Is a Demonstration-Based Extension Model Effective in Enhancing Adoption of Good Agronomic Practices? Lessons from Tete Province, Mozambique

David Muronda[1]*, Morgen Gomo[2], Marian Tukuta[3]
[1]Graduate Student, Chinhoyi University of Technology, Zimbabwe
[2]Agribusiness Specialist, Independent Consultant, Mozambique
[3]School of Entrepreneurship and Business Sciences, Chinhoyi University of Technology, Chinhoyi, Zimbabwe

Abstract. The study assessed the contribution of demonstration-based extension model on adoption of good agronomic practices. Data on knowledge level, the adoption rates of agronomic practices and farmers' perceptions on the effectiveness of the extension model were collected using semi-structured questionnaires. Primary and secondary data were analyzed through meaningful categorization, student's t-test and logistic regression model and descriptive statistics to draw conclusions. The study revealed that a significant proportion of farmers adopted some demonstrated practices to varying extent. Adoption of some practices depended on farmers' socio-economic characteristics such as education level, household size, assets ownership and access to inputs limited adoption of some practices among them fertilizer use and improved maize varieties. Frequent training sessions did not necessarily lead to increased acquisition of knowledge, but well planned and executed programs that gave farmers adequate time to work on their fields, facilitated farmers' learning and subsequent adoption of practices. The study recommended the prioritization of good agronomic practices, use of complimentary extension methods to increase crop productivity and further research on benefits of plant basins in pigeon pea production.

Keywords: Demonstration extension model, effectiveness, adoption of good agronomic practices

Introduction

Agriculture remains the best opportunity for the estimated 1.5 to 2 billion people worldwide living in smallholder households in rural areas to work and trade their way out of poverty (World Bank, 2008). Growth generated by agriculture is up to four times more effective in reducing poverty than growth in other sectors, and agriculture creates multiple pathways through which increases in productivity can reduce poverty including real incomes changes, employment generation, rural non-farm multiplier effects and food prices effects (Schneider & Gugerty, 2011). However, barriers to technology adoption, initial asset endowments and constraints to market access may all inhibit the ability of poorest to participate in the gains from agricultural productivity growth (Schneider & Gugerty 2011). To ensure meaningful development, organizations need to find ways to improve technology adoption, build assets, and improve market access by smallholder farmers. Development practitioners need to address the fundamental constraints on improving performance of low-productivity smallholder agriculture in particular (Pan, Smith & Sulumain, 2015). The current global challenges of increasing production on increasingly declining land fertility require deliberate and far-reaching solutions that is possible if research in extension is stepped up. Historically, research for development in extension services has been a strong driving force for meeting food supply around the world (Wesley & Faminow, 2014). In Africa research has focused on impact of extension services provided by mainly the public sector, single service providers and yet research into use of specific approaches and models is scanty.

* Corresponding Author

In Mozambique, 69 % of the population live in the rural areas and depend on agriculture for their livelihood and survival according to the Mozambique National Statistics Institute (INE), 2011. Thus, agriculture plays a critical role in promoting economic growth, food security, poverty reduction, livelihoods and rural development (Savadogo et al, 1995 in Gêmo & Chilonda, 2013). The contribution of extension to agriculture performance is well known, particularly in technology transfer, farmers' organizations support, facilitation of market linkages and natural resources management (Hanyani-Mlambo, 2002; Gaaya, 1994). However, in the context of Mozambique, little evidence of the contribution of technology transfer is available. This study was motivated by the need to provide evidence of effectiveness of demonstration extension model in facilitating adoption of proven practices in a project context.

Agricultural extension is the delivery of information and technologies to farmers (Moris, 1991), extending relevant agricultural information to people (Swanson et al., 1997), and it is 'the process of helping farmers to become aware of and adopt improved technology from any source to enhance their production efficiency, income and welfare' (Purcell & Anderson, 1997). Extension services can be organised and delivered in a variety of forms, but their ultimate aim is to increase farmers' productivity and income (World Bank, 2008) a conceptualization that formed the backbone of this paper.

In this paper, we examine the use of demonstration plots based extension model by a particular project, the Improvement of Food Security and Income of Smallholder Farmers through the Intensification of Market-Oriented Production of Maize and Pigeon Pea in Tete Province, Mozambique. The project promoted the use of pigeon pea, a legume, in rotation or intercropping with maize as a way of using the nitrogen fixing aspect of pigeon pea to improve maize yields. The project was implemented in three districts (Moatize, Tsangano and Angonia) by the Netherlands Development Organization (SNV) in partnership with Sustainable Agriculture Technology (SAT) and was funded by the Alliance for a Green Revolution in Africa (AGRA). The project had four components; capacity building of farmers and extension staff, improving access of farmers to farm inputs, formation of farmers' organizations and linking of farmers to profitable markets. The paper is based on a study that was conducted to evaluate the effectiveness of the demonstration extension model used in the project to determine the direction of further development and investment in extension for productivity by smallholder farmers

Methodology

The study used a study research methodology with the ex-post facto research design which examines the effect of a naturalistically occurring treatment after the treatment has occurred (Kathuri & Pals, 1993). Lists of participant farmers in the operational localities were used to select randomly a sample of farmers from five localities. A locality is an administrative unit in a district that is made of several villages. Data was collected from five localities; Nkondedzi and Zobue in Moatize District; Chimvano and Maconje in Tsangano District and Seze in Angonia District in Tete Province, Mozambique. The localities were selected purposively based on the number of registered project participant farmers. Three villages were selected randomly from each locality from lists of villages covered during implementation of the project. Participant farmers were selected randomly and for every participant selected, an attempt was made to select one non-participant residing close to participant household.

Individual households were interviewed using semi-structured questionnaires to collect primary data and these were complimented with focus group discussions, where thirty-two groups selected randomly from a list frame were interviewed to get further data on perceptions on demonstrated practices. Secondary data on farmers and demonstration plot yields were further analysed and comparison of yields between participant and non-participant farmers was conducted. During harvesting in 2014-15 season, yield estimates on 362 farmers' fields were conducted. 12.7% of these were non-participants and 87.3% were participants. A quadrant of 49m2 was selected randomly, harvested, shelled and weighed to estimate crop yields. To determine the effectiveness of knowledge transfer to extension officers, both primary and secondary data were used. Key informant interviews were conducted five farmers and three Chiefs of Localities. Project reports were also analyzed and the researchers also revealed some occurrences during project implementation.

Qualitative data was summarized into meaningful groups and tables to determine relationships as suggested by Witte and Witte (2004). Quantitative data was analysed using logistic regression and student t–test. Statistical Package for Social Sciences (SPSS) was used to analyse the collected data.

Results

Demographic Analyses

In this study, 104 farmers were interviewed to collect data using a semi-structured questionnaire. Of these, 60 were project participants and 44 were non participants. It was shown that 87.5% of households were headed by men, and 76.0% of the respondents were men. The findings of the study were slightly female dominated, given that percentage of male respondents were lower (76.0%) than the percentage of men haeded households (87.5%) more than female household heads.

The smallest average household had 4.8 members at Zobue in Moatize District and the largest average had 6.7 members which was in Maconje locality in Tsangano District. A typical household in the study had 5.4 members, 2.6 and 2.8 of these male and female respectively. Of the 5.4 members 64.8% (3.5) were active and involved in farming activities. A higher percentage of active members was observed among men (73.1%) relative to (57.1%) women. The two localities had the lowest and highest number of active household members. A typical household head had been to school for 3.3 years; and in one locality (Chimvano in Tsangano District) had been to school for as low as 1.6 years. The highest average education level of 4.6 years was recorded in two localitites (Maconje in Tsangano District and Seze in Angonia District). Household heads from all the localities in the study area had an average of 22.2 years farming experience. There was an inverse relationship between time spent at school (education level and (time spent farming (farming experience).

Assets Endowment

It was found that only 6.7% of households owned cattle, 8.6% owned motor bikes, 24% owned at least one goat and 50% owned at least one chicken. The study further revealed insignificant differences on assets owned between participant and non-participant farmers except on motorbikes and goats. Participants owned more motor bikes than non-participants, and conversely, non-participants owned more goats than participants.

The study also revealed that 93 % of households depended on sale of crop produce; 2.3% on formal employment; 1.2% on casual labour and 3.5 % households’ depended on livestock sales as their main sources of income. A typical participant household owned an average of 2.8 hectares of land, compared to 2.3 hectares owned by a non-participant household. Of that, participant households cultivated more land (2.5 ha) than their non-participant counterparts (2.1 ha). Farmers in Seze, in Angonia had the least average land area per household, about 1.9 hectares and Tsangano (Chimvano and Maconje localities) had the largest average cultivated land of 3.6 ha per household.

Human capital

A comparison of participant and non-participant farmers was made on number of active household members, experience in farming and education level as proxy variables for human capital. By inspection, participant households had an average of 3.11 active members compared to 2.97 for non-participant households, but statistically there was no difference. Even though statistically not different, participant household heads had a higher education level (3.38 years) than non-participant household heads with an average of 3.07 years. Farming experience of household heads between the two groups was statistically insignificant in spite of, participant household heads having higher average farming experience of 22.7 years compared to non-participant household heads with a mean of 16.7 years.

Farmers' Participation at Demonstration Sessions

On average, farmers participated in the project intervention for 2.2 years, which is about 73.3 % percent of the intervention period. Also, 27% of participant farmers were involved in the demonstration plots for one season; 26.2% participated for two seasons and 45.9% were involved for three seasons. Of the participating farmers, on average, 77.1% of interviewed farmers participated in demonstration sessions at least once a week, 5.3% attended sessions once per fortnight and 17.6% attended sessions once in a month.

Farmers that joined the project at inception, attended demonstration training sessions more frequently than those that joined later, on the one hand. On the other hand, farmers participating in the second year had the most infrequent attendance of training sessions.

The study also investigated the key characteristics of farmers that attended demonstrations at recommended intervals (at least once a week) and those that participated infrequently. There were no observable differences between the two groups in terms of ownership of motor bikes, an indicator of household well-being. Although no statistical test was conducted to assess the existence of differences between the two groups, there were some differences between farmers' status and key socio-economic factors. Farmers that attended demonstration sessions infrequently (less than once per week); had a higher level of education (6.64 years) compared to 2.82 years for the regular attendees of demonstration sessions. However, regular training participants had more farming experience (28.64 years) than the irregular participants (16.92 years). Small differences existed on household size and participating members that participated in farming activities between the two groups. Farmers that attended training sessions infrequently had more assets (cattle, goats, chickens and land) than the regular participants. Training was more applealing to poorer farmers relative to their endowed conterparts. Furthermore, farmers that participated in training sessions frequently were closer to the demonstration sessions (mean distance of 1.4 km) than those attending sessions infrequently (3.95 km). Irregular training attendees planted more area to maize and pigeon pea, but the yields obtained were lower than that of regular participants. Knowledge level of agronomic practices indicated that frequent participation in training sessions was not necessarily associated with increase in knowledge acquisition. However, it was revealed that regular participants had higher average area (hectares) where demonstrated practices were applied

Among farmers that did not participate in demonstration sessions, 25% of respondents cited non-participation in the project as a reason for not attending demonstration sessions. A quarter of the respondents found the training sessions irrelevant; 21.1 percent indicated that they could not attend sessions due to long distances to reach to training sites and 38.9 percent sited other reasons such as lack of experience in participating in such sessions, lack of interest, having been staying elsewhere when the intervention began.

Crop Production

The study asked households to state three main crops which they grew in order of level of production (area cultivated). Most households (87.8%) indicated that maize was predominantly their main crop, while the balance grew beans (6.7%), potatoes (4.4%) and pigeon pea (1.1%) as their main crops. The second most important crop was pigeon pea, which was produced by 55.2 % of farmers, beans (19.5%) was second. The study identified horticulture as the third most important crop produced by 28.6 % farmers, beans (21.4 %) and pigeon pea (20%) as the third most important crop as shown in the table below.

Table 1. Crops produced by households

	Most Important Crop % Land Area	Second Most Important Crop	Third Most Important Crop
Maize	87.8	5.7	4.3
Green Beans	6.7	19.5	21.4
Potatoes	4.4	6.9	2.9
Pigeon pea	1.1	55.2	20
Horticulture			28.6
Others		12.7	20

Maize was the main crop for both participant and non-participant farmers. Pigeon pea was produced as the second most important crop behind maize, with only 2% of participants compared to 0% of non-participants growing pigeon pea as their main crop. More non-participant farmers produced beans as a main crop than their participant counterparts. Thus, the promotion of maize and pigeon pea was resonated with reality in the study area.

A comparison of productivity of three main crops based on farmers' recall revealed statistically significant differences on area planted to maize and pigeon pea, with participant farmers having cultivated larger areas in both cases, and crop yields were different between participant and non-participant farmers. Non-participant farmers planted more area of the other crops as compared to participants

A comparison of 2014/15 season yields for maize between participant and non-participant farmers showed that participant farmers achieved higher average yield (1.7 t/ha) than non-participants (1.2 t/ha) and the difference was significant. The same trend on yield differences between the two groups manifested in the 2013/14 season.

The comparison of means using a t-test showed that yield under planting basins (CA) was much higher (2.5 t/ha) than where plant basins were not used (0.49 t/ha). Under planting basins, the yield estimates also indicated that participant farmers obtained a significantly higher yield (2.5 t/ha) than non-participants (1.47 t/ha).

Maize under mono cropping produced a higher yield (1.6 t/ha) than intercropping (1.37 t/ha).

Pigeon pea yield under planting basins (CA) was not different from that where these were not used. Mono cropping produced a higher yield (0.8 t/ha) than intercropping (0.59 t/ha). This could be explained by inefficient land use under intercropping. Intercropping pigeon pea with maize provided additional benefits such as increased access and utilization of artmospheric nitrogen, reduced the requirements for fossil-based fertilizer, facilitated net land saving, increased yield stability and yield per unit area, reduced pest problems and requirements for agrochemicals as demonstrated by Jenseen et al, (2020).

A comparison of seed varieties showed that ICEAP 00557 produced a higher yield (0.68 t/ha) than local seed (0.62 t/ha). It was also shown that all participant farmers and 69.6% of non-participants used the improved ICEAP 00557, an indicator that the improved variety had been accepted in the study area.

Level of Knowledge of Good Agronomic Practices

The study assessed the level of knowledge on good agronomic practices (GAP) by administering an oral test comprising eighteen questions. The responses were weighted against a possible total of 30 marks. The results indicated that participant farmers obtained a mean score of 21.2 (70.6%) compared to 12.7 (42.3%) of their non-participant counterparts. A t-test showed significant differences, thus participants performed better than their non-participant counterparts. The score for participants at 71% showed that the participants really embraced the GAP taught through the project.

Focus group discussions also revealed that most farmers had acquired a lot of knowledge. All thirtytwo participant farmers' groups understood the key practices promoted in the project. Most notably were the merits and demerits of rotation and intercropping in maize and pigeon pea production. Farmers indicated that intercropping gave a better yield in a below normal rainfall, despite difficulty of carrying out farm operations. Both cropping systems helped to improve soil fertility and rotation improved crop health.

Knowledge acquisition was further confirmed by key informants (chief of administrative posts and government extension workers). They indicated that farmers had acquired sufficient knowledge on land preparation, use of composts and manure, fertilizer application (timing and method), early planting, plant population and pest control. On the benefits of attending demonstration sessions, key informants singled out knowledge acquisition, in contrast to farmers' who felt that demonstration sessions gave them adequate opportunities to learn new practices, improve organization and farmers' networks, facilitated increase in crop yield, improved organizational capacity and improved farmers' livelihoods.

Adoption of Good Agronomic Practices

The demonstration extension model was structured to promote the adoption of eleven good agronomic practices described in Table 2 below.

Table 2. Description of promoted good agronomic practices

Agronomic practice	Description
Organic fertilizer	Organic fertilizer use refers to the application of manure and or compost to any field at any application rate.
Fertilizer use	In this study, it means the use of any inorganic fertilizer that is intended to enhance crop growth and yield.
Early planting	In this study early planting refers to any planting that is done soon after the first effective rains.
Crop rotation	It refers to a cropping sequence in which a cereal is grown on a field after a legume year after year.
Intercropping	In this study, it refers to growing of two crops in a planned manner; it is where a legume is grown in rows or plant stations that are alternated with rows or plant stations of a cereal crop.
Timely harvesting	In this study, it is crop removal from the field before losses are experienced, in pigeon pea it is when at least 75% of pods are dry and in maize it is when the husks are dry, but before the cob falls over from the stem.
Pest control	Refers to deliberate effort that is carried to destroy, limit and eradicate pests from the field crops after damage is revealed.
Planting basins	It is the opening up of plant basins (holes) in an untilled land, sometimes referred to as minimum tillage as opposed to tilling of entire land or ridging.
Recommended spacing	It refers to spacing of maize and pigeon pea at 0.9m between rows and 0.5m within row

Adoption of a practice in this study occurs when a farmer has used the practice on any part of his or her field during and after the promotion of the practices. Of the total interviewed households, 82.2% adopted at least one practice, 63% adopted at least two practices, 36.9% adopted at least three practices and 8.2% adopted four practices.

Table 3. Adoption of good agronomic practices

Level of Practice	Mean area (ha)		Percentage of Farmers that adopted practice		Comment on differences
	Participant Farmers	Non-participant farmers	Participant Farmers	Non-participant farmers	
1 Practice	1.18	1.03	90.2	71.9	Insignificant*
2 Practices	1.01	0.73	75.6	46.9	Significant *
3 Practices	1.00	0.70	39.0	34.4	Significant *
4 Practices	0.97	0.00	14.6	0.0	Significant *

Note: *t-test at $p<0.05$ confidence level

A comparison of adoption/use of promoted practices between participant and non-participant farmers revealed that 90.2% of participant farmers adopted at least one practice compared to 71.9 % of the non-participant farmers. As shown in the table above, a higher proportion of participant farmers used good agronomic practices as compared to their non-participant counterparts.

On average, participant farmers applied agronomic practices on a larger area than non-participants except on the first practice where there were no significant differences statistically.

A ranking in order of proportion of farmers who adopted the practices revealed that use of improved pigeon pea seed (80.9%) and timely harvesting (2.4%) had the highest and least adoption rates respectively. Participant farmers had a higher rate of adoption of all the practices than non-participant farmers. On average, about one fifth (21.4%) of participant farmers adopted practices compared to one about tenth (11.9%) of non-participants. Similarities were also revealed on the practices adopted by highest proportion of farmers for each farmer group. The highest proportion of farmers in both farmer groups adopted use of improved pigeon pea seed. The largest percentage difference in adoption rate (48.8%) was revealed on “spacing”, where non-participant farmers did not use the practice. Farmers who adopted practices stated above used them mainly on maize, with other crops getting secondary treatment. A larger proportion of participant farmers used the practices in the 2014/15 season, the third year of exposure to practices. This implies that extension programs should be structured to give farmers sufficient time to apply learned practices in their own fields.

The study revealed that farmers thinned pigeon pea, but cited lack of seed as a major challenge to apply the same practice in maize. Farmers planted maize earlier than pigeon pea, a revelation that may help to explain the low pigeon pea yields obtained by producers. Delayed planting of pigeon pea reduces yields significantly since the crop requires a long season to reach maturity. The study found no significant differences between participant and non-participant farmers on land areas where agronomic practices were applied except on harvesting where area harvested timely was higher for participant farmers.

The study assessed the degree of adoption of agronomic practices by the two farmer groups. Table 3 below gives a summary of comparison of average areas (hectares) on which the listed practices were applied and the degree of adoption. The degree of adoption was determined using the proportion of area where the adopted practice was applied to the total average land cultivated by each farmer category. Participants had a higher degree of adoption than non-participants in all practices except composting, fertilizer use and weeding, practices that present significant financial or labour challenges for both farmer categories. On average, participant farmers applied adopted practices to 1.0 hectares, with a 44.8% degree of adoption compared to their non-participant counterparts that used adopted practices to 0.5 hectares with a 28.7% degree of adoption.

Table 4. Comparison area (ha) and degree of adoption of good agronomic practices 2014/15 farming season

Adopted Practice	Participants		Non-participants	
	Mean area (ha)	Degree adoption	Mean area (ha)	Degree of adoption
Composting	1.0	40.0	1.0	47.6
Early planting	1.7	66.7	0.0	0.0
Fertilizer use	1.0	38.5	1.2	57.1
Timely harvesting	1.0	40.0	0.0	0.0
Intercropping	1.0	39.4	0.0	0.0
Manure	0.6	25.0	0.0	0.0
Pest control	1.3	53.3	1.1	54.0
Plant basins	0.4	17.5	0.3	14.3
Rotation	0.6	22.0	0.0	0.0
Recommended spacing	1.3	50.2	0.9	44.5
Thinning	1.1	42.0	0.4	19.0
Improved seed*	0.6	86.1	0.3	67.1
Weeding	1.6	62.2	1.5	69.9
Average	**1.0**	**44.8**	**0.5**	**28.7**

Note: *Indicate pigeon pea seed

Factors influencing adoption of good agronomic practices

The study also predicted the influence of key variables on the adoption of agronomic practices. It was hypothesized that adoption of agronomic practices was influenced by farmers' characteristics and asset ownership. Farmers' characteristics included; age, education level, gender, frequency of attendance at demonstration sessions and participation status. Assets selected for analysis included, chicken, goats, cattle and land. Age and education level were expected to influence adoption positively. Male headed households were considered likely to adopt new practices as compared to female-headed households. Frequency of attendance of training sessions was postulated to have a positive effect on adoption of practices. Participation in the project was also expected to influence adoption of demonstrated practices. Assets ownership was found to influence technology adoption in other studies and likewise, the study considered assets to influence adoption of promoted agronomic practices. Land was considered likely to affect adoption in two ways; the smaller the land holding, the likely farmers would adopt practices that promote intensification and the bigger it is, the higher the chances that farmers may adopt extensification practices. To evaluate the influence of these factors on adoption of practices, a logistic regression analyses was conducted. Table 5 and 6 show odds values at given p-values. A dependant value was taken to be an agronomic practice that was adopted by a farmer. It was revealed that none of the variables significantly influenced the likelihood of adoption (at 95% confidence level). However, participant farmers at 90% confidence level were six times more likely to adopt early planting and with 81.1 % confidence about eight times likely to adopt pest control practice than their non-participant counterparts. It is worth noting that most of the variables had a positive influence on adoption of practices even though not statistically significant.

A logistic regression analyses on the variables that influenced the likelihood of adoption of weeding, intercropping and use of planting basins revealed that farmers that owned goats were 6.8 times likely to adopt weeding compared to those who did not.

Even though not significant, farmers that attended demonstration sessions at least once a week were three times likely to adopt weeding on their fields. Further, participant farmers, with 81.4% confidence were seven times likely to adopt planting basins than non-participant counterparts.

Table 5. Logistic regression results: likelihood of adoption of early planting, pest control and crop spacing

Practice	Early planting		Pest control		Spacing	
Variable	Odds Ratio	P-value	Odds Ratio	P-value	Odds Ratio	P-value
Education (yes=1)	2.47	.25			2.18	.27
Participant (yes=1)	6.04	.09	8.58	.1		
Cattle ownership					3.81	.26
Goats ownership			2.97	.40		
Chicken ownership					3.81	.26
Frequency of demo sessions attendance (at least once a week=1)	2.14	.24				
Land holding (2ha or less=1)	2.14	.24				

Extension agents must use strategies that encourage farmers' attendance at demonstration sessions. Age of farmer influenced adoption of pest control; the younger the farmer, the higher the chances he or she will adopt pest control practice. Using logistic model, with 90 percent confidence, farmers below 35 years of age were four times likely to adopt pest control compared to older farmers. Knowledge level of demonstrated practices also positively influenced adoption of pest control. With a 99% confidence level, farmers with adequate knowledge on agronomic practices were 1.6 times likely to adopt pest control. Knowledge on agronomic practices positively influenced adoption of rotation. It was further showed that knowledge of good agronomic practices also positively influenced adoption of recommended spacing.

Table 6. Logistic regression results: likelihood of adoption of weeding, intercropping and planting basins

Practice	Weeding		Intercropping		Plant basins	
Variable	Odds Ratio	P-value	Odds Ratio	P-value	Odds Ratio	P-value
Sex of household head (male=1)	2.97	.43				
Active household members (at least 3 =1)	1.42	.60				
Education (yes=1)	3.48	.18				
Farming experience (10 years or more)	1.82	.47				

Practice	Weeding		Intercropping		Plant basins	
Variable	Odds Ratio	P-value	Odds Ratio	P-value	Odds Ratio	P-value
Participant (yes=1)					7.25	.19
Goats ownership	6.80	.04				
Chicken ownership					13.16	.16
Land holding (2ha or less=1)	2.09	.29	4.30	.21		
Attendance of demo sessions once a week=1)	8.85	.09	4.305	.21		
Age (>35 years =1)					2.61	0.39

The logistic regression analyses also revealed that farming experience negatively influenced adoption of spacing and thinning. Farmers with less than 10 years farming experience; were more likely to adopt recommended spacing and thinning practices relative to their counterparts with more farming experience.

Non-adoption of some promoted good agronomic practices

An assessment of reasons for non-adoption of agronomic practices found that 34.2 % of farmers felt that at least one practice promoted was of little value to them. Weeding more than three times was considered expensive, labour intensive, very hard labour and not necessary. Some farmers felt that thinning led to crop damage, reduced crop yield and to some farmers did not have any positive effect on crop yields. For some farmers fertilizer use increased production costs and many cited lack of access to fertilizer as major impediment. The cost of fertilizer also requires that farmers have savings or access credit, which is not readily available for smallholder farmers. Composting was less attractive to farmers due to long decomposition period and the hard labour requirements, especially for female-headed households. Recommended spacing was considered difficult by some farmers due to reliance of crop ridges which could not easily fit into the spacing. The study showed that farmers did not apply intercropping due to fear of reduced crop yields and difficulty of carrying farming operations in intercropped fields.

Evaluation of Effectiveness of Extension Methods

The project used a demonstration extension model where farmers were shown how to carry out different agronomic practices and exposed to the outcomes of the promoted practices at demonstration plots and their own fields. The demonstrations were complimented by individual field visits by extension agents, radio broadcasts and lead farmers. In assessing the effectiveness of extension methods, farmers were asked to indicate the sources of information of key agronomic practices, usefulness, overall outcomes and the quality of extension services.

Sources of information for agronomic practices

The study investigated the sources of information for key agronomic practices shown in Table 7 below. Demonstration sessions were key sources of information for all the good agronomic practices. Lead farmers were rarely mentioned as sources of information for the promoted practices, the same trend being revealed on radio broadcasts, and field days. It was quite shocking given the reliance of the intervention on especially Lead farmers and radio broadcasts in dissemination of extension messages. The lack of recognition of lead farmers as sources of information on key agronomic practices could be a result of poor selection of lead farmers and need for comprehensive training of lead farmers to gain the confidence of smallholder farmers.

Table 7. Sources of information for agronomic practices

Agricultural Practice	Most mentioned source of information	2nd most mentioned source of information	3rd most mentioned source of information	Least mentioned source of information
Minimum soil disturbance	Demonstrations	Train & visit	Fellow farmers & elders	Lead farmers
Planting with first effective rains	Demonstrations	Train & visit	Fellow farmers	Lead farmers & Radio broadcast
Thinning	Demonstrations	Train & visit	Fellow farmers	Field day, radio broadcast & T&V
Plant spacing	Demonstrations	Train & visit	Lead farmers	Field day & Radio broadcast
Keeping fields weed free	Demonstrations	Train & visit	Fellow farmers	
Fertilizer, manure/ compost use	Demonstrations	Train & visit	Fellow farmers	Field day & Radio broadcast
Intercropping	Demonstrations	Train & visit	Fellow farmers	Lead farmers

In the project, lead farmers were not adequately incentivised. In similar interventions, reasonable incentives such as provision of means of transport, and structured capacity building program to enhance performance of lead farmers need to be considered.

Usefulness of extension methods

Farmers were asked to rank the usefulness of extension methods in their own context. The extension methods ranked included fellow farmers, lead farmers, demonstrations, field days, radio broadcasts and train and visit by extension officers. Demonstrations were ranked the most useful, followed by farmer to farmer exchange of knowledge, train and visit came third, lead farmer approach was ranked fourth, with field day and radio broadcasts being ranked fifth and sixth respectively. On the other hand, key informants (lead farmers and chief of localities) ranked highly train and visit, field days were ranked as the second most useful extension method ahead of demonstration plots.

Evaluation of the quality of extension services

The study used eighteen Likert items to evaluate the process and effects of the extension services provided over the three years (2012 to 2015). A three Likert scale was used; with respondents being asked to indicate whether they agreed, were neutral or disagreed to the eighteen statements.

Most (55.2%) of farmers disagreed that most of the training was conducted during peak period and thus affected farming activities. Some farmers (45.5%) also felt that training materials were sufficient and 66.7% of them felt that the training sessions were not time consuming, which is an important factor for women, who are time constrained to attend training. The study also showed that 63.7% of farmers showed that trainers were adequately skilled to conduct training sessions. It was further confirmed by 59.7% farmers that the training content was relevant and 12.2% farmers felt the content was irrelevant with 29.9% of farmers being undecided. The majority (60 %) of farmers felt that the training content was simple. In the view of 73.5% respondents, extension services provided through the extension model improved farming knowledge, 75% respondents felt that extension facilitated practical learning and 70.6% got enough opportunity to observe benefits of practices before trying them in their fields. Most respondents (71.9%) felt that farmers' networks improved as a result of the project. It was further revealed that 84.6% of the interviewed farmers acknowledged that crop yield increased, and 87.9% confirmed that farmers' income increased due to extension services provided through the intervention. Most of the respondents (82.8%) revealed that community organization improved and 84.5% indicated that farmer group organization also improved. Overall, it was further pointed out by 85% that farmers' livelihoods were much better than those of non-beneficiary farmers.

Quality of extension services

The study evaluated the quality of extension services through use of four Likert questions on a scale of five; from 0 (very poor) to 5 (excellent). Farmers were asked to rank the level of motivation, quality of practical skills, visits and contacts with Project Extension Officers. The study showed that 59.7% of farmers felt that Extension Officers were highly motivated, 14.5% felt they had average while 25.8% felt extension officers had excellent motivation. The majority of farmers (71 %) revealed that officers were good at demonstrating practices. Only 8% felt the officers had average abilities to demonstrate while 21% pointed out that the demonstration skills were excellent. About 3.3% and 1.6% of respondents felt that the visits to their fields were very poor and poor respectively. The study also showed that 22.6 percent of farmers felt that the extension visits were average, whilst 51.6% and 21% felt that the visits were good and excellent respectively. On the rating of frequency of contacts with Project Extension Officers, 3.2% and 4.8% of the respondents disclosed that they were never and had irregular contacts respectively. However, 22.6% of farmers had regular contacts, 56.5% had more regular contacts with Project Extension Officers.

Discussion

The study revealed some useful insights into adoption and relevance of good agronomic practices, effectiveness of knowledge transfer on good agronomic practices, effectiveness of extension model and potential areas for improvement of future extension programs.

Farmers who joined the project at inception attended demonstration sessions more frequently than those who joined later. This is evidence that over time, farmers begin to appreciate the benfits of attending demonstration sites as farmers believe by seeing. Also, the more educated a farmer was, the less frequently they attended demonstration sessions. This was consistent with findings by Uematsu and Mishra (2010) who suggested that formal education can be a barrier to technology adoption, especially for small scale farmers who have higher tendency to work off-farm.

Regular training session's attendees had more experience than their irregular counterparts, thus demonstration plots are more suitable where there is high proportion of experienced farmers than the less experienced. Furthermore, farmers closer to demonstration sites attended trainings more frequently than those residing further away. Thus, demonstration centres should be within 4 km radius to enable access by farmers. The study did not find a positive relationship between frequent attendances at demonstration sessions and knowledge acquisition. Farmers that attended trainings sessions infrequently gained nearly the same knowledge as their counterparts that participated frequently. This suggests that training sessions need not to be held quite often to be effective, but wide spaced well organized training sessions can lead to effective learning. Irregular training participants had more assets (cattle, goats, chickens and land) than the regular participants, thus well-endowed farmers could require separate training regime. Irregular training attendees planted more area to maize and pigeon pea, but the yields obtained were lower than that of regular participants. This implies that regular attendance in training sessions have a negative impact on area cultivated as farmers have to spend part their time attending training sessions, which is however compensated by high productivity. Knowledge level of agronomic practices indicates that frequent participation in training sessions is not necessarily associated with increase in knowledge acquisition. However, regular participants had higher mean area where demonstrated practices were used.

The study revealed that both participant and non-participant farmers produced the same crops, but a higher proportion of non-participants produced beans as their main crop, a crop that was not promoted by the project. This suggests that development practitioners are better off promoting a wide range of crops to reach to a large proportion of households. Widening crop selection promotes participation by large number of farmers in similar interventions. Use of planting basins contributed significantly to increased maize yields than use of conventional crop ridges. In spite of participants planting larger areas, pigeon pea yields for non-participants were found to be higher than their participant counterparts. This shows that it is better to encourage farmers to cultivate manageable areas and scale-up gradually to increase crop productivity. The benefits of using planting basins in pigeon pea could not be established in this study, and warrants further investigation.

A significant proportion of farmers adopted demonstrated practices to varying extent, and degree. Farmers also gained substantial knowledge due to participation in the demonstration sessions. The adoption of some practices depended on farmers' characteristics such as education level, household size, assets ownership. However lack of access to inputs limited adoption of some practices particularly use of fertilizer and improved maize varieties.

Well planned and executed demonstration programs that give farmers adequate time to work in their fields are helpful in facilitating farmer learning. Extension agents should thus seek to increase productivity before persuading farmers to expand cultivated areas. Extension agents need to group farmers based on level of education and assets endowment and develop appropriate training material and strategies. Uptake of certain practices is made easier if farmers apply them to crops of their interest as evidenced by lack of improvement of pigeon pea yields by participant farmers.

The study confirmed that the demonstration extension model did not only give adequate opportunities to farmers to learn and adopt new practices, but also facilitated community organization, improved farmers' networks, facilitated increase in crop yield, improved organizational capacity of farmers' groups and improved farmers' livelihoods. These findings are consistent with work done by Khan et al (2009) who found that that demonstration plots were not only successful in creating awareness among farmers about modern technologies but also motivated them to apply these in their farming practices. Singh et al (2014) also showed that demonstrations were useful in imparting knowledge and adoption level of farmers in various aspects of oilseed production technologies. It was also shown that not all practices were relevant to farmers, thus extension agents and institutions need to prioritize and limit practices given that the proportion of farmers adopting practices decreased with increasing number of demonstrated practices. Practices that depend on use of external inputs need to be complimented with input support schemes if effective adoption is to be realised. The study also confirmed that engagement of organizations with a reputation in extension as capacity builders is effective in improving extension service; enhance competence and confidence of extension workers. Future programs need to use similar extension system structure, with experts providing regular training to field level extension agents.

The project was implemented over three seasons, which is a limited time for farmers to learn and adopt new technologies. The first season was really a pilot, with very few farmers signing on to the project. After observing some successes by their neighbours, the second season realized a large increase in participation. A large number of farmers do not adopt whole heartedly during the first season of participation. This meant, some of the benefits could have been realized by farmers when the project was already finished.

Further study on use of radio broadcasts, lead farmers and performance of pigeon pea in plant basins vis-a-viz- ridges is recommended.

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Disclaimer

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Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

David Muronda and Morgen Gomo contributed in the conceptualization, study methodology, and validation. Morgen Gomo prepared the original draft, David Muronda was involved writing—review and editing. Visualization is mostly attributed to Morgen Gomo. Marian Tukuta guided the conceptualization of the study, literature review, and data analyses.

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