Food and Agriculture Organization of the United Nations

Barriers, incentives and benefits in the adoption of climate-smart agriculture

Lessons from the MICCA pilot project in Kenya

Background report 9

Barriers, incentives and benefits in the adoption of climate-smart agriculture

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MICCA Programme

Pilot Project: Enhancing agricultural mitigation within the East Africa Dairy Development (EADD) Project in Kenya

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 2015

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ACKNOWLEDGEMENTS

The development of the methodology and tools, the survey questionnaire and FGD check list, and the analysis were supported by Janie Rioux from the MICCA team at FAO. Collection of the data presented in this report was made possible by a committed team of six enumerators: Hellen Sang, Emmanuel Serem, Dorcas Jepngétich, Abraham Lagat, Richard Biwot and Robert Tabut. The team worked tirelessly for long hours during field work and we highly appreciate their contribution to the success of this study. We are grateful to the MICCA field project team led by Josephine Kirui, Sylvia Wafula and Moses Ndathie for providing smooth logistical facilitation and facilitating the focus group discussions during field work in Kaptumo Division. The management of Kapcheno Multipurpose Company is also acknowledged for providing local support to the field activities. Finally, we are indebted to the 197 farmers and farmer trainers who freely gave of their time.

1 INTRODUCTION

Climate change poses new challenges to the fight against poverty and sustainability of agrarian livelihoods in sub-Saharan Africa. Predictions indicate that climate change will adversely affect agricultural production in sub-Saharan Africa through declining crop yields and livestock productivity caused by rainfall variability, rising temperatures and increased pest/disease incidences (Kurukulasuriya *et al.*, 2006; Kurukulasuriya and Rosenthal, 2003). More recent findings confirm that climate change is likely to cause considerable crop yield losses thereby adversely affecting smallholder livelihoods in Africa (Lobell *et al.*, 2011). As a result, food security and income generation opportunities for the farming households that are most reliant on agriculture may be in jeopardy.

The North-western region of Kenya is a major producer of food crops and livestock products in the country (Government of Kenya, 2005). This means that major changes in productivity of key agricultural enterprises from the effects of climate change may lead to far-reaching implications on national food security and farmers' livelihoods. Therefore, the current challenge faced by agricultural policy-makers, researchers and extension workers in Kenya is how to design policies, generate and disseminate technologies and information that will offer greater resilience to the agricultural production system under changing climatic conditions. In the first part of the decade, efforts have been made by different national and international institutions to enhance farmers' resilience to climatic risks and mitigate climate change in agriculture. For example, the FAO's Mitigation of Climate Change in Agriculture (MICCA) programme with a pilot project in Kaptumo, Nandi County. This study is part of the MICCA pilot project in Kenya.

The main aim of the MICCA programme is to support developing countries in their efforts to mitigate climate change in agriculture. The programme focusses on gradual transformation of agricultural productivity through implementation of climate-smart agricultural policies and practices (FAO, 2012). The MICCA programme envisages that successful promotion of such policies and practices would occur within the context of sustainable management of land, water and genetic resources to improve farmers' responsiveness to climate change challenges affecting agriculture, livelihoods and poverty alleviation. Climate-smart agriculture (CSA) as defined by FAO comprises of three main pillars: 1) sustainably increasing agricultural productivity and incomes, 2) adapting and building resilience to climate change, and 3) reducing and/or removing greenhouse gases emissions, where possible. CSA is designed to implement sustainable agricultural development while addressing the food security and climate change challenges. In this regard, two MICCA pilot projects have been implemented in Kenya and Tanzania for the past three years.

In Kenya, the MICCA pilot project, which was initiated in September 2011, mainly focussed on smallholder dairy farmers, with the aim of integrating climate-smart practices into the farming system and improving productivity. To achieve this, the MICCA pilot project co-operated with the East African Dairy Development (EADD) project to promote a variety of CSA practices including agroforestry, improved fodder production, tree nurseries, manure management, composting and biogas generation (FAO, 2012).

This study examines the incentives and constraints to adoption of the promoted climate-smart agricultural practices in Kaptumo, Nandi County of Kenya. Findings and insights from this study provides useful knowledge on the dynamics of adoption of the CSA practices and lessons learnt to further inform extension, projects and up-scaling. The results from this study are valid for the population in the MICCA pilot site and may be generalized to similar areas in Nandi County and other counties in the country, which are characterized by tea-maize-dairy farming system and small land sizes. The study considers wider policy, institutional and social structures and processes that may affect adoption. In addition the assessment also provides farmers' perceptions on initial benefits of those practices in terms of agricultural production, livelihoods diversification, overall resilience to climatic risks and household food security.

1.1 Overview of the MICCA pilot project in promotion of CSA practices in the pilot site

The MICCA project work in Kaptumo, Nandi County of Kenya was implemented through a system of volunteer farmer trainers and small-scale farmer groups. Dissemination of CSA practices and knowledge in the pilot site applied an innovative farmer-led extension approach that relied on volunteer farmer trainers (Kiptot *et al.*, 2006; Kiptot *et al.*, 2012). Farmer trainers hosted demonstration plots used to train other farmers on CSA practices (Rosenstock *et al.*, 2014).

The main CSA practices demonstrated include 1) improved fodder production (Napier grass, Rhodes grass, Brachiaria grass, Columbus grass, forage sorghums, desmodium, dolichos lab and Lucerne (Alfalfa); 2) agroforestry and fodder trees (Calliandra, Leucaena, Trichandra, tree Lucerne, Sesbania sesban, Grevillia and Croton); 3) tree nursery establishment and management for both fodder shrubs and agroforestry trees; 4) better manure management through composting and biogas generation and 5) feed conservation by baling hay and making silage (Rosenstock *et al*., 2014).

During the implementation period of three years, 23 volunteer farmer trainers directly reached about 1500 farmers belonging to 32 farmer groups. These farmer groups were formed as the main training units while volunteer farmer trainers for each group were selected through the Kapcheno dairy. In addition, with the technical support of the MICCA pilot project, 32 group tree nurseries were established with 90, 000 seedlings and 2 biogas digesters were constructed (Rosenstock *et al.*, 2014). According to the project staff, the project also organized field days to reach many farmers and learning tours within and outside the county for farmers to exchange ideas on improved farming practices (Moses Ndathie, personal communication, July 2014).

2 METHODOLOGY AND CONDUCT OF THE STUDY

2.1 The study area

Nandi County is located in the Rift Valley region and covers an area of 2,884 Km^2. The county is bordered by Kakamega County to the west, Uasin Gishu County to the north-east, Kericho County to the south-east, Kisumu County to the south and Vihiga County to the south-west. Nandi County lies between the Equator to the south to latitude $0^0$34'N and longitudes $34^0$45'E and $35^0$25'E. It receives bimodal rainfall averaging 1200 — 2000 mm annually. The long rains start in early March to end of June while short rains start in mid-September to November (Government of Kenya, 2013).

The 2012 population forecast based on the 2009 national census predicted a population of 818,946 equally split by gender (Government of Kenya, 2013). The county's inter-censual growth rate stands at 2.8 percent slightly lower than the national growth rate of 3.0 percent (Republic of Kenya, 2013). Administratively, Nandi County has 5 sub-counties, 11 divisions including Kaptumo Division. Data were collected from six locations of Kaptumo Division, Nandi County of Kenya, which constitute the project area. The locations where EADD-MICCA project activities are implemented were purposively sampled. These locations are Kaptumo, Kapkolei, Ndurio, Koyo, Kapsaos and Kaboi.

2.2 Survey sampling procedure

Kaptumo Division is expected to have a population of 26, 782 based on 2009 census report (KNBS, 2010). An updated list of 440 farmers excluding names of close family members to increase variability in the data, was developed with the participation of local key informants. These are members of farmer groups formed by the MICCA pilot project, and thus directly participated in various project activities and trainings. This sampling frame of project participants constituted the population from which a representative sample was drawn for the purpose of this adoption study. Following the formula in Mugenda and Mugenda (1999), a statistically determined optimal sample size within a 95 percent confidence level, 6.5 percent confidence interval and 0.5 standard deviation was calculated to be 150 farmers. This sample size was distributed across the six locations using proportion-to-population formula as shown in Table 2.1.

Table 2-1: Survey sample size distribution by gender across 6 locations in Kaptumo Division

LOCATION	Participants in farmer groups			Sample allocation			
	Total	Male	Female	Total	Male	Female	Proportion (%)
Ndurio	81	35	46	28	12	16	18
Kaptumo	123	96	27	42	33	9	28
Kapkolei	45	41	4	15	14	1	10
Koyo	78	61	17	27	21	6	18
Kapsaos	71	57	14	24	19	5	16
Kaboi	42	31	11	14	10	4	10
TOTAL	440	321	119	150	109	41	100

Stratified random sampling design was applied selecting farmers for in-person interviews (Alreck and Settle, 1985). Locations formed the main strata for sampling. The allocated number of farmers presented in Table 2-1 was randomly sampled in each of the six locations from a list of all farmers participating in farmer groups. The unit of sampling was the household (of the farmer in farmer groups), using the definition for a household , as a group of individuals belonging to the same residential place where distinct economic activities of production and consumption simultaneously occurs (Ellis, 1993). Some households had more than one participant in the farmer groups. This meant that cleaning of the list of farmers preceded random selection to ensure that each household had equal chance of being selected.

2.3 Data collection process

Household survey data were collected using a structured questionnaire (Annex 7.2). The questionnaire asked about: 1) household information, 2) farm characteristics, 3) participation project activities, 4) adoption of improved fodder and agroforestry practices, 5) adoption of manure management practices and 6) household food security and adoption benefits.

Prior to actual data collection, a team of six enumerators was trained in questionnaire administration, translation and recording of geo-referenced responses. The enumerators also participated in pre-testing of the questionnaire and shared their initial experiences with translation. The team leader and enumerators went through each of the questionnaires filled during pre-test and clarified issues that were unclear.

Enumerators were given names of farmers and paired for ease of coordination of visits to homesteads. A total of 150 homesteads were visited and the household member belonging to a farmer group was interviewed using a structured questionnaire. Data were collected on household size and characteristics; livestock and crop production; participation in EADD-MICCA capacity building activities; adoption of specific CSA practices (including improved fodders, agroforestry practices, tree nursery management, manure composting and biogas use). In addition, information was collected on adoption constraints and perceptions on early benefits from the CSA practices adopted.

2.4 Focus group discussions

Homogenous groups of stakeholders that had actively participated in the project activities or interacted with farmers in the six locations of Kaptumo Division were constituted separately and guided through focussed discussions. We targeted 6-10 participants for each of the target groups. In total 47 participants took part in the five focus group discussions (FGDs) as shown in Table 2-2. Check lists of questions for the FGDs are in Annex 7.3. The five FGDs were conducted in parallel with the household interviews as follows:

- FGD 1- MICCA/EADD staff and Kapcheno dairy (provided background information on project and implementation process).
- FGD 2- Farmer trainers- randomly sampled from the 6 sub-locations
- FGD 3- Farmers randomly sampled from Kaptumo, Ndurio, Kaboi (these locations receive reliable rainfall and have more tea, so likely to have lower interest in dairy)
- FGD 4- Farmers randomly sampled from Koyo, Kapsaos, Kapkolei locations (rely mostly on maize cultivation)
- FGD 5- Women farmers (not in the other FGDs) randomly sampled from two women groups.

Table 2-2: Participants by gender in focused group discussions, Kaptumo Division, Nandi County

Participants in FGD	TOTAL	FEMALE	MALE
1. Project staff from EADD/MICCA/ICRAF and Kapcheno dairy	6	2	4
2. Farmer trainers	11		11
3. Farmers from predominantly tea production	9	4	5
4. Farmers from predominantly maize production	10	2	8
5. Women farmers from women groups	11	11	
TOTAL	47	19	28

At the meeting, the team leader explained the objective of the group discussions and highlighted the broad themes for deliberations. The team leader also directed the discussions, guided by a set of questions in the relevant checklists. Further probing was done to focus the deliberations and generate comprehensive information. Deliberate efforts were made for the discussions to be as interactive and participatory as possible by encouraging contributions from all participants. Both the team leader and project staff documented all deliberated issues. Data were collected in field notebooks and flip charts.

2.5 Data analysis and presentation of results

All collected data from household interviews were first entered in Ms Excel 2013 for easier data coding and then exported to Statistical Package for Social Scientists (SPSS 20) software for analysis. Qualitative responses were grouped into common themes and coded in Ms Excel 2013. Basic data cleaning and processing as recommended by Verbeek (2008) preceded statistical analysis based on descriptive procedures in SPSS 20 software. Analysis of FGD information involved summarising responses in MS Word 2013. Main results from the household survey and FGDs are presented in tables, graphs, using pictures and narratives in the text.

3 RESULTS OF THE STUDY

3.1 Household socio-economics and farm characteristics

3.1.1 Household type and size

Most of the households were male-headed (71 percent) while female-headed households constituted 29 percent of the sample. Majority of the farmers who participated in MICCA pilot project activities were male (65 percent) while 35 percent of them were female. A majority (90 percent) of farmers in the project group were household heads, which implies that they also made decisions on farming activities. A typical household in the study site had an average of six members, half of whom worked mostly on the farm while the rest were school-going children or adults working elsewhere. Disaggregated by gender, household average size for male-headed households was 6.2 and 5.5 for female-headed households. Overall, the average farmer’s age was 45.9 years.

3.1.2 Education level and main occupation

About 45 percent of the farmers had attained secondary level of education, followed by 33 percent with primary and 15 percent with college education. A similar trend was found across gender with 47 percent of male and 42 percent of female famers having attained secondary education (Table 3-1). This indicates that a majority of farmers have appreciable formal knowledge to understand and implement climate-smart agricultural technologies promoted in the area.

Table 3-2: Education levels attained by farmers

Highest education level	Overall % (n=150)	Proportion (%) of farmers by gender	
		Male (n=98)	Female (n=52)
None	0.7	0.0	1.9
Adult education	4.0	3.1	5.8
Primary	32.7	30.6	36.5
Secondary	45.3	46.9	42.3
College	15.3	16.3	13.5
University	2.0	3.1	0.0
Total	100	100	100

Farming was the main livelihood occupation for a majority (85 percent) of respondents compared to off-farm activities (Table 3-3). Results in Table 3-3 show that farmers had diverse sources of income. At least a third of all farmers mainly sold milk to generate household income. This finding clearly shows that improvement of milk production and marketing as envisaged by the EADD-MICCA pilot project can benefit most farmers thereby narrowing gender disparity based on income.

Table 3-3: Primary occupation of farmers and their main sources of income

	Overall % (n=150)	Proportion (%) of farmers by gender	
		Male (n=98)	Female (n=52)
Primary occupation			
Farming activities	85.3	86.7	82.7
Off-farm activities	14.7	13.3	17.3
Main sources of income			
Selling milk	33.3	33.0	33.8
Selling tea	28.3	30.3	24.3
Seasonal farm labourer	11.2	10.1	13.2
Salaried employment	6.9	6.0	8.8
Occasional piece jobs	6.0	6.7	4.4
Selling maize	4.7	4.9	4.4
Selling seedlings	4.5	4.1	5.1

Petty business	2.5	1.1	5.1
Selling agroforestry trees	1.2	1.5	0.7
Selling coffee	0.7	1.1	-
Selling poultry and eggs	0.5	0.7	-
Table banking	0.2	0.4	-

Selling tea products is another important source of household income for about 28 percent of the respondents. Income from tea sales was cited by a relatively higher proportion of male (30 percent) than female (24 percent) farmers (Table 3-3). To supplement farm income, one in every ten farmers earned wages from seasonal casual labour supply to other farms. Disaggregated by gender, this type of income source involved mostly female (13 percent) than male (10 percent) farmers. Other sources of income such as salaried employment, selling seedlings and petty business were reported in less than 10 percent of all responses (Table 3-3).

3.1.3 Access to agricultural markets and credit facilities

Results in Table 3-4 show that two-thirds of farmers usually relied on motorbike transport to reach the market. A high proportion (71 percent) of male farmers used motorbikes compared to about 58 percent of female farmers. This is perhaps due to the fact that taking farm produce to the market is mostly done by men. Motor bike was mostly preferred for transportation of farm products (e.g. milk, tea leaves, vegetables, etc.) because farmers incurred relatively lower cost (KES 61) and took less time to reach the market (23 minutes).

About 15 percent of farmers used public transport mostly among female farmers (25 percent). Farmers who relied on public transportation incurred slightly higher cost (KES 74) and took more time (37 minutes) to reach the market compared to those who used motorbikes. Use of bicycle and walking were likely to be used less because of the hilly terrain. The 2 percent of male farmers who reported the use of bicycles did not own them; instead they likely paid a fee to the 'boda-boda' cyclists for the service. These results therefore show that farmers who are close to the market will possibly walk (but there are not many who are close) and that those who are further away will likely take public transport or use a motorbike.

Table 3-4: Common means of transportation cost and time taken to the nearest market

Usual transportation means	Proportion of use (%) by gender		Overall % (n=150)	One way cost (KES) by gender		Overall KES (n=150)	Time (min) by gender		Overall min (n=150)
	Male	Female		Male	Female		Male	Female	
Motor bike	71.4	57.7	66.7	62.9	55.6	60.7	23.6	23.0	23.4
Public vehicle	10.2	25.0	15.3	81.0	74.6	77.4	42.0	32.3	36.5
Own car	8.2	11.5	9.3	253.8	145.0	207.1	19.4	16.7	18.2
Walking	8.2	5.8	7.3	0.0	0.0	0.0	32.9	33.3	33.0
Bicycle	2.0	0.0	1.3	70.0	0.0	70.0	50.0	0.0	50.0

New technologies aimed at improving farm productivity may require additional finances through credit facilities for their effective implementation. About 45 percent of the farmers obtained agricultural credit from various sources (Figure 3.1). Access to credit for farming purposes did not significantly differ between male-headed and female-headed households. Generally, most of the loans received were used for purposes aimed at improving farm production such as purchase of farm inputs (40 percent), purchase of livestock (21 percent) and purchase of land (16 percent).

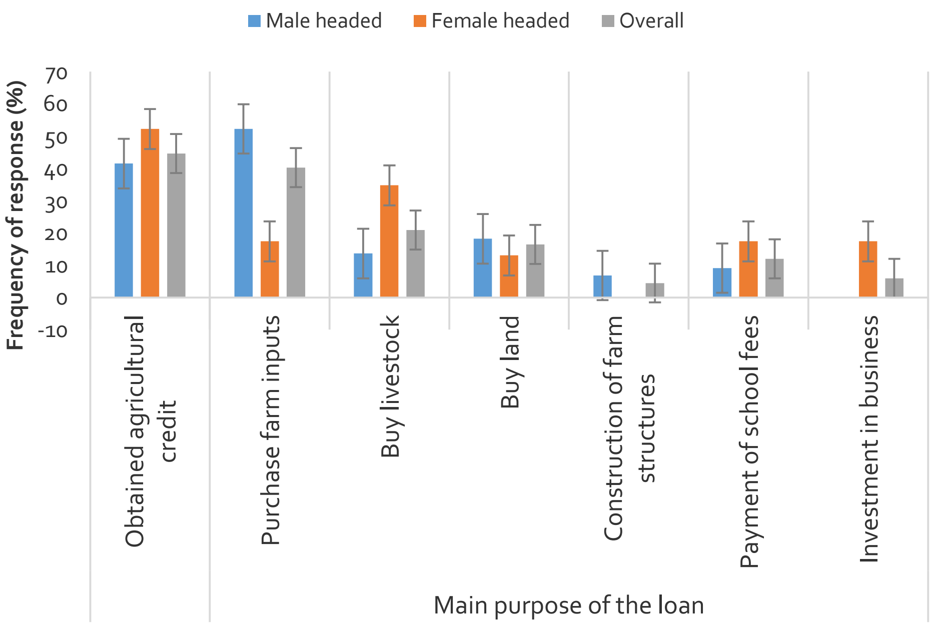

Figure 3.1: Distribution of farmers who obtained agricultural credit and main uses of the loan

Error bars in this and subsequent figures that do not overlap indicate statistical difference at 5 percent level of significance.

More male-headed than female-headed households purchased farm inputs (e.g. seeds, fertilizers, mineral licks etc.) with loan amount. Conversely, higher percentage of female-headed than male-headed households bought livestock using the loan money (Figure 3.1). This finding indicates that male farmers are already advantaged in terms of livestock ownership and would simply purchase variable farm inputs unlike their female counterparts. Fewer households diverted part of the credit to non-farm uses such as payment of school fees and investment in petty business ventures implying that most of the agricultural credit was invested in intended activities aimed at improving farm productivity.

3.1.4 Land ownership, labour availability and farm productivity

According to the household survey, the average farm size was 4.1 acres and disaggregated by gender, male-headed households owned 4.4 acres and female-headed households managed 3.6 acres (Table 3-5). This finding points to small average land holdings that may require the application of intensive and sustainable practices in order to support the increasing needs of farming households with rising population. Most of the households owned land with title deeds (81 percent) on which mixed crop-livestock farming is practiced by almost all households (98 percent). This indicates that a majority of households have secure land tenure, which could serve as security for investment into longer term improved practices such as planting agroforestry and fodder trees as well as acceptable guarantee to secure affordable credit to do so. However, according to the women FGD, men are the custodians of land title deeds with limited user-rights extended to women and youth, thereby making it difficult for them to plant trees viewed in the community as ‘marking own farm boundary’.

Table 3-5: Selected farm characteristics

Characteristic	Overall (n=150)	Average ownership by gender	
		Male-headed (n=106)	Female-headed (n=44)
Farm size managed by household (acres)	4.1	4.4	3.6
Household members working on-farm (number)	3.0	2.9	3.2
Household members working on-farm (%)	49.0	46.1	56.0
Hired labourers (number)	2.6	2.7	2.3
Period hired labour (months)	6.3	5.9	7.5
Number of livestock owned (median)			
Cattle	4.0	4.0	4.0
Goats	3.0	3.0	1.0
Sheep	3.0	3.0	3.0
Chicken	11.5	12.5	10.0
Donkeys	1.0	1.0	1.0
Rabbits	3.0	2.5	9.0

Overall, half of the household members supplied family labour to their own farms and this proportion was higher among female-headed households. About 55 percent of the sampled households hired on average three labourers to supplement family labour for half a year (Table 3-5). Male-headed households hired slightly more workers but for a relatively short period compared to the female-headed households. This labour hiring pattern could be due to the relatively large size of the farms managed within male-headed households, which is mostly under tea production. Some of the activities for which labour was hired included picking tea leaves and feeding and grazing livestock.

The median number of livestock owned by an average household was four cattle, three goats, three sheep and 12 chickens. A median number of about three rabbits and a donkey were reported in fewer households. About 95 percent of the households interviewed kept at least one improved dairy cattle.

An improved breed heifer

Milk production and marketing information is presented in Table 3-6. The average daily milk output, sales, prices and revenue were comparatively higher during the wet season than the dry season, irrespective of the type of cattle breed (i.e. local or improved). This is likely to be due to the greater feed availability during the wet season. This finding shows that there is a potential for climate-smart practices such as improved fodder production and effective feed conservation to help even out milk production between the two seasons.

Table 3-6: Average productivity and income from the main farm enterprises

Output by type of farm enterprise	**Wet season by type of household**			**Dry season by type of household**		
	Overall	Male-headed	Female-headed	Overall	Male-headed	Female-headed
Dairy cattle						
Average milk output (litres/cow/day)	9.5	9.3	10.0	6.6.	6.5	6.7
Amount of milk sold (litres/day)	7.5	7.3	7.9	4.8	4.6	5.2
Price of milk (KES/litre)	30.9	31.3	30.1	35.4	35.0	36.3
Income from sale of milk (KES/day)	228.7	224.7	237.9	172.8	161.9	198.8
Tea production						
Yield (kg/acre)	5,582.6	4,712.0	8,738.4	3,049.9	2,689.0	4,358.0
Quantity sold (kg)	7,504.3	6,383.7	11,566.7	4,228.2	3,572.6	6,604.8
Price (KES/kg)	22.0	22.4	20.7	22.1	22.5	20.7
Income from sale of tea (KES)	155,437.7	134,113.0	232,739.6	89,648.0	76,919.3	135,789.6

However, discussions with different farmer groups revealed a serious marketing concern caused by delayed payment from Kapcheno dairies due to non-payment by the main milk buyer, which has compelled some farmers to sell their milk to hawkers. Even though farmers got immediate payment, they also admitted that prices were relatively lower and they had no access to saving and credit facilities as well as check-off system for farm inputs.

The common crops grown in the study area were mainly maize and tea. On average the area under tea production (1.5 acres) was twice that of maize (0.7 acres). This indicates tea is more financially attractive as a source of income due to relatively stable prices across seasons. Tea is also a perennial crop so it doesn’t need to be planted with additional inputs each year.

3.2 Adoption of climate-smart agricultural practices

3.2.1 Participation in project activities

Promotion of climate-smart agricultural practices involved several project activities aimed at building the capacity of farmers. About three-quarters of interviewed farmers participated in at least half of the 15 different capacity building and training activities (Figure 3.2).

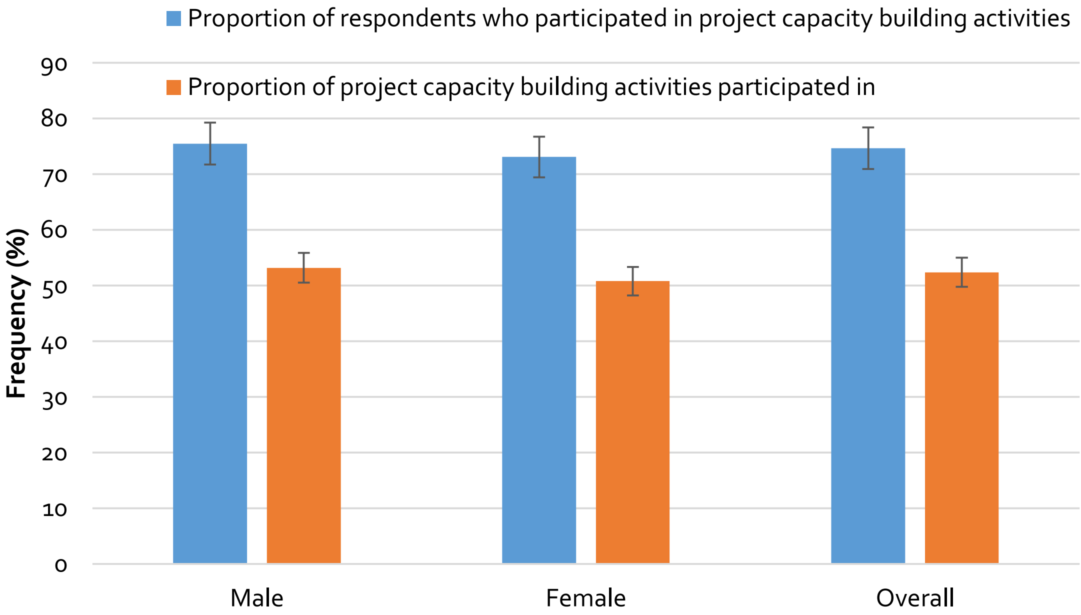

Figure 3.2: Farmers' participation in capacity building activities promoted by MICCA pilot project

The project activities in which farmers participated in are presented in table 3-7.

Most farmers were trained in improved fodder production (70 percent), better livestock management (68 percent), feed conservation and utilization (65 percent) and tree planting (65 percent). High participation of farmers in training aimed at improving livestock productivity indicates a growing interest to increase milk output and income, which is likely related to reducing revenues from tea sales.

More than half of farmers participated in capacity building activities related to environmental conservation and mitigation of climate change such as awareness campaigns on climate change, establishment of tree nurseries and tree planting (3-7).

Table 3-7: MICCA pilot project capacity building activities farmers participated in

Activity organized by the project	Overall % (n=150)	Participation by gender (%)	
		Male (n=98)	Female (n=52)
Training on fodder establishment and management	70.0	70.4	69.2
Training on animal health, breeding, calf rearing and milk quality	68.0	67.3	69.2
Training on fodder conservation and utilization of crop residue	65.3	64.3	67.3
Training on tree planting and management	64.7	64.3	65.4
Field days	60.0	62.2	55.8
Training on nursery establishment and management	55.3	56.1	53.8
Training on pasture management and paddocking	54.7	54.1	55.8
Climate change awareness sessions	54.7	56.1	51.9
Training on feed formulation	44.2	45.3	45.9
Training on manure management	42.3	47.3	50.0
Training on compositing	40.4	42.0	42.9
Training on biogas production	38.5	39.3	39.8
Workshops/seminars	26.9	38.0	43.9
Exchange trips	23.1	26.7	28.6
Training in group dynamics	54.0	52.0	57.7
Training on feed formulation	44.2	45.3	45.9
Training on manure management	42.3	47.3	50.0
Training on compositing	40.4	42.0	42.9
Training on biogas production	38.5	39.3	39.8
Workshops/seminars	26.9	38.0	43.9
Exchange trips	23.1	26.7	28.6

About 54 percent of farmers were trained in group dynamics, which according to project staff, was in recognition that more farmers needed collective action to adopt most of the CSA practices so as to achieve discernible impact on agricultural production in the face of climate change and enhance resilience of rural livelihoods.

However, there were six MICCA pilot project capacity building activities that just few farmers participated in as shown in Table 3-7. They include training on feed formulation (44 percent), better manure management (42 percent), compositing (40 percent) and biogas production (38 percent). Others were participation in workshops (27 percent) and exchange trips (23 percent). Fewer male than female farmers participated in these project activities (3-7). Low participation in training particularly on manure management, compositing and biogas digesters may affect actual adoption of these practices.

Table 3-8 presents which information was the most important for farmers on the access to various improved agricultural practices through the MICCA pilot project capacity building activities. About 76 percent of farmers mostly accessed information on improved milk production, followed by animal health (49 percent) and agroforestry practices (41 percent). The least cited information was on climate change awareness (17 percent), improvement of natural pastures (14 percent) and better manure management (11 percent). Level of access to particular information would influence the likelihood of farmers adopting the promoted practices such as improved fodder production, agroforestry and manure management.

Table 3-8: Most important information accessed through the MICCA pilot project

Information accessed on:	Overall % (n=150)	Response by gender (% of cases)	
		Male (n=98)	Female (n=52)
Milk production	75.7	78.1	71.1
Animal health	48.6	46.6	52.6
Agroforestry practices	40.5	42.5	36.8
Feed conservation	32.4	24.7	47.4
Planting/sowing methods	27.0	23.3	34.2
Fodder management	27.0	30.1	21.1
Climate change awareness	17.1	19.2	13.2
Improvement of natural pastures	14.4	13.7	15.8
Manure management	10.8	13.7	5.3

3.2.2 Improved fodder production

Nine in every ten farmers reported to have planted some fodder crop on their farms. This proportion provided overall incidence of adoption of improved fodder crops. Improved fodder cultivation was reported in more male-headed (92 percent) than female-headed (82 percent) households (Table 3-9). This could be related to the comparatively smaller average farm sizes within female-headed households as well as the property deed belonging to male that likely constrained planting of fodder crops.

Table 3-9: Type of improved fodder crops currently planted on farms

Type of fodder planted	Overall % (n=150)	Proportion(%) by gender	
		Male-headed (n=106)	Female-headed (n=44)
Napier grass	88.0	90.6	81.8
Rhodes grass	34.7	35.8	31.8
Fodder sorghum	7.3	6.6	9.1
Desmodium	3.3	2.8	4.5
Lucerne (alfalfa)	2.7	2.8	2.3
Dolichos lablab	0.7	0.9	-

A female farmer admiring her plot of Napier-Desmodium intercrop and Calliandra shrubs on her left-hand side

Napier grass (88 percent) and Rhodes grass (35 percent) were the commonly grown fodder crops. Whereas Desmodium (3 percent), Lucerne alfalfa (3 percent) and Dolichos lablab (1 percent) were the least adopted improved fodder types. Brachiaria and Columbus grasses were not adopted at all. The improved fodders except for Napier grass were mostly planted after the interventions though MICCA pilot project and EADD project.

The extent of adoption of improved fodder crops was measured by the area actually cultivated by farmers. The results in Table 3-10 show that farmers allocated small areas (about 0.6 acres) for the cultivation of improved fodder crops. This is around 18 percent of the average farm size. Napier and Rhodes grasses covered a higher area under cultivation compared to other fodder types.

Table 3-10: Average area under improved fodder production

Type of fodder planted	Area cultivated (acres) by gender					
	Overall		Male-headed		Female-headed	
	Mean	Std.	Mean	Std.	Mean	Std.
Total area under improved fodders	0.55	0.50	0.55	0.52	0.56	0.43
Proportion of farm under improved fodders (%)	17.72	14.55	17.16	14.98	19.24	13.40
Napier grass	0.40	0.36	0.40	0.38	0.41	0.29
Rhodes grass	0.32	0.32	0.33	0.34	0.29	0.27
Fodder sorghum	0.15	0.08	0.14	0.09	0.16	0.08
Lucerne (alfalfa)	0.20	0.10	0.18	0.12	0.25	0.00
Desmodium	0.17	0.12	0.14	0.15	0.23	0.04
Dolichos lablab	0.30	0.00	0.30	0.00	0.00	0.00

Std. is Standard deviation

Generally, a majority (90 percent) of farmers cultivated improved fodder crops on a portion of their farm, with only few (mostly female) farmers who planted on farm boundary or terrace bank (Figure 3.3), possibly due to the smaller scale of the land. This finding demonstrates that farmers are growing more improved fodders on the farms to increase farm productivity.

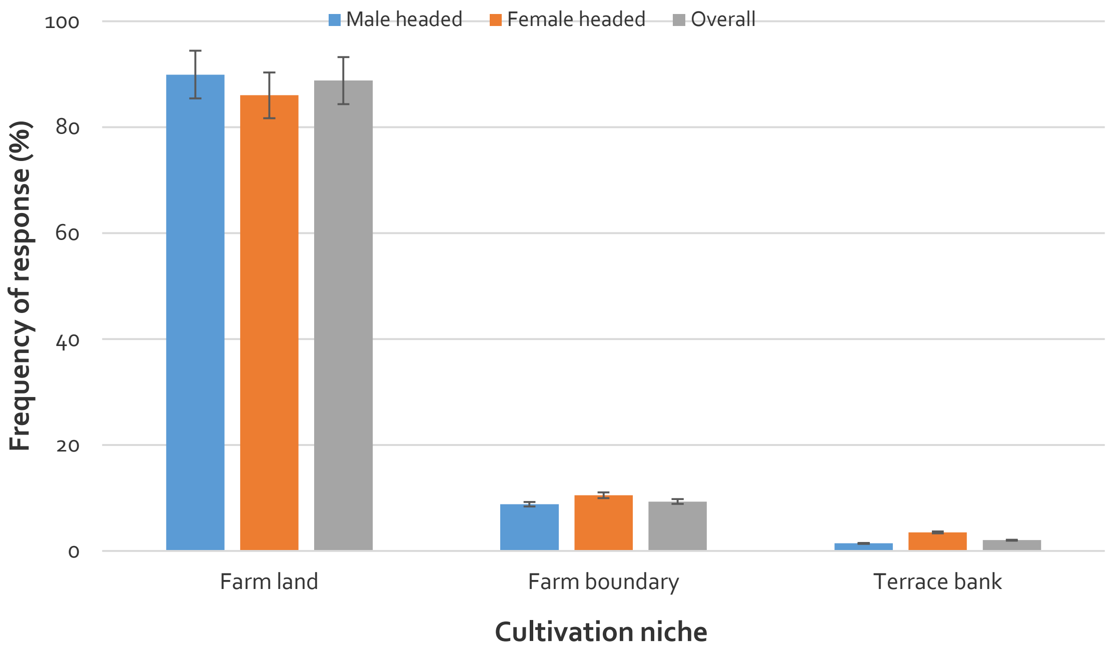

Figure 3.3: Common niches for cultivation of improved fodder crops

Access to planting materials and seeds from various sources was essential for adoption of the promoted fodder crops. Slightly over half of the farmers who had adopted some of the improved fodder crops sourced planting materials from their neighbours mainly for Napier grass. 20 percent of them purchased fodder seeds from the market especially for Rhodes grass. One tenth of the farmers received seeds for crops such as Desmodium, Dolichos lablab and Lucerne (alfalfa) through the project farmer groups (Figure 3.4).

Figure 3.4: Main sources of fodder seeds and planting materials

Farmers considered several key criteria when they chose the type of fodder crops to adopt on their farms. Results in Table 3-11 show that the most important criteria included more milk production (84 percent) when an animal is fed on a particular fodder, high herbage yield (60 percent), easy to harvest and feed to animals (49 percent) and faster growth (46 percent). Fewer male than female farmers also considered availability and cost of planting materials, extension advice and fodder types that are tolerant to pests and diseases (Table 3-11).

Table 3-11: Important criteria considered when choosing the type of fodder to plant

Criteria	Overall % (n=132)	Response by gender (%)	
		Male-headed (n=97)	Female-headed (n=35)
More milk production	84.1	85.6	80.0
High yielding crop	59.8	61.9	54.3
Easy to harvest and feed to animals	49.2	47.4	54.3
Fast growth	45.5	49.5	34.3
Availability& cost of seed/planting material	21.2	19.6	25.7
Advice from extension workers	15.9	13.4	22.9
Tolerance to climate variability	12.1	10.3	17.1
Tolerant to pests/diseases	10.6	10.3	11.4

The extent of adopting specific fodder crops depended on four major factors shown in Figure 3.5. The area put under fodder crop production by a majority of farmers was related to the available farm size and the number of livestock owned. Other factors were availability of seed/ planting materials considered by half of the farmers and labour availability among about 40 percent of them (Figure 3.5).

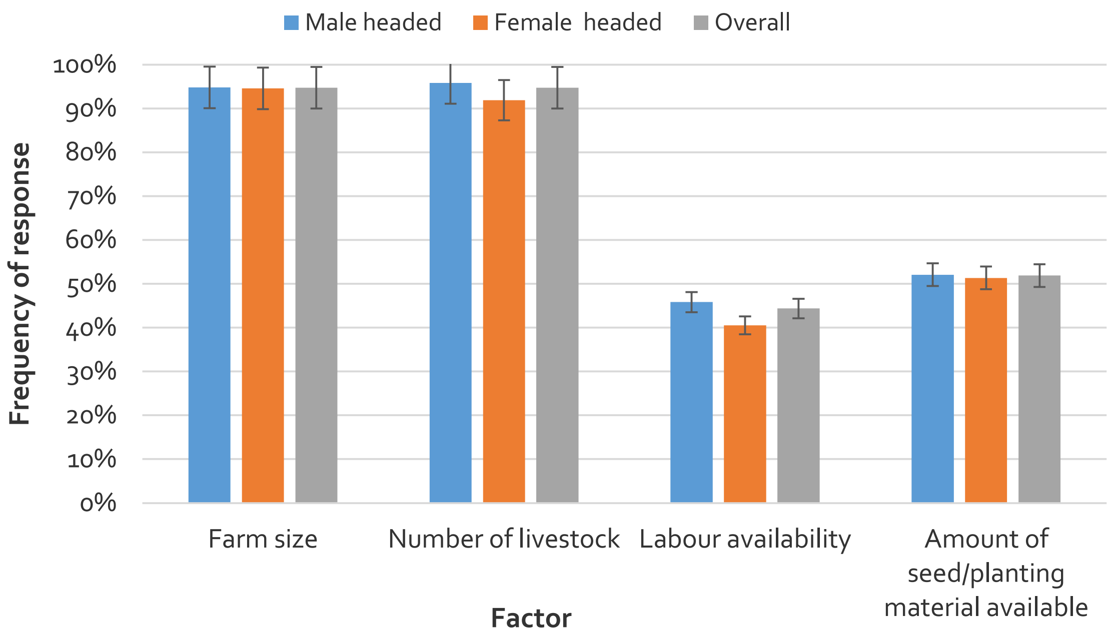

Figure 3.5: Factors influencing the area under improved fodder production

Feed conservation is useful in ensuring that livestock feed is available during both dry and wet seasons to stabilize milk productivity. However, more than half of the interviewed farmers did not practice any feed conservation (Figure 3.6).

Among those who conserved feeds, a higher proportion of female-headed households' baled hay or wilted the herbage; whereas, more male-headed households reported making silage (Figure 3.6).

These different preferences of conservation methods between the genders most likely relate to hired labour availability within the households. The male-headed households were found to have hired relatively high labour for short seasons, which could also be applied in the labour-intensive silage making.

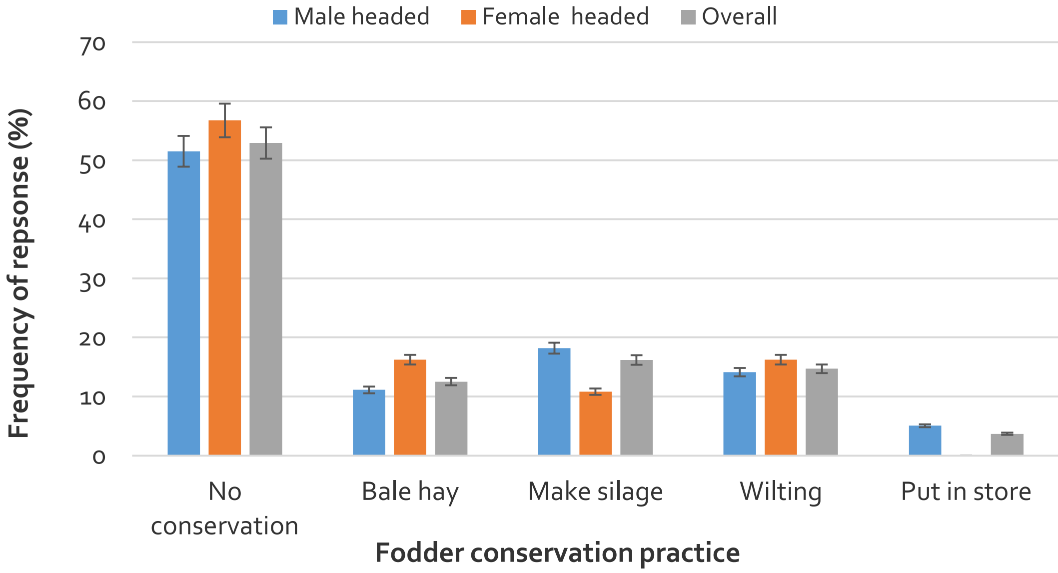

Figure 3.6: Main fodder conservation practices

A farmer preserving livestock feeds in a store on his farm

Given the low level of livestock feed conservation, feed scarcity was experienced on average in 3 out of the 12 most recent months, up to July 2014. The annual trend in scarcity of livestock feed is shown in Figure 3.7. Participants identified feed scarcity peaks between January and March affecting over 80 percent of the households. This period is characteristically dry before the on-set of long rains around mid-March. Feed scarcity was lowest between May and November due to reliable rainfall amounts received and availability of crop residues used to feed animals during this period.

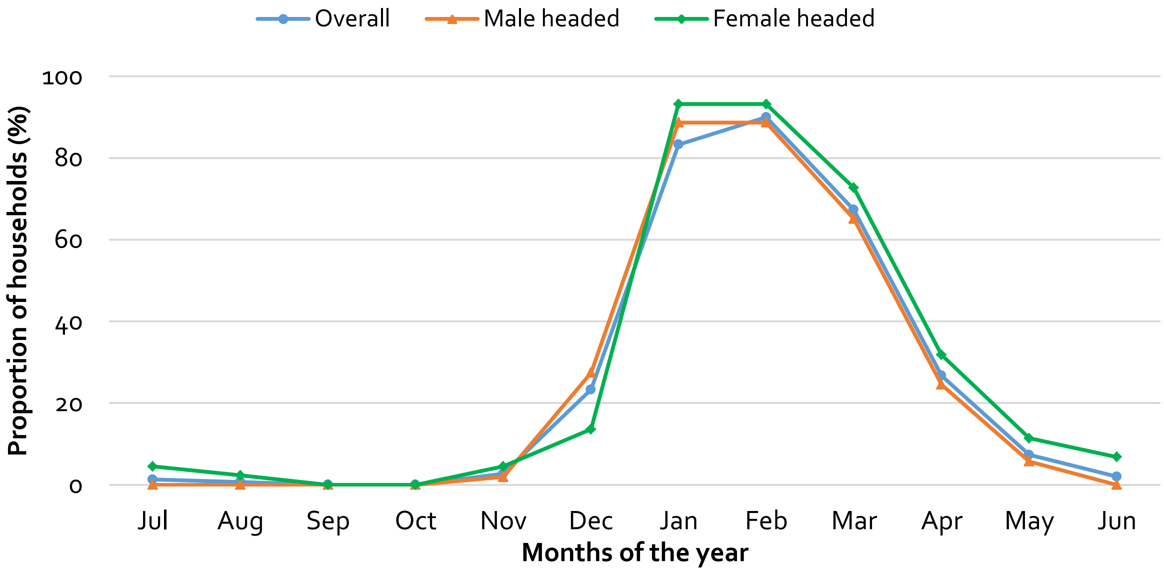

Figure 3.7: Trend in livestock feed scarcity during the past 12 months (July 2013 to June 2014)

3.2.3 Agroforestry and fodder trees

Types of agroforestry and fodder trees adopted by farmers are presented Table 3-12. Almost all (93 percent) of the homesteads had some of the promoted trees. A larger share of male-headed (94 percent) than female-headed (89 percent) had planted trees on their farms possibly due socio-cultural factors such as land tenure and customs that may limit women from planting trees. Common trees found on farms were Croton (83 percent) and Grevillia (69 percent). Fodder trees adopted by farmers included Calliandra (24 percent), Sesbania sesban (13 percent) and Leucaena (5 percent). Tree Lucerne was the least adopted by less than 1 percent of famers and only reported in female-headed households.

Table 3-12: Percentages of households planting trees on farms

Type of agroforestry/ fodder tree	**Overall % (n=150)**	**Proportion by gender (%)**	
		Male-headed (n=106)	Female-headed (n=44)
Planted agroforestry/ fodder trees	92.7	94.3	88.6
Croton	82.7	84.0	79.5
Grevillia	68.7	71.7	61.4
Calliandra	23.5	26.7	15.9
Sesbania sesban	12.7	13.2	11.4
Leucaena	5.3	6.6	2.3
Tree Lucerne	0.7	0.0	2.3

Extent of adoption of agroforestry and fodder trees was established by the average number of trees planted per household. Results in Table 3-13 show that some trees were planted in high numbers and this can be explained by their size and use. On average there were 68 Croton and 51 Grevillia trees planted on the farm. Among the adopted fodder trees, a farmer had planted an average of 94 Calliandra and 70 Sesbania sesban trees. The average number of trees for Croton, Calliandra and Leucaena was higher among male-headed than female-headed households, an indication of underlying different preferences among gender and socio-cultural barriers such as land size and tenure that restrain female farmers from planting more trees.

A grown Calliandra fodder tree on a farmer's field

Table 3-13: Average tree population planted on the farm by type

Type of agroforestry/ fodder tree	Average number of trees planted by gender					
	Overall		Male-headed		Female-headed	
	Mean	SE	Mean	SE	Mean	SE
Croton	68.2	6.9	72.4	9.1	57.7	8.0
Grevillia	50.5	7.0	51.3	8.8	48.3	10.0
Calliandra	94.1	30.9	97.1	37.5	82.1	40.6
Sesbania sesban	69.5	27.9	69.7	37.6	68.8	20.6
Leucaena	20.4	5.3	21.1	6.0	15.0	0.0

SE is Standard Error of the Mean

We compared the average number of trees planted before and after the intervention by the MICCA pilot project to assess extent of farmers' response to the promoted types of agroforestry and fodder trees. A higher average number of Calliandra, Sesbania sesban and Grevillia were planted after the implementation of the MICCA pilot project (

Table 3-14). Tree Lucerne was only established during the period of the project. However, Croton and Leucaena were mostly planted before MICCA interventions (

Table 3-14).

Table 3-14: Comparison of average number of trees planted before and after MICCA intervention

Type of agroforestry/ fodder tree	Before MICCA intervention		After MICCA intervention	
	Mean	SE	Mean	SE
Calliandra	48.2	9.4	112.4	42.8
Sesbania sesban	36.3	12.8	88.8	43.2
Croton	71.1	8.3	57.9	9.6
Grevillia	47.6	5.8	57.3	19.0
Leucaena	50.0		16.1	3.6
Tree Lucerne	-	-	50.0	0.0

SE is Standard Error of the Mean

Regarding the niches within the farm where farmers established agroforestry and fodder trees, results show significant gender differences based (

Figure 3.8). Male headed households mostly established small woodlots within the farm land whereas female headed households preferred planting tree lines on the farm boundary. This difference could be attributed to the relatively small land sizes within female headed households, hence the likely high competition between trees and other crop enterprises on the farm. Less than 10 percent of the farmers planted trees on terrace banks.

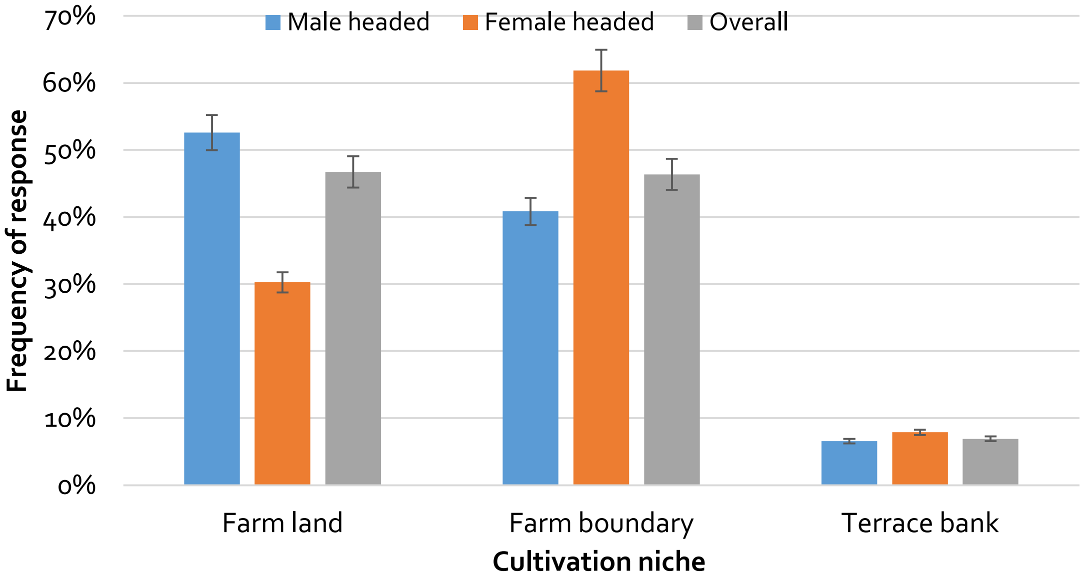

Figure 3.8: Common niches for cultivation of agroforestry and fodder trees

Farmers obtained tree seedlings from five different sources as shown in Figure 3.9. The MICCA project group nursery was the main source of seedlings, especially for fodder trees. A higher proportion of male headed than female headed households obtained seedlings, and they planted mostly from this source. This could possibly be attributed to the dissimilar but complementary view on the benefits from MICCA project group nurseries by the two genders; women likely viewed tree nursery as an immediate income generation enterprise hence they mostly sold the seedlings from the nurseries whereas men saw the nurseries (mostly managed by women) as convenient source of seedlings for planting trees with possibility of economic and environmental benefits in the long run.

The second source was the local market, from where significantly more female headed households obtained seedlings mainly for fruit trees such as Avocados. Neighbours were also a major source of seedlings, mostly among female headed households and especially for indigenous trees commonly preferred for firewood and whose seeds are collected locally. Only 15 percent of farmers got seedlings from their own tree nurseries as just few of them had established one. Private nursery operators supplied tree seedlings to mostly male-headed households (Figure 3.9).

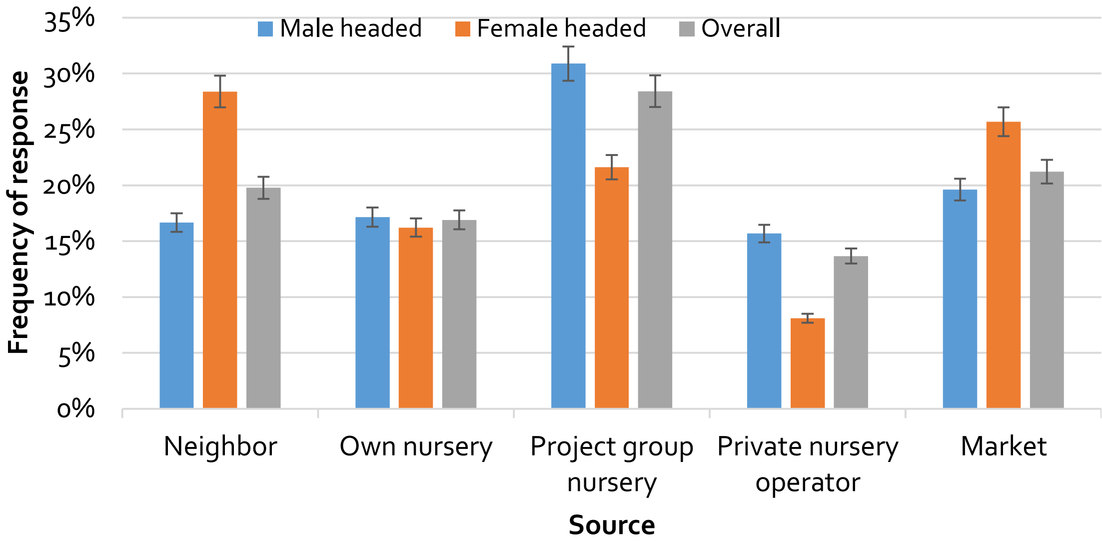

Figure 3.9: Main sources of seedlings for agroforestry and fodder trees

Farmers considered five main criteria when choosing suitable agroforestry and fodder trees to plant. The main factors were the number of uses, period to maturity and availability of seedlings, from more to less important (Figure **3.10**). Farmers were likely to plant trees with a multiple use, with a faster maturity, and whose seedlings were readily available in the area. Other factors, less important but preferred by female famers, were tolerance to dry spells and better income prospects from the sale of the trees and their products (Figure 3.10).

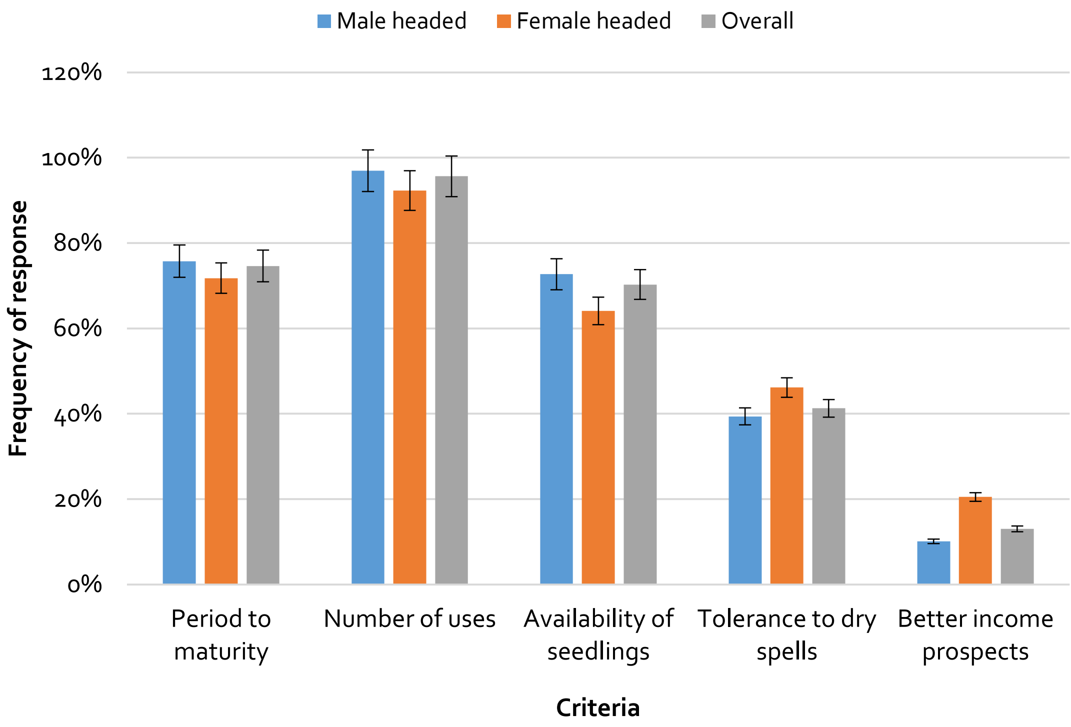

Figure 3.10: Criteria considered when choosing the type of agroforestry and fodder trees to plant

3.2.4 Tree nursery establishment and challenges

About 41 percent of the farmers had established their own or group tree nurseries. The main challenges faced in tree nursery management are presented in Table 3-15. The main challenges were unreliable rainfall (63 percent), damage by pests and diseases (63 percent) and unavailability of preferred seeds (60 percent). Other hardships encountered revolve around poor markets for tree seedlings (48 percent), poor germination of seeds (40 percent) and theft of seedlings from nurseries (5 percent). Effective promotion of tree nurseries would therefore require proper integration of practical solutions to these problems.

Table 3-15: Challenges faced in the management of tree nurseries

Challenge	Overall % (n=84)	Proportion by gender (% of cases)	
		Male headed (n=60)	Female headed (n=24)
Unreliable rainfall	62.9	66.7	55.0
Damage by pests/diseases	62.9	64.3	60.0
Unavailability of seeds	59.7	64.3	50.0
Lack of market for seedlings	48.4	45.2	55.0
Poor germination of seeds	40.3	42.9	35.0
Theft of seedlings	4.8	7.1	0.0

3.2.5 Manure management: composting and biogas use

The majority of farmers (88 percent) collected livestock manure in the last 12 months (up to July 2014). The most common manure management practices are shown in Figure 3.11. Most of the farmers typically store manure both under shade or simply uncovered in the open. These common management practices do not minimize GHG emissions. Only about 10 percent of farmers practised composting or manure protected with polythene covers as promoted by the project to mitigate climate change. Female headed households who practised composting were less than half of male headed households. According to farmer trainers, compositing is difficult particularly because the common paddocking system requires extra labour to collect the scattered fresh cow dung.

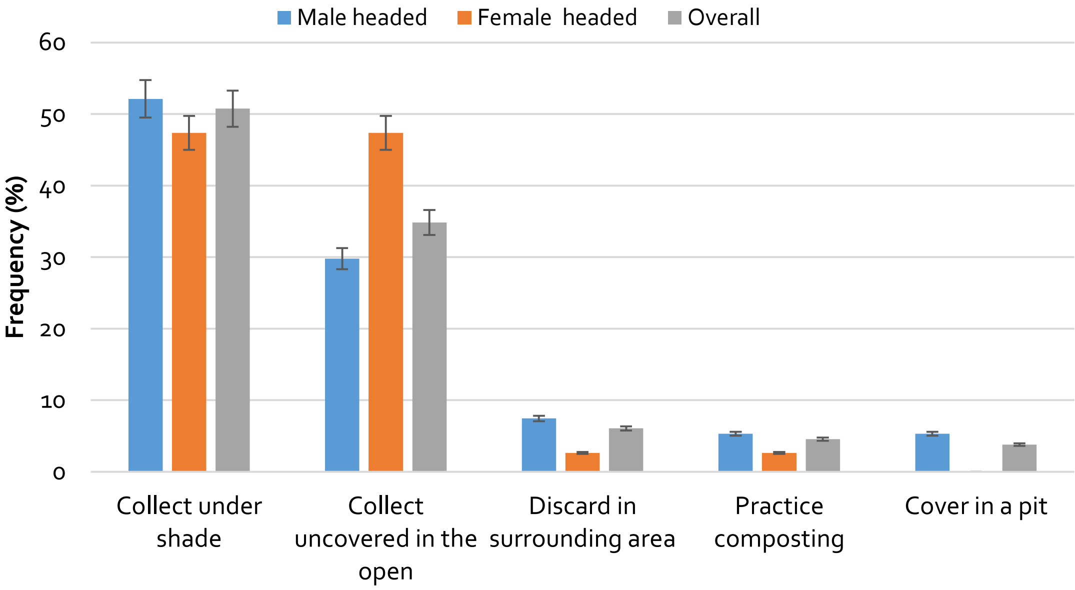

Figure 3.11: Livestock manure management practices

Collected manure was used in various ways as presented in anure was used as construction material for houses, dry dung for cooking and in in some households' digesters to generate biogas. Only a single household was found to have a functioning biogas digester.

Table 3-16. Manure was predominantly used in food crop production (41 percent) and applied to fodders (35 percent). These two main uses of manure were higher within female headed than male headed households. Use of manure in crop production contributes to sustainable nutrient cycling and crop-livestock integration within a farm.

Moreover, manure was used as construction material for houses, dry dung for cooking and in in some households' digesters to generate biogas. Only a single household was found to have a functioning biogas digester.

Table 3-16: Common uses of livestock manure

Manure utilization	Overall % (n=150)	Response by gender (%)	
		Male headed (n=106)	Female headed (n=44)
Used in food crop production	40.5	39.5	43.2
Applied to fodder	35.3	34.9	36.4
Used as construction material	21.8	23.1	18.2
Sold to others	1.8	2.1	1.1
Used dry dung for fuel	0.3	0.4	0.0
Used in biogas generation	0.3	0.0	1.1

3.3 Adoption profile of climate-smart agricultural practices

According to focus group discussions (FGDs), perceptions on the adoption of improved fodder crops did not differ between the upper tea and the lower maize zones. Participants in two separate FGDs (one for each upper and lower zone) indicated that some farmers had adopted Rhodes and Napier grasses and planted few Calliandra fodder trees. Both groups also mentioned that farmers in their areas planted mostly indigenous trees. However, farmers in the lower zone pointed out that they specifically practised dairy farming as a commercial enterprise unlike those in the upper zone who relied on tea production as the main income earner. Furthermore, results revealed that some farmers in the lower zone practised tree nursery for income generation and compost-making whereas those in the upper tea zone reported silage-making and improved paddocking.

Results presented in Table 3-17 show significant relationships among the adopted CSA practices. For example, the adoption of Rhodes grass was found to have positive and significant associations with the adoption of Napier grass, fodder sorghum, Lucerne, Desmodium, Calliandra, and biogas digester. This implies that farmers who adopted Rhodes grass were also likely to implement the other CSA practices to supplement livestock feeding and use manure in biogas digesters. This finding indicates the existence of important synergistic relationships that could be harnessed to achieve a wide scale uptake of CSA practices in the area.

Table 3-17: Spearman's rho correlations in adopted climate-smart agricultural practices

CSA practice	Napier grass	Rhodes grass	Fodder sorghum	Lucerne (Alfalfa)	Desmodium	Dolichos lablab	Calliandra	Leucaena	Sesbania sesban	Tree Lucerne	Grevillia	Croton	Composting	Biogas digester	Tree nursery
Napier grass															
Rhodes grass	0.3**														
Fodder sorghum	0.1	0.2**													
Lucerne (Alfalfa)	0.0	0.2**	0.3**												
Desmodium	0.1	0.3**	0.4**	0.2*											
Dolichos	0.0	0.1	0.3**	0.0	0.4**										
Calliandra	0.1	0.2**	0.2*	0.3**	0.2	0.2									
Leucaena	0.0	-0.1	0.1	0.0	0.1	0.4**	0.4**								
Sesbania	0.0	0.1	0.3**	0.1	0.3**	0.2**	0.0	0.3**							
Tree Lucerne	0.0	0.1	0.3**	0.5**	0.4**	0.0	0.2	0.0	0.2**						
Grevillia	0.1	0.3**	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1					
Croton	-0.3**	0.1	0.0	-0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.3**				
Compost making	0.1	0.0	0.2*	0.2**	0.1	0.3**	0.2**	0.1	0.0	0.0	0.0	0.0			
Biogas digester	0.1	0.2*	0.1	0.2*	0.2	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.2*		
Tree nursery	0.1	0.2*	0.1	0.0	0.2**	0.1	0.2	0.2*	0.1	0.1	0.2	0.1	0.0	0.0	

Asterisks indicate significant correlations: ** at 1% level and * at 5% level (2-tailed).

Statistical relationships between the adoption of specific CSA practices and selected household characteristics are presented in Table 3-18. Results show that the adoption of CSA practices had significant associations with varied socio-economic factors. For instance, adoption of Napier grass was associated with secure land ownership (with title deed) and hired labour for relatively longer periods. Adoption of Rhodes grass tended to increase among farmers who managed relatively large farms, hired labour, obtained agricultural credit and owned more cattle. Interestingly, adoption of fodder trees such as Calliandra and Leucaena was associated with comparatively younger farmers as indicated by the negative correlations with farmer’s age (Table 3-18).

Table 3-18: Statistical relationship between CSA practices adoption and household socio-economic characteristics

CSA practice adopted	Socio-economic characteristic (Spearman's rho statistic)							
	Farmer's age	Farmer's education level	Farm size	Land tenure	Hired labour use	Obtained credit	Number of cattle owned	Participation in MICCA capacity building activities
Napier grass	0.0	0.1	-0.1	0.2*	0.2*	0.1	0.0	0.2*
Rhodes grass	0.1	0.1	0.2**	0.0	0.3**	0.2*	0.3**	0.2*
Fodder sorghum	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.3**
Lucerne (Alfalfa)	0.0	0.0	0.0	-0.1	0.0	0.2*	-0.1	0.0
Calliandra	-0.2**	0.1	-0.1	-0.1	-0.1	0.1	0.0	0.3**
Leucaena	-0.2*	0.2*	0.0	-0.1	-0.3**	-0.1	0.0	0.3**
Tree Lucerne	-0.1	-0.1	0.0	0.2*	0.0	0.1	0.0	0.0
Grevillia	0.0	0.1	0.1	0.1	-0.1	0.0	0.0	0.3**
Croton	-0.1	0.1	0.1	0.2*	0.0	-0.1	0	0.3**
Composting	0.0	0.1	-0.2*	0.0	0.0	0.0	0.0	0.3**
Biogas digester	0.0	0.2*	0.1	0.0	0.1	0.2*	0.1	0.1
Tree nursery	0.0	0.0	0.0	0.0	-0.4**	0.0	-0.1	0.3**

Asterisks indicate significant correlations: ** at 1% level and * at 5% level (2-tailed).

Participation in MICCA capacity-building activities had positive relationships with most of the adopted CSA practices as presented in Table 3-18. This result clearly indicates that adopters of CSA practices participated in a relatively high number of the MICCA capacity building activities, thereby augmenting knowledge on the interventions, whereas non-adopters were involved in just few of them.

The adoption of a biogas digester was positively related with education level of the farmer, underscoring the importance of enhanced knowledge in the uptake of this CSA practice. As expected, there was a significant positive correlation between the adoption of biogas digester and access to credit. However, these results cannot be generalized as only one case in the sample was found with a functioning biogas digester.

These statistical findings point to underlying social, financial and technical constraints that possibly limited the uptake of CSA practices among non-adopters as discussed next.

3.4 Adoption constraints, incentives and early benefits

3.4.1 Constraints to adoption of climate-smart agricultural practices

Non-adopters of the promoted climate-smart agricultural practices gave several reasons that limited their uptake. Key barriers to adoption of improved fodder crops are provided in Table 3-19. The major constraints cited by farmers were lack of labour to carry out agronomic activities (48 percent), lack of information on suitable fodders (44 percent) and lack of initial capital for establishment (41 percent). Others included lack of space on the small land holdings (37 percent), unavailability of planting materials (26 percent) and availability of alternatives such as grazing pastures (11 percent) and cheaper purchase of fodders (7 percent). These constraints generally affected a higher proportion of female headed than male headed households, possibly due differences in control of decision-making and resource ownership (Table 3-19).

Table 3-19: Key constraints to adoption of improved fodder crops

Constraint	Overall % (n=58)	Multiple responses by gender (%)	
		Male headed (n=32)	Female headed (n=26)
Lack of labour	48.1	42.9	53.8
Lack information on suitable fodders	44.4	42.9	46.2
Lack of money for establishment	40.7	35.7	46.2
Small land size	37.0	21.4	53.8
Lack of seeds/planting materials	25.9	21.4	30.8
Availability of grazing pastures	11.1	7.1	15.4
Cheap to buy	7.4	14.3	0.0

Majority of the farmers who did not have tree nurseries, cited factors presented in Table 3-19 as the main limitations to the establishment of nurseries. Key was the unavailability of seeds (24 percent), lack of knowledge on nursery management (21 percent) and alternative sources of seedlings from private nursery operators (19 percent). Lack of knowledge on nursery management was cited by most female farmers because relatively few of them participated in the MICCA pilot project training on nursery establishment. Unreliable water supply (13 percent) and lack of labour for nursery management (12 percent) were other constraints.

Table 3-20: Factors that limit the establishment of tree nurseries

Limitation	Overall % (n=84)	Response by gender (%)	
		Male headed (n=60)	Female headed (n=24)
Unavailability of seeds	23.8	26.7	16.7
Lack of knowledge on nursery management	21.4	16.7	33.3
Availability of seedlings from other nursery operators	19.0	23.3	8.3
Lack of reliable water	13.1	13.3	12.5
Lack of labour	11.9	10.0	16.7
Cumbersome	9.5	8.3	12.5
Poor market for seedlings	1.2	1.7	0.0

Adoption of improved manure management practices comprised of composting, application in crop production and generation of biogas faced diverse constraints presented in Table 3-12.Small quantities of manure (30 percent), labour-intensity of the activity (29 percent) and lack of knowledge (28 percent) were the main factors that limited proper composting of manure. Use of manure in crop production was constrained primarily by small manure quantities and lack of labour to collect and apply it on the farm (43 percent each). This could be that composing and using manure in crop production is not yet a relevant innovation to many farmers in the study area.

The main factors that limited the adoption of digesters for biogas generation were lack of initial capital for construction of the units (58 percent), lack of knowledge on biogas installation (30 percent) and limited manure quantity (12 percent) as presented in Table 3-12.

Table 3-21: Main constraints to adoption of improved manure management practices

Obstacles by category of improved practice	Overall (%)	Proportion by gender (%)	
		Male headed	Female headed
Barriers to composting of manure	n=137	n=94	n=43
Small manure quantities	29.9	29.8	30.2
Cumbersome	28.5	27.7	30.2
Lack of knowledge on composting	27.7	26.6	30.2
Lack of labour to collect manure	10.2	10.6	9.3
Lack of interest	2.9	4.3	0.0
No livestock owned	0.7	1.1	0.0
Barriers to manure use in crop production	n=129	n=93	n=36
Lack of labour to collect or apply manure	42.9	46.2	37.5
Small manure quantities	42.9	30.8	62.5
Lack of interest	14.3	23.1	0.0
Barriers to biogas generation from manure	n=147	n=105	n=42
Lack of funds for biogas construction	57.8	62.9	45.2
Lack of knowledge on biogas installation	29.9	26.7	38.1
Limited manure quantity	8.8	7.6	11.9
Lack of labour for manure collection	2.7	1.9	4.8
Lack of access to credit	0.7	1.0	0.0

These survey findings on barriers to adoption of CSA practices were also supported by the views of participants in focus group discussions. They reported that composting has been low since most farmers do not have zero grazing units, making manure collection a labour-intensive activity. According to them, unavailability of suitable seeds for fodder shrubs and Desmodium limited the uptake of improved fodder production practices while dry spell associated with unpredictable rainfall patterns caused a total failure of some fodder tree seedlings they had transplanted. Another major concern raised consistently by participants in all the FGDs was the delayed payment from Kapcheno dairies.

Participants hold the view that services they received from Kapcheno dairies have become poor, thereby exposing farmers to low milk prices offered by hawkers. This marketing problem for milk affected not only the credibility of farmer trainers during the promotion of

CSA practices (as they were recruited through Kapcheno dairies and were seen as part of its management) but also the financial capacity of farmers to adopt the practices.

3.4.2 Early benefits of climate-smart agricultural practices

Farmers' perceptions on the contribution of CSA practices to household food security (definition in this study restricted to household food availability) and farm income are presented in

Figure 3.12. Farmers perceived that the adopted CSA practices contributed to both farm income and household food availability in a similar pattern.

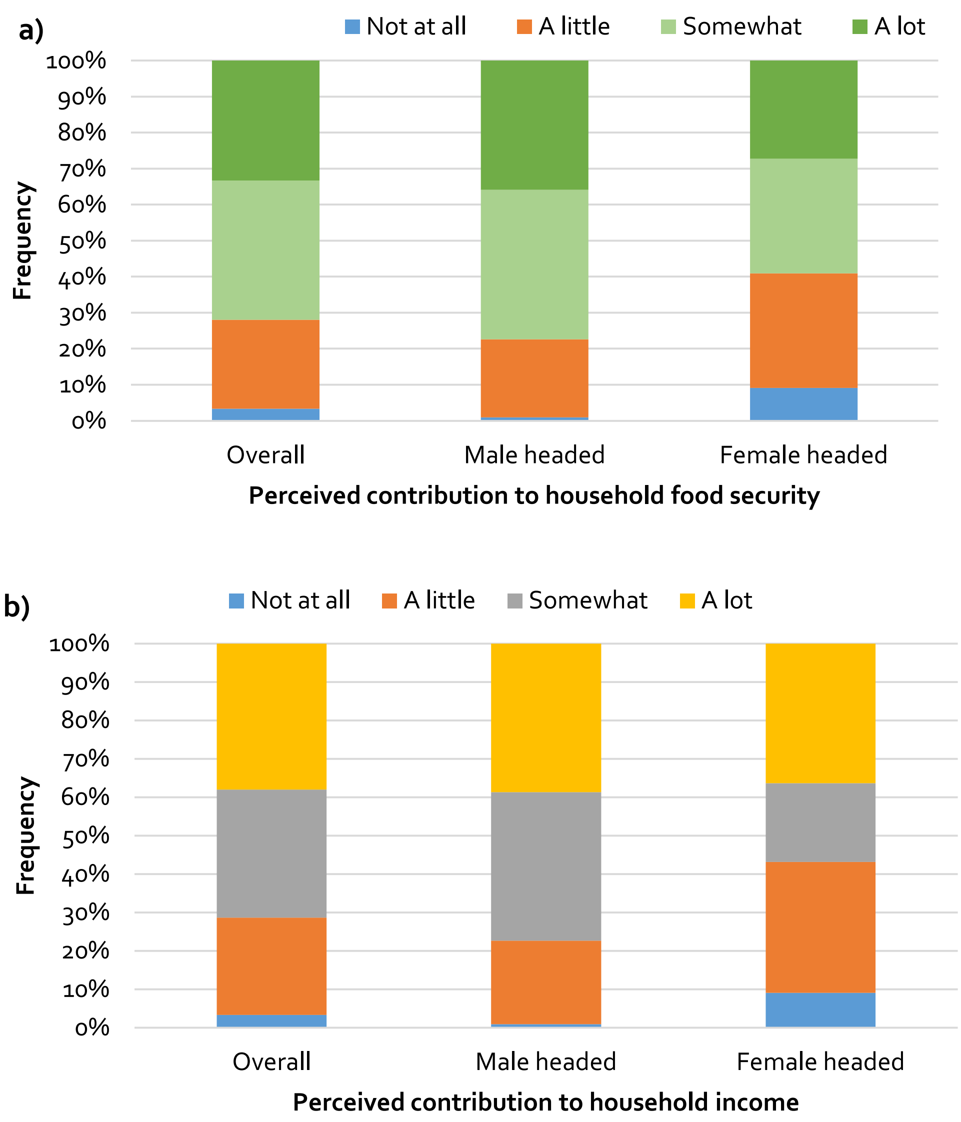

Figure 3.12: Perceived contribution of climate-smart agricultural practices to household food security (a) and income (b)

Overall, about a third of all farmers saw a “lot” of contribution and another one-third perceived “somewhat” of a contribution to household food availability and income. There were very few of them who perceived no contribution of CSA practices to household food availability and income (Figure 3.12).

Disaggregated by gender, a higher fraction of female headed than male headed households felt that implementation of CSA practices has so far little or no contribution to improve their households’ food security situation (Figure 3.12a)

Conversely, more male headed than female headed households mostly observed that the adoption of CSA practices has made a fairly good contribution to household food security. Similar contrasting perceptions between male and female headed households were reflected insofar as the contribution of CSA practices to farm income was concerned (Figure 3.12b).

Specific benefits realized from the implementation of improved agroforestry and fodder trees are shown in Figure 3.13. The main economic benefits identified by farmers included source of firewood, construction materials and farm income for a majority of households. Some of the observed environmental benefits were improvement of air circulation and creation of beautiful scenery within homesteads. Significant gender differences existed particularly on farm income and the reported environmental benefits. Respondents indicated very little benefits in terms of livestock feeds from fodder trees were because very few farmers had planted them.

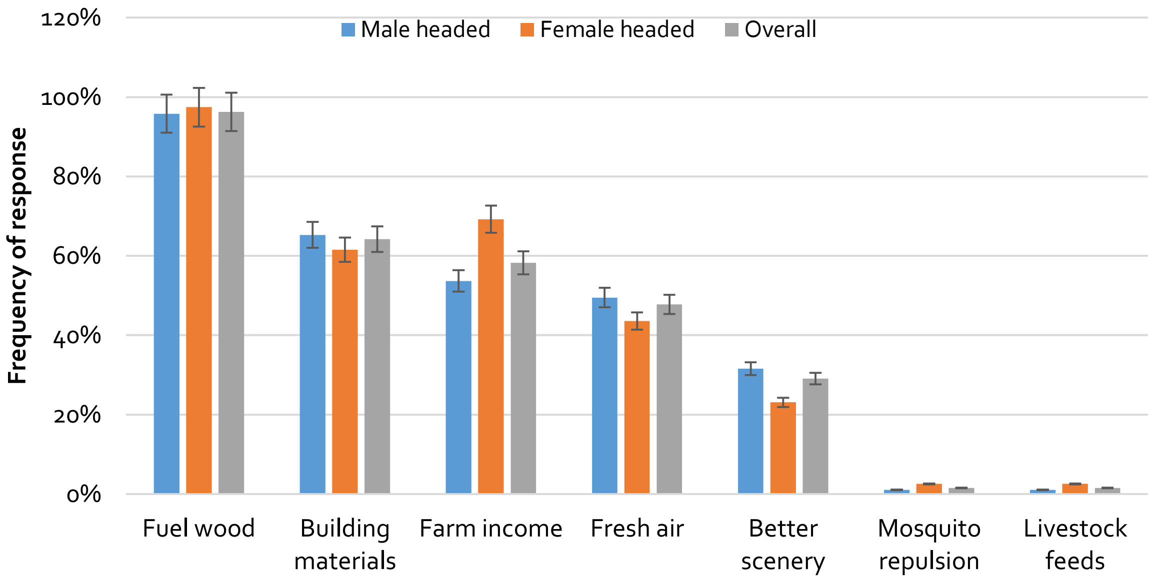

Figure 3.13: Benefits from adopted agroforestry and fodder trees

Results presented in Table 3-22 indicate that the application of livestock manure to supply nutrients to crops contributed largely by improving yields rather than reducing cost of production meaning that it wasn't used to substantially replace fertiliser purchases. Perceived financial benefits were relatively low (less than 10 percent) possibly because use of manure is a labour-intensive activity with considerable direct or opportunity cost of labour.

Table 3-22: Key benefits attributed to the use of livestock manure in crop production

Benefit	Overall % (n=150)	Frequency by gender (%)	
		Male headed (n=106)	Female headed (n=44)
Increased crop yields	69.2	69.6	68.4
Low cost of production	23.1	23.9	21.1
Increased farm income	6.2	5.4	7.9
Good for the environment	1.5	1.1	2.6

According to the two households with functioning biogas units, the main benefits from biogas use were reduced dependency on firewood and financial savings on the money that would otherwise be spent on firewood or gas. This view was supported by farmer trainers who confirmed that biogas use has several benefits including less time spent on cooking, reduced cutting of trees for firewood and slurry use in indigenous vegetables, passion fruits and fish ponds. This implies that when the critical constraints are overcome, adoption of biogas digesters could generate desirable benefits for the environment and household economy.

Trends in food unavailability over a period of 12 months within sampled households are depicted in Figure 3.14

There is no gender difference when food is reasonably sufficient within most households during the months of June-December. However, clear gender differences emerge during the food scarce months of January-May. During this period, proportionately more female headed households are affected by lack of food for consumption, implying that these households are the most vulnerable ones. This could be attributed to poor farm productivity they achieve associated with low input use.

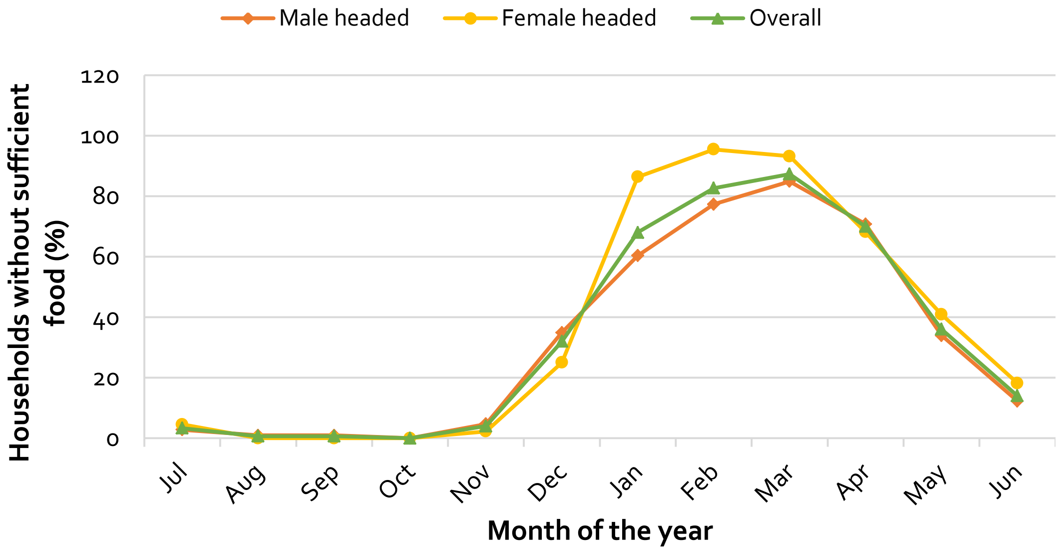

Figure 3.14: Households that did not have sufficient food during the last 12 months

A summary of the most important benefits resulting from the adopted climate-smart agricultural practices promoted by the MICCA pilot project is given in Table 3-23.

The main benefits identified by the adopters were improved farm income (24 percent), increased time availability for non-farm activities (16 percent), reduced labour demand and contribution to better environment (14 percent each). Overall, just one in every ten farmers have realized increased crop productivity and improved household food security. These benefits were largely derived from the adoption of CSA practices on agroforestry (33 percent), improved fodder production (29 percent) and better dairy herd management (16 percent). According to participants in focus group discussions, considerable gains are yet to be realized by a majority of them in terms of improved milk quality and availability of fuel wood from some of the promoted CSA practices. They identified the least beneficial CSA practices as tree nursery establishment (7 percent), manure composting (3 percent) and biogas installation (1 percent). This could partly explain the lower adoption levels reported on these specific CSA practices.

Table 3-23: Most important benefits from the adopted climate-smart agricultural practices

Most important benefit from CSA practice (% of multiple responses)	Climate-smart agricultural practice							
	1. Agroforestry/tree planting	2. Improved fodder production	3. Improved cattle management	4. Natural pasture improvement	5. Tree nursery establishment	6. Manure composting	7. Biogas production	Overall (%)
More income	30.4	28.9	16.4	11.9	8.4	3.4	0.6	23.9
More time availability	32.7	28.8	14.2	11.9	7.8	3.9	0.7	15.8
Less labour use	32.8	27.2	14.8	11.4	10.3	2.6	0.8	13.8
Better for the environment	36.0	26.0	18.4	9.8	6.2	2.7	0.8	14.3
Less affects by climate risks	31.8	25.2	18.6	13.5	6.6	3.3	0.9	12.3
Improved food security	29.7	28.0	17.5	11.2	7.3	5.6	0.7	10.1
Increased crop production	28.0	28.3	18.9	10.6	5.9	8.3	0.0	9.2
Improved milk quality	25.0	33.3	16.7	16.7	0.0	8.3	0.0	0.5
Source of fuel wood	33.3	33.3	0.0	33.3	0.0	0.0	0.0	0.1
Total (n)	116	100	57	39	25	12	2	100.0

3.4.3 Incentives for adoption of climate-smart agricultural practices

Farmers provided an inventory of incentives as presented in Table 3-24 which have potential to boost the adoption of CSA practices.

Table 3-24: Necessary incentives for adoption of climate-smart agricultural practices

Required incentives for adoption of CSA practices (% of multiple responses)	Climate-smart agricultural practice					
	1.Agroforestry/ tree planting	2.Improved fodder	3.Improved cattle	4.Natural pasture	5.Tree nursery establishment	Overall (%)
Continued assistance from the project	35.6	27.8	12.7	12.2	7.8	25.2
See good examples by frontrunners	34.4	27.2	12.8	10.4	10.4	15.3
Access to affordable credit	30.6	32.4	16.7	13.9	2.8	13.3
Access to planting materials/seeds	42.9	28.6	10.2	8.2	8.2	6.0
Govt. support to access inputs	34.3	28.6	14.3	8.6	5.7	4.3
Remunerative farm output markets	27.3	30.3	21.2	15.2	3.0	4.0
More benefits/farm income	37.9	17.2	17.2	6.9	17.2	3.6
Lower cost of initial investment	36.0	24.0	20.0	16.0	4.0	3.1
Secure land ownership	50.0	25.0	8.3	0.0	16.7	1.5
Access to market	28.6	28.6	14.3	14.3	14.3	0.9
More/cheap labour supply	33.3	33.3	16.7	16.7	0.0	0.7

Key among the necessary incentives, cutting across the five main CSA practices, included continued assistance from the project (25 percent), more training and demonstrations on selected improved practices (23 percent), good examples set by frontrunners (15 percent) and access to affordable credit (12 percent). Access to planting materials or seeds could enhance the adoption of agroforestry (43 percent) and improved fodder production (29 percent) practices.

Complementary results from focus group discussions with farmers indicate that the factors, which have encouraged adoption of climate-smart agricultural practices include:

i. Increasing numbers of improved cattle breeds whose requirement for feeds is high hence the need to adopt high yielding fodders. This is consistent with the survey finding that about 95 percent of the households own improved cattle.
ii. Increasing appreciation that dairy enterprise can be good alternative source of farm

income as revenue from tea declines. For instance, participants in group discussions said that annual bonus earned on tea sales was decreasing and as a result, they appreciate dairy as a business that would enhance their income when they adopt the promoted climate-smart agricultural practices.

iii. Maize farming, a competing enterprise for farm allocation, has recently been adversely affected by maize lethal necrosis disease. Consequently, their reliance on maize crop to meet household consumption needs is in jeopardy hence the need to diversify farm enterprises by adopting CSA practices to improve productivity and household resilience.

iv. Reducing land size due to population increase has compelled a majority of farmers to opt for intensive production of improved fodders as areas for grazing have become fewer due to increasing pressure on land.

v. High cost of commercial feeds for livestock has compelled farmers to look for cheaper coping strategies, which include on-farm production and conservation of feeds.

vi. The attractiveness of Rhodes grass, which when conserved as hay has high demand and return during the dry season. Farmers said that they achieved high yields as they harvested up to four times in a year, particularly when rainfall was adequate.

vii. Manure use for crop production is becoming popular in the area for organic vegetables cultivation and passion fruit farming because it reduces cost of inorganic fertilizers and increases yields.

Even though the identified incentives have contributed to the uptake of some of the promoted CSA practices, there were still key barriers which impede the adoption process in the study. These general barriers and useful lessons learned are discussed in Section 4.

4 DISCUSSION ON BARRIERS TO ADOPTION AND LESSONS LEARNT

Besides the specific barriers already presented in Sub-section 3.4.1, general factors that influence the adoption of climate-smart agricultural practices that were deliberated during the focus group meetings are discussed in two broad categories: 1) socio-economic and cultural barriers and 2) policy and institutional frameworks.

4.1 Socio-economic and cultural barriers to adoption of CSA practices

Adoption of new technologies, innovations or practices take place within a socio-cultural environment and requires key capital inputs such as labour, finances, produced and social capital (Ellis, 1993). Better organization and allocation of the various forms of capital would enhance efficiency important for the adoption and diffusion of interventions to achieve the desired impact in the farming system (Mutoko *et al.*, 2014).

Findings from this study show that adoption of composting and biogas is low, which could both be attributed to the type of farming system and resource availability that were cited by farmers were small manure quantities and high labour demand. As already mentioned this could imply that these two CSA practices may not be relevant innovations to consider in the study area. Perhaps those farmers with low amounts of manure are not part of the target population who are likely to or even capable of adopting compositing practice. However, as pointed out by farmer trainers, the common open-grazing system mainly in paddocks makes collection of dispersed fresh cow dung for either composting or utilization in a biogas digester a labour-intensive activity. Addressing this challenge would entail farmers embracing zero-grazing system whose initial cost for establishment is prohibitive for a majority of the smallholders.

Availability of seeds was reported in both household survey and focus group discussions as the main limitation to adoption of agroforestry and fodder trees. However, it emerged during group discussions that the major underlying cultural barrier related to land tenure considerably affected the adoption particularly of Calliandra and Trichandra whose seeds were provided by the MICCA pilot project. Participants in the women focus group discussion revealed that culturally, in the study area the household head (mostly the man) is the *de facto* owner of family land and the main decision-maker on allocation to family members and different uses. Given that planting of trees is viewed as marking the boundary of one's piece of land, it is a real challenge for women, sons and daughters who participated in the project to adopt agroforestry and fodder trees. This is due to lack of right for them to make such decisions for the household head who may not have attended project activities. An approach that might help to overcome this cultural barrier to adoption is to occasionally encourage participating members to come with the overall decision-maker in their extended households during some of the project activities.

4.2 Policy and institutional frameworks influencing adoption of CSA practices

National policy on climate change and agriculture is yet to come into force in Kenya to systematically facilitate CSA efforts as those promoted by the MICCA pilot project. Such policy framework is expected soon and would provide the required impetus to entrench the promoted CSA interventions within the farming system. According to discussion with MICCA pilot project implementers, there is also a need for a complementary policy that clearly stipulates how small-scale farmers who have adopted CSA practices such as agroforestry can also benefit from carbon credit schemes. At the moment such a policy framework does not exist which means that smallholder farmers do not have a formal channel through which they too could benefit from such schemes.

Participants in focus group discussions observed that the devolved system of government provides even better prospects for accelerating the formulation process of relevant policies and by-laws at the county level. They suggested that, putting in place a county environmental policy aimed at protecting the swamps, riverbanks and steep slopes through planting of trees would motivate farmer groups to establish tree nurseries to supply seedlings for that purpose. With better incomes from the sale of tree seedlings, farmers' financial capacity to invest in improved farming would improve as found by Odendo *et al.* (2009), thereby potentially allowing them to adopt other CSA practices such as improved fodder production and later installation of biogas digesters.

The department of agriculture and livestock development is currently fully devolved to the county level but its ability to offer timely advice to farmers is affected by resource constraints. There is therefore a need to strengthen the existing agricultural extension services and build the capacity of extension workers particularly on promising climate-smart agricultural practices. Resource constraints affect service delivery in many public institutions, however the innovative farmer trainer approach that was tested in the promotion of MICCA pilot project activities has potential to improve efficiency and effectiveness of extension delivery system. When properly integrated into the mainstream extension delivery system, the farmer trainers approach would ensure sustainability and scaling-out of climate-smart activities in this and other areas (Kiptot *et al.*, 2011).

Effective partnerships and collaboration with other interested organizations is another avenue that can generate substantial synergy to accelerate the adoption rate of the promoted CSA practices in the study area (Odongo, 2010). For instance, systematic collaboration with organizations such as Lake Victoria Environmental Management Program (LVEMP) on promotion of tree nursery establishment, Kenya Agricultural and Livestock Research Organization (KALRO formerly KARI) on improved fodder production and Ministry of Energy on biogas installation would increase prospects of these practices being adopted by a majority of famers. Even though the MICCA pilot project activities were implemented under EADD consortium of organizations, according to the project implementers, an institutional arrangement to harness comparative advantages from different stakeholders working in the same area was lacking.

4.3 Lessons learnt from the implementation of the MICCA pilot project

According to the focus group discussion held with project implementers, farmer trainers and farmers in the study area, the implementation of the MICCA pilot project in Kenya has provided useful lessons, which can benefit similar projects in the future. First, the MICCA pilot project implementers acknowledged that there was need for sufficient time dedicated to the inception of the project. This would provide adequate opportunity for the project team to connect well with the local community and establish effective collaboration with other stakeholders in the project site. Such initial engagements would be essential for understanding how culture may affect adoption of interventions and what existing synergies can be harnessed from other actors. The MICCA pilot project implementers felt that if they had conducted a stakeholder analysis to map out relevant activities by different actors they would have possibly created effective linkages to accelerate promotion of CSA practices in the area. For example, they realized that if they had established partnership with LVEMP at the start of MICCA pilot project, resultant synergies would have benefited more the establishment of tree nurseries in the area. Furthermore, they proposed that future projects should consider a project life of up to five years to work on the kind of issues addressed in MICCA pilot project. For instance, project implementers felt that the three years were too short for the project aimed to minimize the effects of climate change on agriculture through promotion of CSA practices such as agroforestry trees, which takes time for actual adoption

Women's Success Story

A group of women in Kamotony area were worried that they were unable to provide for their children in the face of hard economic times. They formed a group but did not quite know what they could gainfully do together. According to them, they would dejectedly ask themselves, "**Sasa sisi tutafanya nini kutoka hali hii**?" (What can we do to emancipate ourselves from this situation?).

When they interacted with the MICCA project staff and were trained on various climate-smart agricultural practices, it became clear what they would do—they established a group tree nursery.

They generated income from selling indigenous tree seedlings, tea leaves, ornamental trees and garden flowers from the tree nursery gave them a financial stepping-stone for investing in dairy production. They have increased milk productivity after applying the knowledge gained through training on improved fodder production and dairy cattle management. This has allowed them to access credit facilities, which has enabled them to make further investments in their farm enterprises. Unlike in the past they are now able to pay their children's school fees without difficulty. Some even use proceeds from milk sales to make monthly contributions to the National Health Insurance Fund for their family members. In addition, the application of composted manure on to their kitchen gardens and passion fruits has contributed to improved household nutrition.

They suggested that the adoption of CSA practices has generally reduced their stress levels and enhanced cohesion in their homes. The success of this group has made it easier for them to adopt some practices such as agroforestry, which ordinarily would be difficult for cultural reasons. Apart from being a source of firewood and herbs, the planting of trees has freed up time they used to spend collecting firewood, which they now use productively in other activities.

Looking forward, this women's group will use income from sale of milk not only to build social capital as a dairy management group but also to increase their financial capital through regular table banking.

to take place and benefits to be realized. However, the MICCA pilot project has partnered with EADD, which continues to work with farmers in the area and thus ensure further support and sustainability of the CSA actions.

Second, farmer trainers identified continuous involvement of the county administration in the project activities as necessary for local mobilization and backing of promoted improved practices. They were of the view that participation of county administrators and local leaders in project activities such as field days, trainings and demos would not only create ownership but also provide requisite approval of the project activities. This would likely accelerate the uptake of CSA practices in the area with the facilitation of farm trainers.

Third, it was proposed during focus group discussions that integration of a simple reward scheme in the project would likely motivate various participants involved in project activities. For example, during field days a county administrator would be invited to issue certificates of recognition, project badges or even small tokens to exemplary farmers and farmer trainers, as established by Mureithi *et al.* (2006). The MICCA pilot project lacked such a rewarding mechanism to recognize and motivate those model farmers who have adopted improved practices. Besides, it was suggested that volunteer farmer trainers who have well maintained demo plots for learning and have trained many farmers also need to be motivated in some way, in line with Kiptot *et al.* (2012).

Farmer Trainers' Success Story

Before the inception of the MICCA pilot project, planted fodders and utilization of crop residues for livestock feeding were uncommon in Kaptumo Division. Many farmers simply grazed their animals along the road sides or on hilly, forested or swampy communal areas. This open system of livestock feeding not only caused environmental degradation but also meant that some children occasionally missed school or lacked time to attend to school work as they tended to animals.

With the promotion of CSA practices, the amount of production of improved fodder crops such as Napier and Rhodes grasses has grown along with improvements in the quality of natural pastures.

This has led to increased income from milk sales and reduced incidences of tick borne diseases as livestock movement is limited. Moreover, children now have more time to attend to school work since they hardly take animals to graze in the forest. One of the farmer trainers said that he felt a sense of great achievement to have helped farmers in his area to stop grazing animals in the fragile hills. In addition, confining cows to graze mostly in paddocks has also led to reduced soil erosion on paths leading to the forests and riverine areas.

5 CONCLUSIONS AND RECOMMENDATIONS

This study established mixed results on adoption of the promoted climate-smart agricultural practices in the MICCA pilot site in Kenya. Findings clearly revealed the most adopted CSA practices as improved fodder production (i.e. Napier and Rhodes grasses) and planting of agroforestry trees (i.e. Grevillia and Croton). Whereas the least adopted improved practices included establishment of tree nurseries, fodder trees, manure composting and installation of biogas digesters.

This adoption behaviour was influenced by several factors, which created either incentives or barriers for the uptake of specific CSA practices. Key constraints to adoption included inadequate farm labour, lack of adequate knowledge, availability of seeds, and lack of funds to implement some of the improved practices. Better understanding of both incentives and barriers examined in this study provide useful learning lessons for scaling-out of promising CSA practices in this and other agro-ecosystems. Some of the important lessons learnt from implementation of this project include the need for wider stakeholders' consultations during project inception, instituting an effective collaboration platform to harness synergy from other partners, continuous involvement of local leadership to enhance project ownership and integration of a simple reward mechanism to motivate project participants (i.e. farmers and trainers) who perform well.

However, to ensure that many farmers are empowered to benefit more from the improved agricultural practices, this study recommends that the EADD and/or the county government extension continue the work in those locations of the pilot site that are yet to be reached. This could be achieved by increasing and motivating farmer trainers to train more groups, supporting them with seeds to establish demonstration plots in their farms and organizing for additional field days and learning tours for farmer groups to build their capacity on CSA practices.

To overcome some of the financial constraints to adoption of CSA practices at the local level, as suggested by farmers themselves, there is a need for them to embrace collective action to mobilize resources through table banking, merry-go-rounds, cost-sharing and group credit access. Farmers also felt that strengthening social capital based on the existing dairy management groups would provide the required group collaterals to access credit facilities.

Finally, as recommended by farmer trainers, deliberate arrangements are required to support farmer-to-farmer dissemination of promising improved practices. A reward mechanism requiring that non-participating farmers be periodically allowed to visit model farms maintained by participating farmers, will ensure that those farmers who are not necessarily in groups are also adopting climate-smart agricultural practices. This way the adoption of CSA practices will get entrenched and more economic and environmental benefits realized by many farmers.

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7 ANNEXES

7.1 Terms of References: Study on barriers and incentives to adoption of climate-smart agriculture and lessons learnt in the MICCA pilot project in Kenya

General Description of tasks and objectives to be achieved

The study conducted using quantitative (geo-referenced structured interviews) and qualitative methods (focus group discussions and field observations) will:

- Analyse the adoption of climate-smart agriculture (CSA) practices in the pilot site to understand the constraints, incentives and adoption potential, considering also the wider policy, institutional and social structures and processes that may affect adoption.
- Look at the benefits of the CSA practices in terms of agricultural production, livelihoods diversification, adaptive capacity and overall resilience and food security, including success stories on adoption.
- Provide recommendations and lessons learned on CSA implementation to inform extension, further projects and out-scaling.

Expected Outputs:

1. Methodology and tools: desk review, sampling strategy, questionnaires for interviews and focus groups, etc.
2. Report: A well-structured written report (with tables, graphs, boxes, maps and pictures), and annexes
3. Dataset: raw data in excel

7.2 Tool (Survey questionnaire)

Adoption Study of MICCA Pilot project in Kenya

Household Questionnaire

Interview No: ________	Date: ________________	Enumerator: _______________________	Location: ______________

Introduction: "My name is …………, and I am working for the FAO's MICCA project, which cooperates with the EADD project in your area. The project promotes improved climate-smart agricultural practices as a way to improve productivity, resilience and mitigate the effects of climate change. Selected interventions and trainings have been implemented already in the Kaptumo Division for the past 3 years. We are now surveying about 150 households to get information on how the application of improved practices has changed your farming activities and rural livelihoods. We would like to get your permission to ask you some questions about your participation in the MICCA project. All information you provide will be analyzed anonymously and treated with highest confidentiality."

Part A: Household Information

1. Household identification information

Sub-location name [use codes below]	GPS reading at homestead		
	Longitude (°N/°S)	Latitude (°E/°W)	Altitude(m)

Kaptumo = KT Kaboi = KB Kapsaos = KS Ndurio = ND Koyo = KY Kapkolei = KL
Name of household head: ____

Name of respondent (if not HH head): ____

2. What is the size of your household (i.e. number of all household members staying here and eating from the same pot for more than half of the year)? __________________________________

3. How many family members work only on the farm? ________ only off the farm? _________

4. Kindly share with us some information on these household members (fill the table appropriately).

[88= Do not Know (DK); DK 99= Refuse to Answer (RA)]

HH member	Gender 1=Male 2=Female	Age (years)	Highest education level*	Marital status **	Primary occupation ***	Main sources of income **** [Record max 3]		
Farmer in farmer group						1.	2.	3.
Household head						1.	2.	3.

*Education level: 0=None 1=Adult education 2= Primary 3= Secondary 4= College 5= University 6=Other (specify) ____

***Marital status: 1 = Married; 2= Single; 3 = Divorced; 4 = Widowed; 5 = Other (specify) ___________________

***Primary occupation: 1= Farming 2=Off farm

****Sources of income

1 =	Selling milk	4 =	Seasonal farm labourer	6 =	Government job
2 =	Selling tea	5 =	Occasional jobs off farm	7 =	Other (specify) _______________
3 =	Selling seedlings	88=DK 99=RA			

5. (a) What is your usual means of transportation to the market? [select one]

   1=Car; 2=Motor bike; 3=Bus/public transport; 4= Bicycle; 5=Walk; 6=Other (specify)

   (b) Cost of transport [one way]: Ksh _____________________

   (c) Time to the nearest market centre and tarmac road by your usual means of transport?

   Distance to market (minutes)______________ Distance to tarmac road (minutes)________________

6. Did any member of the household obtain agricultural credit in the last 12 months? _____

   1= Yes 0=No

7. If YES, what was the main purpose of the loan? *[select one]* _________

   1) Purchase farm inputs (e.g. seeds, fertilizers)
   2) Buy livestock
   3) Buy land
   4) Construction of farm structures
   5) Buy machinery and equipment
   6) Payment of labor costs
   7) Other (specify) ______________

Part B: Farm Characteristics

8. What is the size of all the land managed by the household? _____________ acres [or DK]

9. What is the main type of ownership for the land you have? *[select one]*

   1=Traditional/communal; 2=Freehold without title; 3= Freehold with title;

   4= Leasehold/Rented in; 5= Other (specify)______________________________________

10. Do you practice any agriculture and/or livestock keeping on your farm? *[tick once]*

    0= None; 1 = Cropping only; 2 = Livestock only; 3 = Cropping and Livestock; 88 = DK; 99 = RA

11. Who is the main decision-maker regarding different farming activities? *[record one, DK RA]*____

1=HH head; 2=Spouse; 3= Son; 4= Daughter; 5=Farm worker; 6= Other _________________

12. Did you hire staff/laborer on your farm in the last 12 months? *[tick once]*

1 = Yes   0 = No   88 = DK   99 = RA

13. If YES, how many and for how long? *[note all, mark DK, RA*

Hired laborers_____ months______

14. What type and number of livestock do you own? *[note multiple, mark DK, RA]*

Livestock type	Number
Cattle	
Goats	
Sheep	
Chicken	

Livestock type	Number
Pigs	
Donkeys	
Rabbits	
Other:	

15. Where do you feed your cattle? [rank from 1= most important to 3=least important]

1.	
2.	
3.	

1 = Install at homestead 2 = Grazing on paddocks 3 = Grazing on communal land
88 = DK 99 = RA

16. In case you own cattle, please specify the type and give us some information regarding milk production and marketing in the last 12 months *[record all, mark DK, RA]*

Cattle Type	Season of the year	Average milk per animal per day (litres)	Amount sold (litres/day)	Where milk sold*	Why this selling option?**	Price per litre *(Ksh.)*
Traditional	Dry					
	Wet					
Improved breed	Dry					
	Wet					

*1= Individual consumers 2=Traders (brokers, hawkers) 3= Kapcheno Dairy 4= Institutions (schools, hospitals)
5 = Hotels 6= Processors 7= Supermarkets 8= Other (specify) ______________________________

* * 1= Better price 2= Prompt payment 3= Less distance/transport cost 4= Less quality restrictions 5= Other (specify) ___________________________

17. What was the annual production and utilization of MAIZE AND TEA you cultivated in 2013/14 agricultural year?

Crop	Growing season	Area (acres)	Quantity produced	Unit of measure	Quantity sold	Price per unit *(Ksh)*
Maize	Long rains					
	Short rains					
Tea	Long rains					
	Short rains					

Part C: Participation in EADD-MICCA Project Activities

18. Did you ever participate in the EADD- MICCA project capacity building activities like trainings, awareness creation and demonstration activities? ________________ 1 = Yes; 0 = No; 88 = DK; 99 = RA

19. If YES, in which of the following project interventions (implemented by EADD) did you participate?

Project activities	1=Yes; 0=No [note all]	Project activities	1=Yes; 0=No [note all]
Training on fodder establishment and management		Training on fodder conservation & utilization of crop residue	
Training on nursery establishment and management		Training on pasture management and paddocking	
Training on manure management		Training on composting	
Training on animal health, breeding, calf rearing, milk quality		Climate change awareness sessions	
Training on feed formulation		Field days	
Training in group dynamics		Workshops/seminars	
Training on biogas		Exchange trips	
Training on tree planting and management		Other (specify)	

20. What is the most important information or service you accessed through the MICCA/EADD project? *[rank from 1= most important to 3=least important]*

1.	2.	3.

1= Animal health; 2= Milk production; 3= Planting/sowing method; 2= Source of seeds/planting materials; 3 =Nursery management; 4= Fodder management; 5= Manure management; 6= Natural pasture improvement; 7= Feeding/feed conservation; 9= Agroforestry, 10= climate change 11= Other (specify) _________

Part D: Adoption of Improved Fodder and Agroforestry Practices

21. Have you planted fodder on your farm currently? ___________ 1=Yes 0=No 88=DK 99=RA

22. If YES, what types of improved fodders have you grown on your farm and their production levels? *[note multiple, mark DK, RA]*

Fodder types	Growing (1=Yes; 0=No)	Where cultivated*	Area cultivated (acres) or DK	When established (month & year)	Sources of seed**	Production level***
Napier grass						
Columbus grass						
Bracharia grass						
Rhodes grass						
Fodder sorghums						
Cow Kandy						
Lucerne (Alfalfa)						
Desmodium spp.						
Dolichos lablab						
Other:________						

* 1 = Farm land 2 = Farm boundary 3= Terrace bank 4= Bush land
**1= Neighbor 2 = Own seed 3 = Project Farmer group 4 = Market 5= Other (specify)______
***1= Poor 2 = Moderate 3 = High

23. What criteria are important to you when choosing the type of fodder to plant? *[rank from 1= most important to 3=least important]*

1.	2.	3.

1= High yielding; 2=Fast growth; 3= Animal produce more milk; 4=Disease/pest tolerant; 5= Easy to harvest and feed to animal; 6=Availability/cost of seed/planting material; 7=Advice from extension workers; 8= climate tolerant; 9=Other (specify)________________________________

24. What determines the total area of the farm you put under improved fodder production? *[rank from 1= most important to 3=least important]*

1.	2.	3.

1= Farm size; 2=Number of livestock; 3=Labour availability; 4= Amount of seed/planting material available; 5= Other (specify)________________________________

25. How do you conserve feed for your livestock? *[note multiple]* __________________________

0=No conservation; 1= Bale hay; 2= Make silage; 3=Other (specify) ____________________

26. If you have NOT planted fodder what are the reasons? *[rank from 1= most important to 3=least important]*

1.	2.	3.

1=Small land size; 2=Lack of seeds/planting materials; 3=Lack of labour; 4=Cheap to buy; 5= Lack information on fodder types to plant; 6= Lack of money for establishment; 7=Other (specify)____

27. How is the availability of feed for your livestock over the past 12 months? *[fill in the table appropriately using codes below]*

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Feed availability: 1=Scarce; 2=Moderate; 3=Adequate

28. Have you planted any agroforestry trees on your farm currently? ___________ 1=Yes 0=No 88=DK 99=RA

29. If NOT, why? [note all, DK, RA] _________________1= Lack of preferred seedlings; 2=High cost of seedlings; 3= Small land size; 4= Unreliable rainfall; 5= Other (specify) _____________________

30. If YES, what types of agroforestry trees have you grown on your farm and their production levels? *[note multiple, DK, RA]*

Agroforestry tree types	**Growing** (1=Yes; 0=No)	Where cultivated*	Number of trees	When established (month & year)	Sources of seedlings**	Production level***
Calliandra calothyrsus						
Leucaena trichandra						
Sesbania sesban						
Tree Lucerne						
Grevillia						
Other:						

* 1 = Farm land 2 = Farm boundary 3= Terrace bank 4= Bush land
**1= Neighbour 2 = Own nursery 3 = Project Group nursery 4 = Private Nursery operator 5= Market
***1= Poor 2 = Moderate 3 = High

31. What criteria are important to you when choosing the type of trees to plant? *[rank from 1= most important to 3=least important]*

1.	2.	3.

1= Period to maturity; 2= Number of uses; 3=Availability of seedlings; 4= Tolerance to dry spells; 5=Other (specify) ______________________

32. What are the benefits of agroforestry trees (including nursery) that you have on your farm? [*rank*] ____________

1.	2.	3.

Source of fuel wood; 2= Source of construction materials; 3=Source of income; 4= Improve scenery 5=Fresh air 6= Other (specify) __________

33. Have you established a tree nursery on your farm? ______ 1=Yes 0=No 99= RA

34. If NOT, why? ___________ 1=Unavailability of seeds; 2= Lack of knowledge on nursery management; 3= Lack of labour; 4= Lack of reliable water; 5= Availability of seedlings from other nursery operators; 6= Poor market for seedlings; 7= Other (specify) ___________________________

35. If YES, what are the 3 MAIN CHALLENGES you have faced in tree nursery management? [*rank from 1= most important to 3=least important*]

1.	2.	3.

1= Unavailability of seeds; 2= Poor germination; 3=Unreliable rainfall; 4=Damage by pests/diseases; 5= Lack of market for seedlings; 6= Other (specify) ___________________________________

Part E: Adoption of Manure Management Practices

36. Have you collected livestock manure from your farm in the last 12 months?__________ 1=Yes 0=No 88= DK 99= RA

37. If YES, how do you manage the manure produced by your livestock? [tick one answer one]

    1= Cover in a pit; 2= Collect under shade; 3= Collect uncovered in the open; 4=Compost it; 5= Discard in surrounding area; 6= Add ash; 7= Other ________________

38. What do you do with livestock manure? [rank from 1= most important to 3=least important]

1.	2.	3.

1= Used in food crop production; 2= Apply to fodder; 3= Use dry dung for fuel; 4= Use in biogas generation; 5= Use as construction material; 6= Sell to others; 7=Other (specify) ____________________

39. If you use your manure for crop production (including fodders), what is the most important benefit? *[select one]*_______________________________________

    1= Increased crop yields; 2= Low cost of production; 3= Increased farm income 4 =good for the environment; 5=Other (specify) ___________

40. If you do NOT use manure for crop production (including fodders), what is the main barrier? *[Select one]*____

    1= Lack of labour to collect or apply it; 2=Small manure quantities; 3= No livestock owned 4= Other specify)______________________________________

41. Do you practice compositing? 1=Yes 0=No 88= DK 99= RA

42. If you do NOT practice compositing, why not? [*select one*]

    1= Lack of labor to collect manure; 2=Small manure quantities; 3= No livestock owned 4=time consuming; 5= don't know how to do composting; 6=Other

(specify)______________________________________

43. Do you have a biogas digester? ____ 0=No; 1= Yes in planning; 2=Yes in construction; 3= Yes functioning

44. If you use your manure for biogas production, how has it benefitted your household? *[record multiple]*_______ 1=Less cooking time; 2= Reduced firewood use 3= Saved money that could be used to buy fuel wood or gas; 4 =Reduced smoke pollution; 5= Other (specify) ______________________________________

45. If you do NOT use your manure for biogas production, what is the main constraint that you face? *[select one]*_____________ 1= Lack of knowledge on biogas installation; 2=Lack of funds for biogas construction; 3=limited manure quantity; 4= Lack of labour for manure collection; 5= no access to credit; 6=Other (specify) ___________

Part F: Household Food Security and Adoption Benefits

46. In the last 12 months (July 2013-June 2014), in which months did your household NOT have enough food to meet your own needs? *[note all months, mark X, DK, RA]*

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

47. In your view, to what extent has the implementation of the improved practices increased your household food security? *[tick once]* 0 = Not at all; 1 = A little; 3 = Somewhat; 4 = A lot

48. In your view, to what extent has the implementation of the improved practices enhanced your household income? *[tick once]* 0 = Not at all; 1 = A little; 3 = Somewhat; 4 = A lot

49. In your opinion, which practices have been MOST BENEFICIAL and what do you consider as the three MOST IMPORTANT benefits from applying these improved practices?

Improved practice*	Important benefits**		
	1.	2.	3.
1.			
2.			
3.			

Improved practices* 1= Improved fodder production; 2= Agroforestry/tree planting; 3= Manure compositing; 4= Biogas construction; 5=Tree nursery establishment; 6= Natural pasture improvement; 7= Improved livestock management and health; 8 =Other (specify) _______________

Benefits** 1=More income; 2= Increased crop production; 3= Less affected by climate risks; 4= Less labour use; 5= Less time demanding; 6= Better for the environment; 7= Improved household food security; 8= Other (specify)____

50. If you are not applying any of the practices, what do you need to adopt these improved practices in your farm? [rank max 3]

1.	2.	3.

1=More training/demos on practices; 2= Lower cost of initial investment; 3= Access to planting materials/seeds; 4= More/cheap labour supply; 5= See good examples by adopting farmers; 6= More benefits/farm income; 7= Access to affordable credit; 8= Remunerative markets for farm product; 9= More assistance from a project; 10= Secure land ownership; 11= More govt. support to access inputs; 12= access to market; 13=Other (specify)____

EVALUATION OF INTERVIEW AND FARM PRACTICES

How do you assess the reliability of the responses provide by the interviewed person?______ *1 = Reliable 2 = Unreliable 3 = Cannot estimate the reliability*

What important observations can you make about the farmer's fields? [briefly describe evident practices on the farm]____
____
____
____
____
____
____

Enumerator, please thank the respondent for the information provided and time allowed for the INTERVIEW!

and in case of follow up please ask for the Mobile number of HH head/respondent: ____

7.3 Tool (FDG Check Lists)

CHECKLIST FOR FOCUS GROUP DISCUSSIONS

Introduction

"My name is …………., and I am working for the FAO's MICCA project, which cooperates with the EADD project in your area. The project promotes improved climate-smart agricultural practices such as improved fodders, Agroforestry, better manure management, and animal health as a way to mitigate the effects of climate change. Selected interventions and trainings have been implemented already in Kaptumo Division for the past 3 years. We are now conducting an adoption study to get information on the constraints and incentives for the uptake of these practices, potential for further adoption and lessons learned from the implementation of project activities. We value each of your contributions and expect that you actively participate in the discussions as key stakeholders in this area. All information you provide will be treated absolutely anonymously and with highest confidentiality."

FGD Guiding Questions

FGD1: Project staff from EADD/MICCA/ ICRAF and Kapcheno dairy

1. PROJECT: What are the activities and improved practices promoted by the MICCA-EADD project? How did you promote the improved agricultural practices in the project area?

2. ADOPTION: What improved practices are popular among farmers? In your estimation, what proportion of participating farmers in the project area has adopted at least one of the improved practices? What do you think are the main reasons for the uptake of these improved practices? (ask by practice using a flip chart)

3. BENEFITS: What are the benefits of these practices?

4. BARRIERS: Are there some improved practices that have been abandoned or dis-adopted? Which ones have not been adopted at all? What hinders their uptake within this farming system? What other reasons outside this farming system might have contributed to their unsuccessful adoption?

5. SUPPORT: What institutional support would facilitate wider promotion of improved practices in this area? Which institutions/organizations are relevant to the promotions and implementation of improved agricultural practices? How are these institutions supporting the promotion of these practices in the project area?

6. POLICY: What policy support could encourage successful application of improved agricultural practices in this area? Kindly share with us any information you have on any effort by the government (County and National levels) that would create a favorable environment for their uptake.

7. SUSTAINABILITY: In your assessment, how prepared is the community or other stakeholders to continue with the promotion and upscaling of the improved practices in this area? What are you already doing that empowers the community to go on with the activities?

8. EVALUATION: What do you consider as the greatest strengths in the implementation approach of EADD-MICCA project? What are its major weaknesses? What lessons have you learned from

working in this project? How can similar projects benefit from these experiences?

FGD2: Farmer trainers

1. PROJECT: What are the activities and improved practices promoted by the MICCA-EADD project through the farmers groups?

2. ADOPTION: Which of the improved farming practices are being taken up by farmers? What do you think are the main reasons? What socio-cultural/economic factors could be contributing to this? (ask by practice using a flip chart)

3. BENEFITS: What are the benefits of those practices in term of farm/milk productivity, income, livelihoods? What are the potential environmental co-benefits? (E.g. how has the improved practices helped to reduce the use of inorganic fertilizers and consume less wood fuel?) Kindly share with us the success stories.

4. BARRIERS: Why have some improved practices not been adopted, abandoned or dis-adopted? For those practices that have not been adopted at all, what do you think are the reasons? Kindly share with us the failure stories.

5. UPSCALING: What practices should be prioritized and why? What kind of support and by whom would be required for large-scale adoption? How can more farmers be reached with information on improved practices? Any challenges you faced or suggestions for improvements?

FGD 3-4-5: Project participating farmers (2FGDs for two sets of locations, and 1FGD with a women group)

1. PROJECT: What are the activities and improved practices promoted by the MICCA-EADD project?

2. ADOPTION: What improved farming practices have been mostly up taken by farmers like you? What encouraged them to adopt? (ask by practice using a flip chart)

3. BENEFITS: What benefits are realized as a result of the improved farming practices adopted? How has farm productivity (milk, crop yields) changed? What about changes in farm incomes and rural livelihood opportunities? What are the potential environmental co-benefits from these improved practices? Kindly share with us the success stories.

4. BARRIERS: Which practices are abandoned or dis-adopted after some time of practicing them and why? Which ones were not adopted at all and what hindered their uptake? How can the adoption of these improved farming practices be enhanced? Kindly share with us the failure stories.

5. SUPPORT: What are farmers doing to empower themselves to continue implementing these improved practices (e.g. farmer-farmer extension, exchange visits, farmer trainers, table banking, group credit access, etc.)? What kind of support and by who is required to do more?

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I4396E/1/02.15