

CHAPTER 7

Associating the RIPAT Approach with Ecological Agriculture, Food Security and Poverty Reduction: A Case of RIPAT-SUA Project, Morogoro, Tanzania

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Abstract

Literature shows that conventional farming has failed to support farmers to meet food security and the agro-chemicals that are used are beneficial for crop yield in terms of quantity, but they contaminate crop products, soils, and water bodies. Ecological farming seeks to improve food crop yields for balanced nutrition, strengthen fair markets for their produce, enhance healthy ecosystems, and build on ancestral knowledge and customs of farming. Projects applying the RIPAT approach promote agricultural technologies with the aim of increasing food and nutrition security and ultimately reduce poverty. Whether the technologies introduced through the RIPAT approach portray the principles of agro-ecology is an area of inquiry dealt with in this chapter, using RIPAT-SUA project as a case study. Primary data were collected through a survey using a questionnaire, focus group discussions, key informant interviews and

participatory rural appraisal. Household food insecurity access scale was used to determine food security. Results showed that elements of agro-ecology supported by the RIPAT-SUA project's basket of technology options include diversity (new crops), efficiency (intercropping cereals with legumes), recycling (incorporation of crop residues in the soil), human and social values (banana vs the environment), synergies (livestock and crop production, intercropping cereals with legumes), culture and food traditions (orange-fleshed sweet potatoes, iron-rich beans and dairy goats), and circular and solidarity economy (high value crops which attract buyers and consumers). Furthermore, through the RIPAT-SUA project, food and nutrition security and income have also improved. Therefore, projects applying the RIPAT approach adhere to agro-ecology, and through supporting farmers to grow well-sorted varieties of crops and livestock and applying technologies from the basket of options generated from a situation analysis, it is possible to improve food and nutrition security, and income, and ultimately reduce poverty. It is recommended that the use of the RIPAT approach should be applied in any agricultural interventions among small scale farmers and agricultural projects should be designed with a lens of food and nutrition security by implementing a wide range of relevant technologies associated with crops and livestock produced under agro-ecology principles.

Keywords: Agro-ecology, RIPAT-SUA project, RIPAT approach, Food security, Poverty reduction

Introduction

Improvement of agricultural productivity for poverty reduction and food security has been an endless agenda to developing countries, especially in sub-Saharan Africa (SSA) where agriculture contributes substantially to employment, gross domestic product (GDP), export earnings and food security (AGRA, 2014; Larsen & Lilleø, 2014). According to FAO (2017a), conventional farming is still one of the most practised farming methods because of its benefits to the producers and consumers, including availability and price. However, one of the drawbacks of conventional farming is application of chemical fertilizers and pesticides that are used and sprayed on crops. Although chemicals are beneficial for crop yield in terms of quantity, they however contaminate crop products, soils and water bodies. Animals and human beings can feed on the agro-chemicals indirectly by eating contaminated crop products or directly by drinking contaminated water and are hence exposed to

health risks. Williams (2012) refers to conventional agriculture as a farming system which includes the use of synthetic chemical fertilizers, pesticides, herbicides and other continual inputs, genetically modified organisms, concentrated animal feeds, heavy irrigation, intensive tillage operations, or concentrated monoculture production.

To respond to the problems of conventional farming methods, ecological agriculture is strongly being advocated worldwide (FAO, 2018a). According to FAO (2018a), ecological agriculture 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, rather than battling nature with chemical inputs. Hordijk *et al.*, (2012) asserts that ecological farming include all methods such as organic farming, which regenerate ecosystem services like prevention of soil erosion, enhancing water infiltration and retention, carbon sequestration in the form of humus, and increased biodiversity.

The Sokoine University of Agriculture (SUA) and her collaborators are committed to contribute to sustainable development to attain Tanzania National Development Priorities and Sustainable Development Goals (SDGs) through provision of quality research, outreach, and consultancy services. Among others, SUA is collaborating with Research, Community and Organizational Development Associates (RECODA) to implement a joint agricultural development project applying Rural Initiatives for Participatory Agricultural Transformation (RIPAT) approach, which is abbreviated as RIPAT-SUA. The project is titled "Validation and Popularization of the RIPAT Approach", and its aims are, among other things, demonstrating a practical application of the RIPAT approach in agricultural projects and how these facilitates bridging agricultural technology gaps. The project was implemented in three agro-ecological zones (land catena) of the Uluguru Mountains which include high, mid and lowlands.

RIPAT is a result of a collaborative study by RECODA, which is an organization based in Tanzania and Rockwool Foundation (RF) of Denmark (Vesterager *et al.*, 2013). The RIPAT came into being based on an attempt to explore why many agricultural development projects have generated little impact among rural farmers and why significant technology gaps still exist amongst small-scale farming contexts regardless of many improved agricultural technologies having been developed (Ringo *et al.*, 2014). The RIPAT approach is documented as a step-by-step guide on how organizations working with small-scale farmers can transfer various technologies aiming at improving food and

nutrition security and income of poor small-scale farmers in the Global South (Vesterager *et al.*, 2013). RIPAT applies the best from bottom-up and top-down extension approaches unlike conventional agricultural extension methods which rely on imposing centrally based technology solutions ('one size fits all') hence have often failed to produce good results. RIPAT is founded on three pillars which are creation of vision of a better future, establishment of farmer groups with the aim of forming producer associations, and close collaboration with local government authorities and extension agents.

RIPAT aims at bridging the technology gap and promoting adoption of new farming technologies that are likely to improve food security and nutrition, household income and environment. World Food Programme (WFP) (2006) considers food security to prevail when "all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". In the Tanzania's Agricultural Sector Development Programme (ASDP) II (URT, 2017) document, food security is defined to prevail when "all people at all times have physical and economic access to adequate amounts of nutritious, safe, and culturally appropriate foods, which are produced in an environmentally sustainable and socially just manner, and that people are able to make informed decisions about their food choices". However, the more acceptable definition worldwide is that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2017a). The definition describes the four pillars of food security namely: accessibility (having food purchasing power), availability (ability to produce food), utilization (eating habits) and stability (resilience/sustainability of the availability of food). The definition of food security is a basis for measuring food insecurity whereby the components of the definition have to be captured. However, URT (2017) recommends measuring household food security in terms of Integrated Food Security and Nutrition Assessment System (IFSNAS), in Kiswahili "*Mfumo wa Uchambuzi wa Uhakika wa Chakula na Lishe*" (MUCHALI) which was designed as one among the strategies to reach the means to food security (Food and Nutrition Security - FNS). The recommendation to use MUCHALI is in accordance with international development to move away from technically difficult, data-intensive, and costly ways to measure household food security, like using dietary energy consumed (DEC) or monetary values of all food items consumed. USAID Title II and Child Survival and Health Grant programs require relatively simple,

but methodologically rigorous, indicators of the food access component of household food insecurity that can be used to guide, monitor, and evaluate programme interventions. Such a methodology - Household Food Insecurity Access Scale (HFIAS) - is demonstrated by Coates *et al.*, (2007) and was used to determine food security in the research on which this chapter is based.

Conventional farming methods have tried to increase yields by using external inputs which have failed to prove sustainability and meet the definition of food security based on the four pillars of food security (FAO, 2017a). Citing the famous conventional green revolution methods implemented in Asia, Groniger (2009) showed that the methods indicated good promise in increasing yields but failed to be up-scaled in Africa and sustainable and environmentally friendly in terms of biodiversity. According to Sands *et al.*, (2009), the strategies developed by the Green Revolution focused on fighting starvation and were very successful in raising overall yields of cereal grains but did not give sufficient relevance to nutritional quality. They identified that high yield-cereal crops have low quality, with essential amino acid deficiencies, have high carbohydrate content, and lack balanced essential vitamins, minerals and other quality factors.

Experience gathered from conventional farming methods of Green Revolution agriculture showed that it affected both agricultural biodiversity (or agro-diversity) and wild biodiversity (Kilusang, 2007) as it relied on just a few high-yielding varieties of each crop. Furthermore, this has led to concerns about the susceptibility of food supply to pathogens that cannot be controlled by agrochemicals, as well as permanent loss of many valuable genetic traits bred into traditional varieties over thousands of years. Land degradation and soil nutrients depletion became rampant, leading to forcing farmers to clear formerly forested areas to keep up with production or remain with low yields (Vandana, 1991).

A situation analysis which was conducted by RIPAT-SUA project staff aiming at understanding the potentials and challenges of the current farming practices and to identify appropriate solutions including development of a basket of options revealed challenges related to crop and livestock production (Malisa *et al.*, 2018). The challenges related to crop production include poor knowledge of crop agronomic practices; soil and water management, lack of capital; subsistence mind-set and farming, failure to address the impact of climate change, soil degradation, inaccessibility of improved planting materials, and limited logical

crop diversification, intensification, and integration. Livestock-related challenges include inadequate management practices (breed selection and maintenance, feeding, housing, treatment, and vaccination), record keeping and marketing.

Contrary to conventional agriculture, farmers adopting ecological farming seek to improve food crop yields for balanced nutrition, strengthen fair markets for their produce, enhance healthy ecosystems, and build on ancestral knowledge and customs. Agro-ecology is recognized as both a mitigation and adaptation strategy for climate change. Moreover, agro-ecology is a new farming method that increases yields while reducing environmental impacts. Wachira (2016) noted that ecological agriculture involves all techniques that restore ecosystem services, which include water infiltration and its retention, increased biodiversity, carbon storage and soil erosion prevention, noting that many methods are used including strip intercropping, no till, terrace cultivation, multispecies cover cropping, shelter belts and pasture cropping. According to Magdoff (2015), the practice of ecological agriculture involves building the strengths of natural ecosystems into agro-ecosystems, purposely disturbed to produce food and fibre, for which the overall strategies include using practices of (a) growing healthy plants with good defence capabilities, (b) stressing pests, and (c) enhancing populations of beneficial organisms. These are accomplished by enhanced habitat management both above ground and in the soil.

RIPAT-SUA project showed an outstanding performance; all intended interventions in the basket of technologies/options were successfully introduced to the community such that there were functional farmer groups¹ and uptake of agricultural technologies (RECODA, 2019). The basket of options (BO) for the project contained varieties of crops such as perennial crops (banana), root crops (orange-fleshed sweet potatoes - OFSP and cassava) and annual crops including horticultural crops, cereals, and legumes (maize intercropped with beans). Moreover, raising livestock such as dairy goats under zero grazing, local chickens, and pigs, as well as microfinance in terms of village savings and loans associations (VSLA) was promoted. Based on the RIPAT approach, production of these crops and livestock along the land catena of the Uluguru Mountains is done with emphasis on utilization of locally

¹ Functional farmer groups under projects applying the RIPAT approach refers to a group with above 20 members, meeting as per their constitution with an average attendance of about 70% and the leaders are elected democratically.

available resources). The basket of options is prepared after situation analysis has been done to ensure that, upon its accomplishment, there will be improved livelihoods and resilience of small-scale farmers emanating from crop diversification, integration, and intensification (sustainably increased yields per unit area) (Ringo *et al.*, 2014). Whether the introduced basket of options to curb challenges facing agricultural production portrays the principles of agro-ecology is an area of inquiry dealt with in this chapter. The study on which this chapter is based was inspired by the definition of agro-ecology (ecological agriculture) by Wachira (2016), that ecological agriculture refers to all techniques that restore ecosystem services, which include water infiltration and its retention, increased biodiversity, carbon storage and soil erosion prevention. Thus, methods such as strip intercropping, no till, terrace cultivation, multispecies cover cropping, shelter belts and pasture cropping are the ecological agricultural practices that were emphasized on with the RIPAT-SUA project.

Hence, there is a need to study how improvement of food and nutrition security under projects applying the RIPAT approach is in line with ecological agriculture.

Methodology

The study was conducted in an area where the RIPAT-SUA project was under implementation, particularly in villages/streets adjacent to Sokoine University of Agriculture (SUA, covering land catena of the Uluguru Mountains in three agro-ecological zones (i.e., high, mid and low land areas) in Mvomero District and Morogoro Municipality. The areas are in the Eastern zone of Tanzania. Morogoro Municipality is located at the Northeast of Morogoro Region between 6° 00' and 8° 00' latitudes South of the Equator and between longitudes 36° 00' and 38° 00' East of the Greenwich Meridian. Mvomero District is located between latitudes 06° 26' South of the Equator and between longitudes 37° 32' East of the Greenwich Meridian. According to Tanzania's 2012 Population and Housing Census, Morogoro Municipality had 56,723 households, and Mvomero District had 58,314 households with total populations of 286,248 and 312,109 respectively (URT, 2013).

Study population and sample size

The target population (N) was all RIPAT-SUA project beneficiaries from 8 RIPAT Start groups comprising 205 households. Respondent households of the study were in different agro-ecological zones in which

84, 49, 72 households were located at highland, midland, and lowland areas of the Uluguru Mountains respectively. From the population of 205 households, 136 households were selected. The sample size was determined using a formula by Yamane (1967), which is $n = N / [1 + (N * e^2)]$, where: n is the sample size, N is the population or sampling frame, and e is sampling error, i.e., 0.05. Therefore, $n = 205 / [1 + (205 * 0.05 * 0.05)] = 205 / 1.6 = 136$. The households selected were as categorised in Table 7.1.

Data collection

Secondary data were collected from district agricultural reports/data, SUA and RECODA publications, and RIPAT-SUA project reports. Primary data were collected through a survey using a questionnaire, focus group discussions (FGDs) using an FGD guide and key informant interviews (KIIs) using a checklist of items for discussion. Moreover, Participatory Rural Appraisal (PRA) was used whereby transect walk was employed to identify the available agro-ecological practices. Before conducting the FGDs, demographic and socio-economic data from all the participants were collected. Data related to their involvement in the RIPAT-SUA project, especially farming and animal rearing methods related to ecological agriculture, were also collected. FGDs were used to get in-depth understanding of ecological agriculture. In line with Barbour (2011) and Bryman (2004), each focus group comprised 6 to 12 members. The sense of that number range is that if FGD participants are too many, some of them just sit idle, and if they are too few, they may not be able to discuss difficult topics very effectively. A total of 3 FGDs were organized based on the agro-ecological zones involved in the study.

Results and discussion

Social demographic characteristics of the households involved in the study

The study findings showed that most of the households in the study area were male headed (72.8%) (Table 7.1). Males in the study area are responsible for household production activities, and this gives them more power on household matters in comparison to women. The respondents ranged from 18 years and above, about half of the respondents (49.2%) were at the age ranging from 51 years and above (older age). According to URT (2006), the economically active age ranges from 34 to 65, meaning that most of the respondents involved in the study were economically

active. Elderly people acquire knowledge and train their members of the family including youth on different agricultural technologies. However, 14.7% of the respondents were youth, with the age ranging from 18 to 45 years, which shows that the project was sensitive to gender by putting youth into consideration rather than being sidelined.

Table 7. 1: *Social demographic characteristics of the respondents*

Household characteristics		Frequency	Percent
Sex of the household head	Male	99	72.8
	Female	37	27.2
Age of the household head	18–35	20	14.7
	36–50	52	38.2
	51 and above	64	47.1
Marital status of the household head	Single	8	5.9
	Married	94	69.1
	Divorced	15	11.0
	Widow/er	19	14.0
Household size	1–5	94	69.1
	6–12	42	30.9
Level of education	Standard 7	104	76.5
	Form IV	19	14.0
	Diploma	1	.7
	University	6	4.4
The main source of household income	No formal education	6	4.4
	Crop production	67	49.3
	Mixed farming	49	36.0
	Formal employment	5	3.7
	Business	13	9.6

Furthermore, the results showed that 69.1% of all the respondents were married; 11% were divorced; 5.9% were single; and 14% were widowed. This shows that married people are more likely to participate in agricultural activities compared to unmarried ones. The main reason is that married farmers have more labour force to be involved in such activities. The results also showed that the majority (76.5%) of the respondents had primary education level, followed by leavers of the ordinary level of secondary education (form four) who were

14%. According to URT (2015), basic education is primary level and secondary level education. This is because there are fewer employment opportunities for people with primary education or secondary education, making them more involved in agricultural activities. Lastly, the results showed that close to a half (49.3%) of the respondents were involved in crop production as their main source of income in the study area. Similar results were observed by Lugamara *et al.* (2017) who reported that most of the households in Mvomero and Gairo Districts depend on agriculture.

RIPAT-SUA project's basket of options and agro-ecology

Establishment of a basket of technologies

Projects applying the RIPAT approach select technologies to adopt and practise from a basket of options that contain different improved agricultural technologies, established in a participatory way. For the RIPAT-SUA project, the project implementing organizations - RECODA & SUA - in collaboration with farmers and extension officers in the project area, carried out a situation analysis which culminated into a basket of options. Table 7.2 shows the agricultural technologies available in the basket of options.

The technologies include ones for improved banana, orange-fleshed sweet potatoes (OFSP), cassava, iron-rich beans, and conservation agriculture (cereals, in this case maize, intercropped with legumes, in this case, iron-rich beans).

As for conservation agriculture (CA), the results showed that 36.8% of the farmers were practising (CA). CA involves minimum mechanical soil disturbance, soil protection through soil cover, and crop rotation and intercropping (Silici, 2014). CA uses farmyard manure which ensures the quality of the crops produced to protect the health of the consumers while at the same time protecting the soil for future uses. A similar result was reported by Mtakwa *et al.* (2019) who reported that conservation agriculture improved soil fertility and increased crop yields in all places where it had been applied for a long time. However, there is inadequate availability of manure; hence some farmers plant without using any fertilizer because of low purchasing power.

Participatory situation analysis is employed to identify agricultural potentials and challenges of a certain area hence determine what technologies to be contained in the basket of options (BOs) to tap the potential and counteract the challenges thereby achieving the set goal of agro-ecological practices for sustainable income, food and

Table 7. 2: *Basket of options in the study area*

RIPAT-SUA basket of options		Frequency n	Percent	Reason for selection of the technology from the basket of option
Improved local banana	Implementing the technology	117	86.0	<ul style="list-style-type: none"> • For business (income) • For food • The area is suitable for banana cultivation • For both business and food
	Not implementing the technology	19	14.0	
OFSP	Implementing the technology	71	52.2	<ul style="list-style-type: none"> • For business (income) • For food • To cover the soil • For both business and food
	Not implementing the technology	65	47.8	
Cassava	Implementing the technology	61	44.9	<ul style="list-style-type: none"> • For food • For both business and food
	Not Implementing the technology	75	55.1	
Iron rich beans	Implementing the technology	43	31.6	<ul style="list-style-type: none"> • To nourish the soil • For food • For both business and food • To cover the soil
	Not implementing technology	93	68.4	
CA (Maize)	Implementing the technology	50	36.8	<ul style="list-style-type: none"> • To conserve the soil • For food • For long term use of the soil
	Not implementing the technology	86	63.2	

nutrition security, and environmental conservation. It was learned from the project implementation staff that there had been adequate community sensitization and awareness creation to the extent that farmers were well provoked to express concerns about their lives and any options that they thought might lead to poverty reduction, food security, and environmental conservation. The introduced technologies in the BOs were well managed by the implementing organizations and local government which had the required capacities to mould the innovations to fit into the local customs and physical conditions. The way the BOs were developed complied with the agro-ecology elements on co-creation and sharing of knowledge which explains about how use of agricultural innovations respond to local challenges when they are established through participatory processes (FAO, 2019; Benítez *et al.*, 2020). It was learned that, in designing BOs, consideration was also put on the land catena (slope top-sequence) i.e., which crops and/or management to employ to ensure long term improvement of soil health, food, and nutrition security, and general environmental conservation. It was learned from the FGDs with farmers that the choice of what to implement from the BOs helped many farmers to join the project and adopt various interventions based on socio-economic characteristics at the household level.

Associating RIPAT-SUA project's basket of options with agro-ecology

The study findings showed that farmers in the study area had adopted different agro-ecological practices. The most adopted practices and the proportions of farmers who were practising them in brackets were incorporation of crop residues into the soil (62.5%), intercropping (52.2%), application of farmyard manure (51.5%), mulching (27.2%), planting cover crops (24.3%), and , fallowing (2.9%) (Table 7.3).

Based on the FGD findings, incorporation of crop residues in the soil was mostly done when ploughing the land. Crop residues incorporated in the soil decompose at a later stage to form humus, which is important for soil micro-organisms and the plants. Intercropping, which was adopted by more than half of the respondents, helps in nutrients cycling in the farm and thus making the land more fertile and for a long time. Intercropping allows use of small land to produce diverse crops which increase accessibility of food to the household while recycling nutrients. Well-planned intercropping improves soil nutrients and input efficiency, proper space utilization, and pest regulation, thus enhancing crop yield stability all year round (Silici, 2014).

Table 7. 3: *Agro-ecological practices adopted by the respondents (n = 136)*

Agricultural practices	Households in the three agro-ecological zones			Total	χ^2	Sig. (2-sided)
	Lowland (% of total)	Midland (% of total)	Highland (% of total)			
Fallowing	0.7	2.2	0.0	2.9	5.129	0.077
Not fallowing	34.6	25.0	37.5	97.1		
Intercropping crops	14.0	13.2	25.0	52.2	7.527	0.023
Not intercropping plants	21.3	14.0	12.5	47.8		
Planting cover crops	6.7	5.9	11.1	23.7	1.547	0.461
Not planting cover crops	28.1	21.5	26.7	76.3		
Pest control using chemicals	20.6	14.7	11.0	46.3	9.540	0.008
Not using chemicals to control pests	14.7	12.5	26.5	53.7		
Applying farmyard manure	19.9	11.8	19.9	51.5	1.486	0.476
Not applying farmyard manure	15.4	15.4	17.6	48.5		
Blending manure and industrial fertilizer	1.5	0.7	3.7	5.9	2.348	0.309
Not blending manure & industrial fertilizer	33.8	26.5	33.8	94.1		
Applying industrial fertilizer	10.3	13.2	10.3	33.8	5.023	0.081
Not applying industrial fertilizer	25.0	14.0	27.2	66.2		
Incorporating plant residues into soil	17.6	14.7	30.1	62.5	11.292	0.004
Not incorporating plant residues into soil	17.6	12.5	7.4	37.5		
Mulching	5.2	3.7	17.8	26.7	17.434	0.000
Not Mulching	30.4	23.0	20.0	73.3		
Tilling	30.9	14.7	31.6	77.2	15.624	0.000
Not tilling	4.4	12.5	5.9	22.8		

As for farmyard manure, which was also adopted by more than half of the respondents, the FGD findings showed that the practice was more relevant to farmers who were involved in banana production and maize production under conservation agriculture. Application of manure improves soil fertility and water retention capacity as well as microbial activities of the soil. The findings corroborate information in an FAO report (2012) which says that farmyard manure has a high proportion

of organic material which nurtures soil organisms and is essential in maintaining an active soil life. The improvement of soil water retention capacity counteracts the impacts brought by climate change which, most of the time, is associated with uneven distribution of rains in the cropping season. Furthermore, the application of farmyard manure is associated with high yields of banana and maize crops which, in turn, increase household food security and income thereby reducing poverty. According to Altieri and Nicholls (2020), agro-ecology focuses on doubling food to the community with minimal neagative impacts on the environment.

Relatively low adoption of fallowing in the study area can be explained by land scarcity prevailing in the area. According to Malisa *et al.* (2016), farmers on the Uluguru Mountains experience land scarcity. As a result, fallowing is fading away overtime.

The RIPAT-SUA project's basket of options contained the following agricultural technologies: varieties of crops such as perennial crop (banana), root crops (orange-fleshed sweet potatoes - OFSP and cassava) and annual crops including horticultural crops, cereals, and legumes (maize intercropped with beans). Moreover, livestock such as dairy goats are raised under zero grazing. Local chickens and pigs keeping, and microfinance-village savings and loans associations (VSLA) are also done. An assessment of the basket of options revealed that some of the crop varieties, including iron-rich beans and OFSP, were new in the project area and, hence increasing diversity. According to FAO (2018a), diversity is one of the ten key elements of agro-ecology.

Transect walk and FGD participants indicated that bananas, as a perennial tree-like crop, improve the environment through provision of soil cover and shade, acting as windbreaks, and controlling soil erosion as they are planted across the slope. Beans, which are leguminous, improve soil fertility and fit well in intercropping with maize. Root crops, especially cassava, were described as drought tolerant and, therefore, were among crops considered to be important for ensuring food security. Other crops which were helpful in improving food and nutrition security were iron-rich beans and OFSP. The two crops supply protein and vitamin-A, respectively. It was further learned that the introduced crops had different nutrient requirements and their roots occupy different soil depths, optimizing use of soil nutrients.

Pigs, dairy goats, and chickens were described by FGD participants as important components as they serve as sources of manure in addition to income and food (milk, chicken meat and eggs). The combination

of livestock and crops (mixed) enhances nutrient cycling whereby livestock provide manure while crop by-products are used as animal feeds. Regarding food and nutrition security effect, the integration of animals and crops was reported to improve food and nutrition security, income, and was seen to act as a risk aversion strategy in case of crop failure. In case of drought, a farmer can still sell animals or animal products and obtain income to maintain their purchasing power. The purchasing power aligns well with the FAO food security definition which clearly shows that among the components of food security is accessibility (FAO, 2017b).

The study findings further showed that more than 95% of the crops were raised under rain-fed agriculture; hence the project introduced various rainwater harvesting methods such as the use of infiltration pits whereby holes prepared for banana and maize were supplied with manure and a gap left during filling the holes so that they could trap rainwater. Other soil and water conservation measures promoted by the project include contour ridges which were constructed across the slope, mulching and banana planting across the slope (RECODA, 2019). The use of mulching in banana fields facilitated *in situ* rainwater harvesting while also controlling evapotranspiration, especially in the lowland areas of the Uluguru Mountains where temperatures are relatively high compared to the mid and highland areas. Water-pans, which are small dams lined with polythene sheet, were also introduced in the project area, and proved to be effective in harvesting rainwater for use during the dry season. It was revealed, through FGDs, that various rainwater harvesting techniques had helped farmers to be employed in farm activities all year-round, compared to the past when they were busy only during the rainy season. It was further learned that farmers were quite aware of the impacts of climate change, such as unreliable rainfalls in terms of amount and distribution and, therefore, they did not hesitate to embrace climate change adaptation measures.

The assessment of the BOs revealed that Village Savings and Loan Association (VSLA) was included in the BOs and that, through savings, a farmer who was a member of VSLA was able to take a loan worth three times his/her shares. The avenue for farmers to access loans helped them to get capital for investing in the introduced agricultural technologies such as planting materials, holes making for banana and maize, contour ridge making/terracing, and establishment of water pans. VSLA's rules made the group members stay together for learning by doing, leading to the group plots becoming persuasive demonstration plots and a source

of planting materials. VSLA also empowers farmers to access food. Thus, the implication of the findings is that VSLAs are needed if farmers are to adopt agro-ecological practices. According to RECODA (2019), VSLA serves as a glue of crop and livestock production activities and a safety net for other activities.

Table 7.4: *A summary of elements of agro-ecology and their association with RIPAT-SUA project's basket of options*

Agro-ecology elements	RIPAT-SUA project's interventions
Diversity	Diversification is achieved through designing the basket of options (BOs) which ensures agricultural potentials are tapped, and challenges are solved in order to ensure food security and nutrition while conserving, protecting and enhancing natural resources. This involves introducing new crops to an area through participatory field trials.
Co-creation and sharing of knowledge	Participatory situation analysis to develop BOs together with community sensitization led to development vision which addressed the rural-communities' felt needs (food and nutrition security, income and environmental conservation) in an organized and collaborative manner. Group demonstration fields have proven to be instrumental in knowledge creation and sharing.
Synergies	Project implementing organizations facilitate recruitment of lead farmers (LFs) and Extension Officers (community-based experts) who work together, in conformity with the Public Private Partnership (PPP), to help in ensuring low costs are incurred in out-scaling the project interventions and in ensuring sustainability. Also, combining livestock and crop production, and intercropping cereals with leguminous crops yield synergistic effects.
Efficiency	The project has been advocating the use of locally available materials i.e., farmyard manure, compost, rainwater harvesting, mulching, local/recycling seeds, intercropping cereals with legumes and other indigenous technologies which make the agro-ecological practices produce more while using lesser external resources; hence improved agricultural productivity.

Agro-ecology elements	RIPAT-SUA project's interventions
Recycling	Intercropping (cereals and legumes), mixed farming (crops and livestock production) and incorporation of crop residues in the soil ensure maintenance of the soil health/fertility and management of pests and diseases which altogether lower costs of production while conserving the environment.
Resilience	The development of BOs and their implementation in a holistic manner helps to solve a wide range of challenges facing livelihoods (agricultural) improvement such as drought (rainwater harvesting and planting drought tolerant crops), lack of capital (introduced VSLA), inadequate post-harvest handling (value chain development including processing, marketing and utilization), etc. thereby significantly improving the livelihoods and resilience of small-scale farmers.
Human and social values	The project was meant for protecting and improving rural livelihoods whereby the project participants were selected with a gender lens i.e., to be a member, one should be of the age of at least 18years and above (youths included) and 50% or above should be women
Culture and food traditions	The project embraced community sensitization and mobilization to utilize locally available resources and opportunities in ensuring food and nutrition security. In this regard, traditional / staple food production and utilization were promoted while considering the ecosystem's health.
Responsible governance	The project dealt with policy advocacy aiming at establishing and/or enforcing by-laws at local government levels (district, ward and village) which protect small-scale farmers' rights and ensure their well-being. Policy briefs have been developed to advocate the same at national and international levels.
Circular and solidarity economy	The project started with producer groups (PGs) with a microfinance (VSLA) component; the PGs later united to form a producer association (PA). The efforts are furthered through training on Farmer Market School (FMS), which intends to see an improved capacity of farmers to engage with the market.

Source: RIPAT-SUA quarterly reports (2020/21), RIPAT-SUA final report (2021), RECODA & SUA policy briefs no. 1 & 2 (2020), FAO (2018a)

Based on the study findings, the RIPAT-SUA project, through the developed basket of options and the associated management in production and post-harvest handling (processing, transportation,

utilization, and marketing), portrays a food system. The project deals with production of a wide range of crops and livestock under various arrangements, and in collaboration with various actors (SUA, RECODA, Local government authorities, and Tanzania Agricultural Research Institute-TARI). It also deals with processing OFSP into various products and organized marketing under a reputable programme (farmer market school-FMS). Thus, the activities carried out by the project reflect the definition by FAO (2018b), that food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry or fisheries, and food industries, and the broader economic, societal and natural environments in which they are embedded.

Benefits associated with the application of agro-ecological practices

Based on multiple responses results, benefits accruing to farmers from practising agro-ecological aspects include high-quality crop production (70.4%), soil fertility improvement (39.8%), soil micro-organisms (21.3%), low cost of production (20.4%), increased income (17.6%), and preservation of soil moisture (7.4%) (Table 7.5). Through FGDs, it was found that farmers were trained on compost manure making and its application, and that benefits accrued to compost manure and farmyard manure were similar. They indicated that, with the application of farmyard/compost manure, the soil becomes fertile with improved water retention capacity, and that this helps farmers to reduce the cost of production and risk of crop failure due to drought. Similar findings were observed by Silici (2014) who reported that efficient use of inputs and other locally available resources, along with a diversified pool of agricultural products and 'by-products' (such as animal feeds), guarantees financial viability under agro-ecological practices. Agro-ecology tries to achieve long-term benefits through improvement of soil health and sustaining agricultural systems. As for the quality of the crops produced, FGD participants indicated that crops produced following agro-ecology practices are of higher quality in terms of taste and are free from chemical contamination. For a farmer to compete and win the crops market, it requires production for high-quality crops, especially when the identified consumers/markets are interested in crops produced under agro-ecology practices i.e., with minimum or no use of agrochemicals.

Table 7. 5: Agro-ecology benefits

Benefits of agro-ecology	Responses		Percent of cases
	N	Percent	
The soil remains fertile for a longer time	43	22.5	39.8
Harvesting high-quality crops	76	39.8	70.4
Conserve the environment/ soil microorganism	23	12.0	21.3
Increase income	19	9.9	17.6
Low cost of production	22	11.5	20.4
Conserve soil moisture for a longer time	8	4.2	7.4
Total	191	100.0	176.9

Further, the results showed that practising agro-ecology conserves the environment and microorganisms found in the soil. The microorganisms found in the soil are very important in ensuring the sustainability of soil fertility/(health) through releasing nutrients to the soil after decomposing organic materials such as crop by-products, compost, farmyard manure, plant debris, and other dead organisms. Other benefits of the microorganisms are that the decomposition of organic matter leads to recycling and regulating carbon, fixing carbon for plant uptake, and improved soil structure. RIPAT-SUA project introduced different agronomic practices for different technologies available in the basket of options.

The main agro-ecological practices that were introduced for banana production were planting the crop in relatively big holes with a diameter of 0.9 m and depth of 0.9m which is filled with a mixture of topsoil and manure to a level of allowing trapping of rainwater, hence making it act as an infiltration pit and a niche for microbes to survive and replicate. It was learned that farmers were trained on the application of manure to other crops such as maize, vegetables, and fruit trees. Furthermore, other farming activities advocated by the project were minimum soil disturbance and rainwater harvesting to use manure/compost in planting their crops. This was evidenced by one of the key informants, who reported that:

“Farmers were trained on how to use manures and see the impact of using it in groups in field where training by doing was conducted. The crops produced using manures on the group plots became persuasive demos influencing farmers to adopt the technology of manure application on their fields.

In addition, the results showed that practising agro-ecology lowered production costs as the manures kept in planting holes maintained soil fertility for about two to three years leading to steady/good yields. This implies that the farmers will have to incur costs during the first year of land preparation, but in the second year, they will incur lower costs, hence decreasing the cost of goods production. Crops produced using conventional methods necessitate purchase of external inputs hence high costs. The RIPAT-SUA project, through the application of the RIPAT approach, emphasizes on the use of locally available resources and opportunities such as compost making, mulching, farmyard manure, contour cultivation, rainwater harvesting, minimum soil disturbance, and intercropping which altogether reduce the cost of production to the farmers while maintaining good yields and maintaining the environment.

Challenges of practicing agro-ecology

The results in Table 7.6 show the main challenges of practicing agro-ecology as identified by the farmers who were interviewed. Inadequate availability of manure and presence of crop pests were the main challenges, which were mentioned by 31.9% and 33.6%, respectively, of the respondents.

Table 7.6: *Challenges of practising agro-ecology*

Challenges	Responses		Percent of cases
	N	Percent	
Inadequate availability of manure	38	31.9	39.2
Pest	40	33.6	41.2
Lack of market	9	7.6	9.0
Low production	14	11.8	14.0
Difficulty in preparation	14	11.8	14.0
Drought	4	3.4	4.0
Total	119	100.0	1220

As seen in Table 7.6, the other challenges were limited market, low production, difficulty in preparation and drought. The inadequate availability of manure means that the farmers would not be able to expand production of crops. Along the land catena of Uluguru Mountains, farmers located in the midland and highland areas have limited access to manure because they are not livestock keepers. The RIPAT project approach supplies livestock, though in small numbers,

which were distributed through a solidarity chain; it is expected that in future farmers will be able to get manure from the supplied animals when they have multiplied. Agro-ecology emphasizes on minimum uses of chemicals in production of crops. However, some of the pests persistently live on local herbs, and this destroys farmers' crops.

Food security and its linkage with ecological agriculture

Food security was determined in terms of eating patterns, eating habits and using a household food insecurity access scale. The scale was introduced in Section 1 of this chapter. Pertinent results and associations between ecological agriculture and food security are reported below.

Food security in terms of food consumption patterns and food security situation

The households or household representatives that were interviewed were asked whether, due to their implementation of the RIPAT-SUA project, their households' food consumption patterns and food security status had changed in terms of improvement or otherwise. The results showed that among 88.2% and 82.4% of the households, food consumption patterns and food security situation, respectively, had improved, as indicated in Table 7.7.

Table 7.7: *Whether food consumption pattern and food security situation had changed due to implementation of the RIPAT-SUA project (n = 136).*

Consumption pattern and food security situation	Status as a result of the project	Frequency	Percent
Consumption pattern	Changed	120	88.2
	Not changed	16	11.8
Food security situation	Changed	112	82.4
	Not changed	24	17.6
All	-	136	100.0

The respondents said that the main reasons for improvement in food consumption pattern, with the proportions of them who gave the reasons, were: benefits brought by the project, especially enabling them to plant different crops which enabled them to eat more diverse food items (15.4%), using crop production technologies which increased crop yield (10.3%), planting crops which contain high nutrients (8.1%),

and obtaining various nutrients due to consumption of orange-fleshed sweet potatoes (OFSP) (6.6%). With respect to improvement in the food security situation, the respondents said that the main reasons for the improvement, with the proportions of them who gave the reasons, were more households affording eating three meals per day (18.4%), increased yields of crops grown (11.8%), and eating three meals containing more nutrients (11.0%).

The situations of food consumption pattern and food security in Table 7.7, with the reasons for the same, mean that the RIPAT-SUA project contributed to improvement in food security quantitatively and qualitatively. Quantitatively, the participants in the RIPAT-SUA project were able to eat more meals, and qualitatively they were able to eat more nutrients. Those benefits had potential to spread to some other households which did not participate in the project through the household members copying from their neighbours, relatives, and friends the introduced technologies. The spread of the benefits would further reduce poverty in terms of improvement in food security and income.

Food security based on a household food insecurity access scale

Apart from determining food security in terms of food consumption patterns and food security situation as described above, food security was also determined using the Household Food Insecurity Access Scale (HFIAS) for measuring food access, in accordance with Coates *et al.* (2007). The scale comprises nine (9) standard questions on food access related events in households during the course of four weeks (30 days), in which the respondents are requested to reply Yes or No, and then follow-up questions are asked to those who replied Yes so that they specify whether they experienced the relevant food access related events rarely, sometimes, or often. Then, four types of indicators can be calculated to help understand the characteristics of and changes in household food insecurity (access) in the surveyed population and grouped into: (1) Household Food Insecurity Access-related Conditions, (2) Household Food Insecurity Access-related Domains, (3) Household Food Insecurity Access Scale Score, and (4) Household Food Insecurity Access Prevalence. The results based on using the HFIAS were as reported hereunder. For this chapter, the focus was on the first and third types of the four indicators. This was done for

good technical comparison of food insecurity (access) among agro-ecological zones.

Household food insecurity access-related conditions

The respondents were asked whether, over the previous four weeks prior to the day when data were collected, they had experienced the household food insecurity access-related conditions listed in Table 7.8. Among those conditions, the ones that had mostly been experienced (regardless of the frequency of the experience), with the percents of households which had experienced them in brackets, were household heads or any household members having not been able to eat the kinds of foods they preferred because of a lack of resources (37.5%), household heads or any household member having had to eat a limited variety of foods due to a lack of resources (36.8%) and household heads or any household member having had to eat some foods that they really did not want to eat because of a lack of resources to obtain other types of food (35.3%). Among those events listed in Table 7.8, the ones that had least happened, with the percents of households in which the events had occurred in brackets, were having there ever been no food to eat of any kind in their household because of a lack of resources to get food (7.4%), the household heads or any household member having gone to sleep at night hungry because there was not enough food (2.2%), and the household head or any household member having gone a whole day and night without eating anything because there was not enough food (1.5%).

Based on the responses to the HFIAS, households were judged to be food secure if they replied No or Yes and Rarely to Question 1, which is “Did you worry that your household would not have enough food”? The reason behind using that question to determine the incidence of food security is that it is the only one of the 9 questions that measures household food supply (Coates *et al.*, 2007). Questions 2 to 4 measure quality of food consumed, while questions 5 to 9 measure food intake and its physical consequences. Those who replied No to question 1 were 100, and those who replied Yes and Rarely to the same question were 15. Therefore, food secure households were 100 plus 15, i.e., 115 out of 136 households (84.6%). This means the rest 21 households (15.4%) had various extents of food access insecurity, but the extents were not categorised further because that group (15.4% of the households involved) was very small and hence not appropriate for further categorisation for statistical comparison.

Table 7.8: *Households which had experienced food insecurity access-related conditions (n = 136)*

Responses to the food security questions asked	Yes		No	
Whether the household had worried that the household would not have enough food	36	26.5	100	73.5
Whether the household head or any household member had not been able to eat the kinds of foods they preferred because of a lack of resources	51	37.5	85	62.5
Whether the household head or any household member had to eat a limited variety of foods due to a lack of resources	50	36.8	86	63.2
Whether the household head or any household member had to eat some foods that they really did not want to eat because of a lack of resources to obtain other types of food	48	35.3	88	64.7
Whether the household head or any household member had to eat a smaller meal than they felt they needed because there was not enough food	28	20.6	108	79.4
Whether the household head or any household member had to eat fewer meals in a day because there was not enough food	42	30.9	94	69.1
Whether there was ever no food to eat of any kind in their household because of a lack of resources to get food	10	7.4	126	92.6
Whether the household head or any household member went to sleep at night hungry because there was not enough food	3	2.2	133	97.8
Whether the household head or any household member went a whole day and night without eating anything because there was not enough food	2	1.5	134	98.5

Household food insecurity access scale score

In addition to asking the respondents whether the events had happened, they were asked whether the events had occurred rarely (once or twice in the past four weeks, hence 1 point); sometimes (three to ten times in the past four weeks, hence 2 points); or often (more than ten times in the

past four weeks, hence 3 points). For households which had responded negatively to the previous question, the score on this question was 0, but for households which had responded positively to the previous question, the score was 1 (rarely), 2 (sometimes) or 3 (often). If a household had scored 0 for all the items, it would score 0 out of 27 possible maximum points; if a household had chosen 1 for all the 9 items, the household would score 9 out of 27 possible maximum points; if a household had chosen 2 for all the 9 items, the household would score 18 out of 27 possible maximum points; and if a household had chosen 3 for all the 9 items, the household would score all the 27 possible maximum points. Since 1 point represented rarely, 2 points represented sometimes, and 3 points represented often while each of the nine items had a negative connotation, the fewer the points a household scored, the more food secure it was. The minimum and maximum points scored out of the maximum possible of 27 points were 0 and 27 respectively. The mean and median points scored by the 136 respondents were 3.478 and 1 respectively.

Linkage between food security and ecological agriculture in the study area

Some agro-ecological practices were relevant in different agro-ecological zones (i.e., high, mid, or lowland areas) in Mvomero District and Morogoro Municipality where data was collected for the research on which this chapter is based. Therefore, food insecurity (access) was compared among high, mid, and lowland areas. To analyse the differences, the points scored on the HFIAS were checked for normality by computing and visually observing the normal distribution curve which was found positively skewed. The points were thus transformed to a normal distribution using natural logarithm (ln) transformation and became normally distributed. Natural logarithm was used for the transformation because it is a function of choice for transforming positively skewed variables to normal distributions (Field, 2018). After the transformation, one-way analysis of variance was used to compare household food insecurity access (by comparing the points scored) among the three agro-ecological zones. The points scored out of the possible maximum of 27 points were 2.458, 4.243 and 3.882 for the lowland, midland, and highland areas respectively. These points mean that households in lowland areas had the best food insecurity (access), followed by households in the highland areas. The possible explanation is that in the highland and midland areas, diversity in terms of food

crops produced is more pronounced than in the lowland areas. This is due to climatic conditions of the area being favourable to production of a diversity of food crops, and due to more availability of water for irrigation which makes it possible for farmers to have crops in the field all year round. The results of comparing the levels of food security are presented in Table 7.9.

The results in Table 7.9 show that the food insecurity (access) differed significantly among the three agro-ecological zones, which is indicated by the p-value (0.029) that was less than 0.05. Further analysis using Post Hoc Tests to determine Least Significant Differences (LSD) showed that there were significant differences in food insecurity (access) between lowland and midland areas ($p = 0.009$) but that there were no significant differences in food insecurity (access) between lowland and highland areas ($p = 0.074$) and between midland and highland areas ($p = 0.275$).

Table 7. 9: Results of comparing food insecurity (access) among different agro-ecological zones

Agro-ecological zones	N	Mean values compared		Sum of squares	df	Mean square	F	Sig.	
		Mean scores on the HFIAS	Corresponding natural logarithm values						
Lowland	48	2.459	1.225	Between Groups	4.658	2	2.329	3.703	0.029
Midland	37	4.243	1.866	Within Groups	45.284	72	0.629	-	-
Highland	51	3.882	1.615	-	-	-	-	-	-
All	136	3.48	1.557	-	49.942	74	-	-	-

Conclusion and recommendations

Conclusion

Based on the study findings from RIPAT-SUA Project, it is concluded that projects applying the RIPAT approach adhere to agro-ecology through situation analysis which leads to developing a basket of technologies some of which, if not all of them, are implemented. The RIPAT-SUA project has contributed to improving food and nutrition security, and income. Therefore, it is concluded that, through supporting farmers to grow well-sorted varieties of crops and livestock, applying technologies selected from a basket of options generated from a situation analysis, it is possible to improve food and nutrition security, and income, and ultimately reduce poverty. Generally, the adoption of the technologies

implemented by the projects applying the RIPAT approach reflects direct benefits from agro-ecology elements.

Recommendations

Based on the conclusion above, the following recommendations are made:

- i. The use of the RIPAT approach, especially the participatory situation analysis leading to the designing of a basket of options with a lens of agro-ecology, should be applied in any agricultural interventions especially among smallholder farmers.
- ii. Agricultural projects should be designed with a lens of food and nutrition security by implementing a wide range of relevant technologies associated with crop and livestock produced under agro-ecology principles.
- iii. Further studies are required on how specifically soil health and nutrition are improved because of the implementation of agro-ecology projects applying the RIPAT approach.

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