Transformative Engagement Network (TEN)

Building resilience against hunger and climate change in smallholder farming communities through transformative engagement

**Masters in Transformative Community Development**

***Cover sheet for final research paper submission***

**Title of Research Paper:** Adoption of Renewable Soil Fertility Management Technologies in Bolero Extension Planning Area (EPA), Rumphi, Malawi


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***I, Chizamsoka Nyirongo, certify that the research paper is my own work and I have not obtained a Degree in this University or elsewhere on the basis of this Research.***

## ABSTRACT

The study wanted to understand smallholder farmers' perceptions of soil fertility levels and climate change and analyzed factors affecting adoption of renewable soil fertility management technologies (RSFMTs), namely agroforestry (fertilizer tree systems), residue management, crop rotation and intercropping with leguminous plants (green manure) in Bolero Extension Planning Area (EPA) in Rumphi district, Malawi. It further looked at strategies for improvement in the adoption of the technologies. Data on people's adoption was collected from Bolero A, Bumba, Chirambo and Jalira strata covering one hundred and thirteen (113) respondents using a pre-tested structured questionnaire, key informant interviews, focus group discussions and literature reviews. Respondents for the study were selected using a simple random sampling method. Majority of respondents perceived that the current soil fertility levels were decreasing and that climate change is affecting them negatively. The study used a logistic regression model to analyze the factors affecting adoption. Household head decisions, land ownership, technology attributes, farmers' groups and contact with extension agents were the most important factors influencing adoption of RSFMTs. The study recommends that active participation and involvement of smallholder farmers, improvement to stakeholder collaboration and more awareness and dissemination of information as regards smallholder agriculture are required in the promotion and adoption of agricultural-related technologies in Bolero EPA, if we are to improve smallholder agriculture to reach poverty reduction and food security objectives.

*Key words:* *Malawi, Rumphi, Bolero, technology, logistic*

## 1.0 Introduction

Malawi's agriculture faces a number of climate change negative impacts such as dry spells, droughts, floods, erratic rainfall and changes in the distribution of pests and diseases, leading to declining soil fertility, low yields and increased poverty levels. Soil fertility loss in smallholder agriculture in sub-Saharan Africa is the greatest biophysical constraint to increased agricultural productivity, a major threat to food security (Kiptot, 2008; Sanchez et al., 2009) and a challenge on the preservation of natural resources (Anijichi, *et al,* 2007). Climate change refers to any change in climate over time, whether due to natural variability or/and as a result of human activity (IPCC, 2007). This paper uses the term climate change in a broad context that includes changes in weather variability. Over-dependence on natural resources and agriculture means that any adverse effects of climate change poses great risks to livelihoods and poses a challenge of developing sustainable agricultural technologies to improve smallholder farmers' livelihoods and ensuring adoption of the same since the majority of them mostly depend on rain-fed agriculture. Farmers are trying to practise sustainable agriculture that is resilient, increases productivity and contributes to national food security and development goals, though some of their actions are short-term and unsustainable, such as cultivation of hillsides or tobacco farming. Adaptation options will help farmers to maximize future income under new climate conditions (Seo and Mendelsohn, 2008), support poverty eradication and induce sustainable development. Renewable soil fertility management technologies (RSFMTs) have been suggested as one of the key adaptation strategies for sub-Saharan Africa to mitigate growing water shortages, worsening soil conditions, floods, drought and desertification (Kurukulasuriya and Rosenthal, 2003) brought in part by climate change and have potential to help in achieving sustainable food production levels since low crop yields are not only attributed to lack of rains, but also to soil fertility conditions. Climate change is changing hydrological cycle, weather patterns and increased the intensity and frequency of extreme weather conditions all of which have an impact on poor people's livelihoods in developing countries (FAO, 2007; IPCC, 2014). This paper will emphasize on agroforestry, residue management, crop rotation and intercropping with leguminous plants that are being promoted by development agencies. Although these technologies can be applied to various crop systems, this study focuses primarily on maize due to its overriding importance for food security in Malawi.

Agroforestry involves deliberate growing of fertilizer trees or shrubs in and around crop fields to benefit from biomass to replenish soil fertility (Thangata & Alavalapati, 2003). Residue management mainly uses maize stalks and other biodegradable substances to improve soil structure (Ajayi *et al*., 2007). Crop rotation involves growing a sequence of different crops on the same plot in order to improve fertility, control weeds, pests and diseases while intercropping means growing two or more crops together in the same field for nitrogen fixing or pests and disease repellant (Ajayi *et al*., 2007).

RSFMTs can help farmers become resilient to climate change by increasing crop yields, sequester carbon, improve soil fertility and raise incomes. Some farmers are using inorganic fertilizers for immediate results, but are also faced with the continued loss of soil fertility if they increase the amounts every year (Branca, *et al* 2011).

This study identifies factors that influence adoption of RSFMTs by smallholder farmers in Bolero, who are affected by soil fertility loss, frequent dry spells and erratic rainfall in their farming activities. The information from this study will help development agencies, researchers, policy-makers and smallholder farmers themselves in the planning and implementation of these technologies to suit farmers' circumstances and provide an insight on how to target appropriate technologies for smallholder farmers.

## 1.1 Background information

Malawi is one of the densely populated countries in sub-Saharan Africa with a population density of 139 people per $km^2$ (NSO, 2008). Over 86% of the population live in rural areas and predominantly rely on rain-fed agriculture. This is exerting pressure on the land-based resources in meeting the demands for food, income and other livelihood activities due to the reduced ability of land to produce or provide goods and services (Mloza-Banda and Nanthambwe, 2010). There has also been an increase in land fragmentation, in which it is no longer common for smallholder farmers to cultivate on bigger plots. Due to small land-holdings, land is cultivated continuously with maize as a staple food crop thereby leading to soil fertility decline apart from climate change effects. This is also contributing to land degradation, which poses another threat to sustainable agricultural production as smallholder farmers extend their farming to more fragile and new areas.

## 1.2 Statement of the problem

Land degradation and soil fertility loss have become significant threats to food security in Malawi (Chinangwa, 2006), particularly in Bolero.

Adaptation strategies being promoted and practised in Africa have exceptional successes though research shows that these efforts are not very successful as community members are facing food and income security challenges, thereby reducing their impact (Ajayi, 2003). Bolero is one such area facing declining soil fertility and prolonged dry spells thereby threatening food security. For instance, the area received less than 50mm as an average cumulative rainfall amount from 1$^{st}$ October 2013 to 10$^{th}$ March, 2014 (DCCMS, 2014) while there is limited use of organic matter by farmers in Rumphi district who usually burn the residues after harvesting (RDSEP, 2009). Bolero Agricultural Office indicated increased adoption rates in the EPA despite some farmers not adopting the technologies permanently. Non-adoption of these technologies will continue to contribute to low per-capita food production, malnutrition, low incomes, lack of fodder for livestock production and high deforestation rates (Ajayi, 2007) while adoption will reduce such shocks, given that agriculture is very exposed to soil fertility loss and negative climate change impacts.

## 1.3 Research objectives

### 1.3.1 Main objective

The main objective of this study is to assess factors leading to the adoption of RSFMTs by smallholder farmers in Bolero EPA.

### 1.3.2 Specific objectives

The specific objectives are:

(i) To assess farmers' perceptions of soil fertility levels as a factor affecting adoption of RSFMTs.

(ii) To assess farmers' perceptions of climate change as a factor affecting adoption of RSFMTs.

(iii) To determine other factors affecting adoption of renewable soil fertility management technologies.

(iv) To identify strategies that can be used for the advancement of adoption of RSFMTs

### 1.3.3 Research questions

(i) What is the link between farmers' perceptions of soil fertility levels and adoption of RSFMTs in Bolero?

(ii) What is the link between farmers' perceptions of climate change and adoption of RSFMTs in Bolero?

(iii) What are other factors affecting the adoption of RSFMTs in Bolero?

(iv) What are the strategies that can be used for the advancement of adoption of RSFMTs in Bolero?

## 2.0 Literature Review

This study examines the factors that are hypothesized to be influential in decision-making about adopting RSFMTs by smallholder farmers. Adoption is defined as a decision of full use of an innovation as the best course of action available (Rogers, 2003). Adoption and non-adoption of agricultural technologies is influenced by various socio-economic, demographic, institutional and technical factors including farmers' perception of the attributes of technologies and their attitudes towards risk (Adesina and Zinnah, 1993). Also socio-economic, cultural, political, geographical, ecological and institutional factors do shape the human-environment interactions (Eriksen *et al*., 2011).

Climate change adaptation is one of the policy options influencing development practice (IPCC, 2007) and it refers to adjustments to practices, processes and systems to minimize current and/or future adverse effects of climate change and take advantage of available opportunities to maximize benefits (Eriksen *et al.,* 2011; Pouliotte et al., 2009; Smithers & Smit, 2009). Adaptation strategies are either planned or autonomous, with the latter being done without awareness of climate change predictions but based on experiences and prevailing conditions (Smithers & Smit, 2009). This is needed both in the short-term and long-term basis (Adger *et al*., 2003; Eriksen *et al*., 2011). The adaptation theory contends that socio-economic, ecological and institutional systems and individuals can and do adapt to changing environment (Smithers & Smit, 2009:19). The extent of sustainable adaptation depends on the adaptive capacity, knowledge, skills, robustness of livelihoods and alternatives, resources and institutions accessible to enable undertaking effective adaptation (IPCC, 2007). Other factors are knowledge about climate change, assets, access to appropriate technology, institutions, policies and farmers' perceptions (Adger *et al*., 2003). Climate change and soil fertility perceptions also influence adoption of adaptation strategies (Smithers and Smit, 2009) although it is difficult to relate such perceptions to effective adoption of RSFMTs (Weber, 2010). Adaptation strategies being promoted and practised in Africa have exceptional successes though research shows that these efforts are not very successful as smallholder farmers are facing food and income security challenges, thereby reducing their impact (Ajayi, 2003).

Adoption of agricultural technologies is guided mainly by innovation-diffusion-paradigm, economic-constraint-paradigm and adopter-perception paradigm. The innovation-diffusion-paradigm identifies information dissemination as a key factor in influencing adoption decisions (Rogers, 2003; Prager and Posthumus, 2010). The economic-constraint-paradigm contends that technology adoption is influenced by utility maximization behaviour and economic constraints due to asymmetric distribution of resources (Deressa *et al*., 2008; Prager and Posthumus, 2010). The adopter-perception-paradigm contends that the adoption process starts with the adopters' perception of the problem and technology proposed (Adesina and Zinnah, 1993; Prager and Posthumus, 2010). Perceptions are context and location specific due to heterogeneity in factors that influence them such as culture, education, gender, age, resource endowments and institutional factors (Posthumus *et al*., 2010).

Adoption potential, from farmer's perspective can be considered to have three components: feasibility, profitability and acceptability (Swinkles and Franzel, 1997). Feasibility considers whether farmers have the required information to manage the technologies and resources such as labour, institutional support and farmers' own experiences to maintain them. The economic constraints of a household to access resources influence the ability and willingness to adopt technologies because richer farmers may be less risk averse, have more access to information and have greater capacity to mobilize resources, hence, a high level of innovativeness (Reij and Waters-Bayer, 2001) and may also not be willing to adopt because they have disposable income to buy food in times of low yields. Farmers' knowledge of the usefulness of improving their soil fertility will encourage them to adopt RSFMTs. Profitability is concerned with the financial benefit obtained from using a particular technology such as saving time, reducing drudgery or improving income levels (Vedeld and Krogh, 2001). Transfer of technology to the farmers has an important influence on technology adoption. Usually farmers lack up-to-date information and knowledge about innovations as argued by the innovation-diffusion model, that a technology has to be transmitted from a researcher to farmers through competent extension services (Negatu and Parikh (1999). As regards acceptability, this includes a range of criteria in addition to profitability and feasibility, such as perception of soil fertility problem, previous investment, income levels, riskiness, suitability to accepted gender roles, cultural acceptance, compatibility with other enterprises and other priorities (Franzel, 1999).

For example, a 10 year participatory trial on agroforestry adoption with 48 farmers near Zomba in southern Malawi found that adoption of pigeon pea agroforestry system was based more on immediate livelihood benefits, such as the provision of a secondary food or fuel than on long term soil quality or maize-yield benefits. However, wealthier and younger farmers, and those with larger landholdings were more likely to adopt the *Sesbania sesban* agroforestry system, which has the greatest impact on maize yields via improved soil health (Sirrine *et al.*, 2010).

Thangata and Alavalapati (2003) investigated farm and farmer characteristics that influenced adoption of agroforestry approaches in the densely populated Domasi valley of southern Malawi by considering the adoption of mixed inter-cropping of *Gliricidia sepium* and maize. They found that younger farmers, farmers with frequent contacts to extension staff and those with larger households were more likely to adopt due to higher labor requirements of agroforestry compared to monocropped maize. An earlier study by Thangata *et al.* (2002) addressed the same question but used a linear programming approach and data from Kasungu in central Malawi. They found that adoption of improved fallow was driven by available land and labor resources.

A study by Chinangwa (2006) in Machinga and Zomba districts, southern Malawi looked at farmers' perceptions of soil fertility problems as a driver to adoption of soil fertility improvement technologies. It revealed that majority of farmers perceived soil fertility to be low and that it would continue to decline for their choice on adopting the technologies, though this could be as a result of shortage of income to but inorganic fertilizers. It is also possible that the study failed to show that it was older farmers who perceived soil fertility depletion more than younger ones.

A study by ActionAid (2008) in Salima district, central Malawi showed that a Farmer Field School involving women known as Salima Women's Network on Gender pools together to maintain community gardens. Through regular meetings, they have been able to share tools, seeds and knowledge on diverse farming methods and have been able to increase yields to more than what they could have grown individually since it is easy to identify strategies for the advancement of adoption of agricultural technologies when one is in a group of fellow farmers. This supports the study by Kavoi *et al*. (2014) in Eastern Kenya which sought to determine factors related to low uptake of improved agricultural technologies and one of its specific objectives was to identify existing networks in the target area. The findings showed that over 90% of respondents agreed that being a member of more than one group could help farmers interact and share information.

A study in Tanzania and Uganda by Boyd *et al.* (2000) was aimed at discovering factors for the adoption of low-cost agricultural technologies and it revealed that the majority of crop-dependent farmers practised soil and water conservation technologies. Many Ugandan farmers had diversified away from crop production in order to generate cash income thereby neglecting the technologies. Ugandan farmers with limited access to land and work-oxen invested more in the technologies while farmers' perception of the severity of land and consequent soil depletion were characterized by extensive adoption of technologies.

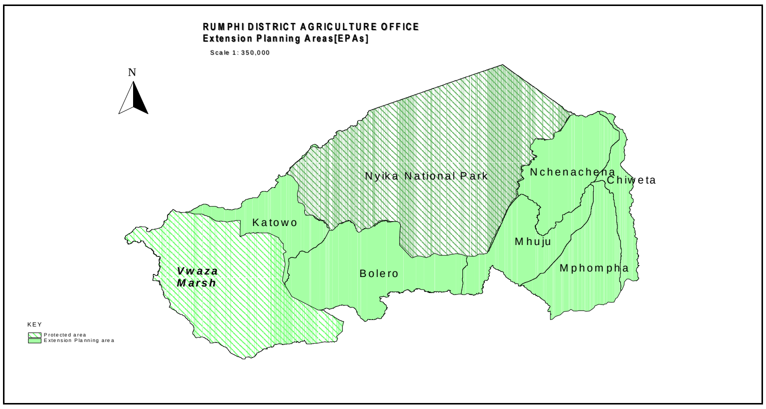
A survey by Nyanga *et al.* (2011) in Eastern Zambia, which looked at smallholder farmers' perception of climate change and conservation farming in order to understand attitudinal and knowledge-based drivers of adoption, discovered that farmers were aware of climate change and perceptions related to changes in floods and droughts and were significantly associated with adoption of conservation agriculture though mostly attributed this to supernatural forces rather than human activity. There was also widespread expectation of subsidy input packages or material rewards for uptake of technologies. But, 50% of farmers dis-adopted once they no longer qualified for such incentives (Baudron *et al.* (2007).

# 3.0 Research Methods

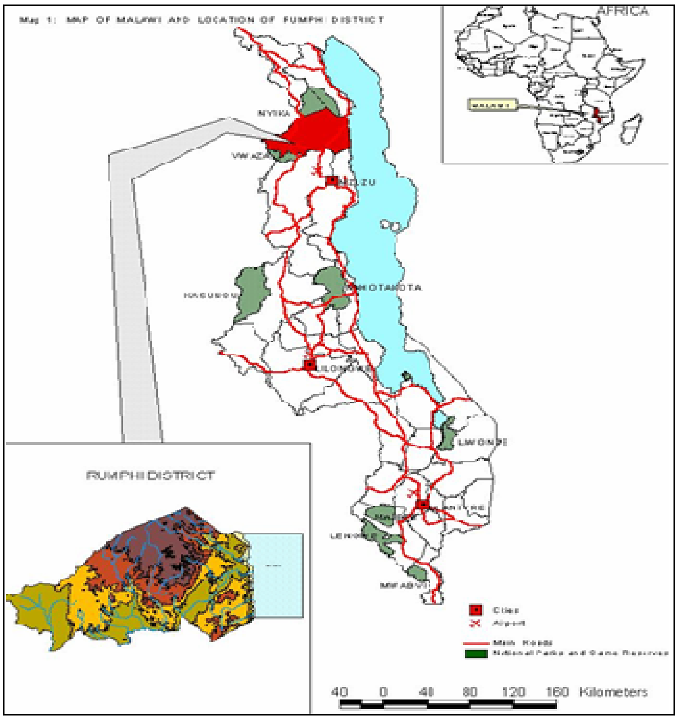
## 3.1 Description of the study area

Rumphi is one of the 28 districts in Malawi located in the northern region. It is bordered by Chitipa (N), Karonga (NE), Mzimba (S) and Nkhatabay (SE); covers a total land area of 4,769km$^2$, making about 4.03% of total land area of Malawi (118,484km$^2$). As at 2008, the area had a population of about 169,112 with 2.8% as an average annual population growth (NSO, 2008). Bolero EPA has a population of 58,550; 11,710 farm families; 112 villages; average land-holding size of 2.7 hectares/family. Women constitute 51% of the population and an average of 5 persons per household). The main livelihood activity is subsistence agriculture (Rumphi FISP Database, 2012/2013).

The study area consisted of 4 sections: Bolero A, Bumba, Chirambo and Jalira. This study area was selected because it is vulnerable to land degradation in particular deforestation and environmental degradation. The area is also characterized by relatively inadequate and variable rainfall. This has led to the area facing dry spells that have led to food shortages. Smallholder farmers in the area have also been practising conservation agriculture for over 10 years.




*Source: Ministry of Agriculture, Irrigation & Water Development*




Source: *Rumphi District Socio-Economic Profile (2009*

## 3.2 Sampling procedure

Under each section, 30 respondents were randomly selected resulting in having 120 respondents from the four sections as a total sample. The sample had reduced due to non-availability of respondents at the time of interviews. Purposive sampling was used in the selection of key informants, namely, extension staff, lead farmers and chiefs and focus group discussants were made up of farmers. Key informant interviews targeted participants who were known to have knowledge and experiences on the topics for discussion. Each section contributed 8 respondents as key informants and 12 as focus group discussants.

### 3.3 Data collection

This was a one-way survey where a combination of methods such as household survey, focus group discussions and key informant interviews were employed in data collection. A household survey involved administration of a questionnaire to collect both qualitative and quantitative information and a total of 113 respondents were randomly interviewed. Research objectives informed the kind of data collection methods used whilst research questions guided the content of questions used in this study. Information that was collected was characterized in four categories: basic characteristics of respondents; information on knowledge (memories and experiences regarding soil fertility and climate change), information on factors influencing adoption of RSFMTs and information on strategies that can be used for the advancement of adoption of RSFMTs. The questionnaire (Annex 1), checklist for focus group discussions (Annex 2) and checklist for key informant interviews (Annex 3) were developed and pre-tested before revising the research instruments including a review of secondary data.

Respondents were asked personal information regarding age, marital status, size of gardens, family sizes, gender and education attained. On farmers' knowledge and experiences, questions sought causes of climate change and soil fertility, perceived changes on soil fertility and climate. This was very useful in order to determine any perceived changes and experiences smallholder farmers have positively or negatively encountered over time in their farming. As regards adoption of RSFMTs, respondents were asked to state whether they practise these technologies, namely agroforestry, residue management, intercropping and crop rotation. Questions were framed in a way that allowed respondents to compare conditions in the recent past (10-15 years) and long time ago (time from their youth). Focus group discussions and key informant interviews were carried out for respondents to give their views on a number of issues and cross-check the information obtained through household survey. Secondary data were also collected through review of publications and official reports. Internet search method was also employed to access data stored via websites (Newing, 2011).

## 3.4 Data Analysis

### 3.4.1 Qualitative Data

Content analysis was used to analyze qualitative data (Bryman, 2008). Lists of causes and impacts of soil fertility loss and climate change and farmers' responses were summarized according to themes. Analysis of qualitative information from focus group discussions and key informant interviews was a continuous process starting from data collection in which major themes were identified before description of the results. Some qualitative data in this study has been illustrated by direct quotes to show actual experiences of smallholder farmers since the study also relied on farmers' views.

### 3.4.2 Quantitative Data

A Pearson's Chi-Square ($\chi 2$) test was used for cross-tabulation of categorical variables to test for association of adoption factors as regards RSFMTs. Data analysis was performed using SPSS version 20 statistical software computer package and first analyzed using descriptive statistics to show characteristics of the adopters and non-adopters and their relationships with adoption by applying the Maximum Likelihood Estimation. The data was also subjected to logistic regression model analysis (Equations 1 and 2).

Literature indicates that decision-making process by farmers to adopt new technologies can be quantitatively analyzed using logistic regression modelling approach (Adesina *et al.,* 2000; Chaves and Riley, 2001). Logit model was used to examine the variables for adopters and non-adopters. The dependent variable (Y) was adoption of RSFMTs and was dichotomized with a value of 1 if a farmer is an adopter and 0 for a non-adopter. The model was appropriate in this study where the dependant variable had a number of its observations clustered at a limited value, zero (0). It used all observations, both those at the limit and those above it, to estimate a regression line (Rahm & Huffman, 1984). Logit model also analyzed the description and tested hypotheses about relationships between a categorical variable and categorical predictor variables (Peng *et al* (2002) and was useful in describing the relationship between one or more independent variables and a binary response dependent variable (Agresti, 2007). Both qualitative and quantitative data were analyzed and outputs have been presented in table 1 for easy interpretation. The study focused on adoption of RSFMTs as a dependent variable and the following as explanatory variables – age, gender, household head decisions, marital status, education, household size, farm size, land ownership, crop type, income source, technology attributes, farmer groups, contact with extension agents, and culture.

The model used to analyze the factors affecting adoption of RSFMTs and in this case, is given by:

$$Logit\,(y) = ln\left(\frac{P_i}{1-P_i}\right) = \alpha + \beta X + \varepsilon_i \quad \text{....................} \quad \textit{(Equation 1)}$$

Where $P_i$ is the probability of adopting, $\alpha$ is the *Y* intercept, $\beta$ is the regression coefficient, X is the predictor and $\varepsilon_i$ is the error term.

$$Y_i = \beta_0 + \beta_1 AGE_i + \beta_2 GENDER_i + \beta_3 HOUSEHOLD\ HEAD_i + \beta_4 MARITAL\ STATUS_i + \beta_5 EDUCATION_i + \beta_6 HOUSEHOLD\ SIZE_i + \beta_7 FARM\ SIZE_i + \beta_8 LAND\ OWNERSHIP_i + \beta_9 CROP\ TYPE_i + \beta_{10} INCOME\ SOURCE_i + \beta_{11} TECHNOLOGY\ ATTRIBUTES_i + \beta_{12} FARMER\ GROUPS_i + \beta_{13} EXTENSION\ STAFF_i + \beta_{14} CULTURE_i + \epsilon i \quad \ldots\ldots\ldots\ldots\ldots \quad \textit{(Equation 2)}$$

***Age*** relates to where older farmers are more likely to adopt a technology because of their accumulated knowledge and experience (Abdulai and Huffman, 2005). However, young farmers have a lower risk-aversion and more likely to adopt new technologies that have long lags between investments and yield of benefits (Featherstone and Goodwin, 1993) (+ / -).

As regards ***gender***, women are the core labour force for agriculture, but are often affected due to lower incomes and smaller pieces of land than male farmers. The usual resource inequalities in ownership and control of productive resources such as land and income between genders play a role. This could affect women to test and adopt the technologies. Some extension agents tend to exclude women even if a technology is gender-neutral. It is assumed that male farmers are more likely to adopt the technologies than female farmers (+ / -).

***Household-head decisions*** will mostly stand within a particular household, especially in relation to technology adoption. In this case, a household head can make a decision whether to adopt a technology or not (+/-).

***Marital status –*** Married couples do share new knowledge as regards farming though women do not mostly access technical training because they are mostly busy with household duties including caring for children and the sick (+).

***Level of education*** is another factor that will enable farmers to easily grasp information on technologies whose adoption will provide an opportunity for increased yields and economic returns due to more efficient adoption decisions (Adeola, 2010). However, uneducated farmers will also attempt to adopt the technologies in order to raise their lives or status just like the educated farmers (+).

***Household size*** influences adoption where there are higher numbers of household members by contributing more to farm works because of the low opportunity cost and availability of labour at household level (Fernandez-Cornejo *et al* (1994) (+).

***Farm size*** is a factor influencing adoption of technologies where farmers with larger landholdings can afford to devote part of their fields to try out a technology thereby increasing the probability of adoption since such farms are associated with availability of capital and high-risk bearing ability (Norris and Batie, 1987) though farmers with smaller landholdings could also be triggered to adopt the technologies in an attempt to increase yields, incomes and improve nutrition (+).

***Land ownership*** could influence technology adoption if the investments are tied to the land and that benefits of these investments are long-term (Fernandez-Cornejo *et al*, 1994). People farming on borrowed land are less likely to adopt technologies that require high investments but the benefits of adoption are not accrued to them (Foti *et al*., 2008) (+).

***Crop type*** **–** Farmers would mostly not adopt a technology if they are involved in other investments such as tobacco or other cash crops with a belief that they can buy food after selling their tobacco while those in need of food would likely adopt so as to increase food levels (Boyd *et al*., 2000) (+/-).

***Income level*** may enhance or distract adoption of agricultural technologies. Where land is a limiting factor, farmers with higher levels of income to buy food during crop rotation period would be more likely to take land out of production than farmers with lower income levels though the former might also decide not to adopt. (+/-).

***Technology attributes*** would make farmers either to adopt or not if a particular technology is able to offer livelihood benefits (Sirrine, 2010). Farmers would look at the advantages and disadvantages of the technologies before making a decision to adopt or not (Olwande *et al*., 2009; Rogers, 2003) (+/-).

***Farmer groups*** would provide an important platform for gaining and exchanging new knowledge or any relevant information related to farming as farmers are always joining different agricultural groups while learning different technologies (Nchinda et al, 2010) (+).

***Contact with extension services*** means participation in agricultural programmes and has a positive impact on farmers' access to information, managerial capabilities and productivity (Abdulahi and Huffman, 2005). Farmers will test and adopt a particular technology based on the frequent contacts with extension staff (+).

***Culture*** may either encourage or discourage adoption of agricultural technologies, especially if a particular technology is culturally accepted or not (+/-).

# 4.0 RESULTS

This section presents the results regarding farmer characteristics, perceptions of soil fertility levels and climate change, factors influencing adoption of RSFMTs and strategies that can be used for the advancement of adoption of RSFMTs.

## 4.1 Farmers characteristics

From a total of 113 respondents, 56.6% were practising RSFMTs while 43.4% were not practising; 53.1% were females and 46.9% were males; 23.9% had size of gardens of above 2 hectares while 76.1% had less than a hectare and 88.5% indicated farming as source of their livelihood.

## 4.2 Perception of soil fertility levels

Of the total respondents interviewed (113), 95.6% perceived a decrease in soil fertility levels while 3.5% perceived an increase in soil fertility levels and 0.9% did not respond.

## 4.3 Perception of climate change

Out of 113 respondents, majority of the respondents (95.6%) perceived a negative change in climate change/variability while 4.4% were of the view that climate has positively changed.

## 4.4 Regression Analysis of Factors Affecting Adoption of RSFMTs

**Table 1 shows logistic regression coefficients for the factors that influence farmers' adoption of RSFMTs in Bolero EPA**

| | Variables | B | S.E. | Wald | Sig. | Exp(B) | 95% C.I.for EXP(B) Lower | Upper |
|---|---|---|---|---|---|---|---|---|
| Step 1[a] | Constant | -14.724 | 4.530 | 10.563 | .001 | .000 | | |
| | Age | 1.650 | 1.102 | 2.243 | .134 | 5.206 | .601 | 45.107 |
| | Gender | .084 | 1.339 | .004 | .950 | 1.088 | .079 | 15.002 |
| | Household head | 2.502 | 1.464 | 2.920 | .087** | 12.207 | .692 | 215.257 |
| | Marital status | .233 | 1.196 | .038 | .846 | 1.262 | .121 | 13.145 |
| | Education | -.050 | .815 | .004 | .951 | .951 | .192 | 4.704 |
| | Household size | .322 | .847 | .144 | .704 | 1.379 | .262 | 7.255 |
| | Farm size | -1.270 | 1.208 | 1.105 | .293 | .281 | .026 | 2.997 |
| | Land ownership | 3.930 | 1.711 | 5.278 | .022* | 50.922 | 1.781 | 1455.666 |
| | Crop type | 2.574 | 1.958 | 1.729 | .189 | 13.121 | .283 | 608.529 |
| | Income source | .382 | 1.262 | .092 | .762 | 1.466 | .124 | 17.372 |
| | Soil fertility perception | -2.145 | 1.821 | 1.386 | .239 | .117 | .003 | 4.159 |
| | Technology attributes | 4.893 | 1.311 | 13.920 | .000* | 133.308 | 10.201 | 1742.174 |
| | Farmer groups | 2.839 | .841 | 11.398 | .001* | 17.101 | 3.290 | 88.891 |
| | Extension staff | 2.027 | 1.082 | 3.510 | .061** | 7.590 | .911 | 63.261 |
| | Culture | 1.450 | 1.108 | 1.711 | .191 | 4.262 | .486 | 37.400 |

Source: Model output

**Indicates significance at $\alpha = 0.1$ (90%)

*Indicates significance at $\alpha = 0.05$ (95%)

-2 Log Likelihood = 54.817, P = 0.001

Goodness of fit Hosmer & Lemeshow (H-L) $\chi^2 = 6.269$, df = 8, P = 0.617

**Table 1** shows that household-head decisions, land ownership, technology attributes, participation in farmer groups and contact with extension staff were significant factors that influenced farmers' adoption of the technologies. The insignificant variables were not considered in the final model, thus, the final model contains the following independent variables: household-head decisions ($X_3$), land ownership ($X_8$), technology attributes ($X_{11}$), farmer groups ($X_{12}$) and contact with extension staff ($X_{13}$).Therefore, the model can be estimated as:

$$\text{Logit (Y)} = -14.724 + 2.502X_3 + 3.930X_8 + 4.893X_{11} + 2.839X_{12} + 2.027X_{13}.$$

As expected, the significant variables; household head decisions ($X_3$), land ownership ($X_8$), technology attributes ($X_{11}$), farmer groups ($X_{12}$) and availability of extension staff ($X_{13}$) have positive logistic coefficients of above one (1).

Table (1) shows that the model fitted the data well with goodness of fit Hosmer and Lemeshow (H-L) test $\chi^2$ (8) of 6.269 and was not significant at 0.05 (P = 0.617). The -2 Log Likelihood was significant (P = 0.001) showing that the model fitted the data. The model can therefore be considered for analyzing factors that affect adoption of RSFMTs.

### 4.5 Strategies that can be used for the advancement of adoption of RSFMTs

Out of 113 respondents, 95.6% indicated that training more farmers would be the most important way to promote adoption of RSFMTs, 3.5% suggested provision of loans while 0.9% did not respond. Furthermore, 63.7% were of the view that it is the responsibility of extension staff to undertake the promotion of these technologies while 36.3% indicated that it was the responsibility of all community members to change their mindsets to increase adoption of the technologies in an attempt to increase food production.

# 5.0 Discussion

This chapter discusses major findings of the study on the adoption of RSFMTs in Bolero. These are perception of soil fertility levels, perception of climate change, factors affecting adoption of RSFMTs and strategies that can be used for the advancement of adoption of RSFMTs. Description of factors affecting adoption of RSFMTs was based on the interpretation of the output of binary logit model.

## 5.1 Perception of soil fertility loss

Majority of smallholder farmers in Bolero are aware that low soil fertility is a critical problem that is affecting their livelihoods and have adopted RSFMTs in order to improve soil condition while at the same time aim at increasing food production and improve their livelihoods as compared to conventional farming. This supports other studies in the sub-Saharan Africa (Kiptot, 2008; Sanchez *et al*., 2009); in Kenya (Anijichi *et al*., (2007); Western Kenya (Swinkles and Franzel, 1997).

Farmers attributed soil fertility loss to unsustainable human activities including liberalization of tobacco farming and that soils are being subjected to continuous cultivation leading to a decline in organic matter content. Farmers also stressed that continued use of inorganic fertilizers will continue to reduce the soil fertility further if applied in larger quantities.

Farmers' knowledge of the usefulness of improving their soil fertility and their attempt to find an alternative to expensive inorganic fertilizers have led to the adoption of RSFMTs though most focus group discussants and some key informants argued that dry spells were not actually new but had increased in their frequency during the recent past.

Focus group discussants and key informants reached a consensus that there is soil fertility loss as a result of human activities, especially deforestation and tobacco farming and it has affected their farming. One key informant, aged above 45 years observed that:

"*We never used to apply fertilizer in our gardens when we were young. Though population has increased, our farming practices are not assisting us to take care of our soils and other natural resources*".

Another lady key informant in her 40s pointed out that:

*"...when we were young, we used to have rivers running with water throughout the seasons, our forests were intact and our parents used to harvest more without fertilizer even from smaller pieces of land"*.

## 5.2 Perception of Climate Change

Majority of the respondents perceived negative climate change impacts in their farming, mainly dry spells and erratic rainfall. By understanding these changes, farmers were willing to adopt RSFMTs as an adaptive measure against climate change or variability due to their advantages and compatibility. This is a common finding from other studies on perceptions of climate change such as in Zambia (Nyanga, 2011; Kalinda, 2011); Southern Malawi (Chinangwa, 2006); in Nile basin of Ethiopia (Deressa et al., 2008); central Tanzania (Slegers, 2008); in the Sahel (Mertz *et* *al*., 2009) and Asia (Marin, 2010). In tandem with adopter-perception paradigm (Adesina & Zinnah, 1993; Prager & Posthumus, 2010), this study has shown that there is a significant link between smallholder farmers' perceptions of negative climatic events and adoption of RSFMTs. Farmers' perception on rainfall variability has therefore had a positive influence on the adoption of RSFMTs in Bolero EPA. Most focus group discussants indicated that generally they were not likely to invest in inorganic fertilizer because it "burns" crops if there is insufficient rainfall.

Most smallholder farmers perceived human activities than natural forces as the main cause of climate change or variability as they mostly referred to deforestation due to tobacco farming as a major contributing factor. Some of the expressions from farmers were as follows:

*"We are copying modern way of doing things than what we used to do in the past and everything is negatively changing….." Here, most of the land is being used for tobacco farming which is being promoted by market-oriented agencies over food crops while neglecting conservation initiatives..."*

*"Rich countries are contributing to major changes in climate and weather patterns which are felt by farmers in poor countries like Malawi..."*

A few farmers were biblical that climate change was a natural phenomenon and that *"it is a sign that the world is ending"*.

Focus group discussants and key informants revealed that they do experience increased variation in rainfall between them and neighbouring areas such as Katowo and Mhuju. They noted that while their area is mostly encountering dry spells and erratic rainfall than before, neighbouring places, mainly Katowo would receive good rains during the same season.

One lady key informant said that:

*"...in the past the first rains could come in early October and the second set of rains used to fall from late October to early November. Nowadays rainfall comes late and goes at anytime, even in January or February when crops are in the garden. Sometimes rains fall heavily and destroy our crops and it is hard to plan and predict the rains nowadays..."*

## 5.3 Description of factors affecting adoption of RSFMTs

Household-head decisions influenced adoption of RSFMTs because the household-head is the primary decision-maker, has more access and control over the information and production resources irrespective of whether the household is male-headed or female-headed. Therefore, it was shown that a household-head with a positive attitude was able to gather and positively use relevant information as regards adoption of RSFMTs. This also relates to the fact that it is mostly household-heads that participate in agricultural social groups and networks and are in control of land in Bolero.

Land ownership status of farm households was found to be influential in adoption decision of RSFMTs since the majority of the respondents owned permanent land on which they were farming despite the majority having smaller pieces of land due to land fragmentation. Even focus group discussants stressed that personal land ownership encouraged the adoption of RSFMTs in the study area because majority of farmers have permanent and secure pieces of land which was culturally acquired through inheritance. Here it shows that land ownership could be a pre-condition to adopt and practise the technologies since smallholder farmers wanted to try and use technologies within their own land than on borrowed or rented land where the final crop yield and other benefits are accrued to them (Fernandez-Cornejo *et al*, 1994).

Majority of farmers believed that RSFMTs are important and easier in the face of soil fertility loss and negative climate change impacts. Respondents had ideas of how technologies were benefitting them to ensure increased crop yields and income. Focus group discussants and key informants digressed that the "*technologies were more rewarding than conventional farming in terms of immediate benefits, such as food, income, increasing yields, ease of use, reducing pests and diseases, reduced labour, conserving soil moisture and incurring less costs*". For example, farmers were able to gain food and fuel from agroforestry species especially pigeon peas while they gain income through the sale of Faidherbia albida seeds to other farmers with livestock as feed. This study supports other studies that farmers' perception about a technology is one of the factors influencing adoption of RSFMTs in Bolero (Sirrine, 2010; Olwande, 2009; Ajayi, 2007; Flett *et al.*, 2004; Rogers, 2003).

Though farmers perceived RSFMTs adoption as a good investment, they still faced problems in application of the technologies as a result of lack of updated information, lack of meteorological data, shortage of extension agents and minimum involvement in participatory processes such as planning, monitoring and evaluation in development initiatives.

Farmer groups, as a social capital, positively influenced adoption of RSFMTs because of savings, knowledge, labour exchange and it is hands-on. The approach has been a driver of adopting other technologies since groups act as a means to access information, secure a job, savings, protect against unforeseen events, reduce information asymmetries, enforce contracts and asset recovery (Mwaura *et al.*, 2012; Di Falco & Bulte, 2010; Barrett, 2005). This concept allows smallholder farmers to utilize collective action and participatory methods to adopt technologies according to their own specific situation by developing their analytical skills and critical thinking to help them make better decisions (Vasquez-Caicedo *et al*., 2000) by empowering farmers and their organizations. The study proved that farmer groups were more empowered through collective action and communication and expected to help farmers increase yields and has generally been adopted by many development agencies in Bolero EPA, though some respondents did not join the groups due to lack of knowledge (ignorance), negative attitudes and laziness. This supports other studies in East Africa (Adong *et al.*, 2013; Friis-Hansen & Duveskog, 2012; Davis *et al*., 2012; Di Falco & Bulte, 2010; Bahigwa, 2005), in Cameroon (Nchinda *et al*., 2010) and in Peru (Gotland *et al*., 2004); in southern Malawi (Thangata & Alavalapati, 2003).

Farmers' contact with extension agents also had a positive influence on the adoption of RSFMTs. Majority of farmers who were in contact with extension agents were exposed and had adopted RSFMTs through demonstrations, trainings and field days from where they acquired new knowledge and skills. In this study, the extension agents were a government worker, those belonging to NGOs and Lead Farmers (village-level worker) who act as most important sources of agricultural information to farmers. This supports other studies in Nigeria (Adeogun *et al*., 2008); in Ethiopia (Mekonen, 2007; Abrhaley, 2006); in Tanzania (Abdulahi & Huffman, 2005) and in Cameroon (Adesina *et al*., 2000).

### 5.4 Strategies that can be used for the advancement of adoption of RSFMTs

The study found that there is need for improved training in various agricultural technologies, soil fertility and climate change issues for farmers to acquire updated knowledge through regular campaigns, field days, demonstrations and farmer groups. This will transform farmers' mindsets about the technologies. Extension agents as well need to re-learn and refresh their knowledge to acquire updated information so as not to confuse farmers as expressed by one respondent:

*"A certain NGO advised us to plant eucalyptus along our only reliable stream when other agencies told us these trees are known for their water-guzzling effect despite having other advantages".*

Focus group discussants digressed that the main problems in the adoption of agricultural technologies include lack of properly-designed and uncoordinated efforts by development agencies who are delivering different messages to already poor and hard-hit smallholder farmers. Farmers felt development agencies would have been key actors in influencing farmers' change of mindsets by supporting, protecting and guiding them than just getting their job done.

"*The relationship between us and private entities such as NGOs and tobacco companies is not good enough because they are not very conversant with our local conditions but are faster when* *called to assist than Government workers including Lead Farmers, who reside with us but are slow to respond to our calls.*

*"Tobacco farming has had a negative impact on our environment due to lack of collaboration as we are taken as mere recipients of support".*

## Conclusion and recommendations

This study has shown that adoption of RSFMTs in Bolero EPA is potentially high as majority of smallholder farmers are aware of negative changes to soil fertility levels and climate. Most farmers revealed that they can no longer plant their crops without any type of technology including inorganic fertilizers if they are to harvest something. Perceptions related to soil fertility loss and climate change were significantly associated with adoption of RSFMTs despite other problems such as small landholdings, shortage of extension agents, uncoordinated efforts by development agents, lack of up-dated information, negative attitudes and ignorance. The main technology in the area is maize-legume intercropping seconded by agroforestry, since the area has abundant *Faidherbia albida* species and pigeon peas. Residue management was ranked third though it requires technical skill for farmers to benefit from it and competes with livestock feed, while crop rotation fetches for larger landholdings. Household-head decisions, land ownership, technology attributes, participation in farmers' groups and contact with extension agents, were the factors found to have significant influence on the adoption of RSFMTs in the study area.

Development agencies should make sure that farmers, including youths and women, who are also a majority segment in the national population, are actively involved in discovering, analyzing and designing their vulnerability situations by even including indigenous knowledge while reinforcing coordinated efforts in a way that choices of technologies should be done through a collaborative engagement. More awareness, dissemination and training sessions for both extension agents and farmers should be scaled-up in order to further transform farmers' mindsets to have a self-help philosophy, improve adoption rates, strengthen impacts of RSFMTs and build farmers' capacity for them to become self-reliant and empowered towards sustainably adopting RSFMTs. Farmers need to be actively involved in all the stages including monitoring and evaluation than relying on extension agents.

Increased involvement, participation and coordination of all stakeholders including smallholder farmers will set an important direction for increased food production and poverty reduction. It is therefore vital to put in place a working institutional set-up that puts communities, as owners of projects together with development agencies since no single agency alone can effectively ensure comprehensive implementation of activities. Such kind of collaboration will address institutional barriers, ensure conditions of empowerment and renewed knowledge, existence of an integrated and transparent system for the promotion of all interventions including good governance.

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## ANNEX 1 : QUESTIONAIRE

**Factors Affecting Adoption of Renewable Soil Fertility Management Technologies in Bolero EPA, Rumphi, Northern Malawi**

**(Farmer Questionnaire)**
Name of the farmer________________________
T/A:_______________________ District:_________________________
EPA:_______________________ Section:________________________
Village:_____________________ Date interviewed ________________________
Time started _____________________ Time finished ___________________

Farmer Category: (1) Practising (0) Non-practising

**SECTION A**

**Respondent Profile (Factors affecting adoption of renewable soil fertility management technologies)**

1. Gender of respondent? 1 = male; 0 = female

2. Are you the head of the house? 1 = Yes; 0 = No

3. Marital status of respondent
(1) Married
(0) Single (widowed, divorced or separated)

4. What is the age of the household head?
(1) 15 – 44 years
(0) More than 45 years

5. What is the level of education of household head?
(1) Primary (Standard 1 – 8)
(0) Secondary (Form 1 – 4)

6. What is the household size?
(1) 1 - 3
(0) More than 4

7. What is the size of the garden (Hectares?)
(1) 0.5 – 1.0 hectares
(0) 2 and above

8. Who owns the land where farming is done?
(1) Own garden (Inherited/purchased)

(0)  Borrowed (rented, pledged)

9. What is the type of land ownership where farming takes place?
(1) Private/Leasehold land
(0) Customary/Public land

8. What assets do you have that are assisting you in your farming?
(1)  Farm tools (plough, hoe, panga)
(0)  Household assets (Television, radio, cellphone, bicycle, motorcycle, car, income)

9. What types of crops are grown by your household?
   (1)  Food crops (maize, cassava, groundnuts, beans, soy bean)
   (0)  Cash crops (cotton, tobacco, paprika)

10. What are your sources of income at your household?
(1)  Farming
(0)  Business (employment, Ganyu, remittances, sale of firewood, sale of charcoal, bee-keeping)

## SECTION B

**Perceptions of soil fertility**

11. What is your perception of soil fertility levels in Bolero?
(1) Increasing
(0) Decreasing

12. What could be the cause for your answer in (11) above?
 (1)  Natural causes (climate change)
 (0) Man-made

13. If it is man-made as in 12 above, how?
(1)  Deforestation (Cutting down of forests, clearing land for food crops)
(0)  Unsustainable farming practices

14. Which of the following technologies have you adopted to increase food production in the event of soil fertility loss?
   (1) Climate-smart agriculture (Use of crop residues, intercropping, agroforestry, crop rotation)
   (0) Fertilizer application

## SECTION C

**Perceptions of climate change and adoption of renewable soil fertility management technologies**

13. What is your perception of climate change in Bolero as compared to 20 years ago?
   (1) Negatively changed
   (0) Positively changed

14. If (1) in 13 above, what are the impacts?
  (1) Dry spells (increased temperatures, short rainfall season)
  (0) Erratic rainfall

15. With the said climate change, what are you going to do to increase food production?
  (1) Adopt conservation farming
  (0) Apply more fertilizer

16. What could be the cause of climate change?
   (1) Natural causes
   (0) Man-made

17. If (1) in (16) above, how has nature caused climate change?
   (1) ………………………………………….
   (ii) ………………………………………….

18. If (0) in 14a above, how has man contributed to climate change in Bolero?
  (1) Deforestation (careless cutting down of forests, clearing land, tobacco farming)
  (0) Unsustainable farming practices

## SECTION D

**Factors affecting adoption of renewable soil fertility management technologies**

19. Do you belong to any farmer group? 1 = Yes; 0 = No

20. If yes in question 19 above, which group?
   (1) Agricultural group (soil and water conservation group, Agroforestry group)
   (0) Village Savings and Loans

21. If no in 19 above, why don't you belong to any farmer group?
   (1) Not interested (can't afford membership fee)
   (2) There is no farmer group

22. Do you have extension workers in this area? 1 = Yes; 0 = No

23. If yes to 22 above, which organization does the extension worker belong?
   1 = Government; 0 = NGO

24. How frequent does an extension worker visit you in a month?
    (1) Once a month
    (0) More than twice a month

25. How do you assess extension delivery service in Bolero? 1 = Good; 0 = Bad

26. Have you ever heard of renewable soil fertility management technologies in agriculture?
    1 = Yes; 0 = No

27. If yes to question 26 above, from where did you hear about renewable soil fertility management technologies?
    (1) Extension worker (including Lead Farmer)
    (0) Farmers club

28. Have you ever been trained in renewable soil fertility management technologies?
    1 = Yes; 0 = No

29. Which crops are you exchanging during crop rotation?
    (1) Maize and legumes (beans, soy bean, groundnuts)
    (0) Maize and agroforestry trees (pigeon peas, gliricidia, Msangusangu, Tephrosia)

30. Which crops are you growing together (Intercropping)?
    (1) Maize and legumes (beans, groundnuts)
    (0) Maize and agroforestry trees (pigeon peas, gliricidia, Msangusangu)

31. Have you ever practiced any of the technologies that you were trained in? (Level of adoption)
    (1) Currently practising
    (0) Not practising (never practised, practised but stopped)

32. For your response 1 in 31 above, how did you get your initial resources to start practising?
    (1) Used my own resources from within the household
    (0) Got loan/grant/support from outside the household

33. For response (1) in 32 above, why are you practising renewable soil fertility management technologies?
    (1) Soil fertility improvement (soil erosion control, high yielding)
    (0) Low cost (low labour demand, pests and disease control)

34. For your response (0) in 31 above, why are you not practising renewable soil fertility management technologies?
    (1) Expensive (labour demand, procurement of materials)
    (0) Grants/support stopped (project ended)
35. For your response (0) in 34 above, would you still be practising renewable soil fertility management technologies if support stops?

1 = Yes; 0 = No

36. If No in 35 above, why would you not be practising renewable soil fertility management technologies?
    (1) Expensive (income, labour)
    (0) Not interested (land is still fertile, I was not selected, never heard of them)

37. Which two renewable soil fertility management technologies are more difficult/expensive to practise?
    (1) ………………………………………………………
    (0) ……………………………………………………..

38. Why is that the case as in 37 above?
    (1)
    (0)

39. Are there cultural limitations for a farmer not to adopt each of the technologies?
    1 = Yes; 0 = No

40. What are the two common cultural reasons for adopting or not adopting intercropping (maize and legumes)?
    (1) ……………………………………………………..
    (0) ……………………………………………………..

41. What are the two common cultural reasons for adopting or not adopting agroforestry?
    (1) …………………………………………………………
    (0) …………………………………………………………

42. What are the two common cultural reasons for adopting or not adopting crop rotation?
    (1) ………………………………………………………………….
    (0) ………………………………………………………………….

43. Which farm operation is labour intensive?
    (1) Laying of crop residues
    (0) Weeding

44. Which would you say is more rewarding between renewable soil fertility management technologies and conventional farming?
    (1) Renewable Soil Fertility Management Technologies
    (0) Conventional farming

## SECTION E

**Strategies for the advancement of adoption of renewable soil fertility management technologies**

45. Should renewable soil fertility management technologies still be promoted?
    1 = Yes; 0 = No

46. What do you think should happen in order to promote adoption of renewable soil fertility management technologies?
    (1) Train more farmers (establish more groups, more demonstrations, more field days)
    (0) Provide loans

47. Who do you think is responsible for undertaking these as in 27 above?
    (1) Extension staff (Government, Lead Farmers and NGOs)
    (0) Fellow villagers (including Village Headmen, ADC, VDC)

48. How do you assess extension service delivery in Bolero?
    1 = Good; 0 = Bad

## ANNEX 2: FOCUS GROUP DISCUSSION CHECKLIST – SMALLHOLDER FARMERS

**Factors affecting adoption of renewable soil fertility management technologies in Bolero EPA, Rumphi, Northern Malawi**

1. What is your perception of soil fertility levels in Bolero?

2. What could be the cause for your answer in (1) above?

3. What is your perception of climate change or variability in Bolero?

4. What are the impacts of climate change or variability in Bolero?

5. What could be the cause of climate change or variability in Bolero?

6. What have you done so far to increase food production in the event of such changes?

6. Have you ever trained farmers in renewable soil fertility management technologies?

7. What are the renewable soil fertility management technologies from the list below?

8. Have you ever mounted any on-farm demonstration on renewable soil fertility management technologies?

9. Do you have any criteria that you use when selecting farmers who host on-farm demonstrations?

10. What is your assessment in terms of adoption of renewable soil fertility management technologies in Bolero EPA?

11. What challenges are you facing in the course of promoting renewable soil fertility management technologies?

12. Are there any incentives given to farmers who host the demonstrations?

13. If yes, what are these incentives?

13. Have you ever experienced some farmers dropping out of conservation farming programmes?

14. Were any follow-ups made to find out why the farmers decided to drop out of conservation farming?

15. What were the reasons for farmer drop-out of RSFMTs adoption?

16. Is culture part of the reasons for farmers to adopt or not these technologies?

17. What opportunities do you see that can help to promote adoption of RSFMTs in this area?

18. If renewable soil fertility management technologies are to be enhanced, what do you think should be added or removed to the programme?

**ANNEX 3: KEY INFORMANT INTERVIEW CHECKLIST**

- **FIELD STAFF, LEAD FARMERS AND CHIEFS**

**Factors affecting adoption of renewable soil fertility management technologies in Bolero EPA, Rumphi, Northern Malawi**

1. Have you noticed any changes in climate over the last 20 years?
2. What have been the impacts that you are experiencing if compared to 20 years ago?
3. What could be your perception of climate change in Bolero?
4. What are the impacts of climate change or variability in Bolero?
5. What do you think is the cause of climate change in Bolero?
6. How has the number of hot days stayed over the last 20 years?
7. Have you noticed any changes in the mean rainfall over the last 20 years?
8. How has the number of rainfall days stayed for the past 20 years?
9. What is your perception of soil fertility levels in Bolero for the past 20 years?
10. What could be the cause for your answer in (9) above?
11. What adjustments in your farming have you made due to changes in climate?
12. What adjustments in your farming have you made due to changes in the amount of rainfall in Bolero?
13. What do you think are the causes of these changes in rainfall?
14. What adjustments in your farming have you made due to soil fertility changes in Bolero?
15. What are the advantages of renewable soil fertility management technologies?

| **Technology** | **Advantages** |
|---|---|
| Agroforestry | -<br>- |
| Intercropping maize with legumes | -<br>- |

| | |
|---|---|
| Crop rotation (maize with legumes) | -<br>- |
| Residue management | -<br>- |

**Hint:** *(i) Soil erosion control (ii) Soil fertility improvement (iii) High yielding (iv) Pests & diseases control (v) Low labour demand (vi) Low cost*

16. Where have you obtained information regarding these changes and their adjustments?

17. What do you think have been the main challenges/difficulties in applying the following technologies in your farming ways?

| **Technology** | **Challenges/Difficulties** |
|---|---|
| Agroforestry | -<br>- |
| Intercropping | -<br>- |
| Crop rotation | -<br>- |
| Residue management | -<br>- |

*Possible answers are (i) Culture (ii) Lack of information (iii) Lack of income (iv) Shortage of labour (v) Shortage of land (vi) Attitude*

18. Should renewable soil fertility management technologies still be promoted?

19. What do you think should happen in order to promote the adoption of renewable soil fertility management technologies in Bolero?

20. Who do you think is responsible for undertaking these as in 19 above?

21. How can you rate the working relationship between Government extension staff and those from NGOs regarding agricultural technologies?

22. How do you assess extension delivery service in Bolero?

23. Are there cultural reasons that are contributing to adoption or non-adoption of these technologies in Bolero?