SMALLHOLDER FARMERS' MOTIVATIONS FOR ADOPTING SUSTAINABLE INTENSIFICATION IN TANZANIA

Student Name: Nyandula Samwel Mwaijande

Farming Systems Ecology Group

Droevendaalsesteeg 1 – 6708 PB Wageningen - The Netherlands

WAGENINGEN
UNIVERSITY & RESEARCH

SMALLHOLDER FARMERS' MOTIVATIONS FOR ADOPTING SUSTAINABLE INTENSIFICATION IN TANZANIA

Student Name: Nyandula Samwel Mwaijande

Student Registration Number: 830514593090

Credits: 36

Course Name: MSc Thesis Farming Systems Ecology

Course Code: FSE-80436

Supervisor(s): dr. ir. JCJ (Jeroen) Groot

Isaac Jambo

Examiner: dr.ir. WAH (Walter) Rossing

Preface

This thesis is made as a completion of the master education in Organic Agriculture specialized in Agroecology. Because of the presence of Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) in the study area of choice, I was able to look into differences in adoption of innovations between types of smallholder farmers, and their underlying motivations for adopting improved farming practices for Sustainable Intensification (SI) in Babati and Kongwa & Kiteto districts in Tanzania. I was engaged in researching and writing this thesis from March 2016 to January 2017. The study was undertaken in combination with my internship at the International Institute of Tropical Agriculture (IITA), Arusha-Tanzania. The research was challenging, but conducting extensive investigation has allowed me to answer the research question that I identified. Fortunately, my supervisors were always available and willing to answer my queries.

I am grateful for the opportunity to pursue my academic endeavour in a foreign land. This would not have been possible without the Netherlands Fellowship Programme (NFP) scholarship. I extend appreciation to my employer, Gairo District Council in Tanzania for granting me a study leave.

Several persons have contributed academically, practically and with support to this master thesis. Special thanks to my supervisor (s) Jeroen Groot of the Department of Plant Sciences at Wageningen University and Research Centre (WUR) and Isaac Jambo (PhD student) for their professional guidance, comments, constructive criticisms, moral support, tireless assistance and unreserved accessibility during this project. Your understanding, support and guidance throughout the research offered immense encouragement and confidence in times of despair and in meeting deadlines. Working under your supervision has taught me to work independently without constant close supervision.

Sincere gratitude to Cor Langeveld, my study advisor for the support and guidance through the course selection, scheduling of my study plan and even making efforts to encourage me when things were tough during my studies.

Among many others I greatly appreciate IITA, amongst others the Africa RISING project for approving and welcoming me during my fieldwork in Arusha, Tanzania. I also extend my appreciation to the village guides, agricultural staffs and farmers of Babati and Kongwa & Kiteto districts for providing all the support and relevant data during the data collection exercise. My study has been a success thanks to your cooperation and support.

I thank my course mates who become friends, Daniel, Shaibu, Lusha, Andreas, Eduardo among many. During my stay I also received support from the Amazing Grace Parish in Wageningen. Pastors Farai and Busi Maphosa, Assistant Pastor Adesowa and all church members offered me spiritual and moral support. Thanks to my friends Irene, Theresia Denis, Anna, Subira and Theresia Jacob. All together you have made the Netherlands feel like home away from home, and the two years of study full of memories to cherish.

I am humbled and honoured to thank my family's support, my husband Bernard Mwakibete you have been my strength, hope and motivation, for me to rise up and work hard. My mother Isabela Ipopo, late father Friday Mwakasungula and late grandparents Samwel Gwake Mwaijande & Miriam Sambili Mwaijande you have been the source of my inspiration, courage, confidence and foundation of my character. My aunt Deborah Elizabeth Sander and Violeth Mwaijande, sister Emiliana Felix, my nephew Atuganile Jeremiah, siblings Earvin Winkson and Subira Winkson deserve my sincere gratitude for their remarkable support. Above all, I thank God almighty for bringing me this far.

This thesis is dedicated to the memory of my beloved grandmother Miriam Sambili Mwaijande who would have been happy to see me study abroad.

Executive summary

Smallholder farmers in Tanzania are mainly challenged by low crop yield associated by poor farming practices including: burning or removing crop residues, low knowledge and intense tillage which leads to loss of nutrients from arable land. On the other hand, adoption level of agronomic practices is strongly influenced by gender of the household head, farm size, labour availability and credit constraints. Higher costs of inputs raise the costs and risk of production and reduce profitability of new innovations. Hence farmers level of adoption likely to be reduced. Smallholder farmers' motivations for adopting Sustainable Intensification (SI) should be taken into account.

Understanding of motivations can be based on Self-Determination Theory (SDT). SDT uses an empirical approach that identifies three psychological needs, for autonomy, competence and connectedness. SDT further differentiates the concept of motivation by specifying types of motivational processes that differ in the degree to which they represent autonomy versus control. Autonomous choice is also known as intrinsic motivation, whilst controlled choice (coercion) is considered as extrinsic motivation. The extrinsic type of motivation involves different subtypes, such as external, introjected, identified and integrated regulations, whereas intrinsic motivation includes only intrinsic regulation.

Through adoption of SI technologies farmers would be able to tackle low crop productivity and yield. SI is an approach focusing on increasing production while trying to mitigate adverse effects to the environment, thereby contributing to natural capital and the flow of environmental services. Due to the presence of the Africa RISING project in Tanzania, some of the SI technologies were introduced to smallholder farmers in Babati and Kongwa & Kiteto districts. SI activities introduced to the farmers are soil fertility management (e.g. fertilizers, manures, cover crops), erosion mitigation (e.g. terracing, ridges, cover crops), intercropping cereals with legumes such as pigeon pea, improved animal nutrition (e.g. fodder planting), conservation agriculture (reduced tillage, crop rotations), planting practices (cultivar selection, planting arrangement) and enhanced storage of production.

This study was undertaken to evaluate differences in adoption of technologies between different types of smallholder farmers and their underlying motivation in adopting improved farming practices for SI in Tanzania. The study aimed to (1) compare which technologies are practiced across different farm types and between villages, (2) examine drivers influencing the motivation of smallholder farmers to adopt new farming practices in the context of sustainable intensification, and (3) determine perceived benefits and barriers of adopting the proposed sustainable intensification practice.

A household survey was conducted in 171 households in Babati and Kongwa & Kiteto districts. The purposive sampling technique was used to select 11 villages which are cultivating crops in various farming systems in the study areas. A combination of methods was employed for collecting primary data; semi-structured questionnaire having both open and closed questions, focus group discussions and observations within farmer households' compounds and the farmer fields. Closed questions were answered using a Likert scale to measure respondent's attitude regarding their perceptions on SI innovations. The questions were formulated based on the subtypes of motivation and SDT. Content analysis was used whereby field notes from the observations, interviews, focus and group discussions were analyzed to obtain major concepts and ideas with respect to the research questions. Statistical Package for Social Science (SPSS) version 24 and RStudio were used for statistical and visual data

analysis. The quantitative analysis involved the computation of descriptive statistics such as frequencies, means and standard deviations and cross tabulations.

Smallholder farmers in both districts currently used SI technologies such as intercropping of cereals with legumes, use of organic manure, use of improved seeds and use of improved spacing. Farmers in Babati district use Purdue Improved Crops Storage (PICS) bags, in contrary to Kongwa & Kiteto district. Some of the technologies were rarely practiced in both districts. For example, irrigation was applied in Matufa village only in Babati district because it is located in the lowland areas. Smallholder farmers in both districts were planning to plant fodders as field boundaries that serve as, feeds for their livestock and increase crop productivity. Farmers in Babati also planned to make ridges/terraces and practice crop rotation, while in Kongwa & Kiteto farmers planned to use cover crops and double up legume technology.

Contrasting statements were obtained about the role of economic factors in decision-making when comparing the analysis of motivations with the perceived benefits and barriers of adoption. In the motivations analysis, farmers stated to be more intrinsically motivated to practice new farming practices than extrinsic motivated. However, it is important to note that extrinsic motivation was also a contributing factor towards adoption of new farming practices. Analysis of reasons and barriers of adoption demonstrated that economics drives the most of the farming decisions. There was limited room for non-economic motives in farming and most of the farmers seek for technologies that are cost effective and provide quick pay back. Therefore, economic analysis should not be neglected when it comes to factors influencing farmers to adopt new farming practices. Smallholder farmers in both districts were convinced that SI technologies are used to identify field boundaries, improve soil quality and conserve soil and water. According to farmers in Babati, SI technologies enhance utilization of crop residues and improve soil fertility, while in Kongwa & Kiteto farmers were convinced that SI increased income from agricultural production and mitigate the effects of climate change. Despite the increasing efforts made and perceived benefits attained by farmers, still the adoption of SI technologies has generally been limited. This is due to the high initial capital required to establish or implement SI technologies, fear of trying something new, time consuming and need labour to implement it. Due to these barriers, implementers of SI projects should involve farmers more on which technologies suit the needs of the farmers, hence the technologies more likely to be adopted. This could lead to higher willingness to adopt SI. This study demonstrated that interventions by policy makers, researchers and extension workers to address farmer needs should consider farmers motivations towards adoption of SI technologies.

Table of Contents

List of Tables

List of Figures

List of Acronyms

Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
FAO	Food and Agriculture Organization
FGDs	Focus group discussions
GDP	Gross domestic product
IITA	International Institute of Tropical Agriculture
IRNM	Integrated Natural Resource Management
MFC	The Ministry of Agriculture, Food Security and Cooperatives
NFP	Netherlands Fellowship Programme
NRM	Natural Resource Management
PICS	Purdue Improved Crop Storage
SDT	Self-Theory Determination
SI	Sustainable Intensification
SSA	Sub-Saharan Africa
SPSS	Statistical Package for the Social Science
USAID	United States Agency for International Development
WUR	Wageningen University and Research

1. Introduction

1.1 Background information

The agricultural sector plays an important role in the overall development of Tanzania's economy and rural livelihoods, serving more than 90 percent of rural households (Nkonya et al., 1997). It contributes 27 percent to the Gross Domestic Product (GDP) and provides 35 percent of foreign currency in the economy (MFC, 2012). Agriculture per se is not only providing food but it also supplies raw materials for industrial activities. In Tanzania, smallholder farmers dominate agriculture. They grow different kind of crops for home consumption and income generation. Food crops that are commonly cultivated include maize, rice, sorghum, wheat, millet, bean, pigeon pea, cowpea and sweet potato. The main cash crops cultivated include coffee, cashew nut, cotton, sisal and tobacco. Smallholder livelihoods also heavily rely on livestock production systems where cattle, goats and sheep are kept for meat, draught and cash (Kassie et al., 2013).

Wolter (2008) reported that smallholder farmers in Tanzania cultivate farms on average 3.0 hectares each. Crop production is characterized by low yield (Nkonya et al., 1997, Wolter, 2008, Kassie et al., 2013, Timler et al., 2014). The yield of most crops varies considerably depending on agronomic practices applied by smallholder farmers. For example, the average yield of maize in Babati and Kongwa & Kiteto districts are 2.1 Mg/ha and 1.1 Mg/ha respectively (Hillbur, 2013a). The common constraints are poor farming practices, including burning or removing crop residues, low knowledge and intense tillage which leads to loss of nutrients in the arable land hence lowering yield (Edwards, 1987, Shetto and Owenya, 2007, Thierfelder and Wall, 2011). Other challenges include pest and weed control, particularly Striga weed. Likewise, inadequate grazing areas, diseases and low availability of water affect livestock keeping for soil improvement. Unavailability of water is strongly amplified by climate change, especially for farmers who depend much on rainfall. Rainfall is erratic and unpredictable with recurrent drought periods (Timler et al., 2014). Investing in improved crop varieties may improve productivity and yield. Also, productive animal breeds may lead to improving livestock production. Crops and animals being adaptive to the given environment may enhance productivity. Improved crop varieties should therefore be early maturing, drought-tolerant and resistant to pests (Timler et al., 2014).

On the other hand, it has been reported that the farmers' adoption level to new agronomic practices is strongly limited by resource availability, imperfect information, market, policy and institutional factors (Marenya and Barrett, 2007, Shiferaw et al., 2009). Likewise, the level of education and gender of the household head, size of the farm owned, risk and uncertainty, human capital, labour availability, credit constraints, and tenure security are the factors most strongly influencing adoption decisions (Feder et al., 1985, Marenya and Barrett, 2007, Shiferaw et al., 2009). Smallholder farmers with insufficient income fail to move out of poverty, as they are less likely to invest in appropriate farming practices. Moreover, higher costs of inputs raise the cost and risk of production, and reduce the profitability of new innovations hence the farmer's level of adoption is likely to be reduced. Without adoption of improved agricultural practices such as improved seeds, fertilizer application, the crop yields and productivity remain low, hence resulting in low food security and poverty (Mazvimavi and Twomlow, 2009, Thierfelder and Wall, 2011).

Motivation for the smallholder farmers to adopt management of natural resources in a sustainable way is one of the important ways to tackle low productivity and yield (Kassie et al., 2013). Smallholder farmers are motivated to adopt new sustainable farming practices in different ways (Moller et al., 2006). Motivation can be assessed by the Self-Determination Theory (SDT) (Ryan and Deci, 2000b, Moller et al., 2006). SDT is an approach to human motivation and personality in which issues related to choice or, more precisely, to human autonomy are on the front (Ryan and Deci, 2000a, Moller et al., 2006). SDT uses the empirical process which identifies three psychological needs: the needs for autonomy, competence and connectedness (Pretty et al., 2006) (Figure 1). SDT further differentiates the concept of motivation by specifying types of motivational processes that differ in the degree to which they represent autonomy versus control.

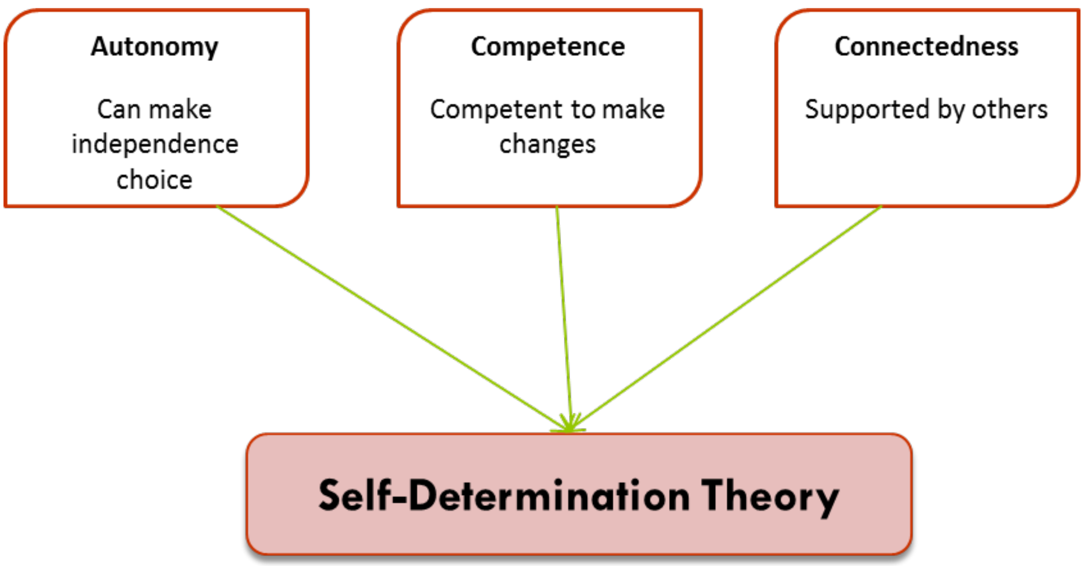

Figure 1: Self-Determination Theory (Human's three basic needs) Source: (Ryan and Deci, 2000b).

Autonomous choice is also known as intrinsic motivation, whilst controlled choice is extrinsic motivation (Moller et al., 2006). When farmers are intrinsically motivated, they are driven by interest, satisfaction and enjoyment of the activity itself. In contrast, extrinsic motivation involves strong force from coercive external factors such as threats, deadlines, directives, pressured evaluations, rewards and punishments (Ryan and Deci, 2000a, Ryan and Deci, 2000b, Niven and Markland, 2016). The extrinsic type of motivation involves different subtypes, such as external, introjected, identified and integrated regulations, whereas intrinsic motivation includes only intrinsic regulation (Ryan and Deci, 2000a, Ryan and Deci, 2000b, Niven and Markland, 2016) (Figure 2). According to Perret and Stevens (2006), smallholder farmers decide to adopt or reject new innovations depending on the predicted change that will help them attain their goals. These goals are focused on economic, social and environmental aspects (Greiner et al., 2009). However, Shiferaw et al. (2009) showed the reluctance of farmers to adopt new practices, when the new practices are presented in a command and control way through coercion. This coercion results into diminishing intrinsic motivation as farmers are forced to adopt new innovations (Ryan and Deci, 2000b). It is argued that when motivation is more intrinsic, the probability of adoption and continued use is higher, and the quality of implementation is better (Chirkov et al., 2003, Moller et al., 2006).

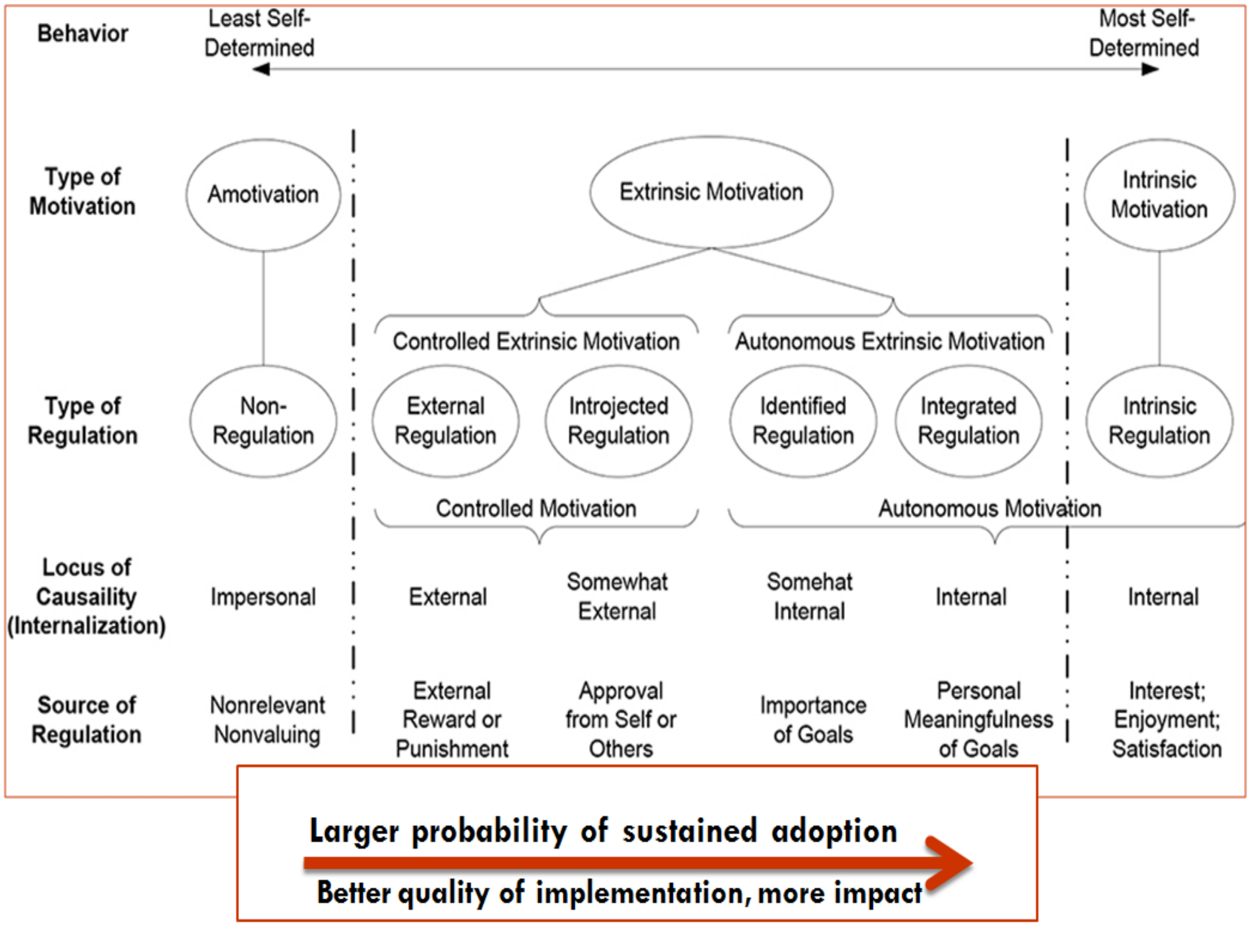

Figure 2: The Self-Determination Continuum showing types of Motivation with their regulatory styles, loci of causality, and corresponding processes. Adapted from several sources: (Ryan and Deci, 2000a, Ryan and Deci, 2000b, Gagné and Deci, 2005).

According to Herrero et al. (2010) it is expected that smallholder farmers could intensify production through proper management of fertilizer inputs, water and feeds in order to minimize waste and environmental impacts. This intensification should be supported by improved access to markets, new varieties and technologies (Herrero et al., 2010). The adoption of improved and sustainable technologies in agriculture is a critical option for enhancing food insecurity and reducing poverty (Pretty et al., 2003). Thus, in order to increase yield and profitability, adoption of farming practices for Sustainable Intensification (SI) should be suggested (Pretty et al., 2006). SI is an approach focusing on generating more output from the same area of land while trying to mitigate adverse effects to the environment, therefore contributing to natural capital and the flow of environmental services (Pretty, 2008, Pretty et al., 2012). SI involves several farming practices which are able to increase yield of crops and livestock, such as: application of improved varieties, appropriate fertilizers, intercropping cereals with legumes, improved animal nutrition (e.g. improved fodder planting), and conservation agriculture which focuses on minimal tillage and crop rotation (Edwards, 1987, Kassie et al., 2013). Hobbs et al. (2008) reported that the main reason for sustainable farming practices is to conserve and improve natural resources and to use them more efficiently. This is achieved by integrated management of soil, water and biological resources in combination with external inputs.

Through the on-going project Africa Research in Sustainable Intensification for the Next Generation (Africa RISING), innovations of these SI practices were introduced to smallholder farmers in Babati and Kongwa & Kiteto districts. The project is funded by the Feed the Future initiative of the United States Agency for International Development (USAID). In Tanzania, the International Institute of Tropical Agriculture (IITA) leads the research activities implemented by the Africa RISING project. Through action, research and development partnerships, Africa RISING aims to create opportunities for smallholder farm households to move out of hunger and poverty through sustainable intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. The project activities are conducted in two regions namely Babati and Kongwa & Kiteto districts. In these districts the project is focused on conducting a sustainable intensification of maize-legume-livestock integrated farming systems. Activities that are carried out include training and introducing of farming practices interventions to the smallholder farmers such as soil fertility management (e.g. fertilizers, manures, cover crops), erosion mitigation (e.g. terracing, ridges, cover crops), intercropping with legumes such as pigeon peas, improved animal nutrition (e.g. fodder planting), conservation agriculture (reduced tillage, crop rotations), planting practices (cultivar selection, planting arrangement) and good storage.

The purpose of this study is to assess the motivation of smallholder farmers in adopting new farming practices for sustainable intensification in Tanzania. The study helps to understand inherent factors that can motivate smallholder farmers to adopt certain farming practices promoted in a sustainable intensification program. Also, through this study farmers are familiar with the sustainable practices and they are able to suggest possible interventions for production and income improvement. Furthermore, the study result provides useful information to policy makers that help them in formulating appropriate and effective agricultural and food security policies.

1.2 Objectives

1.2.1 Main Objective

The overall objective of this research is to evaluate differences in adoption of innovations between different types of smallholder farmers, and their underlying motivation in adopting improved farming systems for sustainable intensification in Tanzania.

1.2.2 Specific Objectives

Specifically, the research aims:

i. To compare which technologies are practiced across the districts, farm types and between villages in Babati and Kongwa & Kiteto districts.
ii. To examine drivers influencing the motivation of smallholder farmers to adopt new farming practices in the context of sustainable intensification.
iii. To determine perceived benefits and barriers on adoption of externally proposed farming practices for sustainable intensification.

1.2.3 Research Questions

i. What are the similarities and differences in technologies being practised across the districts, farm types and between villages?

ii. What are motivational drivers influencing smallholder farmers to adopt new farming practices in the context of sustainable intensification?
iii. What are the perceived benefits and barriers on adoption of externally proposed farming practices for sustainable intensification?

1.3 Structure of the report

This study consists of five chapters. The first chapter provides some background information to the study and existing literature, study objectives and research questions. The second chapter describes materials and methods used to answer the formulated research questions and includes detailed description of the study area. The third chapter presents the research findings and the fourth chapter consists of a discussion on the findings. The last chapter concludes and recommends on the major findings of the study.

2. Materials and Methods

2.1 Study area

The study was conducted in Tanzania, specifically in Babati and Kongwa & Kiteto districts, which are located in Manyara and Dodoma regions, respectively. These regions were chosen as the project site based on analysis of cropping systems, poverty, population, country development priorities, and the potential for successfully improving agricultural productivity. Villages in the project area have highly variable rainfall, elevation (Table 1 and 2) and access to markets (Charles et al., 2016).

Babati district is located below the Equator between latitude 3° and 4° South and longitude 35° and 36° East. It has a total population of 312,392 people, of which 158,804 males and 153,588 females with an average household size of 5.2 people (Tanzania, 2012). The district covers an area of 6,069 km^2 with ecological zones influenced by a landscape that ranges from 900 to a well above 2000 m above sea level (Löfstrand, 2005a). Babati district is characterized by a semi-humid climatic condition. The district receives bi-modal rainfall; short rains occur between October and January while the long rainy season runs between February and May (Bekunda, 2012). Most of the soils range from sandy loam to clay alluvial soils (Timler et al., 2014). The majority of the smallholder farmers in the district depend on crop cultivation and livestock production for their livelihood. They practice mixed crop-livestock, mostly maize-based systems, which are widely found in the district and intercropped with varying species, such as common beans, pigeon peas and sunflowers, according to altitude and rainfall availability (Table 1). Livestock comprises local breeds of cattle, sheep, goats, chickens and pigs. Cattle are widely used for draught, for example pulling carts or ploughing fields (Okori, 2014).

Table 1: Overview of the general characteristics of Babati district

Village	Shaurimoyo	Matufa	Hallu	Seloto	Sabilo	Long
Altitude (masl)	1018	1019	1233	1644	1648	2185
Annual rainfall (mm)	786	788	769	845	763	851
Population size	315	4823	1367	6059	3667	3009
2012 pop density (/km^2)	86	248	123	329	178	332
Ecozone	v. low elev v. low rainfall	v. low elev v.low rainfall	Low elev low rainfall	Med elev high rainfall	Med elev low rainfall	High elev high rainfall
Cropping systems	Maize	Maize-rice	Maize-legume	Maize-legume	Maize-legume	Maize-legume

Kongwa district covers 4041 km^2 and is located between latitude 5˚30’ to 6˚0’ South and longitude 36° 15’ to 36° East (Kimaro et al., 2012). The district has a total population of 309,973 people, of which 149,221 males and 160, 752 females, with an average household size of 5 people (Tanzania, 2012). The elevation of Kongwa district ranges from 900 to 1,000 meters above sea level. The rainfall pattern in the zones is bi-modal with short rains commencing in November/December to January and long rains falling from mid-February to May. Kiteto district covers 16,685 $km^2$and lies between latitude 40° 31’ and 6º 03’ South and longitude 36° 15’ and 37° 25’ East. The district has a total population of 244,669 people, of which 120,233 males and 124436 females, with an average household size of 4.8 people (Tanzania, 2012).

The district lies between 1,000m – 1,500m above sea level. There is only one rainy season which is between the months of January and April. Kongwa and Kiteto districts are characterized by a semi-arid climatic condition. Both districts receive little and unreliable rainfall (Table 2). The area is characterized by sandy soil with a high infiltration rate and poor soil fertility (Timler et al., 2014). The main economic activity in Kongwa & Kiteto district is crop production and livestock keeping. The predominant cropping systems are cereal-legumes based with the major crops cultivated including maize, sorghum and pearl millet. Pigeon peas, groundnuts and bambara nuts are major legumes grown in the area. Sunflower seems to be the most important cash crop due to the climatic condition (Timler et al., 2014). Livestock keeping is also an important economic activity in the region. The major livestock enterprises in Kongwa and Kiteto districts that underpin livelihoods of farmers are cattle, sheep, goats, pigs, chicken, donkeys and dogs (Okori, 2014).

Table 2: Overview of the general characteristics of Kongwa & Kiteto district

Village	Laikala	Moleti	Mlali	Chitego	Njoro
Attitude (masl)	1176	1278	1322	1332	1800
Annual rainfall (mm)	722	776	765	708	935
Population size	4845	6454	8923	5388	5709
2012 Pop. density (/km2)	97	107	283	53	n.a
Ecozone	Low elev v. low rainfall	Low elev low rainfall	Med elev med rainfall	Low elev low rainfall	n.a
Cropping system	Maize – Sorghum	Maize	Maize	Maize	Maize-Sunflower

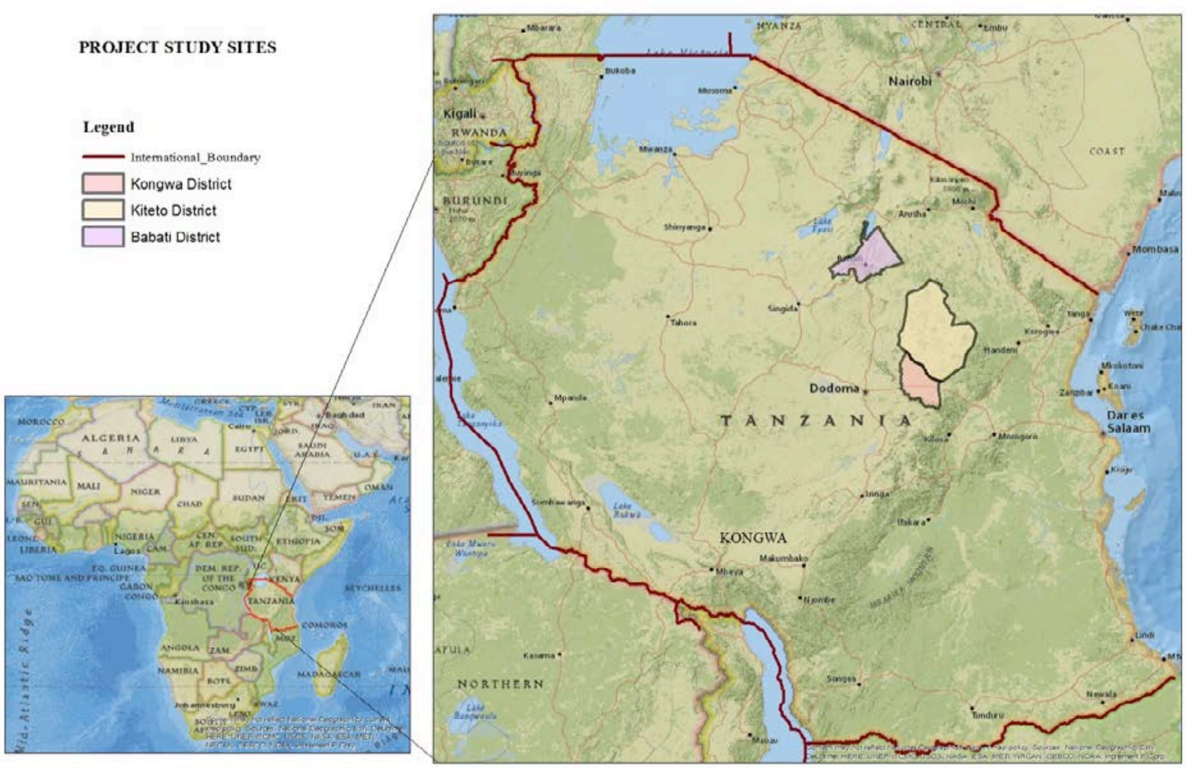

Figure 3: Map of Tanzania with project study sites (Babati and Kongwa & Kiteto districts).

2.2 Research design

This section describes how data was collected, what instruments were employed and how the collected data were analyzed. Table 3 below provides an overview of the research design.

Table 3: Research design

No	Specific objectives	Specific type of data	Sources of data	Data collection method	Data analysis
	Overview of the farmers characteristics	Farm and household characteristics	171 smallholder farmers	Survey (semi-structured questionnaire)	SPSS version 24 Descriptive statistics (frequency, means, percentage & standard deviation).
1	To compare which technologies are practiced across different farming types and villages in Babati and Kongwa & Kiteto districts.	Traditional agricultural technologies & tillage systems, Currently SI technologies available, SI technologies plan to use.	171 smallholder farmers, 5 Key informants to represents others, FGDs in each village (11 villages).	Survey (semi-structured questionnaire), Interviews (Key informants interview guide), Focus group discussion (FGDs checklist, Flip chart, Recorder), Farm and Field visit (researcher's diary, camera), Literature review.	SPSS 24 version Descriptive statistics, Cross tabulation (frequencies, percentages), Microsoft Excel (Graphs), Content analysis - (Major concepts developed).
2	To examine drivers influencing motivation of smallholder farmers to adopt new farming practices in the context of sustainable intensification	Motivations for adoption of new farming practices Subtypes motivations questions -External -Introjected -Identified -Integrated -Intrinsic SDT questions -Autonomy -Competence -Connectedness	171 smallholder farmers	Survey (Semi-structured questionnaire), Likert scale data Literature review	SPSS software Non-parametric test (Kruskal-Wallis test), R software (Stacked bar graphs).
3	To determine the perceived benefits and barriers on adoption of externally proposed farming practices for sustainable intensification.	-Perceived benefits of SI technologies -Barriers for adopting SI technologies	171 smallholder farmers 10-12 farmers in FGDs from each village (11 villages in total)	Survey (semi-structured questionnaire), Likert scale data, Interviews, Focus group discussions, Literature review.	SPSS version 24 Non-parametric test Kruskal-Wallis test) RStudio (stacked bar graphs)

2.3 Sampling procedure

The study involved 171 households from both Manyara and Dodoma regions. The data set was collected from 93 households in six villages in Babati district namely Shaurimoyo, Matufa, Hallu, Seloto, Sabilo and Long and 78 households in five villages of Kongwa & Kiteto district, namely Laikala, Moleti, Mlali, Chitego and Njoro. The purposive sampling technique was used to select 11 study villages which are cultivating crops in variable farming systems in Babati and Kongwa & Kiteto districts. These areas are located within different agro-ecological zones where the Africa RISING project is being implemented. The area was also categorized by varied farming systems where a number of crops are grown and a variety of animals are raised. Due to the heterogeneous population of farmers, classification of farmers based on their farm type was employed to address the needs of different types of farmers. The sampled farmers were classified according to their farming type orientation (Subsistence, Commercial and Combined subsistence and commercial). These study sites were necessary to get required data on drivers of SI innovation by smallholder farmers. A list of farmers from the database of the Africa RISING project was used as a sampling frame. Table 4 below indicates a study sample of 171 respondents who were selected from the sampling frame of farmers of Babati and Kongwa & Kiteto districts.

Table 4: Distribution of respondents (n=171) involved in the study; Babati district (n=93) and Kongwa & Kiteto district (n=78)

Babati district		Kongwa & Kiteto district	
Village	**No of respondents**	**Village**	**No of respondents**
Shaurimoyo	19	Laikala	16
Matufa	15	Moleti	15
Hallu	16	Mlali	16
Seloto	14	Chitego	15
Sabilo	14	Njoro	16
Long	15		
Total	**93**	**Total**	**78**

2.4 Data collection methods

In this study, data was collected in Kongwa & Kiteto district for the period of two months. In addition, the study used a previously collected data set from Babati district. Both primary and secondary data collection methods were used to obtain the information required for the study. A combination of methods was employed for collecting primary data. These methods include one to one interviews aided by a semi-structured questionnaire with both open and closed ended questions, focus group discussions and observations within farmer households' compounds and the farmer fields. The variables of interest were socio-economic variables such as age, sex, marital status, education and household size etc. Farm specific variables on adoption practices for SI included the farm size and farm orientation. Likert scale data was used to measure respondent's attitude with regards to their perceptions on SI innovations. The scale ranged from 1 - strongly disagree to 5 - strongly agree (Brown, 2011). The questions were formulated based on the subtypes of motivation such as external, introjected, identified, integrated and intrinsic. Also, the questions based on SDT such as autonomy, competence and connectedness were administered to farmers. Moreover, 11 focus group discussions were organized with 10-12 farmers from each village (11 villages in total), to explore tillage systems, current traditional and improved agricultural technologies performed such as proper use of fertilizer, use of improved seeds and other practices. A focus group discussion gave an in-depth view of whether adoption practices enhance SI among the farmers in the study area. Key informants (extension officers, lead/facilitator farmers) from Babati and Kongwa & Kiteto districts were interviewed using a checklist to obtain solid information concerning behaviour of farmers on adoption of new farming practices in the whole area. Farm and field observations were done to complement the other techniques, in order to get more insight in the agronomic practices that are actually performed by farmers.

2.5 Data processing and analysis

This section provides a description of the methods which were used in the actual analysis of the data set to test the statistical significance of the various factors hypothesized to influence differences in adoption of innovations between different farm types and villages. Raw primary data from researcher observation, respondent questionnaires, focus group discussions and interviews were examined to detect errors, omission, contradictions and unreliable information collected. This was done to ensure that the data was accurate, consistent, uniformly entered and well arranged to enable recording and tabulation. Field data editing was done daily in the field for legible and accurate information. Secondary data from official documents and publications were examined as well. Both qualitative and quantitative analyses were carried out based on specific objectives of the study as described below.

2.5.1 Qualitative data

A qualitative method of data analysis known as content analysis was employed whereby field notes from the observations, interviews, focus and group discussions were analyzed to obtain major concepts and ideas with respect to the research questions.

2.5.2 Quantitative data

Prior to the analysis, the data collected from smallholder farmers were coded. The data entry was done by using the Statistical Package for Social Science (SPSS) computer program version 24. The quantitative analysis involved the computation of descriptive statistics such as frequencies, means and standard deviations, and cross tabulations. Socio-economic and farm characteristics of smallholder farmers were summarized and presented in percentages, means and standard deviations. Cross tabulation was used to analyse the multiple responses. Graphs of frequency distribution were generated in Microsoft Excel using data from SPSS.

The scripts for Likert scale data were written in RStudio. With Likert scale data we cannot use the mean as a measure of central tendency as it has no meaning i.e. what is the average of strongly agree and disagree? The most appropriate measure was the mode (the most frequent responses) or the median. Therefore, stacked bar graphs were adopted to show the full scale of survey responses, from strongly disagree to strongly agree, for each survey question (Jason.bryer.org, 2017)

A non-parametric test (i.e. Kruskal-Wallis test) was used to compare the distributions of scores on a quantitative variable obtained from two or more groups (Field, 2013).The data used for this study was considered as ordinal data in the analysis. For that reason, the Kruskal-Wallis test was adopted to test the statistically significant differences between farm types and villages. The alpha level for testing for statistical significance was set at 0.05. The results were presented in tables.

3. Results

3.1 Farm and household characteristics

The results show that the majority (96%) of the farmers in Babati and a large percentage (54%) of the farmers in Kongwa & Kiteto were engaged in combined subsistence and commercial farming (Table 5). In addition, the majority of the farmers in both districts were males, married, and attained senior primary education. Furthermore, the average age and farm size of farmers in Kongwa & Kiteto were slightly higher and larger than those of the farmers in Babati (Figures B1 and B2) in Appendix B. However, the average household size was larger in Babati compared to Kongwa & Kiteto (Figure B3).

Table 5: Farm and household characteristics of respondents (n=171)

Characteristics	Babati district (n=93)		Kongwa & Kiteto district (n=78)	
	Freq	Percent	Freq	Percent
Farming type				
Subsistence	4	4	36	46
Combined subsistence and commercial	89	96	42	54
Gender				
Male	87	94	70	90
Female	6	6	8	10
Marital status				
Married	85	91.4	71	91
Single	1	1.1	3	3.8
Widow	7	7.5	3	3.8
Separated	0	0	1	1.3
Education level				
Junior primary	13	14	3	3.8
Senior primary	68	73.1	50	64.1
Junior secondary	3	3.2	0	0
Senior secondary	2	2.2	4	5.1
Tertiary	1	1.1	0	0
University	2	2.2	0	0
None	4	4.3	21	26.9

3.2 Comparison of practiced technologies between districts

3.2.1: Currently used traditional technologies and tillage systems

Focus group discussions were used to make an inventory of currently used traditional agricultural practices and tillage systems in different villages in Babati and Kongwa & Kiteto districts (Tables A1 and A2 – Appendix A). The results show that in both villages farmers commonly used *Euphorbia tirucalli*, *Gmelina indica* trees, and sisal as farm boundaries and livestock pens.

In addition, farmers in Babati cultivated their fields twice by using a tractor or oxen, while farmers in Kongwa & Kiteto practiced two tillage systems. Some farmers in Kongwa & Kiteto cultivated their fields once and sow the seeds, while other farmers planted without tilling the soil, but rather clean the field, dig the holes and plant the seeds.

3.2.2: SI technologies use by district, farm type and between the villages

In both districts farmers were practicing intercropping of maize and pigeon peas, manure application and use of improved spacing (Figure 4). On the other hand, more farmers in Babati used improved seeds than in Kongwa & Kiteto. Farmers in both districts were planning to plant fodders surrounding their farm. Farmers in Babati were planning to make ridges and practice crop rotation, while in Kongwa & Kiteto farmers planned to use cover crops and double up legume technology.

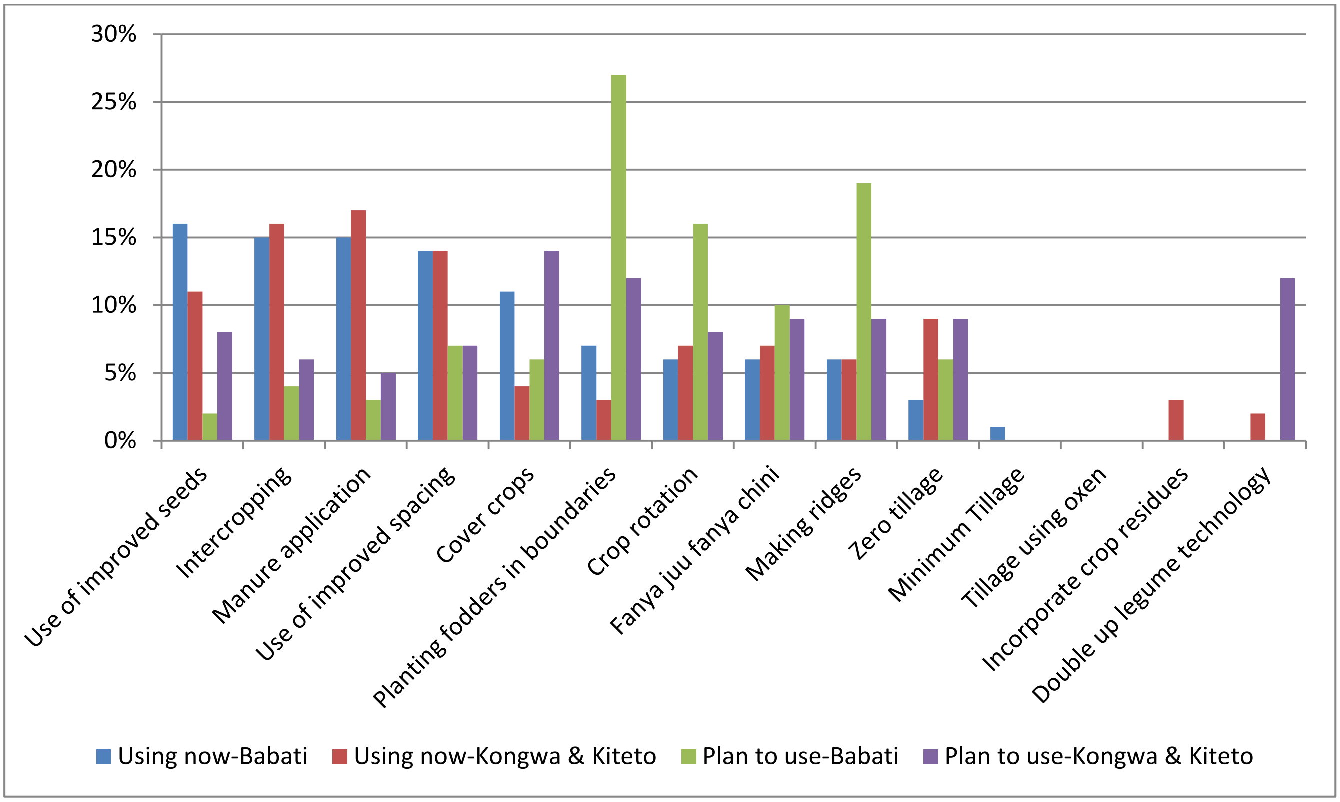

Figure 4: Percentage of farmer responses for SI technologies used and planned to use in Babati, Kongwa & Kiteto districts.

Subsistence farmers in both districts were practising intercropping maize and pigeon peas, application of manure and use of improved spacing (Figure B4). On the contrary, farmers in Babati highly used improved maize seeds compared to Kongwa & Kiteto. Moreover, farmers in Babati were planning to plant fodders in their boundaries and make ridges, while in Kongwa & Kiteto, farmers were planning to practice double up legume technology and cover crops.

Farmers with a combined subsistence and commercial orientation in both districts were practicing intercropping maize and pigeon peas and applying manure in their fields (Figure B5). In contrast, farmers were using improved seeds in Babati, while in Kongwa and Kiteto they were practising improved spacing. Yet, farmers from both districts were interested to plant fodders in their fields and practice crop rotation. Farmers from Babati were interested to make ridges, while farmers from Kongwa and Kiteto were planning to try to cover crops.

Generally, SI technologies used and planned to use by farmers were varied between villages (Figures B6-B7 (Appendix B) and Tables A3-A4 (Appendix A)). Farmers from all villages substantially used manure, intercropping maize and pigeon peas and use of improved spacing (Figures B6 and B7). Also, the results from FGDs show that farmers from both villages use of terraces/ridges and use of measurements (Tables A3 and A4). Moreover, farmers from Babati also used improved seeds and Purdue Improved Crop Storage (PICS) bags (Figure B6 and Table A3). However, cultivation/planting by using Magoye ripper, crop rotation and irrigation were rarely practiced by farmers in Babati villages, while drying of groundnuts by using Mandera coke was also rarely practiced in Kongwa & Kiteto villages (Tables A3 and A4).

Smallholder farmers from different villages in Babati were planning to plant fodders as field boundaries and make ridges (Figure B8), while in Kongwa & Kiteto farmers were planning to use cover crops and double up legume technology (Figure B9).

3.3 Motivation for adoption of new farming practices

Farmers' drivers towards adoption of SI practices were assessed based on subtypes of motivation, such as *External, Introjected, Identified, Integrated and Intrinsic* regulation. The factors affecting the degree of self-determination (*Autonomy, Competence and Connectedness*) for farmers to be motivated to adopt new farming practices were assessed as well. Farmers were asked to use a 5-point Likert scale (1_strongly disagree, 2_disagree, 3_neutral, 4_agree and 5_strongly agree) to indicate their opinions towards adoption.

The results show that the *External* drivers farmers consider were 'economics drives most of their farming decisions', 'adopt SI technologies with quick pay back' and 'no room for non-economic motives in farming' (Figure 5). These drivers were considered as well between farm types and in different villages in Kongwa & Kiteto (Figures B11-B13 in Appendix B). Moreover, farmers between farm types and from different villages in Babati also planted pigeon peas because the crops rewards in terms of price (Figures B10 and B12 in the Appendix B).

In Kongwa & Kiteto there were statistically significant differences between subsistence farmers and combined subsistence and commercial farmers for the driver 'maintenance of communal grazing if I am paid'. In Babati there was no significant differences for the drivers tested between farm types. Differences in response to 'Maintenance of communal grazing if am paid' also show statistical significance between villages in both districts. Also statistically significant differences were revealed between villages in Babati for the drivers 'planted pigeon peas because rewards in terms of price' and 'adopt SI because of peer pressure', while for the Kongwa & Kiteto villages the drivers 'adoption of SI technologies with quick pay back' and 'adoption of SI if paid to do so' show statistically significant differences.

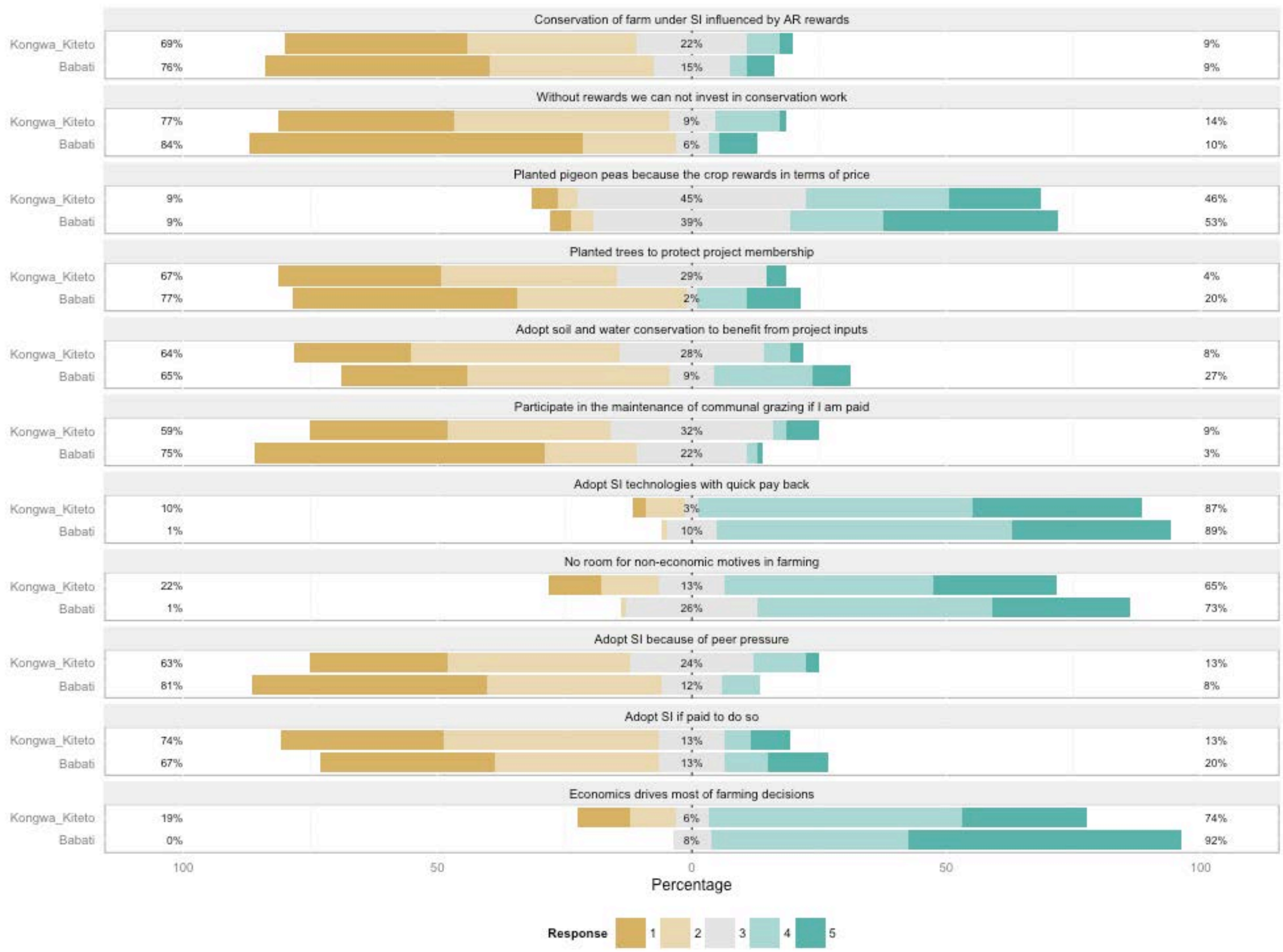

Figure 5: Farmers responses to *External* drivers for adoption of new farming practices for Babati and Kongwa & Kiteto. Rating scale from 1='strongly disagree' to 5='strongly agree'

Table 6: P-values from Kruskal-Wallis test to External drivers for adoption of new farming practices between farm types (subsistence farmers and combined subsistence and commercial farmers) and in different villages within each district.

External drivers for adoption of farming practices	P-values Babati Farm types	P-values Kongwa & Kiteto Farm types	P-values Babati Villages	P values Kongwa & Kiteto Villages
Conservation of farm under SI influenced by AR rewards	0.45	0.14	0.35	0.96
Without rewards we cannot invest in conservation work	0.91	0.13	0.13	0.48
Planted pigeon peas because the crop rewards in terms of price	0.65	0.79	0.00*	0.68
Planted trees to protect project membership	0.99	0.53	0.09	0.46
Adopt SI technologies to benefit from project inputs	0.39	0.18	0.11	0.55
Participate in maintenance of communal grazing if I am paid	0.57	0.05*	0.00*	0.00*
Adopt SI technologies with quick pay back	0.48	0.88	0.56	0.04*
No room for non-economic motives in farming	0.49	0.95	0.54	0.69
Adopt SI because of peer pressure	0.91	0.13	0.01*	0.29
Adopt SI if paid to do so	0.80	0.60	0.56	0.01*
Economics drives most of farming decisions	1.00	0.53	0.96	0.79

* Significant at $p < 0.05$.

The findings of *Introjected* drivers show that farmers between districts, farm types and in different villages account that natural resource conservation gives them a sense of satisfaction (Figure 6 and B14-B17 in Appendix B). On top of that, this driver shows statistically significant in different villages in Kongwa & Kiteto (Table 7), while between farm types there was no significant difference observed for the tested drivers. Also, there was a statistical difference on the driver 'pigeon pea planted to impress project implementers' between farm type and in different villages in Babati.

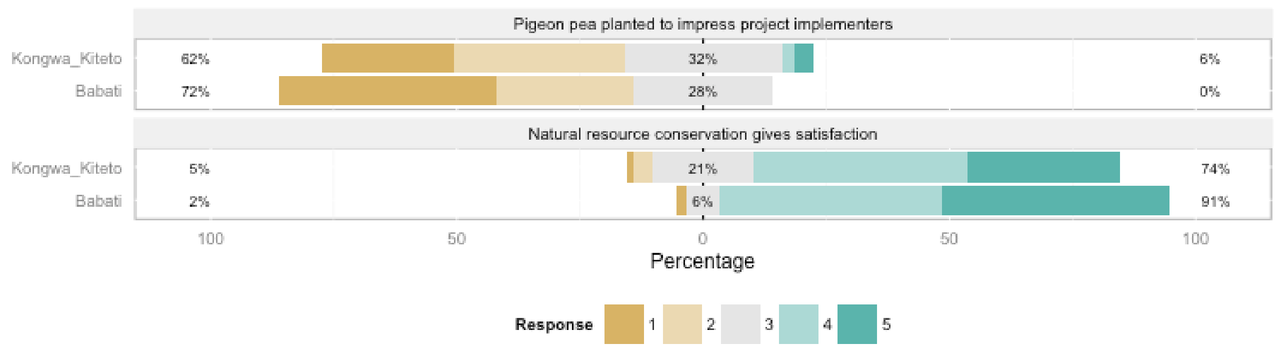

Figure 6: Farmers responses to *Introjected* drivers for adoption of new farming practices for Babati and Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 7: P-values from Kruskal-Wallis test to *Introjected* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district

Introjected drivers for new farming practices	P-values Babati Farm type	P-values Kongwa & Kiteto Farm type	P-values Babati Villages	P values Kongwa & Kiteto Villages
Pigeon pea planted to impress project implementers	0.03*	0.39	0.00*	0.38
Natural resource conservation gives me sense of satisfaction	0.75	0.11	0.34	0.00*

*Significant at $p < 0.05$.

The results of *Identified* drivers delineate that farmers in both districts believe that SI technologies are important for natural resource management, improved land productivity and soil conservation reduce soil erosion in their fields (Figure 7). In distinction, farmers in Babati reckon as well the driver 'incorporating crop residues is important for land sustainability' while in Kongwa & Kiteto farmers think that 'SI are important for their household food security' and 'adopt SI technologies that are very cost effective'. Moreover, farmers between the farm types and different villages in Babati highly rated majority of the identified drivers than farmers from Kongwa & Kiteto district (Figures B18-B21 in Appendix B).

In Babati there was a statistically significant difference between farm types on the driver 'upset if activities harm my land', while in Kongwa & Kiteto, differences were noticed in the importance of incorporating crop residues for sustainability of their land (Table 8). The results further show that in different villages in both districts there was statistical difference on the driver 'SI are important for improved land productivity'. For the case of each district, statistically significant difference was seen in

Babati villages for the divers 'incorporating crop residues is important for sustainability of their land' and 'soil conservation reduces soil erosion in their fields', while in Kongwa & Kiteto there was statistical significance on the driver 'SI considered as part of social responsibility in their community'.

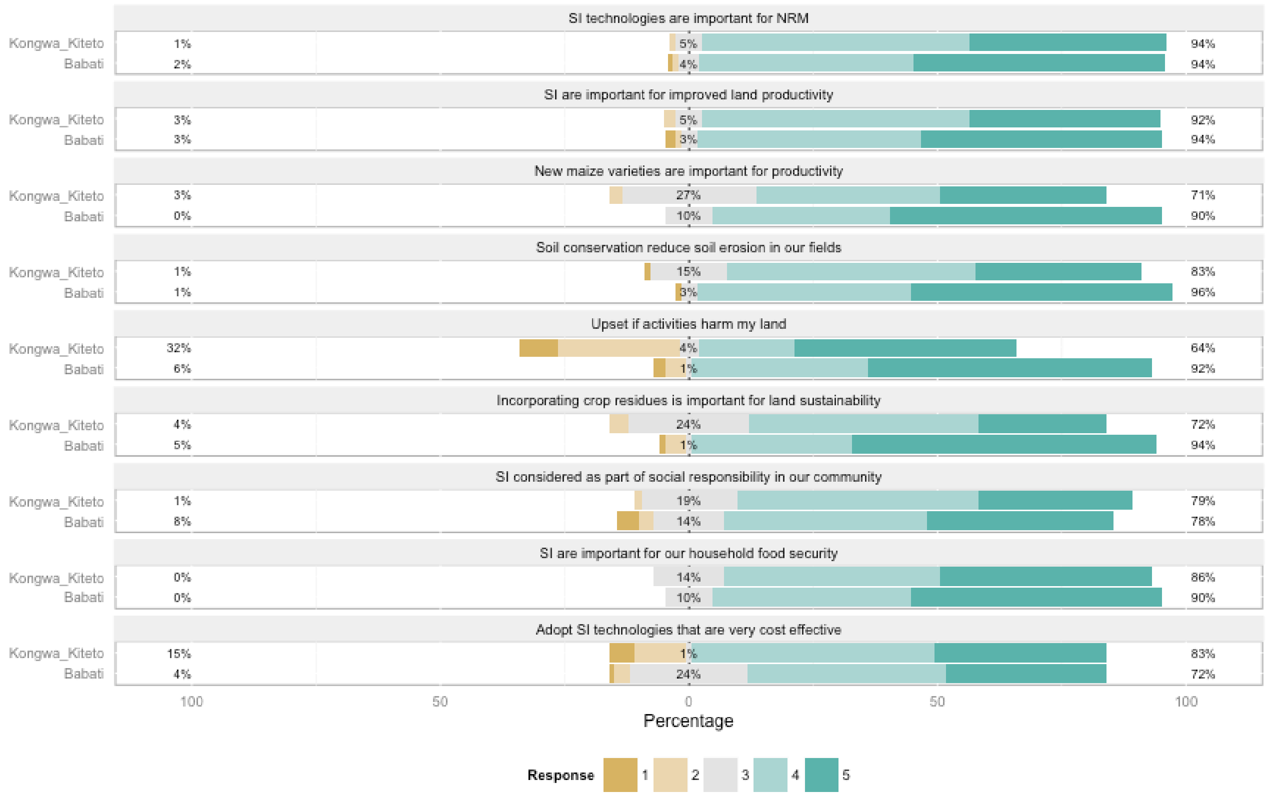

Figure 7: Farmers responses to *Identified* drivers for adoption of new farming practices for Babati and Kongwa & Kiteto district. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 8: P-values from Kruskal-Wallis test for *Identified* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district

Identified drivers for adoption of new farming practices	P-values Babati Farm type	P-values Kongwa & Kiteto Farm type	P-values Babati Villages	P values Kongwa & Kiteto Villages
SI technologies are important for NRM	0.41	0.48	0.54	0.08
SI are important for improved land productivity	0.85	0.58	0.03*	0.05*
New maize varieties are important for productivity	1.00	0.49	0.29	0.54
Soil conservation reduce soil erosion in our fields	0.35	0.08	0.04*	0.34
Upset if activities harm my land	0.05*	0.45	0.13	0.30
Incorporating crop residues is important for land sustainability	0.53	0.03*	0.02*	0.16
SI considered as part of social responsibility in our community	0.70	0.26	0.42	0.03*
SI are important for our household food security	0.57	0.76	0.11	0.14
Adopt SI technologies that are very cost effective	0.61	0.33	0.84	0.61

*Significant at $p < 0.05$.

The findings of *Integrated* drivers show that farmers in Babati consider that SI is necessary for sustainable production, while in Kongwa & Kiteto farmers think that climate change effects mitigated through SI (Figure 8). The P-values for integrated drivers between farm types in both districts and in different villages in Babati were similar (Table 9). The statistically significant difference was noted between villages in Kongwa & Kiteto on the drivers 'climate change effects mitigated through SI' and 'minimal profit each year than a risk investment with financial risk'.

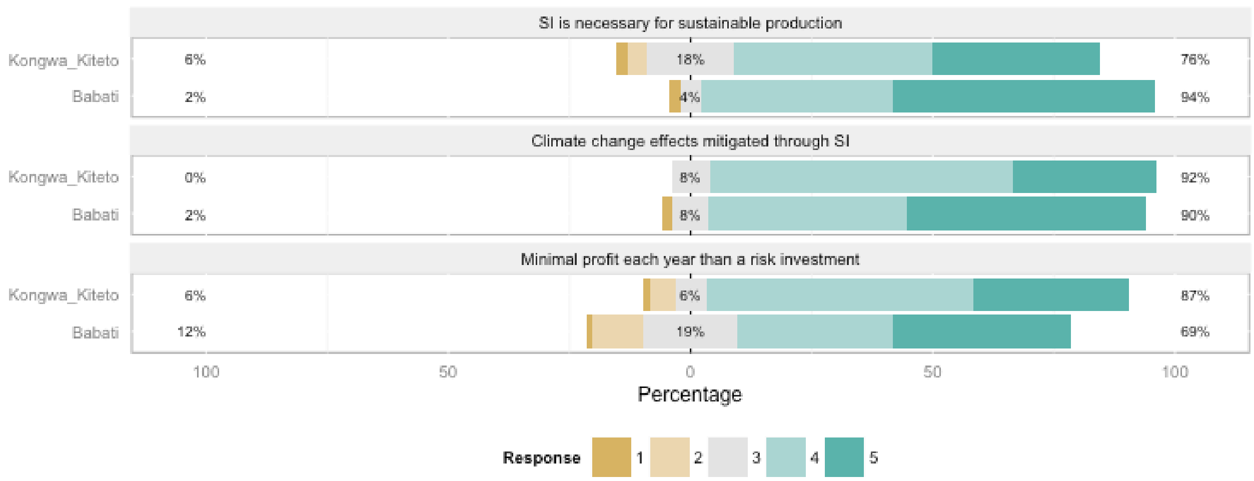

Figure 8: Farmers responses to *Integrated* drivers for adoption of new farming practices for Babati and Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 9: P-values from Kruskal-Wallis test for *Integrated* drivers for adoption of new farming practices between farm type (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district

Integrated drivers for adoption of new farming practices	P-values Babati Farm type	P-values Kongwa & Kiteto Farm type	P-values Babati Villages	P values Kongwa & Kiteto Villages
SI is necessary for sustainable production	0.98	0.08	0.57	0.22
Climate change effects mitigated through SI	0.83	0.08	0.17	0.02*
Minimal profit each year than a risk investment	0.09	0.92	0.67	0.00*

* Significant at $p < 0.05$.

The results show that farmers in Babati strongly agreed on the majority of the *Intrinsic* drivers compared to farmers in Kongwa & Kiteto (Figure 9 and B26-B29 in Appendix B). In both districts farmers consider that 'protecting environment is important', 'SI personally rewarding' and 'attached to their lands that's why they want to improve it'. In addition, P-values were similar between farm types in Babati (Table 10). However, there was statistical significance in different villages in Babati on the driver 'enjoy doing SI activities in their farm', while in Kongwa & Kiteto differences was noted on the driver 'enjoy participating in the maintenance of communal grazing'. These drivers also show statistical significance difference between farm types in Kongwa & Kiteto.

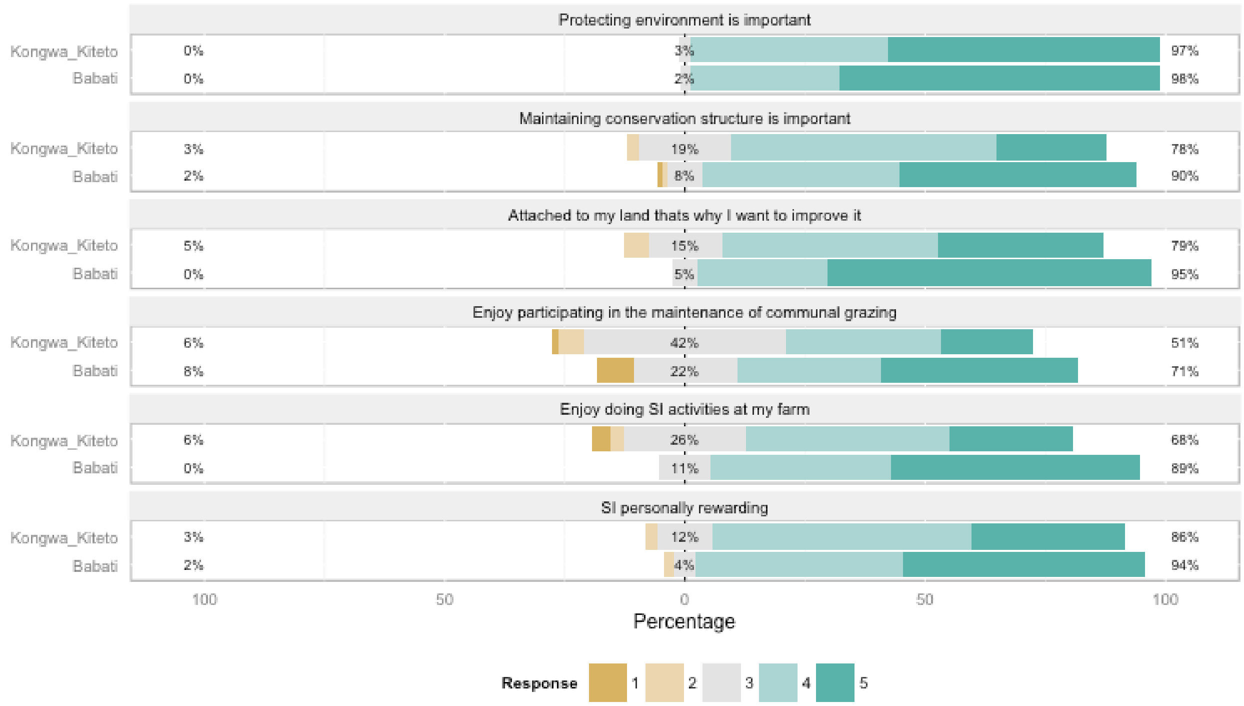

Figure 9: Farmers responses to *Intrinsic* drivers for adoption of new farming practices in Babati and Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 10: P-values from Kruskal-Wallis test for *Intrinsic* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district

Intrinsic drivers for adoption of new farming practices	**P-values Babati Farm type**	**P-values Kongwa & Kiteto Farm type**	**P-values Babati Villages**	**P values Kongwa & Kiteto Villages**
Protecting environment is important	0.70	0.77	0.73	0.41
Maintaining conservation structure is important	0.27	0.86	0.19	0.31
Attached to my land that's why I want to improve it	0.32	0.13	0.27	0.10
Enjoy participating in the maintenance of communal grazing	0.69	0.05*	0.26	0.02*
Enjoy doing SI activities at my farm	0.31	0.04*	0.05*	0.23
SI personally rewarding	0.30	0.85	0.06	0.13

* Significant at $p < 0.05$.

The results of *Autonomy*, *Competence and Connectedness* drivers to adoption of SI technologies tell that farmers from both districts highly valued cooperation with neighbours for successful soil and water conservation work (Figure 10 and B30-B33 in Appendix B). Also, the project and government allowed the community to choose the type of technology to adopt in the community or individual farm. Moreover, farmers in Babati think that they have skills and knowledge on soil and water conservation. In both districts the P-values were similar (Table 11). However, In Babati the driver stated that 'community choose type of technology to adopt' shows statistically significant difference between villages, while in

Kongwa & Kiteto the differences was observed on having skills and knowledge on soil and water conservation technologies.

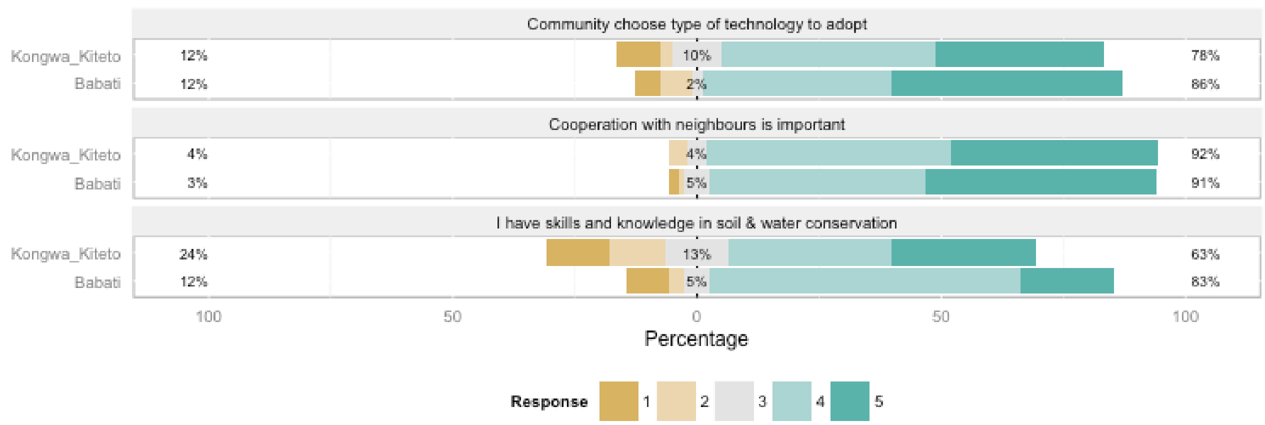

Figure 10: Farmers responses to Autonomy, Competence and Connectedness drivers for adoption of new farming practices in Babati and Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 11: P-values from Kruskal-Wallis test for autonomy, competence and connectedness drivers for adoption of new farming practices between farm type (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district

Autonomy, Competence and Connectedness items	P-values Babati Farm type	P-values Kongwa & Kiteto Farm type	P-values Babati Villages	P values Kongwa & Kiteto Villages
Community choose type of technology to adopt	0.40	0.38	0.02*	0.20
Cooperation with neighbours is important	0.24	0.33	0.44	0.11
I have skills and knowledge in soil & water conservation	0.96	0.14	0.75	0.05*

*significant at P <0.05

3.4: Perceived benefits and barriers for adoption

3.4.1: Perceived benefits of SI technologies

Smallholder farmers in both districts were highly convinced of the benefits from SI technologies (Figure 11 and B34-B37 in Appendix B). In both districts farmers were convinced that 'SI technologies are used to identify field boundaries' and 'improve soil quality' and 'soil and water conservation'. Moreover, farmers in Babati think that 'SI technologies enhance utilization of crop residues' and 'improving soil fertility', while in Kongwa & Kiteto farmers accept that 'SI technologies increased income from agricultural production' and mitigate effects of climate change.

Statistical significant differences were observed on control of weeds and pest in intercropped fields between farm types in Babati, while in Kongwa & Kiteto the results show differences on utilization of crop residues. In addition, statistically significant differences were also noted in different villages in Babati on the following statements; 'utilization of crop residues', 'improved nutrition of farm households', 'increased crop and livestock productivity' and 'increased use of manure'. For Kongwa & Kiteto there were statistically significant differences in different villages on 'increased fodder production' and 'control of weeds and pest in intercropped fields'.

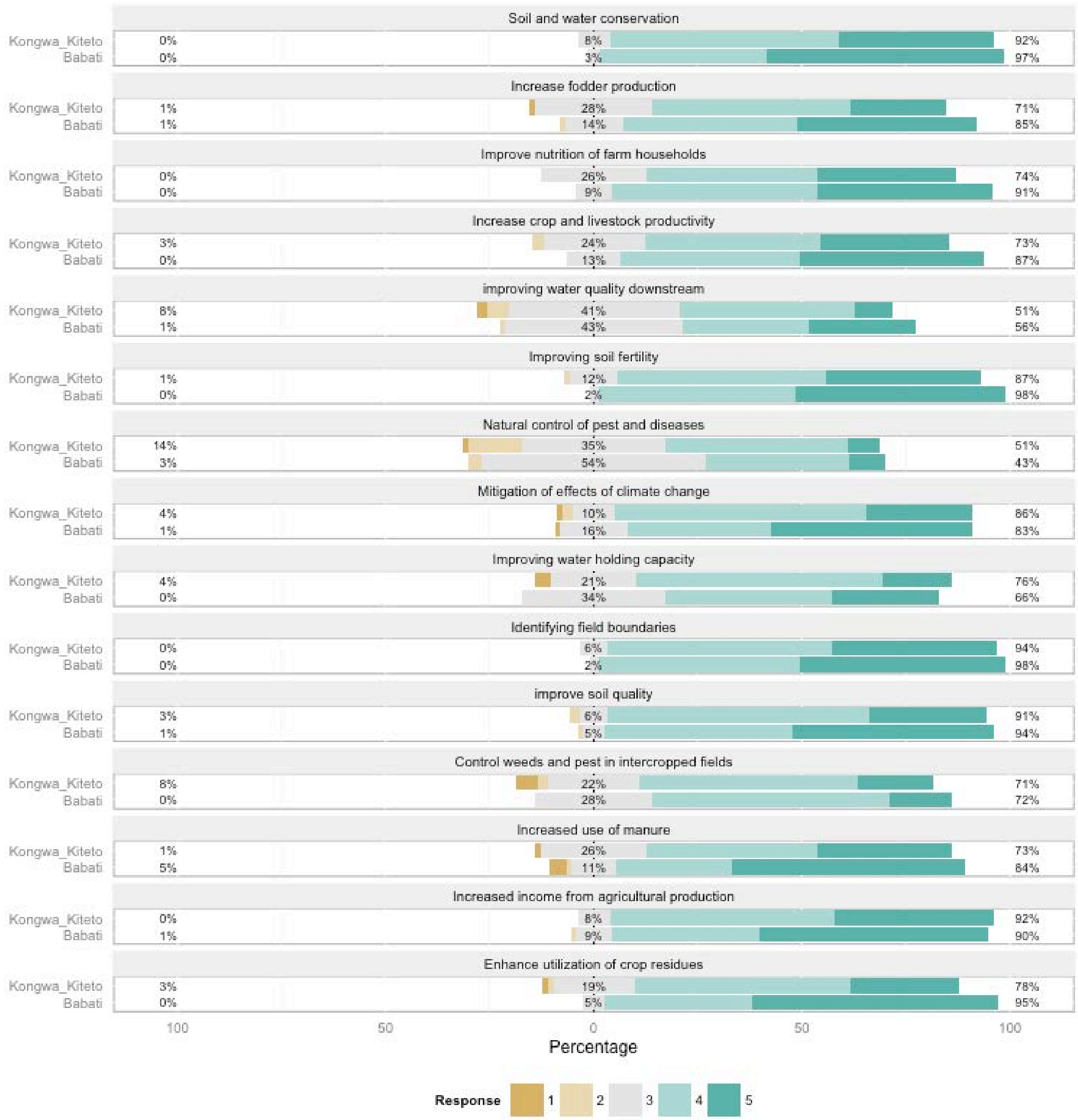

Figure 11: Farmers' perception of the benefits attained from SI technologies between districts. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 12: P-values from Kruskal-Wallis test for perceived benefits of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district (Babati and Kongwa & Kiteto districts)

Perceived benefits of SI technologies	P-values Babati Farm types	P-values Kongwa & Kiteto Farm types	P-values Babati Villages	P values Kongwa & Kiteto Villages
Soil and water conservation	0.44	0.19	0.27	0.07
Increase fodder production	0.17	0.97	0.12	0.01*
Improve nutrition of farm households	0.17	0.34	0.01*	0.59
Increase crop and livestock productivity	0.19	0.24	0.01*	0.31
Improving water quality downstream	0.27	0.61	0.56	0.22
Improving soil fertility	0.31	0.83	0.65	0.09
Natural control of pest and diseases	0.14	0.60	0.65	0.70
Mitigation of effects of climate change	0.24	0.15	0.22	0.19
Improving water holding capacity	0.12	0.40	0.24	0.29
Identifying field boundaries	0.95	0.16	0.09	0.75
Improve soil quality	0.85	0.30	0.74	0.14
Control weeds and pest in intercropped fields	0.05*	0.45	0.60	0.00*
Increased use of manure	0.64	0.58	0.05*	0.27
Increased income from agricultural production	0.37	1.00	0.09	0.69
Enhance utilization of crop residues	0.48	0.00*	0.01*	0.16

*significant at P <0.05

3.4.2: Barriers to adoption of SI technologies

The results of the constraints that might hinder farmers to adopt SI technologies in Babati and Kongwa & Kiteto are presented in Figures 12 and B38-B41. The major barrier in both districts was that SI innovations require money to implement. This was also found between farm types and in different villages. Moreover, farmers between farm types and different villages in Kongwa & Kiteto say that SI technologies are time consuming. Subsistence farmers in Babati were challenged by fear of trying something new.

The results of the statistical test show that there were no significant difference noted between farm types and in different villages in Babati (Table 13). However, there were statistically significant on fear of trying something new between farm types in Kongwa & Kiteto. Also, 'lack of knowledge about SI', 'not owning enough land to try SI', 'SI seems to be too risky and 'results in lower yield', show statistically significant in different villages in Kongwa & Kiteto.

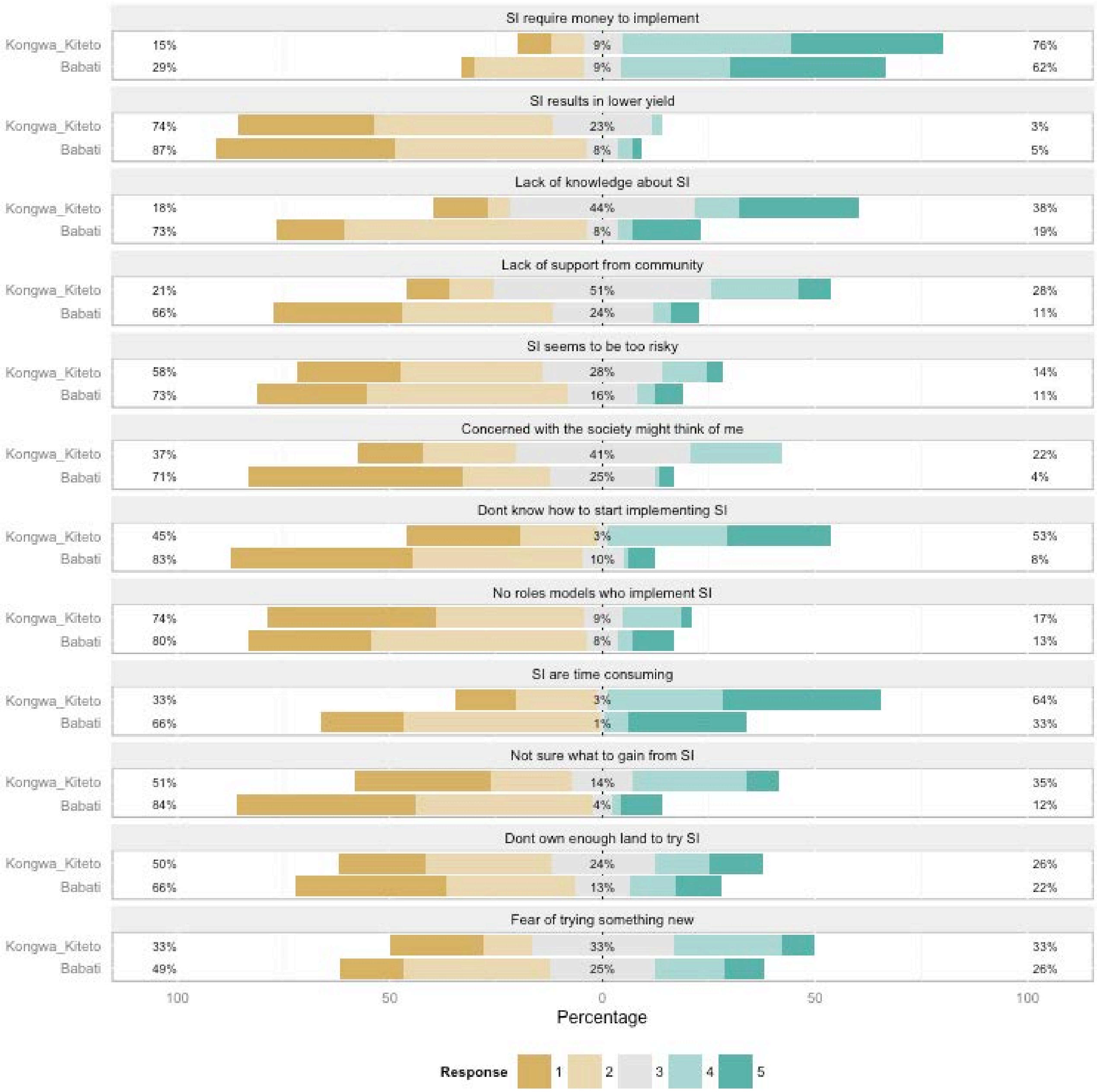

Figure 12: Farmers responses on barriers for adopting SI technologies for different districts (Babati and Kongwa & Kiteto). Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Table 13: P-values from Kruskal-Wallis test for the barriers towards adoption of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) and in different villages within each district (Babati and Kongwa & Kiteto districts)

Barriers for adopting SI technologies	**P-values Babati Farm types**	**P-values Kongwa & Kiteto Farm types**	**P-values Babati Villages**	**P values Kongwa & Kiteto Villages**
SI require money to implement	0.77	0.41	0.50	0.65
SI results in lower yield	0.96	0.59	0.05*	0.63
Lack of knowledge about SI	0.26	0.37	0.02*	0.31
Lack of support from community	0.57	0.70	0.26	0.91
SI seems to be too risky	0.90	0.55	0.02*	0.41
Concerned with the society might think of me	0.59	0.69	0.98	0.77
Don't know how to start implementing SI	0.55	0.07	0.38	0.60
No roles models who implement SI	0.67	0.90	0.69	0.94
SI are time consuming	0.72	0.98	0.12	0.95
Not sure what to gain from SI	0.16	0.71	0.82	0.14
Don't own enough land to try SI	0.58	0.26	0.04*	0.35
Fear of trying something new	0.15	0.03*	0.94	0.46

* Significant at $p < 0.05$.

4. Discussion

4.1 Farm and household characteristics

This study has shown the farmers' motivations for adoption of SI practices in Babati and Kongwa & Kiteto districts. As shown by other researchers, farm and households characteristics are important in determining motivations for adoption of new farming practices (Marenya and Barrett, 2007). We found that households were headed by males (Table 5), which can be explained by other studies (Kassie et al., 2013, Nkamleu and Manyong, 2005, Marenya and Barrett, 2007, Uaiene et al., 2009), showing that women have less access to critical resources such as land, cash and labour and are generally discriminated against in terms of access to external inputs and information. Even though in their studies it was found that gender per se does not heavily affect the adoption of new farming practices (Kassie et al., 2013, Nkamleu and Manyong, 2005, Marenya and Barrett, 2007, Uaiene et al., 2009). In contrast, the study conducted by Mercer (2004) stated that males were always more likely to adopt new farming practices than females. We also found that majority of farmers were married (Table 5). This correlates with their age; whereby all were adult people (Figure B1 in Appendix B). Marenya and Barrett (2007) found that Integrated Natural Resource Management (INRM) practices require more physical effort, hence the relatively healthier and stronger younger farmers are the more likely to implement them than their older farmers.

The education level of an individual is usually valued as a means of liberation from ignorance and enables one to know the basics of farming practice. The study findings show that the majority of farmers attained senior primary education which is a basic education and provides knowledge that helps them to improve their activity on agriculture (Table 5). The findings were in line with Knowler and Bradshaw (2007) who stated that education level of a farm operator has been assumed to influence the adoption of conservation agriculture practices positively. However, Mercer (2004) stated that the education of the household head may be irrelevant if the head utilizes the knowledge of other more educated household members.

We found that an average household size in both districts was higher (Figure B3 in Appendix B) than the overall country average household size of five people (Tanzania, 2012). This may imply that households have labour source, which is needed in farming activities. In a more recent study, Njuguna et al. (2015) reported that large families are an important source of cheap labour especially during peak seasons when planting, weeding and harvesting occur. Availability of cheap labour enables farmers to adopt new farming practices (Njuguna et al., 2015). Alavalapati et al. (1995) pointed out that farmers who have limited family labour are less attracted to adopt new technologies as it may increase the seasonal demand of labour. In contrary, Audu and Aye (2014) suggested that households with large number of family members are less adopting new technologies compared to families with few members. The authors suggest this is due to fear, as they are risking more; they have a larger family to provide income for.

Land is one of the productive resources for people to engage in agriculture. The findings of this study show that majority of the smallholder farmers in both districts owned land (Figure B2 – Appendix B). The size of the land differs from one district to another. We found that farmers in Kongwa & Kiteto own more hectares of land than Babati farmers. This might imply that farmers in Kongwa & Kiteto might have an opportunity to try different SI innovations to their farms compared to Babati farmers. However, our findings differed from Nyangena (2008), who found that farmers with a small area of land were more likely to invest in soil conservation than those with larger land holdings. Also, Hillbur (2013a) reported that Kongwa & Kiteto is dominated by labour-intensive farming, the tendency to farm larger areas to produce enough food leads to increased need for hired labour hence hinder farmers to practice SI technologies rather, they farm conventionally.

To date, smallholder farmers in both districts are practising combined subsistence and commercial farming, to have food for their family and to sell part of the produce in order to support their livelihoods (Table 5). However, Babati farmers are more engaged in combined subsistence and commercial farming compared to Kongwa & Kiteto. This difference might be due to different agro-ecological zone as in Babati they have fertile land and more rainfall which influence them to practice agriculture comfortably.

4.2 Comparison of practiced technologies between districts

4.2.1: Currently used traditional technologies and tillage systems

Farmers from both districts used oxen and tractor for cultivation (Tables A1-A2 in Appendix A). This is due to the availability of tractor and animals i.e. cattle and donkey. Hillbur (2013a) reported that in Babati the mechanization has been comparatively high with a large number of tractors available. This is in line with our findings, because farmers in Babati cultivate their land twice by using tractor compared to Kongwa & Kiteto who cultivate their land once. Hillbur (2013a) also found that in Kongwa & Kiteto the adoption of these techniques depends on the availability of oxen and training in how to use the implements. Moreover, Kongwa & Kiteto is among the districts that tend to take in hired labour to a large extent at labour peaks, thus indicating that labour is available and the need for mechanization is low. Farmers in Kongwa & Kiteto also plant without tilling the soil, which is known as slash and burn. Mostly only wealthy farmers use tractors. Hillbur (2013a) found that with the slash and burn practice the result of crop yield is low compared to conservation tillage.

On the other hand, improved traditional technologies largely differ between both districts (Tables A1-A2 in Appendix A). In Babati we found that farmers practiced different traditional technologies than Kongwa & Kiteto. For examples; farmers treat their animals by using indigenous medication and store their produce by using huts, wood and cow dung, and these was not seen in Kongwa & Kiteto. Furthermore, farmers in both districts commonly use indigenous trees i.e. *Euphorbia tirucali* as farm boundaries, windbreaks, insect repellent-ants and livestock pens. Farmers are motivated to use this practice because it’s easier to implement and reduces conflict between farmers after demarcation.

4.2.2: SI technologies use by district, farm type and between the villages

SI technologies used and planned use across the study area was almost the same between the districts, farm type and in different villages (Figure 4 and B4-B9 in Appendix B). Intercropping of maize and pigeon pea are practiced in both districts. In the past, many farmers were mixing crops randomly such as maize, sunflower & pigeon pea. Due to the implementation of SI project in the study areas, many farmers have modified their cropping systems by planting only maize with pigeon pea using proper seed rate and recommended spacing. This is done to allow maize to benefit from pigeon pea by taking up fixed nitrogen, ground cover (for weed suppression) and pests repellent (Segerbäck, 2009). The findings of Löfstrand (2005b) revealed that intercropping is very common in Babati and practised by about 60% of the farmers. The introduction of pigeon pea intercropping came spontaneously as there was a good market for it. Most of the pigeon pea produced are exported to India. Hillbur (2013b) also pointed out that intercropping of maize and pigeon pea was already present in both districts and had good results.

In addition, the use of organic manure is a result of having livestock in both districts. Livestock keeping is practiced across all districts; hence provide manure which is used as organic fertilizer. Our findings concur with the study conducted by Okori (2014) in Babati and Kongwa & Kiteto that livestock keeping is an important economic activity to the smallholder farmers, and availability of livestock support extensive farming and provide farmyard manure. Hillbur (2013a) conducted a survey in Tanzania to find out opportunities and challenges to SI and institutional innovation. The findings stated that about 10% of the planted area was fertilized with organic fertilizer in the long rainy season 2007/08, while the use of inorganic fertilizer was insignificant. In Kongwa & Kiteto organic fertilizer was applied to only 2.2% of the land in the long rainy season, and the use of inorganic fertilizer was negligible in the district.

In this study, farmers in Babati highly use improved seeds compared to Kongwa and Kiteto. These findings are similar to (Hillbur, 2013b), who stated that farmers in Babati used improved seeds on >50% of the acreage in the short rainy season, and 24% in the long rainy season, while in Kongwa and Kiteto the use of improved seeds was low. The usage of improved seeds is low because of unavailability of quality seeds. Furthermore, if it is available the seeds are very expensive and some of the crop dealers sell fake seeds. This discouraged farmers to use improved seeds and decided to use local seeds instead. Moreover, from survey that we conducted farmers in both districts claimed to make terraces/ridges, use of improved spacing and measurements. However, these findings were different from what we observed during farm and field visits. Making terraces/ridges, use of improved spacing and measurements were the most challenging practices to the farmers because it’s labour intensive and time consuming for farmers with big land sizes, for example in Kongwa & Kiteto.

Findings also show that farmers in Babati use PICS bags while in Kongwa & Kiteto such bags are not used. Hoeschle-Zeledon (2015) reported that PICS bags are effective in storing the maize at a large scale. The use of insecticides is eliminated and insect infestation is minimal. Hoeschle-Zeledon (2015) further pointed out that in Babati district 400 farmers from two villages of Sabilo and Seloto were trained on the use of PICS bags as improved storage technology. Also about 10 dealers in different places in Babati were identified as agents for distributing and selling PICS bags to farmers and nearby villages. Another study from Suleiman and Kurt (2015) revealed that PICS technology has been considered low-cost, non-chemical technology that enables smallholder farmers to store their seed and grains with minimal loss. This technology has been easily accepted by farmers due to effective storage systems for a variety of crops, including maize, sorghum, common beans against insect infestation, fungal growth and aflatoxin accumulation. However, some of the farmers do not afford to buy it because it is expensive and sometimes it is not available when they need it.

We found that there are some SI technologies which rarely practiced in both districts. For example; irrigation was practiced in Matufa village only in Babati. This village is located in the lowlands areas, hence paddy rice, sugarcane, maize and vegetables are cultivated due to availability of water. The findings is similar to Said (2006) who indicated that majority of the farmers in Babati depends on rainfall for agriculture activities. For Kongwa & Kiteto, drying of groundnuts by using “Mandera coke” are rarely used because this technology needs capital to implement it as farmers said they don't have money to buy the equipment's.

Farmers from both districts were planning to plant fodders in their boundaries in order to have feeds for their livestock, demarcate their fields and increase crop productivity. This is in line with Eklund (2009) findings which stated that many people in Babati are agro-pastoralists. There are almost as many livestock as people so there is a great need for fodder and pasture for the livestock. In Babati district, farmers planned to make ridges/terraces and practice crop rotation, while in Kongwa and Kiteto farmers plan to use cover crops and double up legume technology. According to Löfstrand (2005a) ridging is a technique that only used to a minor extent in Babati. Ridging is mainly used for some root crops like for example sweet potatoes and cassava. The ridges are mainly done with hand hoes.

4.3 Motivation for adoption of new farming practices

In both districts farmers strongly agreed that natural resource conservation gives them a sense of satisfaction (Figure 6 and B14-B17 in Appendix B). This implied that farmers started to be aware about the importance and advantages of conserving natural resources in their areas. The findings showed that natural resource conservation was a key important factor to be considered with the farmers as it may reduce soil erosion and increase crop yields. Hillbur (2013a) stated that in Sub-Saharan Africa there is an increase of population and rapid urbanization which lead to deterioration of arable land, water and natural resources therefore, there is a need for natural resource conservation.

Also we found that majority of the identified drivers for adoption of new farming practices were highly rated by smallholder farmers (Figure 7 and B18-B21 in Appendix B). This implied that farmers are more autonomous, or self-determined which reflects that the SI practices are accepted or owned as personally important. Farmers in both districts considered that the SI technologies are important for natural resource management and improved land productivity. Moreover, farmers in Babati strongly agreed that soil conservation reduces soil erosion in their fields and incorporating crop residues is important for their land sustainability. This implied that the importance of crop residues for the land sustainability was well known by the farmers and this is the reason for the farmers to incorporate it in their farms. The study conducted by Hoeschle-Zeledon (2015) showed that there is no specific areas allocated for grazing animals in Babati and high competition for grazing results in limited biomass to meet livestock demands most of the year. Hence, instead of incorporating crops residues in their farm was used as the main feed resource for animals especially during the dry season. Moreover, through soil conservation techniques such as practising fanya juu fanya chini (contour bunds), planting of trees and making ridges farmers were able to minimize the adverse effects of soil erosion in their areas.

On the other hand, farmers in Kongwa & Kiteto stated that SI was important for their household food security. This is because, in Kongwa & Kiteto farmers are challenged by unpredictable weather and drought hence, sometimes they experienced crop failure. But, since they started to practice SI technologies crop failure risk was minimized. Also, they attained produce from more than one crops especially when they practice intercropping and double up legume technology. Keeping animals such as cattle and local chicken further help them to have household food security. Smallholder farmers in Babati stated that SI is necessary for sustainable production, while in Kongwa & Kiteto minimal profit each year than a risk investment was an integrated driver towards adoption of new farming practices (Figure 8 and B22-B25 in

Appendix B). Pretty et al. (2011) revealed that sustainable production would thus avoid the unnecessary use of external inputs, utilize crop varieties and livestock breeds with a high ratio of productivity to use of externally and internally derived inputs, minimize the use of technologies or practices that have adverse impacts on the environment and human health and harness agro-ecological processes such as nutrient cycling and biological nitrogen fixation etc.

As shown by the results of this study, farmers in Babati are more driven by internal factors than Kongwa & Kiteto (Figure 9 and B26-B29 in Appendix B). Although in both districts farmers highly rated that 'protecting environment is important to them', 'attached to the land that is why they want to improve it' and 'they find SI technologies to be personally rewarding'. Smallholder farmers stated to be intrinsically motivated to practice SI technologies because they enjoy doing so and consider the skills encouraged by the activity to be valuable to them. Ryan and Deci (2000a) indicated that whenever people were intrinsically motivated they felt competence and positive coping. In this study intrinsic motivation were the most important reasons that motivate farmers to practice SI technologies and the majority of farmers rated intrinsic drivers higher than extrinsic drivers. However, it is important to note that extrinsic motivations were also a contributing factor towards adoption of new farming practices. Farmers in both districts indicated that economics drives most of their farming decisions, adopting SI technologies with quick pay back and there is no room for non-economic motives in farming (Figure 5 and B10-B13 in Appendix B). In distinction, farmers in Babati stated that they planted pigeon pea because the crops rewards in terms of price. The study shows that economic factor has high influence in their farming decisions. Farmer emphasis on only economic benefits can lead to choice of short term benefit technologies that might have negative impacts in the long run. Inadequate considerations of the various benefits in interventions for promotion of new technologies could affect perception and hence choice of technologies farming practices. Most of the farmers seek for technologies that are cost effective and quick pay back. Similarly, Arellanes and Lee (2003) found that economic are most likely to significantly influence adoption behaviour of the farmers.

Based on SDT, the study showed that farmers from both districts highly valued cooperation with neighbours for successful soil and water conservation work (Figure 10 and B30-B33 in Appendix B). Through cooperation with other farmers, they gained knowledge and skills that might help them to practice SI technologies without any problems. Also, the project and government allowed the community to choose the type of technology to adopt in the community or individual farm. Kessler (2007) pointed out that in order for the development to occur, the power must be within the people. Also it is required to have ownership and the representation in decision-making bodies. However, during FGDs we found that this is the challenge for farmers specifically among the villages in Kongwa & Kiteto, where farmers argued that, they were not involved in project decisions. For instance, during conducting field work, whereby project implementers mostly use extension worker and lead farmers without involving the rest of the farmers. Therefore, it was difficult for farmers to adopt new farming practices even if they saw trial plots. Moreover, farmers were given improved seeds late and the implementers of the project told them to plant it in their fields even if it was late season. This discouraged farmers a lot as some of them they took initiative to plant it and experienced crop failure and some of them decided not to plant it. Meijer et al. (2015) found that availability of incentives (improved seeds, fertilizers) may incentivise farmers to participate in the project even if were not motivated to practice certain SI technologies. Moreover, farmers in Babati have skills and knowledge on soil and water conservation. Knowledge and skills help farmers to try certain SI technologies in their fields. Similar studies of Ryan and Deci (2000a) found that students will more likely to adopt and internalize a goal if they understand it and have the relevant skills to succeed it. Apart from this study, Meijer et al. (2015) found that the potential of successful and sustained adoption will increase when smallholder farmers acquired knowledge and skill and they are able to adapt the new technology themselves.

4.4 Perceived benefits and barriers for adoption

4.4.1: Perceived benefits of SI technologies

Smallholder farmers in both districts were highly convinced with the benefits of SI technologies (Figure 11 and B34-B37 in Appendix B). In both districts, farmers were convinced that SI technologies are used to identify field boundaries. Therefore, farmers planted multipurpose trees such as *Gliricidia sepium*, *Gliveria spp* and grasses such as Napier grass in the field boundaries and sometimes they incorporate these trees in the maize fields as might increase maize productivity. It is not only about identification of field boundaries, farmers' also attained fodder, green manure and cover crop. Our findings concur with a study conducted by Löfstrand (2005a) that trees along the field can mark the boundary, reducing the risk of others claiming the right to the land. Also the author pointed out that in Babati, farmers' plant trees like *Grevillia robusta, Sesbania sesban, Faidherbia albida* and *Casuarina equisetifolia* along contours and field borders. Moreover, in many villages there are by-laws saying that villagers have to plant a certain amount of trees per year in their land. Likewise, farmers in both districts were convinced that soil and water conservation are the benefits attained from SI technologies. Farmers were encouraged to practice cover crops, fanya juu fanya chini (contour bunds), planting trees and fodder trees on hillsides and making ridges for the purpose of soil and water conservation. These practices help to conserve soil and water hence reduce the risk of crop failure compared to when they did not practice these technologies. Lutz et al. (1994) revealed that soil conservation can often reduce the risk of crop failure by improving moisture retention in dry areas. The author further pointed out that in Haiti's Maissade area, land treated conservation structures i.e. diversion ditches was found to produce an average of 51 percent more corn and 28 percent more sorghum than did plots without conservation structures in 1988 (a year of poorly timed rainfall). Smallholder farmers in both districts also pointed out that SI technologies improve soil quality. Through practising of double up legume technology, intercropping of cereals and legumes and application of manure the soil quality are improved.

Farmers in Babati were highly convinced that SI technologies enhance utilization of crop residues. The importance of crop residues to the farmers are well known nowadays, and farmers started to leave crop residues on their farm in order to improve soil fertility, instead of feeding their animals. However, farmers are still challenged with the management of crop residues left in the field as livestock keepers enter their animals to graze in the fields after harvest. Our findings differ with Löfstrand (2005a) who reported that farmers in Babati usually used crop residues as fodder for livestock and not left in the fields. Although the author pointed out that practice of leaving crop residues in the field is becoming more common in the area, but there is still a demand for residues as fodder. Similarly, Vanlauwe et al. (2014) noted that in many smallholder farming systems in Sub-Saharan Africa (SSA), there are competing demands on available crop residues, especially for livestock feeds. Removal or little of crop residue left in the fields lead to low crop yields (Vanlauwe et al., 2014). Moreover, farmers in Babati convinced that SI technologies improve soil fertility. Through incorporation of manure, utilization of crop residues, practice intercropping of cereals and legumes and double up legume technology in their fields the crop yields increased than before as the soil become fertile. However, Löfstrand (2005a) found that in Babati application of manure and other fertilisers is low leading to depletion of the soils.

In Kongwa & Kiteto farmers were convinced that practising SI technologies help them to increase income from agricultural production and mitigate effects of climate change. Farmers integrated cereals and legumes in the same piece of land. Integrating cereal with legumes aim to reduce unnecessary cost of inputs and weed control and therefore farmers earn higher net return. Also animals kept for milk, meat and manure production help farmers to earn income from it. Pretty et al. (2011) stated that farmers need to see for themselves that added complexity and increased efforts can result in substantial net benefits to productivity, but they also need to be assured that increasing production actually leads to increase in income. In addition, farmers were convinced that SI technologies mitigate the effects of climate change and improve water holding capacity. Farmers planted trees in their fields as a result stimulate rainfall in the area, also they practice fanya juu fanya chini (contour bunds) technique in order to conserve soil moisture. In addition, farmers used drought resistant seeds and early maturity to mitigate the effects of climate change. This is similar to Hillbur (2013b), who found that farmers in Kongwa & Kiteto were encouraged to use improved drought-tolerant varieties to overcome dry periods.

4.4.2: Barriers to adoption of SI technologies

Most of farmers stated that improved practices or adopting new technologies is costly and the initial capital required to establish or implement such practices is high compared to conventional methods (Figure 12 and B38-B41 in Appendix B). Examples of costly SI technologies are the use of improved seeds, inorganic fertilizer, PICS bags and cultivate fields by using tractor or oxen. Therefore, these technologies are available to farmers, but farmers/communities are not ready to change. Several studies have investigated the constraints of SI technologies. The work of Feder et al. (1985) shows that capital in the form of either accumulated savings or access to the capital markets is required to finance many new agricultural technologies (fertilizer, pesticides applications and improved seeds). Feder et al. (1985) also pointed out that using of tractor or other machinery requires a large initial invest. However, Kassie et al. (2012) found that wealthier households are better able to bear possible risks associated with adoption of practices and may be more able to finance purchase of inputs, such as fertilizer and improved seeds. This study also indicates that practices being time consuming is another often-mentioned barrier affecting farmers' decisions about adoption of new SI technologies. Some new farming practices are time consuming and need labour for adoption/implementation. For example, fanya juu fanya chini (contour bunds), and making ridges/terraces generally require more time and labour inputs, so labour shortages may prevent adoption. Smallholder farmers in Babati also fear of trying something new because they worry about the high costs and time. Also, they are afraid that they will not gain high yield due to weather changes. Kassie et al. (2013) found similar result in Tanzania where farmers avoid risks by using traditional varieties, instead of investing in expensive inputs in the presence of shocks and the absence of reliable insurance mechanisms.

Although the research has reached its aims, there were some unavoidable limitations. Data collection went well however, sometimes farmers have their own schedule which researchers were supposed to accommodate and make adjustments to their programs without making the farmers feel pushed into their own programs. The distribution of sample size between the district, farm type and in different villages was not equal (Table 4). The sample size in Babati was higher than Kongwa & Kiteto. Also number of farmers from some of the villages differ. For example, Shaurimoyo village in Babati district have higher number of respondents than other villages. Moreover, The sample size of farm types largely differ. Subsistence farmer in both districts have smaller number than farmers with a combined subsistence and commercial. Thus farmers with a combined subsistence and commercial might dominate the results when the analysis targeted all the sample group. We suggest the farm types size equally for the next survey. Moreover, some of the SI technologies used and planned use were not listed in the survey questionnaire which affects the end results of analysis when the researcher didn't ask the farmers about other SI technologies they practiced apart from what it was written. We suggest to take into account for the next survey.

Kruskal-Wallis test was used to compare the distributions of scores between farm type and in different villages for research questions 1 & 2. Stacked bar graphs was also used to show the differences in farmers' responses between the districts, farm type and villages. Due to having results from both methods, the results from stacked bar graphs was more likely used on discussing the findings because majority of the statements which showed statistically significant differences in Kruskal-Wallis test got lower responses on stacked bar graphs. We suggested that it is better to use stacked bar graphs in order to visualize the responses attained in Likert scale data.

It was expected that knowledge and input availability limits implementation of sustainable agronomic practices to the smallholder farmers. We found that knowledge is not among the constraints towards SI technologies adoption. Input availability showed to be challenge to the farmers especially when farmers supposed to buy improved seeds and PICS bags. Moreover, mostly of the findings for this study were unexpected as it was expected that farmers would be extrinsic motivated than intrinsic motivation. We found that farmers are intrinsically motivated to adopt sustainable intensification technologies.

5. Conclusion

In order to tackle low crop productivity and yield in a sustainable way it is important to think about motivations of smallholder farmers to adopt sustainable intensification practices. Various technologies have been introduced to the farmers. However, the degree of adoption differs between technologies. The study investigated smallholder farmers' motivations for adopting sustainable intensification in Babati and Kongwa & Kiteto districts of Tanzania. There was no major difference in SI technologies currently used between farm types and in different villages in both districts. Smallholder farmers mostly practice intercropping, improved seeds and manure. Also farmers are stated to be intrinsically motivated to practice such SI technologies. However, it is important to note that extrinsic (economic) motivations were also a contributing factor towards adoption of SI practices. Economic implications are supposed to be taken into account when trying to look on the drivers that motivate farmers to adopt new farming practices.

Smallholder farmers in both districts attained various benefits from SI technologies such as demarcation of fields, improved soil quality, soil and water conservation. Perceptions of farmers towards adoption of SI technologies differ from one district to another. Farmers in Babati convinced that SI technologies enhance utilization of crop residues which results in improved soil fertility, while farmers in Kongwa & Kiteto convinced that practising SI technologies mitigate effects of climate change and increase their income from agricultural production. Despite the stated success of SI, smallholder farmers may be resistant to adoption of new farming practices. Some of the factors limiting adoption of new technologies are high cost of implementation of new technologies, time-consuming nature, labour intensiveness and fear of trying something new.

This study demonstrated that interventions by policy makers, researchers and extension workers to address farmer needs should consider farmers motivations towards adoption of SI technologies. Therefore, farmers should be involve in promoting the implementation of SI technologies, this will make adoption of technology more likely. Moreover, the study suggests that the formulation of sustainable agriculture policies and programs at the national level should be guided by a better understanding of the motivations of farmers so as to be able to tailor and bundle incentives for maximum effectiveness and efficiency. This research propose further investigation on what should be done to tackle the barriers highlighted in this study such as economic, time-consuming and labour intensiveness and how to design mechanisms that will provide farmers in Babati and Kongwa & Kiteto with the economic incentives to adopt more SI technologies.

References

ALAVALAPATI, J., LUCKERT, M. & GILL, D. 1995. Adoption of agroforestry practices: a case study from Andhra Pradesh, India. *Agroforestry Systems,* 32**,** 1-14.

ARELLANES, P. & LEE, D. R. The determinants of adoption of sustainable agriculture technologies: evidence from the hillsides of Honduras. Proceedings of the 25th International Conference of Agricultural Economists (IAAE), 2003. Citeseer, 22.

AUDU, V. I. & AYE, G. C. 2014. The effects of improved maize technology on household welfare in Buruku, Benue State, Nigeria. *Cogent Economics & Finance,* 2**,** 960592.

BEKUNDA, M. 2012. Research in Sustainable Intensification in the sub-humid maize-based cropping systems of Babati.

BROWN, J. D. 2011. Likert items and scales of measurement. *Shiken: JALT Testing & Evaluation SIG Newsletter,* 1**,** 10-14.

CHARLES, A., AZZARRI, C., HAILE, B., COMANESCU, M., ROBERTS, C. & SIGNORELLI, S. 2016. *Africa RISING Baseline Evaluation Survey (ARBES) report for Tanzania*, Intl Food Policy Res Inst.

CHIRKOV, V., RYAN, R. M., KIM, Y. & KAPLAN, U. 2003. Differentiating autonomy from individualism and independence: a self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of personality and social psychology,* 84**,** 97.

EDWARDS, C. A. 1987. The concept of integrated systems in lower input/sustainable agriculture. *American Journal of Alternative Agriculture,* 2**,** 148-152.

EKLUND, J. 2009. Agroforestry as a tool toward sustainable development in Babati district.

FEDER, G., JUST, R. E. & ZILBERMAN, D. 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic development and cultural change,* 33**,** 255-298.

FIELD, A. 2013. *Discovering statistics using IBM SPSS statistics*, Sage.

GAGNÉ, M. & DECI, E. L. 2005. Self-determination theory and work motivation. *Journal of Organizational behavior,* 26**,** 331-362.

GREINER, R., PATTERSON, L. & MILLER, O. 2009. Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural systems,* 99**,** 86-104.

HERRERO, M., THORNTON, P. K., NOTENBAERT, A. M., WOOD, S., MSANGI, S., FREEMAN, H., BOSSIO, D., DIXON, J., PETERS, M. & STEEG, J. 2010. Smart investments in sustainable food production: revisiting mixed crop-livestock systems.

HILLBUR, P. 2013a. The Africa RISING research sites in Tanzania: Opportunities and challenges to sustainable intensification and institutional innovation.

HILLBUR, P. 2013b. Research on institutional innovation and scaling issues in Africa RISING.

HOBBS, P. R., SAYRE, K. & GUPTA, R. 2008. The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society of London B: Biological Sciences,* 363**,** 543-555.

HOESCHLE-ZELEDON, I. 2015. Africa Research in Sustainable Intensification for the Next Generation: Sustainable intensification of key farming systems in East and Southern Africa—Technical Report, 1 October 2014 to 31 March 2015.

Jason.bryer.org. (2017). *likert*. [online] Available at: http://jason.bryer.org/likert/ [Accessed 20 Jan. 2017].

KASSIE, M., JALETA, M., SHIFERAW, B., MMBANDO, F. & MEKURIA, M. 2012. Interdependence in farmer technology adoption decisions in smallholder systems: Joint estimation of investments in sustainable agricultural practices in rural Tanzania. *Foz do Iguaçu, Brazil***,** 18-24.

KASSIE, M., JALETA, M., SHIFERAW, B., MMBANDO, F. & MEKURIA, M. 2013. Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological forecasting and social change,* 80**,** 525-540.

KESSLER, C. 2007. Motivating farmers for soil and water conservation: A promising strategy from the Bolivian mountain valleys. *Land Use Policy,* 24**,** 118-128.

KIMARO, A. A., WELDESEMAYAT, S. G., MPANDA, M., SWAI, E., KAYEYE, H., NYOKA, B. I., MAJULE, A. E., PERFECT, J. & KUNDHLANDE, G. 2012. Evidence-based scaling-up of evergreen agriculture for increasing crop productivity, fodder supply and resilience of the maize-mixed and agro-pastoral farming systems in Tanzania and Malawi.

KNOWLER, D. & BRADSHAW, B. 2007. Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food policy,* 32**,** 25-48.

LÖFSTRAND, F. 2005a. *Conservation agriculture in Babati District, Tanzania.* slu.

LÖFSTRAND, F. 2005b. Conservation agriculture in Babati District, Tanzania: impacts of conservation agriculture for small-scale farmers and methods for increasing soil fertility.

LUTZ, E., PAGIOLA, S. & REICHE, C. 1994. THE COSTS AND BENEFITS OF SOIL CONSERVATION: THE FARMERS'VIEWPOINT. *The World Bank Research Observer,* 9**,** 273-295.

MARENYA, P. P. & BARRETT, C. B. 2007. Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya. *Food Policy,* 32**,** 515-536.

MAZVIMAVI, K. & TWOMLOW, S. 2009. Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural systems,* 101**,** 20-29.

MEIJER, S. S., CATACUTAN, D., AJAYI, O. C., SILESHI, G. W. & NIEUWENHUIS, M. 2015. The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International Journal of Agricultural Sustainability,* 13**,** 40-54.

MERCER, D. E. 2004. Adoption of agroforestry innovations in the tropics: a review. *Agroforestry systems,* 61**,** 311-328.

MFC 2012. Agricultural Statistics. *In:* TANZANIA MINISTRY OF AGRICULTURE, F. A. C. (ed.).

MOLLER, A. C., RYAN, R. M. & DECI, E. L. 2006. Self-determination theory and public policy: Improving the quality of consumer decisions without using coercion. *Journal of Public Policy & Marketing,* 25**,** 104-116.

NIVEN, A. G. & MARKLAND, D. 2016. Using self-determination theory to understand motivation for walking: Instrument development and model testing using Bayesian structural equation modelling. *Psychology of Sport and Exercise,* 23**,** 90-100.

NJUGUNA, I. M., NGRSQUO, C. & MAKAL, S. K. 2015. Influence of demographic characteristics on adoption of improved potato varieties by smallholder farmers in Mumberes Division, Baringo County, Kenya. *Journal of Agricultural Extension and Rural Development,* 7**,** 114-121.

NKAMLEU, G. B. & MANYONG, V. M. 2005. Factors affecting the adoption of agroforestry practices by farmers in Cameroon. *Small-scale forest economics, management and policy,* 4**,** 135-148.

NKONYA, E., SCHROEDER, T. & NORMAN, D. 1997. Factors affecting adoption of improved maize seed and fertiliser in northern Tanzania. *Journal of Agricultural Economics,* 48**,** 1-12.

NYANGENA, W. 2008. Social determinants of soil and water conservation in rural Kenya. *Environment, Development and Sustainability,* 10**,** 745-767.

OKORI, P. 2014. Report of the Kongwa Kiteto action sites innovation platform launch.

PERRET, S. R. & STEVENS, J. B. 2006. Socio-economic reasons for the low adoption of water conservation technologies by smallholder farmers in southern Africa: a review of the literature. *Development Southern Africa,* 23**,** 461-476.

PRETTY, J. 2008. Agricultural sustainability: concepts, principles and evidence. *Philosophical Transactions of the Royal Society of London B: Biological Sciences,* 363**,** 447-465.

PRETTY, J., TOULMIN, C. & WILLIAMS, S. 2011. Sustainable intensification in African agriculture. *International journal of agricultural sustainability,* 9**,** 5-24.

PRETTY, J. N., MORISON, J. I. & HINE, R. E. 2003. Reducing food poverty by increasing agricultural sustainability in developing countries. *Agriculture, ecosystems & environment,* 95**,** 217-234.

PRETTY, J. N., NOBLE, A. D., BOSSIO, D., DIXON, J., HINE, R. E., PENNING DE VRIES, F. W. & MORISON, J. I. 2006. Resource-conserving agriculture increases yields in developing countries. *Environmental science & technology,* 40**,** 1114-1119.

PRETTY, J. N., WILLIAMS, S. & TOULMIN, C. 2012. *Sustainable intensification: increasing productivity in African food and agricultural systems*, Routledge.

RYAN, R. M. & DECI, E. L. 2000a. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology,* 25**,** 54-67.

RYAN, R. M. & DECI, E. L. 2000b. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist,* 55**,** 68.

SAID, S. 2006. Irrigation in Africa: Water conflicts between large-scale and small-scale farmers in Tanzania, Kiru Valley.

SEGERBÄCK, A. 2009. Pest Management: A case study from Babati District, Tanzania.

SHETTO, R. & OWENYA, M. 2007. *Conservation agriculture as practised in Tanzania: three case studies: Arumeru district, Karatu district, Mbeya district*, ACT, FAO, CIRAD, RELMA.

SHIFERAW, B. A., OKELLO, J. & REDDY, R. V. 2009. Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. *Environment, development and sustainability,* 11**,** 601-619.

SULEIMAN, R. A. & KURT, R. A. Current maize production, postharvest losses and the risk of mycotoxins contamination in Tanzania. 2015 ASABE Annual International Meeting, 2015. American Society of Agricultural and Biological Engineers, 1.

TANZANIA, N. 2012. Population and housing census: population distribution by administrative areas. *Ministry of Finance, Dar es Salaam*.

THIERFELDER, C. & WALL, P. C. 2011. Reducing the risk of crop failure for smallholder farmers in Africa through the adoption of conservation agriculture. *Innovations as key to the green revolution in Africa.* Springer.

TIMLER, C., MICHALSCHECK, M., KLAPWIJK, C., MASHINGAIDZE, N., OLLENBURGER, M., FALCONNIER, G., KUIVANEN, K., DESCHEEMAEKER, K. & GROOT, J. 2014. Characterization of farming systems in Africa RISING intervention sites in Malawi, Tanzania, Ghana and Mali.

UAIENE, R. N., ARNDT, C. & MASTERS, W. 2009. Determinants of agricultural technology adoption in Mozambique. *Discussion papers***,** 1-29.

VANLAUWE, B., WENDT, J., GILLER, K., CORBEELS, M., GERARD, B. & NOLTE, C. 2014. A fourth principle is required to define conservation agriculture in sub-Saharan Africa: the appropriate use of fertilizer to enhance crop productivity. *Field Crops Research,* 155**,** 10-13.

WOLTER, D. 2008. Tanzania–Why a Potential Food Exporter is still Importing Food. *OECD Development Centre, Paris. www. oecd. org. Site visited on,* 2**,** 2014.

Appendix A – Tables

Table A1: Currently improved traditional technologies and tillage systems practiced between villages in Babati district

Improved traditional technologies	Shaurimoyo	Matufa	Hallu	Seloto	Sabilo	Long
Storage of crops produce by using storage huts, wood and cow dung	-	-	✓	✓	✓	-
Harvesting crops and pilling up one place then carrying it by using cart	-	-	-	✓	-	-
Euphorbia tirucali, Gmelina indica trees and sisal used to make cow sheds and farm boundaries	✓ *	-	-	-	✓	✓
Treatment of animals with indigenous medicine	-	-	-	-	✓	-
Planting fodders for animals (elephant grass)	-	-	-	-	-	✓
Crop residues left in the farm for soil fertility	-	-	-	-	-	✓
Storage of produce by using tree warehouse which take 10-20 bags	-	-	-	-	-	✓
Reduce the number of livestock and not allowed to graze in crops farms	-	✓	-	-	-	-
Planting of trees & conservation of the environment through indigenous trees	✓	-	-	-	-	-
Tillage systems						
The fields are cultivated twice by using tractor or ox. Second time cultivation they follow the tractor/oxen and sow the seeds.	✓	✓ **	✓	✓	✓	✓
Zero tillage	-	✓	-	-	-	-

Note: *Trees used only for farm boundaries **Proper seed rate

Table A2: Currently improved traditional technologies and tillage systems practiced between villages in Kongwa & Kiteto district

Improved traditional technologies	Laikala	Moleti	Mlali	Chitego	Njoro
Euphorbia trees used as farm boundaries and livestock pens	✓	✓	✓	-	-
Proper application of manure	✓	✓	-	-	-
Tillage systems					
Zero tillage	✓	-	-	✓	✓
Planting without tilling/disturbing the soil it's only includes cleaning the field, digging the holes & plant the crops	✓	✓	✓	✓	✓
Farm cultivation using hand hoe, oxen and tractor (planting crops same day by following the oxen/tractor****)	✓	✓	✓	✓	✓

Note: ****Tractor used for farmers who are worthy

Table A3: Currently SI technologies practiced between villages in Babati district

SI technologies	Shaurimoyo	Matufa	Hallu	Seloto	Sabilo	Long
Intercropping (cereals & legumes) e.g. maize-pigeon peas, sorghum-pigeon peas etc.	-	✓	✓	✓	✓	✓
Fertilizer application (manure and industrial)	✓	✓	✓	✓	✓	✓
Terraces/ridges	✓	✓	✓	✓	✓	✓
Use of improved seeds	✓	✓	✓	✓	✓	✓
Agroforestry (Crops, friendly trees – Gliricidia & legume)	-	✓	✓	✓	✓	✓
Fanya juu fanya chini/contour bands	-	✓	✓	✓	✓	✓
Cultivation/planting by using Magoye ripper	✓		-	-	-	-
Crop rotation	-	✓	-	-	-	-
Planting trees surrounding field (Gliricidia, Gliveria)	-	✓	-	✓	✓	✓
Use of measurements (rows & spacing)	✓	✓	✓	✓	✓	✓
Livestock keeping (improved cattle, goats & chickens)	✓	-	✓	-	-	✓
Irrigation	-	✓	-	-	-	-
Use of Purdue Improved Crop Storage (PICS) bags	✓	✓	✓	✓	✓	✓

Table A4: Currently SI technologies practiced between villages in Kongwa & Kiteto district

SI technologies	Laikala	Moleti	Mlali	Chitego	Njoro
Intercropping cereals with legumes ie. maize-pigeon peas, sorghum & pigeon peas, etc.	✓	✓	✓	✓	✓
Proper application of fertilizer (manure)	✓	✓	✓	✓ *	✓
Terraces/ridges	✓	✓	✓	✓	✓
Use of improved seeds	-	✓	✓ **	✓	✓
Agroforestry (Crops, friendly trees – Gliricidia & legume)	✓	✓	✓	-	-
Fanya juu fanya chini/contour bands	✓	✓	✓	✓	-
Cultivation/planting by using Magoye ripper	-	-	✓	-	✓
Crop rotation	-	-	✓	✓	-
Planting trees surrounding the field (Gliricidia, Gliveria)	-	✓	✓	✓	-
Use of measurements (rows & spacing)	✓	✓	✓	✓	✓
Livestock keeping (improved cattle, goats & chickens)	✓	-	✓ ***	-	✓
Drying of groundnuts by using Mandera coke	-	-	✓	-	-

Note: *Industrial fertilizer ** Resistance seeds & early maturity *** Chickens

Appendix B – Figures

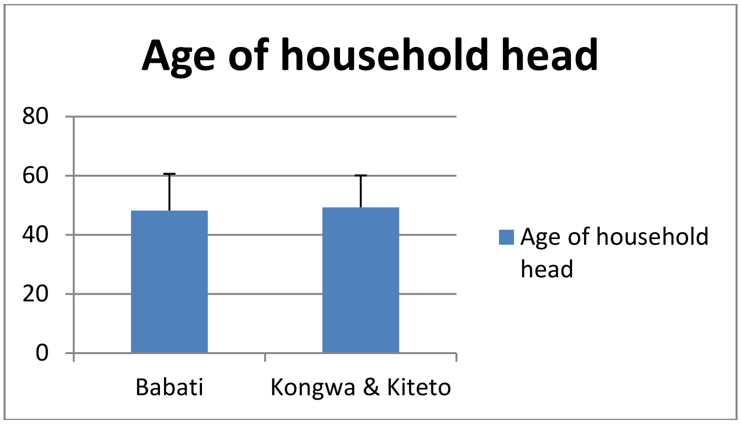

Figure B1: Mean of age of household head in Babati and Kongwa & Kiteto district. Error bar shows standard deviation.

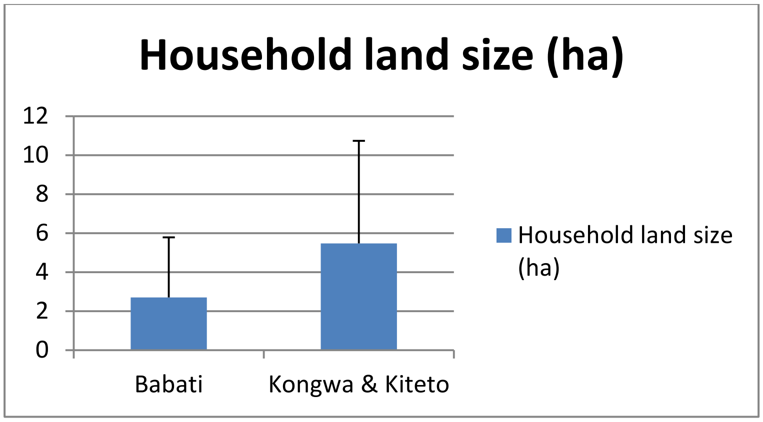

Figure B2: Mean of land size (ha) in Babati and Kongwa & Kiteto district. Error bars show standard deviation.

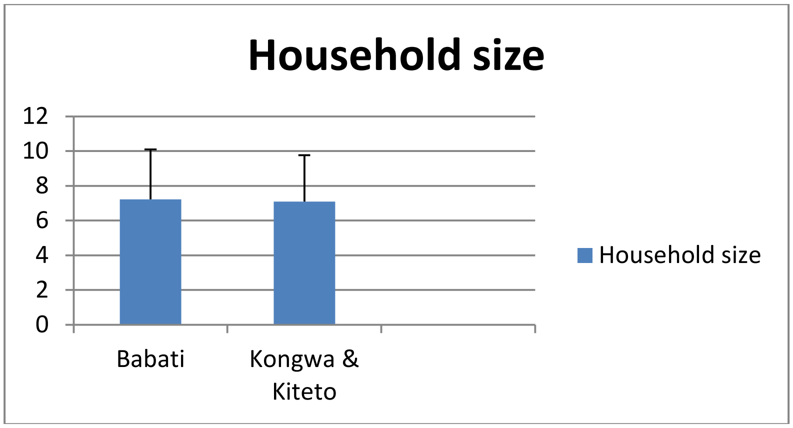

Figure B3: Mean of household size in Babati and Kongwa & Kiteto district. Error bars show standard deviation.

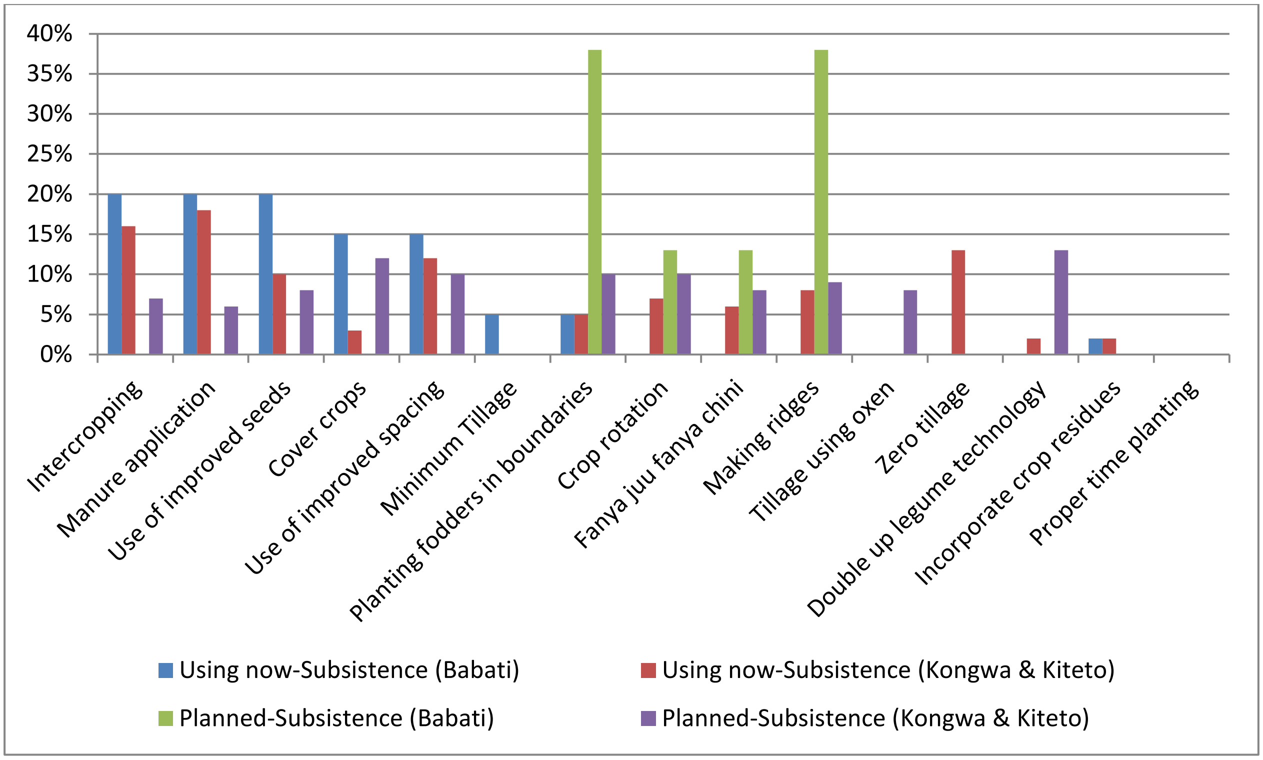

Figure B4: SI technologies used and planned to use by subsistence farmers in Babati, Kongwa & Kiteto district.

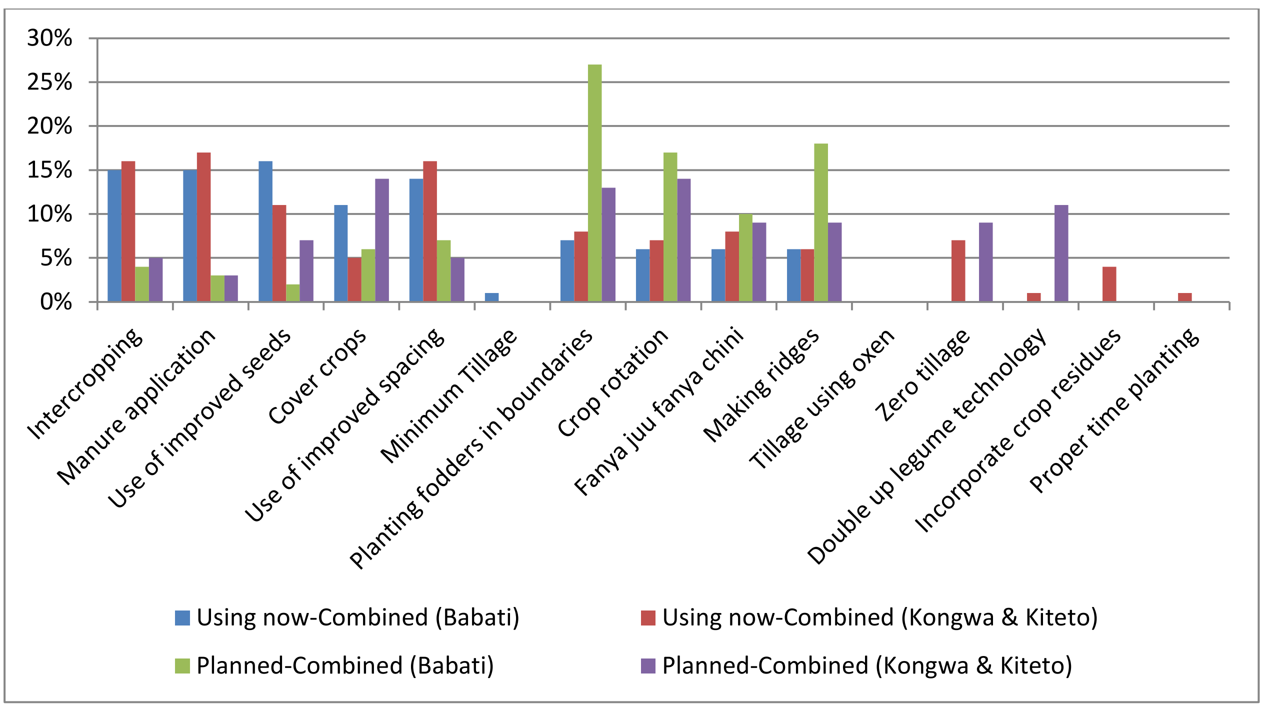

Figure B5: SI technologies used and planned to use by farmers with a combined subsistence and commercial orientation in Babati, Kongwa & Kiteto district.

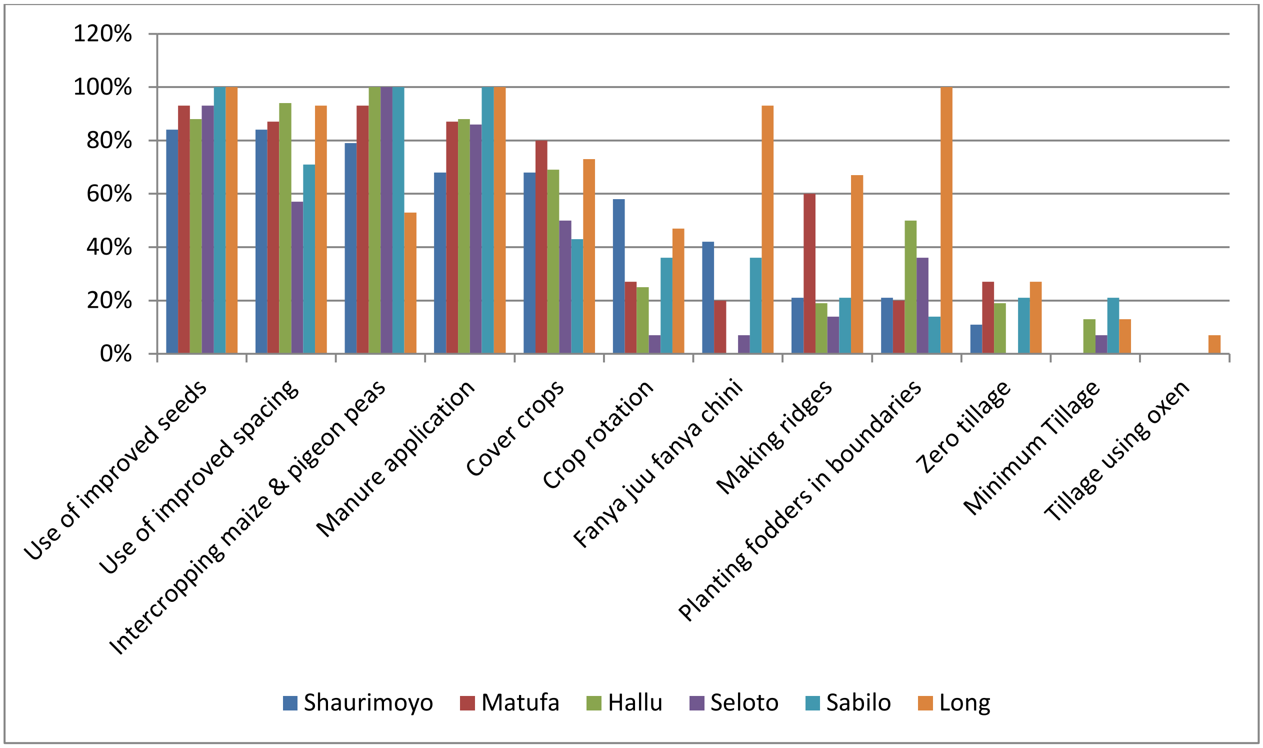

Figure B6: SI technologies which are used by farmers in different villages in Babati district.

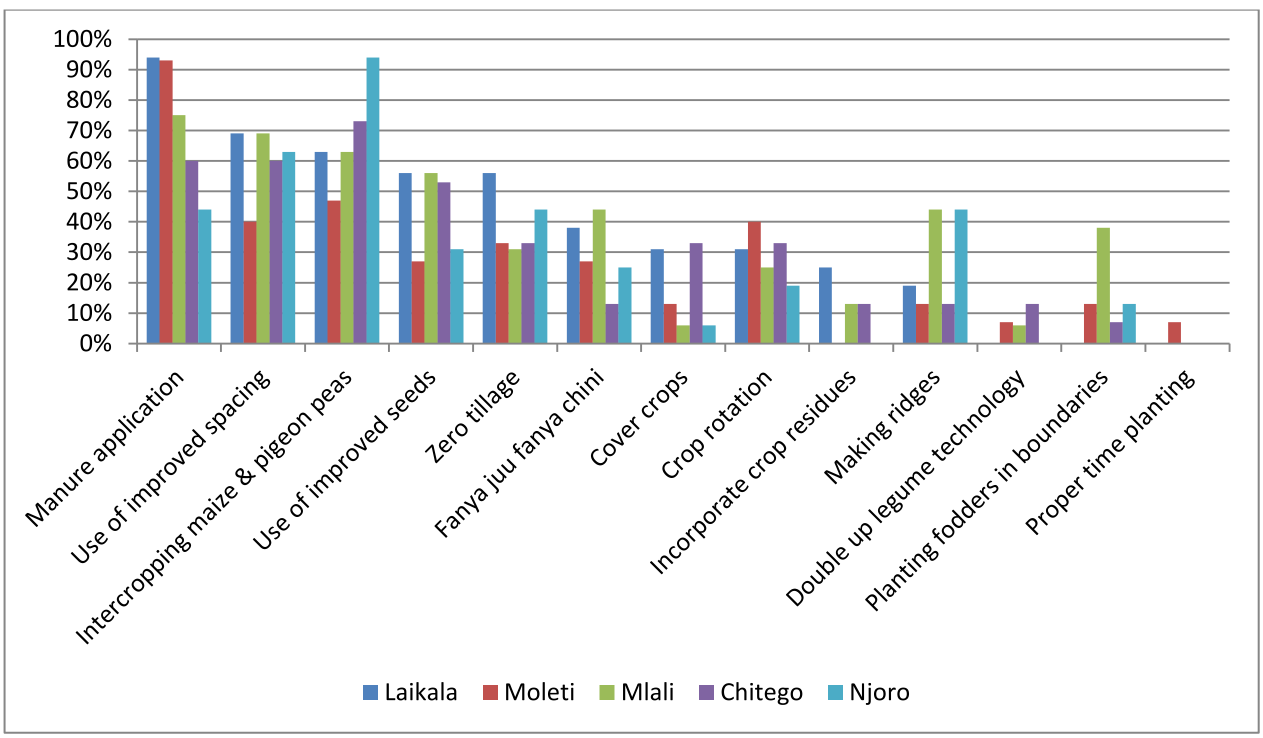

Figure B7: SI technologies which are used by farmers in different villages in Kongwa & Kiteto district.

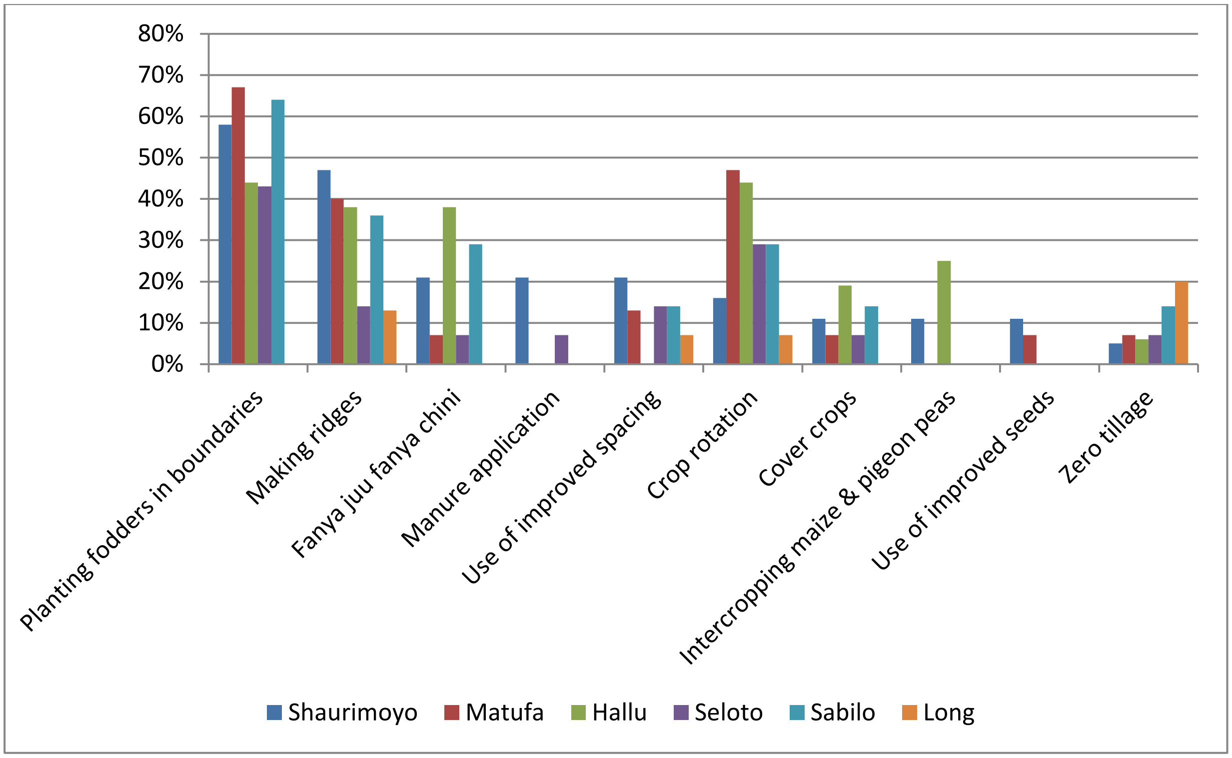

Figure B8: SI technologies which farmers are planned to use in different villages in Babati district.

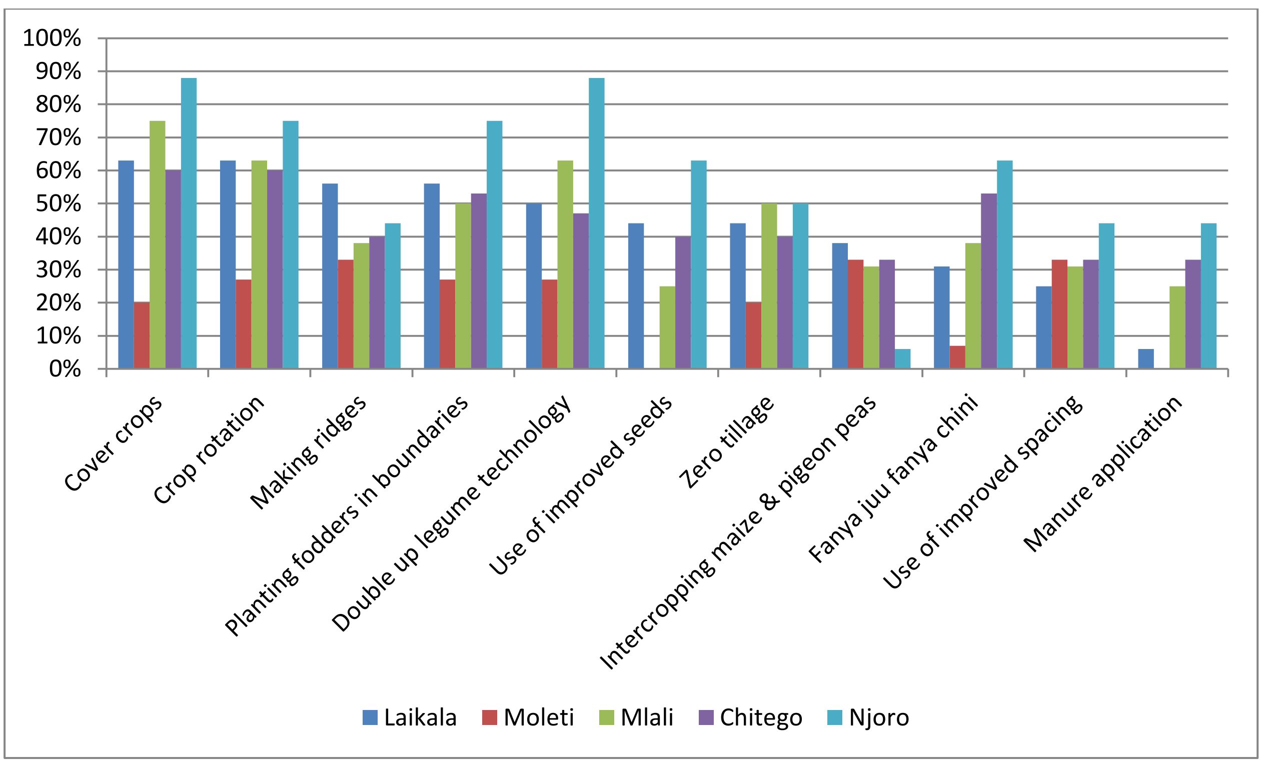

Figure B9: SI technologies which farmers are planned to use in different villages in Kongwa & Kiteto district.

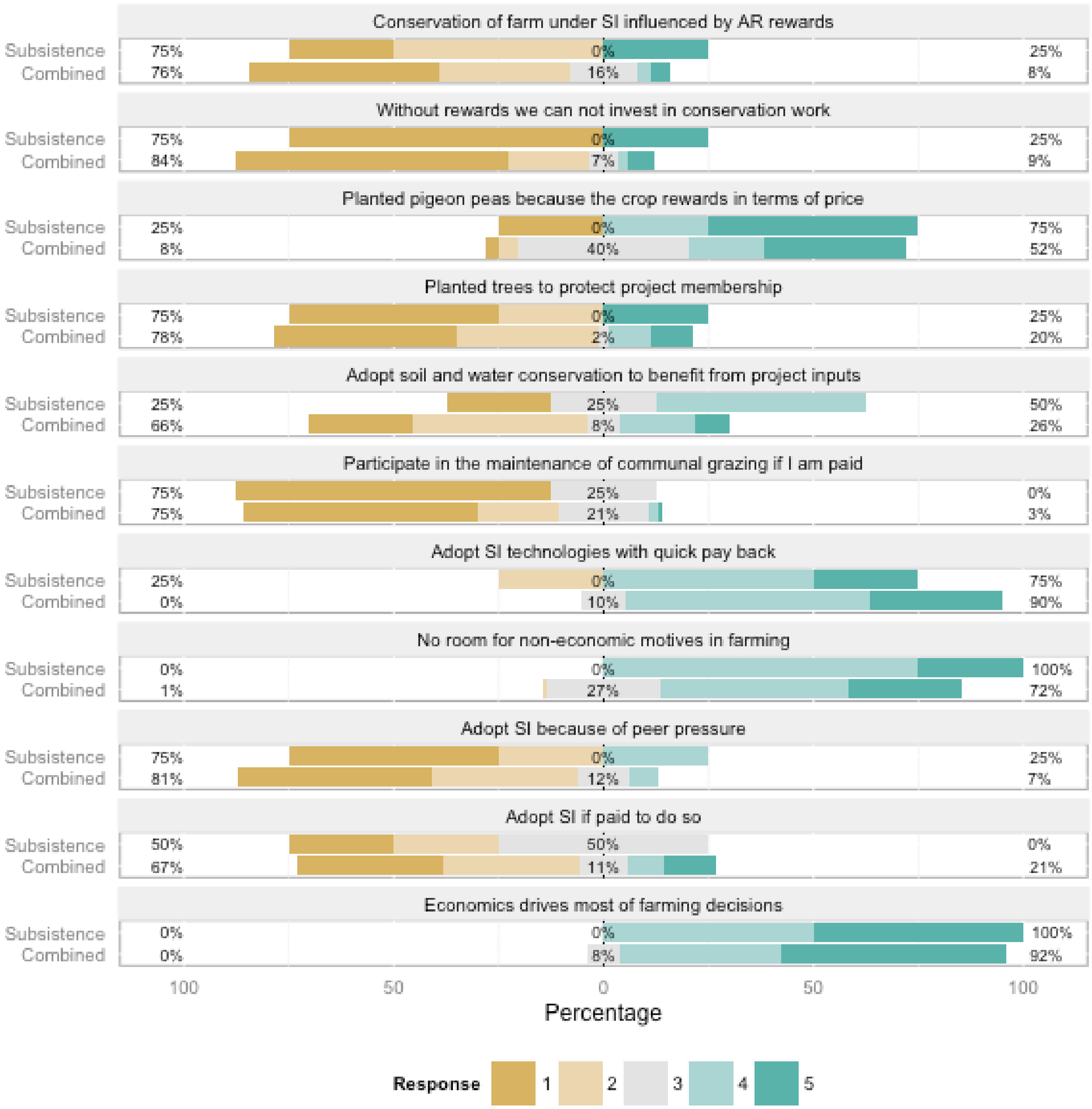

Figure B10: Farmers responses to *External* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

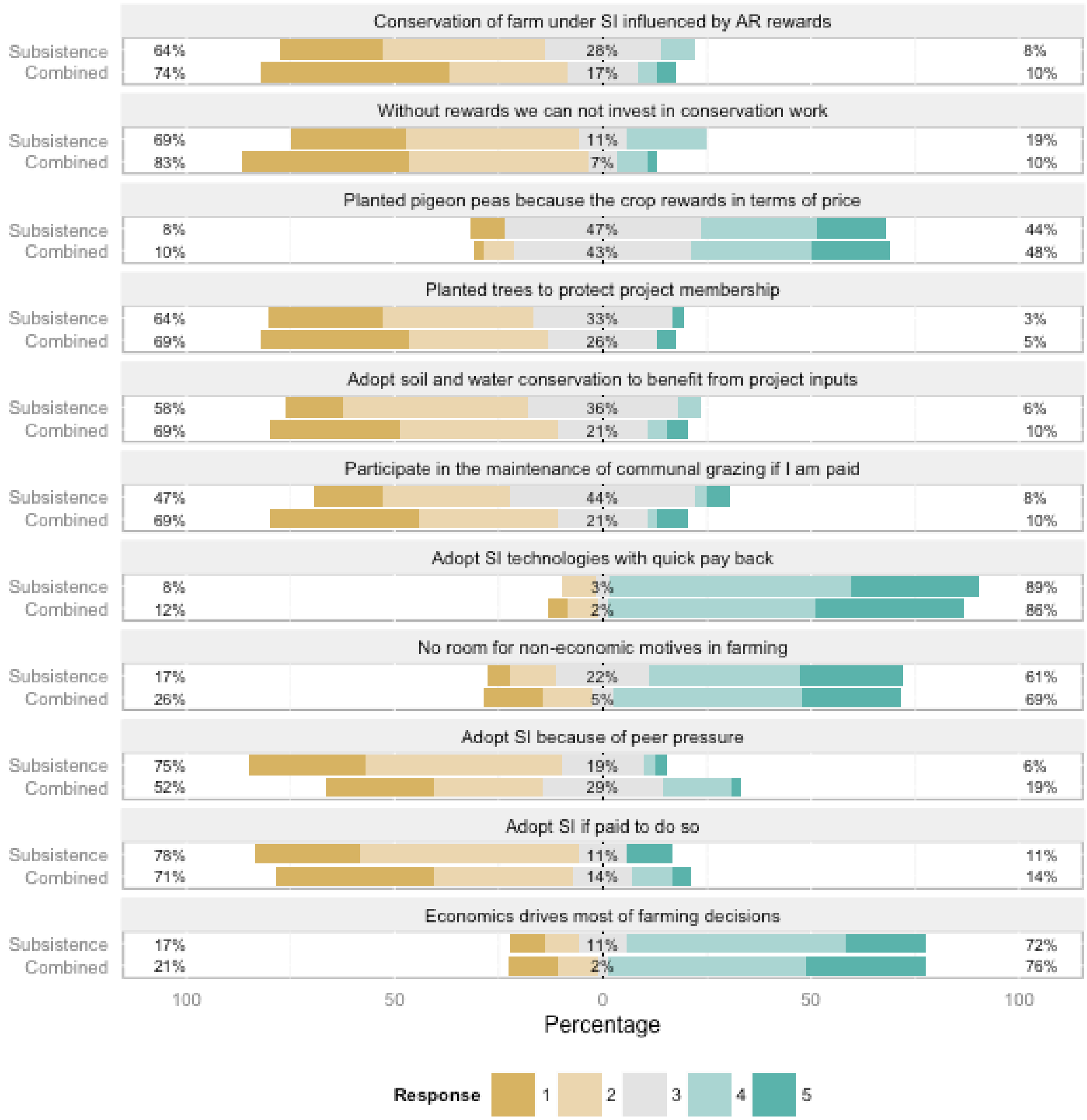

Figure B11: Farmers responses to *External* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

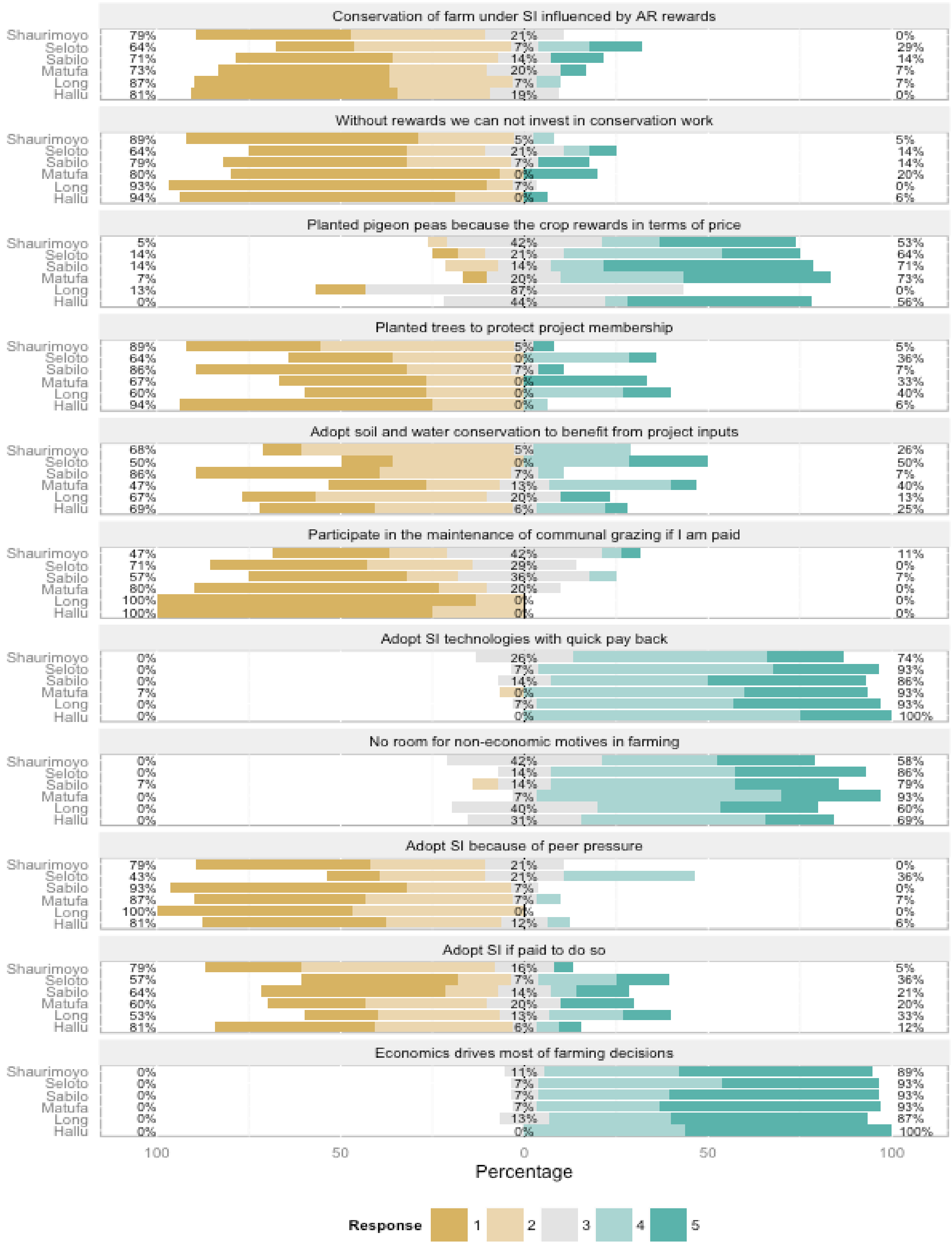

Figure B12: Farmers responses to *External* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

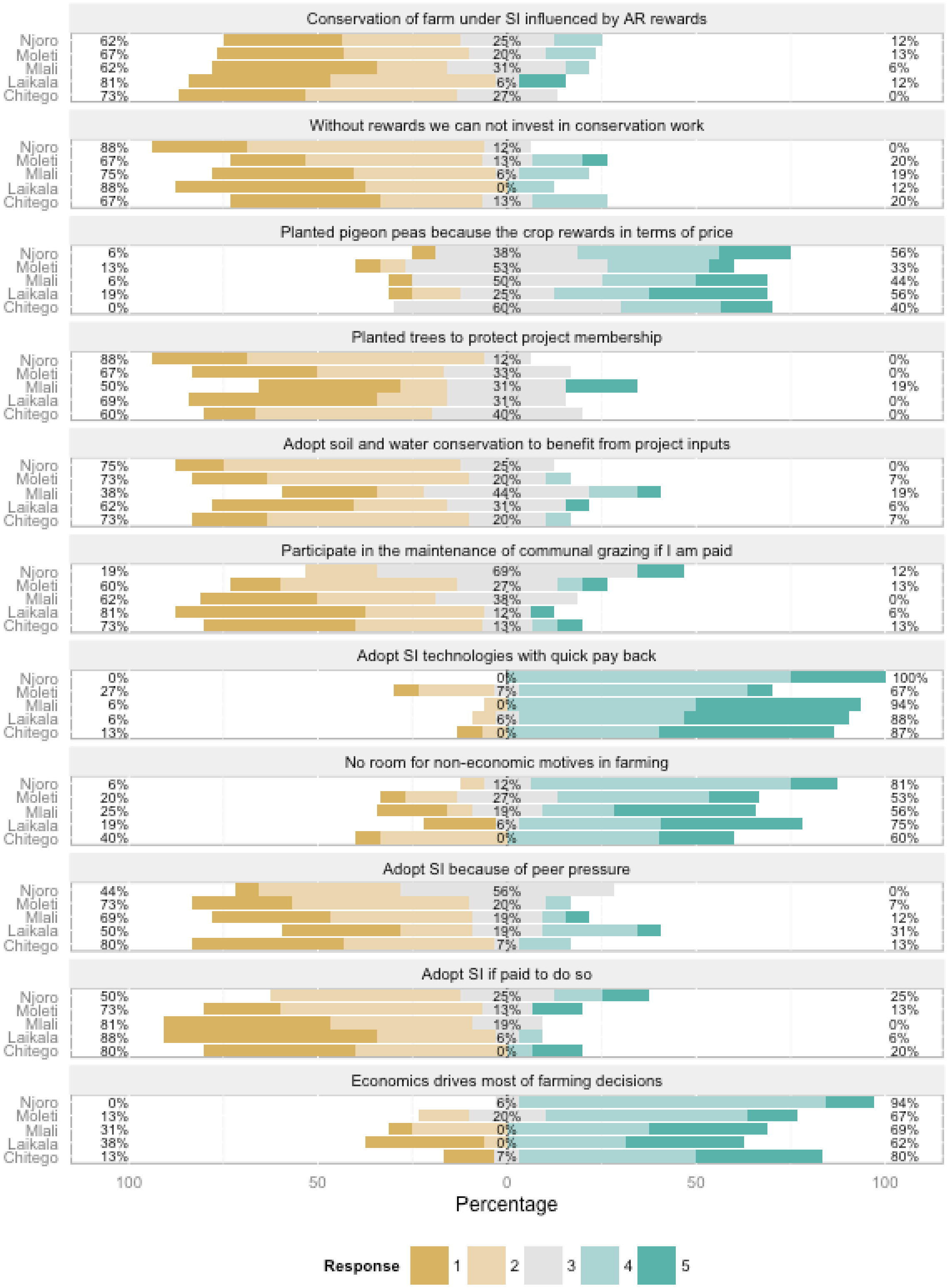

Figure B13: Farmers responses to *External* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

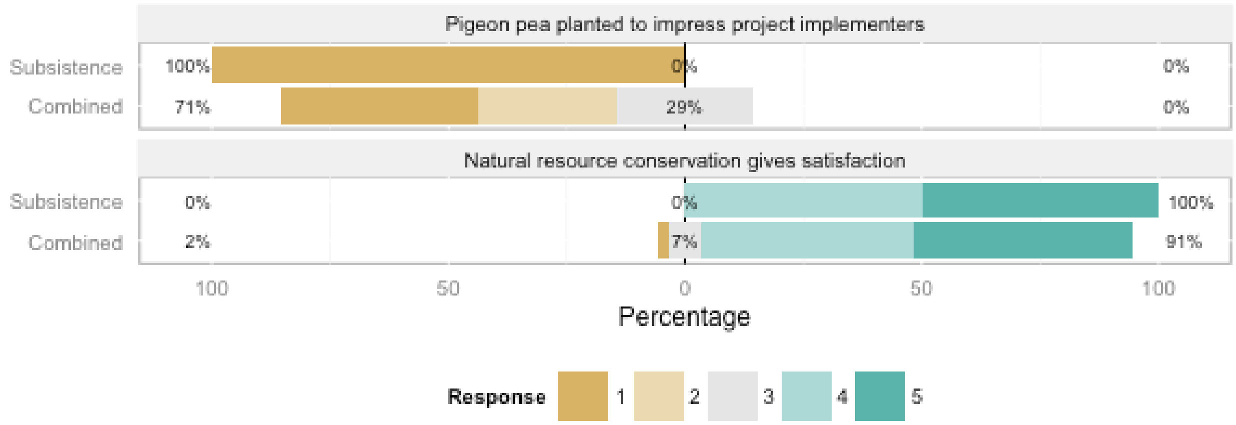

Figure B14: Farmers responses to *Introjected* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

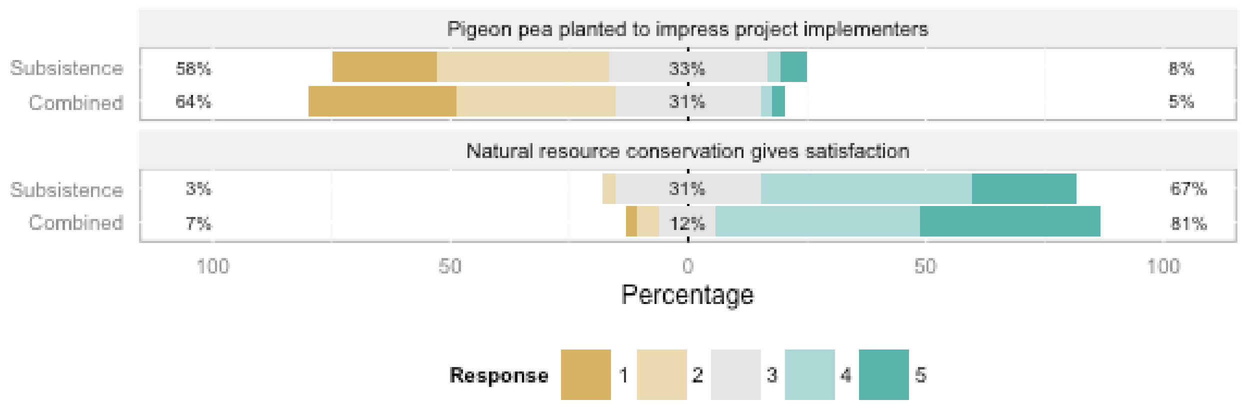

Figure B15: Farmers responses to *Introjected* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

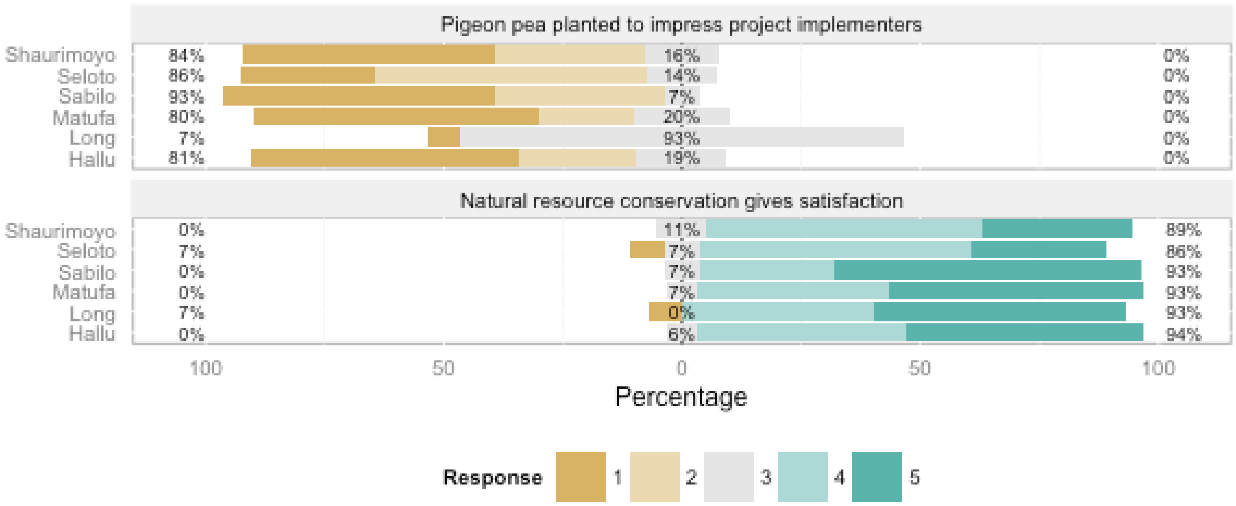

Figure B16: Farmers responses to *Introjected* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

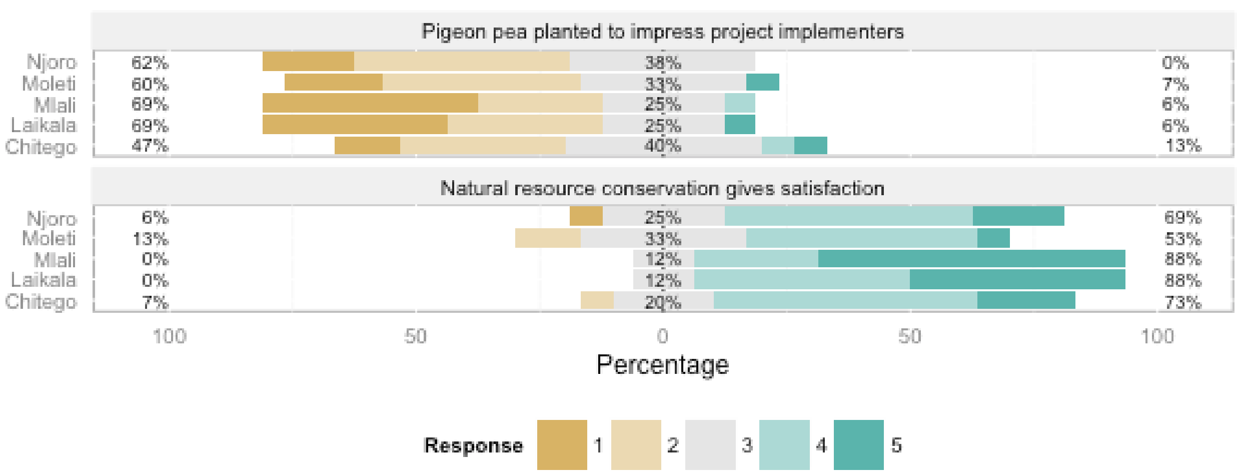

Figure B17: Farmers responses to *Introjected* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

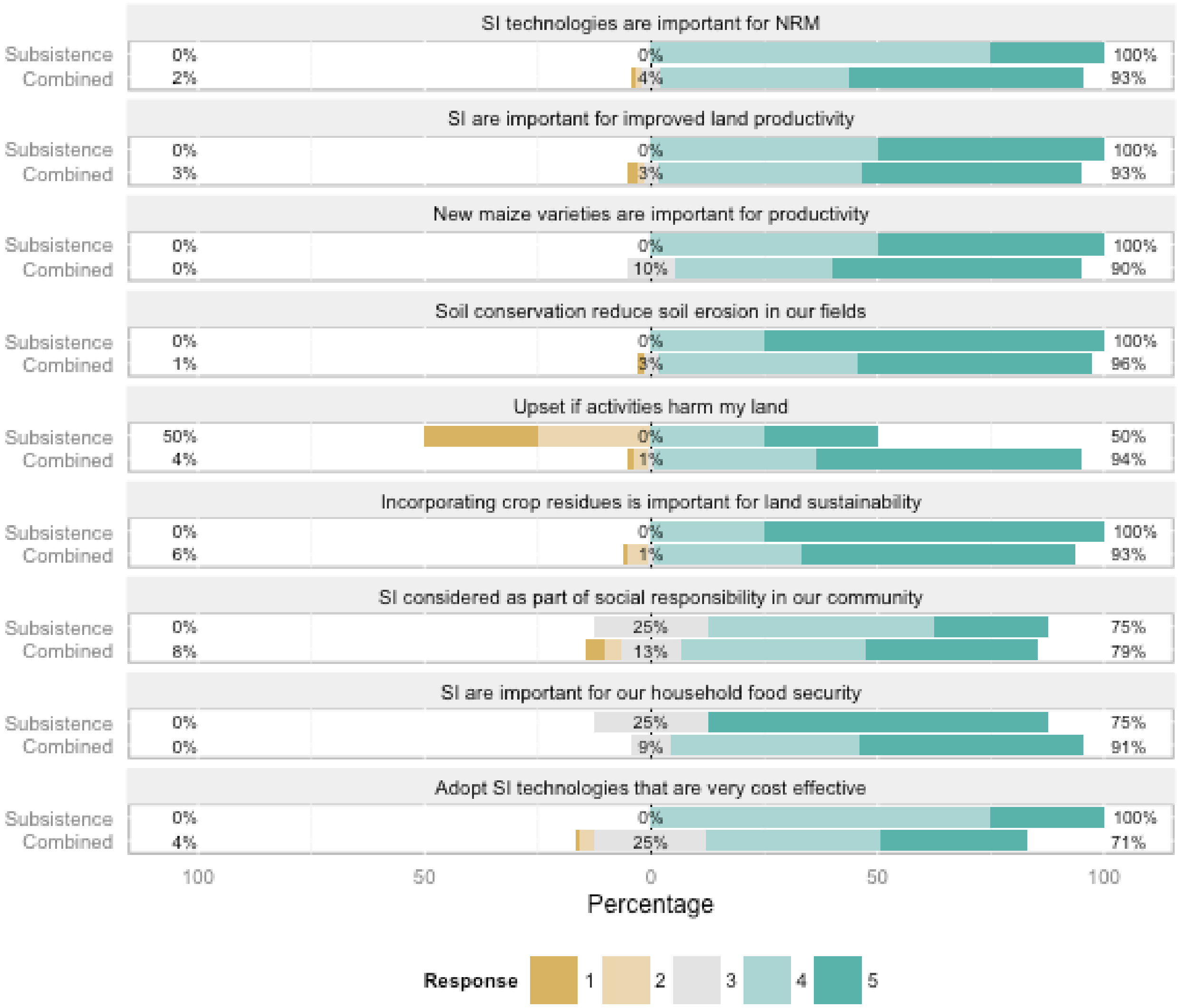

Figure B18: Farmers responses to *Identified* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

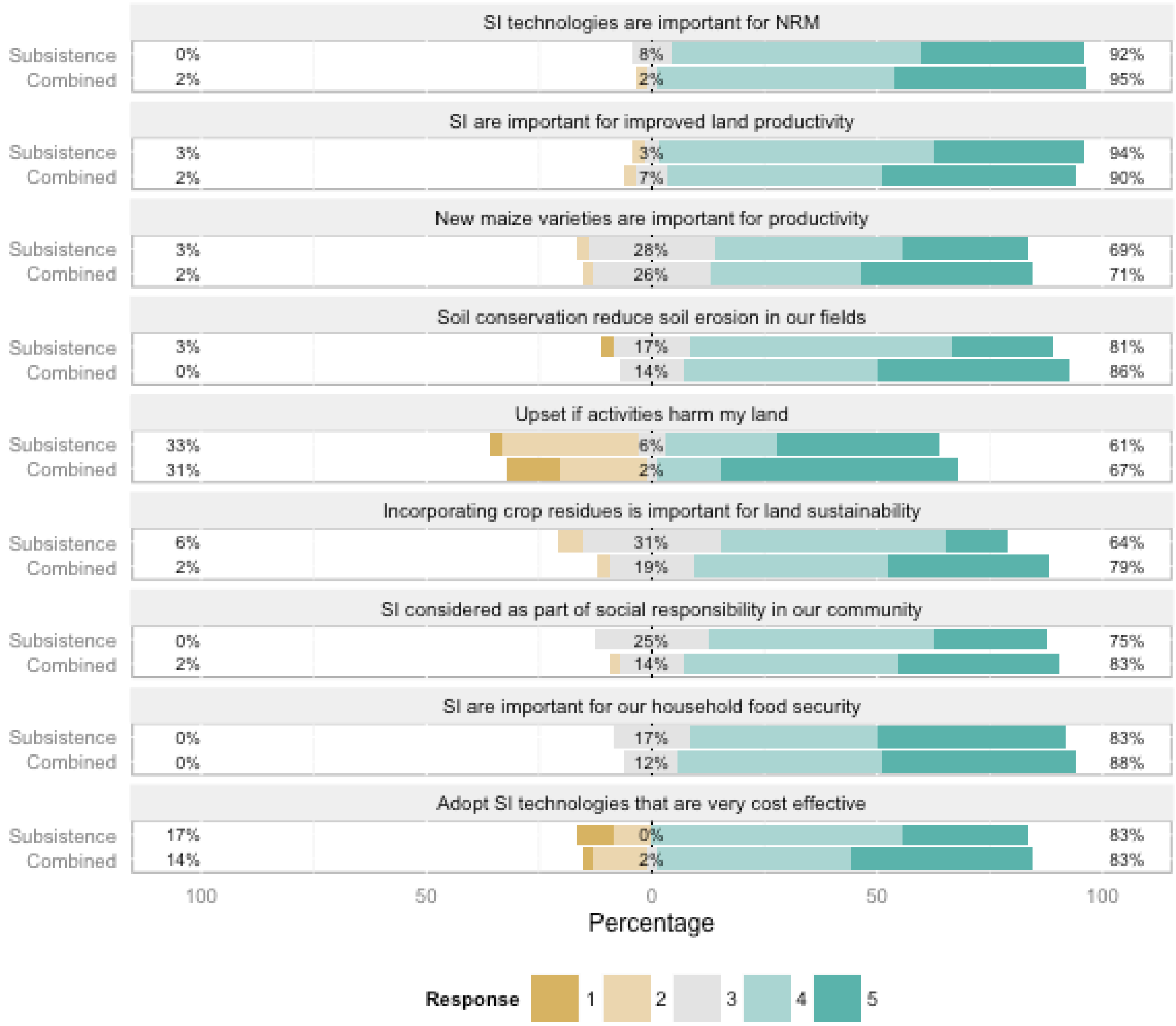

Figure B19: Farmers responses to *Identified* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

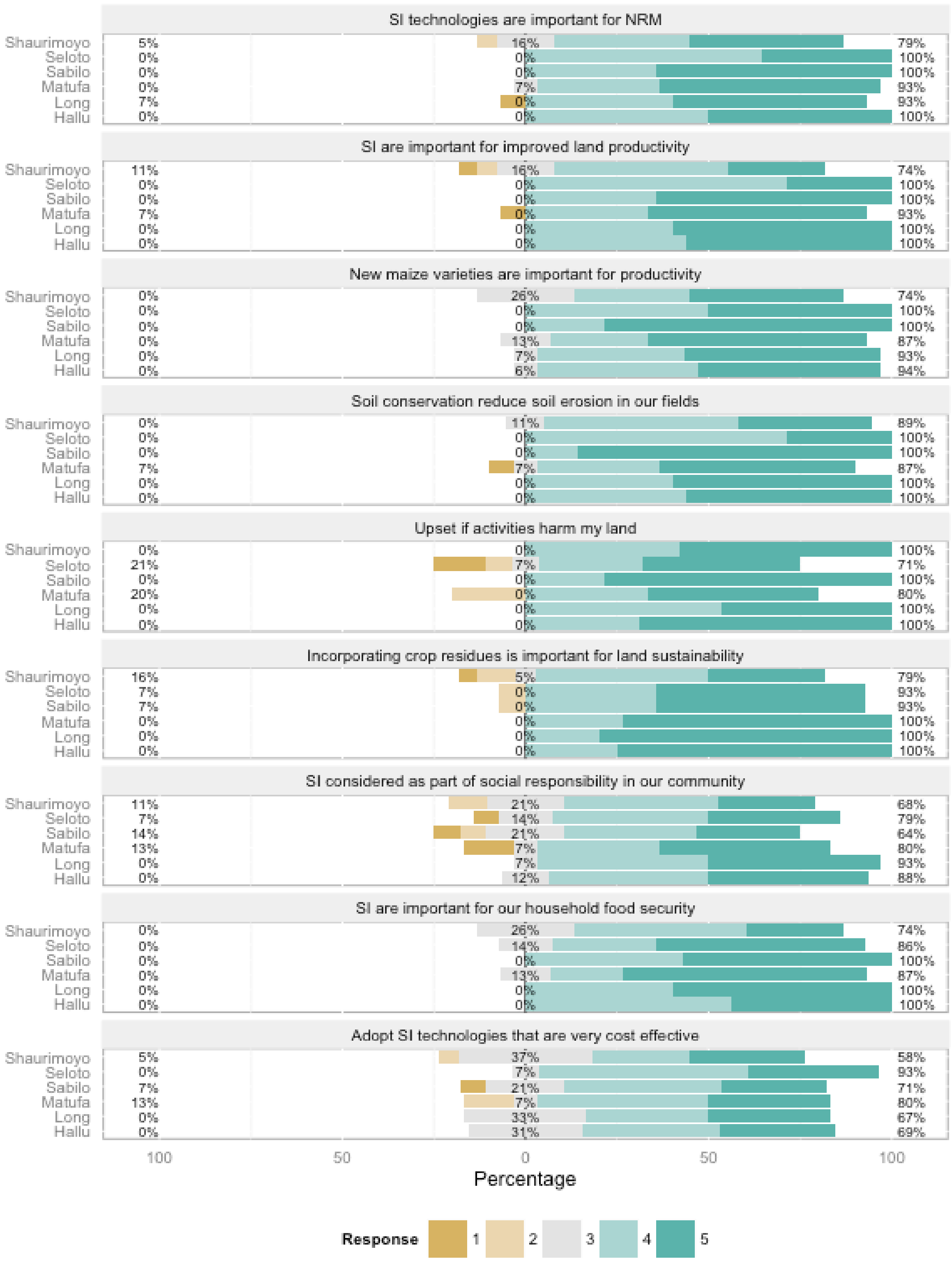

Figure B20: Farmers responses to *Identified* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

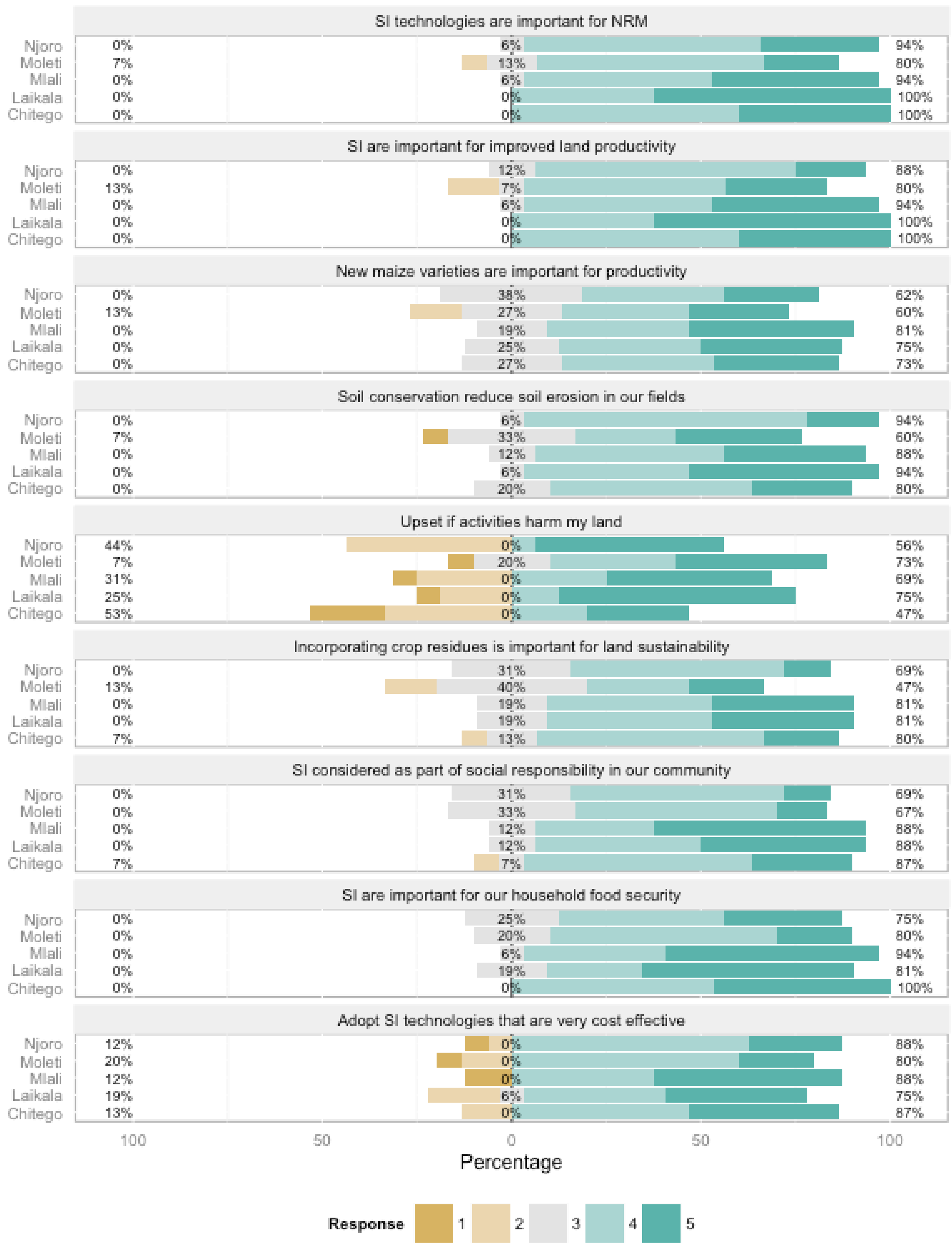

Figure B21: Farmers responses to *Identified* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

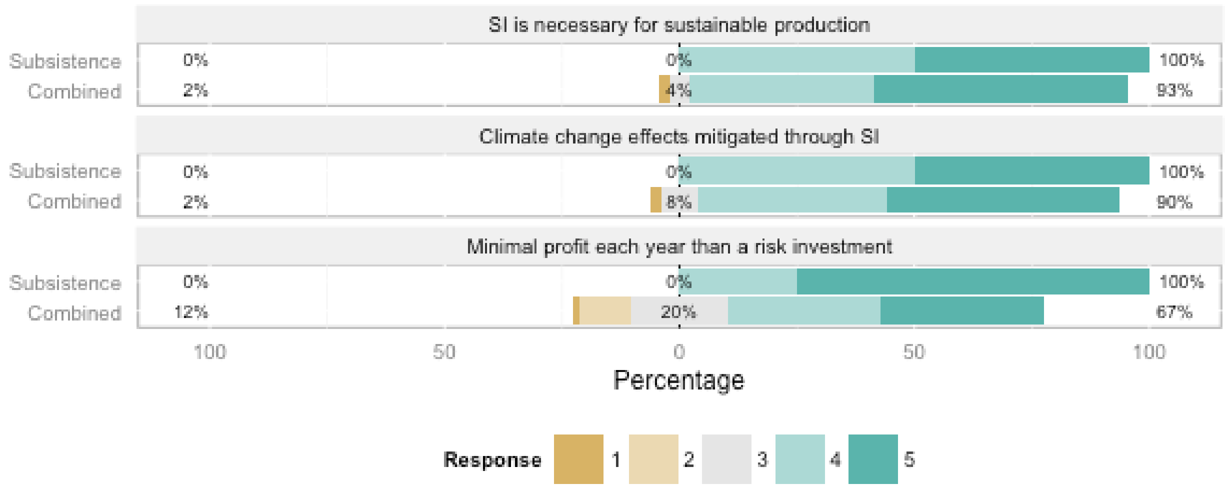

Figure B22: Farmers responses in *Integrated* drivers adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

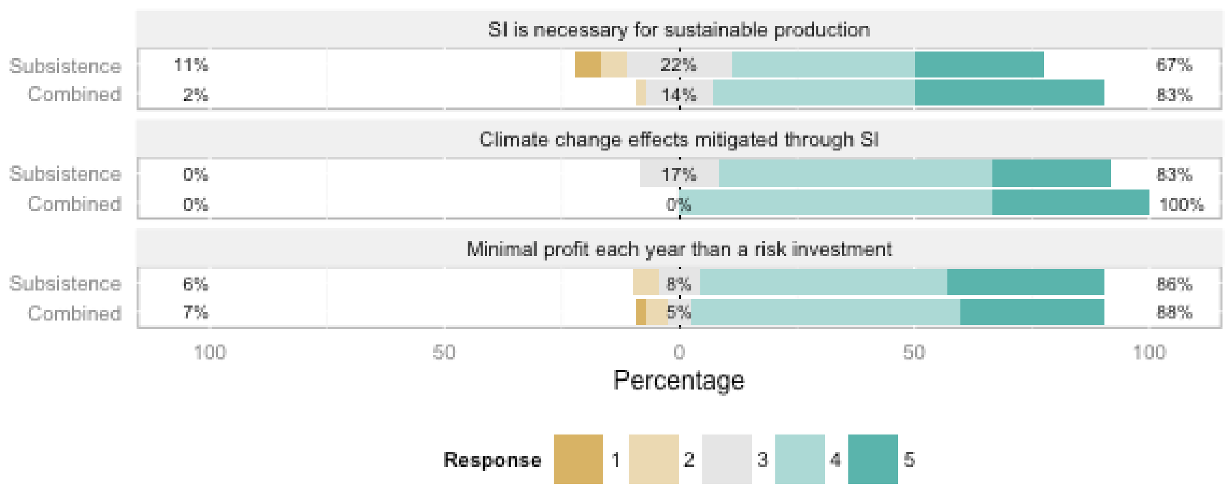

Figure B23: Farmers responses to *Integrated* drivers adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto district. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

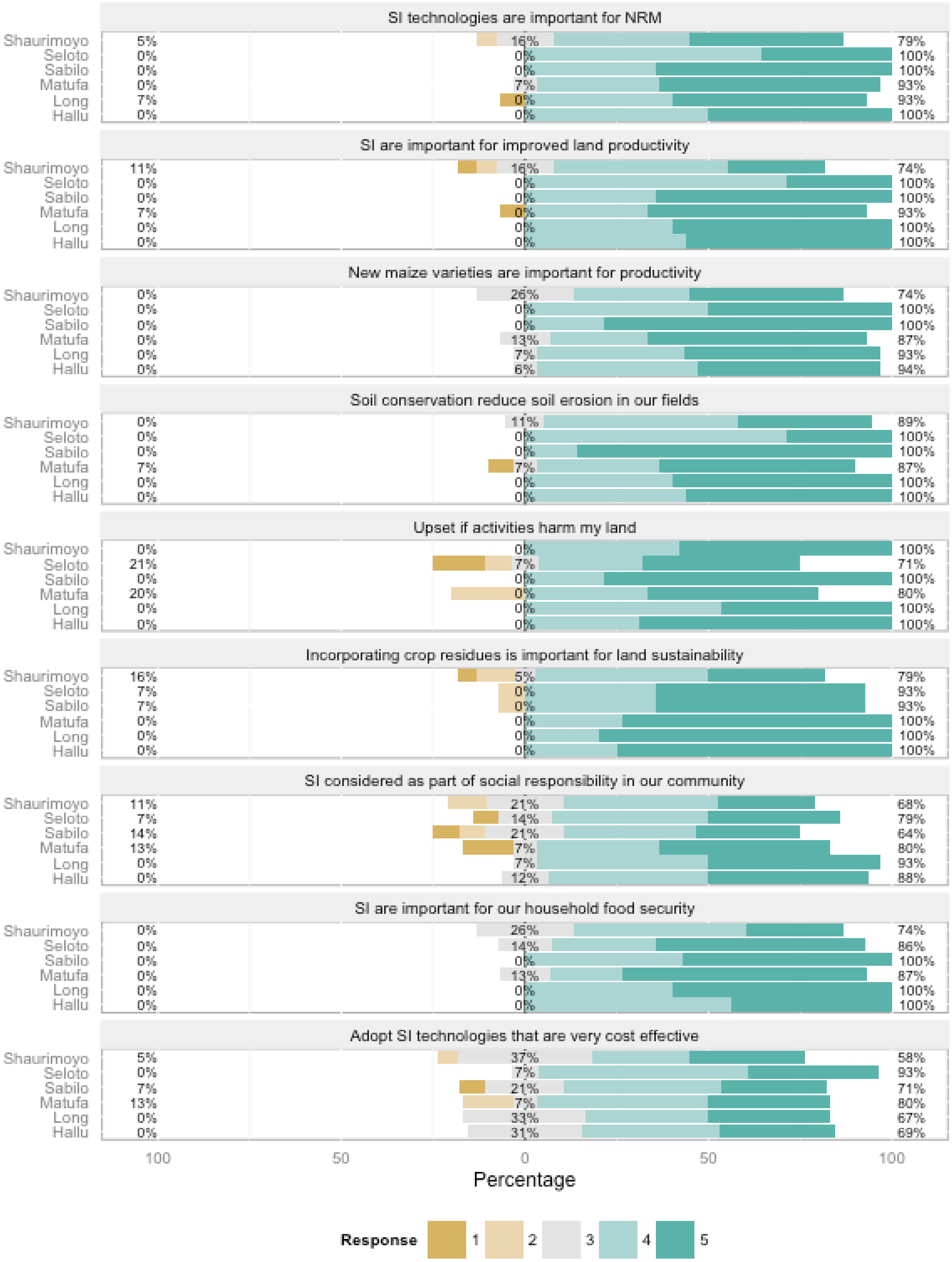

Figure B24: Farmers responses to *Integrated* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

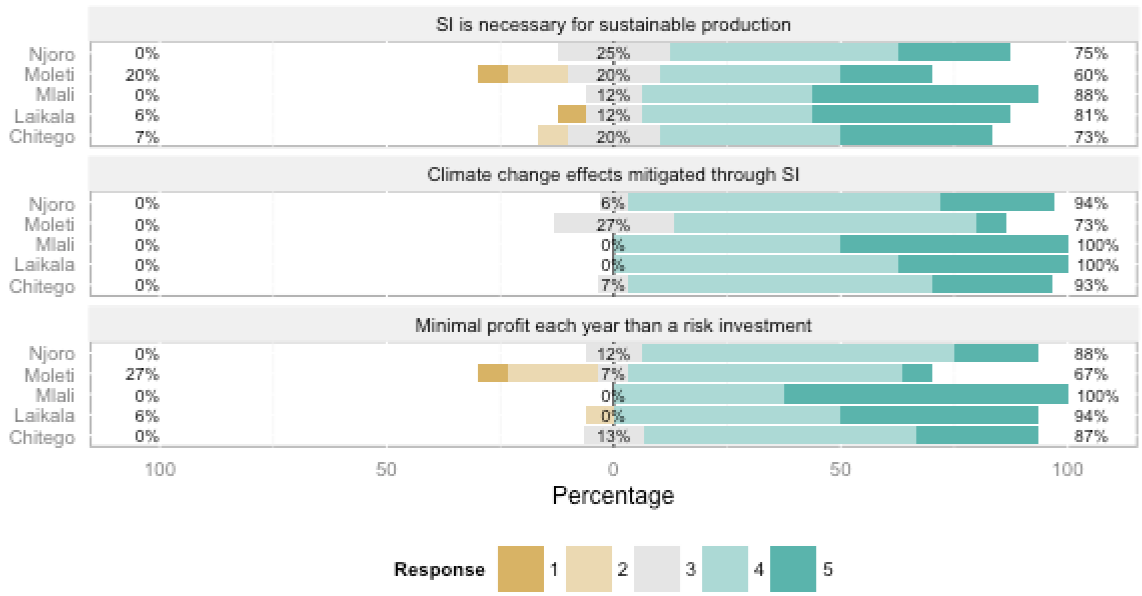

Figure B25: Farmers responses to *Integrated* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

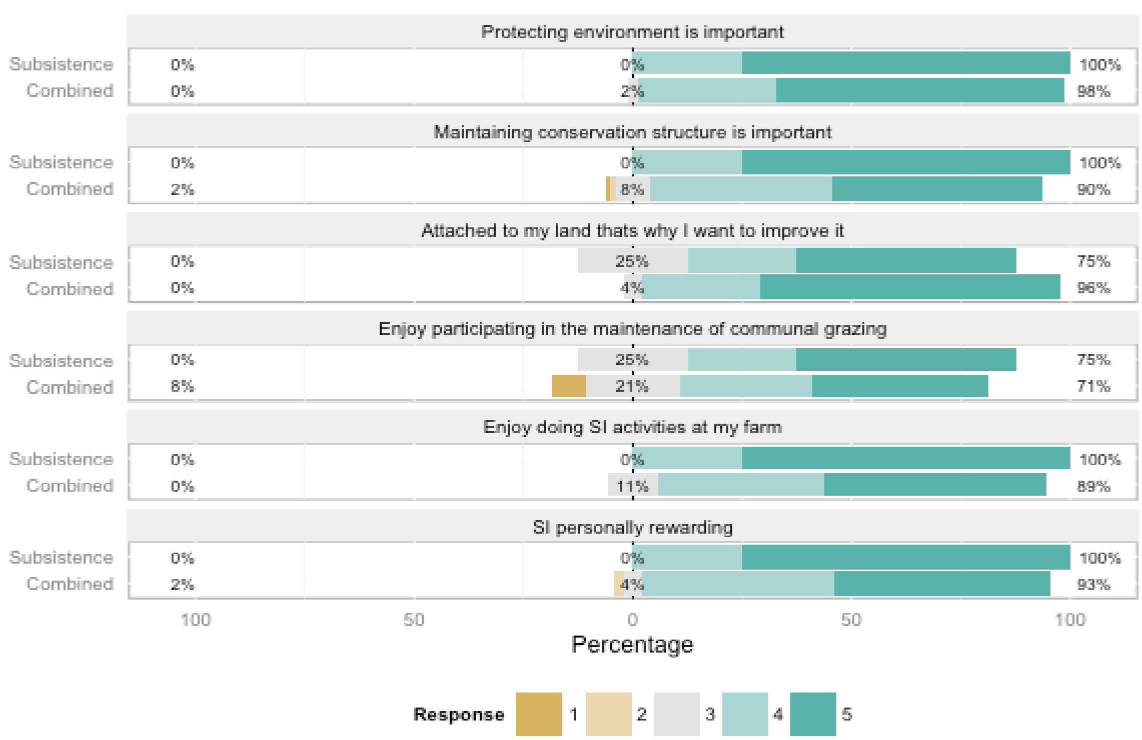

Figure B26: Farmers responses to *Intrinsic* for adoption of new farming practices by farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

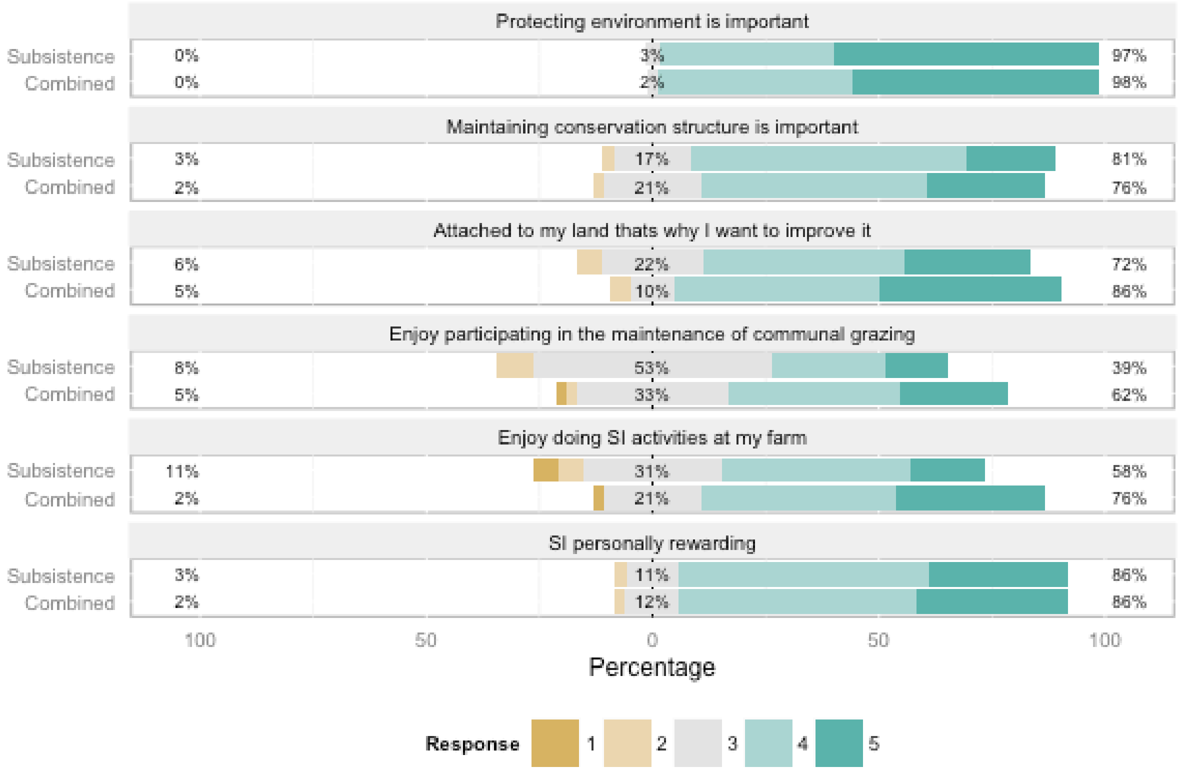

Figure B27: Farmers responses to *Intrinsic* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = ‘strongly disagree’ to 5 = ‘strongly agree’.

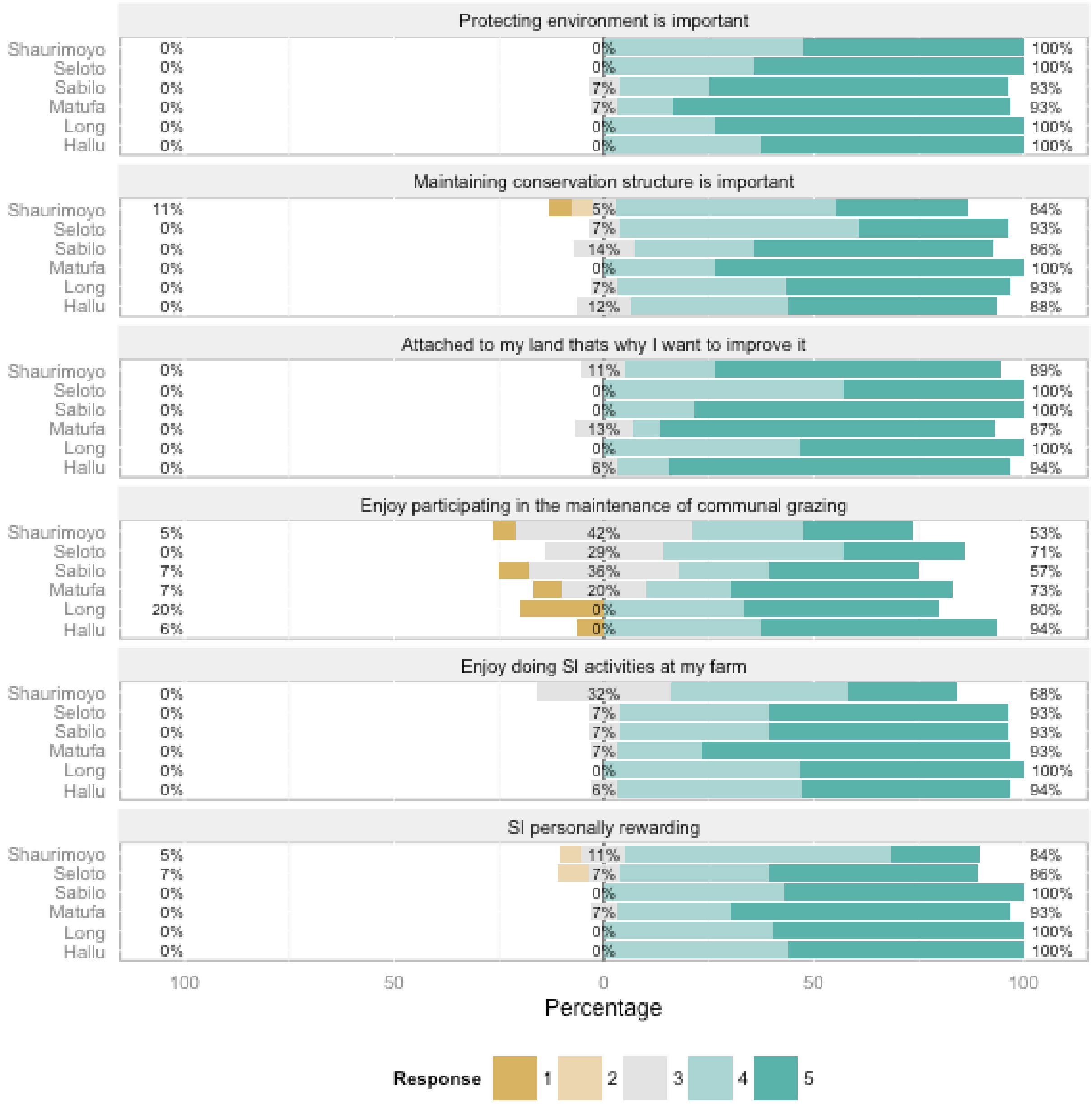

Figure B28: Farmers responses to *Intrinsic* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

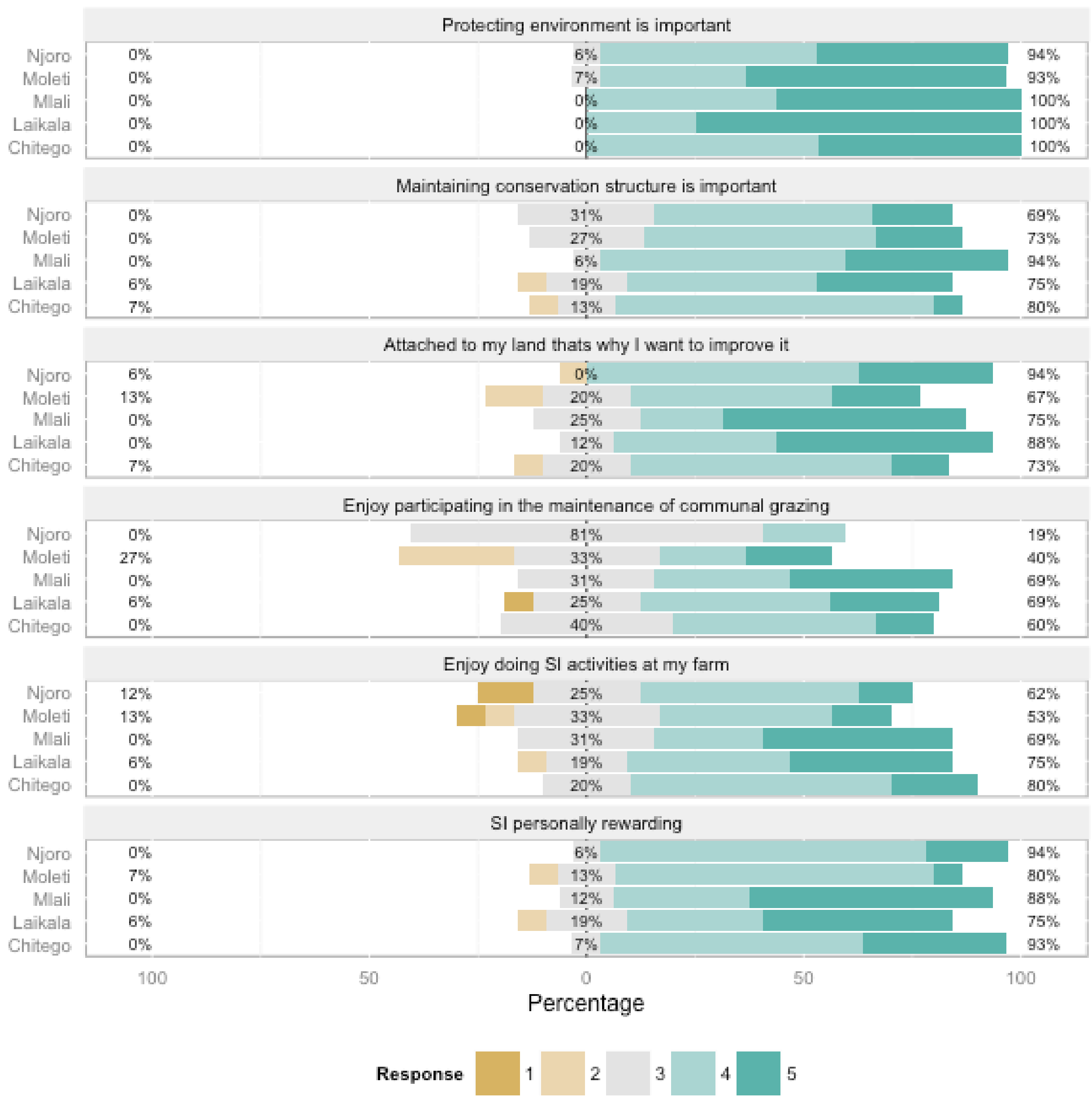

Figure B29: Farmers responses to *Intrinsic* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

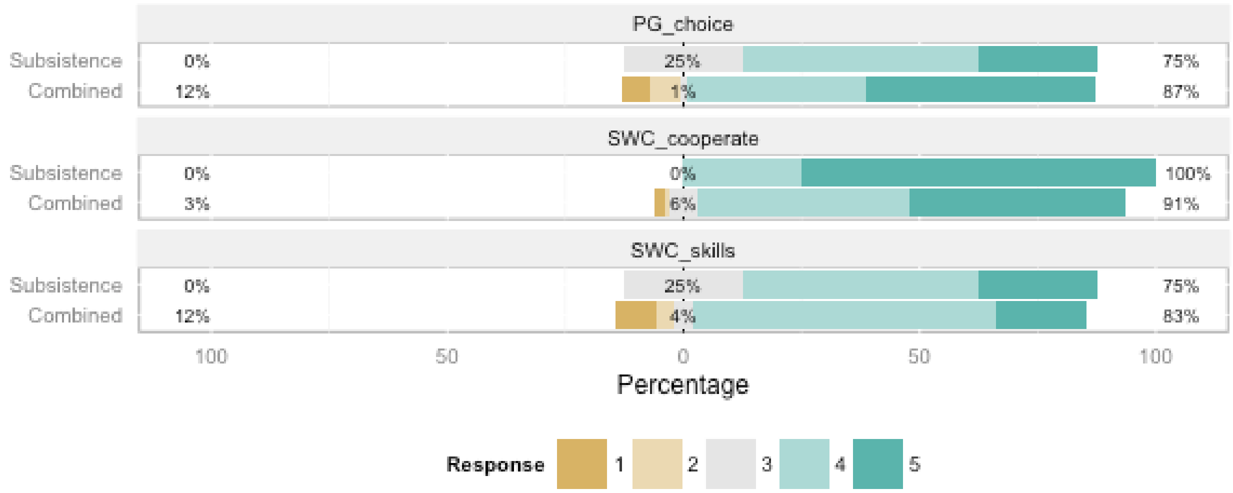

Figure B30: Farmers responses to *Autonomy, Competence and Connectedness* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

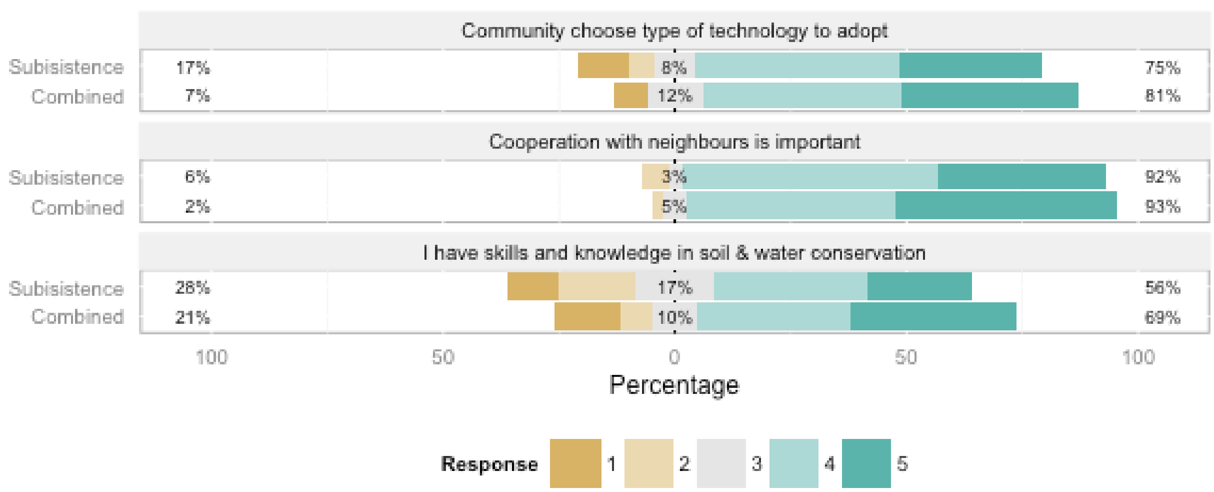

Figure B31: Farmers responses to *Autonomy, Competence and Connectedness* drivers for adoption of new farming practices between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

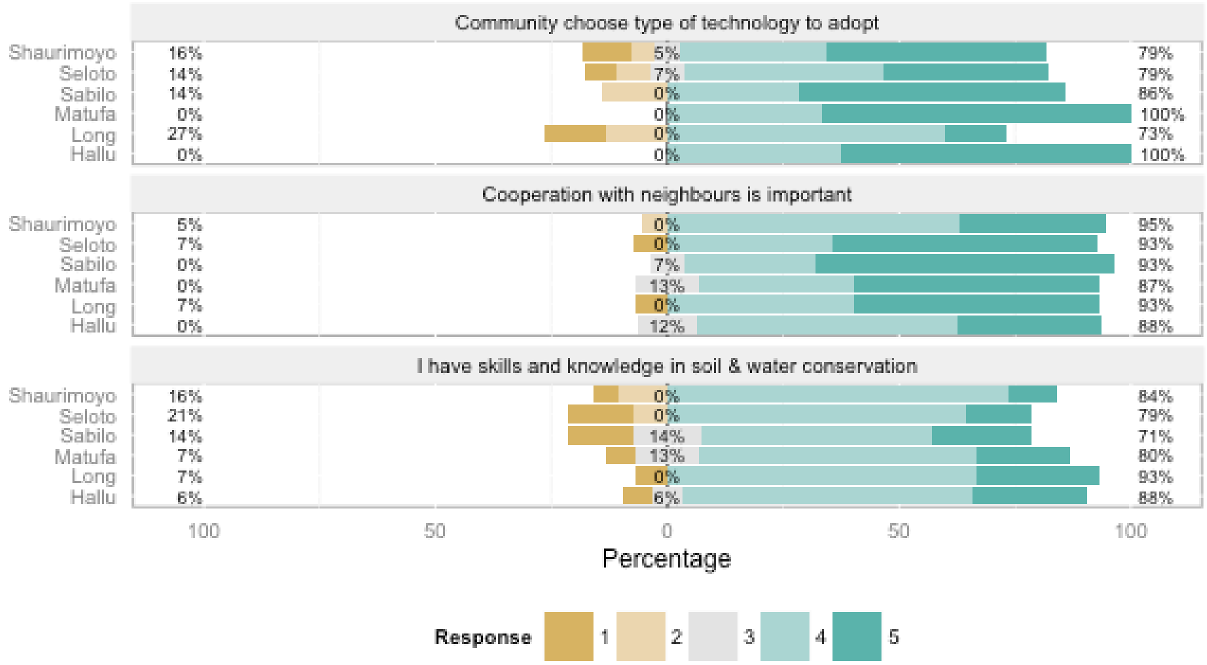

Figure B32: Farmers responses to *Autonomy, Competence and Connectedness* drivers for adoption of new farming practices in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

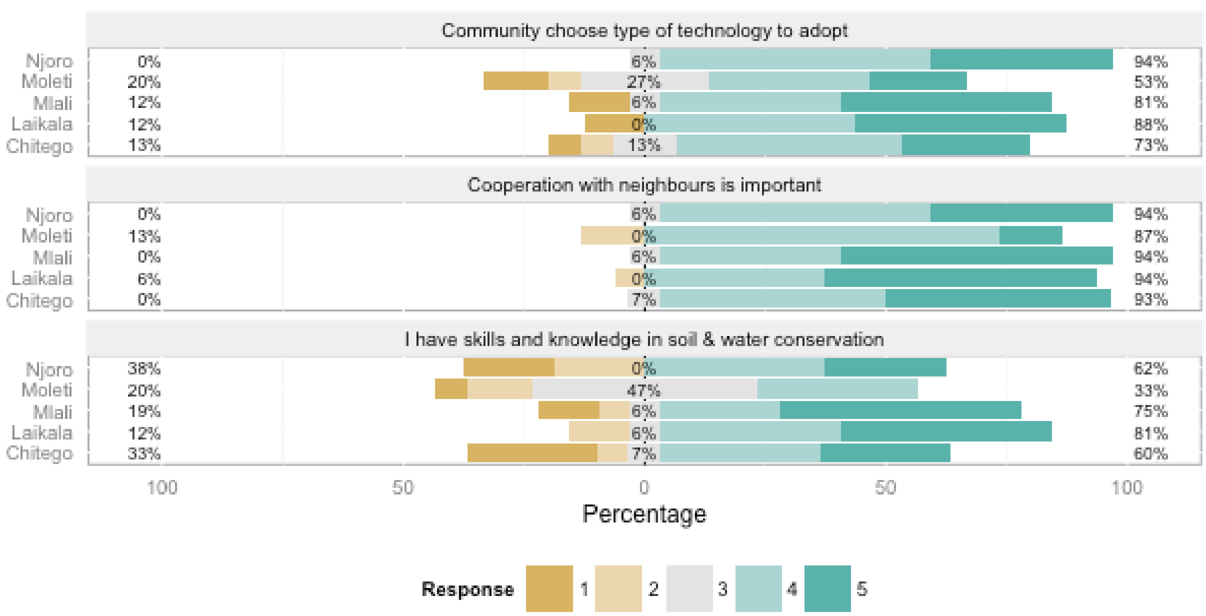

Figure B33: Farmers responses to *Autonomy, Competence and Connectedness* drivers for adoption of new farming practices in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

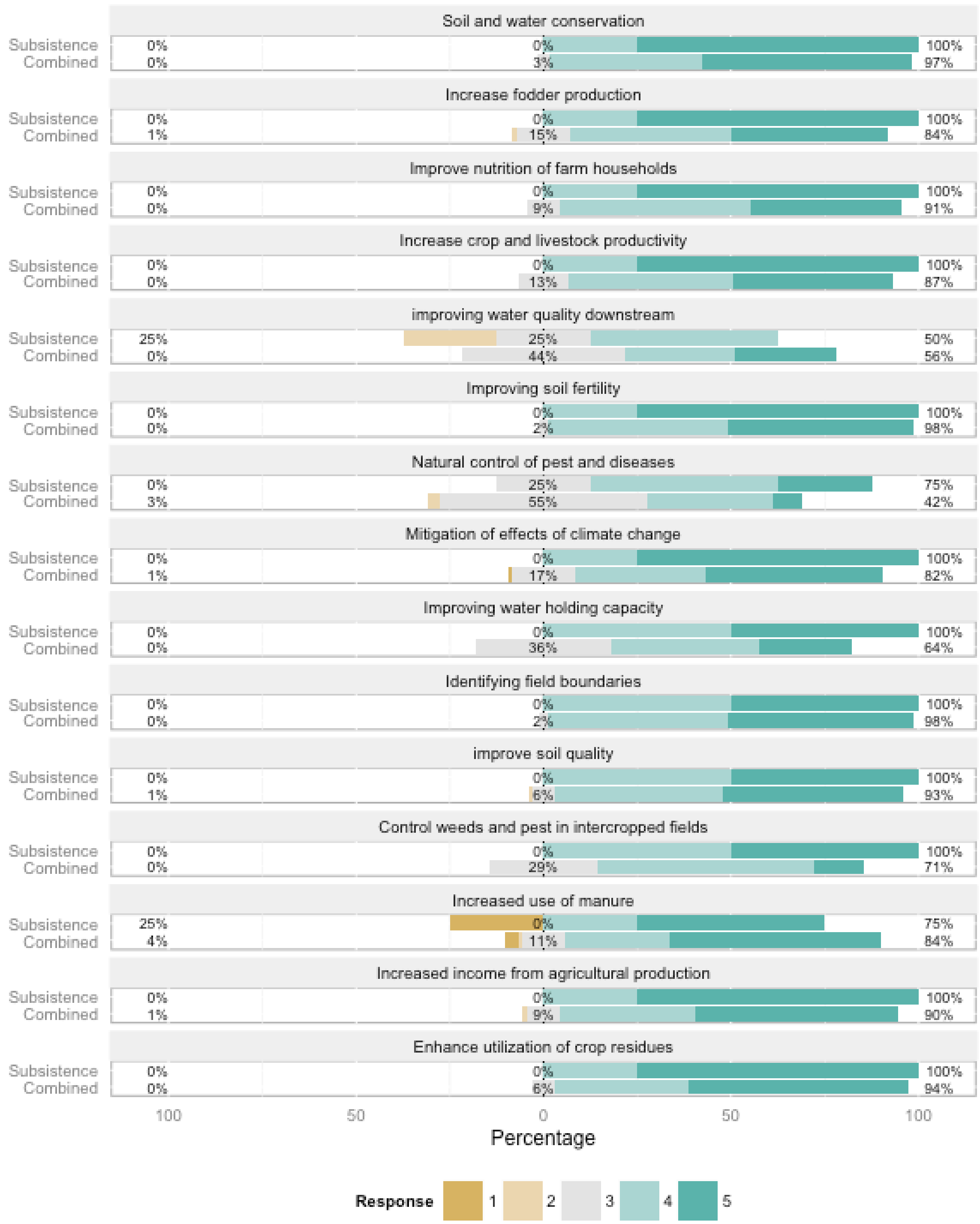

Figure B34: Farmers responses to perceived benefits of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

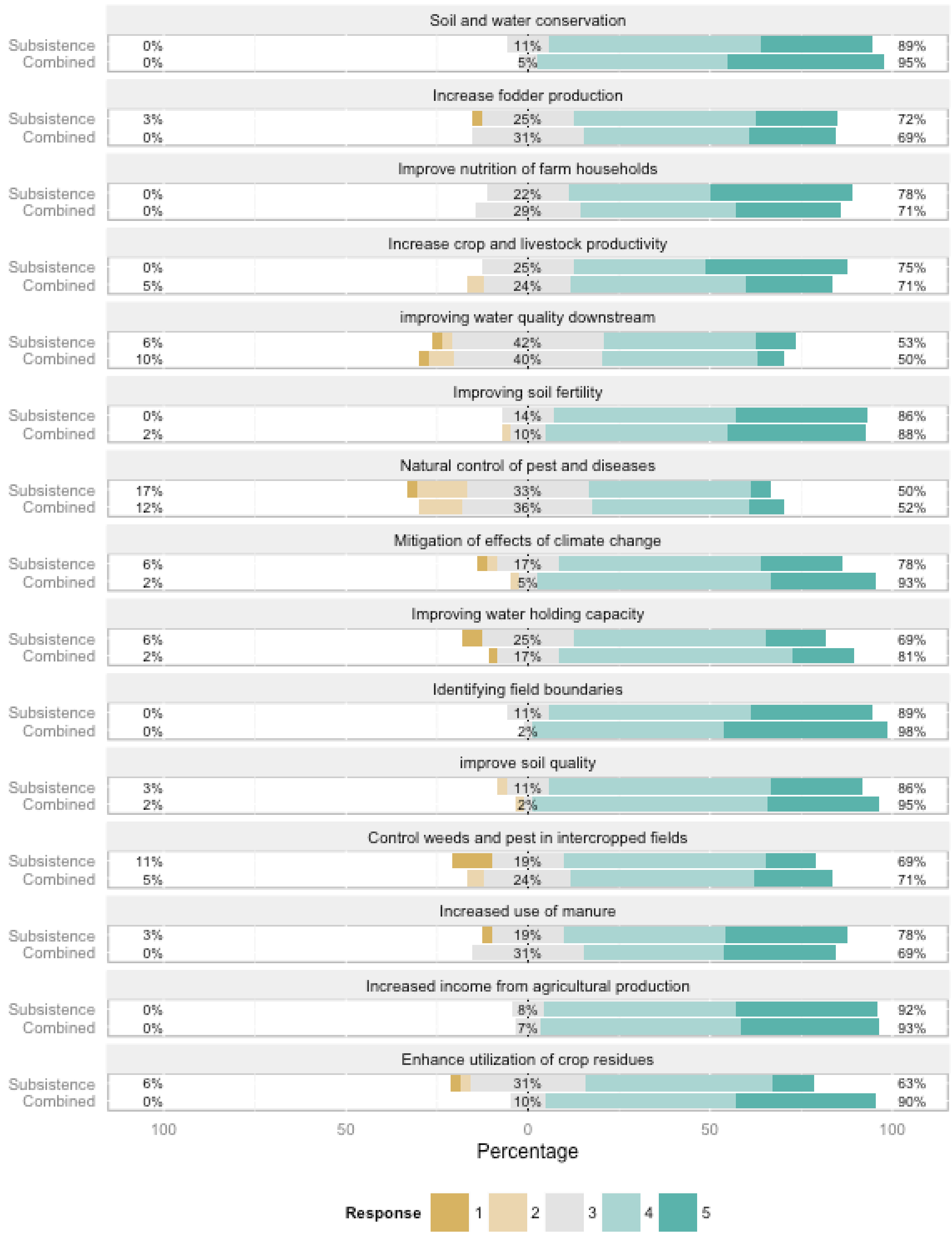

Figure B35: Farmers responses to perceived benefits of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

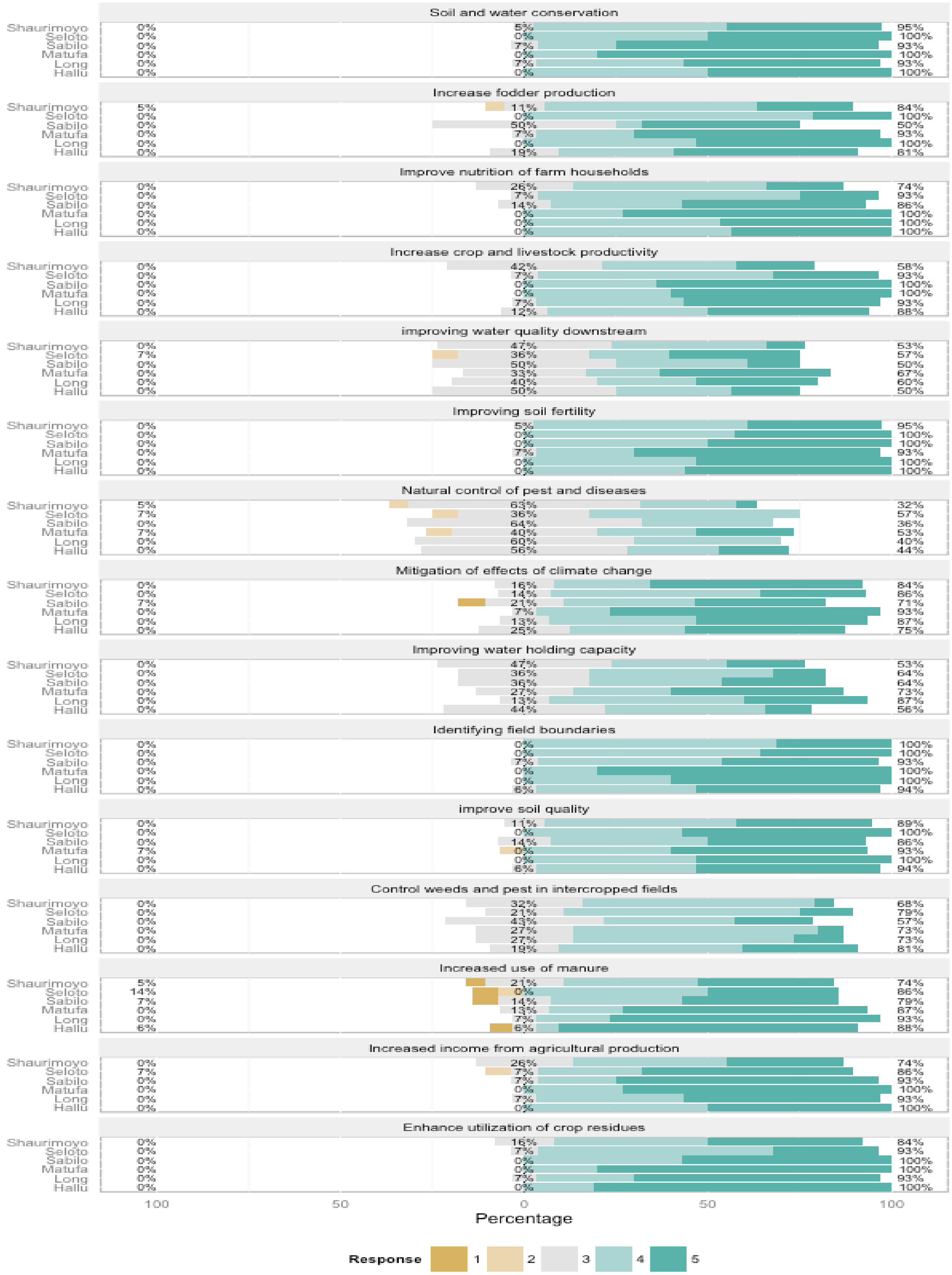

Figure B36: Farmers responses to perceived benefits of SI technologies in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

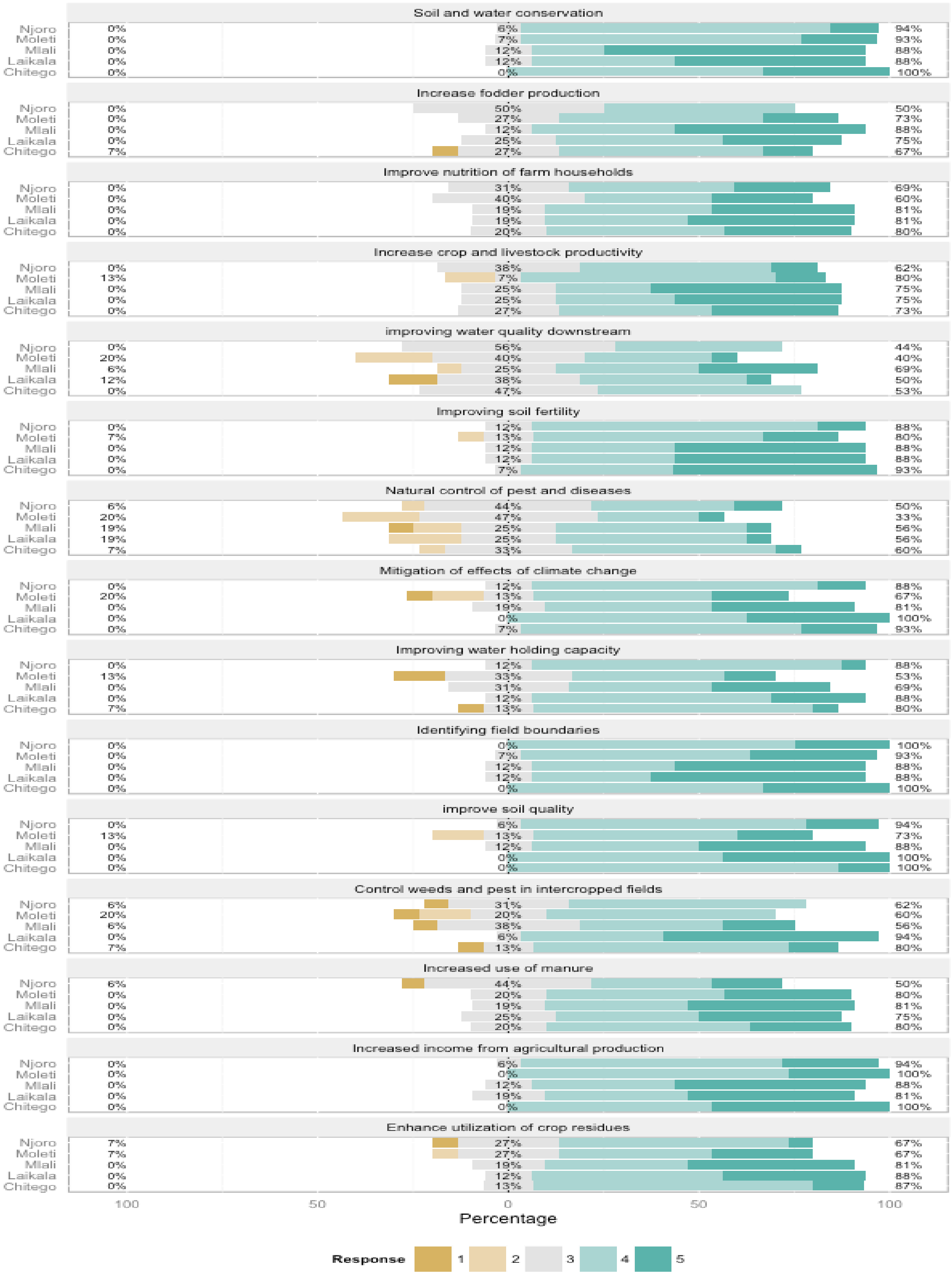

Figure B37: Farmers responses to perceived benefits of SI technologies in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

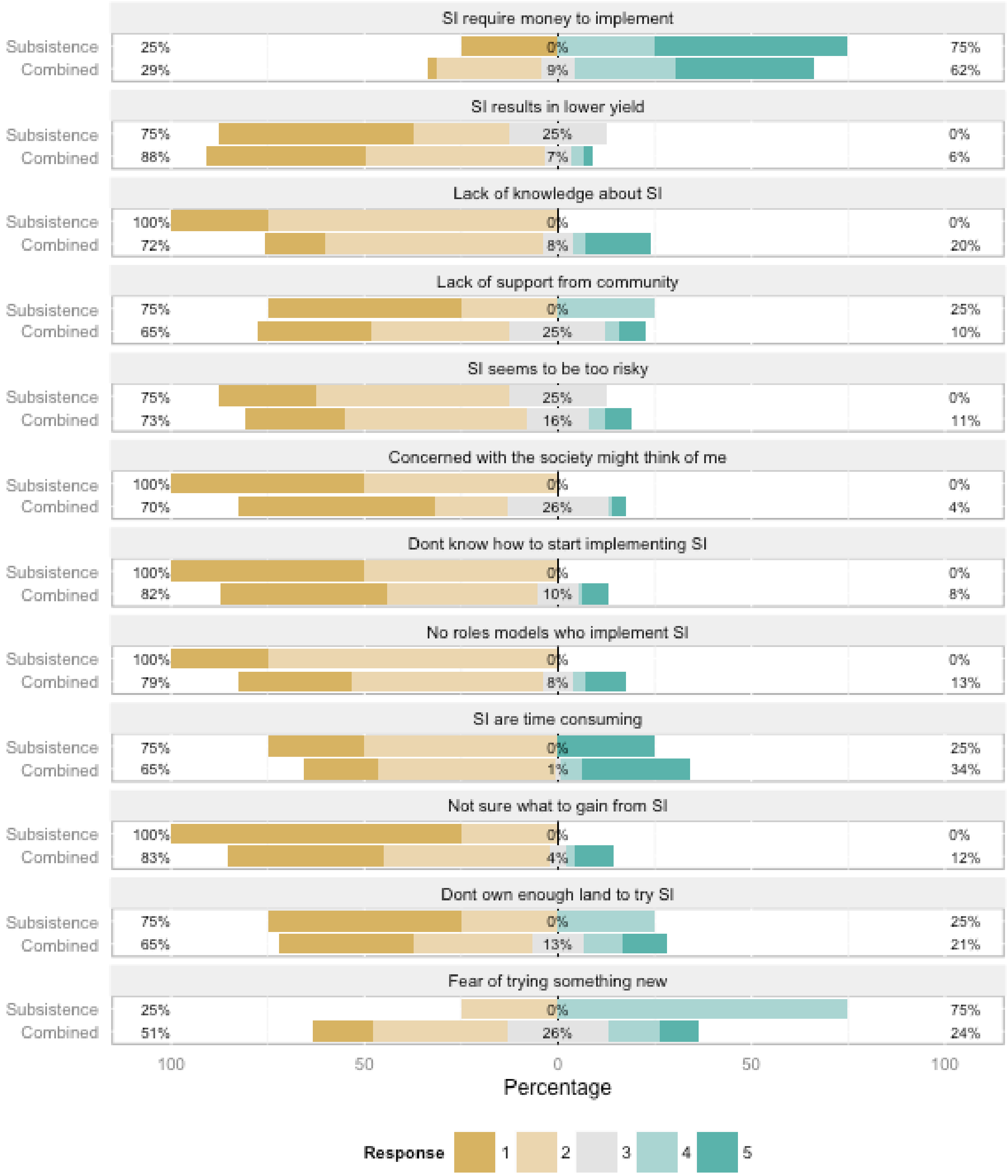

Figure B38: Farmers responses to barriers for adoption of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

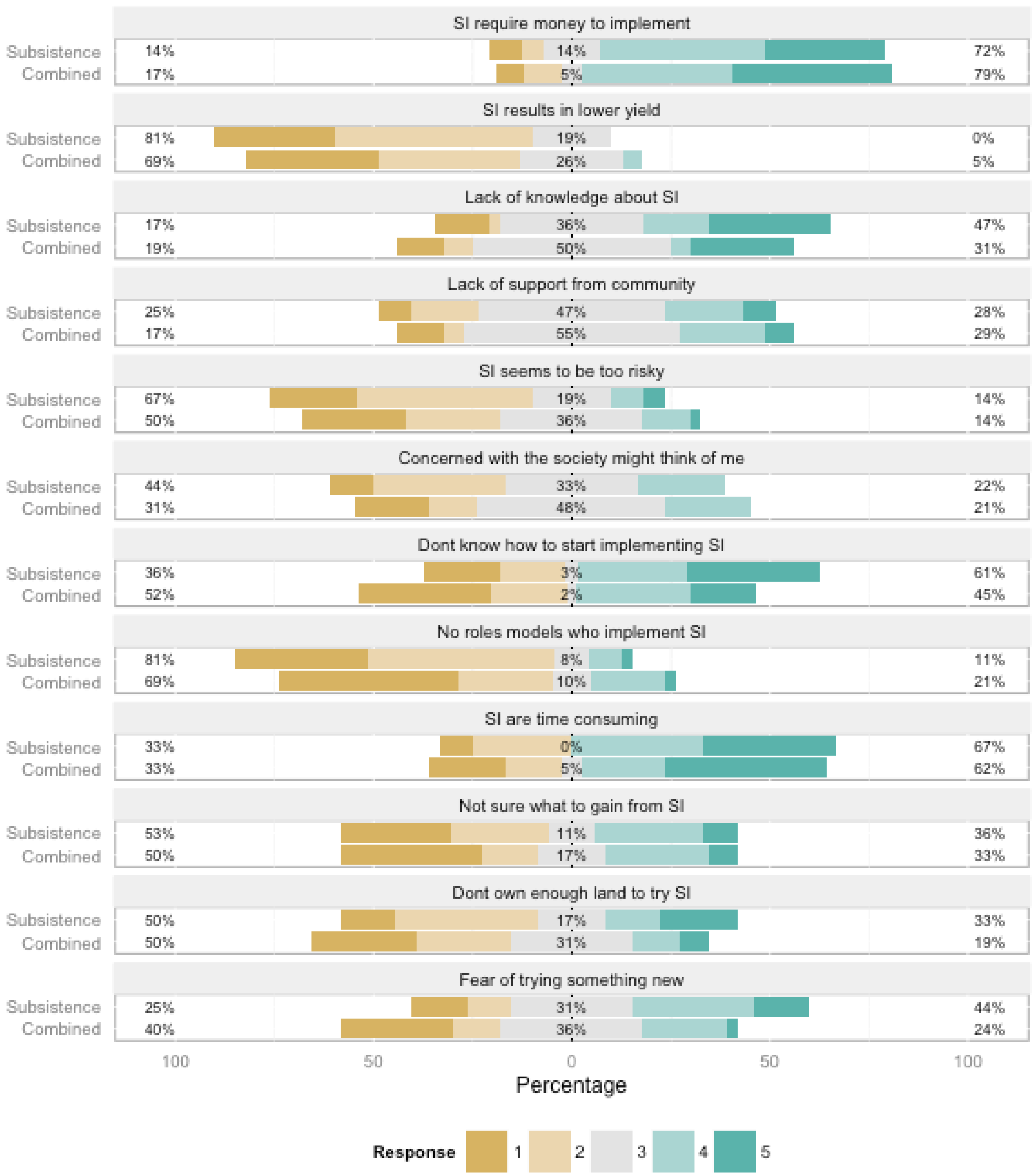

Figure B39: Farmers responses to barriers for adoption of SI technologies between farm types (subsistence farmers; combined subsistence and commercial farmers) in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

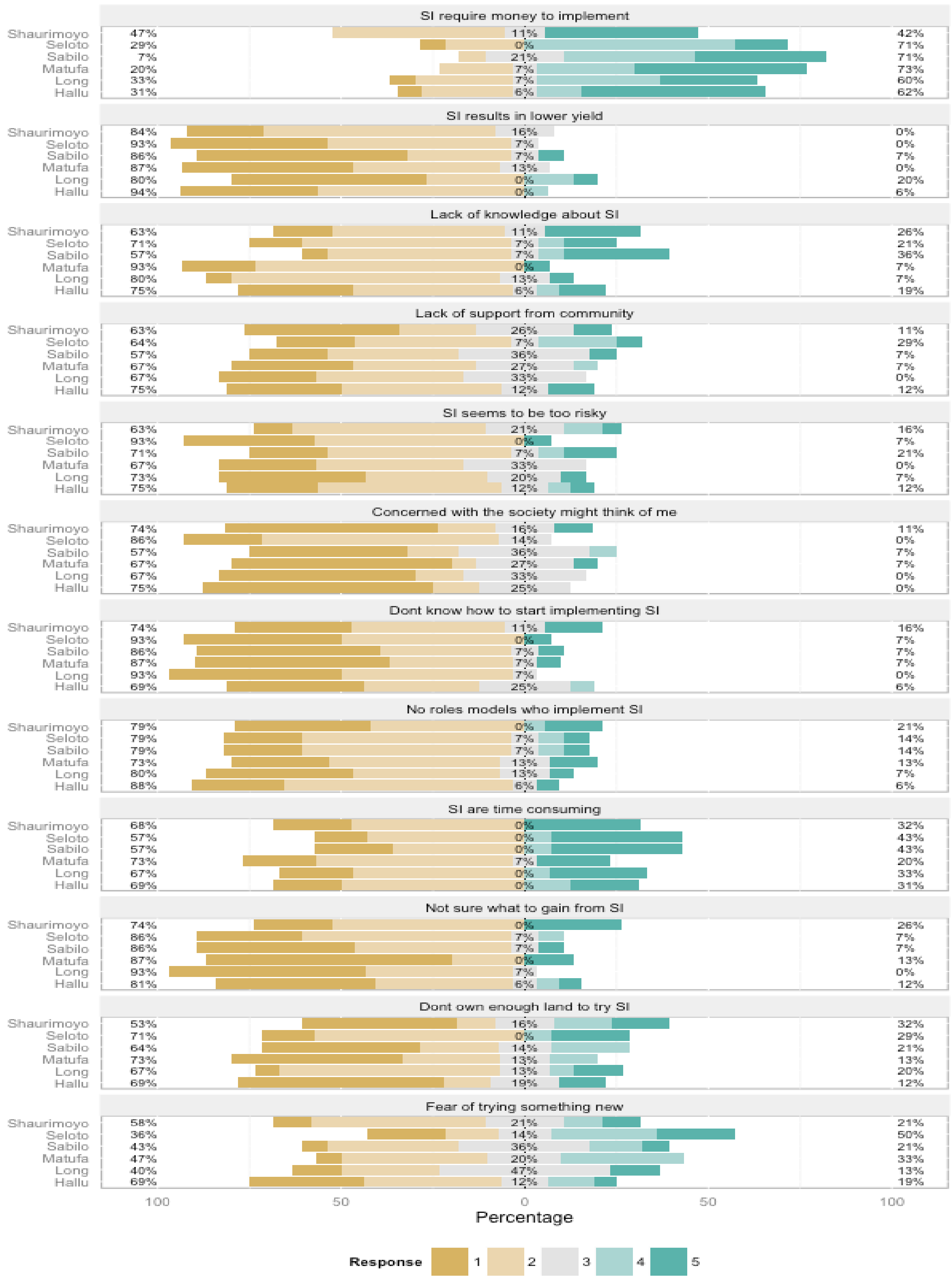

Figure B40: Farmers responses to barriers items for adoption of SI technologies in different villages in Babati. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

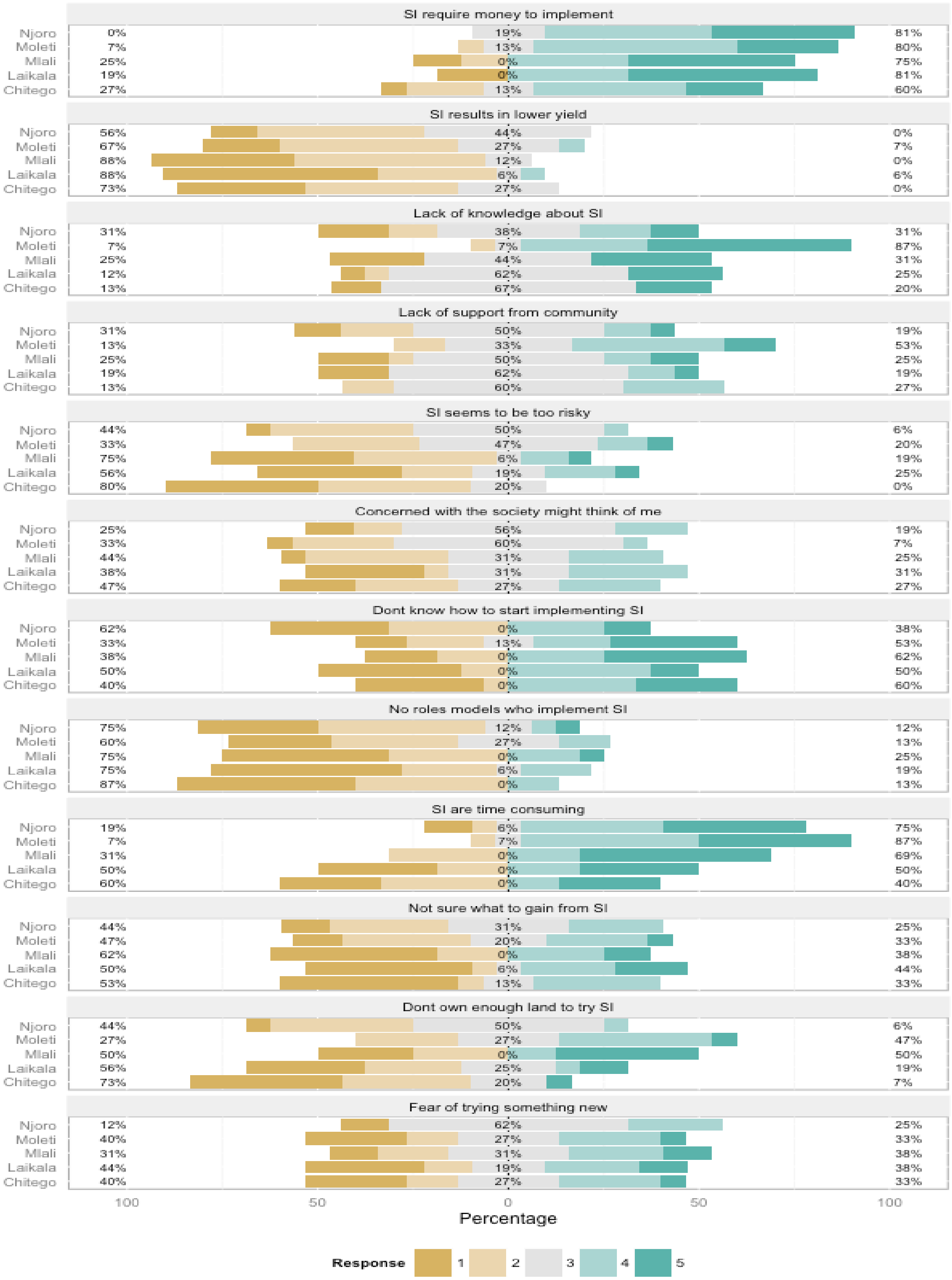

Figure B41: Farmers responses to barriers items for adoption of SI technologies in different villages in Kongwa & Kiteto. Rating scale from 1 = 'strongly disagree' to 5 = 'strongly agree'.

Appendix C: Thesis Questionnaire

Name of interviewer:

A. General information of the household

Name of the interviewee	
Gender	
Household size	
Marital status	
Total household land size	
Village name	
Ward	
District	
Region	
Farming Type	**(a) Subsistence (b) Commercial (c) Combined**
GPS coordinates	**S** **E** **Elevation**
Date of Interview	

#	Name (all household occupants) 1 should be the household head	Age	Gender	Relationship to the household head	Marital status	Education level
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						

Code for Marital status: 1= married, 2 single, 3 widow; gender: 1= male, 2 = female;
Code for Education Level: 1 =junior primary, 2 = senior primary, 3 = junior secondary, 4 = senior secondary, 5 = tertiary, 6 = University 7 = None

B. SPECIFIC OBJECTIVE 1: Many sustainable intensification technologies are used to control erosion, improve fertility, increase production and maintain the sustainability of farms

SI practice	Never used	Using now	Plan to use
Intercropping maize with pigeon peas			
Fanya juu fanya chini (contour band)			
Crop rotation			
Cover crops			
Making ridges			
Planting fodders in boundaries			
Manure application			
Use of improved spacing			
Zero tillage			
Double up legume technology			
Other (Specify)			

C. SPECIFIC OBJECTIVE 2: The drivers for motivations and adoption of new practices and technologies by farmers to move from their current system to more effective and sustainable farming system.
Strongly disagree 1 2 3 4 5 Strongly agree

1 2 3 4 5 SI technologies are important for natural resource management (Identification)

1 2 3 4 5 SI technologies are important for improved land productivity (Identification)

1 2 3 4 5 New maize varieties under SI project are important for improving maize productivity(Identification)

1 2 3 4 5 Soil conservation technologies under SI project are important for reducing soil erosion in our fields (Identification)

1 2 3 4 5 The conservation of farm under SI is influenced by the rewards being provided by the AR project, (External)

1 2 3 4 5 Without the rewards we cannot invest in conservation work encouraged by the SI project (External)

1 2 3 4 5 The pigeon pea varieties encouraged by the project are mainly planted because the crop is rewarding in terms of price (Extrinsic)

1 2 3 4 5 The pigeon pea varieties encouraged by the project are mainly planted to impress the project implementers when they come to monitor the fields (Introjected)

1 2 3 4 5 I use SI technologies in my field because it is necessary for sustainable production and for the future of my children (Integrated)

1 2 3 4 5 I planted trees along the boundaries of my farm because I wanted to protect my project membership (External)

1 2 3 4 5 Adopting soil and water conservation technologies is the condition to benefit from project inputs (seed, livestock, chicken, beekeeping and trainings) (External)

1 2 3 4 5 The project and government allows the community to choose type of technology to adopt in the community or individual farms (Autonomy)

1 2 3 4 5 Cooperation with neighbours is important for successful soil and water conservation work (Connectedness)

1 2 3 4 5 The natural resource conservation gives me sense of satisfaction (Introjected)

1 2 3 4 5 I have the skills and knowledge in soil and water conservation technologies (Competence)

1 2 3 4 5 I would be upset if my activities harm my land (Identification)

1 2 3 4 5 Protecting environmental is important to me (Intrinsic)

1 2 3 4 5 Improving productivity in my land through incorporating crops residues is important for sustainability of my land (Identification)

1 2 3 4 5 Maintaining conservation structure for my land is important to me (Intrinsic).

1 2 3 4 5 I am very attached to my land that's why I want to improve it (Intrinsic)

1 2 3 4 5 I only participate in the maintenance of communal grazing land if I am paid (extrinsic)

1 2 3 4 5 I enjoy participating in the maintenance of communal grazing land because is part of my community (Intrinsic)

1 2 3 4 5 I enjoy doing SI activities at my farm (Intrinsic)

1 2 3 4 5 I adopt SI technologies with quick payback at my farm (Extrinsic)

1 2 3 4 5 There is no room for non-economic motives in farming (External)

1 2 3 4 5 I adopt SI technologies because of peer pressure (External)

1 2 3 4 5 I consider SI technologies as part of social responsibility in our community (Identification)

1 2 3 4 5 I would like to adopt SI technologies if paid to do so (External)

1 2 3 4 5 SI technologies are very important for our household food security (Identification)

1 2 3 4 5 The only way to mitigate effects of climate change is through sustainable intensification (Integrated)

1 2 3 4 5 I find SI technologies to be personally rewarding (Intrinsic)

1 2 3 4 5 Economics drives most of my farming decisions (External)

1 2 3 4 5 I would only adopt any sustainable intensification technologies that are very cost effective (Identified)

1 2 3 4 5 It is better to make a minimal profit each year than a risk investment with financial risk (Integrated)

D. SPECIFIC OBJECTIVE 3

3.1: Perceived benefits of sustainable intensification techniques

1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree

1 2 3 4 5 Soil conservation

1 2 3 4 5 Increased folder production

1 2 3 4 5 Improve nutrition of farm households

1 2 3 4 5 Increase crop and livestock production

1 2 3 4 5 Improving water quality down stream

1 2 3 4 5 Improving soil fertility

1 2 3 4 5 Natural control of pest and diseases

1 2 3 4 5 Mitigate effects of climate change

1 2 3 4 5 Improving water holding capacity

1 2 3 4 5 Identifying field boundaries

1 2 3 4 5 Improve soil quality

1 2 3 4 5 Control weeds and pests in intercropped fields

1 2 3 4 5 Increased use of manure

1 2 3 4 5 Increased income from agricultural production

1 2 3 4 5 Utilization of crop residues

3.2: Barriers to adopting SI/ Conservation technologies by farmers

1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree

1 2 3 4 5 Money required to implement most of the SI innovations and practices

1 2 3 4 5 SI innovations result in lower yields

1 2 3 4 5 Lack of specific knowledge about SI innovations

1 2 3 4 5 Lack of support from community members

1 2 3 4 5 SI innovations seems to be too risky for a small holder farmer

1 2 3 4 5 Concerned with what the society might think of me

1 2 3 4 5 Don’t know how to start implementing the SI technologies

1 2 3 4 5 No role models nearby who are implementing some of my SI options

1 2 3 4 5 SI innovations are time consuming

1 2 3 4 5 Not sure what to gain from SI innovations

1 2 3 4 5 Don’t own enough land to try SI innovations of my choice

1 2 3 4 5 Fear of trying something new

Thank you for your time.

Do you have any question that you would like to ask me

Appendix D: Checklist (Focus Group Discussions, Interview guide)

- Give an overview of the discussion/discussion i.e. explain to the farmers what I mean by SI and packages

Sustainable intensification involves several farming practices that seem promising to the farmers such as: application of improved varieties like seeds etc, manure application, intercropping with legumes, cover crops, conservation agriculture (minimal tillage, crop rotation), incorporating crop residues, use of appropriate plant spacing, and improved animal nutrition (e.g. fodder planting).

- Agricultural production
  What are the major crops grown in the area?
  (Among them, group whether they are food or cash crops)
  What tillage systems are practiced in the area?
  What are the major livestock kept in the area?
  What shocks do farmers usually experience in the area that threatens crop/livestock production?

- Innovations, Innovations adoption, motivations for innovations and constraints to adopt new innovations
  What traditional agricultural innovations are available in the area?
  What motivate farmers to practice these innovations?
  Which agricultural innovations are considered new in the area? What do you think is the benefits of your interest in the use of new technologies for sustainable intensification? / What drives farmers' interest to practice new innovations in the area?
  Why farmers in the area are not practicing some of these innovations? / What are some of the factors that affect/hinder the adoption of new farming practices by smallholder farmers?

- Any comments, suggestion of farming practices which farmers' needs in the area?