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Agricultural practices for rural development and environmental conservation under Chagga home garden production systems: a case of Moshi District, Tanzania

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Abstract

The paper shares experience from a research and development project that attempted to address the low productivity and deterioration of the Chagga home gardens farming system. A cross-sectional research design was used whereby primary data was collected from 82 households, eight focus group discussions and ten key informants. In addition, project documents and district agricultural reports were reviewed to complement the primary data. Key findings show that adoption of improved banana varieties was high by 84.1% followed with 73.2%, 72% and 69.5% which were Orange fleshed sweet potatoes, Village Savings and Loans Association and conservation agriculture respectively. The high adoption of improved banana varieties and recruitment of community-based experts familiar with complexity of the home gardens are among the notable project outcomes. Nonetheless, improvement of traditional irrigation and rainwater harvesting was deemed necessary in counteracting hazards of climate change and its variability. It is concluded that improvement of the Chagga home gardens is inevitable given their current low productivity and the impact of climate change. In addition, there is need to commercialize agriculture in the study area to match the ever-increasing population but in a way that is sustainable with the existing farming system. It is hereby recommended that further studies be conducted for a better understanding of the complexity and livelihood potential of the Chagga home gardens.

Keywords: Chagga home gardens; RIPAT Approach; Livelihoods improvement; Farmer groups; Biodiversity

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1. Introduction

The global population is expected to reach over 9 billion by 2050, which necessitates the continuous need to increase food production and buffer stocks at least by 70% (FAO and WFP, 2010). Developing countries which are mostly vulnerable to hunger and food scarcity are expected to work even hard with reliable strategies to meet the growing demand and to avert food insecurity and poverty. According to the 2022 census, Tanzania's population stands at 61,741,120 a 27.23 percent increase from that of 2012 (Wizara ya Fedha na Mipango et al., 2022); the National Bureau of Statistics et al. (2018), projects the country's population to be 86,871,546 million in 2035.

To curb the rapid population growth and mitigate the adverse effect of global food shocks and food price volatilities in the developing countries and particularly in Tanzania, deliberate efforts are required to strengthen and intensify local food production. Among the suggested solution according to FAO (2018) is the application of ecological agriculture which centres on food production that makes the best use of nature's ecosystems such as improvement of soil health and plant quality through available biomass and biodiversity. The home garden production system is among the ecological farming which has been practiced for a long time. According to Odebode (2006), generally home gardening refers to the cultivation of a small portion of land which may be around the household or within walking distance from the family home. The home gardens are described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income.

A four-year research and development project under the sponsorship of Danish Mission Council Development Department (DMCDD) was implemented in Moshi District to improve the livelihoods and resilience of people living with HIV/AIDs (PLHAs) and the community at large. The project area was on the slopes of Mount Kilimanjaro where the people practice the famous Chagga home garden farming systems; hence, critical focus was given on how to improve the home gardens through improvement of the agricultural practices for rural development and environmental conservation. Generally, the project aimed at involving disadvantaged groups i.e., women, the youth and people living with HIV/AIDS (PLHAs) so as to bring equitable development to all (UN, 2015).

The Chagga home garden production system is the main farming system of the study area which is characterized by intensive integration of numerous multipurpose trees and shrubs, with food/cash crops and livestock on the same piece of land (Fernandes et al., 1984). Large trees such as Albizia spp and Gravillea robusta form the upper storey with bananas and coffee forming the lower canopy. Fodder, cocoyam, herbs, and grasses form the ground layers. The importance of the home gardens is the great diversity which provides subsistence food and cash crops as well as insurance against drought, pests, and economic hardships (Notarnicola et al., 2017). According to Hemp and Hemp (2008), the home gardens used to provide continuous ground cover and a high degree of nutrients cycling which makes it possible for the gardens to remain sustainable on the erosion prone slopes of Mt. Kilimanjaro. Banana (Musa spp.) is a common food crop in Chagga home gardens; the bananas are important for food, various beverages, and cash earnings (Fernandes and Nair, 1986). In the past, coffee was an important cash crop which featured well in the Chagga home gardens; however, its popularity has gone down over time due to a number of reasons one of which is fluctuations in world prices.

Although the Chagga home gardens are mainly practiced in the upper lands and midlands (> 1000 m.a.s.l), there is a lot of interdependence with lowlands for the livelihood of the community. Farmers from the upper and midlands move to the lowlands to raise annual food crops mainly maize and beans. Other minor crops grown include sunflower, finger millet, cassava, sweet potatoes, and some fruit trees especially mangoes and avocado. Few farmers with access to irrigation systems also grow vegetables and rice for food as well as for income generation. Farmers residing in the lowlands, besides producing annual crops, also keep zebu cattle in combination with several other livestock under zero grazing or natural pasture (free range grazing). Farmers from the upper and midlands obtain animal feeds from the lowlands through cut and carry method whereby crop residues are collected as a dry feed stock. As a result, nutrient mining and soil erosion are common on mid and lowland areas mainly due to the depletion of vegetation and free-range grazing.

The project on which the paper is based applied the "Rural Initiatives for Participatory Agricultural Transformation (RIPAT) Approach" which from the project design has inbuilt spreading and sustainability through two phases i.e., RIPAT 'Start' and RIPAT 'Spreading' with capacity building to community-based experts (extension officers, local institutions, and lead farmers). The approach aims at closing agricultural technology gaps as a means of improving livelihoods and self-support among rural smallholder farmers. The approach is documented as a step-by-step guide on how organizations which work with smallholder farmers can transfer various agricultural technologies in the global South (Vesterager et al., 2017).

A group known as 'Kikundi cha Wanawake Kilimanjaro Kupambana na Ukimwi' (KIWAKKUKI) is devoted to delivering services to PLHAs, and their caregivers as well as to the orphans and other vulnerable children who came out of the HIV/AIDS- episode. This approach worked well in the past but, with donor fatigue to support projects related with HIV/AIDS, KIWAKKUKI was stranded and was looking for another approach which would mobilize the communities to improve their livelihood as well as empower themselves to rid of a mind-set of dependency and victimisation which has been somewhat characteristic for the PLHAs, despite their access to antiretrovirals (ARVs).

Nair (2001) argues that despite the importance of home gardens in the provision of sustenance to millions of farmers and prosperity to households around the world, the extent of scientific studies on this system has been relatively low when compared to their economic value, ecological benefits or social-cultural importance would warrant. The research and development project applying RIPAT Approach was implemented in the Chagga home gardens to add to the limited scientific studies on these home gardens and to provide possible solutions to the identified challenges/weakness facing the system. The project considered increasing productivity while retaining the expected stability of the Chagga home gardens so as to increase smallholder farmer income for improved livelihood and guarantee food and nutrition security (URT, 2017).

The objective of this paper is to document the findings of the end of the project evaluation which assessed the project outcomes and impact, as well as the effectiveness and efficiency of the project in achieving its objectives. The documentation facilitates sharing of the lessons learned in the attempts to address the challenges of low productivity of the Chagga home gardens while at the same time trying to maintain the stability of the farming system.

1.1. Study area and context

The study was conducted in Moshi District Council, Kilimanjaro Region located in the northern part of Tanzania. The study area was chosen because of the dominant Chagga home garden farming system which dominates a good picture of agricultural practices for rural development and the environmental refugee/conservation. The district is located at Latitude 2o, 30'50" South; and Longitude 37' to 38' East. According to Tanzania's 2012 Population and Housing Census, Moshi district council had 93,275 households with a total population of 466, 737 (URT, 2012). The project was initially implemented in four villages i.e., Kikarara, Tsuduni, Kidia and Mdawi; but later spread to other six villages. The four project villages are closer to Mount Kilimanjaro and represent three agro-ecological zones i.e., upper (1401 - 2000masl), mid (901 - 1400 masl) and lowland 400 – 900 masl) areas. Kidia is a very special village as it bounders the foot of Mount Kilimanjaro, a place where the tallest tree in Africa is found and where tourist attractions such as the Mambori waterfalls are found.

The home gardens are a form of conservation of biodiversity and represent agro-ecological farming systems which seek a set of practices and a social movement on how different components of nature can interact in achieving sustainable farming systems that optimize and stabilize yields (FAO, 2018). Although the Chagga home gardens have been stable for a long time in ensuring sustainable agriculture and supporting the livelihoods of communities, the farming system is now deteriorating (Hemp and Hemp, 2008). According to Meena and O'Keefe (2007), hazards of climate change have become so evident that, low rainfall is being experienced in patches, with longer dry spells in between. Sometimes total annual rainfall can be relatively high (>1000mm) but, with poor distribution. Moreover, deterioration of the indigenous irrigation systems has worsened the situation.

A situation analysis carried out before the start of the project applying the RIPAT Approach revealed challenges related to poor soil fertility, limited crop-livestock integration to allow nutrient recycling, low income and risk diversification, soil erosion, limited knowledge in conservation agriculture (CA), inferior animal breeds and firewood problems. Furthermore, the hand hoe is still being used for tilling/land preparation especially in the highlands. In the lowlands hand hoes are used for planting and weeding. In addition, crop diversification, crop-livestock integration and intensification are still limited. Inadequate knowledge of improved technologies that can enhance agricultural production in home gardens and environmental conservation make the system to remain backward (Subedi et al., 2004). Despite the strengths of the Chagga home gardens, it is not able to address the challenges brought about by climate change.

The situation is made more complicated by the ever-increasing population, environmental degradation and increasing poverty. The population density in the project area was estimated to be 440 people per square kilometre, compared to the national average of 51 people per square kilometre (URT, 2012). There are on-going land use and livelihoods changes in the home gardens (Soini, 2003; Soini, 2005), but with a clear cause and effect relationship between poverty and environmental degradation. Environmental degradation leads to widespread poverty; while at the same time poverty is the cause of environmental degradation as it undermines people's capacity to manage resources wisely (Shetto and Owenya, 2007). There is desperation leading to social ills like drunkenness. The youth are especially vulnerable due to landlessness that is leading to widespread migration to urban areas to seek for economic opportunities.

According to Fernandes et al. (1984) many challenges face the Chagga home gardens, the most significant being their low productivity which, if not improved, will not be able to meet the demand for food of the rapidly

growing population. They further noted that with the present trend of young people migrating to urban areas, it is mostly the older people who are left to manage the home gardens. Further to the above, extension workers focus on individual crops and components; thus, failing to adopt an integrated approach and consequently losing sight of the possible interactions of the various components within the farming system.

Evaluation of the research and development project applying the RIPAT Approach indicates that there is improvement in the Chagga home gardens, and the targeted community is more food and nutrition secure because of the adoption and diffusion of interventions provided under the project. The implementing organization – Research, Community and Organizational Development (RECODA) upholds the saying that; "unpublished work, is a buried work"; so, has endeavoured to share the attempts to improve the home gardens.

1.2. Project implementation

After the situation analysis, grouped basket of options/technologies were identified which included perennial crops - improved banana varieties; root crops (orange fleshed sweet potatoes - OFSP and cassava), annual crops (conservation agriculture – CA and crop diversification including maize intercropped with pigeon peas), horticultural crops (vegetables and fruits), livestock (dairy goats, pigs, and local chicken) and microfinance (Village Savings and Loans Association - VSLA).

The RIPAT 'Start' phase started with two groups, each with 30 members formed in four villages (Kikarara, Tsuduni, Kidia and Mdawi). Group selection criteria were set which required not less than 50% of the members to be female and 10% to be PLHAs. Each group established a Farmer Field School (FFS)/group plot for learning by doing/experiential learning while at the same time recruiting lead farmers (LFs) who later collaborated with government extension officers (EOs) to facilitate adoption and up-scaling of the introduced interventions. Each group was visited at least once in a week in the first year while in the 2nd and 3rd years they were visited twice and once per month respectively. Each group member was required to choose from the basket of options any technology/crop variety to implement at individual farm level and later to share the knowledge and planting materials with three community members (non-project participants). Sub-groups dealing with banana, root crops, conservation agriculture, livestock, and micro-finance (Village Savings and Loans Associations) were formed and trained under RECODA Academy on how best to manage the technologies and help their fellows to do the same.

Group development stages by Tuckman (1965) guided the group dynamics while ensuring presence of strong leadership abiding by the group constitution and able to manage the group growth. Project monitoring was done during training of the interventions, quarterly project coordination meetings and later through action and reflection questionnaire loaded in the smartphone to make use of Management of Information Systems (MIS). Farmer Field Days were conducted yearly followed by the final year of the project which culminated into the graduation day where certificates were issued to group members and Lead Farmers.

The project objectives included capacity building of the community to be able to integrate PLHAs, improve livelihood of the community and build the capacity of local institutions and community based experts in the implementation of projects applying the RIPAT approach. KIWAKKUKI apart from being treated as a local institution to facilitate adoption and sustainability of the project activities, its role in dealing with people with HIV/AIDS was also considered.

2. Methodology

The paper is a result of the end of research and development project evaluation with the main purpose of assessing the impact that has been achieved in the community, effectiveness, and efficiency of the project in achieving its objectives. The evaluation exercise employed a cross-sectional research design whereby the subjects were studied at one point in time. Survey tools were developed to collect specific information concerning the project's performance in impacting the lives of the community, particularly in the livelihood improvement as a result of the project interventions (i.e. basket of options offered by the project). The sample unit was farmer group members: both female and male members of the farmer groups were considered equally.

The study population were all households that have benefited from projects applying the RIPAT Approach in the four villages (Kikarara, Tsuduni, Kidia and Mdawi) in Moshi district. Random sampling technique was employed to select group members who were interviewed at household level. They were selected randomly using random numbers created in MS Excel using the "=RAND (_)" command, which generated random numbers at village level. The actual number of household respondents was 82; varied from one village to the other as shown in Table 1. According to Bailey (1994) and Gray (2014) a sample which represents the studied population is supposed to be at least 30% or above of the total population. The evaluation sampled 37.4% of the total population of 219.

Table 1. Distribution of Household Respondents by Villages

Ward	Village	Number of Sampled Households Respondents	Percentage (%)
East Old Moshi (Old Moshi *Mashariki*)	Kidia	22	26.8
	Tsuduni	21	25.6
	Kikarara	19	23.2
Kimochi	Mdawi	20	24.4
Total	**4 villages**	**82**	**100**

Purposive sampling technique was employed for selecting key informants (KI) who included Extension (Eos), KIWAKKUKI staff, Umoja wa Vikundi vya Kilimo Old-Moshi (UVIKIO) (literally translated as Association of Farming Groups Old Moshi) leaders, District Project Coordinators (DPC), village leaders and programme leaders/managers from RECODA. A total of 12 KIs were interviewed. Focus Group Discussions (FGDs) participants were selected from each village whereby men and women who were members of farmer groups were sampled. The Key Informant Interviews (KIIs) and FGDs generated information which complemented that generated through the household questionnaire.

In addition to the above, snowball sampling was used to identify other potential individuals or people initially not targeted for consultation but, due to the cropping up of some subjects/issues it was necessary to consult local people with an experience of the area. Farmers selected for interviews using this technique were progressive, the ones with extra information and case studies in relation to the project impact. The technique helped to meet potential informants who were initially not considered for interviewing but, during the survey, the evaluation team learned that they were potential for detailed interviews.

Both primary and secondary data were collected so as to complement each other. Secondary data were collected from district agricultural reports, RIPAT publications and reports and files from farmer groups.

Primary data were collected from households (HHs), FGDs and KIIs with the use of questionnaires, guides, and checklist respectively. The questionnaires collected HHs data related with demographic and socio-economic characteristics of all respondents while the FGD guide helped with acquisition of an in-depth understanding of the women, men and LFs. In each of the four villages involved in this study, two FGDs for men and women were conducted in each village hence, a total of eight (8) FGDs. In addition, a total of twelve (12) key informants (KIs) were interviewed.

Data collected using the structured questionnaire were analysed using the Statistical Package for Social Sciences (SPSS) software. The data were first coded before being analysed. The analysis included computing descriptive statistics (i.e., frequencies, percentages, means, minimum and maximum values). Qualitative data collected through the KIIs and FGDs were analysed through content analysis by synthesizing various arguments, and the arguments were compared with information gathered through the questionnaire. The qualitative data were used to triangulate and complement information collected through the questionnaire.

The study's major challenge in data collection was related to respondents not seeing the immediate benefits of the study. This limitation was solved by clarifying the study's potential contribution a good understanding of the Chagga home garden farming system hence possibility of improving productivity by efforts of the different stakeholders. In addition, limitations related to validity and reliability were addressed through pretesting of the data collection tools in Sango village where a similar project was implemented.

3. Research findings and discussion

3.1. Demographic characteristics

Study findings show that about three quarters (74.4%) of the respondents were heads of household hence, having a big decision making role in the adoption of the introduced interventions. They were also the right respondents to provide accurate information in accordance with the study's objectives. Study findings show that a total of 317 people lived in the 82 sampled households which was an average of 3.9 individuals per household. The observed household size is relatively lower than the national average of 4.8 individuals per household (URT, 2013a). About three quarter (75.6%) of all the households visited had children below the age of 18, which is typical of Sub Saharan Africa's demographic characteristics where the proportion of children below 18 years old is substantially high (FAO, 2015). This demographic pattern was considered to be a threat to the Chagga home gardens as the population density is already at an alarming stage leading to growing scarcity of resource particularly land and water for food production and other economic activities.

The study also observed that, regardless of the prevailing patriarchal system in the Chagga community, women were found to be responsible for most of the family matters including production activities. In relation to marital status, the findings show that most respondents (65.9%) were married, while 3.7% were either divorced or separated, and 3.7% had never being married.

3.2. Household economy and resilience

The study findings show almost all households own a piece of land for mixed farming closer to their homestead popularly known as 'kihamba' which means Chagga home gardens. Nevertheless, the household land holding size is very small i.e., an average of 0.4 hectares (i.e., one acre) while according to Anderson et al. (2016) the

average land holding size to smallholder farmers in Tanzania is between 0.9 and 3.0 hectares (2 - 7 acres). Most households owned or rented land in other areas outside the project area especially in lower Moshi for growing seasonal crops particularly maize. Through the FGDs and KIIs it was observed that reliance on land outside the project area has increased in recent years mainly due to population pressure in the project area thus, forcing most households to complement production from their small 'kihamba's.

Study findings further show that households' ownership of productive assets varied whereby a few (3.6%) owned tractors, 4.9% owned animal ploughs, and 6.1% owned electric generators. It was also revealed that 6.2% of the households had power tiller which they mainly used to transport goods and not for farming activities. Further to the above, the majority (96.3%) of the households owned a hand hoe which is used for weeding: nonetheless, the majority (>90%) hired tractors to prepare land for maize production. Dominance of the hand hoe can be explained by the nature of farming practices (mixed farming that included banana and other crops such as yams and coffee) as well as the small farm sizes which makes it impossible to utilize tractors, power tillers and animal drawn ploughs hence, the dominance of hand hoes. Regardless of the above, the finding to some extent reflects the real situation of productive assets ownership patterns in Tanzania. Based on the 2011/2012 Tanzania Household Budget Survey the proportion of households owning specialized or mechanized agricultural equipment such as tractors and tractor ploughs was 0.1%; while the proportion of households countrywide with at least a hand hoe was 96.5% (National Bureau of Statistics Tanzania, 2014).

3.3. Community mobilization and capacity building

The project applied the RIPAT Approach which from the project design had inbuilt spreading and sustainability i.e., RIPAT 'Start' and RIPAT 'Spreading' phase with capacity building of community-based experts. The RIPAT 'Start' managed to cover 4 villages; each village had farmer groups of 25-30 members and the average attendance of 77% (Table 2).

Table 2. RIPAT Group Members' Attendance to Group Activities from April to June 2017

Village	Group name	Average attendance in April (%)	Average attendance in May (%)	Average attendance in June (%)	Average attendance (%)
Kikarara	Juhudi	78	79	82	80
	Lukundane	78	79	67	76
Tsuduni	Amka	62	65	68	65
	Funguka	72	79	64	75
Kidia	Upendo	91	89	97	92
	Neema	89	91	95	92
Mdawi	Luwadane	73	65	75	71
	Mafanikio	73	75	65	71
	Average	77	78	77	77

Project reports show that thereafter, eleven RIPAT 'Spreading' groups, with an average of 25-30 members were established in six villages of Mahoma, Mowo, Lyakombila, Sango and Shia. Each RIPAT group (producer

group) had the component of Village Savings and Loan Association (VSLA). Therefore, in total there were nineteen VSLA groups and nineteen farmer groups. The eight groups from the RIPAT 'Start' phase have already been registered officially as per government regulations and the process is on-going to register the other eleven new groups formed under RIPAT 'Spreading' phase. As the project has reached 19 farmer groups, each with an average of 25-30 members it means about 500 households with an average proportion of women being 60% were direct project beneficiaries. About 10% of the project participants purposely targeted the PLHAs i.e., 50 households. The Project Manager (PM) from the implementing organization (RECODA) said;

> *'Through the philosophy of help to self-help (solidarity chain) where each direct recipient of the project materials in producer groups was required to support other three community members in terms of knowledge and materials; the number of project beneficiaries was expected to double'.*

The project was also expected to build the capacity of local institutions. Based on the special attention paid to KIWAKKUKI, the organization testified that by being trained by RECODA they acquired competence to manage a project applying the RIPAT Approach in Mamsera, Rombo district, Kilimanjaro Region. The coordinator said;

> *"Our organizational function has developed from service providers to facilitators of farmer producer groups that integrate PLHA to improve food security and income to vulnerable households. Our role now is to empower PLHA to actively work to improve their health and livelihood. We have become agents of change in the society".*

More than 95% of the communities in the project area are Christians (Lutherans). Through FGDs and KIIs it was learned that the Lutheran Church has a powerful influence on the communities especially when it comes to issues related with mobilization, advocacy and communal decision. Therefore, the good attendance in all village meetings was contributed by the announcements and emphasis which was made through the Churches.

3.4. Advocacy and Lobbying

From the FGDs it was learnt that the producer groups were trained on advocacy and lobbying skills and good governance, so they have been selecting their leaders democratically using their constitutions. In addition, they were aware of the group's bylaws and those of their villages, so they used their rights to suggest new ones or enforcement of the existing ones. They were trained on gender related issues and at least women had acquired land user rights but were yet to have ownership rights.

Farmer groups (producer groups) graduated into forming a network of the eight groups (producer association - PA) under RIPAT 'start' phase. The association had started to procure agro-inputs collectively and are on the way to sell collectively as well as in the process of registration under the name of Umoja wa Vikundi vya Kilimo – Old Moshi (UVIKIO). According to the FGDs, it was expected the association would be an important platform for advocacy for community development and environmental conservation.

Observations from the FGDs and KIIs in relation to issues identified for advocacy include improvement of the traditional irrigation system especially the Muo canal and night water reservoirs, acquiring water user's rights and allocation, contour farming and rainwater harvesting, securing community development funds from Kilimanjaro National Park (KINAPA), use of idle structures of Kilimanjaro Native Cooperative Union (KNCU),

etc. Issues related to ecotourism were also earmarked as important areas for advocacy. The era when coffee was an important cash crop under the home gardens acted as a reference point for identifying important economic activities (to revive coffee or other crops and/or livestock) which may lead to economic revival. Based on the introduced interventions by the project, popularization and local value chain development for improved banana varieties, local chicken, OFSP, pigs and dairy goats are foreseen as the promising economic activities. Women FGDs pointed out they prefer local chicken improvement and OFSP while the improved banana varieties were preferred by both.

3.5. Adoption of the Introduced Technologies

Based on the observations from the FGDs, strong producer groups, VSLAs and hands-on skills and practices which were introduced through the FFS plots enabled the target project beneficiaries to stay together and adopt the introduced technologies. The majority (84.1%) of the RIPAT project group members had adopted improved banana varieties and about three quarters 73.2% had adopted orange fleshed sweet potatoes (OFSP). Also, there is a high adoption of conservation agriculture (CA) (69.5%), but fewer adopters of vegetables and pigs at 41.5% and 43.9% respectively (Table 3). The study findings further show that most (93.8%) of the respondents were able to meet their daily food requirements all year round either through their own production or purchasing of extra food through other sources of income. Additionally, three or more meals were consumed by a large proportion (89%) of the households visited one day before the evaluation. This was above the project target of having 40% of community members, particularly PLHAs taking three meals a day.

Table 3. Percentage of the adoption from the basket of options

Rank	Options	Number of Farmers	Percentage - %
1	Improved banana	69	84.1
2	OFSP	60	73.2
3	VSLA	59	72.0
4	CA	57	69.5
5	Dairy goats	50	61.0
6	Improved chicken	49	59.8
7	Improved pigs	36	43.9
8	Vegetable farming (keyhole garden)	34	41.5

Farmers' choices of RIPAT basket of options, showed that the majority (84.1%) had chosen improved banana farming, followed by about three quarters (73.2%) who chose OFSP farming. VSLA activities and CA and crop diversification were ranked third (72%) and fourth (69.5%) respectively. It was learned from the KIIs (Village extension officers and DPC) that the role of the 16 Lead Farmers trained by the project was well acknowledged throughout the project area particularly in promoting agricultural technologies. The DPC added that learning through observation was found to be one of the effective means of passing knowledge to people. She added, "in fact LFs have helped us a lot as we have shortage of extension officers; for example, in Kimochi ward there is only one extension officer who is required to serve five villages with more than 2,000 households". During the FGDs it was pointed out that participants' learning through observation was very effective in enhancing adoption of improved banana and maize farming (Chaka hoe) practices. It was further

observed that, there was a high level of participation of key project stakeholders (local institution - KIWAKKUKI and Lutheran Church), Local government - DPC, EOs and village leaders) at all stages of the project cycle, and this contributed to the increase of project ownership, adoption of the interventions and the expected sustainability.

Generally, adoption of improved banana varieties has significant effects to the improvement of the Chagga home gardens as it addresses the low productivity challenges, limitations of crop and livestock diversification and environmental degradation. KIWAKKUKI staff reported that the introduction and adoption of high value and nutritional crops such as OFSP being instrumental in improvement of home gardens in terms of poverty reduction, food and nutrition security especially to PLHAs.

Findings from the household survey shown that about two fifths (40.2%) of sampled households were keeping different types of dairy goats, while over a third (36.6%) were keeping local breeds. Promotion of dairy goats in the project area was found to be challenged by several factors including poor management of goats by farmers. From the men's FGDs it was observed that farmers complained that it was too expensive and/or tedious to keep improved dairy goats introduced by the project compared to their local breeds. Generally, for the improved breeds they were required to observe timely breeding, deworming and treatment, recordkeeping and provision of supplementary feeding especially concentrates (e.g., maize bran and oil seed cakes) and mineral nutrients. Further to the above, observations from the KIIs (extension officers) showed that the utilization of goat milk was rather limited in the project area therefore, introduction of dairy goats must go hand in hand with the popularization of goat milk utilization until it reaches a point when the consumption will go up. A study by Lilleør and Lund-Sørensen (2013) showed that when it comes to a basket of options, uptake of technologies was usually piecemeal, i.e., some may be adopted quickly while others drag behind as the required capacities are not yet in place, while some other technologies may not be adopted if conditions are not conducive.

3.6. Environmental Conservation

Observations from the FGDs and KIIs show how desperate the communities in the project area were in need of reviving their traditional irrigation system, as they are experiencing water shortage as an impact of climate change and its variability. Both men and women's FGDs from Mdawi explained the way they rehabilitated night water reservoir 'nduwa' in order to facilitate availability of water to irrigate their FFS plot. The village leaders from Kikarara, Tsuduni and Kidia explained how the drying up of one of the oldest traditional canals called 'Muo' has adversely affected their banana farms. However, through KII interview the DPC explained that there were funds allocated by the government to rehabilitate that canal though not enough to cater for the required repair and supervision. One of the village leaders narrated the way they ensured that traditional irrigation systems are functional; that,

> *'We used to organize ourselves to maintain our canals and night water reservoirs but, since we shifted the roles to donors and government, we are now facing lots of challenges'.*

This shows there is a need to mobilize the community to take back the ownership and responsibilities of their traditional irrigation systems though other well-wishers will be allowed to complement their efforts.

To ensure sustainable agriculture (agro-ecological agriculture) it was agreed during the FGDs that the improvement of traditional irrigation system is inevitable, but the emphasis was also put on the application of rainwater harvesting technologies. Observations show that there are lot of untapped potentials of rainwater harvesting through in situ, runoffs, rooftops, small dams'/water reservoirs and construction of barriers in the deep-incised valleys/rivers. However, issues related to water use efficiency was raised through the KIIs that water supply from different sources (streams, rivers and rain) have gone down while the demand is going up due to increased population where demand for water required for domestic use, farm activities, construction and other development activities have increased tremendously. Efficiency of traditional irrigation systems can be achieved through lining of the furrows, use of pipes instead of open furrows, planting high value crops, development of water use rights and paying according to water use.

EOs explained the way the project has capacitated them and LFs in using line level boards for contour demarcation and constructions as well as planting fodder crops along the contour bunds, open spaces, boundary demarcations etc. The project has helped the community to be aware of the locally available resources and gained capacity to exploit them accordingly. However, they expected more agro-forestry technologies to be promoted especially improved avocado varieties or value chains citing the real situation when a bumper harvest of avocado is often difficult to sell.

3.7. Notable Achievements

It was observed from the KIIs with EOs, village leaders and DPC that project participants are moving out of poverty, hunger, and malnutrition due to the adoption of high valued and improved nutritional crops/livestock. Through the use of community-based experts (Extension officers, LFs and KIWAKKUKI) there is continued replication of the achieved results i.e., the project aimed at four villages and eight groups but, RIPAT 'spreading' has added other six (6) villages and eleven (11) new groups. KIWAKKUKI has gained the capacity to implementing projects applying the RIPAT approach independently to the extent of securing funds from a Danish NGO to implement a project applying the RIPAT Approach in Mamsera village, Rombo District. According to Malisa (2016) local institutions such as KIWAKKUKI can be important in influencing households' decision making and that of other decision makers.

It has been observed by another study that LFs are expected to enhance sustainable uptake of technologies because they live in the community, speak the same language, use expressions that suit their environment and instil confidence in their fellow farmers (Sinja et al., 2004). Programme Leader from RECODA added that for a project's approach of working with government systems, recruiting LFs and existing local institutions are among the best ways of ensuring adoption and up-scaling of the technologies and project sustainability.

It was noted from the DPC that the adoption and up-scaling of the interventions was made possible through having competent and committed group facilitators guided by the RIPAT Manual. Apart from learning by doing at FFS plots, RECODA Academy with tailor-made courses were used in recruiting LFs, extension officers (EOs) and local organizations such as KIWAKKUKI. The Academy provided details of the interventions and orientation in the RIPAT Manual which was expected to guide them step-by-step on how to approach their task when working with small-scale farmers. Also, it was observed that adoption of interventions in the RIPAT

'spreading' phase was contributed by testimonies from project participants in the RIPAT 'start' and study visits made to their FFS plots and individual households. One lead farmer said;

> *"LFs were able to spread into new areas relatively easily because in RIPAT 'start' phase we gained competency and confidence through acquired skills and seeing project results which were very persuasive; we gave testimonies to the newly formed groups and/or planned study visits." In this case one can say seeing is believing.*

Uptake of agricultural technologies has been among the main challenges facing smallholder farming systems (URT, 2013b; Berthe, 2015) and solutions have been directed to organic extension approach (Franzel et al., 2015). Use of the RIPAT Approach with a focus on community mobilization to utilize locally available resources, and with the inbuilt spreading mechanisms achieved through the use of recruited community-based experts, is among the most promising organic extension approach (Ringo et al., 2013).

3.8. Project Sustainability

It was learnt that the producer groups (PGs) being in a position to become independent through being strengthened with strong leadership guided by constitutions and later joined to form a network of producer association (PA), these are among the critical factors contributing to project sustainability. The PA is supported by local government, KIWAKKUKI, LFs and periodically visited by RECODA. It was further discussed that the positive changes are expected to endure because the groups have proved the benefits of the project, had a development vision and created ownership such that they are meeting on a weekly basis and are busy with activities which include VSLAs, production at group plots and procuring agro-inputs together on the way of collective marketing. It was learned that perennial crops (banana) and VSLA are among the interventions which farmers preferred the most, so they have acted as a glue to keep the group members together.

4. Conclusions

The paper concludes that interventions to improve the Chagga home gardens are inevitable given their current low productivity and other changes which have occurred over time such as the impact of climate change, the need to commercialize agriculture, and the increasing population which has a direct correlation with increased demand for natural resources. However, there needs to be caution so as to ensure improvement of the home gardens ensures biodiversity is sustainably maintained. Thus, a stable way of land use that meets the community's different demands is required. It is also concluded that, projects applying the RIPAT Approach need to be implemented with a focus of improving the home gardens through tailoring recruitment of community-based experts to facilitate uptake of good agricultural practices (GAPs) to meet the different demands under the system. Lastly, it is concluded that for sustainability of the Chagga home gardens there is need to integrate farming with conservation activities and where possible the two should complement each other e.g., control of soil and water erosion which in turn acts as rainwater harvesting for improving banana production or other crops. Nonetheless, issues related with soil moisture and fertility improvement should be given the due considerations through improvement of traditional irrigations, rainwater harvesting and soil organic matter.

5. Recommendations

Based on what has been presented in the paper and the above conclusions we recommend further studies for a better understanding of the complexity and the livelihood potentials of the Chagga home gardens. Studies on the appropriate fast-growing, nitrogen-fixing species, fruit trees and fodders to be introduced to replace the old and unproductive trees. There is also a need to introduce and popularize new cash/food cash crops to fill the economic gap left by uncertainties of coffee production and its related prices; whereby, promotion of spices and development of banana and avocado value chains could be among the low hanging fruits. In addition, there is an urgent need for attractive agricultural interventions which can attract the youth so as to reverse the current trend of youth out-migrating to cities and towns in search of non-forthcoming income earning opportunities.

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