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

Masters in Transformative Community Development

Title of Research Paper: **Factors Affecting Adoption of Compost Manure among Farmers in Bolero, Rumphi District, Malawi**

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I, Bernard Everson Sakwata, 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

Low adoption of soil fertility improvement technologies in Malawi and other countries in Sub Saharan Africa is a major concern in the attainment of sustainable food security in the region. This paper examines factors causing low adoption of compost manure in Malawi, with Bolero community as a case study. The study interviewed 120 farmers and conducted three focus group discussions. Chi square test was used in the study to establish the effect of different factors on compost manure adoption decision by farmers. The study found out that farmers' perception about compost manure (it is too labour demanding, less effective, and for the poor) is unfavourable for its adoption. Compost manure adoption is affected by farmer characteristics (age, education, and gender), household characteristics (labour availability and income source), farm enterprise (maize farming, tobacco farming, and livestock farming), and, access to inorganic fertilizers. Contrary to other studies, an increase in education level, and increase in household labour availability does not increase adoption among farmers. Furthermore, socio-cultural factors play an important role in compost manure adoption in Bolero, as they influence the adoption factors aforementioned. Socio-cultural practices manifested through gender relations, household power relations, and agricultural practices dictate labour availability, enterprise selection, and access to inorganic fertilizers, among others. The study recommends integration of indigenous knowledge and experiences with scientific knowledge, increased farmers' awareness about other advantages of compost manure, innovations to reduce labour demands in compost manure utilization, and use of group labour in the promotion of compost manure in Malawi.

1.0 INTRODUCTION

It is widely recognized by many scientists that land degradation is a major hindrance to agricultural production in Africa (Bindraban, et al., 2012). Up to 24% of the global land resource is degraded (Nkonya, et al., 2012). Among others, land degradation is manifested through declining soil fertility (Vanlauwe and Giller 2006). Loss of soil fertility is as a result of

population increase that makes most traditional soil fertility improvement methods such as shifting cultivation, natural fallowing, not possible (Ajayi, 2007), continuous cropping without nutrient replacement (Mafongoya et al., 2006), overgrazing, and other poor management practices (Kolawole, 2013). Land degradation and its impact on food production will jeopardize the livelihood of many households (Bindraban, et al., 2012

With the ever increasing global population, there is a need to increase food production by 70 to 100% to feed over 9 billion people by 2050 (Bindraban, et al., 2012). Chemical fertilizer use has been reported to increase soil fertility and improve food security in many parts of the world. However, its adoption among farmers remains low. Among others, high chemical fertilizer prices deter many farmers from its application (Ajayi, 2007). The most feasible option to increase food production in the face of land degradation is to sustainably raise agricultural productivity on existing land (Nkonya, et al., 2012). The key issue in the improvement of agricultural productivity in southern Africa is how to improve and maintain soil fertility within the low incomes of smallholder farmers and land and labour constraints often encountered in the region (Mafongoya et al., 2006).

In response governments and agencies in the Sub Saharan Africa region are promoting more efficient farming technologies. Key among the technologies are nitrogen fixing trees and shrubs, conservation farming, green manure and dual purpose legumes, and, organic manure, both animal and compost (Ajayi, 2007). Similarly, Mafongoya et al., (2006), identifies five options: inorganic fertilizers, grain legumes, animal manures, integrated nutrient management, and agro-forestry. However, despite their potential to improve soil fertility, the adoption of such technologies is lagging behind scientific advances (Tey et al., 2014).

It is widely acknowledged that the success of any development intervention is dependent on the role of the agencies and target communities in the process (Toomey, 2009). Critical success factors often cited include incorporation of indigenous knowledge in development interventions (Botes and Rensburg, 2000). It therefore applies that the success of efficient farming technologies being promoted in Sub Saharan Africa will depend on how agencies and the target communities incorporate local knowledge in the use of the technologies.

Malawi is experiencing loss of soil fertility, which is one of the factors causing the dwindling of crop yields in the country. According to Andersson and D'Souza (2013), land degradation already threatens household food sufficiency for smallholder farmers in Malawi. Similarly, soil fertility loss is one of the constraints to food production in northern Malawi (Kerr, 2005). In response, the Malawi government and partners are promoting various measures, including promotion of soil fertility improvement interventions such as use of compost manure, conservation agriculture, and agro-forestry. In addition, the government is promoting the use of chemical fertilizers through the Farm Input Subsidy Program, (FISP) which has been running over the past decade.

Bolero community in Rumphi district is equally experiencing loss of soil fertility. The name Bolero means fertile soils which were prevalent in the community. However, today the soils are no longer as fertile as they used to be (Mataya et al., 2014). In response, there are several organizations in addition to the government that are promoting soil fertility improvement interventions. Of the several interventions being implemented in response to the problem of soil fertility loss in Bolero community is the use of compost manure. It has been known for a long time that compost manure improves soil fertility (Workneh et al. 2014, Ajayi, 2007).

Despite the presence of several stakeholders promoting the use of compost manure in Bolero, its adoption remains low. If this trend continues, the results will be catastrophic. The soils will be degraded and unable to produce enough to meet the ever increasing demand for food and other cash crops which are a source of livelihood for the community.

This study provides some insights on the underlying factors behind the low adoption of compost manure in Bolero. This will assist extension agencies promoting the use of compost manure to come up with the relevant approaches to improve adoption of compost manure in Bolero. In turn this will improve the soil fertility and soil structure, thereby contributing towards the sustained crop production for food and cash in the community.

The main objective of the study was to find out why there is low adoption of compost manure by farmers in Bolero, Rumphi. The study had three specific objectives; 1) to find out local farmers' perspective about compost manure in Bolero, 2) to find out factors influencing local farmers' adoption of compost manure in Bolero, and 3) to find out the role of indigenous knowledge on farmers' compost manure adoption decision in Bolero

In order to address these objectives, the study had four questions; a) do local farmers consider compost manure an effective source of plant nutrient? b) Do farming household characteristics affect adoption of compost manure in Bolero? c) Do social-cultural practices affect adoption of compost manure in Bolero? c) Does adoption of other soil fertility improvement technologies affect adoption of compost manure in Bolero? d) How is indigenous knowledge incorporated into the current approach by agencies in the promotion of compost manure?

This paper is arranged such that a review of literature on methodological approaches to similar studies, farmers' perception about agricultural technologies, factors affecting farmers' adoption of various technologies, and the role of indigenous knowledge in development is presented in section two. Section three outlines the methodology that was employed in the study, with main results presented in section four. Finally, section five discusses the main findings and draws some conclusions and recommendations for the study.

2.0 LITERATURE REVIEW

There are different aspects about farmers' adoption of compost manure and other technologies in literature. This literature review will focus on three aspects of methodological approaches to farmers' technology adoption studies, farmers' perspective about compost manure, factors affecting farmers' adoption of technologies, and the role of indigenous knowledge in development.

2.1 Methodological Approaches to the Study of Farmers' Adoption Behaviour

Different research methodologies are being employed in the study of farmers' adoption behavior. These include questionnaire and focus group discussion (Tey, et al., 2013), and literature review (Ajayi, et al., 2007). Other studies, like Wossen et al., (2014), use secondary data. Descriptive statistics, empirical modeling, vote counting and meta-analysis are the means of analysis in the studies.

Various models are used to study adoption behaviors among farmers. Logit, probit and tobit models and their modifications are typically used (Waithaka, 2007). Vote count analyses literature by counting the number of times a given variable has been significant, either positive or negative, and insignificant. Limitations with this methodology are that it does not take into account sample size, and has a low statistical power (Baumgart-Getz et al., 2011). Meta-analysis, defined by Baumgart-Getz et al. (2011), as a quantitative summary of a body of literature, improves on the limitations of vote count.

Differences in approaches and methodologies affect the findings and comparability of technology adoption studies. Much as some study findings complement each other, others are in

conflict (Baumgart-Getz et al., 2011). For instance, Knowler and Bradshaw (2007) in their literature review of conservation tillage across the globe found no variables that could explain adoption globally. In a similar study, Kabii and Horwitz (2006) found age, tenure, knowledge and attitude towards a technology to be significant variables. Such conflicting finding makes it difficult to understand the factors determining farmers' adoption of various technologies.

To make up for the shortfalls of each of the approaches mentioned above, this study used of a combination of approaches; questionnaire administration, focus group discussion, key informant interviews, literature review, and observation. In addition to the common themes covered in similar studies, livestock ownership and access to inorganic fertilizers were also explored, as they are relevant to the context of Bolero.

2.2 Farmers' Perception about a Technology

Farmers' perception regarding the effectiveness of a technology affects its adoption (Abdulai, et al., 2014). Widely cited Rogers (2003), recognizes important attributes of farmers perception that influence their adoption decisions. These are relative advantage over available alternative technologies, compatibility with existing practices, values and needs, complexity, trialability and observability. Relative advantage is usually measured in terms of financial advantages (Reimer, et al., 2012). However, in addition to economic gains other factors of relative advantage includes time saving, immediacy of the rewards from the technology, and, reduction of discomfort (Rogers, 2003). Relative advantage is influenced by individual characteristics (Reimer, et al., 2012) including demographic factors such as age and education, which are often considered in most adoption studies (Prokopy et al., 2008).

Famers' correct perception about a technology is an important factor in their adoption decision making. Snapp, (1998), notes that it is important to investigate and assess farmers' perceived benefits and challenges of a technology in order to improve its adoption. Theoretically, farmers who perceive a problem as being important to their farm production are likely to adopt technologies addressing the problem (Bewket, 2007). Perception varies with gender, culture, personal experiences, socio-economic and environmental factors (Legesse and Drake, 2005)

2.3 Determinants of Technology Adoption by Farmers

There are contrasting views on the role of land tenure on adoption of soil improvement technologies. While some studies show that insecure land tenures discourage farmers from investing in soil improvement technologies, (Ayuk, 2001), other studies show that land tenure does not have an effect on farmers' adoption choice of soil fertility improvement technologies (Adesina *et al.*, 1993). From these contrasting views and the varying contexts of the studies, it can be deduced that the role of land tenure on farmers' decision to adopt soil fertility improvement technologies is dependent on the cultural practices of the area and the nature of the technology.

Farmers' technology adoption decisions are also influenced by socio-cultural factors and beliefs systems attached to land. For example, Kalawole (2002) reported that a South African community recognized the problem of land degradation as an act of God, and nothing could be done about it. Local customary practices discourage the adoption of some technologies (Ajayi, et al 2007). Since socio-cultural practices vary spatially, the effect of socio-cultural beliefs and practices on technology is area specific.

Fiscal policies such as subsidies and institutional support for some soil fertility improvement technologies indirectly influence farmers' decisions on soil fertility improvement technologies adoption (Andersson and D'Souza 2013; Ajayi, 2007). For instance, while making a comparison of the net benefit of different soil fertility improvement technologies, Franzel (2004) reports that use of nitrogen fixing soil fertility improvement technologies in Zambia is less profitable to the farmer than the use of subsidized fertilizers. However, if the fertilizer subsidy is removed, use of fertilizer becomes much less profitable than nitrogen fixing soil fertility improvement technologies. This finding is a reflection of the scenario of Malawi's Farm Input Subsidy Program, where fertilizer is heavily subsidized, up to 97% of the gate price. The result is that farmers have paid little attention to other soil fertility improvement technologies in favour of subsidized fertilizers.

Most sustainable agriculture practices are labour intensive, making labour availability an important factor in farmers' adoption decision (Tey, et al., 2013). Many studies identify high labour demand as a constraint to compost manure adoption (Wossen, et al., 2015, Bewket, 2007, Ayuk, 2001, Snapp, 1998). Compost manure making process requires the cutting and mixing of large volumes of biomass. Similarly, the actual application of manure requires a large labour force as compost manure is bulky and cumbersome. Unfortunately, with almost all agricultural processes being done manually, most farmers cannot afford to invest their valuable labour resource in compost manure use.

Age, educational level and gender are considered most important among several farmer characteristics cited in adoption literature, (Nyangena, 2008; Bewket, 2007). There is generally no consensus on the effect of these farmer characteristics on adoption behavior. Much as

majority of studies claim an increase in age increases adoption behavior (Waithaka, 2007), still more some studies contradict this, showing no relationship between age and technology adoption (Kalawole, 2002). Similarly, one body of literature shows that adoption increases with an increase in education level (Abdulai and Wallace, 2014), yet another shows that education has no significant effect on adoption behavior (Ogunlana, 2003). This lack of consensus is also found in adoption studies concerning gender. Most studies agree that females are low adopters (Waithaka, 2007). However, Ogunlana (2003) argues that females are fast adopters.

Considering the debate surrounding the effect of socio-economic factors on adoption behavior highlighted above, it is evident that the effects are context specific. Furthermore, the effect also depends on the nature of the technology being promoted. Differences in study methodologies further contribute to different findings.

2.4 Indigenous Knowledge and Development Practices

Most development projects are initiated by outsiders in the name of development experts, who oftentimes dominate decision making and manipulate instead of facilitating development processes. This has been the cause of failure of many development projects (Botes and Rensburg, 2000). In an attempt to address development failures, there has been increased effort by development institutions to draw from the indigenous knowledge of the communities involved (Briggs and Sharp, 2004).

In 1998 the World Bank established the Indigenous Knowledge for Development: A Framework for Action which recognizes the n.eed to learn from developing countries, on top of bringing global knowledge to them (World. Bank, 1998). Five years of implementation of the World Bank's framework generated a repository of many indigenous knowledge practices in Sub

Saharan Africa in the areas of agriculture, natural resource management, medicine and many more (World Bank, 2004). Despite claims of inclusion of most of the indigenous knowledge practices into development initiatives, the inclusion is yet to be seen.

Different communities in Malawi have their own indigenous knowledge practices. In their study in Zombwe, less than 100 km from Bolero, Briggs and Moyo (2012) found out that farmers burn crop residues, plant cassava in less fertile soils, and use crop residues as indigenous methods of soil fertility improvement.

3.0 STUDY METHODOLOGY

The study was conducted in Bolero community, Rumphi district in northern Malawi (refer to Appendix 1). Bolero was chosen because, firstly, and foremost, it is a Community of Practice for the study program. Secondly, there are several agencies promoting use of compost manure in the community. Lastly, despite the presence of several agencies, adoption of compost manure is low.

Using multistage sampling process, 3 of the 12 sections of Bolero Extension Planning Area (EPA), Mjuma, Lundu and Bolero A, were purposively selected representing high, medium, and low adoption rates, respectively. A total of 9 villages, 3 from each of the sampled sections were randomly selected. In two of the three selected villages, 40 farmers (20 in each village) were systematically sampled for questionnaire administration. One focus group discussion was conducted in each of the remaining village in the sampled sections. This translated into 120 questionnaires administered and 3 focus group discussions conducted.

Questionnaire administration and focus group discussion were pre-tested immediately after training enumerators, and necessary corrections were made. A total of 4 key informants (2 from government, 1 from Total Land Care, and 1 from Harvest Help Find Your Feet) were interviewed. Questionnaires (Refer to Appendix 2), focus group discussions and key informant interviews tackled major themes of household characteristics, income sources, labour availability, land holding sizes, land ownership, livestock ownership, perception about the problem of soil fertility loss, adoption of compost manure, and adoption of inorganic fertilizer.

There is a great difference in sample sizes for farmers' adoption studies between different researchers. Sample sizes vary according to study objectives, size and characteristics of the study

area, and research strategy chosen. Much as other studies use big sample sizes, others use moderately small sample sizes. For example, Waithaka (2007) used a sample size of 253 farming households for an adoption study in the entire Vihaga district in Kenya, and Bewket, (2006) used a sample size of 64 in Ethiopia. In line with this, a sample of 120 was thought to be adequate for the study, which was covering a relatively small area compared to similar studies elsewhere. In addition, there is little heterogeneity among farmers' characteristics and farmlands in the study, hence increasing the sample size wouldn't have made significant difference on the findings.

Quantitative data was analyzed using descriptive statistics like frequencies, percentages etc. for each of the key variables under the themes. Furthermore, relationships between the key variables and adoption behavior were tested and established using Chi-square. Qualitative data was analyzed by identifying key issues appearing under each them.

4.0 RESULTS

This section presents the main findings of the study. It outlines farmers' perception about compost manure, factors affecting farmers' compost manure adoption decision, and indigenous knowledge in compost manure use, among others.

4.1 Farmers' Perception about Compost Manure

Three key farmers' perceptions about compost manure were identified in the study as presented in Table 1 below. The table shows that key perceptions are that compost manure is too labour intensive, it is not as effective as inorganic fertilizer, and, it is for the poor farmer. This was collaborated by farmers across all adoption categories; adopters, former adopters, and non-adopters. These perceptions are generally unfavourable for the adoption of compost manure in the area.

Table 1: Farmers' Perception About Compost Manure

#	Perception	Farmer Category (%)		
		Adopters	*Previous Adopters*	*Non-adopters*
1	Compost manure use is too labour demanding	22	36	47
2	Compost manure improves soil fertility, but it is not as effective as inorganic fertilizers	14	22	18
3	Compost manure use is for poor farmers who cannot afford inorganic fertilizers	n/a	n/a	n/a

4.2 Factors Affecting Farmers' Adoption of Compost Manure

Table 2 below highlights key factors affecting farmers' adoption of compost manure as identified in the study. The factors were categorized into four; farmer characteristics, household characteristics, farm enterprise, and, access to alternative soil fertility improvement technologies.

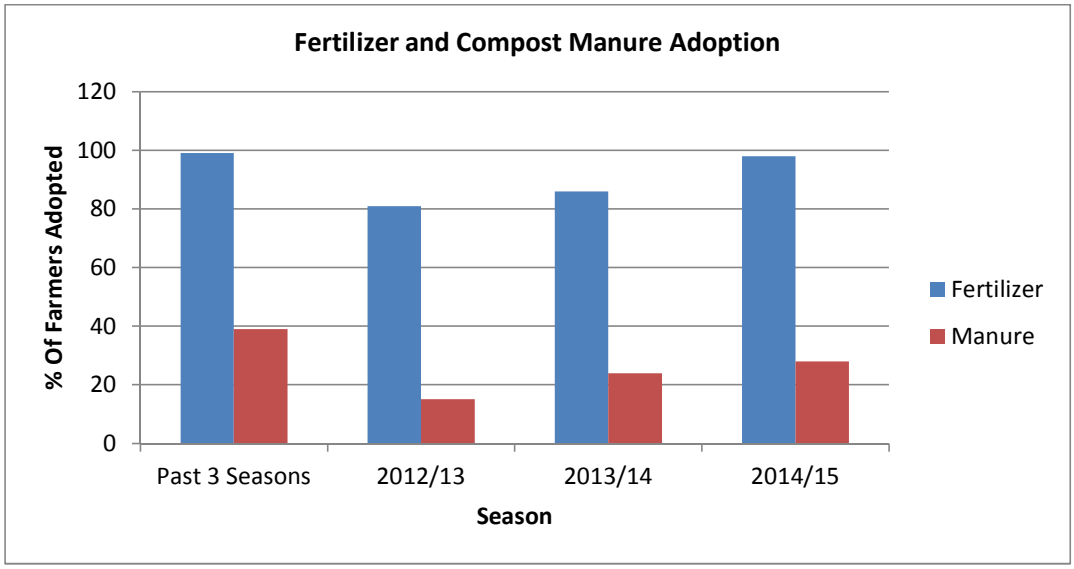
Table 2: Correlation of Different Factors with Farmers' Compost Manure Adoption

No	**Variable Name**	**Pearson Chi Square Value**	**Approx. Sign Value**
Farmer Characteristics			
1	Age of household head	13.810	.313
2	Gender of household head	3.590	.309
3	Education level of household head	14.932	.245
Household Characteristics			
4	Household's main income source	11.589	.950
5	On-farm labour availability in the household	11.092	.269
Farm Enterprise			
6	Maize farming	-	-
7	Tobacco farming	-	-
8	Livestock farming	.301	.960
9	Poultry farming	1.699	.637
Access To Alternative Soil Fertility Improvement Technologies			
10	Access to inorganic fertilizers	-	-

4.3 Comparison of Inorganic Fertilizer and Compost Manure Use

Figure 1 below shows a comparison of compost manure and inorganic fertilizer uses. The results show that inorganic fertilizer is a more accessed soil improvement technology compared to compost manure.

Figure 1: Compost Manure and Inorganic Fertilizer Use in Bolero



4.4 Indigenous Knowledge about Compost Manure

Farmers experience with compost manure use in Bolero has generated relevant local knowledge. This includes the following;

1. Some raw materials for making compost manure being promoted by extension agencies are not effective in improving soil fertility.
2. Some raw materials for making compost manure being promoted by extension agencies attract termites, which destroy crops in the field.

3. Manure use is in conflict with other agricultural practices, both traditional (like free range livestock rearing) and modern (like conservation agriculture) especially in competing for crop residues as raw materials.
4. For optimum utilization, compost manure is used in combination with inorganic fertilizers, with compost manure as a basal dresser, and inorganic fertilizer as a top dresser.

5.0 DISCUSSION AND CONCLUSION

The main findings discussed in this section are farmers' perception about compost manure, factors affecting compost manure adoption, and, the role of indigenous knowledge in compost manure use in Bolero.

5.1 Farmers' Perception about Compost Manure in Bolero

Understanding farmers' perception about a technology is a precondition for developing the right technology promotion approach. Farmers' perception in Bolero is that compost manure use is too labour demanding, compost manure is less effective than inorganic fertilizers, and, it is for poor farmers who cannot access inorganic fertilizers. These dominant perceptions about compost manure in Bolero are generally unfavourable for its adoption.

The perception about compost manure's high labour demand is held by many farmers, non-adopters, former adopters, and adopters. Among non-adopters, 47% of farmers mentioned high labour demand as a reason for not adopting compost manure use. Up to 36% of former adopters and 22% of adopters acknowledged high labour demand as a reason for stopping compost manure use, and a challenge in compost manure use, respectively. The problem is further exacerbated by an intense demand for labour in tobacco farming, which is prevalent Bolero, and is considered more profitable than maize farming on which compost manure is used

However, the challenge of high labour demand in compost manure use can be averted by using group labour. This is well expressed in manure demonstration plots where small groups of farmers work together in compost manure making and application in demonstration fields located in strategic places. In Bolero, this is called *chiwovwirano*. Elsewhere in Ethiopia, it is

called *debo* and *wonfel* (Wossen, et al, 2015). Under this arrangement, a group of community members work together in a garden of one group member, before they move to the garden of another group member. This trend continues until the group works in the gardens of all members. This arrangement can help in addressing the high labour demand associated with compost manure making and application. In addition to meeting high labour demands, the arrangement also enforces farmer learning as there is a lot of learning from peers (Wossen, et al, 2015).

Labour is an important factor to be considered in farmers' adoption of technologies (Ajayi, 2007). To address this factor, there is a need to undertake studies to simplify and save labour in the process of manure making and application. Similar calls have been made by Bewket (2006). Such studies are important because labour is a major constraint among subsistence farmers, especially in Malawi where almost all processes are done manually.

Secondly, farmers perceive compost manure to be less effective in improving soil fertility in comparison with inorganic fertilizers, which is the most adopted soil improvement technology in the community. This perception has been supported by other studies elsewhere (Vanlauwe and Giller, 2006). This perception is a major cause for low adoption of compost manure in Bolero. Twenty two percent (22%) of farmers who once used compost manure stopped because it did not produce expected yields, whereas another 18% have never used the technology, because it produces low yields.

It is important to bring to the farmers' knowledge that in addition to improving soil fertility, compost manure has other advantages. Among others, these include sustained soil fertility,

improved soil structure, and increased water holding capacity of the soils. This will increase the relative advantage and subsequently adoption of compost manure.

Lastly, use of compost manure is perceived as an option for the poor farmer who cannot access inorganic fertilizer. This finding is supported by Ayuki, (2001), who shows that resource endowed farmers use inorganic fertilizers while resource poor farmers use technologies like compost manure, animal manure, crop residues among others. It is therefore important to ensure that the technology targets both the resource poor and resource endowed farmers so that this perception is corrected.

5.2 Factors Affecting Adoption of Compost Manure

The study found out four broad categories of factors affecting farmers' adoption of compost manure in Bolero, namely; farmer characteristics, household characteristics, farm enterprise, and, access to alternative soil fertility improvement technologies. However, there is no clear demarcation between the categories as most of the factors from these categories influence each other.

Important farmer characteristics identified are age, gender and education level. The study found that compost manure adoption level increases with an increase in age of the household head. This is in tandem with other studies (Knowler and Bradshaw, 2007). However, when the age of the household head reaches 50 years, the adoption level drastically reduces. Among others, this is because at this age the household head is aged and his/her contribution to household labour is minimal. In addition, by this time most children are grown ups and have left the household through marriages, further reducing labour availability.

Generally, female headed households in Bolero have a better compost manure adoption level than male headed households. This is mainly because of the relationship between gender and farm enterprises in Bolero. Females are more likely to be involved in maize production, which uses compost manure, unlike males. There are three main reasons for this finding. Firstly, traditionally females are more concerned about household food security than males, hence maize farming meets their concerns. Secondly, women participation in tobacco farming is limited as socially tobacco farming is considered an enterprise for men (Kerr, 2005). Thirdly, men have greater access to labour and inorganic fertilizers, which are highly required in tobacco farming (Kerry, 2005). Since tobacco does not make use of compost manure, it is not surprising that the proportion of male headed household adopting compost manure is lower than that of female headed households.

The level of use of compost manure increased with an increase in education level. This positive relationship between education level and technology adoption has been reported in several studies (Abdulai, et al., 2014, Baumgart-Getz, 2011). However, in the study the actual adoption level drastically reduces with an increase in education level. This can be attributed to the fact that people with high education have a better understanding of new technologies. For this reason, more educated household heads started the use of compost manure in Bolero. However, with the same understanding level, the educated realize that the use of compost manure has low relative advantage in comparison with other alternative means of improving soil fertility, mainly inorganic fertilizers. The low relative advantage is the cause for low adoption of the technology (Rodgers, 2003) among the relatively highly educated. Secondly, the relatively high educated

have a higher chance of accessing fertilizer than the less education through agricultural loans. High access to fertilizer results into low use/ adoption level of compost manure.

The foregoing discussion shows the importance of understanding individual characteristics of the target group. From the discussion, it shows that it is important to consider farmer characteristics in the promotion of compost manure. Targeting female farmers and relatively young farmers would increase adoption levels.

Labour availability and main income source are key household characteristics affecting compost manure adoption identified in the study. Unexpectedly, the level of compost manure adoption decreased with an increase in household labour availability. The reason for this trend can be that most farmers prefer using their available labour in tobacco farming, which does not use compost manure, rather than maize farming which uses compost manure. Tobacco farming is considered more profitable than maize farming. Ironically, women are more affected by labour shortage than men. This is because women have multiple responsibilities on top of providing farm labour eg caring for the sick. In addition, women have limited cash to hire labour (Kerr, 2005). Labour shortage therefore indirectly predestines women to engage into maize farming, which uses compost manure.

Household's compost manure adoption level was related to the main income source of the household. Generally, adoption level was lowest among households with off-farm income sources. This is the case because households with off-farm income sources invest their time and productive labour in other enterprises not related to compost use, such that manure adoption may not be a priority, or may not even be applicable.

From the discussion it can be deduced that the effect of labour on compost manure adoption is also dependent on alternative labour uses. An increase in available household labour availability will enable the household to go into tobacco farming than maize farming, thereby making compost manure use less applicable. It is therefore important to understand household labour dynamics and household livelihood sources in the promotion of compost manure in Bolero.

Important farm enterprises in Bolero are maize farming, tobacco farming, and, livestock farming. Compost manure use in Bolero is limited to maize farming. However, with the dwindling maize selling prices, maize farming is now attracting less attention among farmers. Farmers are focusing on tobacco growing, which is a major cash earner for the predominantly subsistence agriculture community. Tobacco farming in Bolero does not use compost manure. Compost manure use in Bolero is therefore associated with maize farming.

Animal manure being a major raw material for compost manure production, it was expected that livestock farming would increase compost manure adoption level. However, this only applies to poultry farming, whereas cattle, goat, sheep and pig farming show no relationship with compost manure adoption. Over 75% of farmers who own cattle, goats, sheep and pigs who used manure in the past three seasons are one time users. This implies that the farmers used compost manure but later stopped. This trend can be explained by the three steps of the technology adoption process; information acquisition, technology testing, and final adoption, as presented by Ajayi, (2007). It therefore applies that the farmers acquired information about compost manure, and tested the technology. However, it did not meet their requirements and they did not proceed to adopt it. Three main reasons may account for the lack of adoption of compost manure by this

group of livestock farmers. Firstly, these farmers have animal manure in relatively huge quantities that are applied directly to their fields. Secondly, the use of animal manure provides high relative advantage, in form of savings in labour and time. Thirdly, traditionally ownership and control of livestock rests in the hands of males (Kerry, 2005), who, as earlier discussed, are more focused on tobacco farming, which does not use compost manure.

Compost manure adoption level among livestock owners was highest with poultry ownership. This again is as a result of traditional livestock ownership and control practices. There are more chances of women owning and controlling poultry enterprise than with other livestock types. With a higher adoption level among women than men, it is not surprising that poultry ownership has a better adoption level.

The effect of farm enterprise on compost manure adoption is the manifestation of gender and power relations at household level. Farm enterprise selection decision is made by males, unless it is a female headed household. In support of this finding, Kerr (2005) reported that the decision to grow tobacco was made by husbands due to their increased access to fertilizers, and social norms that tobacco farming is for men. These decision making factors should therefore be seriously considered as farm enterprise selection and livestock ownership and control are among the determinants of compost manure adoption decision among farmers in Bolero.

Increased access to inorganic fertilizers, as an alternative soil fertility improvement technology reduces compost manure adoption in Bolero. Inorganic fertilizers are highly accessible to farmers than any other means of soil fertility improvement. Up to 97% of farmers accessed fertilizers compared to only 23% who used compost manure in the 2014/15 farming season. This

implies that farmers using compost manure use inorganic fertilizers as well. Ironically, no farmer applied up to a quarter of his/her total field under cultivation in the season under review. This is the case because inorganic fertilizers offer high relative advantage over compost manure. One notable advantage of inorganic fertilizers over compost manure as recognized by farmers is labour saving.

In addition to labour and time saving, the relative advantage include cost saving through the government's Farm Input Subsidy Program through which poor farmers access fertilizers at subsidized rate of as low as 3% of the gate price, credit facilities through several agricultural institutions that provide fertilizer and other farm inputs to farmers, and availability of several reliable fertilizer outlets through which farmers buy fertilizers.

5.3 The Role of Indigenous Knowledge on Farmers Compost Manure Adoption

In their use of extension messages, local farmers evaluate such messages against local knowledge, experiences and practices to decide the extent to which the information can be acted upon (Briggs and Moyo, 2012). True to this, Bolero farmers have evaluated the use of compost manure over the years and derived at decisions as to how they should adopt it. Among the indigenous knowledge generated so far from the use of compost manure in Bolero is that some raw materials being recommended for compost manure production attract termites in the field, which eventually destroy crops. This has demotivated some farmers from using compost manure. Secondly, some raw materials being promoted in the production of compost manure are not

effective in improving soil fertility. The quality of compost manure is usually compromised by the poor quality of raw materials being used (Ayuki, 2001).

Thirdly, for optimal utilization, compost manure needs to be used in combination with inorganic fertilizers, with compost manure used as a basal dresser, and inorganic fertilizer as a top dresser. Ironically, science acknowledges that combined use of organic and inorganic soil amendments is more effective than use of either alone (Mafongoya, et al., 2006, Ayuki, 2001). According to Nkonya et al. (2012), research conducted in Sub Sahara African countries, including Malawi, confirms this. However, further studies need to be taken to ascertain the best combination and quantities of compost manure and inorganic fertilizers (Ajayi, 2007).

Fourthly, compost manure use is in conflict with other agricultural practices, both modern and traditional in the area. These include conservation agriculture and livestock farming which traditionally uses free range system, both of which require crop residues. Crop residues are the main ingredient of compost manure. Unfortunately, compost manure, which requires huge quantities of crop residues (Ayuk, 2001, Ouedraogo, et al., 2001) is given lowest priority among its competing enterprises for scarce crop residues, as it is regarded as less rewarding. Ironically, these technologies are promoted simultaneously by the same agencies. This is a manifestation of interventions designed and managed by outsiders who do not have an understanding of the context of the communities they are serving (Botes and Rensburg, 2000)

Interestingly, the majority of extension officers in Bolero comprise locals, fully aware of the rich knowledge generated in the use of compost manure, but they ignore it. This is a demonstration of the dominance of the western knowledge of indigenous knowledge, underpinned by the power of agencies. Referring to this dominance, Davis (2005) calls western and indigenous forms of knowledge as the privileged knowledge and suppressed knowledge, respectively. The tendency of ignoring indigenous knowledge in development interventions is common among agencies (Toomey, 2009). This is one of the causes of development project failure in developing countries, rendering Africa "the graveyard of development project" (Lenette and Ingamells, 2014). The current approach in the promotion of compost manure in Bolero is deliberately ignoring local understanding. As noted by Nuttavuthisis et al, (2015), approaches developed without local understanding lack incentives for communities to participate.

The foregoing discussion shows that for compost manure adoption in Bolero to improve, there is a need to incorporate indigenous knowledge and practices. Community development requires a demonstration of an awareness of the status of the communities by agencies, and respect of the communities' indigenous contribution as manifested through their knowledge, skills and potential (Botes and Rensburg, 2000). This implies that the knowledge realized by farmers in Bolero ought to be taken on board by the prevailing scientific knowledge. This calls for a complete departure from the one-size-fits-all approach being taken by most agencies in development work as biophysical and socioeconomic conditions are different (Bindraban, et al., 2012)

5.4 Conclusion and Recommendations

This study explored the factors causing low adoption of compost manure by farmers in Bolero, Rumphi. The study has found out that local farmers' perspective about compost manure in Bolero is that it is less effective in improving soil fertility, it is too labour demanding, and, it is for the poor. This perception is unfavourable for the adoption of compost manure in Bolero.

Farmer characteristics, household characteristics, farm enterprise, and access to alternative soil fertility improvement technologies affect farmers' decision to adopt compost manure. Important farmer characteristics are age, gender and education level, while labour availability and main income source are important household characteristics. Farm enterprises whose selection affects compost manure adoption decision are maize farming, tobacco farming, and livestock farming. Inorganic fertilizer is the most accessible soil fertility improvement technology, and its use affects farmers' decision to adopt compost manure.

Having used compost manure over the years, farmers have developed local knowledge and best practices based on their experiences. These include identification of best and poor raw materials for compost manure making, combined use of compost manure and inorganic fertilizer, and agricultural technologies and practices in conflict with compost manure utilization. However, despite the generation of this knowledge, it has not been incorporated into scientific approach to the promotion of compost manure. This is contributing to the low adoption of compost manure in Bolero.

Socio-cultural practices of Bolero are at play, whether directly or indirectly, in all the factors mentioned above. For instance, gender roles and responsibility determine labour availability,

livestock ownership and control, and farm enterprise selection. Likewise, livestock management practices and decision making at farm level are influenced by cultural practices. This underpins the importance of socio-cultural factors in compost manure adoption in Bolero.

In view of these findings, the study makes four broad recommendations to promote compost manure adoption in Bolero. Firstly, indigenous knowledge should be incorporated in compost manure use. This includes the use of compost manure in combination with inorganic fertilizers, as a basal dresser and top dresser respectively. However, there is a need to establish the right combination and application rates. Furthermore, raw materials being used in compost manure production should be carefully selected. Raw materials that attract termites that destroy crops and those that have low ability to improve soil fertility should not be promoted. This will also improve the effectiveness hence the acceptability of compost manure among farmers.

Secondly, promotion of compost manure utilization should focus on increasing farmers' awareness about the long term advantages of compost manure. These include sustained soil fertility, improved soil structure, increased water holding capacity of the soils, among others. This will increase the relative advantage of compost manure and its adoption among farmers.

Thirdly, methods of saving labour in manure making and utilization process should be explored. Once found, labour saving methods should be promoted to reduce the high labour demand which deter many would be adopters. Reduction in labour demand will increase relative advantage of compost manure, and its acceptability before the farmers.

Finally, use of group labour- *chiwovwirano,* in compost manure making and utilization should be promoted. This will help avert labour shortages experienced in compost manure utilization

process. In addition, this will generate peer pressure to use compost manure among farmers, thereby further promoting its adoption.

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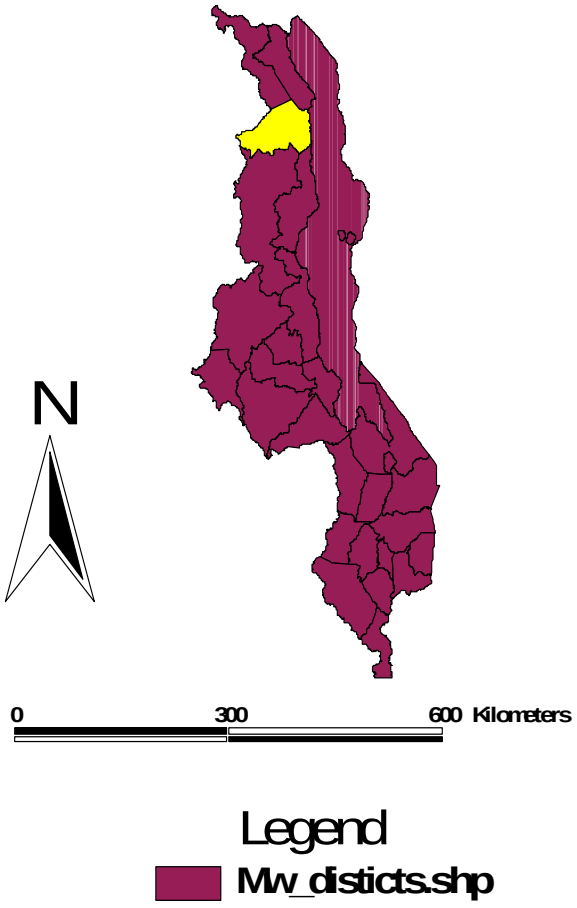
APPENDIX 1: MAP

MAP OF MALAWI SHOWING RUMPHI DISTRICT



Date: May, 2014

APPENDIX 2: QUESTIONNAIRE

ASSESSMENT OF FACTORS CAUSING LOW ADOPTION OF COMPOST MANURE AMONG FARMERS IN BOLERO, RUMPHI DISTRICT, MALAWI

Questionnaire

Interviewee's Name _____ GVH Name _____

Village Name _____ EPA Name _____

Section Name _____ Date _____

INTRODUCTION

My name is _____ and I am here for a study by Mzuzu University. Your household has been selected by chance from all households in the area for this interview. The purpose of this interview is to obtain current information about the use of various farming technologies, especially use of compost manure.

The survey is voluntary and the information that you give will be confidential. The information will be used to prepare reports, but will not include any specific names. There will be no way to identify that you gave this information.

Could you please spare some time (around 30 minutes) for the interview? Consent given ☐

PART A: HOUSEHOLD CHARACTERISTICS

i. Household Head Profile

1. Household Name_____
2. Respondent Name: _____
3. Respondent Age_____
4. Household Head's Age_____
5. Household Head's Gender
    1) Male
    2) Female
6. Household Head's Education Level
    1) Below Std 8
    2) PSLCE
    3) JCE Level
    4) MSCE Level
    5) Tertiary Level

ii. Household Composition/On-farm Labor Availability

7. How many members are there in this household? _____

8. Members' Name (include hired laborers)	**9. Sex** 1= Male, 2= Female	**10. Age** 1= below 15, 2= 15-18, 3= above 18	**11. Does Member Work On The Farm?** 1=No, 2= Partly, 3= Full time

iii. Income Sources

12. What is your main source of income?
    1) Regular employment
    2) Piece work
    3) Tobacco farming
    4) Groundnuts farming
    5) Beans farming
    6) Business
    7) Family members/relatives
    8) Other _____

13. What is your main source of financial support for farming activities?
    1) Regular employment
    2) Piece work
    3) Tobacco farming
    4) Groundnuts farming
    5) Beans farming
    6) Business
    7) Family members/relatives
    8) Other _____

iv. Characteristics Of Dwelling Structure

14. Wall Type	15. Roof Type	16. Floor Type
1) Burnt bricks 2) Unburnt bricks 3) Mud	1) Iron sheet 2) Grass thatched	1) Cement 2) Tiles 3) Mud

v. Farm Sizes, Land Ownership and Crops Grown

Garden details	17. Crops Grown	18. Size	19. Ownership 1= owned, 2= rented, 3= borrowed
A	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	Ha ha ha ha	
B	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	Ha ha ha ha	
C	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	Ha ha ha ha	
D	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	Ha ha ha ha	
Total	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	Ha ha ha ha	

vi. Livestock Ownership

20. Does your household own livestock?

    1) Yes 2) No

21. What type(s) of livestock do you own?

    1) Cattle 4) Pigs

    2) Goats 5) Chicken

    3) Sheep 6) Others _____

22. Do you ever feed your livestock with crop residues from your garden at any time of the yes?

    1) Yes 2) No

PART B: FARMERS' PERCEPTION OF SOIL FERTILITY PROBLEM

In your own perception, how would you describe the soil fertility of the soils in this area over the past few years?

23. Trend in soil fertility over the past 5-10 years	**24. What makes you think so?**	**25. What do you think is the cause**
1) Increased	1) Increased yields 2) Improved quality of yield 3) Others (specify) _____	1) Use of fertilizers 2) Agroforestry 3) Conservation agriculture 4) Improved soil and water conservation practices 5) Increased use of manure 6) Others (specify) _____ _____ _____ _____
2) Decreased	1) Reduced yield 2) Poor quality of yield 3) Production dependent on chemical fertilizers 4) Others (specify) _____ _____ _____	1) Over cropping 2) Deforestation 3) Soil erosion 4) Others (specify) _____ _____ _____ _____
3) Remained the same	1) No change in yield 2) Others _____ _____	
4) Doesn't know		

PART C: ADOPTION OF COMPOST MANURE

There are several soil fertility improvement technologies being used in this community.

26. What is the main soil fertility improvement technology you use?	**27. Why do you prefer this technology over the others?**
1) Chemical fertilizer	1) Less labor intensive 2) Easy accessibility 3) It is instant in providing nutrients to plants 4) Cheap through subsidy program 5) Clean 6) Others (specify) _____
2) Compost manure	1) Cheap 2) Readily available 3) Has long term impact in providing nutrients to plants 4) Improves soil structure 5) Others (specify) _____
3) Animal manure	1) Cheap 2) Readily available 3) Has long term impact in providing nutrients to plants 4) Improves soil structure 5) Others (specify) _____
4) Agroforestry	1) Cheap 2) Readily available 3) Has long term impact in providing nutrients to plants 4) Improves soil structure 5) Others (specify) _____
5) Others (specify) _____	

Compost manure is one of the technologies being promoted in this area.

28. Can you mention any three advantages of using compost manure?
    1) It is cheap
    2) It improves soil fertility
    3) It improves soil structure
    4) It is environmental friendly
    5) Others _____
    6) None

29. Can you mention any three disadvantages of using compost manure?
    1) It is labor intensive
    2) Raw materials are scarce
    3) It takes time to show impacts
    4) Production is dirty work
    5) Others _____
    6) None

30. Have you used compost manure in your garden over the past three seasons?
    1) Yes
    2) No

Questions 31-43 only applicable if the response to question 30 is 1

31. Season(s)	**32. Which Crops Did You Apply Manure To**	**33. Total Hectorage Crop Grown**	**34. Hectorage Applied Manure**	**35. Which Institution Supported You In Compost Manure Use**	**36. Support Provided**	**37. Ownership Of Garden Applied With Manure** 1= owned, 2= rented, 3= borrowed
1) 2014/15	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _ _____	1) Seed 2) Fertilizer 3) Others ____	
2) 2013/14	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _ _____	1) Seed 2) Fertilizer 3) Others ____	
3) 2012/13	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _ _____	1) Seed 2) Fertilizer 3) Others ____	

39. What were the raw materials used in your last production of the compost manure?
    1) Maize stocks
    2) Weed
    3) Tobacco stems
    4) Others _____

40. Where did you get the material from?
    1) The same garden
    2) Other gardens

41. What motivated you to adopt compost manure?
    1) Need to improve soil fertility
    2) Need to improve soil structure
    3) Incentives provided
    4) Inability to access fertilizer
    5) Others _____

42. In your use of compost manure, what benefits have you realized to date?
    1) Increased yield
    2) Improved quality of yield
    3) Improved soil structure
    4) Others _____
    5) None

43. In your use of compost manure, what challenges have you faced to date?
    1) Labor availability
    2) Scarcity of raw materials
    3) Unavailability of extension workers to provide guidance
    4) Others _____
    5) None

44. What do you think needs to be done to address the challenges?

Suggestion	**Responsibility (Peron/institution)**

Question 44 only applicable to those who stopped using compost manure

45. Having adopted the use of compost manure, why did you stop using the technology?
    1) Too labor demanding
    2) It is dirty in production
    3) No more incentives
    4) Did not produce expected yields
    5) Have access to fertilizers
    6) Stopped growing maize/crops that use manure
    7) It is in conflict with other agricultural practices eg Conservation Agriculture, Livestock feeding
    8) Scarcity of raw materials
    9) Others _____

Question 45 only applicable to those who have never adopted the use of compost manure

46. Why is it that you have never adopted the use of compost manure?
    1) Too labor demanding
    2) It is dirty in production
    3) Not targeted with the incentives
    4) Does not produce expected yields in comparison with other technologies
    5) Have access to fertilizers
    6) Does not grow maize/crops that use manure
    7) It is in conflict with other agricultural practices eg Conservation Agriculture, Livestock feeding
    8) Scarcity of raw materials
    9) Others _____

In your opinion what do you think needs to be done by each of the following to promote the use of compost manure in this area?

47. The Community/farmers	**48. Extension Agencies**	**49. The Government**
1) Should set bye-laws promoting compost manure use 2) Incentives should be fairly distributed (beneficiary identification) 3) Should be more committed 4) Others _____ _____ 5) Others _____ _____ 6) Others _____ _____ 7) Others _____ _____	1) More awareness meetings 2) More incentives 3) More trainings 4) Increase extension workers 5) Should have a harmonized approach 6) Others _____ _____ 7) Others _____ _____	1) More awareness meetings 2) More incentives 3) More trainings 4) Increase extension workers 5) Should have a harmonized approach 6) Should make use of compost manure mandatory 7) Others _____ _____ 8) Others _____ _____

PART D: ADOPTION OF OTHER TECHNOLOGIES

Did you use chemical fertilizers in the following seasons?

Season	50. Fertilizer Use	51. Crops Applied	52. Hectorage	53. Source
2014/15	1) Yes 2) No	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) CADECOM 5) Subsidy 6) Bought 7) Gift from relatives/well-wishers 8) Others _____
2013/14	1) Yes 2) No	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) CADECOM 5) Subsidy 6) Bought 7) Gift from relatives/well-wishers 8) Others _____
2012/13	1) Yes 2) No	1) Maize 2) Vegetables 3) Tobacco 4) Others _____	_____ Ha _____ ha _____ ha _____ ha	1) FIDP 2) Find Your Feet 3) Total Land Care 4) CADECOM 5) Subsidy 6) Bought 7) Gift from relatives/well-wishers 8) Others _____

Did you use conservation agriculture in the following seasons?

54. Season	**55. Conservation Agriculture Use**	**56. Which Institution Supported You In Conservation Agriculture?**
1) 2014/15	1) Yes 2) No	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _____
2) 2013/14	1) Yes 2) No	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _____
3) 2012/13	1) Yes 2) No	1) FIDP 2) Find Your Feet 3) Total Land Care 4) Government 5) CADECOM 6) None 7) Others _____