Potential Impacts of Conservation Agriculture in the Lake Victoria Basin

PROJECT REPORT

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Muddy water in Akagera River due to soil erosion on the Highlands

A farmer demonstrating the use of a jab planter a no till equipment

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List of abbreviations

AEZ	Agro ecological zones
EAC	East African Community
CA	Conservation Agriculture
CBO's	Community Based Organisations
FAO-	Food and Agriculture Organization -
FFS's	Farmer Field Schools
ICRAF	International Centre for Research in Agro forestry
ILRI	International Livestock Research Institute
LH	Lower Highlands
LVB	Lake Victoria Basin
NGO's	Non Governmental Organisations
SAKSS	Strategic Analysis and Knowledge Support System
SARD	Sustainable Agriculture and Rural Development
UH	Upper Highlands

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1 Introduction

The Lake Victoria Basin (LVB) covers an area of about 193 thousand square kilometres sustaining an estimated population of 33 million people, who produce an annual gross economic product in the order of US$ 3–5 billion (EAC 2004). Lake Victoria is the second largest fresh water lake in the world with a surface area of 68 thousand square kilometres (EAC 2006). The basin area covers parts of Uganda, Kenya, Tanzania, Rwanda and Burundi (Map 1). Its altitude varies from 580 m around Lake Albert, over about 1100 m around Lake Victoria through the highlands of Rwanda, Burundi and Kenya to peaks of more than 4000 metres above sea level in the Ruwenzoris and Mt Elgon. Annual rainfall in the agricultural zones is between 670 and 2200 mm, with a minimum length of growing period of 230 days. Climatic conditions for agriculture are generally good. Agricultural production is mainly limited by soil conditions and unsustainable agricultural practices.

The land use in the Lake Victoria Basin has undergone substantial changes during the last three decades due to two major human interventions: agricultural expansion and urbanization. The most important impact of these is the increased nutrient flow from the surrounding catchments into the lake, leading to eutrophication. This is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae, and nuisance plants weeds). This enhanced plant growth, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die. Sources of nutrients into the water bodies may include: fertilizers applied to agricultural fields, deposition of nitrogen from the atmosphere; erosion of soil containing nutrients; and sewage treatment plant discharges among others. The root cause of eutrophication in the LVB is the continuing land degradation associated with changes in land use and with agricultural management practices. The result of the deforestation, settlement and conventional farming on vulnerable land is accelerated soil erosion. Sediment and nutrient loads in the lake are high and will further accelerate the process of eutrophication. There is considerable evidence, especially from Kenya, of the strong relationship between land use, runoff and sedimentation from drainage basins (ICRAF 2006). Current monitoring by ICRAF and its partners of the water flow and quality of streams and rivers confirms the relationships between land use and nutrient loads.

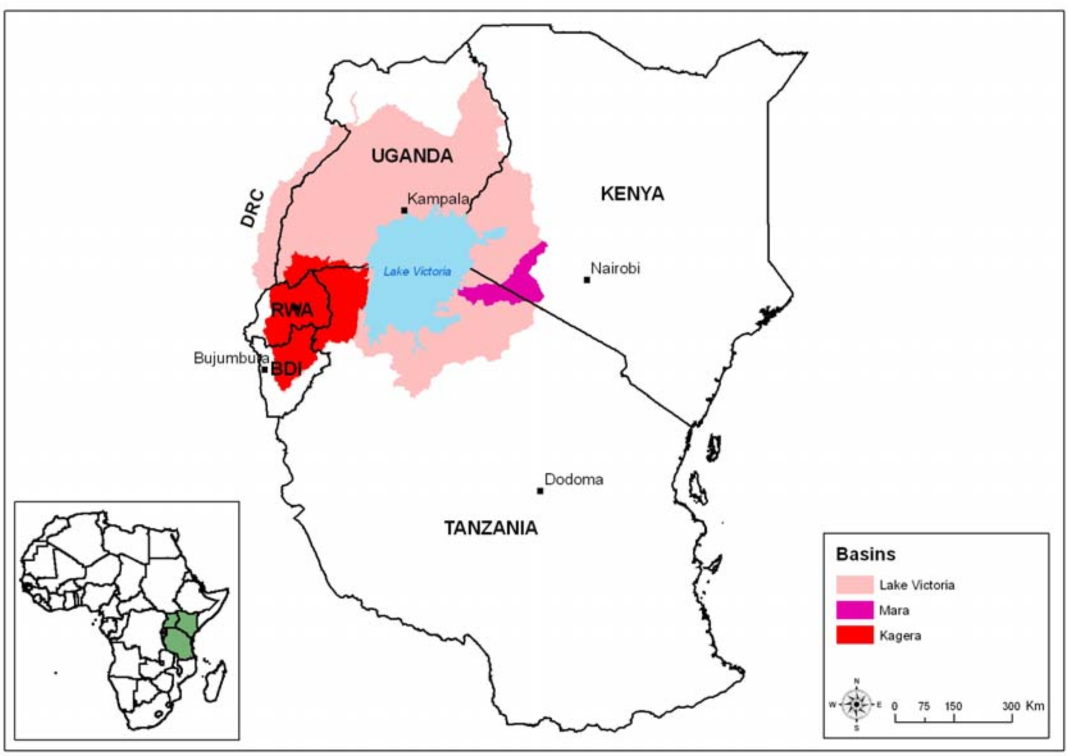
Current trends of agricultural production in the basin are unsustainable because they usually cause large-scale land degradation, loss of watershed function, damage to aquatic ecosystems, fisheries and biodiversity, pollution and poor health. Recently, the environment of Lake Victoria has attracted the attention of policy makers for several reasons:

- Increased nutrient levels (particularly of phosphorus and nitrogen) that enter the lake from urban, agricultural and industrial sources.
- Sediment deposits originating from soil erosion due to poor upland management, charcoal burning and massive deforestation.
- Damage to the natural filter function of the wetlands, especially around the mouths of the rivers entering the lake.

The total sum of these effects has important implications for the productivity of the lake and the surrounding basin. The reduced productivity, in turn, reduces the economic viability of the most common livelihood activities in the LVB: agriculture and fisheries. Numerous attempts have been made to stem the increasing erosion, e.g. through afforestation and reforestation programmes. The main practice causing the erosion, however, is the soil disturbance occasioned by conventional agriculture on fragile lands and steep slopes.

A promising technology to combat this is conservation agriculture (CA), which ensures minimal disturbance of the land, by using no or minimum tillage, covering the soil with organic mulch and rotation of crops with legumes. In recent years CA principles have been introduced to various communities in the Lake Basin and various research initiatives are exploring the benefits of CA to soil and water conservation and to crop productivity.

This report presents findings from a six-month research project: 'Exploring the potential impacts of CA in the Lake Victoria Basin'. A major aim of this research was to assess the wider potential impacts of CA within the basin. The information and knowledge generated is vital for decision makers. It will enable them to make informed decisions about including CA in the agricultural strategies and policies of the riparian countries. The project also aimed at extending and augmenting the physical modelling of nutrient flows which was implemented in the Nyando River Basin by Sang and Ong (2005) to two major river basins: Kagera and Mara (Map 1). This project was implemented through a collaborative arrangement between the World Agroforestry Centre (ICRAF) and the Strategic Analysis and Knowledge Support System (SAKSS) node based at the International Livestock Research Institute (ILRI). The implementation period for the project was June to December 2006.



Map 1. Location the Mara and Kagera river basins in the LVB.

2 Project objectives

The broad objective of the project was to assess the feasibility of curbing land degradation, and promoting productivity and long-term sustainability of the various livelihoods by scaling up the adoption of CA in the LVB. It builds on lessons learnt from an earlier study in the Nyando river basin in Kenya. The specific objectives of this research project were to:

- identify the incentive structure (market opportunities, taxes, institutions etc.) for adoption of CA, and options and opportunities for CA investments to improve land management and increase agricultural productivity
- enhance understanding of agriculture–environment–poverty interactions, the application of CA in these circumstances and the trade-offs and opportunities farmers face
- identify the complimentary set of interventions (policy and institutional) necessary for successful up-scaling of CA
- assess the likely impacts of CA adoption on different types of livelihoods in the basin.

3 Methodology

The study combined the use of biophysical modelling approaches and socio-economic analysis. Based on biophysical modelling, 'erosion hotspots' within the Mara and Kagera basins were identified (Maps 2 and 3). These were defined based on the amount of soil lost in tonnes per hectare per year. Two classes were used to characterize hotspots and non-hotspot areas. Places with soil loss greater than 2.5 tonnes/ha per year were classified as 'hotspots' while those with less soil loss were classified as 'non-hotspots'. Development domains, based on a combination of agricultural potential and market access were mapped for both basins (Maps 4 and 5). The domain map is classified into four classes:

i) Low agricultural potential and low market access (Low/Low or LL)
ii) Low agricultural potential and high market access (Low/High or LH)
iii) High agricultural potential and low market access (High/Low or HL)
iv) High agricultural potential and high market access (High/High or HH)

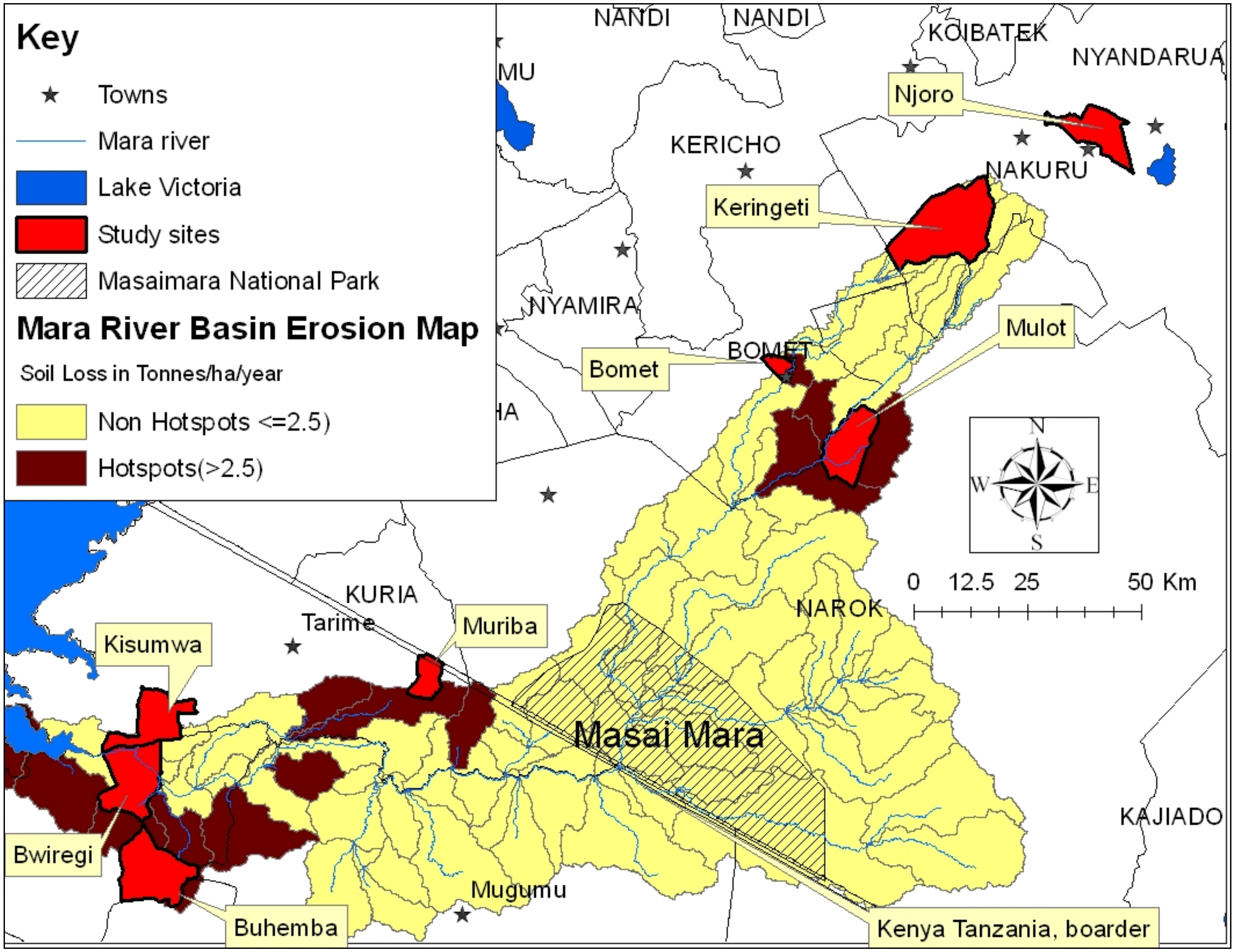
Each of these domains is expected to have similar comparative advantages for different agricultural or rural development options. The spatial delineation and mapping of the domains depends greatly on the quality of the input data. The agricultural potential measure was produced based on continental maps for soil productivity from the Food and Agriculture Organization of the United Nations (FAO) and length of growing period (Jones and Thornton 2004). The resolution of these maps is quite low and in some areas the quality is not very good. Therefore caution needs to be taken when zooming in to small areas in the domain map. The erosion hotspots and development domains were then used in the criteria for selection of the study sites where household surveys were conducted. Study villages were selected from each of the identified domains and within the erosion hotspots and from areas that are currently not hotspots. The current non-hotspots were included because such areas also require attention, as they might become hotspots if current agricultural practices continue without taking measures to conserve soil and water. A total of 373 households were interviewed, 248 from the Mara basin and 125 from Kagera basin (Table 1; Maps 2 and 3).

Table 1: Study sites in Mara and Kagera Basins and the CA adoption sites in Nakuru

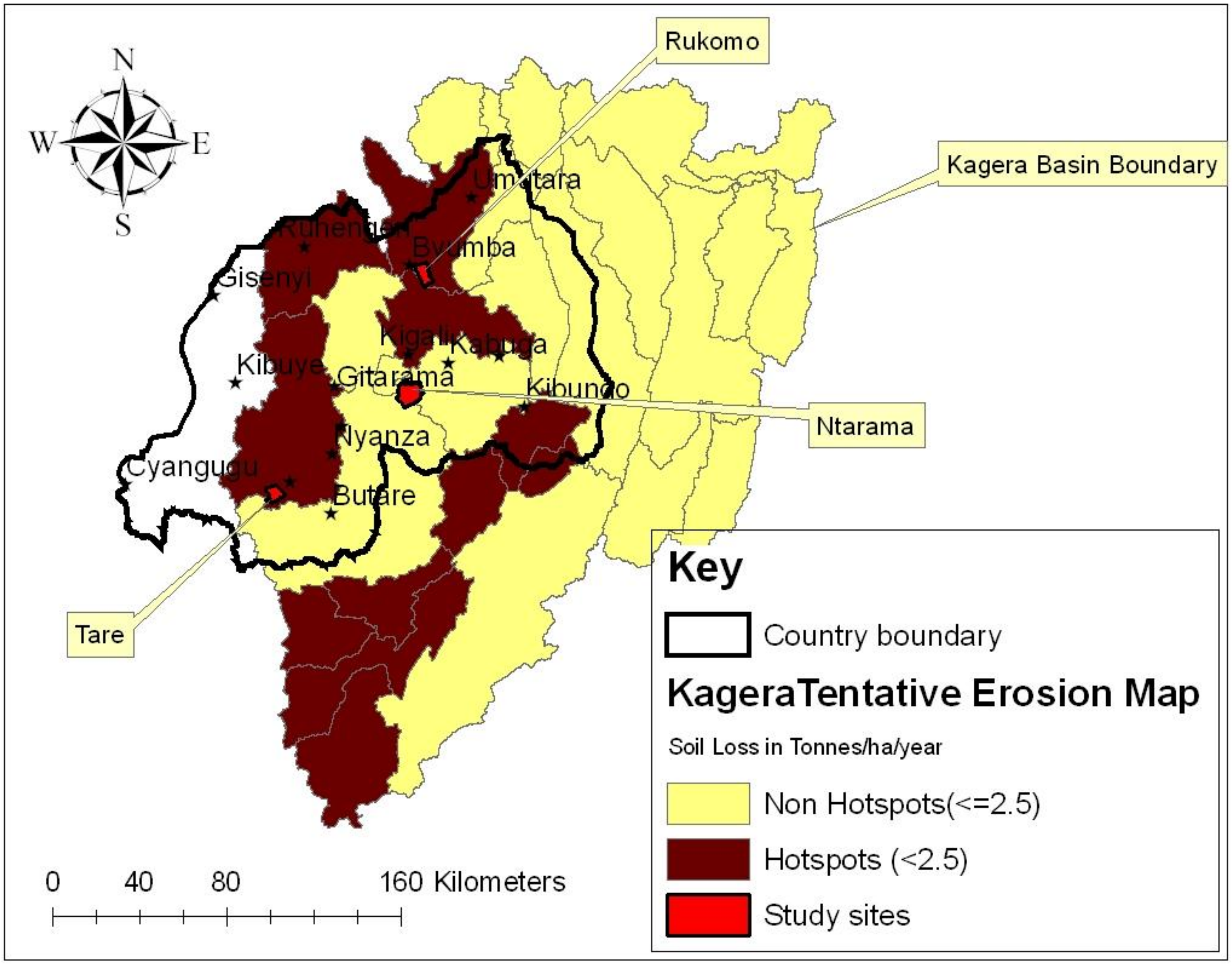
Location	**Village**[1]	**Domain**	**Hotspot?**	**Ward/ division**	**District**	**Country**	**AEZ***
CA adoption study villages	1. Kerma	LH	Not modelled	Njoro	Nakuru	Kenya	LH3
	2. Ngecha	LH	Not modelled	Njoro	Nakuru	Kenya	LH3
Mara Basin	3.Chepng'aina	HH	Yes	Bomet Central	Bomet	Kenya	LH1
	4.Ngiito	HL	Yes	Mulot	Narok	Kenya	LH2
	5.Bungurere	LL	Yes	Muriba	Tarime	Tanzania	Zone 6
	6. Biatika	LH	Yes	Buhemba	Musoma Rural	Tanzania	Zone 4
	7. Kwibuse	HH	No	Kisumwa	Tarime	Tanzania	Zone 4
	8. Ryamisanga	HL	No	Bwiregi	Musoma rural	Tanzania	Zone 4
	9.Kitoben	LL	No	Keringet	Nakuru	Kenya	UH2
Kagera Basin	**Village**	**Domain**	**Hotspot?**	**Sector**	**District**	**Province**	**AEZ**
	10. Gasarenda	HH	Yes	Tare	Nyamaga be	Southern	South-central zone
	11. Munyinya	LH	Yes	Rukomo	Gicumbi	Northern	North central zone
	12. Karambi	LL	No	Ntarama	Bugesera	Eastern	Eastern low lands zone

* Details on physical conditions for these agro-ecological zones (AEZ) is provided in Appendix 2.

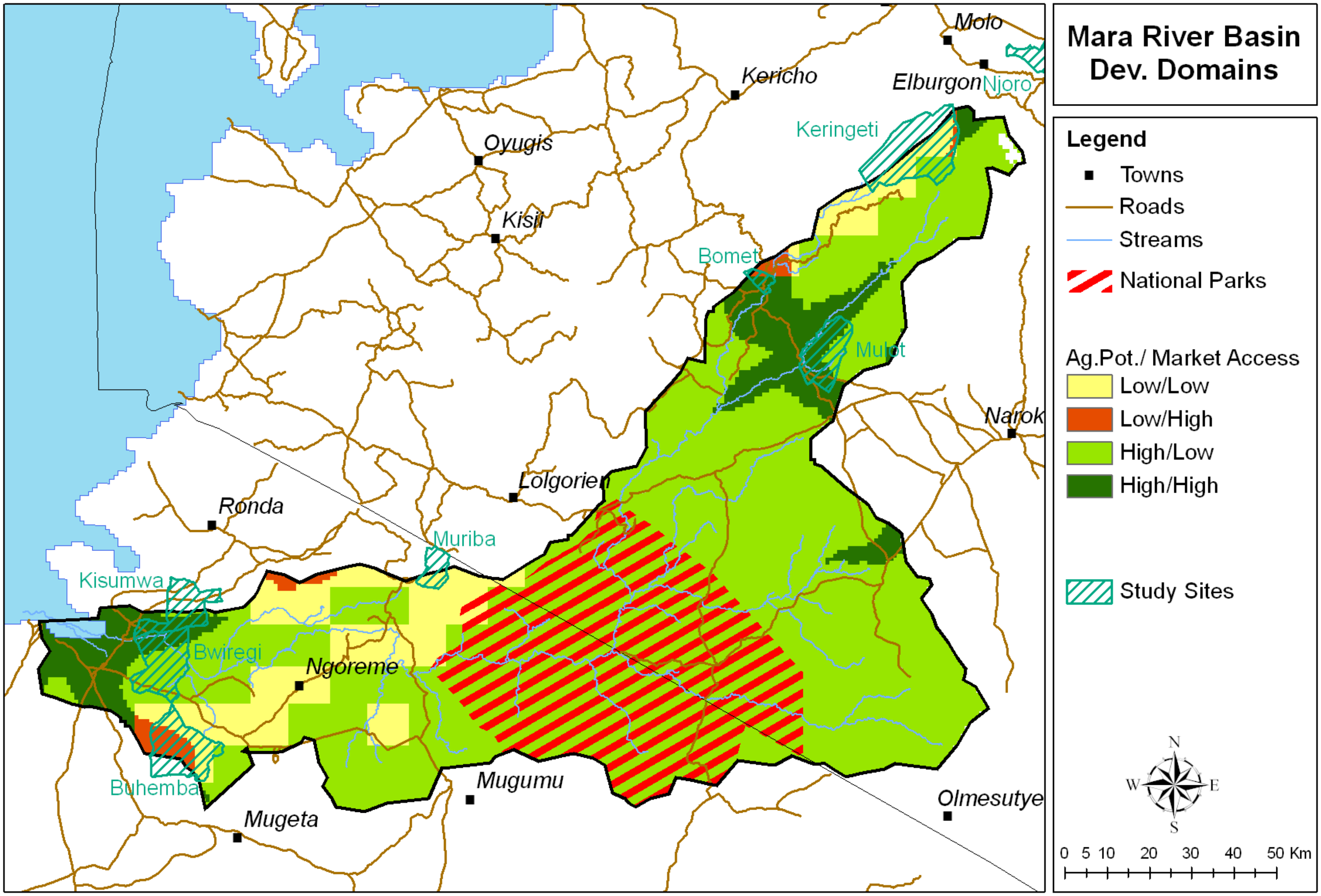
[1] For easy reference in this report the following site names have been used to represent the villages in brackets: Bomet (Chepng'aina), Mulot (Ngiito), Keringet (Kitoben), Tare (Gasarenda), Byumba (Munyinya) and Bugesera (Karambi). For the villages not mentioned here, actual village names are used.



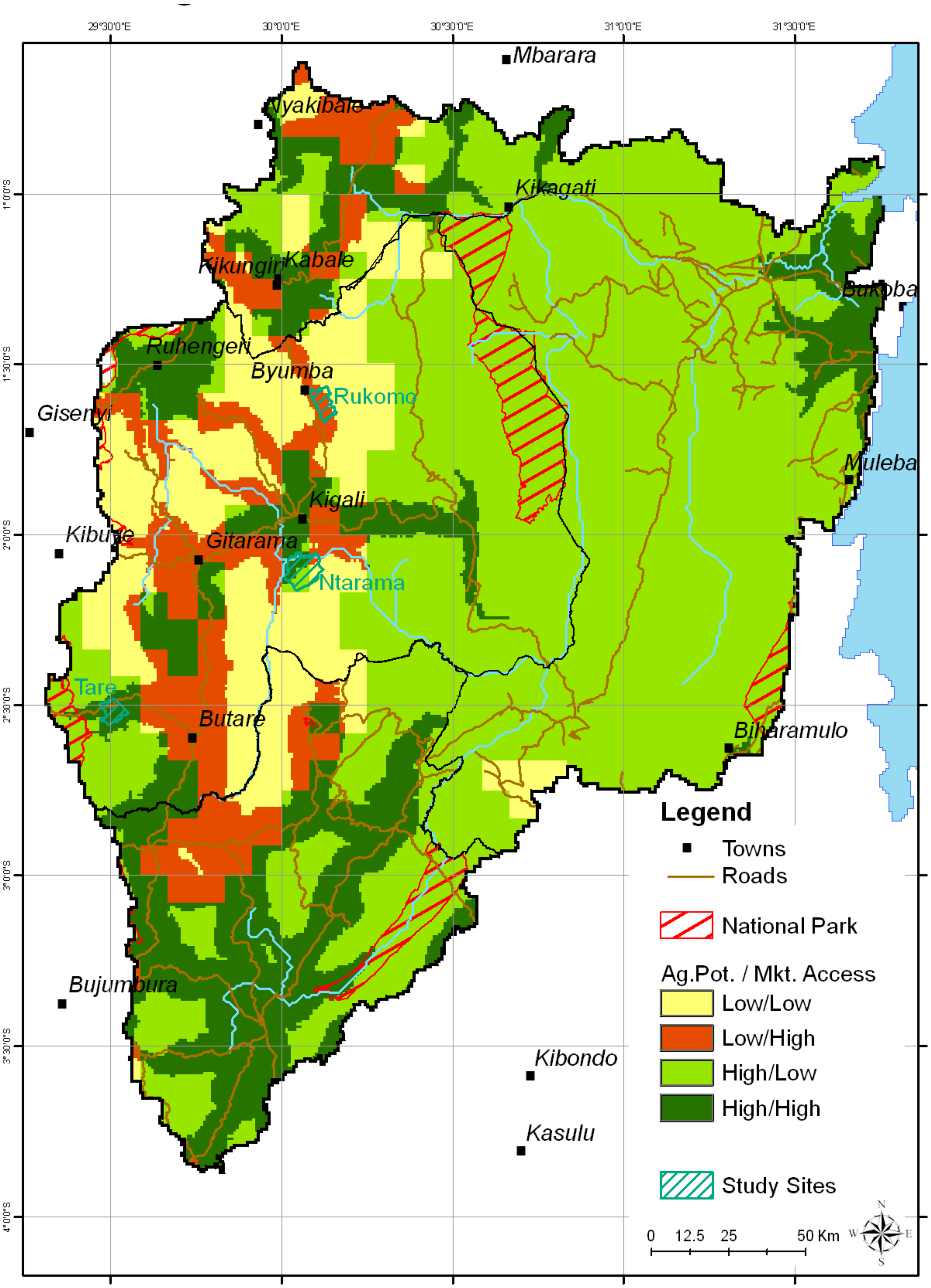
Map 2. Erosion hotspots and study areas in the Mara river basin.



Map 3. Erosion hotspots and study areas in the Kagera river basin.



Map 4. Development domains for the Mara river basin.



Map 5. Development domains for the Kagera river basin.

4.0 Project findings

4.1 CA adoption study in Njoro, Nakuru

4.1.1 Promotion of CA in Njoro Division, Nakuru

CA is not practised in the study sites in the Mara and Kagera basins. Two villages (Kerma and Ngecha), located just outside the Mara basin, were therefore selected to study the adoption of CA. These villages are located in Ngata Location, Njoro Division in Nakuru, Kenya (Map 2). The purpose of this study was to understand different aspects related to the adoption of CA in the area. This site was selected because it was envisaged that it will be reasonable to extrapolate lessons from this site to the Mara basin because: i) socio-economic characteristics of people and economic activities in this area are likely to be similar to those in the basin due to its closeness to the basin; ii) the site is located in the same agro-ecological zone (Lower Highland/LH zone) as the Bomet and Mulot sites (Appendix 2); and iii) the annual rainfall in this area is more less similar to that of Ryamisanga, Kwibuse and Biatika study sites located in the Mara basin.

CA in Njoro Division was funded by FAO under the CA-SARD project. In Kerma and Ngecha villages, the technology was introduced in 2004 and farmers started the practice in 2005, mostly on maize. Two farmer field schools (FFS) were set up, one in each village, to train farmers for nine months, covering both theoretical and practical lessons. FAO provided significant support for the start up of CA in the area in form of: (i) equipment (four jab planters to each group (each worth about KSh 2000); one animal drawn planter for each FFS (market value: KSh 20,000); one tractor drawn (no till) planter worth KSh 200,000 to be shared by all FFS in the district); (ii) training for the extension workers—the project provided training to the extension workers on the application of CA (these workers were used as facilitators in training at the FFSs); and (iii) financial support—each FFS was allocated US$ 600. Half the amount was for costs related to the school, such as purchase of fertilizer, pesticides, herbicides and stationery for learning activities at the FFS. This money was also used to cover the costs of hiring land to serve as a trial plot for the school (Figure 2) and facilitating the CA field day. Although the project used government extension workers as training facilitators, with the other half of the money was used to provide them with facilitation allowances (KSh 500 per visit) for fuel/transport and lunch. The other half of the money was to facilitate extension workers. With such support, the facilitators were able visit the FFS once a week during the 40 weeks when the course was running.

After the training, it was envisaged that the facilitators would continue visiting the school once a month. However, this was not possible because all the facilitators were transferred out of the area. The current extension workers are either not trained on CA or do not have resources to continue the farm based extension work. The cost associated with initiating CA in an area served by one FFS are in the range of US $ 4,000 per FFS, but this includes the high, but shared cost of the planter. It is assumed that a tractor is available in the area where CA is being promoted.

4.1.2 Adoption of CA in Kerma and Ngecha villages

Sixty-four small-scale farmers were interviewed in the two villages, 34 from Kerma and 30 from Ngecha. Summary statistics for the key findings are presented in Table 2. Income portfolios of the respondents in the two study villages were constituted by various activities. Major sources of income included: crop production, livestock keeping and non-farm activities (such as employment in the formal or informal sectors and trade). Income sources with minor contribution to the total net income are grouped under ‘others’; these comprised: renting out land, natural resource related activities (e.g. sale of tree seedlings), remittances and payment in kind (Figure 1, Appendix 1). Non-farm activities made a big contribution to the total net income of the respondents in the past year, their contribution being 37% in Kerma village and 32% in Ngecha village. Livestock keeping contributed by at least a quarter of the total net income of the respondents in the same period in both villages, while crop production contributed 32% in Ngecha and 16% in Kerma.

Table 2. Summary of findings for Kerma and Ngecha villages

	Kerma	**Ngecha**
Total HH interviewed	34	30
Average HH size	6	5
Female headed households (%)	21	13
Proportion applying CA in 2005 (%)	23	40
Average age of the HH head (years)	54.4	51.0
Average net income (KSh/annum)	105,713	282,244
Average net income (US$/annum)[1]	1510	4032
Average farm size (acres)	4.3	6.0
Average farm size (hectares)	1.7	2.4
Proportion of the respondents with access to credit (%)	17.7	33.3
Food insecure HH over the past 12 months (%)	38	10
Land allocated to maize (acres)	1.5	2.0
Share of land allocated to maize (%)	54	60
Share of maize land allocated to CA (%)	15	22
Share of CA land in farm size (%)	3.7	8.9
Maize yield on CA land (kg/acre)	1,560	2,002
Maize yield on CA land (tonnes(t)/ha)	3.9	4.9
Maize yield on non-CA land (kg/acre)	761	1,060
Maize yield on non-CA land (t/ha)	1.9	2.6
Yield ratio: CA/non-CA	2	1.9
Gross margin (KSh/acre): CA maize	21,484	32,503
Gross margin (KSh/ha): CA maize	53,065	80,282
Gross margin (KSh/acre): non-CA maize	5,725	10,640
Gross margin (KSh/ha): non-CA maize	14,141	26,281
Gross margin ratio: CA/non-CA	3.8	3.1
Proportion of the respondents with access to government extension services (%)	53%	67%
Education level of the HH head (%)		
▪ None	14.7	13.3
▪ Primary	55.9	53.4
▪ Secondary	20.6	23.3
▪ Certificate/diploma	5.9	10
▪ Higher	2.9	0

1 Exchange rate (US$ 1 = KSh 70)

For the entire sample, 31% of the farmers adopted CA in 2005. At village level, the adoption rates were 40% and 23% for Ngecha and Kerma villages respectively. In 2005 the adopters had higher income than non-adopters in the two villages (Table 3); this is probably because wealthier people are more likely to adopt a new technology. In both villages, the contribution of crop production to the total net income of the respondents in the past year was higher among the adopters than among non-adopters; its contribution in Kerma village was 27% and 11% among the adopters and non-adopters respectively. In Ngecha, a village with a higher CA adoption rate, crop production contributed 57% to the income of the adopters and 17% to that of non-adopters. These findings suggest that the adopters are likely to be farmers who are more devoted to crop production and use improved farming methods including CA. Although the adopters only applied CA on small portions of their farms, the increased revenues from CA plots contributed to their crop income.

Table 3. Income portfolios of the CA adopters and non-adopters in Kerma and Ngecha villages

Village	Category	Average crop income (KSh)	Contribution from an activity/income source (%)							Mean income
			A	B	C	D	E	F	G	
Kerma	Adopters	36,089	26.9	37.5	0.6	0	30.4	3.8	0.8	134,112
	Non-adopters	10,646	11.0	37.7	1.3	1.7	39.9	5.2	3.1	96,974
Ngecha	Adopters	166,504	57.4	22.8	0.0	0.0	9.3	9.9	0.6	290,048
	Non-adopters	46,275	16.7	32.7	0.5	0.0	46.8	1.9	1.4	277,726

A = crop production; B = livestock; C = rent out land; D = natural resources; E = non-farm activities; F = remittances; G = income in kind.

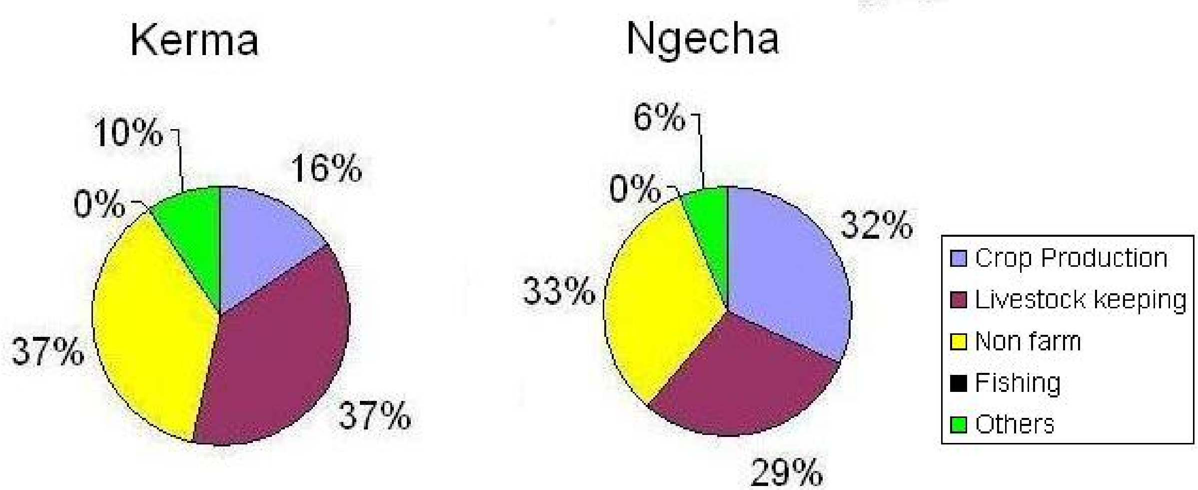


Figure 1. Income portfolios of the respondents in Kerma and Ngecha villages.

Overall, the results give a positive impression of CA. Maize yields from CA plots are twice as high as those without CA and this is true for both villages. Gross margins for CA maize plots were more than three times as high as those for non-CA maize plots. The fact that farmers realise much higher yields and revenues is good news for promotion of the CA technology. However, because it is a new technology, most farmers are simply experimenting with it. Of the total land farmers allocated to maize, in Kerma village 15% was under CA while in Ngecha it was 22%. With such positive results, it is expected that more farmers will adopt the technology, and that there will also be an increase in acreage under CA among farmers that have already adopted the technology.

Econometric analysis indicates that access to credit for agricultural production and extension are important for adoption of CA. Access to credit for agricultural production probably has to do with the need to borrow money to purchase key CA inputs such as fertilizer and improved seeds. Farmers benefit from knowledge and, therefore, government extension agents are important in imparting this knowledge. Indeed in the two villages, government extension workers were providing that service to farmers. Households that were food secure were more likely to adopt CA than food insecure ones. Probably the food secure households are more willing to take risks and to experiment with a new technology while the food insecure may be risk averse, wary about their household food situation if the technology fails. In addition, farmers with large plots allocated to maize were more likely to adopt CA, again probably because they can afford to experiment. Even though CA results in higher yields and revenues, its impact on total household income remains low, largely because CA is currently at an experimental stage, with an average of only 6% of total farm size allocated to the technology (3.7% in Kerma and 8.9% in Ngecha). As farmers become more confident about the technology and allocate more land to CA, the impact of the technology of household income will grow. Most of the farmers in this study started adopting CA in 2005, which is too short a time to realize a discernable positive impact on households and communities.

A high proportion of the adopters used all the three components of CA (58% in Ngecha and 64% in Kerma). Several adopters used two of the CA components in different combinations (Table 4). About one-fifth of the adopters in Ngecha used one component (reduced tillage). This is the most important of the three CA components hence farmers applying this principle were also able to realize increased yields.

Table 4. Components of CA used by adopters in Kerma and Ngecha villages

Village	**Proportion (%)**	**CA components applied**
Ngecha	58	All three components: (crop rotation, permanent crop and reduced tillage)
	21	Two components: (14% permanent crop and reduced tillage and 7% crop rotation and reduced tillage)
	21	One component (reduced tillage only)
Kerma	64	All three components: (crop rotation, permanent crop and reduced tillage)
	36	Two components (27% permanent crop and reduced tillage 9% crop rotation and permanent crop cover)

4.1.3 Income portfolios by wealth group in the Kerma and Ngecha

Economic activities were diversified across all income groups in both Kerma and Ngecha villages (Appendix 1.1). Crop production, livestock keeping and non-farm activities were important among both the rich and the poor. Contribution of different activities to the net income of a household varied among the two villages. In Kerma, crop production contributed less than 20% of household net income in all income groups except for the second income quartile where its contribution was 32%. Households in the other income quartiles gained most of their income from livestock production and non-farm activities. In Ngecha, the respondents were more inclined to crop production; more than 25% of the respondents' incomes in all income groups came from the crop production sector. The lower half income group relied on a combination of crop production and livestock keeping, while the second half had more diverse income sources, including non-farm activities.

A lesson that can be learnt here is that CA technology can also be promoted in areas with diverse economic activities as is the case in many areas in the LVB. The question that still remains unanswered is how to make the poor adopt this technology; this is where it will actually contribute to poverty reduction and increased food security. Findings from the two villages indicate that the technology was mainly adopted by the well-off households (Appendix 1.2). In Kerma village there were no adopters from the lowest income quartile while there were only 12% from the second quartile; the rest were from the highest two quartiles. In Ngecha village adopters were distributed across all income groups, but most were clustered between the second and the third quartile (middle class). Average income in Ngecha village was twice as high as that of Kerma (Table 2), so even the poor households in Ngecha were relatively better off than those in Kerma. This indicates that the poorest bracket of the society might need a lot of support in areas such as improved agricultural inputs, access to credit and other related aspects for them to adopt this technology. The technology might otherwise remain 'being for the rich' as some of the respondents from Kerma village called it during the rapid rural appraisals conducted there.

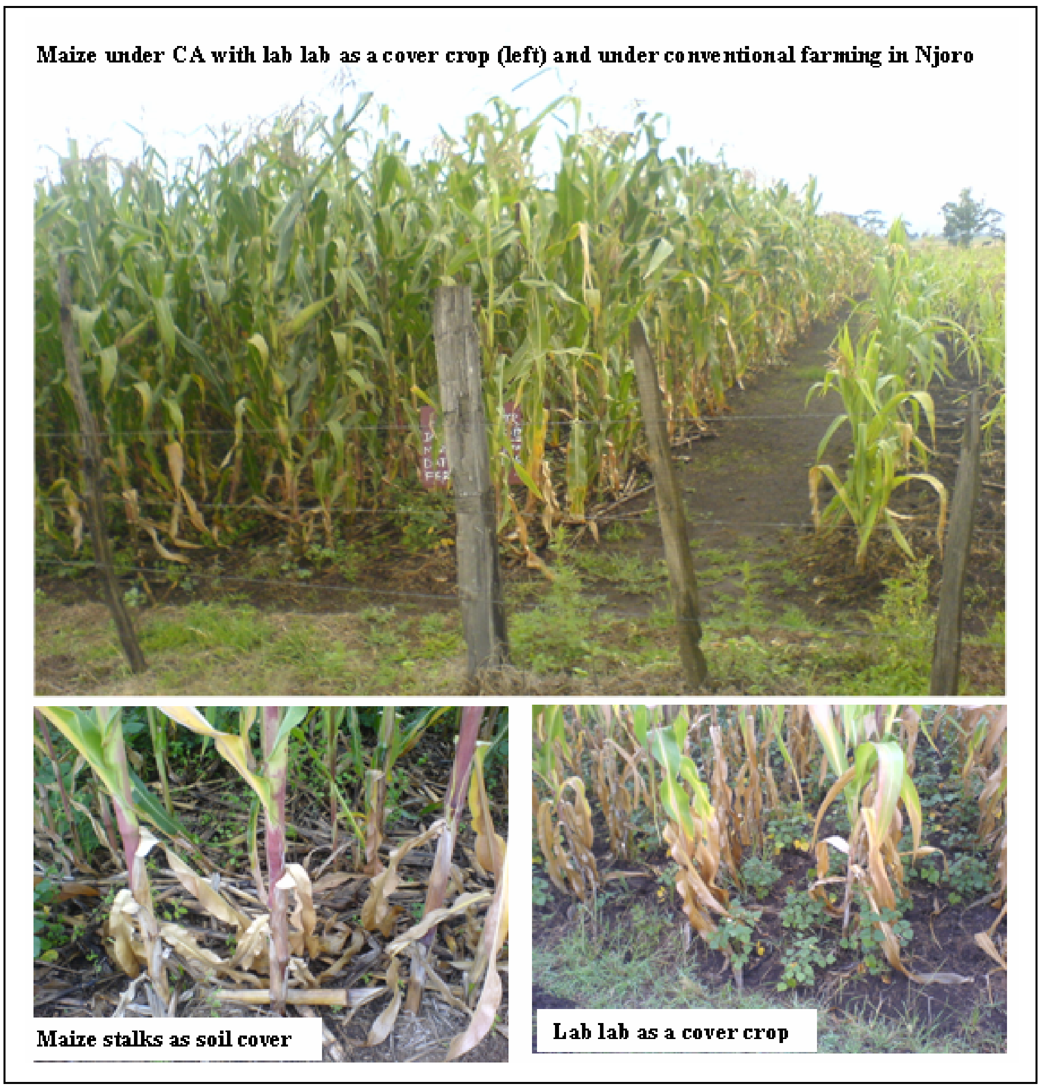


Figure 2. CA application on maize in a trial plot in Kerma village, Njoro.

4.2 Findings from Mara Basin

4.2.1 Introduction

This section presents a summary of findings from the study sites in the Mara river basin. A total of 107 households were interviewed from three sites on the Kenyan side of the basin namely; Chepng'aina (Bomet), Keringet (Nakuru) and Mulot (Narok). On the Tanzanian side, 141 households were interviewed from four sites, namely Bungurere, Kwibuse, Ryamisanga and Biatika. A summary of socio-economic characteristics of the surveyed households is presented in Table 5.

4.2.2 Household income portfolios in the Mara river basin

Sources of income for the respondents in the sites in the Mara basin were similar to those in the CA adoption villages. They included crop production, livestock keeping, natural resources related activities, non-farm activities, remittances and payment in kind. Fishing and fish trading activities were found in Ryamisanga and Kwibuse villages which are located along the shores of River Mara. As was the case in Kerma and Ngecha villages, non-farm activities made a significant contribution to the total net income of the surveyed households (Figures 4 and 5). Although most respondents practised crop production and livestock keeping, their net income from these activities was quite low. Respondents noted that they had been experiencing a decline in agricultural productivity over the past years. They attributed this to a combination of factors such as decrease in soil fertility due to soil erosion and soil exhaustion, frequent droughts and unreliable rainfall and low prices for agricultural products while that of inputs is high among others. Collection of data to indicate the trend of yields and prices of agricultural products in the basin was not possible during this study due to time constraints. However, information from secondary data sources (e.g. MoFP 2002a, 2002b; Funk, 2005) and other studies (Ehui and Pender 2003; ICRAF 2006; Jayne and Chapoto 2006 ;) are in line with the respondents' arguments. As a coping mechanism in response to poor agricultural productivity farmers have been finding means of diversifying their economies through engaging in non-farm activities (Figure 3). Nevertheless, due to lack of capital and entrepreneurial skills, some farmers were found to be engaging in poorly paying activities and sometimes in illegal activities such as selling charcoal from protected forests or illegal brewing. This indeed indicates that rural farmers in the Lake Victoria basin actually have very limited livelihood options despite the basin's vast potential. In light of such limited livelihood options, sustainable environmental management in the area is more challenging unless productivity enhancing technologies are widely promoted and adopted.

Crop production and brick making

Charcoal Selling

Figure 3. Examples of economic activities in the Mara river Basin.

Table 5. Socio-economic characteristics of the surveyed households in the Mara basin

	Kenya			**Tanzania**			
	Bomet	**Keringet**	**Mulot**	**Bungurere**	**Kwibuse**	**Ryamisanga**	**Biatika**
Total HH interviewed	36	34	37	35	35	33	38
Average HH size	6	6	9	8	7	7	8
Female-headed households (%)	22.2	5.9	8.1	5.7	8.6	18.2	10.5
Average age of HH head (years)	50	40	48	48	50	47	52
Annual average net income (KSh) in Kenya and TSh in Tanzania[1]	117,747	259,524	123,342	1,415,544	944,330	1,547,114	1,076902
Average net income (US$)/annum	1,682	3,708	1,762	1089	726.4	1190	828
Farm size (acres)	3.4	8.8	9.7	2.9	3.5	3.8	6.1
Farm size (hectares)	1.4	3.6	3.9	1.2	1.4	1.5	2.5
Average cattle equivalent units (CEU)	4.9	6.7	5.5	4.8	7.9	10.5	9.2
Proportion of the respondents with access to credit (%)	27.8	17.7	29.7	28.6	8.6	6.1	15.8
Proportion of the respondents with access to government extension services (%)[2]	41.6	38.2	35.1	48.6	48.6	39.4	26.3
HH food insecure over the past 12 months (%)	47.2	44.1	54.05	68.6	82.9	60.6	52.6
Average maize yield (kg/acre)	1426	1255	847	676	337	516	544
Average maize yield (t/ha)	3.5	3.1	2.1	1.7	0.8	1.2	1.3
Education level of HH head (%)							
▪ None	22.2	0	16.2	17.1	22.9	15.2	18.4
▪ Primary	41.7	26.5	54	62.9	71.4	78.7	71.1
▪ Secondary	19.4	61.8	24.3	8.6	5.7	6.1	7.9
▪ Certificate/diploma	13.9	8.8	5.4	11.4	0	0	2.6
▪ Higher	2.8	2.9	0	0	0	0	0

[1] Exchange rate (US$ 1 = KSh 70 and TSh 1300)

[2] Figures in this row cannot be compared because they are in different currencies, for comparisons use the next row with incomes converted into US dollars.

[3] Almost all respondents reported that they had little access to these services, in most cases less than once in several years. Government extension workers no longer visit the farmers regularly, only when requested to do so by farmers. The extension workers interviewed explained that this is a new system that has resulted from the lack of resources for logistical support for extension visits (e.g. transport facilities and fuel) due to limited budgetary allocations from governments.

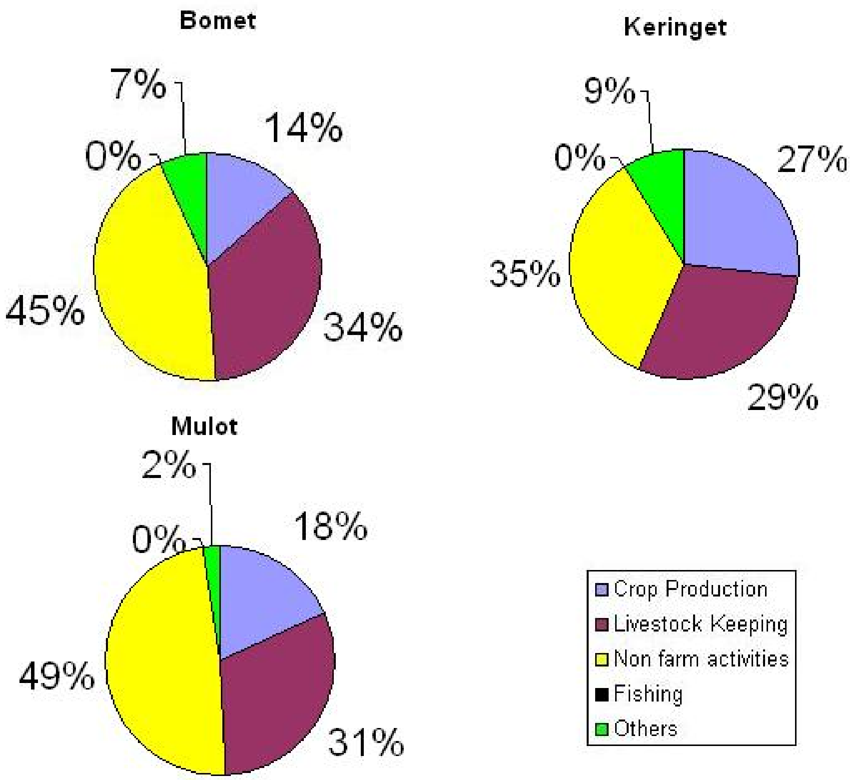


Figure 4. Income portfolios of the respondents in Mara basin, Kenya.

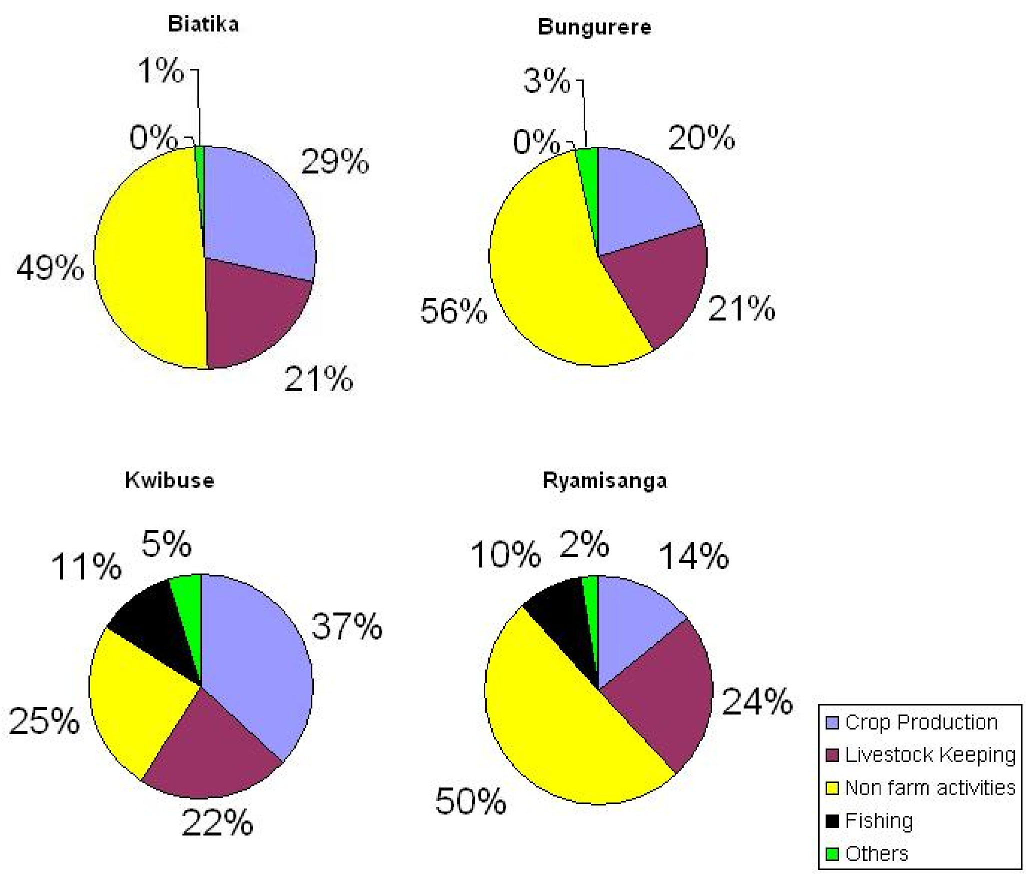


Figure 5. Income portfolios of the respondents in Mara basin, Tanzania.

4.2.3 Agriculture in the study sites in the Mara basin

A wide range of crops were found to be grown by the respondents in the sites visited in the Mara basin. On the Kenyan side of the basin, maize and beans were the common major crops in the three sites surveyed. In Tanzania, major crops in the four study sites were: maize, cassava, sorghum, millet and sweet potatoes (Table 6). Maize was a major crop in almost all of the sites visited. It occupied the largest share of farm land in all sites except in Ryamisanga village where it was the second ranking crop. Bomet, Mulot, Bungurere and Biatika were the major maize growing areas with more than a third of their farm land allocated to Maize (Table 7).[2] Livestock keeping was a major economic activity in the study sites; livestock kept included cattle, goats, sheep and chicken. Cattle were the most commonly kept animals (Appendix 4). Open grazing and semi-zero-grazing were the common cattle management systems. Free range chicken were kept by at least 60% of the respondents for subsistence. Crop–livestock interaction was observed in all sites, the two activities complemented each other in several ways. For example, livestock provided traction, manure and income for use in crop production, while, crop production provided fodder and crop residues as livestock feeds on. More than half of the respondents in the major maize growing areas reported to be using at least 50% of their crop remains to feed their livestock (Appendix 4). In this case it is suggested that when CA is introduced, farmers should also be trained on alternative cover crops or materials to minimize problems that might arise due to high demand for cover materials (mulch) versus livestock feeds.

Table 6. Crops grown by the respondents in the study sites in the Mara river basin

Country	Study site	Major crops	Minor crops
Kenya	Bomet	Maize, beans, Irish potatoes and tea	Bananas, cabbage, wheat, avocado, sweet potatoes, maize, coffee, kale, tomato and millet
	Keringet	Maize, Irish potatoes, peas, pyrethrum and beans	Cabbage and strawberry
	Mulot	Maize, wheat, beans, millet and sorghum	Oranges and Irish potatoes
Tanzania	Bungurere	Maize, coffee, sorghum, millet, bananas, cassava, beans and sweet potatoes	Soya beans, sugar-cane and tomatoes
	Kwibuse	Maize, cassava, millet, sorghum, sweet potatoes and beans	Cabbage, tomatoes and bananas
	Ryamisanga	Cassava, maize, sorghum, millet and sweet potatoes	Simsim, beans, rice, groundnuts, sunflower, water melon, oranges and tomatoes
	Biatika	Maize, beans, cassava, sorghum and tomatoes	Kale, coffee, bananas, sunflower, groundnuts and sweet potatoes

[2] Percentages in this table add up to less than 100% of the farmland because farmers use the rest of their land for other uses such as planting fodder, livestock keeping, planting minor crops and also as fallow land

Table 7. Proportion of the farmland allocated to the major crops in the Mara river basin

Crop/site	Share (%)						
	Bomet	**Keringet**	**Mulot**	**Bungurere**	**Kwibuse**	**Ryamisanga**	**Biatika**
Maize	40.3	28.1	41.9	36.1	28.9	12.7	52.1
beans	29.0	4.3	15.8	6.9	2.5		5.8
Irish potatoes	6.5	8.1	0.3				
Tea	4.4						
Peas		2.7					
Pyrethrum		3.1					
Wheat			14				
Millet			0.5	7.5	10.8	5.8	
Sorghum			0.4	10	10.2	6.9	2.2
Cassava				9	21.5	32.4	6.9
Bananas				10.7			
Sweet potatoes				1.9	2.02	7.1	
Coffee				17.9			
Tomatoes							0.3

Note: Blanks indicate that the crop is either a minor crop or was not grown by the respondents.

4.2.4 Marketing of crops in the study sites in the Mara basin

This section presents information on various aspects related to marketing of agricultural products that was gathered during the study. The information was collected using a combination of qualitative and quantitative methods. Qualitative methods used included discussion with key informants in the study sites such as agricultural extension workers, social workers, local leaders, local crop traders and elders. During these discussions information regarding agricultural marketing in particular, the methods used, facilitating factors and constraints was solicited. Open ended questions were used to gather this information from the respondents. Poor prices of agricultural crops and problems associated with transportation of agricultural products to the markets were identified by the respondents in all study sites (Appendix 7).

Marketing of crops in the study sites in Kenya

Mulot, Bomet and Keringet are located in agro-ecological zones suitable for crop production and livestock keeping. Based on AEZ classification by Jaetzold and Schmidt (1983), the three study sites are situated in the following AEZ: Mulot falls under the Lower Highland 1 (LH1: tea/diary zone), Mulot is located in Lower Highland 2 (LH2: maize/wheat/pyrethrum zone), while Keringet is in the Upper Highland 2 (UH2: wheat/pyrethrum zone). More information on the characteristics of these zones is given in Appendix 2. In good growing years these areas produce high yields for local consumption and surplus for selling to other areas.[3] The introduction of a free market system as a result of trade liberalisation has reduced government control over agricultural marketing; consequently, farmers have been using different marketing strategies. According to the

[3] Bomet was affected by draught in 2005. Mulot had delayed rains in 2005 and later floods in March 2006. These incidences significantly reduced crop yields over the past year, several cases of crop failure and production below the usual average was reported, this reduced amount available for sale.

respondents, farmers in the study sites have not been selling their crops to the Kenya Cereal Board (KCB) despite its existence in their areas. They provided the following reasons for this: 1) Branches near their areas have not been efficient in facilitating sales of agricultural products; issues such as long closure of the Board's branches, or delays in opening the branches as soon as the harvesting season starts were mentioned as disincentives to farmers using the services. 2) Farmers said they found it hard to comply with what they called 'strict' regulations provided by the Board; for example, the Board requires farmers to have their maize dried to a certain degree before it buys the crop and it also requires farmers to transport their crops to the board branch and incur drying costs whenever the maize is found not to be dry enough to meet the set standards. 3) Delayed payment after selling their crops to the Board discouraged farmers especially since they mostly have immediate cash needs.

Options for sale of agricultural products reported to be used by most of the farmers included: (i) sale at the local markets and selling to neighbours and local retailers; (ii) selling to the village assemblers; and (iii) selling to the travelling traders. The use of the first option was, however, limited by the fact that, during harvesting season in an area the supply of crops, say maize or Irish potatoes, exceeds the demand, so neighbours and people within the same village have little need to buy food. This situation leaves the farmers with the option of selling their crops to village assemblers and travelling traders. The advantage of this option is it provides farmers with on-farm markets, cutting the costs of transport and farmers are paid instantly. In this case it provides incentives for the farmers to produce crops that have markets outside their area. For example, farmers in Keringet reported that they sell their Irish potatoes to the travelling traders from various parts of Kenya and from Tanzania. Village assemblers and travelling traders have also been facilitating the sale of maize from Mulot to the pastoralists in Maasai land where maize production is low. Examples of maize prices along the value chain from farm to the retail markets are provided in Boxes 1 and 2 in Appendix 3.

Despite the existence of benefits associated with the operations of the village assemblers and travelling traders, respondents reported that there are two main problems associated with this system. First, due to lack of government control on the prices of agricultural products, buyers have been controlling prices this. Respondents noted that traders in their areas tend to buy crops at very low prices that make it difficult for farmers to make profit. Second, some traders cheat on measurements when purchasing crops by calibrating weighing scales to their advantage, e.g. when buying maize using their scales a sack would contain several kilograms more than the usual 90 kg. This also happens when the traders buy Irish potatoes, where they bring bigger sacks that are larger than normal. This was a major problem reported in Bomet and Keringet. According to the respondents, farmers are aware of these tricks but they still use this option to sell their crops as they do not have a better option. In Mulot area the local government has made attempts to address the problem by developing local bylaws that require travelling traders operating in their area to use farmers' weighing scales. This was not the case in the other sites. For the farmers to enjoy the benefits of using CA, this is an area that will require policy intervention and possibly legal backing to protect farmers from the losses they incur through unfair treatment by the traders.

During the surveys it was noted that assemblers and travelling traders tend to make a lot of profit by buying maize at lower prices during harvesting season, holding it and selling at higher prices in food shortage months mainly in late March, April and May (Appendix 3). Survey respondents and key informants pointed out that such opportunity is not enjoyed by most of the farmers, especially the poor ones due to various reasons including: 1) lack of good storage facilities that compels them to sell their crops immediately after harvest; 2) lack of alternative income generating opportunities which makes them sell their crops (sometimes even selling all their food) to get cash; and 3) lack of capital due to limited access to credit which limits farmers from investing in agricultural marketing. Interventions such as assisting farmers develop good storage facilities, creating alternative income generating opportunities, providing credit to farmers and training them on skills such as agricultural marketing and others are therefore recommended.

Marketing of crops in the study sites in Tanzania

Marketing strategies and problems in the study sites in Tanzania varied according to the sites. Information on agricultural marketing issues identified will therefore be presented in three groups: Kwibuse and Ryamisanga as one group because they had similar characteristics, and then Bungurere and Biatika separately.

In Kwibuse and Ryamisanga villages farming was mainly for subsistence; respondents mainly grew cassava, sorghum and sweet potatoes which were consumed locally. Maize was produced in small quantities as a cash crop. Only 27% of the respondents in Kwibuse and 30% in Ryamisanga reported to have sold any of their crops in the past year. Shares of marketed production were less than 25% for all main crops produced in both villages indicating that the majority of crop output was consumed by the households rather than sold in the market (Appendix 5). Furthermore, the two sites are relatively closer to Musoma town than the other sites; distances from these villages to Musoma are only about 40 and 35 km for Kwibuse and Ryamisanga respectively. Farmers from the two villages often use bicycles to reach markets in Musoma. A combination of the above factors made respondents less concerned about marketing issues than respondents in the other sites were. However, the following issues were raised: 1) poor feeder roads to reach the main road to Musoma town; 2) low prices and lack of accurate weighing scales from the travelling traders who come to the village; 3) lack of government support in providing marketing opportunities which acts as a disincentive to agricultural production; and 4) lack of education on agricultural marketing for the farmers.

Bungurere is an area with good potential for agriculture; it is located in AEZ VI in the Tarime highlands. This zone is characterized by bimodal and very reliable rains (Appendix 2). During good years, the area has two harvesting seasons: February and August. The area supports production of various agricultural products (Table 6). According to the respondents, marketing of agricultural products is a major constraint that farmers face in the area. Lack of efficient institutions to facilitate marketing of agricultural products was pointed out to be a cause for this. Marketing institutions such as the government coffee board have been paying very low prices; they also delay in paying farmers after the purchase of coffee. In addition, the area is very remote and roads are inaccessible during rain seasons. This makes transport costs to the markets such as Tarime and Musoma towns very high. To avoid such costs farmers in Bungurere tend to sell their agricultural products to travelling traders. With this option, respondents noted that farmers experience similar problems as their counterparts in Bomet and Keringet in Kenya presented above. Transporting of agricultural products to Kenyan markets, especially the Ntungamo market that is located in Kuria District, is another marketing strategy that has been adopted by the farmers in Bungurere. This, however, requires farmers to have means of transporting their goods such as donkeys or bicycles. Despite these limitations, the option is currently used by the majority of farmers in the area because Kenyan markets are relatively more accessible than markets within Tanzania. Examples of prices of maize in Bungurere and Ntungamo market in Kenya are provided in Appendix 3.

Biatika, a village located in Buhemba Ward, is an area that is famous for maize production. In good years the area produces maize to feed Musoma town and other parts of the Lake region (personal communication with a local extension officer, 2006). Buhemba has more marketing opportunities than the other sites visited in Tanzania due the presence of gold mines in the area. The mines have attracted large numbers of migrant workers from various parts of the country, resulting in increased demand for agricultural products. According to the respondents options used by farmers to sell agricultural products include: local customers at the local market, travelling traders, village assemblers and rural retailers. The respondents identified several constraints to agricultural marketing in the area: i) poor prices of agricultural products, especially when they sell immediately after harvests; ii) being cheated by the travelling traders who calibrate weighing scales to their advantage; iii) high transport costs to the markets; iv) poor road network (no all-weather roads) and lack of feeder roads to the farms; v) lack of control resulting to frequent price fluctuations; vi) lack of efficient policies to support rural marketing; vii) lack of training in agricultural marketing; and viii) lack of storage facilities to avoid loss of perishable agricultural produce such as tomatoes.

In a nutshell, agricultural marketing constraints identified by the respondents in the study sites in both the Kenyan and Tanzanian sides of the Mara basin were quite similar. Policy and other interventions to address these problems are likely to have greater impact if a basin level approach is taken in their design. Such an integrated approach is much needed as findings from this study have provided evidence of close marketing relations between the two sides of the basin.

4.2.5 Summary of the findings from the Mara river basin

Findings from the Mara river basin indicated that agriculture (crop production and livestock keeping) is an important economic activity in the basin. More than half of the respondents on both the Kenyan and Tanzanian side of the basin reported that they were involved in agriculture. Nonetheless, returns from agriculture in the past year were poor and therefore, income from this sector was also low. Non-farm based sources of income made a major contribution to the total net income of the respondents in the past year in all study sites indicating the importance of alternative sources of income to the livelihoods of the farmers in the basin (Figure 6). This situation was also observed in the village level results in the CA adoption study villages (Kerma and Ngecha). When looking at the income portfolios of the CA adopters versus that of non-adopters in Ngecha village, it was, however, found that the adopters relied less on non-farm sources of income and made most of their income from crop production (Table 3). This implies that in fertile areas, crop production can give high returns if improved soil and water conservation measures are used in combination with improved agricultural inputs.

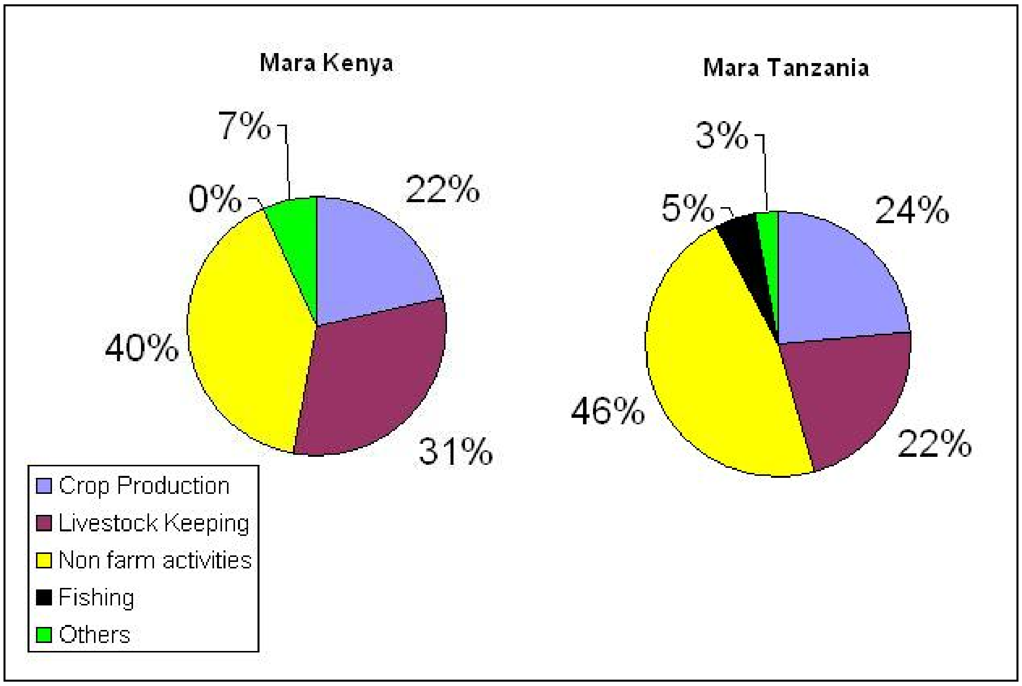


Figure 6. Income portfolios of the respondents in the Mara river basin.

It was also found out that CA as defined by FAO, with three components (reduced tillage, permanent crop cover and crop rotation or crop combination), combined together is not applied in any of the study sites in the basin. Experience from the adoption study in Njoro and other references from Africa provide evidence that this technology increases maize yields (Haggblade and Tembo, 2003; Haggblade, Tembo and Donovan, 2005; Boahen et al. 2005). This crop was grown in all study sites in the Mara basin for food and as a cash crop. Share of land allocated to maize was almost the same, regardless of the farm size indicating the importance of this crop to the households. A cross tabulation of farm size quartiles and maize share is presented in (Appendix 5.2). This suggests that it might be easier to promote the technology in the basin because it works well in a crop that farmers are already used to. Based on experience from the application of CA in Njoro, maize yields doubled in year 2005 after CA application. Average maize yields from the sites in the basin were quite low compared to what was achieved on CA farms in Njoro i.e. 4.9 tonnes (t)/ha (in Ngecha) and 3.9 t/ha (in Kerma) (Table 5). With such potential to increase maize production, it is quite evident that promotion of this technology in the Mara basin will result in increased income and food security among the rural population. Such increase is much needed to combat problems of food insecurity and poverty existing in the area. More than half (58.5%) of the surveyed households were food insecure over the past year.

4.3 Findings from Kagera river basin

4.3.1 Introduction

Due to time constraints, household surveys in the Kagera river basin were only conducted in Rwanda. Throughout this report results from this country will be used to represent Kagera basin. From the 3 sites in Rwanda (Bugesera, Byumba (Rukomo) and Tare), 125 households were surveyed. A summary of the key socio-economic variables from the study sites is provided in Table 8.

Table 8. Socio-economic characteristics of the surveyed households in Kagera basin

	Bugesera	**Byumba**	**Tare**
Total HH interviewed	41	45	39
Average HH size	6	6	8
Female-headed households (%)	19.5	11.1	12.8
Average age of HH head (years)	44.8	42.8	47.5
Average income (RwFr)/annum	312,278	264,932	391,476
Average income (US$)/annum[1]	578	491	725
Average farm size (Hectares)	1.8	0.9	0.9
HH with access to credit (%)	17.1	28.9	28.2
HH food insecure over the past 12 months (%)	75.6	64.4	74.4
Proportion of the respondents with access to government extension services (%)	7	16	23
Education Level of HH head (%)			
▪ None	12.2	35.6	28.2
▪ Primary	80.5	53.3	53.8
▪ Secondary	7.3	8.9	12.8
▪ Certificate/Diploma	0	2.2	2.6
▪ Higher	0	0	2.6

1 Exchange rate (US$ 1= RwFr 540)

4.3.2 Household income portfolios in Kagera basin

Sources of income among the respondents in Rwanda included crop production, livestock keeping and non-farm activities. Payments in kind were also important sources of income for the interviewed households, especially in Byumba and Bugesera where non-governmental organizations (NGOs) such as World Vision and Compassion provide support to the poor. As was the case in Njoro and in the Mara basin, non-farm activities made a big contribution to the total net income of the respondents in Rwanda contributing 28% in Byumba, 30% in Bugesera and Byumba and more than 75% in Tare (Figure 7). Limited farmland could be a possible reason why many households engaged in non-farm activities. Livestock keeping contributed more to total net income in surveyed households in Bugesera than in the other two sites. This might be because residents in this area are traditional cattle keepers and the fact their average farm land sizes are double the size of those in the other two sites giving them enough space to keep livestock.

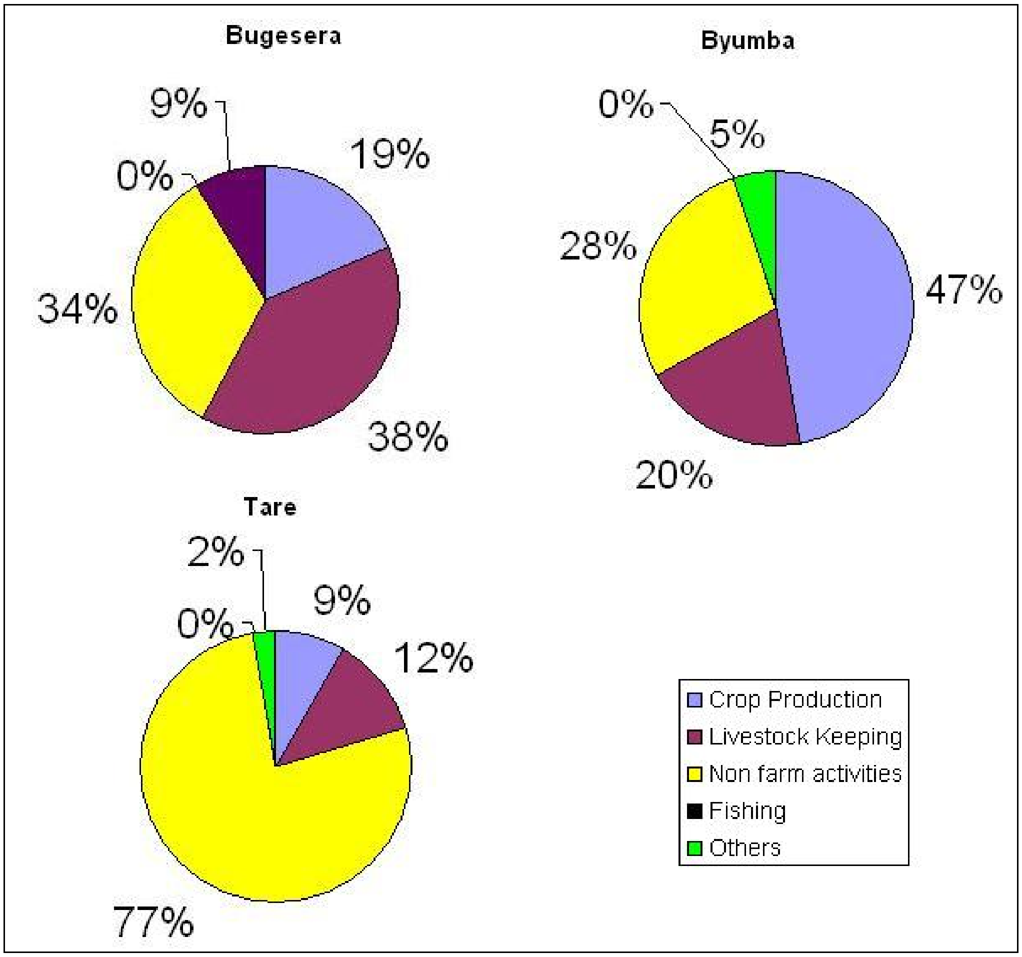


Figure 7. Income portfolios of the respondents in the Kagera basin.

4.3.3 Agriculture in the study sites in the Kagera basin

Major crops common to the three sites in Rwanda were beans (a major cash crop), sorghum, maize and sweet potatoes (Table 9). Intercropping was common in all sites; this was done to more than three crops such as maize, beans, sorghum, sweet potatoes, Irish potatoes etc. This made it hard to precisely determine the area under a particular crop and therefore shares of land allocated to the crops. Furthermore, a number of respondents found it difficult to identify the size of land they had allocated to crops; as a result such information was derived based on estimations through observation by interviewers and their interpreters. Despite these limitations, a good picture of the important crops grown in each of the study sites was obtained (Table 10) as it is in line with information provided by key informants consulted at each site. Relatively fewer households were involved in livestock keeping in the study sites in Rwanda (except Bugesera) compared to the sites in the Mara river basin (Appendix 4); this is probably because respondents in these sites had much less farmland than those in the Mara basin (Table 11). Open grazing cattle management system was common in Bugesera while in the other two sites zero grazing was used by most of the farmers. Crop–livestock interaction was also evident in Rwanda; more than a third of the respondents in all the three sites fed their livestock with at least half of their crop remains. Manure use was also common in all sites: more than 40% of the respondents in all sites used manure (Appendix 4). Use of livestock for ploughing was not common in Rwanda because the land is hilly with a lot of very steep slopes.

Table 9. Crops grown in the respondents in the Kagera river Basin, Rwanda

	Bugesera	Tare	Byumba
Major crops	Beans, sorghum, maize, bananas, sweet potatoes, groundnuts and cassava	Beans, wheat, maize, potatoes, peas, sorghum, sweet potatoes, tea and cassava	Beans, sorghum, maize, sweet potatoes, peas, bananas, potatoes and passion fruits
Minor crops		Carrots, cabbages and onions	Cabbages, *intorye*, onions and tomatoes

Table 10. Share of land allocated to the major crops in the Kagera river Basin, Rwanda

	Share (%)		
Crop	**Bugesera**	**Tare**	**Byumba**
Beans	43.3	20.2	43.8
Sorghum	27.0	6.6	39.9
Maize	19.5	18.9	9.2
Bananas	5.6	5.4	
Sweet potatoes	2.9	4	3
Groundnuts	0.6		
Cassava	1.1		
Irish potatoes		14.8	0.9
Peas		5.7	3.3
Tea		2.0	
Wheat		22.3	
Passion fruits			0.3

4.3.4 Marketing of crops in the study sites in the Kagera basin

Agricultural production in all study sites in Rwanda was mainly for subsistence. This was generally because farmlands were very small. In addition, the respondents noted that agricultural productivity has been decreasing; they associated this to over exploitation of the land because farmers did not use techniques such as improved fallow. Furthermore, all the study sites were affected by drought in the past year so only a few of the respondents had enough crops to sell. In Tare, only 40% of the respondents reported that they market their agricultural products; 60% did so in Byumba and 66% in Bugesera. However, the share of crop output marketed was very small in all villages with most crops having less than 25% share marketed (Appendix 6). Problems related to agricultural marketing identified by the respondents included: 1) low prices of agricultural products; 2) poor feeder roads; and 3) high transport costs to the markets, especially in Byumba and Bugesera. Availability of cooperatives facilitating sale of agricultural products was more developed in Rwanda than in the sites in the Mara basin. However, farmers were not able to generate much cash from their produce because they were selling very small amounts of their products and saving the rest for food. For example, in Bugesera the government has introduced bylaws preventing farmers from selling their crops beyond a certain limit due to frequent problems of food insecurity in the area. Cooperatives operating in the area have set purchasing quotas. This was considered as a problem by the respondents; however, for food security reasons such policies will need to be promoted. This leaves farmers with no source of cash. In this case, promotion of technologies that could result into increased agricultural productivity such as CA and other improved farming methods is needed to provide farmers with opportunities to increase their yields and therefore income.

4.4 Soil and water conservation measures in Mara and Kagera river Basin

CA was not used in any of the study sites in the Kagera and Mara basins. However, most farmers used at least one of the practices or other soil and water conservation measures including mulching (Table 11; Appendix 5). Even though CA has not yet spread in these sites, it may be easy to promote because farmers already understand the need to conserve soil and moisture. More than 50% of the respondents in the Mara and Kagera basins practised crop rotation. Mulching was also a common practice in all villages, with application to perennial crops such as bananas, coffee, cassava, pineapples and vegetables (Figure 8). Unfortunately, the majority of respondents were not aware that mulching can also be applied on annual crops such as maize, beans, sorghum and other crops.

Figure 8. Mulching on coffee and banana farm in Rwanda.

4.5 Discussions of the findings from Mara and Kagera basins

4.5.1 Is there potential for promoting CA in the Mara and Kagera basins?

Data collected from household surveys conducted in this study provides useful background information to support decision making for the design of projects and activities that promote CA in the Mara and Kagera basins (Appendices 4 and 5). Findings from this study provide a basis for answering a key question as to whether there is a potential for applying CA in the two basins. Steiner (1998) made an assessment of the potential for applying CA and outlined factors influencing the application of CA in different AEZs in Africa; these were later modified by Bishop-Sambrook et al. (2004), to come up with a set of ecological factors (Box 1). Considering these factors, it can be concluded that there is high potential for CA application in the two basins because most of the physical conditions suggested here are met in all the sites except for the Nyamata site in Rwanda which has very low rains (sometimes less than 800 mm a year) and experiences frequent droughts. Poor rains and environmental conditions that are too dry are unfavourable for CA because they limit availability of the biomass required for soil cover.

However, from the socio-economic point of view, this study found that there were several limiting factors that should be addressed alongside CA promotion initiatives for the technology to work in the basins. Crop production in most of the sites is mainly for subsistence (Appendix 6). The available cash crops do not to generate enough income to provide the capital needed to buy CA inputs; hence some initial public investment will be inevitable. Rural services (inputs, credit, markets and extension services) are other factors that need to be considered, as these are not well developed in the study sites. For example, the proportions of the respondents with access to credit were only: 25% in Mara basin in Kenya, 15% on the Tanzanian side of the basin and 25% in the sites in Kagera. Government extension services were also found to be weak and rarely reached the farmers (Tables 5 and 8). This was attributed to lack of resources to facilitate extension work due to limited resources from the governments (personal communication with extension workers). Furthermore, various crop marketing problems identified in the study sites (refer to sections 4.2.4 and 4.3.4) will require interventions for the farmers to benefit from the increased yields that are likely to result from adopting CA. Perhaps the most challenging off all, is the issue of using crop residue as livestock feed. Cattle keeping was recorded in all study sites. Information on cattle equivalent units (CEU) for each of the study sites is provided in Table 12. Use of crop remains to feed animals was common in all the sites. It will be challenging to convince farmers to forego this use and leave the crop residues on the fields as soil cover. Issues of access to land and cover crop seeds will also need to be addressed.

Box 1: Pre-requisites for adoption of conservation agriculture

Ecological factors	**Socio-economic factors**
Annual rainfall >800 mm	Cash crops (in order to purchase inputs)
Bimodal rainfall (for biomass production)	Well developed rural infrastructure (inputs, credit, markets and extension services)
Long growing season (more than 6–7 months (for biomass production)	Markets for diverse range of crop (to support crop rotation)
Soils with clay content >20% (to reduce risk of soil compaction)	Secure access to land
Decompaction of soil before shifting to conservation agriculture	Limited value on crop residues (as livestock fodder and fuel wood)
	Shortage of labour, high wages
	Access to cover crop seeds
Source: Bishop-Sambrook et al. (2004).	

4.5.2 What are the recommended sites and crops for CA piloting?

Piloting and scaling up of CA adoption should be done by targeting the erosion hotspots and the moisture constrained areas, especially the semi-arid regions that are outside the hotspots. Survey results indicate that maize is an important crop in most of the study sites in the Mara basin. The study therefore recommends that initial CA piloting activities start by using CA on maize in the high maize producing areas located in the erosion hotspots such as Mulot, Bomet, Biatika and Bungurere. Literature from other parts of Africa point out that the technology also works well on other crops such as sorghum, onions, wheat, cabbage, peanuts, cowpeas and coffee (Calegari and Ashburner 2005; Taimo 2005). These crops are all grown in the two basins so CA promotion initiatives can also include such crops in their activities. Sites such as Ryamisanga and Kwibuse in

Tanzania located outside the erosion hotspots and on the shores of the Mara River will possibly be suitable for testing CA on sorghum and millet. This is because maize is only grown in small quantities in these sites. In the study sites in Rwanda, beans were a major staple and cash crop. Land allocated to maize was small (Table 11), hence it might be hard to introduce CA using maize as a study crop. In this case, CA is likely to be well received by farmers if initial piloting of the technology is introduced on beans and later extended to sorghum, maize, wheat, cow peas and other horticultural crops.

Table 11. Key crop related variables in the study sites

Location	Village	Average farm size (acres)	Average farm size (hectares)	Average net income US dollars	Non-farm income (%)	Crop income (%)	Cattle equivalent units	Maize share in farmland	Major soil and water conservation practices[1]
Adoption villages	Kerma	4.3	1.7	1509	44	20	2.7	54	CA[2] crop rotation and mulching
	Ngecha	6.0	2.4	4032	31	34	4	60	CA[2] crop rotation and mulching
Study sites in Mara, Kenya	Bomet	3.4	1.4	1682	45	14	4.9	40	Crop rotation and mulching
	Keringet	8.8	3.6	3708	36	27	6.7	28	Crop rotation
	Mulot	9.7	3.9	1762	49	18	5.5	42	Crop rotation, trenches and mulching
Study sites in Mara, Tanzania	Biatika	6.1	2.5	828	49	29	9.2	52	Ridges, mulching and crop rotation
	Bungurere	2.9	1.2	1089	55	20	4.8	36	Crop rotation, mulching and ridges
	Kwibuse	3.5	1.4	726	25	37	7.9	29	Ridges and crop rotation
	Ryamisanga	3.8	1.5	1190	50	14	10.5	13	Ridges and crop rotation
Study sites in Kagera	Bugesera	4.4	1.8	578	34	19	2.6	20	Crop rotation and mulching
	Byumba	2.2	0.9	490	28	47	1.9	9	Crop rotation and ridges
	Tare	2.3	0.9	725	76	9	1.2	19	Crop rotation and ridges

[1] These are the practices applied by at least 35% of the respondents in the site, but not necessarily in combination.
[2] CA is applied by the adopters as indicated in Section 4.1.

5. Summary, conclusions and recommendations

5.1 What will it take to promote and sustain CA in the LVB?

i. There is need for an intensive programme to promote CA technology as a means to increase productivity and conserve soil in the LVB. This will require governments in the basin countries to formulate coherent national strategies and policies that support the adoption of CA. A major effort is needed from the ministries of agriculture in terms of incorporating CA into their extension system. Other ministries such as those dealing with environment, water and land also need to create policy environments that support CA.

ii. As is evident from the case of CA introduction in Njoro, this technology requires heavy initial investment in various aspects including training, purchase of specialized CA equipment such as sub-soilers, jab planters and other equipment and farm inputs. Such investment is unlikely to come from governments alone and neither can the farmers afford such costs. Farmers also do not have the confidence to invest in a new technology before they see it working. This calls for strong coordinated efforts between different stakeholders who are willing to work in partnership with governments towards a common goal of promoting this technology in the basin. Such stakeholders may include donors, research and development institutions, rural development agencies (e.g. community-based organizations, NGOs), private sector and others.

iii. Alongside promoting CA technology there is also need to promote the use of improved farming methods including use of hybrid seeds, fertilizers, herbicides, pesticides and increased plant density. The full benefits of CA will be difficult to achieve if farmers continue using local seeds without fertilizer, as is currently the case in many places in the basin. There is also a need to complement CA development with other technologies such as water harvesting and agroforestry.

iv. Public institutions are important tools for promoting technology. There will be a need to encourage formation and development of institutions such as farmers groups, FFS, youth groups and other social groups. Projects to promote CA will be best implemented through such groups. Sustainability of these institutions will require provision of incentives such as access to credit and technical assistance and other incentives such as field tours and soil conservation contests. Partnerships with organizations already working with farmers will be very important.

v. There are champion farmers in the basin who could be very instrumental in promoting the technology. Such farmers need to be identified and encouraged to use the technology. They can be encouraged through provision of training and other technical support. These farmers can then be local trainers for the technology in their areas. However, care should be taken while using the champion farmers, to make sure that there is a good mechanism to also reach the poor farmers. This is because champion farmers tend to quite often be relatively wealthier than others and it may be difficult for the poor farmers to interact with them.

vi. For the farmers to fully benefit from the increase in yields resulting from CA and realize increased incomes, they should also have secure markets for their agricultural products. According to the respondents, farmers in both the Mara and Kagera basins are faced with various limitations while marketing their produce. These problems will need to be addressed. It is recommended that CA promotion programmes should also include the component of agricultural marketing in their plans. Responsible government agencies in the countries need to design and/or enforce policies to address those problems.

5.2 What will make it difficult for CA adoption in the LVB?

i. Lack of adequate institutional support from the government

Ministries of agriculture of the countries in which the LVB is found have not yet included CA in their extension systems despite existing evidence that the technology has great potential to increase crop yields, increase farmer incomes and reduce food insecurity. To date CA has only been introduced to farmers under donor-funded projects. This has limited the sustainability and scaling up of the technology. Governments have not been able to continue the efforts initiated by the donor-funded projects, especially in terms of providing funds to facilitate extension work. Very few extension workers have been trained on CA through donor support. The majority of extension workers have not been trained on the technology.

ii. Donor mentality among the adopters

Farmers join FFSs not just to learn; they quite often expect to get direct individual transfers of cash and credit from the project. When this does not happen they stop participating. For example in Kerma village there has been a drop-out rate of 20–30% from the FFS because some farmers had other expectations beyond training.

iii. Competing uses of crop residues for mulching and livestock feed

It might be difficult for the farmers to achieve permanent soil cover because of competing alternative uses of crop residues. Most farmers in the basin keep livestock. Over the past three years there has been drought, which has compelled farmers to use most of their crop residues to feed animals. In the process, they expose the land to erosion and loss of moisture through evaporation.

iv. Land tenure

Some people do not own land they cultivate; they rent pieces of land each year from different people. This is a disincentive to apply a technology that provides benefit after continuous application, since the farmer may not be assured of access to the same piece of land beyond one or two planting seasons.

v. Difficulties in transforming farmers' perceptions

Changing the perception of farmers on what is the best approach to farming is a challenge. Adopting CA requires a big shift in the mindset of the farmers. Conventional knowledge on agriculture has created a mentality among farmers that they have to till the soil properly before planting (we found that some farmers plough their land three times before planting). There is also a belief that burning crop residues is the best way to clear the farm and control weeds. This is still practised in several places in the Mara basin. It will be a big challenge to persuade farmers to move away from these traditional practices.

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7. Appendices

Appendix 1.1. Income portfolios of the study villages (village level)

Quartile	Crop income	Livestock income	Renting out land	Natural resources income	Non-farm activities	Remittances	Fishing	Income in kind
Kerma	15.7	37.7	1.1	1.2	37.1	4.8	0.0	2.4
Ngecha	32.0	29.0	0.3	0.0	32.7	4.9	0.0	1.1
Bomet	14.0	34.5	0.3	0.0	44.7	5.9	0.0	0.6
Keringet	26.9	29.5	1.1	0.0	34.9	7.6	0.0	0.0
Mulot	18.2	31.0	0.4	0.5	48.5	1.2	0.0	0.1
Biatika	28.7	20.7	0.2	0.0	49.1	0.4	0.0	0.9
Bungurere	20.2	21.2	0.0	0.6	55.1	2.6	0.0	0.2
Kwibuse	37.0	21.8	0.0	0.0	25.1	1.8	11.4	2.8
Ryamisanga	14.4	23.7	0.0	1.2	50.2	0.8	9.5	0.1
Bugesera	19.0	38.5	0.6	0.0	33.8	3.7	0.0	4.4
Byumba	47.0	19.7	0.0	0.0	28.4	1.0	0.0	3.8
Tare	8.5	12.0	1.6	0.0	77.0	0.4	0.0	0.5

Appendix 1.2. Income portfolios of the study villages by income quartile

Study site	Quartile	Crop income	Livestock income	Renting out land	Natural resources income	Non-farm activities	Remittances	Fishing	Income in kind	Proportion of CA adopters (%)
Kerma	1	18.4	29.0	1.8	0.0	40.9	4.2	0.0	5.8	0
	2	31.6	21.2	4.7	0.0	14.9	11.5	0.0	16.1	12.5
	3	17.6	44.1	1.5	5.3	19.7	10.7	0.0	1.0	37.5
	4	12.6	38.6	0.4	0.0	45.9	1.8	0.0	0.7	50
Ngecha	1	37.8	36.2	13.0	0.0	1.2	9.7	0.0	2.1	18.2
	2	40.5	47.3	0.2	0.0	7.3	3.8	0.0	0.9	36.4
	3	24.7	32.1	0.0	0.0	35.0	7.4	0.0	0.8	27.3
	4	34.3	24.5	0.0	0.0	36.3	3.6	0.0	1.3	18.2
Bomet	1	10.7	62.0	0.0	0.0	24.9	2.5	0.0	0.0	
	2	18.4	47.8	0.0	0.0	26.0	7.8	0.0	0.0	
	3	25.1	44.3	1.0	0.0	17.6	9.5	0.0	2.4	
	4	7.9	23.5	0.0	0.0	64.6	4.0	0.0	0.0	
Keringet	1	15.4	38.0	0.6	0.4	45.6	0.0	0.0	0.0	
	2	18.0	72.9	1.5	0.0	6.8	0.8	0.0	0.0	
	3	12.9	56.9	5.3	0.0	24.5	0.3	0.0	0.1	
	4	31.5	19.0	0.0	0.0	39.1	10.3	0.0	0.0	
Mulot	1	-65.3	70.8	10.5	21.0	51.5	11.4	0.0	0.1	
	2	7.4	54.4	0.9	0.0	33.0	3.8	0.0	0.6	
	3	14.6	61.8	0.0	0.0	20.5	2.7	0.0	0.4	
	4	24.0	17.3	0.1	0.0	58.6	0.1	0.0	0.0	
Bungurere	1	21.5	75.6	0.0	0.0	1.8	1.1	0.0	0.0	
	2	32.3	54.2	0.0	0.8	9.5	2.7	0.5	0.0	
	3	38.2	18.0	0.0	0.0	37.5	5.7	0.0	0.7	
	4	14.0	17.0	0.0	0.7	66.3	1.8	0.0	0.1	
Biatika	1	28.9	35.2	0.0	0.0	20.4	8.4	0.0	7.0	
	2	25.0	40.0	0.0	0.0	32.9	0.3	0.0	1.8	
	3	30.4	33.8	1.0	0.0	33.0	0.0	0.0	1.7	
	4	28.7	13.4	0.0	0.0	57.7	0.0	0.0	0.2	
Kwibuse	1	26.5	52.9	0.0	0.0	4.4	0.0	0.0	16.3	

Study site	Quartile	Crop income	Livestock income	Renting out land	Natural resources income	Non-farm activities	Remittances	Fishing	Income in kind	Proportion of CA adopters (%)
	2	26.8	50.3	0.0	0.0	12.9	1.3	0.0	8.7	
	3	36.5	17.9	0.0	0.0	43.2	1.6	0.0	0.8	
	4	39.7	16.5	0.0	0.0	19.8	2.1	19.9	2.0	
Ryamisanga	1	-54.7	9.7	0.0	0.0	140.4	3.0	0.0	1.6	
	2	30.3	8.8	0.0	3.2	51.8	5.5	0.0	0.4	
	3	39.8	10.6	0.0	0.0	40.9	0.8	7.5	0.3	
	4	9.8	28.4	0.0	1.3	49.0	0.2	11.3	0.0	
Byumba	1	-10.8	0.7	0.0	0.0	68.2	5.6	0.0	36.4	
	2	21.5	24.5	0.0	0.0	43.7	0.0	0.0	10.4	
	3	27.1	23.7	0.0	0.0	29.5	5.9	0.0	13.6	
	4	55.5	18.9	0.0	0.0	25.4	0.0	0.0	0.2	
Bugesera	1	-23.6	90.9	0.0	0.0	27.3	0.0	0.0	5.4	
	2	29.1	18.5	0.0	0.0	45.4	2.6	0.0	4.4	
	3	16.0	52.1	0.7	0.0	9.7	15.5	0.0	6.0	
	4	20.7	34.0	0.7	0.0	40.6	0.1	0.0	3.9	
Tare	1	-38.8	34.2	22.3	0.0	71.0	0.0	0.0	11.3	
	2	19.7	25.0	0.0	0.0	53.6	0.0	0.0	1.7	
	3	20.3	16.4	0.0	0.0	61.7	0.0	0.0	1.5	
	4	5.7	9.4	1.7	0.0	82.7	0.5	0.0	0.0	

Appendix 1. Detailed information on the agro-ecological zones for the study sites

a. Kenya

	Agro-ecological zone	Altitude (m)	Temperature In C°	Annual rainfall	60% reliability of rainfall (in mm)	
					1st rains in mm	2nd rains in mm
Chepngaina (Bomet)	LH1- Lower Highland (tea/diary zone)	1900–2350	18.4–15.7	1400–1800	550–950	410–650
Mulot	LH2- Lower Highland (maize/wheat/pyrethrum zone)	1980-2280	16.6–14.8	1100–1300	400–450	350–450
Ngecha and Kerma	LH3- Lower Highland (wheat/maize/barley) zone	1890–2190	17.5–15.7	850–1100	250–300	350–500
Keringeti	UH 2 (wheat/pyrethrum)	2580–2800	13.7–12.0	1100–1400	300–500	450–650
Source: Jaetzold and Schmidt (1983).						

b. Tanzania

	Zone	Sub-zone and areas	Soils and topography	Altitude (m)	Rainfall (mm)
Kwibuse Ryamisanga Biatika	4	Western (parts of Mara)	Wide sandy plains and Rift Valley scarps	800–1500	Unimodal, 800–1000 November–April
Bungurere	6	Granite mountains: Tarime Highlands in Mara	Steep mountain sides to highland plateaus. Soils are deep, friable and moderately fertile on upper slopes, shallow and stony on slopes	1000–2000	Bimodal very reliable 1000–2000
Source:	http://www.fas.usda.gov/pecad/highlights/2005/09/tanzania_2005/images/TZ_AEZ.htm USDA, Tanzania Agroecological Zones, Production Estimates and Crop Assessment Division, Foreign Agricultural Services				

c. Rwanda

	Farming system zone/agro-ecological zone	Soils and topography	Altitude (m)	Rainfall (mm)
Nyamata	Eastern lowlands	Gentle slopes and relatively lower altitudes. Has Xero-ferralsols on slopes and Vertisols in valleys	1200–1400 Mean 1400	700–1200 Mean 1000
Byumba	North-Central Zone	High mountains, very steep slopes and susceptibility to erosion	1400–2000	1100–1200
Tare	Southwest-Central zone	Sandy-loamy soils and serious degradation. Soil fertility is poor to moderately suitable for agriculture	1500–2100 Mean 1900	1200–1500 Mean 1300
Source: Compiled from: Olson (1994); www.afr-sd.org				

Appendix 2. Examples of maize prices along the value chain in the Mara river basin

Box 1: Maize prices along the value chain between Mulot and Narosoora/Loita (in Maasai land)

	Harvesting season (Jul, Aug and September)				Food shortage time (Apr and May)			
Price category	**Price (KSh) per 90 kg bag**	**Price (US$) per 90 kg bag**	**Price (KSh) per kg**	**Price (US$) per kg**	**Price (KSh) per 90 kg bag**	**Price (US$) per 90 kg bag**	**Price (KSh) per kg**	**Price (US$) per kg**
Farm gate price in Mulot	950–1000	13.6–14.3	10.5–11	0.1–0.2	1700	24.3	19	0.27
Wholesale price for maize flour in Maasai land	1500	21.4	16.6	0.2	2100	30	23.3	0.32
Retail price for maize flour in Maasai land	1600	22.9	18	0.3	2200	31.4	24.4	0.34

Source: Discussion with Mr Stephen Martin farmer and transporter Mulot during field survey, 2006.

Box 2: Maize prices along the value chain for the maize produced in Mulot, milled by Hugo's milling service and sold in areas west of Narok

Price category	**Price (KSh) per 90 kg bag**	**Price (US$) per 90 kg bag**	**Price (KSh) per kg**	**Price (US$) per kg**
Farm gate price	900	12.9	10	0.1
Maize at Hugo's factory	1200	17.1	13.3	0.2
Maize flour sold by Hugo to the wholesalers	2025	28.9	22.5	0.3
Retail maize price in west Narok	About 2610	37.3	About 29	About 0.4

Note: Maize flour in is packed in 2 kg packet and named Olerai maize flower.
Source: Discussion with Mr Hugo Wood, owner of milling factory, Narok during field survey, 2006.

Box 3: Maize prices along the value chain between Bungurere village in Tarime highlands and Ntungamo market in Kuria district, Kenya

Price category	**Price (TSh) per 100 kg bag**	**Price (US$) per 100 kg bag**	**Price (TSh) per kg**	**Price (US$) per kg**
Farm gate price	20,000	15.4	200	0.15
Maize at Ntungamo market in Kenya	22,000	16.9	220	0.17

Note: There is no culture of selling maize flour in Bungurere village. Maize flour is only sold during drought times when there is food shortage. The price in those times goes as high as TSh 600 per kg.

Box 4: Maize prices along the value chain between Biatika village in Buhemba and Musoma, Town

Price category	**Price (TSh) per 100 kg bag**	**Price (US$ per 100 kg bag**	**Price (TSh) per kg**	**Price (US$) per kg**
Farm gate price	18,000	13.8	180	0.14
Maize at the local market in Buhemba	20,000	15.4	200	0.15
Maize at Musoma market	25000	19.2	250	0.19

Source: Discussion with agricultural extension officer in Buhemba.

Appendix 3. Livestock statistics by site in Mara and Kagera Basins

		Bomet	Keringet	Mulot	Bungurere	Kwibuse	Ryamisanga	Biatika	Bugesera	Tare	Byumba
Proportion (%) of the respondents with:	At least one animal	97	100	100	97	94	94	90	85	85	84
	Cattle	97	100	88	75	51	52	63	69	41	64
	Goats	22	27	57	72	54	58	61	40	51	60
	Sheep	36	32	14	31	29	30	8	2	21	20
	Chicken	72	65	73	94	86	76	87	51	28	40
	Ducks	0	3	11	3	17	3	18	2.	0	0
	Turkeys	0	3	0	3	0	6	11			
	Pigeons	0	0	0	0	0	3	0	0	0	2
	Pigs									59	2
Proportion of HH feeding their livestock with at least 50% of their crop remains		77	53	68	77	49	49	53	43	58	53
Proportion of the HH using manure (%)		69	62	54	71	43	36	74	39	69	71
Livestock keepers' cattle management system (%)	Open grazing	94	87	65	64	91	89	92	83	10	3
	Semi zero	6	13	32	29	9	11	4	0	4	0
	Zero grazing	0	0	3	7	0	0	4	17	86	97

Appendix 4. Summary statistics for the key variables in Mara and Kagera basins

Appendix 5.1. General information

	Mara, Kenya	**Mara, Tanzania**	**Kagera, Rwanda**
Total HH interviewed	107	141	125
Average HH size	7	8	7
Female headed (%)	12.15	10.64	14.4
Mean age of HH head (years)	46.4	49.4	45
Average income annum (local currency)	KSh 164,695	TSh 1,238,103	RwFr 319143
Average income (US$/annum)	2,353	952	592
Farm size (acres)	7.27	4.10	3 (=1.21 ha)
Share of farm land allocated to maize (%)	37	33.2	22.7
Education level of HH head (%)			
▪ None	13	18.44	25.6
▪ Primary	41.1	70.9	62.4
▪ Secondary	34.6	7.1	9.6
▪ Certificate/diploma	9.4	3.6	1.6
▪ Higher	1.9	0	0.8
HH with access to credit (%)	25.2	14.9	24.8
HH food insecure over the past 12 months (%)	48.6	66	71.2
Proportion of the respondents with livestock (%)	99.1	93.6	84.8
Proportion of the respondents with cattle (%)	94.4	60.3	58.4
Proportion of the respondents with goats (%)	35.5	61	50.4
Proportion of the respondents with sheep (%)	27.1	24.1	14.4
Proportion of the respondents with chicken (%)	70.1	85.8	40
Proportion of the respondents with pigs (%)	0	0	19.2
Proportion of the respondents with ducks[1] (%)	5.6	16.3	1.6
Cattle management system (%)			
Open grazing	81.4	82.6	67.7
Semi zero	17.7	14.1	31.2
Zero grazing	1	3.2	1.1
Use of soil and water conservation practices (%)			
▪ Mulching	40.4	46.7	32
▪ Crop rotation	51.1	76.6	60.8
▪ Trenches	23.4	33.6	36
▪ Use of ridges	51.8	16.8	19.2
▪ Reduced tillage	0.71	2.8	8
▪ Valley and dams	0.71	0.93	3.2
▪ None	21.3	11.21	25.6
Recommended CA piloting sites	Mulot-Narok, Bomet, Keringet	Bungurere Buhemba Kisumwa Ryamisanga (Bwiregi)	Tare, Byumba, Bugesera
Recommended crops for CA promotion (based on crops grown in ach site)	Maize, beans, sorghum, wheat and horticultural crops	Maize, beans, sorghum, peas and wheat	Sorghum, beans maize, wheat and peas

[1] This category also includes turkeys and pigeons.

Appendix 5.2. Cross tabulations of Farm size by share of maize

a) Share of Maize cultivated by farm size in Mara basin Kenya

Farm size (acres)	**Share of maize (%)**
Less than 2.5	27.9
2.5–4.5	23.1
4.5–9	26.0
Greater than 9	23.1
Total	**100**

b) Share of Maize cultivated by farm size Mara basin Tanzania

Farm Size (acres)	**Share of Maize (%)**
Less than 2	28.6
2–3	24.1
3–4.8	21.4
Greater than 4.8	25.9
Total	100

Appendix 5. Share of marketed crop outputs among the major crops in the study villages

	Kerma	Ngecha	Bomet	Keringet	Mulot	Biatika	Bungurere	Kwibuse	Ryamisanga	Bugesera	Byumba	Tare
Proportion of the respondents who marketed their crops in the past year (%)	74	87	83	91	89	47	74	26	30	66	60	40
Crops	**Share sold (%)**											
Maize	27	54	36	38	37	15	0.1	24	12	5	18	11
Beans	31	31	48	31	34	32	9	17		18	5	3
Millet					8		7	1	18			
Sorghum					0		7	15	6	44	24	6
Cassava						6	7	10	7	0		
Irish potatoes	42		60	89							37	9
Tea			100									95
Pyrethrum				100								
Bananas							44			19		31
Coffee							100					
Sweet potatoes							14	0	0	26	12	17
Peas				78							38	10
Wheat	87	83			93							32
Tomatoes						96						
Groundnuts										7		
Passion fruits											67	
Number of crops with at least 25% sold	4		4	5	3	2	2	0	0	2	3	2

Appendix 6. Major crop marketing problems identified by the respondents in the study sites

Study site	Proportion of the respondents identifying a problem (%)		
	Poor price	Transport	Cheating in quantity measurement
Kerma	44	21	18
Ngecha	53	10	47
Mulot	78	30	3
Bomet	78	42	14
Keringet	74	35	27
Kwibuse	40	46	3
Bungurere	63	29	6
Ryamisanga	39	24	0
Biatika	61	39	11
Bugesera	27	44	0
Byumba	44	22	0
Tare	23	8	0

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