on behalf of farmers. They also promote research. GMB also buys farmers' produce and are the Silo of the Country.
Fertiliser companies (Zimbabwe Fertiliser company –ZFC)	Development and distribution of different fertilisers (basal, straight and foliar sprays for different crops, training farmer leadership, horticulture and marketing
Department of Irrigation	Designing of irrigation schemes (operation and maintenance of schemes) and advice farmers on water saving technologies
Livestock production Department and Veterinary services	Dipping of cattle. Advice farmers on supplement feeding including silage making and better care for draft power animals
Agricultural engineering	Pegging fields. Advice on soil and water conservation practices. Designing of contour ridges and grain storage facilities like granaries
Adventist Development and Relief Agency (ADRA)	Promote the food for work schemes for the rehabilitation of community gardens, fencing of gardens, irrigation schemes and dams. They also specialise in community food security, health, education, economic development and emergency management
Syngenta	Development of agrochemicals and hybrid horticultural seeds
Zimbabwe Republic Police (ZRP)	Safeguarding farmers' livestock including advising farmer on cattle branding using unique codes to distinguish livestock owned by different farmers
Local traditional leadership (Chiefs, Village Heads)	Supports and allow different organisations and projects to undertake research in their areas for the betterment of their people. They encourage their people to heed advice of Agricultural extension workers and their partners
Women and Land in Zimbabwe (WLZ)	Offer leadership mentorship to women and training on gender and empowerment issues including eradicating gender discrimination in access, ownership and control of land, natural resources and related opportunities for sustainable livelihoods. They also develop value addition centres and offer poultry, inputs, driers, grinding mills, fences, boreholes to communities
Environmental Management Agency (EMA)	Protecting the environment and training on practices which conserves natural resources. They provide legislation about conservation of natural resources and against poor practices like streambank cultivation
Red cross	They assist the disadvantaged and those infected and/affected by HIV/AIDS with small livestock, farming inputs and food
Heifer International	Livestock (cattle, goats, guinea fowls, poultry
Forestry commission	Training on Agroforestry and prevention of deforestation
Meteorological Department	Dissemination and training farmers on seasonal climate forecasts
Other NGOs	Offer drought relief and livelihoods project within the community

Source: Extension agents' responses from SSIs.

Respondents indicated that these organisations have the resources (including technology) and have helped AGRITEX and its agents in reaching out to farmers with technical and other specialised services. Further, respondents indicated that there is need for strengthening and coordinating these multi-actor linkages to ensure a win-win situation for all parties including farmers and technology developers.

7.4. Conclusions

The study suggests that extension agents are well-educated, mature and sufficiently experienced to perform their jobs effectively. However, challenges within Zimbabwe's AGRITEX and the country at large including poor funding, poor remuneration, poor infrastructure and facilities (e.g. transport and accommodation), lack of in-service training opportunities, and poor general working conditions are hindering agents from performing their service delivery work effectively and efficiently. Although initially, the majority of extension agents indicated that they perceived the quality of their services were good or excellent, further enquiry determined that they are, in fact, not satisfied with quality of services they are currently delivering to farmers due to the numerous challenges they are now facing. They perceived the lack of in-service training, designed to strengthen their competencies and also for them to remain relevant in service delivery to their clients, as one of the main factors affecting technology adoption by farmers. Consistent with Abdullah and Samah (2013), the study documents the need for extension agents to be trained first and equipped with all the necessary technical skills and knowledge on new technology before the technology is introduced to farmers.

The study showed that extension agents no longer view farmers through the monocle of being mere beneficiaries of technology, but also see them as important partners in research and development of technology. Extension agents acknowledged farmers' capacity to adopt technology and to innovate, and the value of their indigenous knowledge, labour and draft power resources, commitment and willingness to learn new practices. Extension and research should build on successful farmers' indigenous innovations and work together with farmers as equal partners if the technology adoption issue is to be addressed. Further, such farmer-extension-research linkages must be strengthened.

Finally, the study found that farmers are more likely to adopt less-expensive, simpler and less risk technologies which increase farm production. Availability of credit facilities at low interest rates, markets, information support, as well as motivated and competent extension service delivery, will go a long way in enhancing technology adoption by farmers.

7.5. Policy implications

AGRITEX needs funding for two main reasons. First is to develop the capacity of its workers, particularly regular in-service training to improve competencies in engaging farmers with modern technologies. Secondly, for improving working conditions including transport and housing facilities, materials for demonstrations and training farmers as well as better remuneration. This will go a long way in motivating the extension agents to do their jobs effectively, which should in turn improve farmers' capacity and willingness to consider the technologies recommended or otherwise presented by extension agents.

The emergence of other key actors in the extension system for Lower Gweru prompts the need for the roles of each actor to be more clearly defined, and linkages between actors strengthened. These linkages have potential for paving ways for the development of technologies tailored by, with and for the farmers that are more relevant to their resource-endowment status and the biophysical conditions of their farms.

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CHAPTER 8: Recommendations and conclusions

8.1. Introduction

The research discussed in the previous chapters was structured around developing an appropriate extension system and accompanying modes that would work for small-scale farmers in Zimbabwe with particular reference to technology innovation and adoption. This chapter discusses the findings presented in Chapter 6 and 7 in the context of the theoretical investigations in Chapters 2, 3 and 4, as well as the framework developed in Chapter 5.

As discussed in Chapter 5, no single extension approach can be appropriate for all small-scale farmers at all times. Thus, there is need to develop an appropriate extension system and complementary extension modes that can best address the specific challenges of small-scale farmers at different times and under varying circumstances. This research suggested six key characteristics of such an appropriate extension system: (1) focus; (2) purpose; (3) role of extension; (4) role of farmers in determining the learning process; (5) nature of learning; and (6) social capital and sustainability.

The three extension modes discussed in Chapter 5 are mass media, individual and group extension. Key determinants in selecting an appropriate extension mode at any given time or circumstance were found to be: (1) purpose for which a mode is sought; (2) literacy level of the farmers involved; (3) cost and time effectiveness; (4) number of farmers to be reached; (5) and stages of farmers in learning a new technology (awareness, interest, evaluation, trial or adoption).

Thus, the general findings of this study are summarised under two broad themes:

- Key characteristics of an appropriate extension system
- Key determinants for selecting appropriate extension modes

Figure 1 shows the contrasting perspectives of the farmers and extension agents who participated in this study of the key characteristics of an appropriate extension system for small-scale farming systems

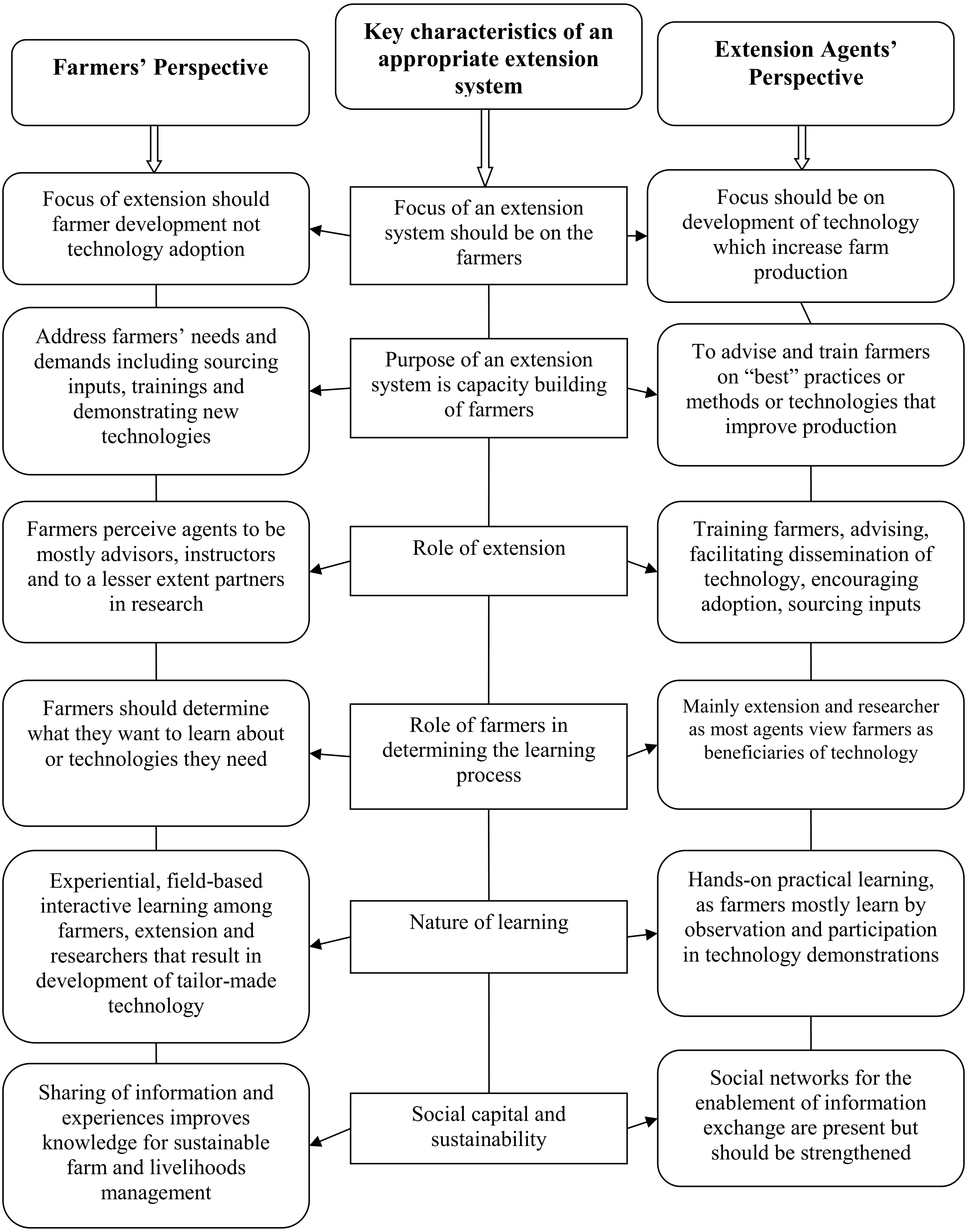

Figure 1: *Perspectives of farmers and extension agents of the key characteristics of an appropriate extension system for small-scale farming systems*

8.2. Key characteristics of an appropriate extension system

In this section, the findings from farmers and extension agents presented in Chapters 6 and 7, respectively, are compared to the evidence and theoretical framework presented in Chapter 5 on the six key characteristics of an appropriate extension system (Figure 1). Each of the six key characteristics is discussed separately.

Focus: As discussed in Chapter 5, an appropriate extension system must focus on farmers' development and not primarily on technology. It must be concerned with empowering and developing farmers' skills leading to improved decision-making pertaining to their farming systems, thus enhancing their livelihood sustainability. As noted in Chapter 3 and findings from extension agents presented in Chapter 7, the extension system in Zimbabwe (AGRITEX) is focussed on development of technology aimed at improving farm production, paying little attention to farmer development. However, Chapter 6 findings indicated that farmers desire an extension system that empowers them by embracing their indigenous knowledge and experiences as well as valuing their input towards developing technologies aimed at solving their problems. Such an extension system has potential to improve farmer technology adoption.

Purpose of an extension system: The purpose of an extension system should be to build the capacity of farmers. Empirical evidence from extension agents, reported in Chapter 7, indicated that the purpose of AGRITEX is to advise and train farmers on "best farming practices and methods" aimed at improving farm productivity. Conversely, farmers perceived that the purpose of an extension system should be centred on addressing their needs and demands for services, including sourcing inputs, trainings and demonstrating desired new technologies. In other words, farmers were advocating for an extension system whose operations are determined by farmers needs as opposed to a one-way top-down flow of communication and instruction.

Role of extension: The theoretical framework developed in Chapter 5 suggests the role of extension should be flexible in order to meet the diverse needs of small-scale farmers at any given time and under varying circumstances. In some instances, extension agents need to teach and instruct farmers on technology and provide feedback to research systems, while other circumstances may require them to be innovation/knowledge brokers who facilitate interactive learning processes amongst farmers and other key stakeholders. Empirical evidence presented in Chapter 6 indicated that farmers perceived the current roles of extension agents to be advisors (100%), instructors (66.5%) and partners in research (56%). Furthermore, farmers expect extension agents to link them with key stakeholders including research institutes and NGOs who bring technologies, inputs and food aid, where necessary. Similarly, Chapter 7 reported that extension agents view their role to include training, advising, facilitating dissemination of technology and encourage adoption and sourcing farming inputs for farmers.

Role of farmers in determining the learning process: An appropriate extension system is one where farmers' needs, perceptions, analyses and conclusions determine the learning to take place. Chapters 2 and 5 reported on how the farmers' knowledge of their challenges and their biophysical environments is better than extension agents or any other key stakeholders. This makes them more than qualified to know where they are lacking or where they require assistance or what they need to learn, and or which technologies are better suited to their farm conditions. However, as found in Chapter 3, AGRITEX in early years failed to acknowledge or build on this farmers' indigenous knowledge about their biophysical conditions and their farming systems. This led to poor adoption of recommended technologies, which were usually developed in foreign biophysical conditions to the farmers' soil and climate conditions. Chapter 3 also discussed how AGRITEX often prescribed standardised 'one size fit all' crop production technological interventions for small-scale farmers in different regions including some areas where livestock production is the only viable form of farming (Birner et al., 2009; Masuku, 2011). Empirical evidence reported in Chapter 6 indicated farmers' preferred learning areas to be about marketing of farm produce, market prices, processing of raw products, value addition and any modern technology which makes farmers' jobs easier, efficient and more productive. This was evidenced by the majority of the respondent farmers who preferred to be participants in innovation and extension projects rather than beneficiaries of innovations developed without their input. Conversely, extension agents perceived that the extension, researchers and NGOs should determine what the farmers need to learn. This was also evidenced by the perception of most agents that farmers are mere beneficiaries of their expertise and technology.

Nature of learning: An appropriate extension system for small-scale farmers should promote interactive, experiential and participatory field-based learning (Van de Fliert, 2003). This entails a genuine engagement between farmers, extension and enablers (policy makers, researchers, technology developers, NGOs) in an iterative learning environment aimed at building capacity of each of the key partners. However, the current state of affairs is that farmers are 'forced' to learn whatever technologies or information AGRITEX agents and other partners brings to them, as they are mainly viewed as students and beneficiaries of technology. As found in Chapter 6 farmers preferred participatory and learning extension approaches where the learning should be more interactive, experiential, field-based and participatory in nature. Similarly, Chapter 7 reported that extension agents indicated that a hands-on practical learning approach is appropriate as small-scale farmers learn better by observation and by participating in technology demonstrations.

Social capital and sustainability: As discussed in Chapter 5, it is imperative for extension systems to foster social learning which is important in ensuring sustainability through building social capital, increasing farm income and rural employment in order to alleviate poverty (Swanson, 2006; Allahyari et al., 2009). Social learning allows extension agents and researchers to develop skills on how to engage farmers in a participatory way, simultaneously creating the social networks for facilitating exchange of knowledge between diverse actors within that network. As found in Chapter 6, farmers indicated the benefits of sharing information and experiences within social networks including improved knowledge for sustainable farm and livelihoods management. Another key benefit noted by farmers is that of having a sense of ownership of tailor-made technologies/innovations developed in these networks, leading to improved adoption of such technologies. Furthermore, farmers highlighted that they are empowered to demand services from extension agents and researchers as a result of participatory learning in extension programmes. Finally, farmers indicated that they are also moving away from being donor dependent to being more self-sufficient as they used to heavily rely on NGOs, donors and Government for handouts. Findings from extension agents reported in Chapter 7 indicated that although the social networks for the enablement of information exchange are present, the linkages need to be strengthened if sustainable solutions to farmers and community challenges are to be developed.

The responses of the farmers and extension agents show that the visions of the two groups are not well aligned. There is little unity of purpose. Extension's vision is increase production through technology adoption. The farmers' vision is about sustaining their livelihoods. The farmers' perspective is that they should be driving the extension and research agendas.

Extension's perspective is that farmers should be beneficiaries of externally-driven processes. Although not explicitly mentioned, the divergent visions and perspectives suggest that the farmers and extension agents have different time horizons – farmers are looking for longer-term solutions to their farming and livelihood challenges, whereas extension is looking for more immediate (short-term) impact characterised by farmers adopting technology. This is consistent with sentiments raised by Chambers (1991:8)

> "One of the crucial changes in approaches towards rural development is the recognition that researchers and planners have much to learn from the people who make a living in rural areas, that programs must take their ideas and experiences into account if they are to be truly relevant. Many failures on the part of rural development professionals are basically due to ignorance, short time horizons, and scientific reductionism".

> "Despite the stated long-term perspective of rural development professionals, we actually tend to have short-time horizons. Economists dominated by discount rates undervalue the future; commercial interests want quick returns; and government programs tend to aim at physical targets by the end of a project/plan period".

While the findings of the study suggest an absolute dichotomy between farmers and extension, the nuance of the data does not. While it is true that the farmers and extension agents have broadly different views, perspectives and time horizons, neither element of the extension mix is blindly ignorant of the other. There is little value is crystallising what is essentially a false dichotomy. Both sets of views, perspectives and time horizons have validity. And extension is rarely about 'either or', but more about 'and'. The implied purpose of the Agriflection framework discussed in Chapters 3, 4 and 7, is to bring about a partnership (grounded in learning), that enables all the role-players to learn from, about and with each other while working toward a common end – which will ultimately be the sustainability of the livelihoods of the farmers which is also the surest way to ensure improved agricultural productivity. This clearly underscores the need for flexibility.

8.3. Key determinants for selecting appropriate extension modes

Theoretical investigations in Chapter 5 highlighted the need for the selection of suitable extension modes which complement an appropriate extension system to ensure extension meets its intended objectives. Three main extension modes – individual, group and mass media – were also discussed in Chapter 5. The theoretical framework proposed five key determinants in selecting appropriate extension modes including: intended purpose for which a mode is sought; literacy level of the farmers involved; cost and time effectiveness; number of farmers to be reached; and stages of farmers in learning a new technology (awareness, interest, evaluation, trial or adoption). These five determinants are evaluated against farmers' and extension agents' findings reported in Chapters 6 and 7 respectively (Table 1). Table 2 provides filtered analysis of the data in Table 1. (Cost effectiveness was excluded as the nature of the data was not consistent with the nature of the responses to the other determinants.)

Table 1: An evaluation of key determinants in selecting appropriate extension modes by farmers and extension agents

Key determinants	Farmer findings	Extension agents findings
Intended purpose	For skills acquisition and fostering interaction among farmers and other key stakeholders, field-based group extension modes are ideal. Individual farm visits are suitable to follow-up to what is learnt in groups.	When introducing new technology, demonstrations are appropriate. When following up on farmers to help with technology implementation and when engaging non-group farmers, individual extension modes like farm visits are appropriate.
Literacy level of farmers	Group modes like demonstrations, field days and look and learn tours are preferred over pamphlets (mass media) because most farmers are semi-literate and learn better by observation.	Most farmers are semi-literate and advanced in age and do not prefer to read magazines or pamphlets hence oral group meetings and practical extension modes are appropriate where farmers learn by observing and doing.
Stage of farmers in learning a technology	Introducing a technology will require group meeting whereas demonstrations are ideal for the evaluation and trial stages. Individual modes is appropriate for following-up what was learn in group mode	Agents acknowledged farmers are usually at different stages of learning a technology, thus appropriate extension modes must be used, e.g for farmers who have completed all stages of learning a technology and are able to demand more extension services, individual extension modes like farm visit or telephone calls are appropriate.
Targeted farmers (Coverage)	Many farmers are reached through group extension modes including meetings, demonstrations and field days because they are also self-organised into farmer groups which makes it easier for extension agents to introduce, demonstrate and disseminate technology to a large number of farmers at once.	Mass media has potential to reach many people but most farmers do not have radios or TVs and do not prefer reading magazines or pamphlets. Group mode is thus preferred as it also covers a large number of farmers at once and is useful in spreading of information to others.
Cost and time effectiveness	Farmers indicated that group extension mode is time and cost effective as information about technology spreads faster.	Agents found the group extension modes (meetings, demonstrations and field days) to be time and cost effective and appropriate given the current challenges facing AGRITEX (e.g lack of transport to visit many farms).

Source: Responses by farmers in FGDs and SSIS and extension agents and SSIs.

Table 2: Comparison of perceptions of modes of extension using key determinants

Mode of extension		Intended purpose	Literacy level of farmers	Stage of farmers in learning a technology	Targeted farmers (Coverage)
Demonstrations	Farmers	To introduce, demonstrate and disseminate technology	When literacy is low	Interest and Evaluation stages	Self-organised farmer groups
	Extension Agents	To introduce new technology		Evaluation and Trial stages	
Field days	Farmers	To introduce, demonstrate and disseminate technology			Self-organised farmer groups
	Extension Agents	To demonstrate productivity of a technology and to convert late adopters and laggards through interactions among key stakeholders	When literacy is low	Trial and Adoption stages	Self-organised farmer groups
Field-based group modes	Farmers	To acquire skills To fostering interaction among farmers and other key stakeholders	When literacy is low		
	Extension Agents		When literacy is low	Interest and Evaluation stages	Self-organised farmer groups
Group meetings	Farmers	To introduce, demonstrate and disseminate technology		Introducing a technology	Self-organised farmer groups
	Extension Agents		When literacy is low		Spread information to large numbers
Individual farm visits	Farmers	To follow-up to what is learnt in groups		After learning in group mode	
	Extension Agents	To following up on farmers To help with technology implementation To engage non-group farmers		After completing all stages of learning a technology	
Individual contact (ICT)	Farmers	To address individual farmers' unique problems			Individual farmers concerned
	Extension Agents	To advice farmers on a case by case basis		After completing all stages of learning a technology	Individual farmers concerned
Look-and-learn tours	Farmers	To learn a technology by observation	When literacy is low		Farmer groups
	Extension Agents	To help farmers understand how a technology works by observation		Interest and evaluation stages	Farmer groups
Mass media	Farmers				
	Extension agents	To create awareness to many farmers within quickly		Awareness	All farmers

In light of the challenges currently affecting AGRITEX as shown in Chapters 3 and 7, AGRITEX agents are mainly using the group extension modes due to its multiplier advantages including time and cost effectiveness and high number of farmers reached at once. This bond well with farmers who prefers group extension modes due to the innovation platforms it offers and also the nature of learning which is participatory, experiential and field-based. Circumstances of farmers discussed in Chapter 2 and also finding in Chapter 6 indicated that most small-scale farmers are advanced in age and semi-literate who prefer to learn practically by observations and doing as opposed to theoretically via magazines or pamphlets.

Drawing on the foregoing discussion and on Tables 1 and 2 the following is observed.

The intended purpose appears one of the most important determinants when selecting an extension mode. Farmers and extension agents in this study share fairly consistent views in this regard. When the intention is to introduce, demonstrate or otherwise disseminate technologies, the most appropriate modes are group modes, most notably demonstrations, field visits and group meetings. However, when the intention is to follow up on information shared in a group mode session, then individual farm visits (and possibly telephone calls) are appropriate.

Similarly, the stage of farmers in learning a technology also appears to be an important determinant. It follows a similar pattern to intended purpose. Group modes are appropriate for introductory, field trial and evaluation stages, while individual modes (particularly farm visits) are appropriate for post-learning support.

This suggests that both group and individual modes have a place in extension. When they are used is determined largely by the intended purpose and where the farmers are in the stages of developing and learning about technologies.

While levels of literacy and cost effectiveness are, of course, important determinants of the extension mode choices, they are more operational conditions than they are elements of extension as a science. Cost effectiveness is a relative term, depending on what criteria are used to determine ‘costs’ and ‘returns’. Literacy levels impact on mass media options, but the ability to read does not necessarily translate to a desire to read, thus even if the farmers were more literate, they still might prefer to learn through practical engagement, instead of information brochures. Similarly, the generally negative view of radio and television is associated with the lack of these facilities. This view may or may not change if these facilities become available.

Again, all of this underscores the need for flexibility. It also underscores the need for planning based on the fruits of experience as extension programmes are implemented in a dynamically changing landscape. It is against this background that this research proposes a new framework for an appropriate extension service for small-scale farmers.

8.4. Framework for an appropriate extension system to deliver more sustainable livelihoods for small-scale farmers

The study proposes a new framework for an appropriate extension system aimed at delivering more sustainable livelihoods for small-scale farmers (Figure 2). This framework is anchored by six main pillars, farmer focused, purpose, nature of learning, role of extension, social capital and sustainability and role of farmers, discussed above. In such an extension system, everything revolves around the building farmers' capacity with the ultimate goal of more sustainable livelihoods and increased productivity. The framework presents a paradigm shift from the rigid "one-size fit-all" extension approaches to a more flexible and adaptable system that is dependent on varying circumstances of farmers and their challenges. Further, the framework is moving away from "forcing technology or so-called solutions to farmers' problems" on farmers to an extension system that considers and genuinely engages farmers in identifying and defining farmers' problems, challenges and developing solutions. The flexibility of the framework ensures that different extension approaches can be used for varying farmer contexts. In other words, the framework is one that does not prescribe a single so-called "best" extension approach or intervention but employs a "horses-for-courses" approach in which an appropriate approach is chosen for a particular circumstance. Thus any of the three major extension approaches: technology transfer, facilitation and learning or a combination of these can be utilised at varying farmer contexts, as and when they are deemed appropriate.

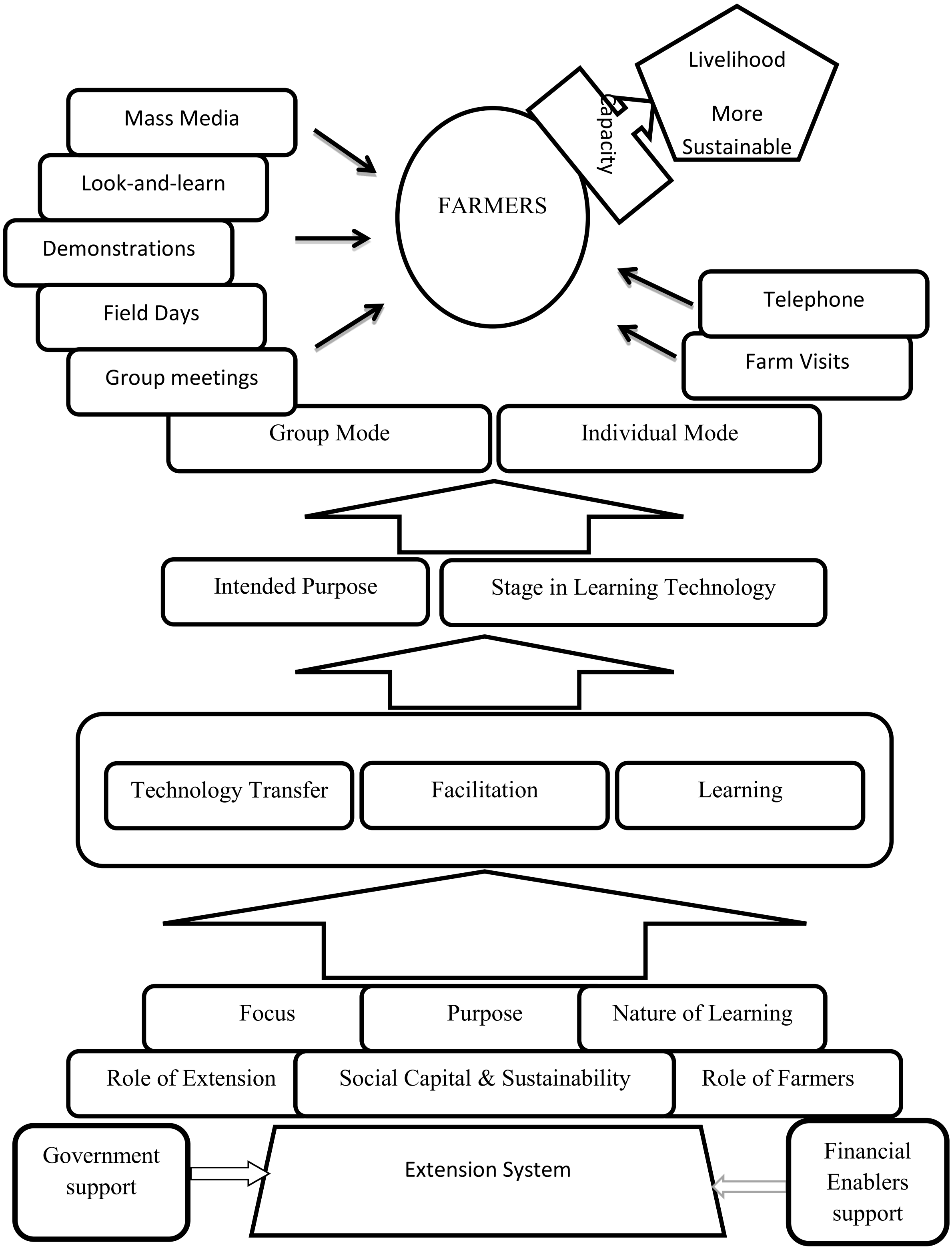

Figure 2: *Framework for an appropriate extension service to deliver more sustainable livelihoods for small-scale farmers*

Furthermore, the framework does not assume all technologies will be developed with farmers, but acknowledges that some technologies cannot be developed with farmers on the ground, as it is impractical to do so. This is the reason why technology transfer approaches, despite their top-down nature, still have a place in the proposed new framework.

The flexibility of the new framework is also exhibited by its incorporation of both group and individual extension modes to complement the different extension approaches. As already discussed, group modes are appropriate for introductory, field trial and evaluation stages, while individual modes (particularly farm visits) are appropriate for post-learning support. While group mode of extension was popular among both farmers and extension agents who participated in this study, individual modes are still important, particularly when it is time for implementation or adoption of technology. As already discussed, choice of extension mode to use is determined largely by the intended purpose and where the farmers are in the stages of developing and learning about technologies.

The success of the new framework (Figure 2) in ensuring sustainable livelihoods of farmers will depend on other factors including an enabling environment and will power of all key actors involved. First, government support in formulating policy changes to accommodate the framework and provide guidelines for its adoption is critical. Second, the role of the enablers, particularly financial backers, should be clearly defined so as not to interfere with farmers' and extension roles in development and testing of technologies.

8.5. Conclusions

The study highlighted that AGRITEX has not been genuinely engaging farmers in an extension conversation aimed at building the farmers' capacity to innovate as its focus is to accelerate technology adoption. This has been one of the key reasons for poor adoption of recommended technology by farmers. Long gone are the days when extension agents were expected as a sole mode of operation to disseminate technology developed by researchers to farmers for adoption. Farmers' views and their participation have become important in defining farmers' challenges, and in developing and testing possible solutions or technologies. This farmer involvement has potential to improve farmers' decision-making and innovation skills. In fact, farmers have shown their ability to take control of issues affecting their livelihoods by demanding certain services they deem are appropriate to deal with their challenges regardless of what has been offered or recommended by extension agents.

The study further noted some mismatches between technology disseminated or ‘imposed’ on farmers and technologies really needed by farmers. For instance, farmers were demanding technologies that would move them from being primary producers into the realm of value addition, including preserving and canning of surplus produce for marketing and selling later. Despite this, extension agents were disseminating completely different technologies, which they thought were needed by farmers. The key factor here is that farmers have great insight into what they need to improve their livelihoods. This further emphasises the need for extension and other stakeholders like technology developers to engage farmers in developing technologies that reflect a genuine understanding of the farmers’ context, system, aims and problems.

The study proposed an appropriate extension system for small-scale farmers that must be backed-up by extension agents who are committed, flexible, and highly competent in technical and extension methods and practices in offering extension services to farmers. These agents also require supporting policy frameworks and management systems that create and facilitate the required flexibility, and which have built into them mechanisms for ensuring that the farmers are engaged throughout.

The study found that, although extension agents generally have basic education, working experience and maturity to perform their jobs, they are hindered by lack of in-service training opportunities designed to strengthen their competencies and brokering skills needed in a diverse multi-actor extension system. Other challenges currently facing AGRITEX and affecting service delivery include poor funding, poor remuneration, poor infrastructure and facilities (transport, accommodation, etc.), and poor general working conditions – and an appropriate policy and management framework.

The study found that the current extension system for Lower Gweru Communal area has changed over the last two decades. Where once there was only the public (AGRITEX) extension agents bringing technology to farmers, there is now a pluralistic system where other actors, most notably NGOs, agro-dealers and researchers, are also bringing technologies for farmers to adopt. These emerging actors however cannot work with farmers without the authority of AGRITEX and are mandated to have AGRITEX field extension agents to introduce them to farmers. In this way the role of extension has expanded to include brokering and facilitation. This has been both a blessing and a curse for the extension agents. On one hand the agents, who have been failing to do their jobs effectively and efficiently due to lack of resources like transport and materials to train farmers, are now able to do so through the new actors. On the other hand, they are becoming passively-aggressive or apathetic. They perceive that they are no longer the drivers of extension service delivery as their work is now ‘dictated’ by these other actors who have the resources and technologies to help farmers. Further, extension agents complained of farmer apathy towards extension projects where NGOs, agro-dealers are not involved. Conversely, farmers are eager to attend meetings and workshops and projects involving NGOs and agro-dealers – something extension agents attributed to availability of resources including inputs and technology for training, demonstration and testing to farmers in their own fields.

Beyond the proposed reforming and redefining of extension roles in an appropriate extension system, the study found that farmers are more likely to adopt technologies which are cheaper, simpler, less risky and compatible with biophysical farm conditions, simultaneously improving farm production. Furthermore, modern technology with similar traits to farmers’ own indigenous practices or technologies developed by farmers and/or their counterparts are easily adopted for example conservation agriculture and thermal compost. Farmers’ circumstances like their resource-endowments, willingness to take risk also play a major role in technology adoption.

Reflecting on these somewhat disparate collective, a number issues have been surfaced relevant to the extension services provided to small-scale farmer in Gweru, Zimbabwe. First, the findings suggest an earnestness on the part of both farmers and extension. They all want to find a way forward. That their views of what should be done vary, is to be expected. Farmer perspectives are necessarily different from extension agents. The issue is not to pit one against the other, but to work towards building a common vision and shared pathway towards its realisation.

All of this point to two things the study explicitly explored and one thing the findings imply. First, the capacity of farmers and extension agents needs to be made a priority. In addition to building their practical farming and farm management capacity, farmers need to learn how to learn, how to engage with scientific enquiry and to take command of these processes. In addition to being technically competent (with frequent refreshing), extension agents need to learn how to foster the capacity of farmers along the lines suggested in a learning approach to extension as suggested in the Agriflection example. Extension agents need to help farmers become better at engaging with scientific enquiry – to put them in a better position to command the factors that affect the sustainability of their farming enterprises, and thereby, their livelihoods.

The second is that extension policy and policy frameworks appear to be out of alignment with the current circumstances obtaining, at least in the Gweru area of Zimbabwe. This is manifested by a number of false dichotomies that have emerged during the analysis of this study. The first, mentioned earlier, is the dichotomy of farmer versus extension agent.

On the issue of technology adoption is another false dichotomy. The study found that AGRITEX engages primarily in top-down transfer of technology to farmers who would rather be consulted first and otherwise involved in the development of technology drawing on their better knowledge of their own circumstances and on their local (indigenous) knowledge and practices, and perhaps using them as a starting point for developing new or improving existing technologies – including tools, systems, methods and processes. Again avoiding the pitfalls of dichotomous thinking, the study clearly shows the need for measured decision-making about the approaches and modes of extension to be employed. Choice of extension approaches is to be governed by the intended focus and purpose of the engagement, the anticipated roles of extension and of farmers, the nature of learning to take place through the engagement, and the social capital and sustainability issues contextualising the extension conversation (Figure 2).

Further, as already discussed, some technologies cannot be developed with farmers on the ground, as it is impractical to do so. Where such technologies have already been developed through other processes that, of necessity, excluded farmer involvement, technology transfer may be more appropriate. But this does not mean that these technologies must be implemented with its historical element of coercion. There is still ample room for farmers to be engaged, as the respondents in this study have indicated, through field days, group meetings, look-and-learn tours and demonstration and trials where imported technologies can be tested, studied and adapted collaboratively with famers. The choice of approach must be a measured choice based on a thorough understanding of the farmers' contexts – which can only be gained by working and walking with the farmers (individually or collectively) face-to-face in the field.

A similar argument can be postulated for modes of extension. Whether to use individual or group modes should be determined by looking particularly at the intended purpose of the engagement and the stage of learning in the development of new and/or introduction of imported technology. Again, it requires sober and measured consideration.

Related to approaches and modes is the challenge of pluralistic extension. The study noted the tension between AGRITEX (public) extension agents and other role-players on the ground. There need be no competition among role-players and service providers. When the development of the farmer is the focus of extension, all resources should be enlisted. Collaboration (which should be possible) is empowering, whereas competiveness is paralysing – and it paralyses farmers and service providers alike.

The final false dichotomy surfaced by this study is the tension between livelihoods and production. The general tendency of AGRITEX has been to focus on increasing production as an end unto itself. Farmers have expressed the need for their farming enterprises to contribute more sustainably to their livelihoods on a longer-term basis. But the two 'goals' are not necessarily mutually exclusive. What is required is bringing the livelihood sustainability demands together with the production increases. The study offers no evidence that the farmers do not want to increase their production levels. If fact, it has found quite the opposite. Farmers do want to see greater production. They want to expand their farming operations into value-adding spaces.

All of this has implications for policy.

8.6. Policy implications and recommendations

An evaluation of AGRITEX against the theoretical framework developed in this study, calls for some technical and philosophical changes to be effected within Zimbabwe' extension system if farmer innovation and technology adoption issues are to be addressed. AGRITEX need to change its philosophy of focusing more on technology adoption rather than developing capacity farmers, and perceiving farmers as mere recipients and beneficiary of advisory services and technologies. Farmers' indigenous knowledge and experiences and perceptive should be valued and considered in developing interventions aimed at addressing their challenges. Thus, farmers should be equal partners with extension and other key stakeholders like technology developers, agro-dealers and NGOs in an extension system. Only then can genuine engagement be possible, where farmers determine what they want to learn about and participate in development of technologies tailor made for their challenges and farms' biophysical conditions.

Although AGRITEX extension agents have basic educational qualifications for extension work and valuable working experience there are hampered in effectively executing their duties due to lack of in-service training opportunities. This calls for the need for regular in-service training aimed at updating their knowledge and skills including learning new technologies so that when farmers demand advice or information support on these technologies, agents will be able to assist.

A key part of these in-service training should also be on equipping extension agents with network building, facilitation and brokering skills in line with the changes in the extension landscape from one dominated by public extension agency (AGRITEX) to a pluralistic one involving new actors, which is the case on the ground. The study noted the passive aggressive and apathetic attitude of extension agents towards emerging new actors, as they felt these new actors' activities are now dictating their day-to-day duties. This indicates that agents are yet to embrace their new roles within the pluralistic extension system. Hence, the need for training aimed at sensitising agents on their 'new' roles. The new actors are in a better position to assist farmers in extension service delivery due to the resources at their disposal, which AGRITEX currently do not have. However, there may be a danger of these actors pursuing their own agendas (i.e promote their own technologies) to benefit themselves at the expense of farmers. Consequently, there is need for extension to play the important role of brokering and facilitation between the diverse actors. And there is a need for clear policy guidelines that are equally binding on public, private and NGO sector role-players and service providers.

The study recommends building on the strengths of NGOs, agro-dealers and donors and coupling them to the public extension (AGRITEX), who are trusted by farmers and are mandated to serve farmers, to ensure improved service delivery in an environment where farmers are not exploited and that service provision is coherent and liberating, rather than paralysing. Thus, where feasible and where it strengthens and improves the overall extension system, AGRITEX should engage in public-private partnerships with relevant private institutions that are currently working with the farmers to ease their funding challenges. In this way AGRITEX and its agents can be able to offer improved and high quality service delivery to its primary clients, mainly small-scale farmers.

The study further recommends the redefinition of roles for extension agents to more of innovation brokers so as to meet the diverse needs of small-scale farmers and other key actors at any given time. In this role the main functions include linking diverse actors and acting as a catalyst for collective learning, facilitation, mediation, documenting learning and translating to ensure actors from diverse backgrounds are understanding each other (Swaans et al., 2013). One of the critical roles is linking farmers with firms offering credit facilities at viable interest rates to enable farmers to acquire their desired technologies, given that cost of technologies and lack of credit facilities for farmers were two major reasons for poor adoption of desired technology.

Finally, as noted earlier, the study documents the readiness of farmers to move from their current primary roles of growing crops into the realm of value addition and processing stage. Farmers themselves are keen on undertaking the value addition directly and not through selling to middle-men, so that they can make more income. However, their capacity to do this needs to be developed further. This suggests yet another role for extension where in a pluralistic flexible system, the government (perhaps through AGRITEX) together with other relevant role-players should collaborate to help farmers to form their own business where farmers are primary owners. In this, setting up companies that run things for the farmers should be avoided. Farmers must not merely be the producers of raw materials or crop earning low incomes, but should be assisted to gain the capacity to expand their farming enterprises vertically and horizontally where they can capture a share of the value of the value chain. The key to this, as this study has amply demonstrated, is in building the capacity of farmers to manage their enterprises, engage with their sustainability contexts and, above all, to learn so that they can engage continuously with scientific enquiry and innovate within a systems context with a view to ensuring the continued sustainability of their livelihoods.

8.7. Recommendations for future research

AGRITEX is mandated to vet technologies brought by different stakeholders before introducing them to the farmers for adoption. Further, research is recommended to be conducted to determine the criteria used in vetting technologies and to evaluate whether or not AGRITEX may be preventing certain technologies which farmers may want to explore or consider learning.

The study recommends for comprehensive future research on how the linkages between key stakeholders including farmers, extension, NGOs, agro-dealers and researchers can be strengthened to enable development of technologies tailor-made to farmers' needs and challenges including the biophysical conditions of the farming area. This has potential for a win-win situation for both technology developers and farmers as technology adoption is likely to be improved and simultaneously technology developers get favourable returns on their investments.

Farmer apathy alluded to by extension agents towards AGRITEX-run extension projects where NGOs, agro-dealers, and researchers are not a part of, needs to be investigated further to determine the real reasons behind this. One theory by agents point to farmers' interest in getting free inputs and technologies. Another theory could be that farmers prefer the nature of learning (participatory field-based learning and demonstrations of new technology) used in these projects.

This study has suggested that AGRITEX extension agents in Gweru need training in the so-called softer extension methods and skills. This may also be true of extension agents in the private and NGO sectors. It would be useful to ascertain the extent of the training requirements of AGRITEX agents in other parts of Zimbabwe as well as of agents in public and NGO extension/development service providers.

As noted earlier, extension agents are usually trained through some formal education system. The study recommends research to be conducted into the qualifications and their respective curricula to see how well they align with the knowledge and skill sets currently required in the field.

Finally, the study recommends further research that will offer insights into technology diffusion and adoption processes in more traditional small-scale farming systems. Such research must answer questions like, what is the basis for adoption and diffusion decision making in resource-poor systems? and what are the dynamics? This will go a long way in aiding the underdeveloped body of scientific knowledge regarding the adoption of technology (process and dynamics) in African small-scale agricultural systems.

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APPENDICES

APPENDIX 1: Focus Group Discussion Guide

Discussion 1: Farming systems

1. What are the main crops that you grow?
2. What are the purposes of growing these crops?
3. Are you into animal production?
4. Which animals do you rear?

Discussion 2: Extension services

1. Describe the frequency of visits by extension agents to your villages or Ward?
2. What are some of the main services you are getting from extension agents?
3. How do you rate services you get from extension agents? Give reasons for your rating?
4. Which extension approaches do you value most and why?
5. In your opinion, how do extension agents perceive you to be in relation to technology adoption and innovation?
6. Which attributes do you desire in extension in extension agents?

Discussion 3: Technology adoption and innovation

1. What are the major technologies that have been recommended to you or your village/Ward?
2. What are/were the adoption status of these technologies?
3. What are the major factors influencing decision to adopt recommended technologies?
4. Is there any help that you require in order to consider adopting recommended technologies?
5. When do you consider learning about new technology and how do you prefer to learn about new technology?
6. What are some of your own or other farmers' innovations that you have developed using your own indigenous knowledge and experience?
7. Do you participate in innovation or extension projects? What are the benefits of your participation?

APPENDIX 2: Semi-structured interview guide: FARMERS

Demographics

Name .... Age..

Gender..................... Education level......................................

Agricultural training...

Farmer circumstances

Farm size.. Farming experience (years)................

Type of livestock owned and numbers of each ....

……………………………………………………………………………………………

Crops grown………………………………………………………………………………..

Purpose for producing these..………………………………………………………….....

……………………………………………………………………………………………..

Extension services

Frequency of visits by extension workers

1. Weekly 2. Fortnightly 3. Monthly 4. Once in 2 months
5. Quarterly 6. Bi-annually 7. Other

How do you rate extension services?

1. Poor 2. Average 3. Good 4. Excellent

Why:……………………………………………………………………………………………

What services do you expect to get from extension workers? ……………………………...........

……………………………………………………………………………………………

……………………………………………………………………………………………

Which extension approach do you value most and why?...

……………………………………………………………………………………………

How do you perceive extension workers?

1. Advisors 2. partners in research 3. Enforcer of technology 4. Facilitator
5. Other

In your opinion, how do extension workers perceive you to be?

1. Equal partners in research 2. Minor partners in research 3. Students 4. Illiterate or useless 5. Beneficiary of their knowledge and expertise 6. Other……………………

Explain?...
………………………………………………………………………………………

What personal attributes do you want in an extension worker?...
………………………………………………………………………………………
……………………………………………………………………………………..
………………………………………………………………………………………

Technology adoption and innovation

List all technologies that have been disseminated to you/your community by the government extension service? Of those how many did you adopt and why. Explain why you did not adopt others?

Technology	**How disseminated (by whom)**	**Tick the ones adopted**	**Reasons for adoption/non adoption**

Which attributes/qualities of a technology attract you to adopt?...
……………………………………………………………………………………..
……………………………………………………………………………………..

What technologies have you developed on your own or with other farmers?

Explore (include small simple technologies like seed storage) (looking for local science)

Technology innovated	Motivation	Process of innovation (Who; how)	Level of sophistication of innovation process	Level of the actual innovation
Seed storage system				

Can you explain the circumstance where you:

Innovate:…………………………………………………………………………………

Are an early adopter:……………………………………………………………………….

Late adopter:………………………………………………………………………………..

Are a laggard:……………………………………………………………………………….

Explain why?...

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

What are the major factors that influence your decision to either adopt or not adopt technology?………………………………………………………………………...

…………………………………………………………………………………………

…………………………………………………………………………………………

Do you participate in extension programs in your area? ………………………………………

If yes, in what capacity?...

Which programmes?

………………………………………………………………………………

Give reasons…………………………………………………………………………………

………………………………………………………………………………………….

Do you prefer to be a recipient of a technology or a participant in the innovation process to come up with an innovation that is tailor made for your situation? Explain choice/ *(When do you like to participate/innovate………………………………………………………………….

………………………………………………………………………………………….

………………………………………………………………………………………….

What are the benefits and or challenges of this participation in innovation projects?................

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Did any of the outcomes of those participatory researches led to you adopting those innovations?.......…………………………………………………………………………

What are your sources of technologies? Rank them according to importance?

1. Farmer groups/clubs 2. Extension services 3. Research institutions 4. Non-Governmental Organizations 5. Seed companies 6. Fertilizer companies 7. Meteorological services 8. Other farmers (informal)/friends/ observation 9. Other

Do you need any kind of support to adopt technologies? Yes/No………………

State the kind of support you need eg. 1. Information support 2. Credit facilities 3. Input and output market support 4. Other 5. Skills to use; training 6. Support system

Do you adopt the whole package of technology or you adopt parts of the technology or you modify the technology to suit your needs and resources?

Explain……………………………………………………………………...…………

………………………………………………………………………………………………

………………………………………………………………………………………………

Capacity building of the farmer

Would you consider learning new or modern technologies that might help improve your farm productivity, given an opportunity?.....................................…………………………

Under what circumstances; why?...

....

....

Which subjects would you like to learn about…………………………………………..……

………………………………………………………………………………………………

Have you had any opportunities to learn or be trained on technologies before? Describe your experiences……………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

What are your preferred sources of learning/training?..

………………………………………………………………………………………………

APPENDIX 3: SEMI-STRUCTURED INTERVIEW GUIDE: EXTENSION

Demographics

Name.. Age..

Gender…... Experience................................

Highest qualification.. Job Title………………………..

How many villages to cover……………………………………………………………..

Name them: ……………………………………………………………………………..

Working experiences

How well do you rate the services you are currently providing to farmers?

1. Poor 2. Average 3. Good 4. Excellent

Explain

....………………………………

…………………………………………………………………………………………………

Do you enjoy your work?

1. Yes 2. No 3. Indifferent

   Explain?...

What are the major challenges affecting your work? How can these challenges be addressed?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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…………………………………………………………………………………………………

…………………………………………………………………………………………………

How do you perceive farmers, in relation to technology adoption and innovation?

1. beneficiary of technology 2. partners in research 3. illiterate 4. Other………

What is your perception of farmers' indigenous knowledge?..

…………………………………………………………………………………………………

………………………………………………………………...

....

Can you list technologies that you have disseminated to farmers? Rate the adoption process for each? What were/are the reasons for adoption rate of each technology? (*Interviewer to complete the Table below*).

Technology	**How**	**Farmer adoption rate**	**Explain reasons for adoption rate**

Can you talk about how you approach your extension work?

Which extension models/approaches have you used before? What circumstances do you use each of the models/approaches? Give reasons for using each model/approach? *(Interviewer to complete the Table)*

Extension model	**Circumstances**	**Explain reasons for using this approach**
Linear		
Advisory		
Facilitation		
Learning		

NB: Interviewer to incorporate the ideas from the comparison of extension approaches table.

In your own opinion what should be done to encourage adoption of technology by small-scale farmers?

What capacity do the farmers you serve have to adopt/innovate? E.g opportunity, knowledge, skills etc..

What are the sources of technologies that you have been disseminating?

Technology	Developed by	Mode of dissemination	Motivation for disseminating the technology

Should small-scale farmers be encouraged to adopt technology developed without their input or should they be encouraged to innovate and participate in the development of innovations suited to their own situations? Justify your answer……………………………………………………

……………………………………………………………………………………………..

…………………………………………………………………………......................................

What are the major factors affecting technology adoption by small-scale farmers? (*Interviewer to use the Extension Carousel of Learning to unpack the factors*)

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…………………………………………………………………………………………….

……………………………………………………………………………………………..

Capacity building of extension agents

Are you prepared to learn new things that will improve your work? What circumstances do you want to learn or do not want to learn? Give reasons

…………………………….....................

…………………………………………………………………………………………….

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…….

Do you get in-service training? Yes/No……………..

If yes, how many in-service training workshops do you usually attend per year?

…………………………………………………………………………………………

Which subjects are usually covered at these training workshops? (*Interviewer to use the Extension Carousel of Learning to unpack the subjects)*

……………………………………………………………………………………………

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Do you find the training useful? Give reasons for your answer….……………………………,,,,,,,

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Do you need more in-service training each year to be effective in your job particularly technology adoption by farmers? Explain your answer.…………………………………….………..

……………………………………………………………………………………………

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If yes, can you specify what areas of training you need?

1) …………………………………………………………………………………...

2)……………………………………………………………………………………

3)……………………………………………………………………………………

Tick the other organisation or stakeholders that you usually collaborate with

Institution	Nature of collaboration	Purpose	Motivation	Results/Impact Again?
Research institutes				
Universities				
Non-governmental organisations				
Seed companies				
Meteorological services				
Fertilizer companies				
Other (Specify)				

What should be done to build small-scale farmers' capacity to adopt and innovate?.....................……………………………………………………………………

..……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

Do you have any questions or comments about your work, technology adoption and or small-scale farming?………………………………………………………………………..........

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