Land Degradation & Development Group

CA2AFRICA

Conservation Agriculture in AFRICA: Analysing and FoReseeing its Impact - Comprehending its Adoption

ASSESSMENT OF CONSERVATION AGRICULTURE (CA) PRACTICES IN BUNGOMA, WESTERN KENYA: TOWARDS AN INSIGHT IN CA ADOPTION AND ITS CONSTRAINTS

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ASSESSMENT OF CONSERVATION AGRICULTURE (CA) PRACTICES IN BUNGOMA, WESTERN KENYA: TOWARDS AN INSIGHT IN CA ADOPTION AND ITS CONSTRAINTS

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ACKNOWLEDGMENTS

I will always remember my first lecture at Wageningen University. I was told that education was not a thoughtful plan of subjects and tasks nicely drawn, but a fact of choosing those experiences that you might consider useful in your life. I kept this thinking throughout the whole year and it got meaningful when I decided to go to Africa.

Africa is this sort of place where an experience becomes a story, where dreams and wills are cut down with the same facility as one purchases an electronic good or one goes out for a dinner in the occidental world. Nevertheless, that people's striving for a fair living is one of the more inspiring things I've ever seen.

But Africa is not only struggle; there are plenty of marvellous things that may amaze to anyone. Definitively, this academic trip turned out to be more than surveys, interviews or soil losses measures, but one time-in life experience.

I would like to be fair by mentioning and thanking all the people who at some point of my Master thesis were actively involved. Jan de Graaff, my supervisor, I would like to thank you for all your support and ideas, without you this research would not have been possible. Thank to Mr. Felix, my rider/translator, for his hard work and kindness, Mr. Wotia who took me under his wings and prompted a good living for me in Bungoma. Special thanks to ACT executive board members Mr. Hamisi Dulla and Mr. Mariki, project coordinators of CA2Africa in Kenya and Tanzania, for their supervision and interest. My Kenyan buddies Richard and David, thanks for the nice moments lived. I would not like to forget to Ana, my fellow Tanzanian colleague, thanks Ana for sharing such an adventure with me.

To my family, the architectures of this dream, the facilitators of my happiness

ABSTRACT

Due to the successful adoption of Conservation Agriculture (CA) in the Americas, international organizations and research institutions are now promoting the CA adoption in Africa. However, local constraints have influenced the uptake of CA in most of the African countries. Moreover the empirical evidence of CA adoption in Africa has not clearly shown whether CA practices are suitable for smallholder farmers in Africa. Therefore the aim of this research was to assess Conservation Agriculture as practiced in Western Kenya, addressing its physical and socio-economic constraints by comparing 25 CA adopters and 25 farmers who were not considered as adopters. A detailed agro-economic survey was held in order to gather all the information needed. Subsequently Olympe software was used to analyse the socio-economic characteristics of all households surveyed. Likewise, the ACED Method was applied to calculate soil erosion losses in both CA and NON-CA Plots. Results show that Conservation Agriculture reduces labour requirements, increases yields, improves soil fertility and reduces soil erosion. However, the analysis of the socio-economic constraints is related to a one year period, 2011. Hence these results must be mainly considered in the context of partial CA assessment with regard to certain climate conditions (wetter or drier seasons) and household needs (i.e. lack of income might discourage CA farmers to practice CA in that specific year). Even though CA as practiced in Bungoma district is seemingly suitable for smallholder farmers the heavy dependence on the amount of capital available to purchase chemicals and the current weather conditions suggest the need for an integral assessment of CA over a longer period of time.

Keywords: no tillage, adoption, Olympe, ACED Method, Conservation Agriculture.

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ABREVIATIONS AND GLOSSARY

CA Conservation Agriculture

CA2AFRICA Conservation Agriculture in Africa: Analysing and FoReseeing its Impact, Comprehending its Adoption

CIRAD Centre de coopération internationale en recherche agronomique pour le développement, or Centre for International Cooperation in Agronomic Research for Development

FAO The Food and Agriculture Organization of the United Nations

ACT African Conservation Tillage Network

KASSA Knowledge Assessment and sharing on Sustainable Agriculture

CA-SARD Conservation Agriculture for Sustainable Agriculture and Rural Development

NGO Non-governmental organization

MoA Ministry of Agriculture, Kenya

KARI Kenyan Agriculture Research Institute

FFS Farmer Field School

DAO District Agricultural Offices

1. INTRODUCTION

1.1. CONSERVATION AGRICULTURE AND ITS ADOPTION IN AFRICA

"You pass the jab planter on all or part of your *shamba*, and as you go you spread maize or whatever crop seeds. You must accompany them with lablab or Mukona (cover crops), assisting them with some fertilizer and then you let them grow… the second year you will get twice as much production as in the previous year". This is a typical encouragement speech that staff members of the Ministry of Agriculture in Bungoma, Kenya give eventually to farmers who they have come across with. This is one explicit prove of what CA consists of, or not?

Conservation Agriculture (CA) as concept relies on three main pillars: 1) Minimum soil disturbance or no tillage; 2) Permanent soil cover and 3) diverse crop rotations (Giller et al., 2009). These principles are promoted to cope with soil degradation problems resulting from certain agricultural practices which may disturb the soil quality (nutrient content or organic matter), lower the yields and worse the profitability of the field.

CA methods or measures are emphasized from a sustainability point of view and their occurrences on the soil ecosystem have been noted as beneficial for an agricultural purpose (Kassan et al., 2009).

These benefits have been occurring in South American countries for decades, such as Brazil and Argentina or North America. Nonetheless the practice of Conservation Agriculture has been spread out to many other places around the globe. By 2009 more than 106 million of hectares under zero tillage were counted across the world (Kassam et al., 2009). About 47% is practiced in South America and less than 0.5% corresponds to Africa, whereby tillage remains as cornerstone of farming. Traditional agriculture is yet encountered in the 93% of all arable farming areas worldwide (Kassam et al., 2009).

CA adoption both in industrialized and developing countries are characterized differently. Adoption constraints in the former case are tightly related to great commercial farms with advanced equipment, high input consumption and extended areas. Contrary, smallholdings are the corner stone of CA adoption in developing countries (Wall, 2007), whereby a lack of small equipment and small farm size form the major constraints. Yet spread and adoption of CA technique especially in developing countries remains a challenge.

International institutions and researchers worldwide claim for the adoption of Conservation Agriculture in Africa fully based on the widespread adoption of CA in South America. It is aimed to improve rural livelihoods in a sustainable framework. However, there has been a low adoption rate over the last years which proves CA adoption in Africa is attached to constraints present at local scenarios, specifically those concerning to smallholder farmers. Yet there is a lack of empirical evidence or evaluation of CA adoption by smallholders in Africa (Giller et al., 2009).

Ojiem et al., (2006) and Knowler et al., (2006) stated that CA adoption by African smallholders may be influenced apparently by an array of socio-economic factors such as input prices, knowledge, labour scarcity, lack of capital, farm size or poor infrastructure. How these constraints are managed and faced by farmers determine which of them are more likely to be successful in CA adoption.

Therefore, addressing how and where CA bests fits and what their constraints under certain physical and socio-economic agricultural environments in Africa turns to be highly needed (Giller et al., 2009).

1.2 AN ONGOING EVALUATION OF CA ADOPTION IN AFRICA : CA2AFRICA PROJECT

Many authors, headed by P.R Hobbs proclaim that CA will play an important role in the near future's policies, as agriculture will have to increase food provision, although managing a limited amount of resources. This achievement can only be accomplished by enhancing the efficiency and efficacy of the use of natural resources. Zero tillage must be implemented at a global scale to overcome the land degradation originated of many years of mismanagement and changeable weather conditions.

Awareness raising on CA adoption has decidedly appeared as more and more publications claim the need for A) a secure food provision in the near future responding to the increase of population and b) a more sustainable crop management to strengthen agriculture against foreseen climate change effects.

In 2009, in order to address the reasons for the limited CA adoption in Africa, a partnership was created amongst 10 different institutions spread out around the world and all of them led by CIRAD, *Centre de Cooperation Internationale en Recherche Agronomique pour le Développement*. Participants elaborated an European Project called CA2Africa, "Conservation Agriculture in Africa: Analyzing and foreseeing its Impact- Comprehending its Adoption, 2009".

The project analyzes CA through a conceptual framework which uses three scales: *field level*, focusing on physical concerns like erosion, *farm level* where trade-offs of resources become crucial and *regional level*, whereby marketing and the institutional setting play an important role. The project is focused on 5 major agro-ecological study areas which fairly well represent the typical African farming systems.

Summarizing, the overall project goal is to understand what physical and socio-economic constraints of smallholders in Africa are in order to enable a better promotion, adoption and success of CA in Africa.

Wageningen University as participant provides assistance in the Kenyan and Tanzania case studies. Tasks assigned were to evaluate physical and socio-economic factors that distinguish a group of local farmers of being adopters or not at both field and farm level. The coordination institution for Eastern Africa is African Conservation Tillage Network (ACT).

1.3 HOW TO ASSESS CA ADOPTION

The Food and Agriculture Organization of the United Nations (FAO) among other institutions promoted under the label of Conservation Agriculture a pile of ideas and practices which responded to the worldwide increasing concern on environmental problems caused by conventional agriculture and food security in the near future (Knowler et al., 2006). This new conceptualization of farming was meant to promote a sustainable management of the land and to improve farmers' livelihood.

Benefits of this new agricultural technique were soon described in detail by several authors and publications. It has been shown that CA prompts positive effects on both bio-physical (i.e. soil erosion control) and socio-economic environments (Lal, 1998). However, other implications arise when assessment of CA adoption is concerned.

Ever since CA as concept was globally introduced, FAO has been creating partnerships and leading initiatives with different organizations worldwide in order to monitor CA evolution over time. In one of those efforts, FAO in association with the German government launched its program so-called "Sustainable Agriculture and Rural Development" or SARD. With that, it wanted to improve living conditions of livelihoods by enhancing sustainable development.

CA was considered within the project as technique to be developed and promoted. As main facilitator and leader institution CIRAD (*Centre de cooperation international en recherché agronomique pour le développement*) gathered all the efforts on analyzing CA adoption in a long-term at global scale. A few examples of CA adoption assessment projects are KASSA (knowledge Assessment and sharing on Sustainable Agriculture), CA-SARD II or CA2Africa.

The latter listed as main pre-task to test a wide range of innovative models, as they were thought as best reliable methods to analyse CA adoption in Africa. The evaluation of CA adoption can hold diverse approaches and guidelines.

Scientists and researchers have been addressing constraints on CA adoption ever since CA gained acceptance. Knowler et al., (2006) gathered and analysed all research done until the date with the final ambition of enlightening reasons to explain adoption.

While analyzing his 23 studies he detected 9 methods that were used to assess adoption: Ordinary least squares (OLT), Random effects (GLS), Logit, Probit, Stepwise regression, Linear Probability Model, Multinomial logit, Cragg model and Multiple classification analysis(MCA). These methods vary among them and might have influenced the overall quality of the study.

There were 9 different methods used to evaluate CA adoption, all of them with diverse processing and analyzing protocols. This entails that there is not a best approach when assessing CA adoption. Yet all of them are subjected to consensus and previous discussion, and their suitability cannot be denied beforehand.

1.4 MINIMIZING LAND DEGRADATION

Land degradation has constituted throughout the history a major hurdle to overcome when agricultural practices are concerned. The forecasted increase of population worldwide in coming years emphasizes the importance of coping with soil degradation in agricultural areas.

Land degradation is largely linked with a declining productivity of the soil in the longer term (Lal, 1998). This productivity is associated with the performance of fair yields to ensure quality of life and food security. Erosion is considered as the main on-site effect of soil degradation.

Nevertheless this effect may vary with regard to its occurrence and severity depending on each agricultural system. Areas located across America or Europe count with a better input supply system, larger farm scale and advanced machinery or equipment. Unlike, agricultural systems in Africa are characterized by small-scale farming whereby productivity is generally low. Around 65 per cent of African population depends on this low-input system as main source of livelihood. Smallholder farmers face lack of capital, limited farm extension and high-demanding labour requirements as main constraints (report). This fragile agricultural environment makes of soil degradation and its control a priority at all levels. Hence, addressing problems of soil degradation resulting from mismanagement of agricultural practices is of major importance.

One of the most known effects of inappropriate agricultural practices took place in the 1930s where soil on almost 100 million of ha was blown away due to excessive tillage or soil exposition in the so-called Dust-bowl that stroke America's rural areas (Hobbs, 2006). Ever since farmers, scientists, researchers and institutions worldwide have agreed on the fact that tillage erosion is one of the main causes of soil degradation (Khachatryan, 1985), (Govers et al., 1999).

Water or wind erosion might be easily detected when they occur on the soil. Contrary, tillage erosion only becomes apparent after several years of ploughing on the soil properties and leads to soil losses (i.e. by runoff) (Van Oost et al., 2006). Over the last years National Agendas, NGOs, research institutions and local authorities have become aware of the relevance of tillage erosion when farming is at stake. Agricultural practices are shifting from colossal machinery and heavy treatments to more sustainable farming practices, within the global aim of securing food provision in a friendly-environment.

As an example of this new worldwide concern or global understanding the Conservation Agriculture concept appeared.

Its first principle (out of 3) outlines specifically a “minimum or no mechanical soil disturbance” (FAO, 2008). Lal (1998) and Erenstein (2002) among others proved with their studies that CA clearly benefits soil erosion control with regard to different soil properties, ranging from soil organic matter retention until minimizing soil losses.

However, the success on soil erosion control when CA is applied depends vastly on local conditions, such as rainfall intensity, %soil cover, erodability of soils and steepness of the terrain (Giller et al., 2009).

Consequently this research, as one of his objectives, has the aim to assess whether Conservation Agriculture as practiced in Western Kenya indeed reduces soil erosion or not.

1.5 INTRODUCTION OF SOCIO-ECONOMIC TOOL OLYMPE

Project leaders of CA2Africa jointly with partners involved in that consortium decided to approach the assessment of CA adoption in Eastern Africa following a stepwise procedure consisting of:

a) Assessment of different innovative models which differ on setting and final results.
b) Final election of CA adoption assessment model at the farm level: Olympe.
c) Training phase to forthcoming researches.
d) Evaluation of data collection.
e) Results.
f) Conclusions.

The Olympe simulation model has been developed by J-M Attonaty (INRA Grignon, France) and associated partners from CIRAD and IAMM. It is based on an integral analysis of farming systems, aiming at providing scientific fundaments for policy makers and authorities in order to consider future actions or plans in the agricultural environment (Penot, 2010).

Olympe software has gained weight in research institutes over the last years. It is considered as a specific tool designed for the improvement of farmers' livelihood through the better understanding of their socio-economic local context up to a regional scale. This research has taken into account modules contained at farm level.

Conservation Agriculture emerged as new agricultural technique successfully applied over the last years mainly in American countries. However, African agricultural systems have triggered a controversy on CA adoption and its suitability in smallholders' environments. Assessment of CA adoption requires a detailed revision of several social and economic factors and conditions.

CA2Africa leaders and software experts have proclaimed Olympe model as suitable to assess CA adoption among Eastern African smallholders.

1.6 PROBLEM STATEMENT

Conservation agriculture has over the last 30 years mainly been adopted in rural areas of South and North America. These rural areas hold almost 50% of 106 million of Ha currently under zero tillage worldwide. Contrary, Africa accounts for only 0.5%. Researchers and institutions expected a higher level of CA adoption in African countries than currently there is. Giller et al. (2009) raise the point that CA adoption in Africa responds to a different agricultural environment characterized as smallholder farming whose constraints have not yet been clearly addressed. The special character of African farming systems conditions the uptake and success of CA by farmers. Yet there is a lack of scientific research and reliable conclusions on CA adoption in Africa, as constraints remain unclear (Giller et al., 2009). As environment awareness of people increases worldwide new initiatives or projects must be undertaken in order to evaluate all the new agricultural technologies and their appropriateness.

1.7 OBJECTIVES

The overall objective of this research is to assess Conservation Agriculture as practiced in Western Kenya, addressing its physical and socio-economic constraints by comparing 25 CA adopters and 25 farmers who are not considered as adopters.

Unfolding this main aim into 3 specific objectives:

A) To assess Conservation agricultures practices in Western Kenya by using a specific socio-economic model called Olympe.
B) To measure soil erosion encountered on farms by using ACED Method.
C) To address what CA adoption constraints (physic and socio-economic) may be found in Western Kenyan's smallholder farming.

1.8 RESEARCH QUESTIONS

My main research question is:

"What are the economic, social and/or physical constraints that determine CA adoption among a group of 50 smallholder farmers in Western Kenya based on information provided by a detailed farm survey and analyzed with Olympe model?"

Sub-questions unleashed by the main question are classified up to:

A) <u>Field level</u>

Do farmers practicing CA obtain better farm results (higher yields) than those applying traditional farming practices?

Do higher yields mean higher profits for smallholder farmers?

Is the soil erosion rate in CA plots lower than in traditional farmed plots?

Which is the influence of steep slopes in farmers’ perception with regard to CA adoption?

B) Farm level

Do CA plots require more or less labour hours?

Does the farmer income increase under CA?

Are crop residues used for other endeavours, such as fodder or fuel?

What are the real constraints on CA adoption for farmers?

What are farmers’ perceptions on CA techniques?

Does CA require large investments when first time applied to the farm?

Is there a farm size threshold for adoption of CA and mechanizations?

2. MATERIALS AND METHODS

2.1. STUDY AREA

2.1.1. Location

Bungoma district covers around 210,000 ha in the Western province of Kenya, Africa. It borders with Uganda in the West and its coordinates are 00-01°N and 34-35°E. Bungoma district has been divided into 4 districts, Bungoma East, West, South and Central.

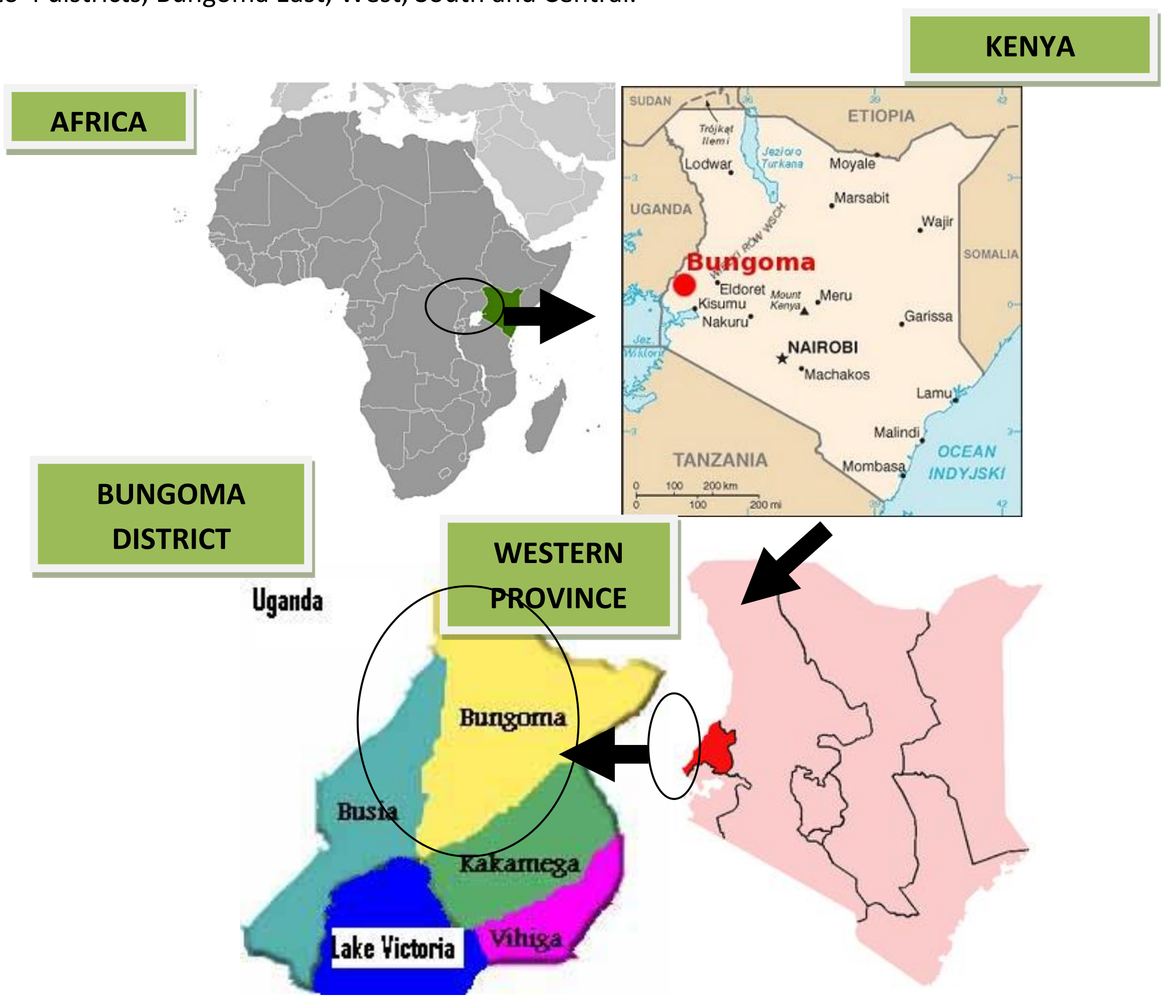

Fig 1: Clockwise Africa, Kenya, Western Province, Bungoma district.

Bungoma district is located south of Mt. Elgon, where the altitude is over 2000 meters and North-East of Lake Victoria, with an altitude of 1200 meters above sea level. The study area was set within the sub-districts of Bungoma Central, Bungoma East and Bungoma West.

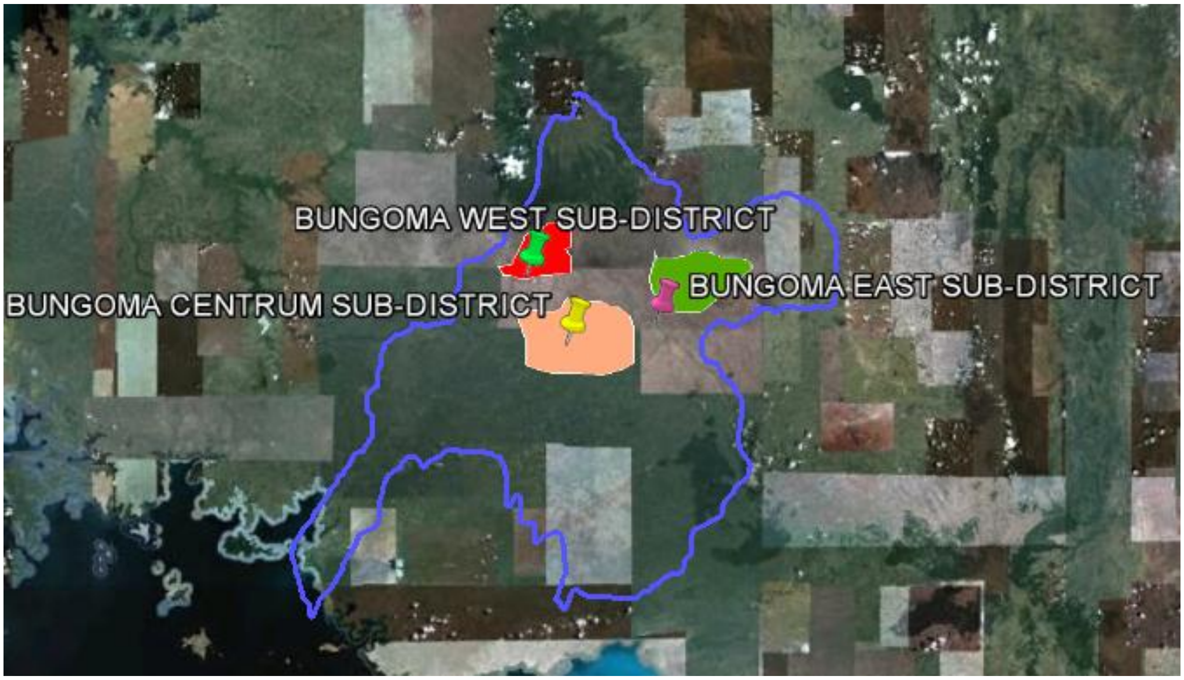

Fig.2: Location of study research area within Bungoma district boundaries

The reddish polygon denotes the extent of the study area in the sub-district of Bungoma West. Likewise, the greenish area delimits the study area in Bungoma East and the light brownish colour depicts the fieldwork area in Bungoma Centro.

2.1.2. Agro ecological characteristics in research areas

The physical influence of Mount Elgon and Lake Victoria as well as its elevation above sea level causes a steep ecological gradient in the district, creating wetter conditions than in the Eastern province of Kenya. This influences CA adoption by smallholder farmers in Bungoma district as soil quality, crop productivity, steepness, rainfall rate and temperature are constraints tightly related to the success of Conservation Agriculture in the area.

The average annual rainfall for the whole district ranges from 1000 to 1800 mm; the seasonal distribution is 500-1000 mm during the 1st rainy season and 430-800 mm during the 2nd rainy season in 6 out of 10 years (60 %reliability)(Jaetzold and Schmidt, 1982).

This rainfall pattern influences the agricultural practices carried out throughout the district. Average annual rainfall in the study areas oscillates between 1200-1400 mm (corresponding to Bungoma East sub-district), 1400-1600 mm (Bungoma Central) and 1600-1800 mm (Bungoma West). Likewise, average daily temperature ranges from 5-10ºC in the Northern part of the district to 20-22ºC in the Southern part.

These singular climate conditions have originated a prominent agro-ecological system within Bungoma district. It can be depicted as follows:

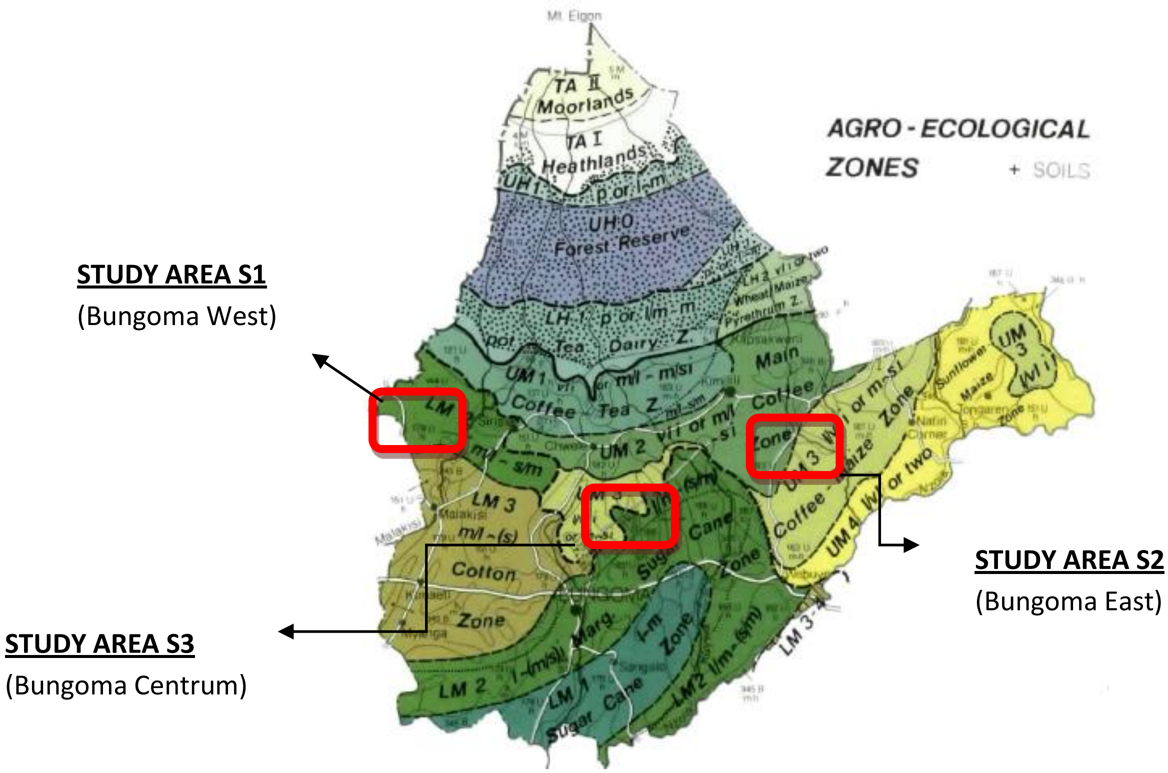

Fig.3: Agro-ecological zones in Bungoma district (Jaetzold and Schmidt, 1982)

According to Jaetzold and Schmidt (1982), the research areas in Bungoma district are ecologically characterized as:

Study area S1 (Bungoma West):

Area defined by its coffee production, good yields by crops such as sunflower, beans, potatoes, sweet potatoes and onions. Soil fertility is considered high.

Study area S2 (Bungoma East):

Coffee and maize are considered major crops which provide good yields. Beans and sweet potatoes perform fairly well. Soil fertility is medium.

Study area S3 (Bungoma Central):

Sugar cane crop is largely found throughout the area. Maize and bananas present lower yields. Soil fertility is low-medium.

2.1.3. Socio-economic context

The Census of 2006 indicated that Bungoma district has around 1.2 million inhabitants (IcFEM report, 2008), a quarter of the total in Western Province. The population has grown with almost 50% in the last 30 years with a population density of 470 inhabitants per square km. Nonetheless, the population is concentrated in the urban areas across the District, including Kimilili, Webuye, Bungoma Town, Sirisia and Kanduye. These urban settlements hold more than 50% of the inhabitants.

The main economic sector in the area is subsistence agriculture with maize, beans, sunflower, sugarcane, coffee and sweet potatoes as the main crops. Smallholder farming is characterized by a low farm income, unable to sustain households in the long term. The Kenyan Poverty rate comprises 55% of population, 5 points less than the Poverty Rate in Bungoma district (60%). More than half of its inhabitants subsist with less than 30 $ dollars per month (IcFEM report, 2008).

2.1.4. CA Evolution and stakeholders involved in Bungoma district

In May 2004 FAO, in association with the National Governments of Kenya and Tanzania and funded by German government, launched the CA-SARD project. It aimed to ensure food security and poverty eradication by enhancing CA adoption in smallholder farming countries in Eastern Africa (Kenya and Tanzania). The project was implemented in 5 districts in Kenya; Bungoma, Likipia, Mbeere, Siaya and Nakuru.

In Kenya the project was undertaken under leadership of the Ministry of Agriculture (MoA) and the Kenyan Agriculture Research Institute (KARI) was responsible for national logistic issues. At field level, the African Conservation Tillage Network (ACT) was engaged as a project manager institution, providing technical coordination and support, staff training (facilitators) and backstopping support with regard to CA adaptation and adoption in the targeted areas.

CA adaptation and adoption by farmers in the districts followed the Farmer Field School (FFS) Methodology. It is meant to successfully transfer agricultural principles to the farm level by emphasizing on-site adaptation of practices, self-learning and enhancing smallholder farmers' innovation.

Table 1: Number of Farmer Field Schools, membership and facilitators.

		MEMBERSHIP			
DISTRICT	**Nb. of FFS**	**MALE**	**FEMALE**	**TOTAL**	**FACILITATORS**
Liakipia	4	89	84	93	1
Bungoma	10	166	107	273	6
Mbeere	10	88	318	406	6
Siaya	10	139	219	358	4
Nakuru	14	130	222	352	6
SUB-TOTAL	*48*	*612 (41%)*	*950 (64%)*	*1482*	*23*

After 2 years of project implementation Bungoma district had registered 10 CA-FFS, which are still in place and holding almost 300 farmers on a 1:1 men/women ratio. The Ministry of Agriculture, through its District Agricultural Offices (D.A.O.) successfully trained 6 facilitators and provided them with insights in CA techniques, monitoring skills and equipment needed.

In 2011, during my stay in Bungoma, I had the opportunity of taking part in some meetings with local CA stakeholders. Specially revealing was the talk I had with the main FFS in Bungoma, **FFS Umbrella**

Network. This organization is responsible for clustering all the FFS within the district, and acting as linkage factor between schools and different stakeholders such as FAO, Ministry of Agriculture, NGOs, ICIPE, KARI, Fisheries, KACE, NAIAP etc. It coordinates them to seek international/national funds or new entrepreneurship ideas. Moreover Umbrella Network assists all FFS with the latest updates on agricultural practices through newsletters, communications, field days and trainings.

The FAO in concordance with MoA and ACT provides a CA support program to all Bungoma CA-FFS schools, coordinated by its representative organization UMBRELLA NETWORK. The objective of the program is the promotion, adaptation and final adoption of CA among smallholder farmers. Activities are divided into 4 groups:

a) Provide facilitator training for both the Ministry of Agriculture and the FFS team. Up to date, 75 farmers have graduated as facilitators.
b) Facilitate farm inputs such as fertilizers and seeds, as well as technical support (BACKSTOPPING)
c) Subsidise field days, where FFSs encourage other schools and individual farmers to share experiences and reveal new on-going researches (i.e. Communication about advantages of CA approach).
d) Organise graduation ceremonies of facilitators

According to data provided by FFS Umbrella Network there are 31 CA-FFSs registered up to date. In the second part of my communication with the chairman of Umbrella Network, **Peter Waboya,** I tried to address some CA issues such as its set of principles, adoption, constraints and challenges that are found in the district.

FFS Umbrella Network's chairman when inquired about CA principles stated that:

- It uses herbicides
- It reduces need of ploughing
- It uses cover crops
- Crop residues are left on the field.

A confused picture of CA principles was drawn, as herbicide application was taken for granted and needed every-time. The Executive board agreed on pointing out that herbicides begin to be a profitable business. Over the last two years there has been a district-wide increase of 210% in the use of herbicides. Multinational chemical companies have appeared along daily-markets, advertisements (flyers, posters or booklets) and field days; or even by providing free samples in the seeding periods. The Committee gathered in the improvised colloquium remarked that companies are encouraging farmers to purchase herbicides in order to fulfil all the supposed requirements of Conservation Agriculture. They also stated that chemical retailers, when enquired about why they sell chemicals to farmers as if they were indispensable for CA, answered that it is due to "unintentional misinterpretations" of the CA principles. Nevertheless Multi-chemical companies shield themselves in the fact that herbicides reduce labour force needed, ergo stimulating CA adoption and success.

Farmers do not apply all the three CA principles on the farm; rather they adapt themselves to the constraints as they appear along the year. Crop rotation is the principle that farmers are most reluctant to assimilate, unlike minimum tillage or crop cover principles.

FFS Umbrella has focused on two different tools or small equipment to undertake minimum tillage: Ox-tron planter and jab planter.

CA benefits according to FFS CA-COORDINATIOR in Bungoma district:

- Main advantage: Yields are increased (it might raise from 6 up to 30 (90 kg) bags of maize during the harvesting period per acre)
- Less labour required

On the other hand, CA adoption constraints are:

- Lack of storage capacity among farmers (i.e.: bag of maize right after harvesting period worth 2000 Kshs, but after three months of storage worth 4500 Kshs).
- Soil fertility throughout the district is decreasing.
- Input prices are increasing.
- No irrigation scheme, vulnerability natural calamities like droughts

Umbrella Network members cite that this lack of adoption is partly due to the short time of CA implementation at larger scale, started in early 2008. However, NON-CA farmers begin to see by themselves the benefits of CA on their neighbours' farms. Yet the CA adoption rate among farmers remains steady over time and has not considerably increased.

The Executive board is trying to diversify crop production by introducing more profitable crops such as tomatoes or watermelons among fellow farmers. Livestock production may increase farmers' income as well. Therefore, the introduction of poultry is desired once its cost/revenue ratio is promising.

As closing-speech the executive members of FFS Umbrella Network called for the study of certain CA challenges yet to be addressed within Bungoma district:

- Change farmers' behaviour
- Small-scale introduction of irrigation scheme
- Encouragement towards new entrepreneurial businesses, like "hot agriculture" (green houses)

This fruitful exchange of opinions and experiences about CA adoption and constraints in Bungoma district gave me the background and knowledge needed to successfully undertake my fieldwork.

2.2. METHODOLOGIES APPLIED

The methodologies in this research are focused on the assessment of physical and socio-economic factors that lead to low adoption in SSA countries, targeting Western Kenya.

The CA2Africa project has set the theoretical framework that will be used to unfold CA adoption constraints in Africa. Assessments in this research have been undertaken at both field level and farm level.

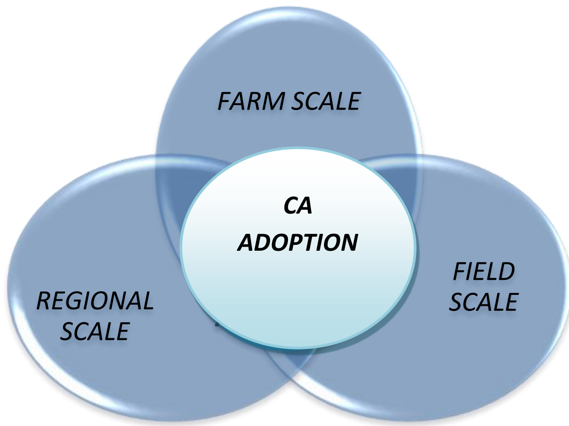

Fig. 4: Conceptual framework used in this research

The suitability of CA principles in smallholder farming conditions in Western Kenya has been assessed following a procedure of stepwise logic. It can be depicted as follows:

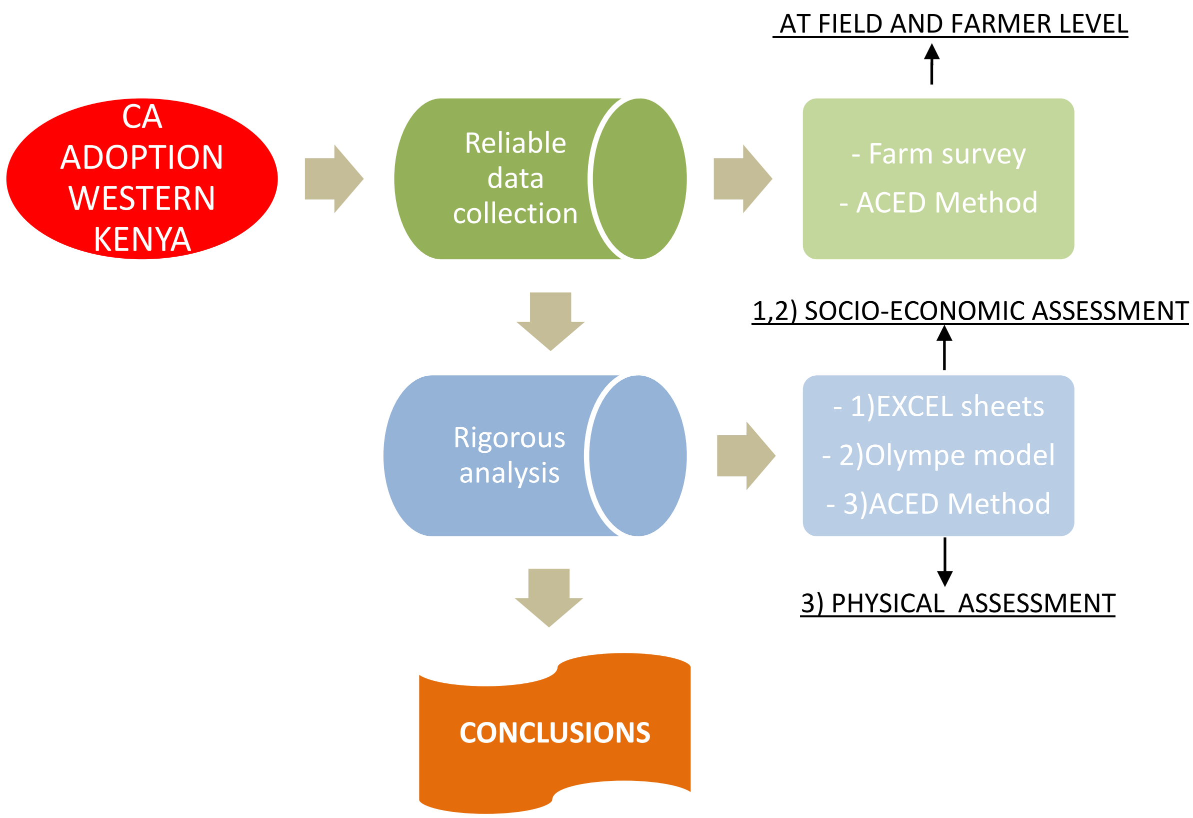

Fig.5: Flow chart activities to undertake in this research

2.3. FARM DATA COLLECTION THROUGH SURVEY

The research started with data collection through a farm survey in Bungoma district, Western Kenya. The fieldwork lasted 3 months, from late August until late November. The questionnaire was prepared by CA2Africa leaders and fine-tuned by Dr. Jan de Graaff, WUR representative in cooperation with the MSc students who were appointed to undertake their MSc thesis within the framework of CA.

The survey form was designed to cover 50 farmers within Bungoma District. 25 of them are considered CA adopters and the other 25 are considered non-CA adopter. The survey form is discussed below and presented in Appendix A.

Selection of CA farmers

The District agriculture officer (D.A.O.) in Bungoma West, Mr. Fredrick Wotia, jointly with his assistant Mr. Emmamuel Muria, proposed a list of CA farmers to be interviewed. Selection attended to:

- Location: CA practices are better recorded and tracked within the Central and-Northern parts of the District.
- Personal communications: Appointed farmers had a fluent communication with agricultural offices and officers.
- Variety of farmers: CA is practiced differently by farmers along the district.
- FFS Approach: Schools leaders were willing to participate in interviews, selection of farmers to be interviewed and exchange of information and concerns.

The final selection consisted of 8 farmers in Bungoma Central (under supervision of Bahati FFS and Jasho FFS), 11 farmers spotted in Bungoma East (Ngwello FFS) and 6 farmers placed in Bungoma West (Toloso FFS). From the initial list of 27 farmers to be interviewed two farmers could not attend.

Selection of NON-CA farmers

The agricultural officers engaged in the data collection process designed Bungoma West sub-district as study area for realizing surveys to the 25 NON-CA farmers. This sub-district has the singularity that because of its extent and changeable topography throughout the region the farming systems practised within the sub-district are representative (at a smaller scale) for the different farming systems that can be found in the whole district.

DATA REQUIREMENTS IN THE FARM SURVEY

The survey form layout (Appendix A) contains enquiries at both farm level and field level. Questions are stated precisely as they are meant to provide a complete picture of smallholder farming in Eastern Africa.

Table 2: Data required in the farm survey

	FIELD LEVEL	FARM LEVEL
SURVEY FORM	Cropping system	Household characteristics
	CA practices applied	Household expenses
	Farm size	Labour force
	Livestock inputs and outputs	Farm land
	Crop inputs	Cropping calendar
	Crop performance (production)	Machinery, equipment
		Farmers' perception

The survey form concludes with enquiries about farmers' perception on CA issues, such as benefits, constraints, future challenges, adoption problems, crop quality, selling prices, cropping calendar and changes on soil erosion.

2.4. SOCIO-ECONOMIC DATA ANALYSIS

Addressing socio-economic constraints for CA adoption has been the core issue of this research. Firstly, data were stored in EXCEL sheets to get an overview of all data by farm for both CA farmers and NON-CA farmers. Once the general picture of farming systems in Bungoma district was drawn, data were subsequently evaluated by the Olympe model, developed by INRA, CIRAD and IAMM in France. This model studies cropping systems in a contextualized environment, the farm. Its suitability in agricultural development projects has been proven (Penot, 2010). However, the model's suitability on Conservation Agriculture has remained untested prior to the elaboration of this research.

Figure 7 shows an overview of the model:

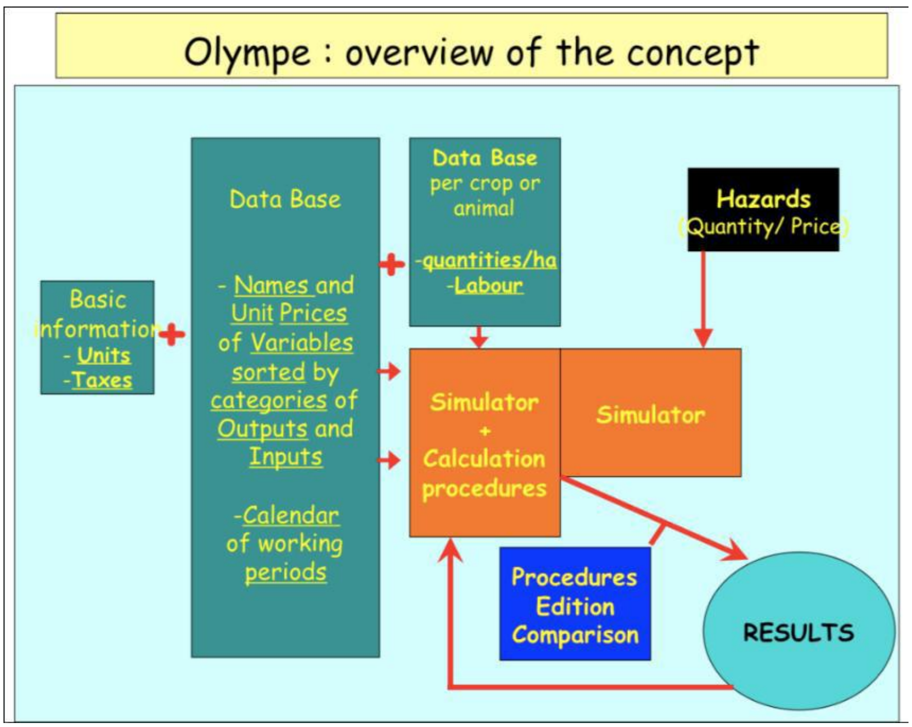

Fig. 7 Overview of Olympe model (Deheuvels, 2008)

This farming system approach requires a large amount of data, categorized under different headings or topics. Once the data has been set up simulations and calculation procedures can be undertaken in order to provide reliable results. A wide array of economic options can be chosen to generate different output files.

The analysis has considered data from 25 CA adopters and 25 NON-CA adopters all gathered in the same Database, called Bungoma project. Project results have been drawn as consequence of multiple socio-economic comparisons established among CA farmers and NON-CA farmers. Data analysis and discussion are largely explained in the next chapter.

2.5. SOIL EROSION EVALUATION: ACED METHOD

This research included a physical assessment of CA practices carried out in Western Kenya by comparing soil erosion losses found on CA plots and NON-CA plots. Soil erosion has been measured based on the ACED method proposed by Herweg (1996). This method helps evaluating the severity of soil erosion estimated as total amount of soil loss. It is considered as a tool for rapidly assessing soil erosion at farm level, based on the following assumptions (Herweg, 1996):

- Soil erosion and soil losses are not evenly distributed throughout the year.
- Soil erosion is not evenly distributed along a slope, even on one field.
- Soil and water conservation measures cannot efficiently control erosion if the measures do not prevent visible damage

The ACED Method has been successfully carried out in several erosion studies (Okoba et al., 2005); (Okoba, 2009). The physical assessment (ACED) proposed in this research has been applied on plots which have been heavily affected by erosion damage, visible at "naked eye". Input data has been provided by using 4 field forms and 1 sketch form (drawing).

Input data and final output (total soil erosion per acre) has been gathered according to:

1) The area of current erosion damage, represented by features of rills and gullies (Herweg, 1996):

Table 2: Classification of rills and gullies

	Width (cm)	Depth (cm)
Shallow rills	< 25	< 15
Shallow - wide rills	25 - 200	< 15
Deep rills	< 50	15 - 100
Deep - wide rills	50 - 200	15 - 100
Wide rills	> 200	< 100
Gullies	any	> 100

< = smaller than
> = greater than

Fig.6: Classification of rills and gullies (Herweg, 1996).

2) Soil parameters (texture or slope)
3) Land management type
4) Soil and water conservation measure if used
5) <u>Expression of damage (soil erosion calculations)</u>

The results of this assessment have contributed to a better understanding on how CA practices qualitatively and quantitatively influence the soil erosion rate in Western Kenya.

3. RESULTS

COMPARISONS CA FARMERS/NON-CA FARMERS

This chapter will resume the data that were gathered during the field work in Bungoma District, Kenya. Different comparisons between CA farmers and NON-CA farmers were made at different levels of study. Firstly, comparisons at field level are discussed. It includes information with regard to the farm household, farming systems, agricultural practises, agricultural machinery, labour force, livestock, cropping calendar and crop production.

Secondly home consumption, family expenses, off-farm income and capital situation are incorporated in the analysis at farm level.

At last but not least an evaluation has been included of how soil erosion is influenced by one or other agricultural technique.

3.1. FIELD LEVEL

3.1.1. Characterization of farm households

In Bungoma district all the households are dependent on farming as main source of income. This very first characterization of the farms has been given from a social perspective. This is, family members, parcels, farming experience of the head of household and land tenure.

Table 3: Farm household typology: average and standard deviation of main features

<table>
<tr><th></th><th colspan="2"></th><th>CA FARMERS</th><th>NON-CA FARMERS</th></tr>
<tr><td rowspan="7">FAMILY AND FARM LAND</td><td colspan="2">Family members</td><td>7.00 ± (3)</td><td>6.76 ± (2.26)</td></tr>
<tr><td rowspan="3">Number of Parcels</td><td>CA</td><td>1.16 ± (0.47)</td><td>-</td></tr>
<tr><td>NON-CA</td><td>1.36 ± (0.86)</td><td>-</td></tr>
<tr><td>TOTAL</td><td>2.52 ± (0.92)</td><td>2.50 ± (1.1)</td></tr>
<tr><td rowspan="3">Average plot size(acres)</td><td>CA</td><td>0.78 ± (1.00)</td><td>-</td></tr>
<tr><td>NON-CA</td><td>1.76 ± (1.30)</td><td>-</td></tr>
<tr><td>TOTAL</td><td>2.54 ± (1.80)</td><td>2.30 ± (1.40)</td></tr>
<tr><td>LIVESTOCK</td><td colspan="2">Average number per group</td><td>3.4 ± (5.31)</td><td>2.9 ± (5.47)</td></tr>
<tr><td>FARMING EXPERIENCE</td><td colspan="2">Years in farming of the head of the household</td><td>24.00 ± (12)</td><td>23.40 ± (13.5)</td></tr>
<tr><td rowspan="3">LAND TENURE</td><td colspan="2">Owned (%)</td><td>96</td><td>88</td></tr>
<tr><td colspan="2">Rented in (%)</td><td>4</td><td>8</td></tr>
<tr><td colspan="2">Owned-Rented out (%)</td><td>-</td><td>4</td></tr>
</table>

The average of family members for the CA farmers is slightly higher than for the conventional farmers. Both groups of farmers average equal number of plots per farm, although CA farmers account CA plots in this average.

CA farmers average larger plot size (2.54 acres) due to the presence of CA plots, which boost the CA farmers' plot size as a whole. CA farmers own a larger number of animals than NON-CA farmers (see table 12).

No significant differences were found in the farming experience. Almost all the farmers own their farm land.

3.1.2. Farming system

The study areas covered a wide range of agrological areas within the District. However, the cropping system "maize intercropped with beans" is predominant throughout the district. Yet around 30-35% of all CA farmers grow in addition cash crops like sugarcane, coffee or tomatoes. This percentage increases up to 60-65% in the case of NON-CA farmers. It must be stressed that all the cropping systems listed in table 5 and table 6 are related mainly to the long season (see Table 4). Farmers grow mainly beans, groundnuts and sunflower during the short season. The perennial crops are grown and harvested once per year. Dairy and draft cattle are mainly the type of livestock kept within the district, as well as poultry (see table 12). The latter is used either as source of meat or income in case of selling to the livelihood.

3.1.3. Annual cropping calendar

Annual crop calendar for common crops are shown in Table 4. Note that in general all the cropping systems respond to the same pattern throughout the seasons. Each operation can be slightly moved forwards or backwards in time. The most remarkable fact to note is that the preparation of the land as it is conceived does not take place on CA plots. Instead, farmers rely on the use of herbicides as preliminary step. Therefore, spraying chemicals on the parcels in early March or so has been considered as land preparation in the CA plots.

Table 4: Annual seasonal calendar for common crops grown in Bungoma district

3.1.4. Cropping system

It has been quoted that Bungoma district holds a pronounced steep ecological gradient due to its weather conditions and abrupt topography (Jaetzold and Schmidt, 1982). As consequence of this 9 different cropping systems that are practised by the farmers have been identified within the District.

Table 5 shows how many CA farmers can be found within the three study areas with reference to the cropping system practised and plot size. MB symbol represents the cropping system maize-beans. It is listed as main cropping system practised by all the farmers. Table 6 shows NON-CA farmers by cropping system (all of them are scattered in Bungoma West sub-district) and plot size. Results from both tables are also depicted further in form of chart (Figure 7 and 8).

Table 5: Number of CA ADOPTERS according to location, cropping systems practised and average parcel size.

		NUMBER OF CA FARMERS(n=25)				
	CROPPING SYSTEM	**B. WEST**	**B.EAST**	**B. CENTRAL**	**AVERAGE SIZE OF CA PLOTS(acre)**	**AVERAGE SIZE OF NON-CA PLOTS(acre)**
Maize + Beans (MB)+	*+cover crop*(1)*	1	1	3	0.5	1.7
	*+Perennial crops**(2)*	1	1	3	0.9	1.3
	+no cover crop(3)	1	1	2	0.4	1.1
	+groundnuts(4)	-	2	-	0.3	0.5
	+(4)+sweet potatoes +sugarcane(5)	1	2	-	1.8	1.2
	+(4)+Banana (6)	-	2	-	0.6	0.5
	+(4)+cover crop(7)	-	1	-	0.3	2.3
	+(1)+(6) (8)	-	1	-	0.5	0.5
	+(2)+Sunflower(9)	1	-	-	0.3	1.5
	+Water melon(10)	1	-	-	0.3	1
	TOTAL	**6**	**11**	**8**	**X=0.6;σ=0.5**	**X=1.16;σ=0.5**

Cover crop: lablab, Mukona or smodium;Perennial crops: Sugarcane, coffee or/and banana.*

NOTE: Each value of the last column corresponds to the average value of all farming systems mentioned. This average value differs from the average value described in table 3, which considers the overall plot size, rather than the cropping systems practiced on the farms.

Farmers characterized in Bungoma Central do not practise any other cropping system rather than maize-beans jointly with cover crops. Farmers in the other two sub-districts are more diversified and heterogeneous. The farming systems based on perennial crops (CA plots) average larger areas than for cash or fodder crops. Among the crops grown on traditional plots sweet potatoes and sunflower average the largest areas.

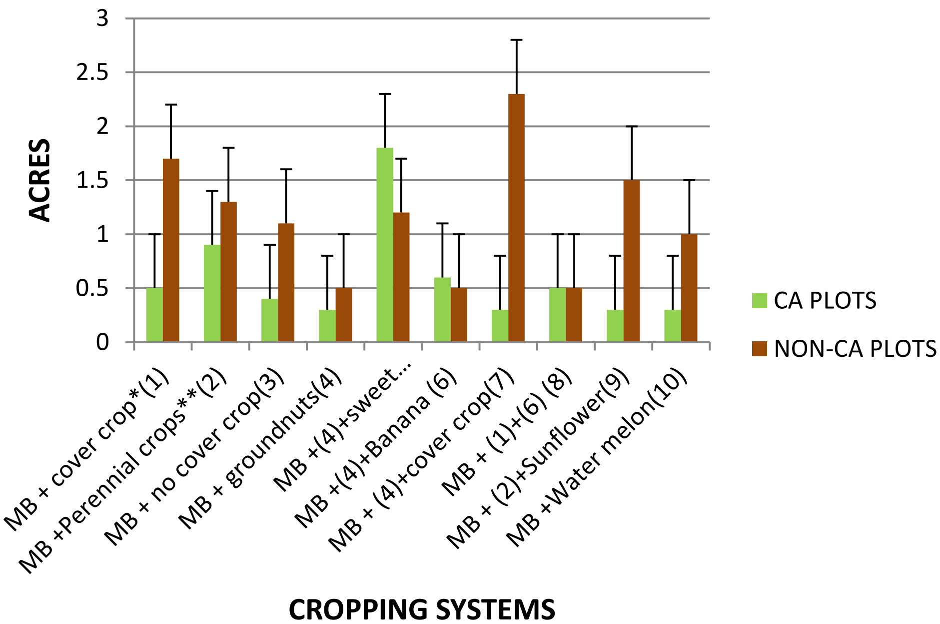

Fig. 7: Average parcel size and standard deviation of CA plots and NON-CA plots (CA farmers) according to the cropping systems practised

Although around 80% of conventional plots encountered are larger than CA plots, perennial crops such as sugarcane and bananas are grown in a larger area when CA is applied.

Table 6: Number of NON-CA FARMERS by cropping systems practised, as well as their plot size average (all in Bungoma West sub-district).

	CROPPING SYSTEM	*NUMBER OF NON-CA FARMERS(n=25)*	AVERAGE SIZE OF PLOTS(acres)
***Maize + Beans* (MB)+**	*+Perennial crops*(1)*	11	0.9
	Only MB(2)	3	0.9
	+Groundnuts + Banana (3)	1	1.3
	+Tomatoes(4)	5	0.8
	+Sunflower(5)	3	1.4
	+(1)+Sunflower(6)	1	1.3
	+(3)+sweet potatoes(7)	1	0.9
	TOTAL	**25**	**X=1.1;σ=0.25**

**Perennial crops: Sugarcane, coffee or/and banana*

NOTE: Each value of the last column corresponds to the average value of all farming systems mentioned. This average value differs from the average value described in table 3, which considers the overall plot size, rather than the cropping systems practiced on the farms.

Contrary to the farming systems undertaken on the traditional plots owned by CA farmers, groundnuts and sunflower are cropped in larger areas than tomatoes, sweet potatoes and maize-beans.

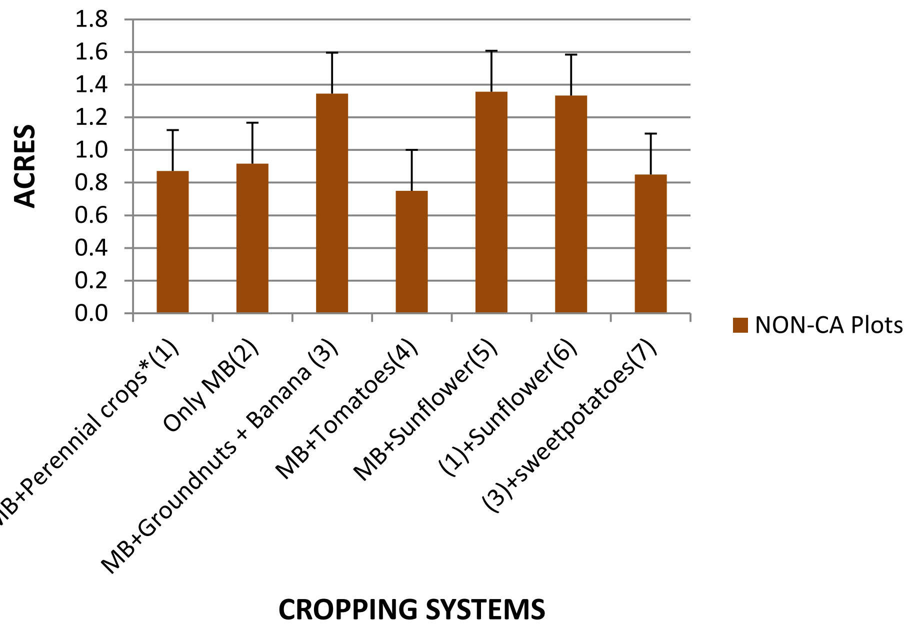

Fig. 8: Average parcel size and standard deviation of NON-CA plots (NON-CA FARMERS) according to the farming systems practised

As can be seen in Figure 8, plot size follows a different trend than the one shown in figure 7. Nevertheless the average plot size remains practically identical.

3.1.5. Agricultural practices

Agricultural practices in this research have been compared with regard to tillage practised, rotation of crops, weeding method and soil cover. Tillage ranges from ploughing the soil to improve soil structure in conventional agriculture to direct planting without prior distortion of the soil. Tools used are jab planter and animal drawn mulch planter. The main cover crops enabling such adoption are Lablab, Mukona and Smodium.

Applying herbicide or not influences significantly the labour force needed for weeding. The last agriculture practice considered is crop rotation, whose benefits in the soil structure and soil fertility have been proven. Figures 9 and 10 divide the agriculture techniques practised within Bungoma District into two groups: Conventional farming practices and Conservation farming practices.

Firstly, animal ploughing is the main tillage technique practised among all the NON-CA farmers (fig.10). Contrary, the use of animal drawn planter and/or jab planter are widespread among CA farmers, once 22 out of 25 farmers use either one(or combination of both) as main tillage tool. 6

out of 25 CA farmers preferably use the combination of Lablab and Mukona as cover crop. Other cover crops used are smodium and beans, with 5 farmers each. In contrast, 72% of the NON-CA farmers do not practice any mulching on their farms. With regard to herbicides, 22 out of 25 CA smallholders do spray herbicides prior to planting. This fact decreases the labour force employed in weeding (see Table 12). Yet manual removal of weeds is practised by all NON-CA farmers. Finally, crop rotation is undertaken by less than 40% of the farmers in both groups.

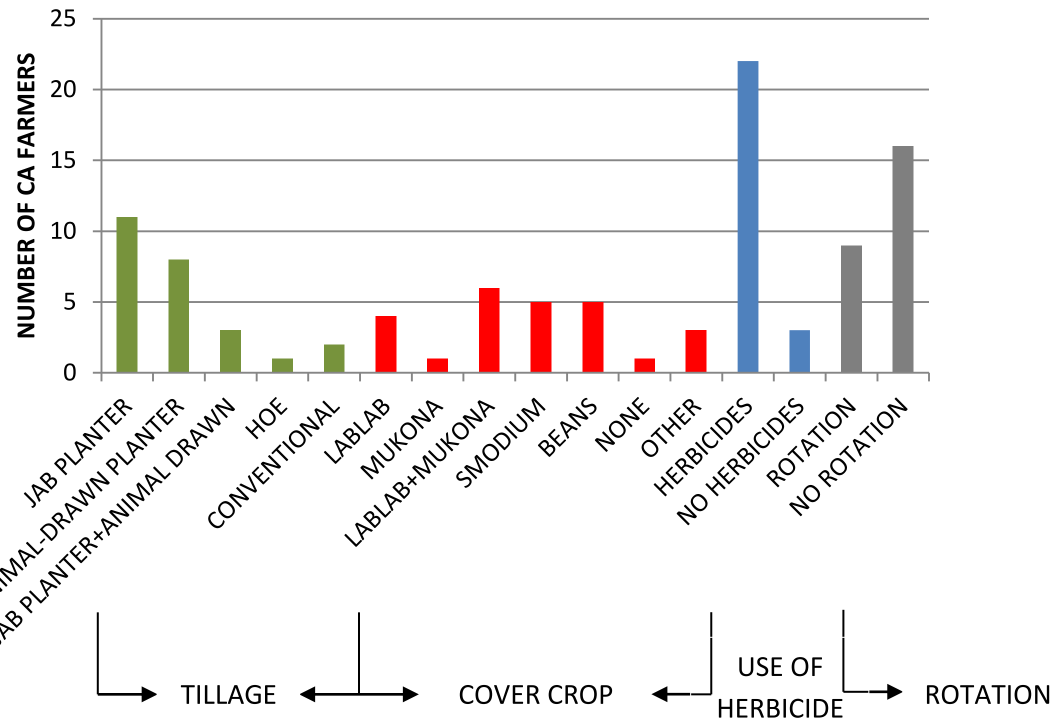

Fig. 9: Conservation Agriculture practises within Bungoma District

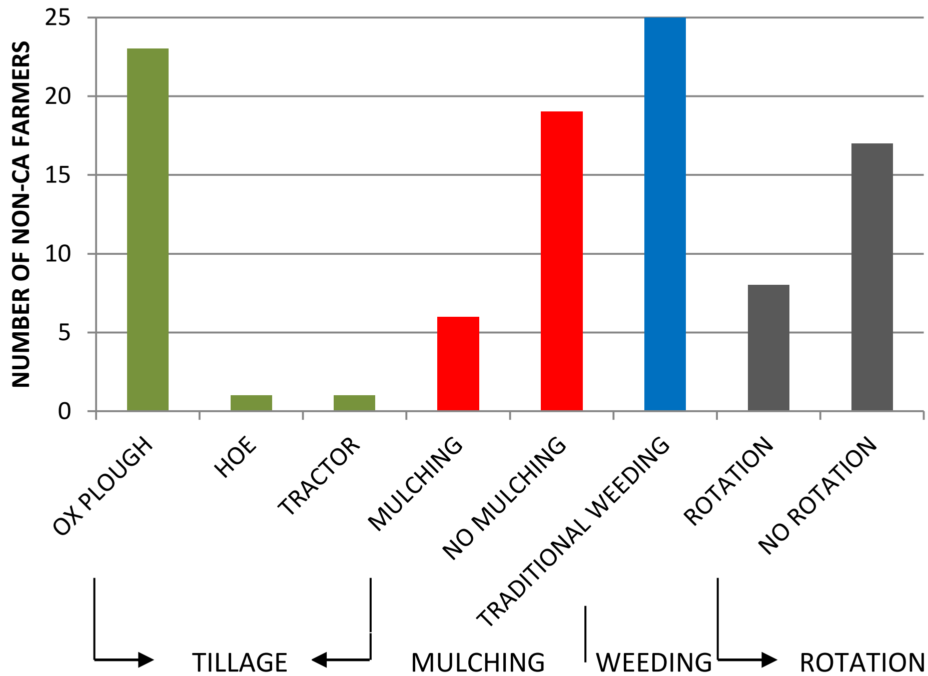

Fig. 10: Conventional Agriculture practises within Bungoma District

3.1.6. Crop production

Compared to conventional agriculture, conservation agriculture plots add extra value to the crop production. Table 7 shows the total crop production value per acre for both groups of farmers. CA plots yield higher crop production, even though their average plot sizes are considerably lower (see table 3). Figure 11 depicts this trend for both groups of farmers.

Table 7: Average total crop production (kshs) per acre

GROUP	AVERAGE TOTAL CROP PRODUCTION VALUE/ACRE(kshs)	
	CA PLOTS	72,061
CA FARMERS	NON-CA PLOTS	46,515
	TOTAL AVERAGE	59,288
NON-CA FARMERS	AVERAGE	43,233
Increment	+27%	

The average crop production value among NON-CA farmers is around 27% lower than the average crop production for CA farmers. In the case of NON-CA plots, CA farmers obtain 7% more of crop production value than NON-CA farmers mainly due to the presence of coffee plots among their farming systems. The sales of this tree crop production considerably increase farmers' income.

The total crop production of any plot is composed of crop earnings (inputs–outputs) and the value of home consumption (crop production not sold out). Both descriptions are shown in table 8 and table 9 respectively.

Table 8: Average net crop earnings per acre generated by type of agriculture practised

GROUP	AVERAGE NET CROP EARNINGS PER ACRE(Kshs)	
	CA PLOTS	35,080
CA FARMERS	NON-CA PLOTS	32,280
	TOTAL AVERAGE	33,680
NON-CA FARMERS	AVERAGE	28,044
Increment	+16%	

The average net crop earnings per acre have been calculated by computing all the inputs and outputs generated from CA plots and NON-CA plots. Table 8 shows that CA farmers earn per acre 16% more than NON-CA farmers.

Table 9 shows the value of the home consumption rated in monetary value and does not include family expenses related to food ingredients or purchase of meat/fish. In order to calibrate effectively this consumption all the production which was not sold out in both seasons was valued with the same market price at that time.

Table 9: Average value of home consumption by type of agriculture practised

GROUP	AVERAGE VALUE HOME CONSUMPTION PER ACRE(Kshs)	
	CA PLOTS	37,520
CA FARMERS	NON-CA PLOTS	14,235
	TOTAL AVERAGE	25,876
NON-CA FARMERS	AVERAGE	15,186
Increment	+41%	

Unlike the average crop earnings per acre, the crop production destined to home consumption by the CA farmers is almost double that of the NON-CA farmers. By comparing table 8 and table 9 it can be concluded that the crop production obtained from CA farms is intended firstly to fulfil the households' consumption needs prior to selling it out at the market. Contrary, crop production obtained from NON-CA farms follows the opposite trend. It is firstly destined to sales rather than home consumption.

Figure 11 shows graphically the combination of tables 8, 9 and 10. The yellowish colour represents the CA production value. In all the cases this value exceeds the production value of NON-CA plots.

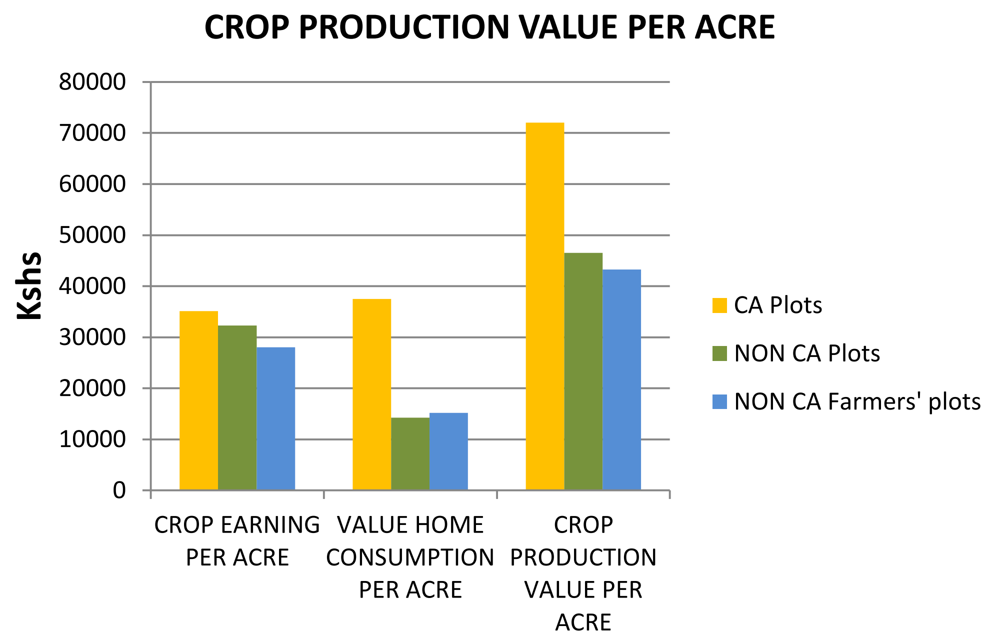

Fig. 11: Crop production value per acre for CA (CA and non-CA plots) and NON-CA farmers (Kshs)

As overall, CA plots have provided substantially better crop yields for the year 2011(see table 22), which has led to a higher crop production value by CA farmers than traditional farmers.

3.1.7. Crop residues

Conservation Agriculture principles require a cyclic use of the crop residues (field-crop-field). In order to achieve higher yields and better crop performance residues should not be used for any purpose other than being mineralized on the field.

Note that half of CA farmers indeed leave the crop residues on the field. Contrary, the other half uses them for other purposes. It is often seen that farmers do use residues to feed their cattle and to assist the family during the nights. More related information is shown in the last chapter.

Table 10: Use of crop residues by CA farmers

CROP RESIDUES	USE	CA FARMERS
Residues of cropping system "Maize-beans-cover crop"	*Forage (%)*	30
	Firewood (%)	20
	Remain on the field (%)	50

An aspect to be noted is that it is often seen that some CA farmers use the crop residues for one or other propose depending on the plot in question, current crop season or livestock needs. Nevertheless, table 10 only contains the information given by the CA farmers, without further considerations.

3.1.8. Agricultural equipment found within Bungoma District

Agricultural equipment consists mainly of ox-plough as tool for tillage in NON-CA plots, and either jab planter or ox-planter to undertake seeding in CA plots. Wheelbarrows are used for transportation tasks.

It is worth to emphasize that around 70% of all farmers surveyed have at least one fully functional bike that was used to either transport any product such as seeds, firewood etc. or to fulfil other personal interests.

Table 11: The use of agricultural equipment classified by CA and NON CA farmers.

		% CA FARMERS			% NON-CA FARMERS		
ACTIVITY	**EQUIPMENT**	**HIRED**	**OWNED**	**OTHER**	**HIRED**	**OWNED**	**OTHER**
LAND PREPARATION	*Ox-plough*	20	40	-	8	76	4
	Hoes	-	95	-	-	96	-
SEEDING	*Jab planter*	50	8	-	-	-	-
	Ox-planter	32	4	-	-	-	-
	Hand sowing	-	-	18	-	100	-
TRANSPORT	*Wheelbarrow*	-	72	-	-	40	-
	Bike	-	64	-	-	76	-
	Ox-cut	-	8	-	-	4	-
	Motorbike	-	8	-	-	4	-

Almost every household owns at least one hoe for their daily work. Nevertheless, NON-CA farmers combine the hoe with the traditional ox-plough in order to prepare the land. Obviously, CA farmers rely less on ox-ploughs due to their commitment to the CA technique.

All the NON-CA farmers undertake seeding tasks on their own, without using any tool or equipment. In contrast, CA farmers do use for this activity CA tools such as jab planter and animal drawn planter. Wheelbarrow is a more recurred tool among CA farmers for transporting.

3.1.9. Labour force employed

Table 12 shows the labour force employed by farmers for the most common cropping system: maize intercropping with beans. The last column has been obtained by computing differences in the time employed to accomplish each operation during the long season and short season. Conservation Agriculture method reduces the amount of work required in all the operations except for planting. Consequently labour costs per acre are reduced (76%) when CA principles are followed.

Table 12: Labour force employed per acre for cropping system "maize-beans" in Bungoma District among CA farmers in 2011.

		NON-CA Plots				CA Plots			
CROPPING SYSTEM	OPERATION	Own labour Average number of workers	Seasonal workers Average number of workers	Time spent (Mandays/acre)	TOTAL LABOUR REQUIRED (Mandays/acre)	Own labour Average number of workers	Time spent (Mandays/acre)	TOTAL LABOUR REQUIRED (Mandays/acre)	%
MAIZE-BEANS(INTERCROP)	*Land preparation*	2.1 ± (0.5)	-	2.6 ± (2.2)	5.5	1.9 ± (0.4)	2.0 ± (1)	3.8	-31
	Planting	1 ± (0.3)	3 ± (0.7)	1.4 ±(1.1)	5.6	1.8 ± (2.3)	1.8 ± (1.6)	3.24	-42
	Weeding	4 ± (2.1)	2 ± (1.1)	4.8 ± (2.3)	29	2.3 ± (0.7)	3.3 ± (1.7)	7.59	-74
	Fertilization	1.5 ± (0.5)	-	2.0 ± (1.2)	3	1.2 ± (0.4)	0.7 ± (0.5)	0.84	-72
	Applying herbicide	-	-	-	-	1.0 ± (0.3)	0.6 ± (0.5)	0.6	+60
	Manuring	1.7 ± (0.6)	-	2.0 ± (1)	3	1.4 ± (0.5)	0.6 ± (0.3)	0.84	-72
	Harvesting	1.5 ± (1.4)	3.6 ± (2.5)	2.3 ± (1.9)	11.73	3.1 ± (2.9)	2.2 ± (1.1)	6.82	-42
	TOTAL	-	-	15.1	**57.83**	-	-	**23.73**	-60

Mandays: 5 hours/day; O**: Own labour (family); S. ***: Seasonal workers; P.'' Permanent workers*

Note: Labour inputs are only for maize and beans, and not for the other intercrops. Due to the limited size of the CA plots and the importance of the cropping system (Maize and beans) for the homestead seasonal labour force is not employed.

Table 13: Average labour cost per acre for cropping system maize-beans among CA farmers.

		CONVENTIONAL TILLAGE PLOTS *AVERAGE LABOUR COST PER ACRE(kshs)*			CONSERVATION TILLAGE PLOTS *AVERAGE LABOUR COST PER ACRE(kshs)*		
CROPPING SYSTEM	**OPERATION**	**O.***	**S.****	**TOTAL**	**O.***	**TOTAL**	**% REDUCED TOTAL LABOUR COST**
MAIZE-BEANS(INTERCROP)	*Land preparation*	547	-	547	380	380	-31
	Planting	140	420	560	324	324	-42
	Weeding	1,920	960	2,880	760	760	-74
	Fertilization	300	-	300	84	84	-72
	Applying herbicide	-	-	-	60	60	+100
	Manuring	340	-	340	84	84	-75
	Harvesting	345	828	1,173	682	682	-42
	TOTAL MAIZE-BEANS CROPPING SYSTEM	3,592	2,208	5,800	2,518	2,518	-57

*Note: the wage used to calculate the average labour cost per acre is 100 kshs; formula used: Manday * number of workers * 100*

Table 14: Average labour cost per acre for all cropping systems among all farmers in 2011.

AVERAGE LABOUR COST PER ACRE(Kshs)	CA FARMERS					NON-CA FARMERS			% REDUCED TOTAL LABOUR COST
	CA PLOTS		NON-CA PLOTS			NON-CA PLOTS			
ALL THE CROPPING SYSTEMS	O.*	S**	O.*	S**	**TOTAL**	O.*	S.**	**TOTAL**	-33
	1,279	1,273	2,070	4,345	8,967	6,625	6,692	13,317	

O: Own labour (family); S. **: Seasonal workers*

3.1.10. Livestock features

The inventory of the current livestock in Bungoma district is depicted in Table 15. Just over half of the farmers (CA and NON-CA) have draft cattle, and not less than 88% of the CA farmers have dairy cattle. In Bungoma district dairy cows are considered as elements that denote prosperity among farmers. They produce milk throughout the year (around 9 months per year) and constitute a valuable asset in case of selling. Around 88% of all the farmers rely on the hatching of poultry as source of meat, eggs and income in case of selling. Both pigs and sheep can be only found among CA farmers. In general CA farmers have more livestock than NON-CA farmers.

Table 15: Livestock kept by NON-CA and CA farmers.

	NON-CA FARMERS			CA FARMERS		
TYPE OF LIVESTOCK	% farmers	Average number among farmers indicated	Overall average	% farmers	Average number among farmers indicated	Overall average
Draft Cattle	52	1.8 ± (0.9)	0.9 ± (1.1)	56	3.1 ± (1.7)	1.7 ± (2.0)
Dairy Cattle	60	2.2 ± (1.1)	1.3 ± (1.4)	88	3.0 ± (2.6)	2.7 ± (2.6)
Pigs	-	-	-	8	3.0 ± (1.4)	0.2 ± (0.2)
Sheep	-	-	-	32	2.9 ± (1.7)	0.9 ± (0.9)
Goats	36	3.0 ± (1.9)	1.1 ± (1.8)	28	2.9 ± (1.2)	0.8 ± (0.8)
Poultry	88	16.0 ± (9.7)	14.0 ± (10)	88	16.0 ± (9.6)	14.1 ± (10.5)
Other	4	2	0.9	4	2	2.0

Table 16 illustrates the net value that livestock is assumed to provide per household. The major difference between columns lies in the amount of inputs required by the livestock. CA farmers have on average more cattle. Despite this fact, the expenditure made by NON-CA farmers with regard to cattle feeding (concentrates) or use (need to hire in draft cattle to plough) is considerably higher.

Table 16: Average livestock inputs, outputs and net earnings by NON-CA and CA farmers

PARAMETER	NON-CA FARMERS	CA FARMERS	% DIFFERENCE(respect to CA)
Inputs(Kshs)	12,128	7,394	-39
Outputs(Kshs)	29,865	23,019	-23
Net earnings(Kshs)	17,737	15,625	-12

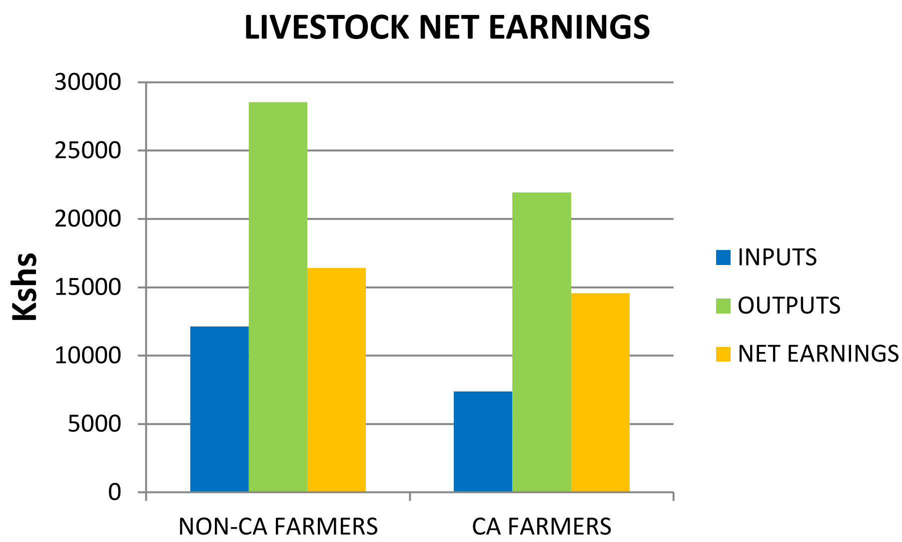

Fig. 12: Livestock net earnings (Kshs)

Figure 12 illustrates the livestock net earnings per farmer. Even though CA farmers have on average more livestock they spend less capital on inputs. As consequence of this the outputs and net earnings generated are lower than from NON-CA farmers.

3.2. FARM LEVEL

3.2.1. Household expenses

The household expenses obtained through the farm survey are highly subjective, since the survey was held only once and covered averages for the whole year. Yet both groups had almost the same estimated annual expenditure of 107,791 and 120,621 Kshs respectively. In Table 17, food expenses (rice, meat and food ingredients) of CA households are higher than for traditional households. The same trend is seen with the school fees and clothing/shoes.

This increment might be due to the result of the crop production in the CA plots, whereby the value of this production apparently enhances the wealth of the household. It could also be due to the fact that richer farmers apply CA technique.

Table 17: Average annual household expenses (Kshs) by NON-CA and CA farmers in 2011.

EXPENSES	NON-CA FARMERS	CA FARMERS	% DIFFERENCE
School fees	33,725	41,128	+18
Clothes and shoes	9,320	10,460	+11
Health(medicines)	10,000	7,360	-26
Washing ingredients	5,168	5,508	+6
Rice	5,630	6,610	+15
Meat	7,408	11,683	+37
Fish	6,007	4,251	-29
Food ingredients	7,082	9,041	+22
Transport	13,132	16,384	+20
Wedding and funerals	3,652	1,852	-49
Misc.	5,068	2,908	-43
Membership associations	1,600	3,436	+53
TOTAL	**107,791**	**120,621**	+11

3.2.2. Off-farm income

Each of the following categories has been considered as income source: off-farm earnings and farm related earnings. The former is calculated as the addition of off-farm agricultural occupation and the amount received through transmittals. The latter is characterized by the renting out or sale of physical assets (i.e. houses, portion of land), and the hiring out of both the draft cattle and ox-plough. Off-farm agricultural occupations are often encountered among farmers. Most of them prefer to settle in the commercial sector, followed by the education sector. The results indicated that NON-CA farmers earn a significant 23% extra income from external agricultural occupations and 14% more from farm related earnings (other than crop or livestock).

Table 18: Annual off-farm activities and average earnings (Kshs) by NON-CA farmers and CA farmers (2011)

OFF-FARM INCOME	NON-CA FARMERS		CA FARMERS	
Off-farm agricultural occupation (% farmers)	52	Commerce:77%	44	Commerce:36%
		Teacher: 15%		Teacher: 28%
		Seas. Worker:8%		Other:36%
Average Off-farm agricultural occupation earnings among farmers indicated (Kshs)		61,664		47,664
Transmittals		3,705		12,440
Farm related earnings [other than crop or livestock(Kshs])		12,029		6,785
Overall average net Off-farm income (Kshs)		77,397		66,889

Overall, NON-CA farmers earned 14% more in other incomes, rather than crop or livestock.

3.2.3. Capital situation

In the case of surveying farmer's capital situation, investments, loans and transmittals have been considered. Recall that these data are highly subjective and reliability must be taken into account. Around 96% of NON-CA farmers were involved in any of the earlier mentioned financial transactions. This ratio drops to 80% among CA farmers. But those CA farmers invested larger amounts of money.

Table 19: Financial transactions by NON-CA and CA farmers in 2011.

TYPE OF TRANSACTION MADE IN 2011	NON-CA FARMERS			CA FARMERS			Difference indicated farmers
	% Farmers	Amount among farmers indicated, Kshs(average)	Overall average, Kshs	% Farmers	Amount among farmers indicated, Kshs(average)	Overall average, Kshs	%
Investment	36	62,222	22,400	20	111,300	22,260	+44
Loan	24	84,167	20,200	16	72,500	11,600	-14
Transmittals	32	11,575	3,705	24	51,833	12,450	+78
TOTAL	96	52,655	15,435	80	78,544	15,606	+33

Transmittals are specified only when family households receive any amount of money coming in from other relatives. The reasons for which farmers made investments and asked for loans are shown in table 20.

Table 20: Reasons for investments and loans.

TYPE OF TRANSACTION MADE IN 2011	Reason to invest in/loans for	% NON-CA FARMERS	% CA FARMERS
Investment	Purchase land	83	40
	Buy inputs/equipment	10	20
	Private business	7	20
	Rent a house	-	20
Loan	Purchase land	33	33
	Buy inputs	16	-
	Private business	33	33
	Payment school fees	16	33

Apparently traditional farmers prefer to invest in purchasing plots to extend their farming area. Contrary, CA farmers are much more heterogeneous with regard to the use of capital.

A final point to be made here is that the type of transactions considered has been simplified due to the complexity of each farmer's economic situation.

3.3. SOIL EROSION

Soil erosion has been measured according to the ACED Method. The fields of 3 NON-CA farms and 4 CA farms were evaluated. The other farmers were excluded due to either the inexistence of erosion features on their land or to the high soil cover rate found at the time.

As can be seen in table 21, the soil erosion calculation takes into account the length, width and depth which characterize all the erosion features found (rill in each case). It is essential to note that 85% of all surveyed farmers practiced some kind of soil and water conservation measure. The practices that showed up in this erosion assessment were grass strips and ditches. In order to proceed to the soil erosion calculation the typical bulk density found in Kenya soils has been set at 1.4 g/cm^3 (Mantel et al., 1997).

The total soil erosion rate per acre calculated in CA plots is almost 58% lower than the rate estimated in NON-CA plots.

Table 21 A: Soil erosion calculation according to ACED Method in 5 CA plots and 4 NON-CA plots.

FARMER	**Number of rills**	**Av. Length (m)**	**Av. Width (m)**	**Av. Depth (m)**	**Size of plot (m^2)**	**Soil loss (m^3)**	**Area of actual damage (m^2)**	**Area of actual damage as % of field size**
NON-CA 1	4	63	0.15	0.1	4,000	3.78	37.8	0.95
NON-CA 5	1	50	0.1	0.05	2,000	0.25	5	0.25
NON-CA13	1	24	0.3	0.12	2,400	0.86	7.2	0.30
NON-CA14	1	14	0.6	0.12	2,000	1.01	8.4	0.42
	1	20	0.7	0.1	2,000	1.40	14	0.70
CA 5	1	5	0.15	0.15	600	0.11	0.75	0.13
CA 10	1	4	0.15	0.1	4,000	0.06	0.6	0.02
	1	63	0.25	0.1	4,000	1.58	15.75	0.39
CA 14	1	32	0.15	0.05	1,000	0.24	4.8	0.48
CA 15	2	20	0.25	0.05	2,000	0.50	10	0.50

Table 21 B: Continued.

FARMER	**Soil loss (m^3/acre)**	**Soil loss(t/acre)**	**Soil loss of actual damage area (m^3/acre)**	**Depth of top soil (cm)**	**Texture**	**Slope (%)**	**Type of plant**	**Soil cover (%)**	**Type of SWC Measure**
NON-CA 1	3.78	5.29	400	20-25	Sand maroon	8	Coffee	40	Grass strips
NON-CA 5	0.5	0.70	200	25-30	Sand maroon	8	Maize-beans	60	Grass strips
NON-CA13	1.44	2.02	480	25-30	Sand maroon	10	Beans	40	Cut-off drain at top of the field
NON-CA14	2.02	2.82	480	25-30	Sand maroon	9	Water melon	50	Grass strips
	2.8	3.92	400	25-30	Sand maroon	8	Tomatoes	60	Grass strips
AVERAGE	2.1	2.95							
CA 5	0.75	1.05	600	20	Clay loam	6	Banana	40	-
CA 10	0.06	0.08	400	30	Sand	5	Maize-beans	65	Ditches
	1.575	2.21	400	30	Sand	5	Maize-beans	65	Ditches
CA 14	0.96	1.34	200	30	Sandy loam	6	Maize-smodium	50	-
CA 15	1	1.40	200	30	Sandy loam	5	Sweet potatoes-groundnuts	40	-
AVERAGE	0.89	1.22							

4. DISCUSSION

The "Discussion" chapter will unfold all the constraints that have previously been set at two different levels, field level and farm level. In order to tackle these different aspects research and sub research questions will be referred to at either level.

4.1. REALISED AND PERCEIVED EFFECTS OF CA BY FARMERS

Do farmers that practice CA obtain better farm results (higher yields) than those applying traditional farming practices?

Rising yields have probably been the main benefit that Conservation Agriculture technology claims to achieve. Yields discussed in table 22 are related to the average of each crop per group of farmers. For the cropping system "maize-beans'' yields are provided for both long and short season.

Table 22: Average estimated yields, by group of CA and NON-CA farmers.

YIELDS	**CA FARMERS**			**NON-CA FARMERS**	
CROP	**CA Plots**	**NON-CA Plots**	**% Difference**	**NON-CA Trad. Plots**	**% Difference (CA plots-traditional plots)**
Maize long season(kg/acre)	1,192	982	+18	1,080	+9
Beans long season(kg/acre)	593	283	+52	165	+72
Maize short season(kg/acre)	769	570	+26	235	+69
Beans short season(kg/acre)	418	528	-21	200	+52
Banana(plunge/acre)	250	50	+80	172	+31
Coffee(kg/acre)	1,300	3,850	-67	1,259	Equal
Sugarcane(t/acre)	30	10	-66	-	-
Sunflower(kg/acre)	-	740	-	182	-
Groundnuts(kg/acre)	519	275	47	76	+86
Sweet potatoes(kg/acre)	678	-	-	2,887	-77
Watermelon(kg/acre)	-	2,500	-	100	-
Tomatoes(kg/acre)	800	-	-	1,150	-30
Cowpeas(kg/acre)	-	-	-	600	-
Kale(kg/acre)	-	-	-	2,800	-

As table 22 shows, yields on CA plots were higher than on NON-CA plots in 2011. During the long season bean yields were three times higher in CA plots than in NON-CA plots, and maize yields were 10% higher. Contrary, yields of both maize and beans during the short season were 60%

higher (average). This fact proves that the visible benefits of Conservation Agriculture technology might appear once cover crops are cropped during the long season. The structure of the soil and moistness are positively influenced by the effects of the cover crops in the soil. As consequence of this the fertility of the soil increases, and that leads to higher yields.

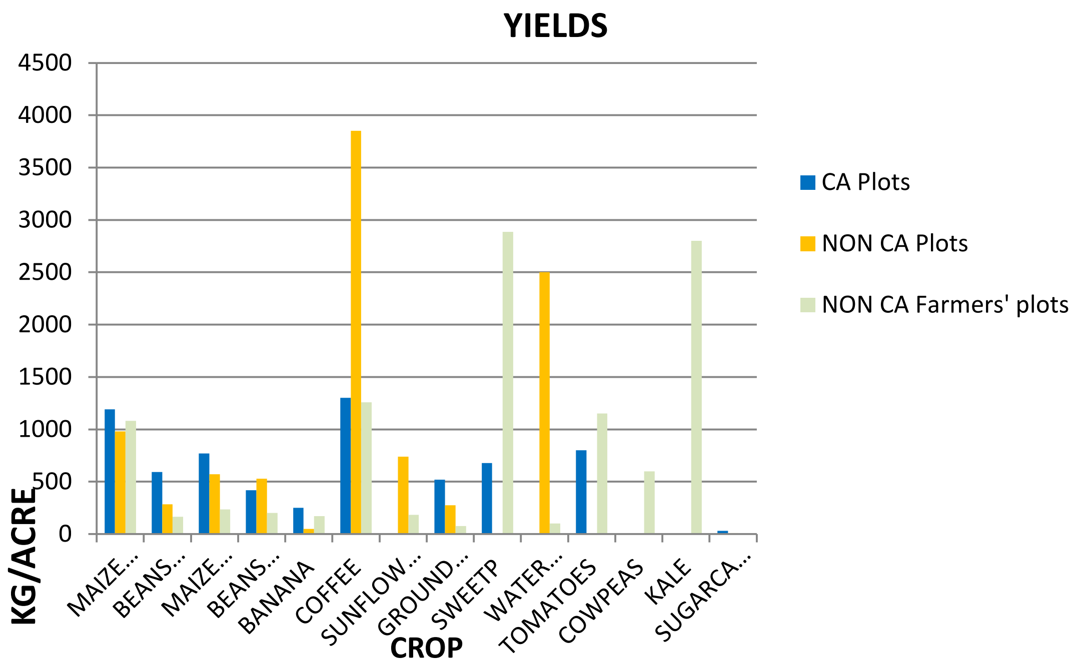

Fig. 13: Crop yields in Bungoma County for 2011 for CA- and Non-CA farmers **(Kg/acre)**

Figure 13 shows in dark colour the yields obtained from the CA plots for 2011. As it was mentioned earlier, maize- beans (both seasons), banana and groundnuts yields were higher on CA plots than on traditional plots in 2011. In contrast to this trend, coffee, sweet potatoes, water melon and tomatoes yields on the traditional plots were higher than on CA plots. Cowpeas, kale and sugarcane cannot be compared since there are only data from either the NON-CA plots from CA farmers or the NON-CA farmers' plots.

Do higher yields mean higher profits for smallholder farmers?

In this section Olympe software has been used in order to determine the average crop gross margins per farmer. These gross margins are calculated as the monetary difference between inputs and outputs per crop. Figure 14 shows the average crop gross margins per farmer.

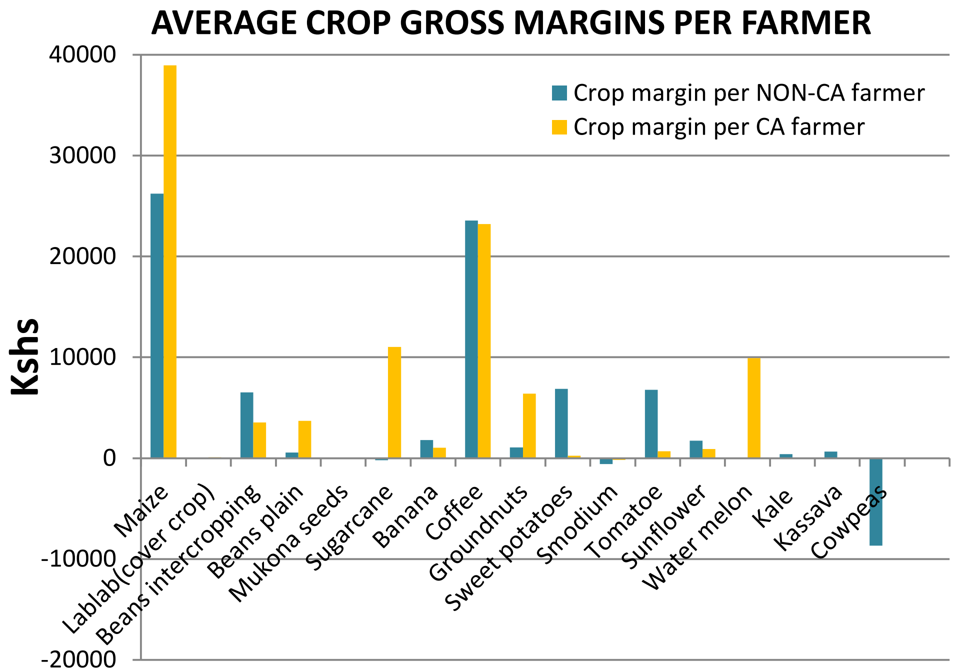

Fig. 14: Crop gross margins in Bungoma County in 2011 for CA and NON-CA farmers (Kshs)

The top 6 of most profitable crops found within Bungoma District for CA farmers are maize, coffee, sugarcane, water melon, beans and groundnuts. In the case of traditional farmers this top 6 results in: Maize, coffee, beans, sweet potatoes, tomatoes and bananas.

It can be stated by comparing CA farmers and NON-CA farmers that only maize, beans (short season) and groundnuts effectively deliver better results on CA plots. None of the other cropping systems show clearly higher gross margins for CA than for NON-CA farmers in 2011. Figure 14 shows that the gross margin of cowpeas is negative for NON-CA farmers in 2011. This is due to the fact that cowpeas were entirely consumed by the households once they were harvested (no sales).

Among all the inputs chemical products represent the major cost of inputs used for the crop production (labour cost aside) of both group of farmers. Overall both type of farmers invest almost the same amount of capital in chemicals. However, different trends can be found as different kinds of fertilizers are discussed. Traditional farmers spend 19 % less on fertilizer D.A.P. than CA farmers. Contrary, capital invested on fertilizer C.A.N. by traditional farmers is 30 % higher than by CA farmers. Even though maize yields were higher than the beans yields on the CA plots in 2011 the cost afforded by CA farmers on bean seeds was 30 % higher than on maize seeds.

Is soil erosion rate in CA plots lower than in traditional farmed plots??

Soil erosion measurements and calculations have been made with the ACED Method. Table 19A-B depicts total soil erosion loss calculated by group of farmers. Seemingly the soil erosion rate on CA plots is 58% less than on traditional plots. The maximum soil loss rate was encountered under cash crop systems (Tomatoes or water melon) and tree crops. Contrary, the intercropping system “maize-beans” minimizes considerably the total soil losses. This study concerned 9 plots whereby soil erosion was visible with the naked eye. Due to either a high soil cover rate or the mere absence of erosion features (such as rills and gullies) all the other plots were not considered in this analysis.

Conservation Agriculture is said to reduce effectively soil erosion. However, this soil erosion control in Bungoma District is carried out by many soil and water conservation measures spread across the District, and bear no relation to the type of agriculture practised. These SWC measures range from soil movements to create ditches to the plantation of narrow lines of vegetation (grass strips or trees). This sustainable way of controlling soil erosion has been taking place since the last 10-15 years. It is a remarkable fact that farmers when questioned about the convenience of these measures to reduce soil erosion could not even address the utility of these measures on their fields. Farmers referred often to the “cultural heritage” as the reason to adopt SWC measures.

It is worth emphasizing that the soil erosion rates calculated must be considered as merely informative. The ACED method is meant to be a tool for rapidly assessing soil erosion without considering further detailed information with regard to soil properties.

Which is the influence of steep slopes on the farmers’ perception for CA adoption?

During the farm survey 11 questions were asked to farmers about their perception with regard to (the adoption of) Conservation Agriculture.

These questions were the following:

a) Have the farmers who adopted CA practises observed an effect on: crop yield:, weeding and cropping calendar?
b) Have farmers observed any change on soil erosion?
c) Does steepness influence upon erosion?
d) Have CA practises reduced the workload required?
e) How and where did you obtain your knowledge on CA?
f) What was the main reason for farmers’ decision to adopt CA?
g) What are the disadvantages and advantages of CA?
h) Is the CA production sold out at higher prices?
i) Is there any increase in the crop quality?
j) With regard to adoption, what are the reasons for low adoption of CA in your region?
k) Why do not farmers apply CA technique in their whole farm?

Appendix A. provides detailed answers on these questions by all 25 CA farmers. Hereunder the major points and answers are discussed.

Table 23: Summary of CA farmers' perceptions on Conservation Agriculture (CA).

QUESTIONS	MAIN ASPECTS	REACTIONS	% FARMERS
1)	Effects on yield	- It increases over time	96
		- No increment is detected/known	4
	Effects on weeding	- It decreases the labour required	96
		- No effect is observed	4
	Effects on cropping calendar	- No effect is noticed	92
		- Crop activities in CA plots may be shift over time	8
2)	Changes on soil erosion	- No change of erosion is observed	84
		- CA effectively minimizes soil erosion	16
3)	Influence of steepness on soil erosion	- No influence is observed	100
4)	Labour force	- CA has reduced labour force required	100
5)	Knowledge on CA	- Farmer was trained by FFS for a short time (days up to one week).	20
		- Farmers was trained by FFS for a longer time(6 months up to 2 years)	60
		- Farmer was trained as facilitator by ACT Network, KARI and FAO	20
6)	Main reason to introduce CA on the farm(only 1 answer)	- Improvement of soil fertility	40
		- Crop performance(higher yields)	48
		- Improvement of soil moisture	8
		- Reduction of labour force	4
7)	CA advantages(more than 1 answer)	- Improvement of soil fertility	84
		- Soil moisture is enhanced	68
		- Money is saved by reduction of labour force	36
		- Other advantages	8
8)	CA disadvantages(more than 1 answer)	- High cost of chemicals	20
		- Unknown effectiveness of chemicals	20
		- CA is a technique which needs adopters to be skilled. Good management is highly required.	48
		- Positive results appear when CA is applied over time	8
9)	Differences on prices CA product-NON-CA product	- No difference is noticed	96
		- Prices on CA products are higher	4
10)	Crop quality	- CA has improved quality of the crop	80
		- No difference is noticed	20
11)	Low adoption of CA	- Lack of information and knowledge	84
		- Lack of capital	8
		- CA's successful adoption requires	8

		time	
12)	Adoption of CA in the whole farm	- Farmers await to see positive results on CA plots before upscale	28
		- Lack of capital to purchase herbicide	60
		- Lack of skills for up scaling	12

Almost all the CA farmers were aware of the main benefits of Conservation Agriculture technique upon crop systems. Approximately 96% of them considered that CA effectively increased yields over time, as well as it improved the fertility of the soil due to the action of cover crops. Yet Bungoma district falls on the skirts of the Mount Elgon, and its soil types cannot be considered as unfertile after all.

Soil erosion was not seen as a threat for the crop production for the coming years. CA technique with regard to the minimization of soil erosion is the least potential impact that CA farmers were aware of. Moreover, the special agro conditions of Bungoma district make soil erosion not a concern among both groups of farmers. Due to the action of cover crops in the soil and the widespread use of chemicals labour force for weeding is released, becoming an advantage among CA farmers.

The improvement of soil moisture was an aspect that almost 70% of farmers agree upon. Higher ratio of soil cover throughout the year keeps humidity within the (sub) soil. Some of these farmers believed that the soil structure was enhanced as well.

On the other hand, listing CA advantages was not an easy task for CA farmers. Almost 40% of them thought of chemicals as key elements to undertake satisfactorily the adoption of Conservation Agriculture. High cost and unknown effectiveness of chemicals were the main concerns for CA farmers when it came to use of chemicals. The high cost of chemicals made CA farmers sceptical of up scaling Conservation Agriculture on the whole farm.

With regard to crop quality, 80% of CA farmers noticed an increment on the quality of crop, both organoleptic (aroma and taste) and on the crop growth. Despite this improvement CA production was sold out under the same market conditions as the traditional production.

When CA farmers were questioned about the low adoption of Conservation Agriculture within Bungoma district 84% of them remarked the lack of information and knowledge on CA as main challenges, once it requires specific training and equipment to kick off.

According to the question number 3”influence of steepness on soil erosion” farmers do not believe that soil erosion is influenced by the steepness of their fields. Moreover, 84% of all the farmers surveyed did not consider soil erosion as a problem to be addressed any time soon.

4.2. FARM LEVEL ECONOMIC ANALYSIS, WITH OLYMPE MODEL

This research has made use of the Olympe software to provide insights into the socio-economic status of 50 farmers within Bungoma district. In the “results” section (3) a wide array of socio-economic themes were discussed among the two groups of farmers. Unlike chapter “results”, the discussion at farm level compares socio-economic characteristics by using the Olympe software for both groups of farmers. This software unravels implicit economic features that would otherwise not be noticed through a simple screening of the data collected.

4.2.1. Overall assessment and discussion of CA and NON-CA farmers’ economic parameters

The economic features of both groups of farms can be brought together in 6 categories, namely crop production, livestock, misc., household, changes in assets and liabilities and family labour. Each category contains a number of economic parameters. Table 24 shows the summary of the socio-economic figures found among all the farmers surveyed in Bungoma in 2011. All the famers relied on the crop production as main source of income.

Table 24: Summary of figures (Kshs) in Olympe for surveyed farmers over the year 2011.

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS		NON-CA FARMERS		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	2,661,667	106,467	2,109,517	84,381	+21
	Inputs/variable costs	819,564	32,783	885,072	35,403	-8
	Gross margin	1,842,103	73,684	1,224,445	48,978	+34
Livestock	Livestock output	575,481	23,019	746,636	29,865	-23
	Inputs/variable costs	184,858	7,394	303,209	12,128	-39
	Gross margin	390,623	15,625	443,427	17,737	-12
Misc.	Other income	169,619	6,785	300,715	12,029	-44
	Fixed costs	20,867	835	16,014	641	+23
	Other expenses	86,004	3,440	2,605	104	+97
Household	Off-farm income	1,502,605	60,104	1,634,203	65,368	-8
	Household expenses	3,015,520	120,621	2712780	108,511	+10
	NET EARNINGS	**782,559**	**31,302**	**871,391**	**34,856**	**-10**
Change in assets and liabilities	*Loans/debts*	81,000	3,240	-172,500	-6,900	
	Fixed assets(Buying)	-81,400	-3,256	0	0	
Family labour	*Mandays*	658	26 ± (18)	1,484	59 ±(29)	-56
	NET EARNINGS PER MANDAY	**1,200**		**589**		**+51**

In previous chapters it has been shown that CA plot size is slightly smaller as average than NON-CA plot size. However, due to the new agriculture technique practiced crop yields on CA plots were higher than on NON-CA plots. Due to this fact CA farmers could count on higher crop margins, although NON-CA farmers invested larger amounts of money for purchasing crop inputs.

Likewise crop production, the gross margin of livestock is calculated as the difference between livestock output (milk and cattle sales) and inputs, defined by purchases of new cattle, veterinary service, expenditure on cattle feeding (concentrates) and the hiring of draft cattle for the preparation of the land. NON-CA farmers earned 12% more than CA farmers. Table 16 depicts similar results.

Miscellaneous category is composed by other related income to the farm (see paragraph 3.2.2.), the fixed costs on the farm and other expenses. The latter is characterized by the expenditure of renting plots and costs of fuel for vehicles. The fixed costs were almost equally distributed for both groups of farmers. However, NON-CA farmers made almost 50% more in other income mainly due to the fact that 3 of them sold out a piece of farmland raising the average income among all the NON-CA farmers.

Household characteristics are described in the paragraph 3.2. Even though NON-CA farmers obtained 8% more in off-farm income their household expenses were 10% lower than on CA farmers. Among all the expenses, schools fees signified 31% for NON-CA farmers and 34% for CA farmers.

Once every economic parameter was taken into account the net earnings were calculated. CA farmers counted on 10% less in the net earnings than NON-CA farmers. Despite this fact, the net earnings per manday (only family labour) for CA farmers are 51% higher than for NON-CA farmers. Overall, CA farmers dedicated 56% less in mandays than NON-CA farmers. The reduction of the workload for the former group as consequence of the adoption of Conservation Agriculture led to different net earnings per manday.

The last category studied was change in assets and liabilities. Liability of CA farmers lies on the grant of loans, in contrast with the NON-CA farmers. Because of the loans CA farmers are involved in the purchase of diverse assets, such as piece of lands or equipment.

Figure 15 depicts the comparison of economic figures for CA and NON-CA farmers.

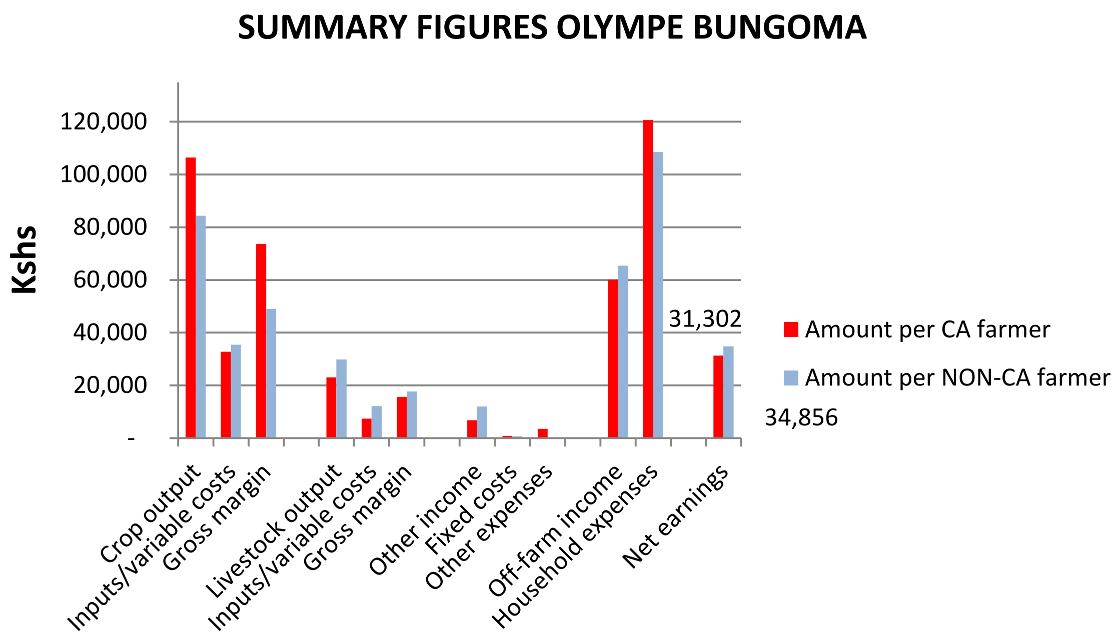

Fig. 15: Summary figures Olympe Bungoma, 2011 for CA- and Non-CA farms (Kshs)

In Appendix C total figures for each farmer (from both groups) are shown.

The summary of the figures created by Olympe model has given 4 major aspects to be discussed. These aspects are crop production, livestock, misc., and household characteristics. Among these aspects crop gross margin, livestock output, off-farm income and household expenditures are shown as the most relevant economic parameters (in quantity). In the next section these parameters will be analysed.

4.2.2. Assessment and discussion of the main economic parameters

During the first part of the chapter "discussion" crop gross margins were discussed, so were the household expenses in the chapter "results". Therefore, an exhaustive analysis of the livestock figures and off-farm income will be given, as follows:

A) Livestock income among CA farmers, NON-CA farmers and overall comparison.

This section examines the contribution of livestock to the general economic picture among farmers.

Figure 16 depicts the share of the livestock output per farmer.

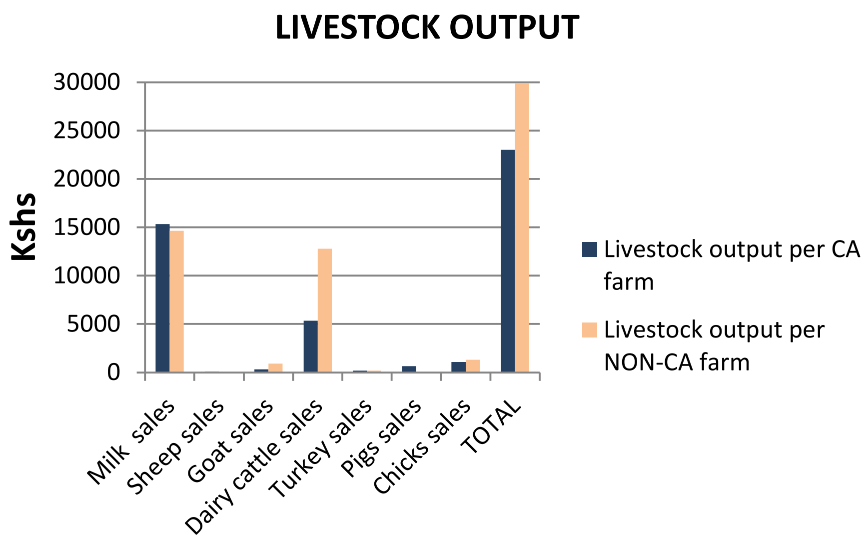

Fig. 16: Livestock output for CA- and Non-CA farms (Kshs)

The production and sale of milk is the single most important income of the livestock production. It yielded almost 15,000 Kshs on average for NON-CA farmers and CA farmers in 2011. In total, it represented more than 52% of total livestock income to NON-CA farmers and 70% to CA farmers.

However, not all the farmers counted on such income. 40% of NON-CA farmers did not have any dairy cattle, and this percentage declines to 12% for CA farmers. Nevertheless, this agro-economic survey obtained information from only one year, 2011. Despite having some dairy cows on their farm around 60% of CA farmers did not get any income from dairy production for the current year. Almost all of the cows related to this figure were considered too young to produce milk yet. This figure dropped to 52% for NON-CA farmers.

The aim of this section was to find out the differences between CA and NON-CA farmers without milk sales, with regard to their crop production, total farm income and household expenses. Table 25 shows the comparison between the two types of farmers who could not count on milk sales within their income in 2011.

The major difference between the two groups of farmers was found in the off-farm income. The NON-CA farmers who did not depend on milk sales largely relied on external income. This percentage was 39% more than the percentage of CA farmers.

As consequence the final balance for NON-CA farmers was 70% higher than for CA farmers. Compared to table 24 the final net results for those CA farmers with NO milk sales was almost 52% lower in comparison with the average of CA farmers. In the case of NON-CA farmers this percentage was increased by 31%.

Table 25: Economic figures (Kshs) of CA and NON-CA Farmers with NO milk sales.

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS(14)		NON-CA FARMERS(13)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	1,225,611	87,544	1,046,867	80,528	+8
	Inputs/variable costs	417,365	29,812	328,834	25,295	+15
	Gross margin	808,246	57,732	718,033	55,233	+4
Livestock	Livestock output	118,178	8,441	121,499	9,346	-10
	Inputs/variable costs	97,604	6,972	128,605	9,893	-25
	Gross margin	20,574	1,470	-7,106	-547	+369
Misc.	Other income	19,211	1,372	91,207	7,016	-80
	Fixed costs	7,010	501	1,008	78	+85
	Other expenses	82,000	5,857	-	-	+100
Household	Off-farm income	807,602	57,686	1,244,002	94,154	-39
	Household expenses	1,356,580	96,899	1,366,420	105,109	-8
	NET EARNINGS	**210,043**	**15,003**	**658,708**	**50,670**	**-70**
Change in assets and liabilities	*Loans/debts*	4,000	286	-125,700	-9,669	
	Fixed assets(Buying)	-600	-43	-	-	
Family labour	*Mandays*	342	24 ±(18)	703	50 ±(30)	-63
	NET EARNINGS PER MANDAY	**620**		**937**		**-34**

Net earnings per manday for CA farmers without sale of milk were 48% lower than for all CA farmers. Contrary, NON-CA farmers with no sale of milk had 37% more of net earnings per manday compared to the entire group.

Figure 17 depicts the economic figures for both groups of farmers with no milk sales.

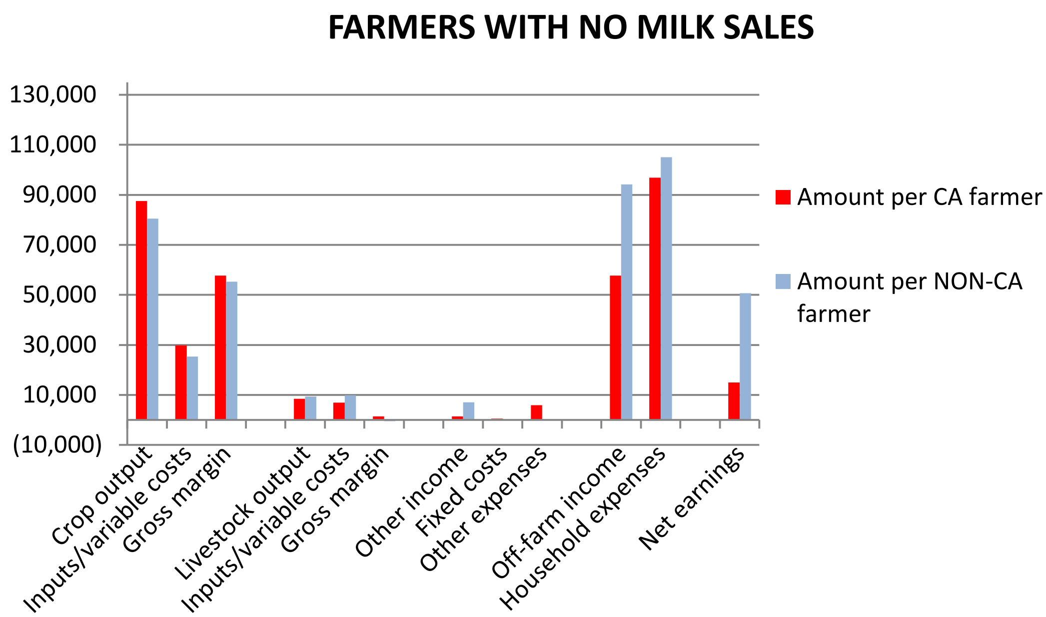

Fig. 17: Economic figures of those CA and NON-CA Farmers with NO milk sales

Besides this general comparison among groups differences can be found within each group as well. Table 26 shows the total final balance of NON-CA farmers who had NO milk production, and the total final balance of the other NON-CA farmers (with milk production).

The former group did not replace this lack of income with an increment of the crop income, although they grew satisfactorily secondary crops such as sweet potatoes and tomatoes. The labour external force expenditure was reduced by 52%. Another interesting fact is that NON-CA farmers without milk sales rose a 64% extra Off-farm income than the other NON-CA farmers. Farmers with milk sales earned 65% less in the net earnings than the other group of NON-CA farmers.

Compared with the entire group these farmers counted on almost 50% less in the net earnings. Their net earnings per manday are very low. The sale of milk must be accompanied by crop production and/or off-farm income, otherwise NON-CA farmers would experiment a shortage of income in the middle term.

Table 26: Economic figures (Kshs) of NON-CA Farmers with NO milk sales and NON-CA farmers WITH milk sales.

CLASSIFICATION	ECONOMIC PARAMETERS	NO MILK SALES(13)		WITH MILK SALES(12)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	1,046,867	80,528	1,062,650	88,554	-9
	Inputs/variable costs	328,834	25,295	556,239	46,353	-45
	Gross margin	718,033	55,233	506,411	42,201	+24
Livestock	Livestock output	121,499	9,346	625,136	52,095	-82
	Inputs/variable costs	128,605	9,893	174,604	14,550	-32
	Gross margin	-7,106	-547	450,532	37,544	-101
Misc.	Other income	91,207	7,016	209,506	17,459	-60
	Fixed costs	1,008	78	15,007	1,251	-94
	Other expenses	-	-	2,602	217	-100
Household	Off-farm income	1,244,002	94,154	409,603	34,134	+64
	Household expenses	1,366,420	105,109	1,346,360	112,197	-6
	NET EARNINGS	**658,708**	**50,670**	**212,083**	**17,674**	**+65**
Change in assets and liabilities	*Loans/debts*	-125,700	-9,669	-46,800	3,900	
	Fixed assets(Buying)	-	-	-	-	
Family labour	*Mandays*	703	50 ±(30)	781	65 ± (28)	
	NET EARNINGS PER MANDAY	**937**		**272**		**+71**

Table 27 provides details about the economic figures for CA farmers. 15 farmers did not have any milk production and 10 of them did have milk sales in 2011.

Unlike traditional farmers, CA farmers with no milk production had on average (by 72%) a lower final net result than those who did sell any production of milk.

Apparently, CA farmers with milk sales increased the crop production by cropping largely beans, groundnuts and water melon, and reduced the labour cost by saving up to 43% cost of external labour. Unlike NON-CA farmers, CA households without milk production as income in 2011 did earn 9% less than the other CA farmers with regard to off-farm income.

Finally, another aspect worthy to be emphasized is that the expenditure on education in terms of tuition fees was significantly reduced (58%) among CA households who had no milk production in 2011. Both groups of CA farmers have on average 5 children all into education age. However, the school attendance of the children of those CA households with a lack of livestock and/or off-farm income decreased severely. This fact can be related to the savings of money when the labour force relies on the own family rather than seasonal workers.

Table 27: Economic figures (Kshs) of CA Farmers with NO milk sales and CA farmers WITH milk sales.

CLASSIFICATION	ECONOMIC PARAMETERS	NO MILK SALES(14)		WITH MILK SALES(11)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	1,225,611	87,544	1,436,056	130,551	-33
	Inputs/variable costs	417,365	29,812	402,199	36,564	-18
	Gross margin	808,246	57,732	1,033,857	93,987	-39
Livestock	Livestock output	118,178	8,441	457,303	41,573	-80
	Inputs/variable costs	97,604	6,972	87,253	7,932	-12
	Gross margin	20,574	1,470	370,050	33,641	-96
Misc.	Other income	19,211	1,372	150,408	13,673	-90
	Fixed costs	7,010	501	13,857	1,260	-60
	Other expenses	82,000	5,857	4,002	364	+94
Household	Off-farm income	807,602	57,686	695,002	63,182	-9
	Household expenses	1,356,580	96,899	1,658,940	150,813	-36
	NET EARNINGS	**210,043**	**15,003**	**572,518**	**52,407**	**-72**
Change in assets and liabilities	*Loans/debts*	4,000	286	-77,000	-7,000	
	Fixed assets(Buying)	-600	-43	-	-	
Family labour	*Mandays*	342	24 ±(18)	316	29 ± (19)	-17
	NET EARNINGS PER MANDAY	**620**		**1,812**		**-65**

Overall, the discussion brought up by the sale of milk can be summarized by saying that both group of farmers differ substantially in their economic distribution when such income is at stake. Whereas CA farmers with milk sales had a higher final balance (by 72%) than the other farmers the NON-CA farmers with no milk sales had on average a lower final result almost by the same percentage and amount (65).

<u>B) Influence of Off-farm income on the households' economic balance.</u>

Off-farm income in this research has been set as the sum of off-farm agricultural occupation income, transmittals, renting out or sale of physical assets (i.e. houses, portion of land) and hiring out both the draft cattle and the ox-plough. In Olympe the first two incomes are tagged within the group of "Off-farm income" and the other incomes are classified under the description of "other income".

Among them, off-farm agricultural occupation represented the largest income; with 80% and 71% of the total Off-farm income of NON-CA and CA farmers, respectively (see table 18).

Table 28 shows the economic figures of those CA and NON-CA farmers who did not count at all on off-farm agricultural occupations.

Table 28: Economic figures (Kshs) of CA and NON-CA farmers with NO off-farm agricultural occupation

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS(13)		NON-CA FARMERS(11)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	1,628,099	126,008	1,044,324	94,939	+25
	Inputs/variable costs	344,858	26,528	440,405	40,037	-34
	Gross margin	1,293,241	99,480	603,919	54,902	+45
Livestock	Livestock output	269,427	20,725	405,887	36,899	-54
	Inputs/variable costs	74,754	5,750	134,804	12,255	-47
	Gross margin	194,673	14,975	271,083	24,644	-39
Misc.	Other income	17,211	1,324	291,208	26,473	-95
	Fixed costs	5,608	431	15,007	1,364	-68
	Other expenses	-	-	2,601	236	-100
Household	Off-farm income	234,001	18,000	32,601	2,964	+84
	Household expenses	1,322,060	101,697	1,438,380	130,762	-22
	NET EARNINGS	**411,456**	**31,650**	**-257,178**	**-18,370**	**+158**
Change in assets and liabilities	*Loans/debts*	-1,000	-77	-46,800	-3,343	
	Fixed assets(Buying)	-	-	-	-	
Family labour	*Mandays*	318	24 ± (19)	638	58 ± (32)	
	NET EARNINGS PER MANDAY	**1,294**		**-403**		**+131**

As table 28 shows, CA farmers with no off-farm agricultural occupation income earned 25% more in the crop gross margin (in comparison to the crop margin of CA farmers, table 24). Likewise NON-CA farmers increased the crop gross margin in less quantity (11%). With regard to household expenses there are shifts for both groups of farmers. On the whole CA farmers spent 10% more than NON-CA farmers. However, when there was no off-farm agricultural occupation income NON-CA farmers spent a significant 22% more on household expenses.

The final net result for CA farmers remained almost identical as it was shown in the summary (table 24), as well as the net earnings per manday. Contrary, NON-CA farmers were unable of replacing effectively this lack of income. As consequence of this their final net result turned out to be negative.

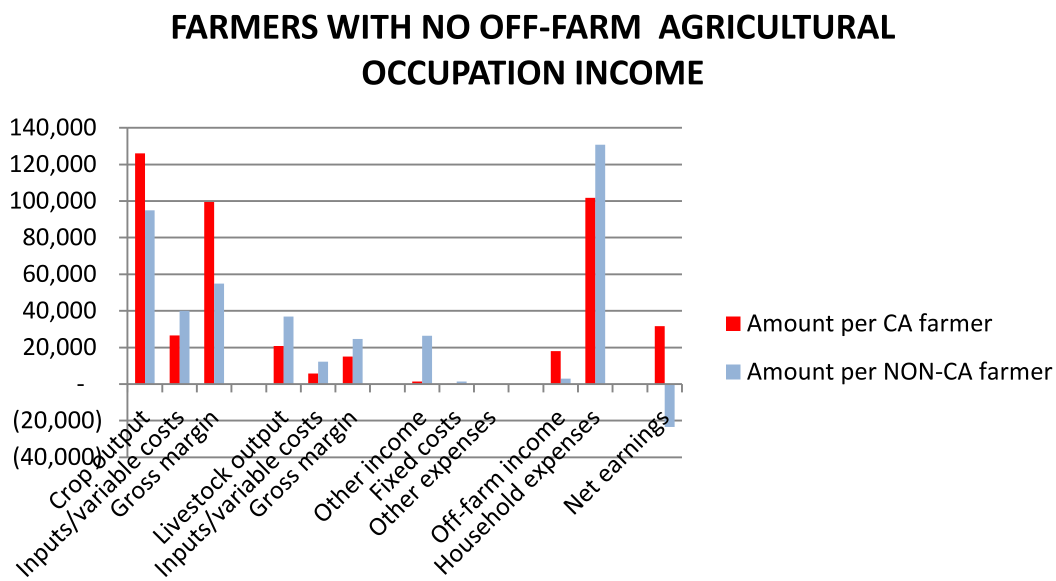

Fig. 18: Economic figures of those CA and NON-CA Farmers with NO Off-farm agricultural occupation

Figure 18 depicts the economic features of farmers with no off-farm agricultural occupation. Likewise to the livestock figures, differences in economic figures can be found among the two groups.

Table 29 shows that those CA households without any Off-farm agricultural occupation income presented a positive final economic balance, similar to the CA households with Off-farm agricultural occupation income. In order to cope with the lack of external income, farmers varied the crop production by focusing on tree crop production like coffee and on some cash crops such as tomatoes, groundnuts and water melon.

External labour cost was reduced by almost 63%. Household expenses declined 28% when compared to the whole group, and school feels seem to be the most affected expense category, as it dropped to 37% less than farmers with off-farm agricultural occupation. Expenditures for transport and meat were reduced by 23 and 17%, respectively.

Table 29: Economic figures (Kshs) of CA farmers with NO off-farm agricultural occupation and CA farmers WITH off-farm agricultural occupation.

CLASSIFICATION	ECONOMIC PARAMETERS	NO INCOME(13)		WITH INCOME(12)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	1,628,099	126,008	1,023,117	85,260	+32
	Inputs/variable costs	344,858	26,528	474,707	39,559	-33
	Gross margin	1,293,241	99,480	548,410	45,701	+54
Livestock	Livestock output	269,427	20,725	306,055	25,505	-19
	Inputs/variable costs	74,754	5,750	110,103	9,175	-37
	Gross margin	194,673	14,975	195,952	16,329	-8
Misc.	Other income	17,211	1,324	152,409	12,701	-90
	Fixed costs	5,608	431	15,259	1,272	-67
	Other expenses	-	-	86,002	7,167	-100
Household	Off-farm income	234,001	18,000	1,268,602	105,717	-83
	Household expenses	1,322,060	101,697	1,693,460	141,122	-28
	NET EARNINGS	**411,456**	**31,650**	**370,652**	**30,888**	**+3**
Change in assets and liabilities	*Loans/debts*	-1,000	-77	82,000	6,833	-
	Fixed assets(Buying)	-	-	-80,800	6,733	-
Family labour	*Mandays*	318	24 ± (19)	340	28 ± (17)	
	NET EARNINGS PER MANDAY	**1,294**		**1,090**		**+16**

A similar discussion is possible for the NON-CA farmers.

NON-CA farmers with no external agricultural occupation income had final negative net results. Conversely, NON-CA farmers with off-farm agricultural occupation had on average a net margin of 61,201 Kshs for their farms. The main difference between groups lied on the existence of the income studied. Despite the large deficit of NON-CA farmers, they grew largely uncommon crops within the District such as tomatoes and coffee.

Yet a slight increment is found with regard to livestock income. NON-CA farmers with no off-farm agricultural occupation earned on average 44% more with livestock output.

Table 30: Economic figures (Kshs) of NON-CA farmers with NO off-farm agricultural occupation and NON-CA farmers WITH off-farm agricultural occupation.

CLASSIFICATION	ECONOMIC PARAMETERS	WITH INCOME(14)		NO INCOME(11)		% Difference
		TOTAL	PER FARM	TOTAL	PER FARM	
Crop production	Crop output	908,339	64,881	1,044,324	94,939	-32
	Inputs/variable costs	385,746	27,553	440,405	40,037	-31
	Gross margin	522,593	37,328	603,919	54,902	-32
Livestock	Livestock output	290,597	20,757	405,887	36,899	-44
	Inputs/variable costs	134,404	9,600	134,804	12,255	-22
	Gross margin	156,193	11,157	271,083	24,644	-55
Misc.	Other income	4,507	322	291,208	26,473	-99
	Fixed costs	-	-	15,007	1,364	-100
	Other expenses	-	-	2,601	236	-100
Household	Off-farm income	1,251,202	89,372	32,601	2,964	+97
	Household expenses	1,077,680	76,977	1,438,380	130,762	-41
	NET EARNINGS	**856,807**	**61,201**	**-257,178**	**-18,370**	**+130**
Change in assets and liabilities	*Loans/debts*	-124,000	-8,857	-46,800	-3,343	
	Fixed assets(Buying)	-	-	-	-	
Family labour	*Mandays*	848	61 ± (28)	638	58 ± (32)	
	NET EARNINGS PER MANDAY	**1,010**		**-403**		**+140**

Unlike CA farmers without any off-farm agricultural occupation income, traditional farmers spent almost 41% more on household expenses in 2011 than the NON-CA farmers with income.

4.2.3. Economic assessment and discussion with regard to farm size

In this chapter economic characteristics of households with regard to specific parameters (livestock or off-farm income) have been discussed.

Hereunder the farmers are classified into different groups according to farm size. . The threshold selected for this classification was 2 acres.

Table 31: Summary of figures (Kshs) in Olympe for group of farmers holding less than 2 acres.

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS(13) TOTAL	CA FARMERS(13) PER FARM	NON-CA FARMERS(15) TOTAL	NON-CA FARMERS(15) PER FARM	% Difference
Crop production	Crop output	970,779	74,675	582,730	38,849	+48
	Inputs/variable costs	271,410	20,878	314,520	20,968	-0.5
	Gross margin	699,369	53,798	268,210	17,881	+67
Livestock	Livestock output	219,694	16,900	224,561	14,971	+11
	Inputs/variable costs	85,754	6,596	120,205	8,014	-18
	Gross margin	133,940	10,303	104,356	6,957	+32
Misc.	Other income	134,010	10,308	177,709	11,847	-13
	Fixed costs	11,608	893	1,009	67	+92
	Other expenses	86,002	6,616	2,604	174	+97
Household	Off-farm income	922,801	70,985	1,129,402	75,293	-6
	Household expenses	1,352,580	104,045	1,298,280	86,552	+17
	NET EARNINGS	**439,930**	**33,841**	**377,784**	**25,186**	**+26**
Change in assets and liabilities	*Loans/debts*	-	-	-5,700	-380	-
	Fixed assets(Buying)	-	-	-	-	-
Family labour	*Mandays*	290	22 ± (15)	712	47 ± (22)	-59
	NET EARNINGS PER MANDAY	**1,517**		**531**		**+65**

Table 31 shows the economic figures of farmers with less than 2 acres of farmland. Apparently, CA farmers reduced their household expenses by 13% in order to cope with their limitations on the crop outputs due to the farm size (30% lower than average, table 24). They had 15% more in off-farm income than the average. As result their net earnings were similar to the net results of the whole group. Due to the limited farm size the workload (mandays) was lower, giving as result an increment of the net earnings per manday by 21% compared to the average.

NON-CA farmers' net result was 18% lower than for the whole group (table 24). NON-CA farmers have as average more than 2 acres of farm size. Therefore farmers who hold smaller farms had worse net results than the average. Household, crop production and livestock were the most affected categories.

When it came exclusively to farm sizes above 2 acres traditional plots yielded more net earnings for the farmers than on CA plots. NON-CA farmers had on average a higher livestock gross margin and other incomes related to the farm. However, crop gross margin was identical for both groups of farmers. Apparently NON-CA farmers used their farm not only for crop production but also to diversify the income, once livestock output and other farm related incomes (e.g. sale of timber) were higher. CA farmers spent larger amounts of money on household expenses as they earned almost 23% more on crop gross margins than the average (table 24).

Table 32: Summary of figures (Kshs) in Olympe for group of farmers holding more than 2 acres.

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS(12) TOTAL	CA FARMERS(12) PER FARM	NON-CA FARMERS(10) TOTAL	NON-CA FARMERS(10) PER FARM	% Difference
Crop production	Crop output	1,690,887	140,907	1,526,787	152,679	-8
	Inputs/variable costs	548,154	45,680	570,552	57,055	-20
	Gross margin	1,142,733	95,228	956,235	95,624	-0.4
Livestock	Livestock output	355,787	29,649	522,075	52,208	-43
	Inputs/variable costs	99,104	8,259	183,003	18,300	-55
	Gross margin	256,683	21,390	339,072	33,907	-37
Misc.	Other income	35,609	2,967	123,006	12,301	-76
	Fixed costs	9,259	772	15,005	1,501	-49
	Other expenses	-	-	-	-	-
Household	Off-farm income	579,803	48,317	504,802	50,480	-4
	Household expenses	1,662,440	138,537	1,414,500	141,450	-2
	NET EARNINGS	**343,129**	**28,594**	**493,610**	**49,361**	**-42**
Change in assets and liabilities	*Loans/debts*	81,000	6,750	-166,800	-16,800	-
	Fixed assets(Buying)	81,400	6,783	-	-	-
Family labour	*Mandays*	368	31 ± (19)	772	77 ± (30)	-52
	NET EARNINGS PER MANDAY	**932**		**639**		**+31**

Overall, CA farmers had higher net earnings per manday than NON-CA farmers, although it is lower than the CA average (see table 24). This is due to the increment of the workload when the farm size exceeds the average size.

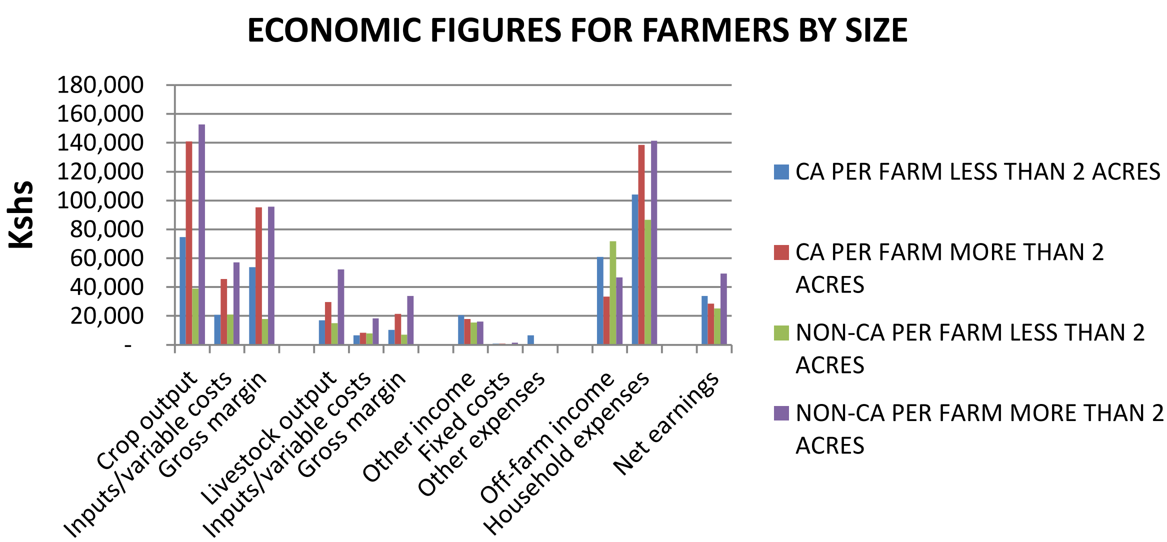

Fig. 19: Summary figures CA and NON-CA farmers classified by size

Figure 19 compares every economic figure of each farmer, for both less and more than 2 acres ownership. Seemingly small CA farmers, with less than 2 acres obtained higher net earnings than CA farmers with larger farms. This situation was different for the NON-CA farmers, who had better net results when their farm size exceeded 2 acres.

4.2.4. Assessment and discussion of a given scenario

Users of Olympe model are not only able to unravel all the economic figures which characterize all the farmers involved in the study, but also they could establish scenarios whereby certain parameters are set to "fluctuate" over time.

Soil erosion in this research has been studied following the ACED Method. It was concluded that CA reduced effectively soil losses on the plots studied for 2011. However, the influence of soil erosion on the cropping system for the coming years remains unknown. In this section of the chapter "discussion" a scenario will be set in order to enlighten the effects of soil erosion on the farmers' economic features over the next 10 years.

Due to soil losses, crop production (outputs) will be reduced by 1% annually in the case of CA farmers. In contrast to this percentage, NON-CA farmers will see their crop production decrease by 3% annually, as a result of soil erosion.

Table 33 shows annual distribution of the crop economic features as well as the final net results. The rest of economic figures remain as they were for 2011.

With soil productivity losses of 3% per year NON-CA farmers would have in 2020 major problems in their financial status. Due to the effectiveness of Conservation Agriculture in reducing the soil losses CA farmers would have almost the same final balance as they had for 2011. This scenario only pretends to give insight in the crop production variation over time, since it does not take into account the variations in the other economic parameters, such as livestock or household expenses.

Table 33: Economic figures (Kshs) of CA farmers and NON-CA farmers with annual reduction in the crop output of 1 and 3%, respectively.

CLASSIFICATION	ECONOMIC PARAMETERS	CA FARMERS(per farm)		NON-CA FARMERS(per farm)		% Difference (2020)
		2011	2020*	TOTAL	2020**	
Crop production	Crop output	106,467	96,287	84,381	62,224	+35
	Inputs/variable costs	32,783	32,783	35,403	35,403	-7
	Gross margin	73,684	63,504	48,978	26,821	+58
Livestock	Livestock output	23,019	23,019	29,865	29,865	-23
	Inputs/variable costs	7,394	7,394	12,128	12,128	-39
	Gross margin	15,625	15,625	17,737	17,737	-12
Misc.	Other income	6,785	6,785	12,029	12,029	-44
	Fixed costs	835	835	641	641	+23
	Other expenses	3,440	3,440	104	104	+97
Household	Off-farm income	60,104	60,104	65,368	65,368	-8
	Household expenses	120,621	120,621	108,511	108,511	+10
	NET EARNINGS	**31,302**	**21,202**	**34,856**	**12,699**	**+40**
Change in assets and liabilities	*Loans/debts*	3,240	-	-6,900	-	-
	Fixed assets(Buying)	-3,256	-	0	-	-
Family labour	*Mandays*	26 ± (18)	-	59 ±(29)	-	-56
	NET EARNINGS PER MANDAY	**815**		**215**		**+74**

*: Annual reduction of 1% in the crop outputs (during 9 years)

**: Annual reduction of 3% in the crop outputs (during 9 years)

If the family labour would remain in 2020 as it is given for 2011 the difference between CA and NON-CA farmers' net results would increase up to 74%.

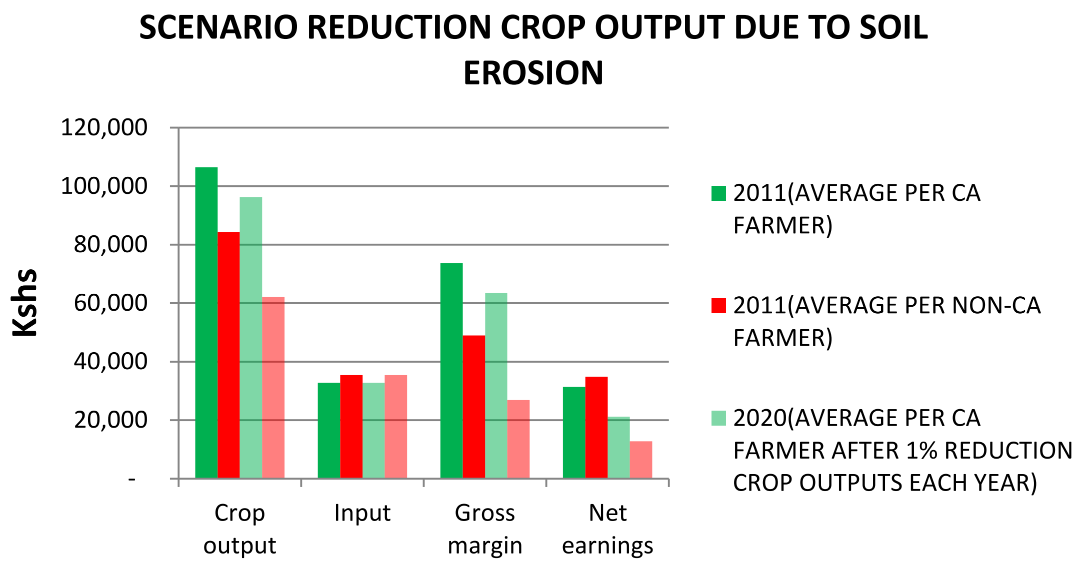

Fig. 20: Output, input, crop gross margin and net results for CA and NON-CA farmer, for 2011 and 2020 after consecutive reductions on crop outputs due to soil erosion (1 and 3% per year, respectively).

Figure 20 depicts the reduction of crop gross margin and total net results when soil erosion related productivity losses of 1 and 3% per year take place in the crop output of CA and NON-CA farmers, respectively.

5. CONCLUSIONS

This research has been undertaken within the framework of the CA2Africa project, aimed to address the socio-economic challenges on the CA adoption by smallholder farmers across Africa. However, I have studied not only the socio-economic constraints of a large group of farmers but also the physical impacts that CA as technique seems to have on the fields. Moreover, a detailed description on the farmers' perception is given in the appendix A.

The main research question was stated as:

"What are the economic, social and/or physical constraints that determine CA adoption among a group of 50 smallholder farmers in Western Kenya based on information provided by a detailed farm survey and analysed with Olympe model?"

The constraints at economic, social and physical level have been discussed throughout the report. Nevertheless, conclusions can be related to the main research question as they provide economic, social and physical evidences of the adoption of CA among farmers in Bungoma district. The following conclusions have been divided into two sections, related to the economic-physical and social findings on CA as practiced in Bungoma District, Western Kenya.

CONCLUSION WITH REGARD TO CA AS PRACTICED IN BUNGOMA DISTRICT:

- CA technique increased mainly maize, beans, bananas and groundnuts yields in 2011.
- Crop production value per acre was 30-35 % higher on CA plots than on NON-CA plots.
- Household expenses within CA households were 10% higher than among NON-CA farmers in 2011.
- When CA is applied livestock gross margin is slightly reduced (CA farmers pay less attention to their cattle performance).
- NON-CA farmers with little livestock output (e.g. no sale of milk) had on average 65% higher net results than farmers with livestock output, mainly due to both higher crop output and off-farm income. Conversely, CA farmers with almost no livestock output had lower net results than other CA farmers.
- Seemingly livestock income is more needed for CA farmers, even though their gross margin is lower than on NON-CA farmers.
- NON-CA farmers generated 14 % higher Off-farm income (from farm related earnings other than crop or livestock and off-farm agricultural occupation) than CA farmers.
- Despite this difference, NON-CA farmers largely depend on the Off-farm income, since farmers who lack of it displayed negative net results in Olympe model. In the case of CA farmers counting

or not on off-farm income almost does not differ in the final net results. Farmers without such income had on average higher crop gross margin and reduced the household expenses.

- Seemingly CA farmers yielded better net results when their farm size was constrained to 2 acres or below. This situation turns around for the NON-CA farmers, who had better net results when their farm size exceeded 2 acres.

- Soil erosion was minimized on CA plots.

- A scenario where the soil losses would affect upon NON-CA plots severer than CA plots would compromise the final net results of the farmers in a middle-long term.

CONCLUSION WITH REGARD TO FARMERS' PERCEPTIONS IN BUNGOMA DISTRICT:

- Farmers noticed an increment in their crop yields.

- Erosion was not a problem to consider in the future.

- CA improved the quality of the crop, especially for maize.

- The main reasons for the low adoption of CA were the high price of herbicides and lack of information and knowledge (knowhow).

- CA decreased the labour requirements.

- The use of herbicides was needed or even "mandatory" in order to undertake CA.

Likewise, I would like to include a few conclusions about the methodology which was used in this research.

CONCLUSION WITH REGARD TO METHODOLOGY:

- Data collection through farm survey often exhausted farmers. Farm surveys in further research should become more concise. Farmers tended to lose concentration from the half of the survey. Hence the reliability of the data given with this type of survey becomes a challenge. Another factor that may influence upon is the lack of experience of interviewers and lack of interview training before the survey.

- ACED Method is based on the erosion visible on the field. In order to undertake a more detailed analysis of the soil erosion diverse factors must be analysed in-situ, such as bulk density or sheet erosion.

- Certainly Olympe is an useful tool for the analysis of farming systems. However, Olympe software requires training and advanced knowledge. Furthermore Conservation Agriculture in this case study adopted a complicated shape once the large number of CA plots, NON-CA plots, crop systems and crop seasons added complexity to the analysis. It turned out that the economic labels contained in the model keep low resemblance with "real" economic parameters. Every economic parameter given by Olympe model had to be transformed to factual economic descriptions. Furthermore, diverse options in the model could not be explored due to some program limitations. Therefore, the Olympe's applicability to the case study was not in all aspects satisfactory.

6. RECOMMENDATIONS

Following the conclusions mentioned before, further research should count on interview training, as well as lesser extent of the farm survey once reliability of the data decreases when farmers start to lose the concentration. The physical analysis of the impact of CA on the farmland should follow a more exhaustive procedure, not only based on visible erosion as ACED method proposes.

The assessment of CA practices in Bungoma district should include different series of data obtained over time, once this analysis is due only for 2011. Another aspect to be considered is the impact of cover crops into the soil. This research assumes that the increment of the crop yields is due partially to the action of the cover crops into the soil (e.g. enhancement of the soil moisture). However, evidences of the improvement of soil structure (e.g. improvement of water retention) are yet to be addressed.

The use of herbicides is assumed by almost all the farmers to be “mandatory” for the adoption of CA. Further research should pay attention to the role of herbicides, and how they might influence on the adoption of CA at both field and farm level. A market analysis with regard to types, prices, and effectiveness might be very informative.

Finally, to be able to successfully apply Conservation Agriculture among farmers attention should also be paid to water harvesting schemes. The CA benefits on the farmland, as well as their consequences, constraints and future challenges are grosso modo well known. However, little is sofar done yet with regard to analysing effects of water harvesting, which may further enhance the benefits of CA techniques.

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APPENDIX A: FARMERS PERCEPTIONS ON CONSERVATION AGRICULTURE (CA) (Summary in Table 21).

ENQUERIES CONCERNING CONSERVATION AGRICULTURE:

1) Have the farmers who adopted CA practises observed an effect on: crop yield, weeding and cropping calendar?
2) Have farmers observed any change on soil erosion?
3) Does steepness influence upon erosion?
4) Have CA practises reduced the workload required?
5) How and where did you obtain your knowledge on CA?
6) What was the main reason for farmers' decision to adopt CA?
7) What are the disadvantages and advantages of CA?
8) Is the CA production sold out at higher prices?
9) Is there any increase in the crop quality?
10) With regard to adoption, what are the reasons for low adoption of CA in your region?
11) Why do not farmers apply CA technique in their whole farm?

Enquiries	CA FARMER 1: REACTIONS	
1	<u>Yield:</u> It's increasing (from 5 up to 15 bags of Maize per acre). <u>Weeding:</u> It takes less time. <u>Crop calendar</u>: Land preparation differs for CA plots because of use of herbicides.	
2	No erosion is observed in CA plots, although splash erosion remains visible in NON-CA plots. It is caused by method of preparation of the land.	
3	No changes are reflected.	
4	Less labour-intensive.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Increasing of crop yields.	
7	<u>Advantages:</u> - Increasing soil fertility - Decreasing soil erosion - it saves money(during land preparation)	<u>Disadvantages:</u> - Skills and knowledge are required for applying herbicide - Adequate management of CA tools and equipment is needed
8	No increase noticed.	
9	CA maize sets heavier grains. Grains are tastier when cooked.	
10	Lack of information and knowledge.	
11	Prohibitive prices of herbicides.	

Questions	CA FARMER 2: REACTIONS	
1	<u>Yield:</u> It's increasing (from 3 up to 10 bags of Maize per acre). <u>Weeding:</u> It takes less time; it is cheaper than conventional weeding. <u>Crop calendar</u>: No difference is perceived.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	Less labour-intensive.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Reduction in cost of labour.	
7	<u>Advantages:</u> - Increasing soil fertility. -Reduction of the cost of labour, especially when land preparation -Increasing crop yields.	<u>Disadvantages:</u> - Skills and knowledge are required for applying herbicide. - Cover crop requires labour to maintain itself at the ground level. - Jab planter and Ox planter requires perfect timing.
8	No increase noticed.	
9	No difference is observed.	
10	Lack of information and knowledge.	
11	Prohibitive prices of herbicides.	

Questions	CA 3 REACTIONS	
1	Yield: It has been improved. Weeding: It takes less time. Crop calendar: No difference is observed.	
2	No erosion is observed in CA plots. However little erosion remains visible in NON plots because of ploughing method. Risk of runoff damaged after planting is increased.	
3	No changes are reflected.	
4	Less labour-intensive.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Improvement of soil structure.	
7	Advantages: -Soil moisture has been improved. -Significant soil structural improvement has been observed.	Disadvantages: - Cover crops do not provide any use other than improving soil fertility. - Despite the use of herbicides the weeding of the plots yet need to be done.
8	No increase noticed.	
9	There is a significant improvement of crop performance.	
10	Lack of information and knowledge	
11	Not enough capital to purchase herbicides.	

Questions	CA 4 REACTIONS	
1	Yield: It's increasing over time (from 3 up to 10 bags of Maize per acre.) Weeding: It takes less time. Crop calendar: No difference is observed.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots.	
3	No changes are reflected.	
4	CA releases labour force.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Increasing of crop yields.	
7	Advantages: - Increasing soil fertility. -Reduction in the cost of labour	Disadvantages: - Soil acidity drops and pH goes down because of application of herbicides.
8	No increase noticed.	
9	There is an appreciable improvement of taste (in maize). CA crops perform better than NON-CA crops.	
10	Lack of information and knowledge	
11	Prohibitive prices of herbicides.	

Questions	CA 5 REACTIONS	
1	Yield: It's increasing over time. Weeding: It takes less time. Crop calendar: No difference is observed.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots.	
3	No changes are reflected.	
4	CA releases labour force.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Increasing of crop yields.	
7	Advantages: - Cover crops improve soil fertility and soil moisture	Disadvantages: - CA technique requires proper management skills in order to handle jab planter or any other equipment
8	Farmer sells CA maize production at 75% higher price than NON-CA maize.	
9	There is an appreciable improved taste (maize). Crop is taller and remains healthier	
10	Lack of information, knowledge	
11	Farmer does not extend CA because of the distance from the household to the other plots he owns. It becomes easier to follow traditional agriculture in those.	

Questions	CA 6 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is observed.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach three years ago(1 year training).	
6	Increment of soil moisture in the field.	
7	Advantages: - Soil moisture is improved, as well as soil fertility.	Disadvantages: - Cover crops need of two or three years to produce eatable grains.
8	No increase noticed.	
9	There is an appreciable improvement of the taste (coffee). CA crops perform better than NON-CA crops.	
10	Lack of information and skills.	
11	Farmer does not dare to adopt CA in all the plots because of his lack of skills.	

Questions	CA 7 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: Crop activities in CA plots can be moved along once soil moisture remains over time.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots , especially during land preparation and weeding.	
3	No changes are reflected.	
4	It releases labour force	
5	Facilitator: Farmer was trained in CA technique by ACT Network, FAO and KARI 4 years(2 years training).	
6	Increment of soil fertility in the field.	
7	Advantages: - Enhancement of soil moisture. - Cover crops improve the soil structure. - Soil fertility is also improved.	Disadvantages: - The use of chemicals is a source of contamination. - Effectiveness of CA technique is only visible after a few years since the adoption. - CA technique needs to be properly managed, therefore good skills are highly required.
8	No increase noticed.	
9	There is an appreciable improved of the taste in the maize. CA crops perform better than NON-CA crops.	
10	High cost of chemicals, as well as lack of information. Common policy at higher levels is needed.	
11	High cost of herbicides.	

Questions	CA 8 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is observed.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach three years ago(2 year training).	
6	Increment of soil fertility in the field.	
7	Advantages: - Soil fertility is improved.	Disadvantages: - The use of chemicals is expensive and risky.
8	No increase noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of information and skills.	
11	High cost of herbicides.	

Questions	CA 9 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is noticed.	
2	No erosion is observed in CA plots. Splash erosion remains visible in NON CA plots, although is considered not important.	
3	No changes are reflected.	
4	It releases labour force	
5	Facilitator: Farmer was trained in CA technique by ACT Network, FAO and KARI 4 years ago(2 years training).	
6	Increment of yields.	
7	Advantages: - Soil moisture is improve. - Soil fertility is also enhanced.	Disadvantages:
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge, information.	
11	High cost of herbicides.	

Questions	CA 10 REACTIONS	
1	Yield: It's increasing over time(from 8 up to 25 bags of maize per acre) Weeding: It demands less time. Crop calendar: No difference is observed.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach three years ago(2 full days training).	
6	Increment of yields.	
7	Advantages:	Disadvantages:
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge, information.	
11	Lack of skills for up-scaling.	

Questions	CA 11 REACTIONS
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is observed.
2	No erosion is observed in both CA and NON-CA plots.
3	No changes are reflected.
4	It releases labour force.
5	Facilitator: Farmer was trained in CA technique by ACT Network, FAO and KARI 4 years ago (2 years training).
6	Increment of yields.
7	Advantages: - Soil moisture is improved - Soil fertility is also enhanced. Disadvantages: - CA requires being skilled.
8	No difference is noticed.
9	CA crops perform better than NON-CA crops.
10	Lack of knowledge and information. The fact of preparing the land without ploughing discourages farmers to take on CA technique.
11	High cost of herbicides.

Questions	CA 12 REACTIONS
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is observed.
2	No erosion is observed in CA plots. Because of ploughing, soils may be washed away after heavy rains when planted.
3	No changes are reflected.
4	It releases labour force
5	Facilitator: Farmer was trained in CA technique by ACT Network, FAO and KARI 2 years ago(2 weeks training).
6	Increment of yields.
7	Advantages: - Soil moisture is improved. - Soil fertility is also enhanced. Disadvantages:
8	No difference is noticed.
9	Crop is healthier and grains are heavier than NON-CA (maize).
10	Lack of knowledge and information. The fact of preparing the land without ploughing discourages farmers to take on CA technique.
11	Farmer would like to wait and see better results (yields) before up scaling.

Questions	CA 13 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference is observed.	
2	In case of existence any soil erosion prior to CA technique adoption has been minimized.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach 1.5 years ago (1 year training).	
6	Increment of yields.	
7	Advantages: - Soil moisture is improved. - Soil fertility is also enhanced.	Disadvantages: - CA requires being skilled.
8	No difference is noticed.	
9	No difference is observed at this time of the year.	
10	Farmers' awareness is growing. It will take some time before spread adoption.	
11	Farmer is expectant to see first results. Afterwards CA is thought to be extended.	

Questions	CA 14 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference noted.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force	
5	Farmer was trained using FFS approach 3 years ago(6 months training).	
6	Increment of soil fertility.	
7	Advantages: - It saves money expended during land preparation	Disadvantages: - Lack of knowledge in the use of chemicals - Effectiveness of herbicides remains unknown
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge and information.	
11	High cost of herbicides.	

Questions	CA 15 REACTIONS	
1	Yield: It's increasing over time Weeding: It demands less time Crop calendar: No difference is observed.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force. Farm management becomes easier.	
5	Farmer was trained using FFS approach 3 years ago(2 years training).	
6	Increment of soil fertility.	
7	Advantages: - Soil fertility is improved.	Disadvantages: - Cover crop germination has poorly been satisfactory. Check and testing of seeds are highly needed.
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge and information.	
11	Farmer wants to check whether yields increase as expected. Afterwards CA is thought to be up scaled.	

Questions	CA 16 REACTIONS	
1	Yield: It's under estimation Weeding: Not known yet. Crop calendar: No difference is noticed.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It seems it releases labour force.	
5	Farmer was trained in CA technique by briefly to facilitator for 2 hours.	
6	Possibility of having higher yields.	
7	Advantages: - Money saving during land preparation	Disadvantages:
8	No difference is noticed yet.	
9	No difference is noticed yet.	
10	Lack of knowledge and information.	
11	Farmer will upscale up to 1 acre coming season.	

Questions	CA 17 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time. Crop calendar: No difference noted.	
2	Soil erosion has been reduced in the CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach 3 years ago (1 day training).	
6	Increment of crop yields	
7	Advantages: - Soil moisture is improved. - Labour released saves money during weeding	Disadvantages: - High cost of inputs like chemicals
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge and information. It needs time to be spread and adopted.	
11	High cost of chemicals.	

Questions	CA 18 REACTIONS	
1	Yield: It's increasing over time Weeding: It demands less time Crop calendar: No difference is noted.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach 3 years ago (2 years training).	
6	Increment of crop yield.	
7	Advantages: - Soil fertility is improved. - Release of labour force allows saving money.	Disadvantages: - High cost of chemicals.
8	No difference is noticed.	
9	CA crops perform better than NON-CA crops.	
10	Lack of knowledge and information.	
11	Farmer is about to implement CA in the whole farm.	

Questions	CA 19 REACTIONS	
1	Yield: It's increasing over time Weeding: It demands less time Crop calendar: No difference is noticed.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach 3 years ago(2 day training).	
6	Increment of soil fertility.	
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased.	Disadvantages: - High cost of chemicals
8	No difference is noticed.	
9	Not remarkable difference is noticed yet.	
10	Lack of knowledge and information. Technique is yet to be spread across the district.	
11	Farmer wants to check whether yields increase as expected. Afterwards CA is thought to be up scaled.	

Questions	CA 20 REACTIONS	
1	Yield: It's increasing over time. Weeding: It demands less time Crop calendar: No difference is noticed.	
2	Soil erosion has been prevented and reduced to the minimum.	
3	No changes are reflected.	
4	It releases labour force.	
5	Facilitator: Farmer was trained in CA technique by ACT Network, Kari and FAO 3 years ago(2 years training).	
6	Increment of crop yield.	
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased. - It saves money during the weeding.	Disadvantages: - CA technique for being understood requires some time in training and implementation. Positive results are not instantaneous.
8	No difference is noticed.	
9	Not remarkable difference is observed.	
10	Lack of knowledge and information. Technique is yet to be spread across the district.	
11	Farmer would like to adopt CA in the whole farm. However high prices of chemicals are a barrier yet to overcome.	

Questions	CA 21 REACTIONS	
1	Yield: It's increasing over time Weeding: It demands less time Crop calendar: No difference is noticed.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained using FFS approach 3 years ago(2 years training).	
6	Increment of soil fertility.	
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased. - CA maize resists better to pest and other diseases.	Disadvantages:
8	No difference is noticed.	
9	CA crops perform well. Seemingly CA crop quality is better in general.	
10	Lack of knowledge and information. Farmers' bad attitude difficult adoption.	
11	High cost of chemicals is prohibitive.	

Questions	CA 22 REACTIONS
1	Yield: It's increasing over time Weeding: It demands les time Crop calendar: No difference is noticed.
2	No erosion is observed in both CA and NON-CA plots.
3	No changes are reflected.
4	It releases labour force.
5	Farmer was trained using FFS approach 3 years ago(2 years training).
6	Increment of soil fertility.
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased. -It saves money during land preparation. Disadvantages: - Use of chemicals requires a proper management. When mismanagement contamination in the neighbour's parcel may appear.
8	No difference is noticed.
9	Crop performance of CA crops is remarkably better than in NON-CA plots.
10	Lack of knowledge and information.
11	High price of chemicals.

Questions	CA 23 REACTIONS
1	Yield: It's increasing over time. (i.e.. from 7 up to 17 bags of maize per acre) Weeding: It demands less time Crop calendar: No difference is noticed.
2	Little erosion observed in plots has now been prevented.
3	No changes are reflected.
4	It releases labour force.
5	Farmer was trained using FFS approach 3 years ago(2 days training).
6	Increment of soil fertility.
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased. Disadvantages: - For the success of CA is needed good quality of seeds, specific equipment and inputs like chemicals. All these requirements difficult adoption.
8	No difference is noted.
9	Maize production results in heavier grains and healthier state.
10	Lack of knowledge and information.
11	Disadvantages cited previously discouraged farmer to upscale.

Questions	CA 24 REACTIONS	
1	Yield: It's increasing over time Weeding: It demands less time Crop calendar: No difference noted.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained in CA technique by FFS 3 years ago for 2 years. Currently the farmer works as facilitator.	
6	Increment of soil fertility.	
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased. - As consequence of the reduction of labour, money is saved.	Disadvantages: - High cost of chemicals - Need of addressing the effectiveness of chemicals
8	No difference is noted.	
9	Grains are heavier, crops seem to be healthier. Grains taste has been apparently improved.	
10	Lack of knowledge and information. Besides the lack of capital to afford inputs can influence negatively in adoption.	
11	Lack of capital to afford chemicals.	

Questions	CA 25 REACTIONS	
1	Yield: It's increasing over time(i.e. maize production went from 11 up to 14 bags) Weeding: It demands less time Crop calendar: No difference is noted.	
2	No erosion is observed in both CA and NON-CA plots.	
3	No changes are reflected.	
4	It releases labour force.	
5	Farmer was trained in CA technique by FFS 3 years ago2 years training). Currently farmer works as facilitator.	
6	Increment of soil fertility.	
7	Advantages: - Soil moisture is enhanced. - Soil fertility is increased.	Disadvantages:
8	No difference is noted.	
9	CA crop performance is improved. Apparently the superior quality of grains is manifested when cooking.	
10	Lack of knowledge and information. Farmers have the impression CA is tedious and very time consuming.	
11	Farmer wants to transform the whole farm into CA within 2-3 years.	

APPENDIX B: SURVEY FORM USED

Conservation Agriculture in AFRICA: Analysing and Foreseeing its Impact - Comprehending its Adoption

FARMING SYSTEMS SURVEY IN EAST AFRICA (FOR OLYMPE DATA ANALYSIS)

Survey identification

Country: ………………….

Area: …………………. Date ……../………/…………

Farm number: ....

Name of the enumerator: ....

Farmer's name: ....

Address: ...., ... (Village)

Type of farming-system(s) (main crops) ...., ………………………

Code of System …… ……………………., ……………………….

(livestock) ……………………, ……………………

In case farmer practices CA, how many years ago did he start?………… years

On how many plots does he/she practices CA now? …………. plots

On how much land in total? …….. ha

And what are the specific practices he applies for CA, which are not applied conventionally:

With regard to tillage: ………………………………………………………..

With regard to cover: ………………………………………………………..

With regard to weed management: ……………………………………………….

With regard to rotations: ………………………………………………………..

Farm number: ....

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1. **Farm household characteristics**

HH member	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Relation to Head								
Gender								
Age								
Years of education								
Still on school								
Years in farming								
Off-farm income								
Main activity								
No days per year								
Estim. Net income / month/year 1000 Shs								
Other activity								
No days per year								
Estim. Net income / month/year 1000 Shs								

Codes: (specify whether income is per month or per year, by striking through the other option)
Off-farm activities: 1 = Farm labour…….; 2 = Forestry labour……; 3 = Fishing………………
4 = Handicraft………; 5 = Commerce/ shop…..; 6 = Industry………………
7 = Transport ……….;8 = Government……….; 9 = Pension………………

- <u>Permanent workers:</u>
How many members of the family take part permanently in the farm's activities? …….
How many permanent workers? ……….
Monthly salary of permanent worker? ……….
- <u>Seasonal workers:</u>
Did you employ seasonal workers over the last year? This is to be verified by details in section 5b.

month	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
Mandays												
Cost												

Add some additional qualitative questions on households, off-farm income, etc.

What has been the main strategy of the farm household: ……………………………………………….

What have been major constraints in farming business: ……………………………………………….

What will be its main strategy in the near future (next 3-5 yrs): ……………………………………….

What will be the major constraints in the near future: ………………………………………………….

2. **Farm land** (by parcel = area with same physical features and tenure)

Parcel number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Size (acres or ha)								
Land tenure (code)								
How many years								
Rental paid								
Rental received								
Soil type (code)								
Estim. Soildepth (cm)								
Soil fertility (code)								
Slope of parcel								
Erosion features								
Result ACED								
Soil & Water Cons.								
Irrigation								
CA practiced?								
Crops in rotation								
This year/this season								
Main intercrop								
This year/prev. season								
Intercrop								
Last year & season								
Intercrop								
Last year/prev. season								
Intercrop								

Codes: Land tenure**:** 1 = Owned ; 2 = Rented ; 3 = Share cropped ; 4 = ...
Soil type: 1 = ...; 2 = ...; 3 = ...; 4 = ...
Soil fertility: 1 = ...; 2 = ...; 3 = ...; 4 = ...
Slope parcel: 1 = ...; 2 = ...; 3 = ...; 4 = ...
Erosion: 1 = ...; 2 = ...; 3 = ...; 4 = ...
SWC: 1 = ...; 2 = ...; 3 = ...; 4 = ...
Irrigation: 1 = ...; 2 = ...; 3 = ...; 4 = ...

Farm map, with farming house, roads and parcels (with numbers)

3. **Livestock (and changes over past year)**

Code for type	**1**	**2**	**3**	**4**	**5**	**6**	**x ***
Type	Draft cattle	Dairy cattle	Other cattle	Pigs	Sheep	Goats	……..
Race							
Actual no. male adult							
Idem female adult							
Idem young animals							
Type of ownership							
Changes over year							
No. born							
No. self-consumed							
No. lost							
No. sold							
Average price							
Period of sales							
No. bought							
Average price							
Period of purchase							

* Others could be chicken, geese, horse, donkey, rabbit, etc. Chose codes

Codes 1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..
1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..

4. **Buildings, machinery, equipment, tools and means of farm transport**

(Indicate separately which items were added this year, and which were already there before)

Code for type	**1**	**2**	**3**	**4**	**5**	**6**	**x***
	This last year		**In the previous years**				
Type * **Costs in 1000 Shs**							
Number built/bought							
Number sold this year							
Year(s) built / bought							
Price (average)/value							
Years to be used							
Final (sales) value							
Ann. costs of repair & maintenance							
Annual fuel costs							

* Others could be (moto)bikes, wheelbarrow, etc. Chose codes

Codes: 1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..
1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..

Farm number: ....

5a Cropping and material inputs per season [Second sheet for previous season]

Parcel number	1	2	3	4	5	6	7	8
Main crop A								
Intercrop B								
Intercrop C								
Inputs (Costs in Shs)								
Qt **Seeds/**plants crop A								
Costs of seeds/pl A								
Qt Seeds/plants crop B								
Costs of seeds/pl B								
Qt Seeds/plants crop C								
Costs of seeds/pl C								
Type of fertiliser 1								
Quantity of fertilizer1								
Price/unit fertilizer 1								
Type of fertiliser 2								
Quantity of fertilizer2								
Price/ unit fertilizer 2								
Type of fertiliser 3								
Quantity of fertilizer3								
Price/ unit fertilizer 3								
Pesticide/ Insecticide type 1								
Costs of pesticide 1								
Pesticide type 2								
Costs of pesticide 2								
Herbicides 1								
Costs of herbicides 1								
Herbicides 2								
Costs of herbicides 2								
Type **small material** 1								
Costs small material 1								
Type small material 2								
Costs small material 2								
Other inputs 1								
Costs of other inputs 1								
Other inputs 2								
Costs of other inputs 2								
Mulch material Qt								
Value mulch material								
In case PERENNIAL								
Av. Age of perennials								
Approx. No of trees								
Initial establ. Costs								
Estimated lifetime (yrs)								
Total estimated costs								

Codes: 1 = ……………..; 2 = ……………..; 3 = ………………; 4 = ………………..

Farm number: ....

5b Cropping and labour inputs per season [Second sheet for previous season]

Parcel number	1	2	3	4	5	6	7	8	Percentage
All in hours (1 full day = 7 hours)									**O**wn/**Perm/ S**eas.labour
Land preparation									
No of ploughing turns									
Total ploughing hours									
Ripping & seeding									
Seeding/planting crop A									
Seeding/planting crop B									
Seeding/planting crop C									
Applying mulch									
No of times weeding									
Total weeding hours									
Fertilisation Type 1									
Fertilisation Type 2									
Fertilisation Type 3									
Manuring									
Spraying pesticides 1									
Spraying pesticides 2									
Applying herbicides									
....									
Harvesting crop A									
Harvesting crop B									
Harvesting crop C									
On-farm processing A									
On-farm processing B									
On-farm processing C									

Codes: : 1 = ...; 2 = ...; 3 = ...; 4 = ...
1 = ...; 2 = ...; 3 = ...; 4 = ...

Cropping calendar: show start and finish of (seasonal) crop cycles per crop (on respective parcels)

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

5c Cropping and outputs per season [Second sheet for previous season]

Parcel number	1	2	3	4	5	6	7	8
Quantities in Kg; farmgate price in Shs								
Main product A								
Amount harvested								
Amount consumed								
Amount sold								
Price main product A								
Byproduct A								
Amount harvested								
Perc. Sold								
Price Byproduct A								
Main product B								
Amount harvested								
Amount consumed								
Amount sold								
Price main product B								
Byproduct B								
Amount harvested								
Perc. Sold								
Price byproduct B								
Main product C								
Amount harvested								
Amount consumed								
Amount sold								
Price main product C								
Byproduct C								
Amount harvested								
Perc. Sold								
Price byproduct C								
Total prod. value(Shs)								

Codes: 1 = ...; 2 = ...; 3 = ...; 4 = ...
1 = ...; 2 = ...; 3 = ...; 4 = ...

Notes/details

6. **Livestock inputs and outputs (over past year, if not stated otherwise)**

Code for type	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Type **Material inputs**	Draft cattle	Other cattle	Pigs	Sheep	Goats	Chicke n	……..
No of days grazing							
No of days stall-fed							
Cost concentrates/week: Shs							
Cost of hay, etc./week: Shs							
Cost veterinary drugs/year Shs							
Other costs:…….. Shs per ……							
Other: ……….. Shs per …….							
Labour inputs							
Herding hours per week (split up over the types of livestock)							
Feeding hours per week (idem)							
Milking hours per week (idem)							
No of days used per draft/year							
No of hours draft per day (av)							
Outputs							
Manure used for own fields							
Qt manure sold/month: (state in what unit) ………………							
Av. Price of manure (Shs/……..)							
No. of days/year **milk** produced							
Qt. milk produced/day (av. in lt)							
Perc. of milk sold (av.)							
Av. Milk price received: Shs/lt							
No. of days/year **eggs** produced							
No of eggs produced per day							
Perc. of eggs sold (av.)							
Av. Price received per egg: Shs							
Room for other product							

Codes: 1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..
1 = ………………; 2 = ………………; 3 = ……………….; 4 = ………………..

Notes/details (e.g. Draft cattle could be hired in or hired out: in case important costs or revenues indicate that information)

7. Household expenses (for whole family over past year period)

Type of expenses	Frequency	Purchase value or costs	Source	Notes
School fees	Annual			
Taxes	Annual			
Membership associations, etc	Annual			
Clothes and shoes	Annual			
Health (medicines)	Annual			
Washing ingredients (soap, etc.)	....			
Major staple food :	Weekly			
Other staple food (rice, maize, rootcrops)	Weekly			
Vegetables	Weekly			
Meat and fish	Weekly			
Food ingredients (salt, oil, etc)	Weekly			
Transport (to market, etc.)	Weekly			
Weddings and funerals	Annual			
Other regular expenses	Weekly			
	Weekly			
Other extraordinary expenses	Annual			
	Annual			

8. Capital situation (investments, loans, subsidies and transmittals)

Type of transaction	Purpose	**Period** (Start and repayment)	Amount Shs	Interest Rate (yearly)	Notes
Investments last year					
Credit and loans					
Transmittals					

Do you have a bank account? Yes / No Since which year? .... Where? ....

Do you have enough savings in bank to cater for a year without any production? Yes/ Possibly / No

APPENDIX C: TOTAL FIGURES PER FARMER

CA FARMERS

CA FARMER 1: ROSA SIKANGULULE

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans	***Crop production***	Crop output	9,900
		Inputs/variable costs	6,060
		Gross margin	3,840
Number of parcels:2	***Livestock***	Livestock output	10,700
		Inputs/variable costs	2,500
		Gross margin	8,200
Average plot size(acres): 0.1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members: 7	***Household***	Off-farm income	-
		Household expenses	38,940
		NET EARNINGS	**-27,000**
Number of livestock: 14	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	16
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 2: WILLIAM MAKOLO

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans	***Crop production***	Crop output	-
		Inputs/variable costs	9,345
		Gross margin	-9,345
Number of parcels:2	***Livestock***	Livestock output	600
		Inputs/variable costs	-
		Gross margin	600
Average plot size(acres):0.5	***Misc.***	Other income	-
		Fixed costs	1,201
		Other expenses	-
Family members:12	***Household***	Off-farm income	-
		Household expenses	44,000
		NET EARNINGS	**-53,946**
Number of livestock:6	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	10
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 3: ALFRED MALUANDA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, lablab	***Crop production***	Crop output	29,702
		Inputs/variable costs	9,324
		Gross margin	20,378
Number of parcels: 2	***Livestock***	Livestock output	-
		Inputs/variable costs	600
		Gross margin	-600
Average plot size(acres): 0.8	***Misc.***	Other income	-
		Fixed costs	1,801
		Other expenses	-
Family members: 7	***Household***	Off-farm income	-
		Household expenses	110,000
		NET EARNINGS	**-92,022**
Number of livestock: 10	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	19
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 4: EVANS MANJALA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, sugarcane	***Crop production***	Crop output	18,402
		Inputs/variable costs	22,274
		Gross margin	-3,872
Number of parcels: 2	***Livestock***	Livestock output	6,000
		Inputs/variable costs	16,100
		Gross margin	-10,100
Average plot size(acres): 0.4	***Misc.***	Other income	-
		Fixed costs	1,001
		Other expenses	42,000
Family members: 5	***Household***	Off-farm income	180,000
		Household expenses	27,020
		NET EARNINGS	**96,008**
Number of livestock: 15	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	24
		NET EARNINGS PER FAMILY MANDAY	**4,000**

CA FARMER 5: KEN BARASA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, lablab, banana, mukuna	***Crop production***	Crop output	13,350
		Inputs/variable costs	4,473
		Gross margin	8,877
Number of parcels:2	***Livestock***	Livestock output	32,250
		Inputs/variable costs	1,250
		Gross margin	31,000
Average plot size(acres):0.3	***Misc.***	Other income	-
		Fixed costs	2,000
		Other expenses	-
Family members:5	***Household***	Off-farm income	-
		Household expenses	27,380
		NET EARNINGS	**10,500**
Number of livestock:13	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	14
		NET EARNINGS PER FAMILY MANDAY	**750**

CA FARMER 6: ISAIAH MUCHOMA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, coffee, lablab	***Crop production***	Crop output	123,000
		Inputs/variable costs	16,374
		Gross margin	106,626
Number of parcels:2	***Livestock***	Livestock output	-
		Inputs/variable costs	2,000
		Gross margin	-2,000
Average plot size(acres):2	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:10	***Household***	Off-farm income	-
		Household expenses	82,100
		NET EARNINGS	**22,526**
Number of livestock:8	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	- 600
	Family labour	*Mandays*	20
		NET EARNINGS PER FAMILY MANDAY	**1,126**

CA FARMER 7: HELLEN MARIBU

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, lablab	***Crop production***	Crop output	216,000
		Inputs/variable costs	129,180
		Gross margin	86,820
Number of parcels:2	***Livestock***	Livestock output	85,710
		Inputs/variable costs	10,000
		Gross margin	75,710
Average plot size(acres): 3.25	***Misc.***	Other income	-
		Fixed costs	6,751
		Other expenses	-
Family members:6	***Household***	Off-farm income	60,000
		Household expenses	167,800
		NET EARNINGS	**47,979**
Number of livestock:17	***Change in assets and liabilities***	*Loans/debts*	82,000
		Fixed assets(Buying)	-80,800
	Family labour	*Mandays*	19
		NET EARNINGS PER FAMILY MANDAY	**2,525**

CA FARMER 8: JUSTIN NALIAKA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, lablab	***Crop production***	Crop output	6,010
		Inputs/variable costs	11,130
		Gross margin	-5,120
Number of parcels:2	***Livestock***	Livestock output	108,000
		Inputs/variable costs	19,800
		Gross margin	88,200
Average plot size(acres):0.5	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:5	***Household***	Off-farm income	24,000
		Household expenses	44,860
		NET EARNINGS	**62,221**
Number of livestock:9	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	13
		NET EARNINGS PER FAMILY MANDAY	**4,786**

CA FARMER 9: SAMSOM WEKESA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts	***Crop production***	Crop output	29,002
		Inputs/variable costs	18,323
		Gross margin	10,679
Number of parcels: 2	***Livestock***	Livestock output	-
		Inputs/variable costs	4,000
		Gross margin	-4,000
Average plot size(acres): 0.5	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	40,000
Family members: 6	***Household***	Off-farm income	106,800
		Household expenses	66,500
		NET EARNINGS	**6,980**
Number of livestock: 1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	23
		NET EARNINGS PER FAMILY MANDAY	**303**

CA FARMER 10: SELINA MASON			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts, sugarcane, sweet potatoes	***Crop production***	Crop output	347,002
		Inputs/variable costs	43,683
		Gross margin	303,319
	Livestock	Livestock output	21,600
		Inputs/variable costs	8,000
		Gross margin	13,600
Number of parcels: 2	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Average plot size(acres): 3.5	***Household***	Off-farm income	120,000
		Household expenses	416,600
		NET EARNINGS	**20,319**
Family members: 8	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	66
Number of livestock: 2		NET EARNINGS PER FAMILY MANDAY	**308**

CA FARMER 11: JAPHETHER WEKESA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts,bananas	***Crop production***	Crop output	25,002
		Inputs/variable costs	30,883
		Gross margin	-5,881
Number of parcels:3	***Livestock***	Livestock output	12,168
		Inputs/variable costs	1,500
		Gross margin	10,668
Average plot size(acres): 0.6	***Misc.***	Other income	134,000
		Fixed costs	-
		Other expenses	-
Family members:11	***Household***	Off-farm income	60,000
		Household expenses	116,480
		NET EARNINGS	**82,306**
Number of livestock:6	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	15
		NET EARNINGS PER FAMILY MANDAY	**5,487**

CA FARMER 12: ENOS WALELA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts,	***Crop production***	Crop output	7,000
		Inputs/variable costs	29,173
		Gross margin	-22,173
Number of parcels: 2	***Livestock***	Livestock output	12,168
		Inputs/variable costs	6,200
		Gross margin	5,968
Average plot size(acres):0.3	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:6	***Household***	Off-farm income	144,000
		Household expenses	114,400
		NET EARNINGS	**13,396**
Number of livestock:4	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	40
		NET EARNINGS PER FAMILY MANDAY	**335**

CA FARMER 13: RICHARD WANDERA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts, sweet potatoes and sugarcane	***Crop production***	Crop output	84,000
		Inputs/variable costs	53,494
		Gross margin	30,506
Number of parcels:3	***Livestock***	Livestock output	900
		Inputs/variable costs	3,000
		Gross margin	-2,100
Average plot size(acres): 2	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:9	***Household***	Off-farm income	36,000
		Household expenses	58,400
		NET EARNINGS	**6,009**
Number of livestock:17	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	26
		NET EARNINGS PER FAMILY MANDAY	**233**

CA FARMER 14: COSMAS KAHEMBA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts, sugarcane, smodium	***Crop production***	Crop output	113,701
		Inputs/variable costs	34,243
		Gross margin	79,458
Number of parcels: 3	***Livestock***	Livestock output	86,400
		Inputs/variable costs	5,000
		Gross margin	81,400
Average plot size(acres):2.5	***Misc.***	Other income	10,000
		Fixed costs	500
		Other expenses	-
Family members:11	***Household***	Off-farm income	18,000
		Household expenses	183,880
		NET EARNINGS	**4,479**
Number of livestock:13	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	14
		NET EARNINGS PER FAMILY MANDAY	**320**

CA FARMER 15: SUSSY KIBUYI			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, smodium, groundnuts, sweet potatoes, sugarcane	***Crop production***	Crop output	54,002
		Inputs/variable costs	17,684
		Gross margin	36,318
Number of parcels:3	***Livestock***	Livestock output	32,200
		Inputs/variable costs	15,000
		Gross margin	17,200
Average plot size(acres): 0.7	***Misc.***	Other income	6,400
		Fixed costs	-
		Other expenses	-
Family members:5	***Household***	Off-farm income	65,000
		Household expenses	194,520
		NET EARNINGS	**-69,602**
Number of livestock:12	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	32
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 16: ADELIDE AKABI			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, smodium, sugarcane,	***Crop production***	Crop output	126,602
		Inputs/variable costs	73,454
		Gross margin	53,148
Number of parcels: 3	***Livestock***	Livestock output	12,000
		Inputs/variable costs	500
		Gross margin	11,500
Average plot size(acres):1.6	***Misc.***	Other income	12,000
		Fixed costs	1,000
		Other expenses	-
Family members:7	***Household***	Off-farm income	96,000
		Household expenses	158,900
		NET EARNINGS	**12,748**
Number of livestock:1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	13
		NET EARNINGS PER FAMILY MANDAY	**981**

CA FARMER 17: FRIDAH SIRENDO			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans,	***Crop production***	Crop output	135,000
		Inputs/variable costs	36,593
		Gross margin	98,407
Number of parcels:2	***Livestock***	Livestock output	16,200
		Inputs/variable costs	14,000
		Gross margin	2,200
Average plot size(acres): 1	***Misc.***	Other income	-
		Fixed costs	4,500
		Other expenses	4,000
Family members:8	***Household***	Off-farm income	84,000
		Household expenses	177,600
		NET EARNINGS	**-1,492**
Number of livestock:10	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	25
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 18: BRIDGID WABWILLE			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, banana, groundnuts, sugarcane, sweet potatoes	***Crop production***	Crop output	41,542
		Inputs/variable costs	32,673
		Gross margin	8,869
	Livestock	Livestock output	-
		Inputs/variable costs	5,000
		Gross margin	-5,000
Number of parcels: 4	***Misc.***	Other income	-
		Fixed costs	1,000
		Other expenses	-
Average plot size(acres):0.5	***Household***	Off-farm income	184,800
		Household expenses	92,420
		NET EARNINGS	**95,248**
Family members:7	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	54
Number of livestock:-		NET EARNINGS PER FAMILY MANDAY	**1,764**

CA FARMER 19: FLAVIOUR MUKHONGO

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, smodium	***Crop production***	Crop output	18,000
		Inputs/variable costs	29,653
		Gross margin	-11,653
Number of parcels:2	***Livestock***	Livestock output	-
		Inputs/variable costs	10,000
		Gross margin	-10,000
Average plot size(acres): 0.6	***Misc.***	Other income	-
		Fixed costs	1,000
		Other expenses	-
Family members:4	***Household***	Off-farm income	144,000
		Household expenses	116,360
		NET EARNINGS	**4,989**
Number of livestock:4	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	16
		NET EARNINGS PER FAMILY MANDAY	**312**

CA FARMER 20: SELIVESTOR MANDILA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, groundnuts, sugarcane, coffee, bananas,	***Crop production***	Crop output	221,000
		Inputs/variable costs	63,614
		Gross margin	157,386
	Livestock	Livestock output	49,920
		Inputs/variable costs	10,000
		Gross margin	39,920
Number of parcels: 6	***Misc.***	Other income	7,200
		Fixed costs	-
		Other expenses	-
Average plot size(acres): 0.75	***Household***	Off-farm income	-
		Household expenses	170,200
		NET EARNINGS	**13,708**
Family members:8	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
Number of livestock:3	***Family labour***	*Mandays*	67
		NET EARNINGS PER FAMILY MANDAY	**205**

CA FARMER 21: TIMOTH BARRASA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, coffee, bananas	***Crop production***	Crop output	73,500
		Inputs/variable costs	21,444
		Gross margin	52,056
Number of parcels:3	***Livestock***	Livestock output	27,700
		Inputs/variable costs	7,000
		Gross margin	20,700
Average plot size(acres): 0.8	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
	Household	Off-farm income	-
		Household expenses	151,400
Family members:11		NET EARNINGS	**-74,642**
	Change in assets and liabilities	*Loans/debts*	4,000
		Fixed assets(Buying)	-
Number of livestock:9	***Family labour***	*Mandays*	25
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 22: ROSMARE WEKESA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower and coffee	***Crop production***	Crop output	509,082
		Inputs/variable costs	59,093
		Gross margin	449,989
Number of parcels: 3	***Livestock***	Livestock output	39,900
		Inputs/variable costs	4,000
		Gross margin	35,900
Average plot size(acres):1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:4	***Household***	Off-farm income	120,000
		Household expenses	176,480
		NET EARNINGS	**469,309**
Number of livestock:10	***Change in assets and liabilities***	*Loans/debts*	-5,000
		Fixed assets(Buying)	-
	Family labour	*Mandays*	62
		NET EARNINGS PER FAMILY MANDAY	**7569**

CA FARMER 23: AGGREY MAIKUMA			
HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans,	***Crop production***	Crop output	56,902
		Inputs/variable costs	18,219
		Gross margin	38,683
Number of parcels:2	***Livestock***	Livestock output	-
		Inputs/variable costs	5,000
		Gross margin	-5,000
Average plot size(acres): 1.4	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:10	***Household***	Off-farm income	-
		Household expenses	71,440
		NET EARNINGS	**-37,757**
Number of livestock:5	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	24
		NET EARNINGS PER FAMILY MANDAY	**-**

CA FARMER 24:			
HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, smodium, watermelon	***Crop production***	Crop output	332,402
		Inputs/variable costs	20,493
		Gross margin	311,909
Number of parcels: 2	***Livestock***	Livestock output	-
		Inputs/variable costs	1,800
		Gross margin	-1,800
Average plot size(acres):0.6	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:4	***Household***	Off-farm income	60,000
		Household expenses	52,440
		NET EARNINGS	**317,669**
Number of livestock:6	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	9
		NET EARNINGS PER FAMILY MANDAY	**35,297**

CA FARMER 25: NORAH WASIKE			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, lablab, sunflower	***Crop production***	Crop output	72,602
		Inputs/variable costs	28,683
		Gross margin	43,919
Number of parcels:2	***Livestock***	Livestock output	20,000
		Inputs/variable costs	12,000
		Gross margin	8,000
Average plot size(acres): 1.25	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
	Household	Off-farm income	-
		Household expenses	155,400
Family members:10		NET EARNINGS	**-103,482**
	Change in assets and liabilities	*Loans/debts*	-
		Fixed assets(Buying)	-
Number of livestock:13	***Family labour***	*Mandays*	12
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMERS

NON-CA FARMER 1: FREDRICK SIKUWU			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, groundnuts, sweet potatoes, banana, coffee	***Crop production***	Crop output	149,401
		Inputs/variable costs	126,403
		Gross margin	22,998
Number of parcels:5	***Livestock***	Livestock output	48,300
		Inputs/variable costs	3,000
		Gross margin	45,300
Average plot size(acres): 1.3	***Misc.***	Other income	103,000
		Fixed costs	-
		Other expenses	-
Family members:6	***Household***	Off-farm income	-
		Household expenses	162,320
		NET EARNINGS	**8,978**
Number of livestock:3	***Change in assets and liabilities***	*Loans/debts*	-2,800
		Fixed assets(Buying)	-
	Family labour	*Mandays*	108
		NET EARNINGS PER FAMILY MANDAY	**83**

NON-CA FARMER 2: HELLEN WEKESA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, coffee, sunflower	***Crop production***	Crop output	205,851
		Inputs/variable costs	13,844
		Gross margin	192,007
Number of parcels: 3	***Livestock***	Livestock output	-
		Inputs/variable costs	24,000
		Gross margin	-24,000
Average plot size(acres):1.3	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:8	***Household***	Off-farm income	-
		Household expenses	107,680
		NET EARNINGS	**60,328**
Number of livestock:-	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	67
		NET EARNINGS PER FAMILY MANDAY	**900**

NON-CA FARMER 3: HUSEIN NANDEBE

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, tomatoes	***Crop production***	Crop output	4,000
		Inputs/variable costs	4,763
		Gross margin	-763
Number of parcels:1	***Livestock***	Livestock output	-
		Inputs/variable costs	1,000
		Gross margin	-1,000
Average plot size(acres): 0.5	***Misc.***	Other income	71,200
		Fixed costs	-
		Other expenses	-
Family members:3	***Household***	Off-farm income	-
		Household expenses	52,080
		NET EARNINGS	**22,120**
Number of livestock:-	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	42
		NET EARNINGS PER FAMILY MANDAY	**527**

NON-CA FARMER 4: ABEL MUTORO

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower	***Crop production***	Crop output	286,801
		Inputs/variable costs	113,532
		Gross margin	173,269
Number of parcels: 3	***Livestock***	Livestock output	33,000
		Inputs/variable costs	6,000
		Gross margin	27,000
Average plot size(acres):1.5	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:7	***Household***	Off-farm income	161,000
		Household expenses	145,720
		NET EARNINGS	**215,549**
Number of livestock:9	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	108
		NET EARNINGS PER FAMILY MANDAY	**1,996**

NON-CA FARMER 5: BENEDICT BUSOLO			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans,	***Crop production***	Crop output	28,000
		Inputs/variable costs	19,944
		Gross margin	8,056
Number of parcels:2	***Livestock***	Livestock output	2,800
		Inputs/variable costs	3,000
		Gross margin	-200
Average plot size(acres): 0.4	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:8	***Household***	Off-farm income	120,000
		Household expenses	141,400
		NET EARNINGS	**-13,544**
Number of livestock:2	***Change in assets and liabilities***	*Loans/debts*	-12,500
		Fixed assets(Buying)	-
	Family labour	*Mandays*	12
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 6: JOSEPH NALIANYA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans,	***Crop production***	Crop output	-
		Inputs/variable costs	21,303
		Gross margin	-21,303
Number of parcels:1	***Livestock***	Livestock output	3,500
		Inputs/variable costs	5,000
		Gross margin	-1,500
Average plot size(acres):1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:6	***Household***	Off-farm income	490,000
		Household expenses	131,320
		NET EARNINGS	**335,877**
Number of livestock:2	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	41
		NET EARNINGS PER FAMILY MANDAY	**8,192**

NON-CA FARMER 7: TOBIAS MANYONGE

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, banana, kels	***Crop production***	Crop output	33,702
		Inputs/variable costs	11,604
		Gross margin	22,098
Number of parcels: 2	***Livestock***	Livestock output	2,500
		Inputs/variable costs	2,400
		Gross margin	100
Average plot size(acres): 0.6	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members: 5	***Household***	Off-farm income	60,000
		Household expenses	69,640
		NET EARNINGS	**12,558**
Number of livestock: 4	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	48
		NET EARNINGS PER FAMILY MANDAY	**262**

NON-CA FARMER 8: JAMINI CHETUTUME

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, tomatoes	***Crop production***	Crop output	105,000
		Inputs/variable costs	10,084
		Gross margin	94,916
Number of parcels: 1	***Livestock***	Livestock output	-
		Inputs/variable costs	2,200
		Gross margin	-2,200
Average plot size(acres): 1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members: 4	***Household***	Off-farm income	6,000
		Household expenses	93,660
		NET EARNINGS	**5,056**
Number of livestock: 1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	19
		NET EARNINGS PER FAMILY MANDAY	**266**

NON-CA FARMER 9: RICHARD OLWEMA			
HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, banana	***Crop production***	Crop output	-
		Inputs/variable costs	34,683
		Gross margin	-34,683
Number of parcels:2	***Livestock***	Livestock output	-
		Inputs/variable costs	9,000
		Gross margin	-9,000
Average plot size(acres): 0.6	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:10	***Household***	Off-farm income	60,000
		Household expenses	73,840
		NET EARNINGS	**-57,523**
Number of livestock:1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	56
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 10: SCOLASTIC WAMALWA			
HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, banana, coffee	***Crop production***	Crop output	131,351
		Inputs/variable costs	48,863
		Gross margin	82,488
Number of parcels: 3	***Livestock***	Livestock output	-
		Inputs/variable costs	21,700
		Gross margin	-21,700
Average plot size(acres): 1.25	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:9	***Household***	Off-farm income	57,600
		Household expenses	118,160
		NET EARNINGS	**228**
Number of livestock:1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	111
		NET EARNINGS PER FAMILY MANDAY	**2.05**

NON-CA FARMER 11: TIBERIUS SIMIYU

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans,	***Crop production***	Crop output	12,000
		Inputs/variable costs	10,084
		Gross margin	2,084
Number of parcels:1	***Livestock***	Livestock output	-
		Inputs/variable costs	2,000
		Gross margin	-2,000
Average plot size(acres): 1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:5	***Household***	Off-farm income	-
		Household expenses	61,440
		NET EARNINGS	**-61,356**
Number of livestock:1	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	26
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 12: BOAZ MALIUMBA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans,	***Crop production***	Crop output	-
		Inputs/variable costs	9,054
		Gross margin	-9,054
Number of parcels: 1	***Livestock***	Livestock output	3,300
		Inputs/variable costs	4,500
		Gross margin	-1,200
Average plot size(acres):1	***Misc.***	Other income	72,000
		Fixed costs	-
		Other expenses	-
Family members:10	***Household***	Off-farm income	1,000
		Household expenses	68,700
		NET EARNINGS	**-5,934**
Number of livestock:10	***Change in assets and liabilities***	*Loans/debts*	8,000
		Fixed assets(Buying)	-
	Family labour	*Mandays*	29
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 13: TITUS NDIWA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, tomatoes	***Crop production***	Crop output	116,761
		Inputs/variable costs	73,903
		Gross margin	42,858
Number of parcels: 3	***Livestock***	Livestock output	30,000
		Inputs/variable costs	16,600
		Gross margin	13,400
Average plot size(acres): 0.5	***Misc.***	Other income	25,000
		Fixed costs	-
		Other expenses	-
Family members: 7	***Household***	Off-farm income	25,000
		Household expenses	166,400
		NET EARNINGS	**-60,142**
Number of livestock: 10	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	76
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 14: DAVID WANYONYI

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, tomatoes, water melon	***Crop production***	Crop output	63,101
		Inputs/variable costs	25,103
		Gross margin	37,998
Number of parcels: 2	***Livestock***	Livestock output	104,700
		Inputs/variable costs	15,200
		Gross margin	89,500
Average plot size(acres) :0.75	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	2,600
Family members: 6	***Household***	Off-farm income	-
		Household expenses	120,480
		NET EARNINGS	**4,418**
Number of livestock: 4	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	79
		NET EARNINGS PER FAMILY MANDAY	**56**

NON-CA FARMER 15: GRACE NANYANA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower	***Crop production***	Crop output	36,200
		Inputs/variable costs	36,564
		Gross margin	-364
Number of parcels: 2	***Livestock***	Livestock output	67,400
		Inputs/variable costs	20,200
		Gross margin	47,400
Average plot size(acres): 1.5	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members: 6	***Household***	Off-farm income	26,000
		Household expenses	71,840
		NET EARNINGS	**1,196**
Number of livestock: 5	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	44
		NET EARNINGS PER FAMILY MANDAY	**27**

NON-CA FARMER 16: JESTMORE SIMIYUKAPURU

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower	***Crop production***	Crop output	40,600
		Inputs/variable costs	31,193
		Gross margin	9,407
Number of parcels: 2	***Livestock***	Livestock output	16,200
		Inputs/variable costs	25,000
		Gross margin	-8,800
Average plot size(acres): 1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members: 7	***Household***	Off-farm income	-
		Household expenses	103,200
		NET EARNINGS	**-102,593**
Number of livestock: 5	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	58
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 17: RUTH MUCHUNGI			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, coffee, banana	***Crop production***	Crop output	144,000
		Inputs/variable costs	77,022
		Gross margin	66,978
Number of parcels:3	***Livestock***	Livestock output	127,280
		Inputs/variable costs	37,000
		Gross margin	90,280
Average plot size(acres): 1	***Misc.***	Other income	-
		Fixed costs	15,000
		Other expenses	-
Family members:3	***Household***	Off-farm income	-
		Household expenses	273,820
		NET EARNINGS	**-131,562**
Number of livestock:11	***Change in assets and liabilities***	*Loans/debts*	-52,000
		Fixed assets(Buying)	-
	Family labour	*Mandays*	27
		NET EARNINGS PER FAMILY MANDAY	**-**

NON-CA FARMER 18: JOHAM WOTIA			
HOUSEHOLD FEATURES	**CLASSIFICATION**	**ECONOMIC PARAMETERS**	**AMOUNT (Kshs)**
Main crops: Maize, beans, coffee, banana	***Crop production***	Crop output	233,601
		Inputs/variable costs	51,343
		Gross margin	182,258
Number of parcels: 3	***Livestock***	Livestock output	1,290
		Inputs/variable costs	46,000
		Gross margin	-44,710
Average plot size(acres):1	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:11	***Household***	Off-farm income	200,000
		Household expenses	171,160
		NET EARNINGS	**166,388**
Number of livestock:2	***Change in assets and liabilities***	*Loans/debts*	-112,000
		Fixed assets(Buying)	-
	Family labour	*Mandays*	71
		NET EARNINGS PER FAMILY MANDAY	**2,343**

NON-CA FARMER 19: RICHARD WANJALA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower, groundnuts, banana, coffee, sweet potatoes	***Crop production***	Crop output	20,000
		Inputs/variable costs	6,623
		Gross margin	13,377
Number of parcels:5	***Livestock***	Livestock output	99,500
		Inputs/variable costs	7,900
		Gross margin	91,600
Average plot size(acres): 0.85	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:7	***Household***	Off-farm income	2,000
		Household expenses	20,000
		NET EARNINGS	**86,977**
Number of livestock:5	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	75
		NET EARNINGS PER FAMILY MANDAY	**1,160**

NON-CA FARMER 20: PETER MANGENI

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sunflower, banana, kassava	***Crop production***	Crop output	22,401
		Inputs/variable costs	3,883
		Gross margin	18,518
Number of parcels:4	***Livestock***	Livestock output	11,700
		Inputs/variable costs	500
		Gross margin	11,200
Average plot size(acres):0.5	***Misc.***	Other income	4,500
		Fixed costs	-
		Other expenses	-
Family members:3	***Household***	Off-farm income	17,000
		Household expenses	19,400
		NET EARNINGS	**31,818**
Number of livestock:7	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	39
		NET EARNINGS PER FAMILY MANDAY	**816**

NON-CA FARMER 21: CATHERINE MACHUMA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, sweet potatoes, bananas	***Crop production***	Crop output	116,276
		Inputs/variable costs	37,404
		Gross margin	78,872
	Livestock	Livestock output	68,900
		Inputs/variable costs	12,700
		Gross margin	56,200
Number of parcels:3	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Average plot size(acres): 1	***Household***	Off-farm income	57,600
		Household expenses	115,200
		NET EARNINGS	**77,473**
Family members:6	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	56
Number of livestock:8		NET EARNINGS PER FAMILY MANDAY	**1,383**

NON-CA FARMER 22: MAURICE W. JUMA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, coffee	***Crop production***	Crop output	203,300
		Inputs/variable costs	58,953
		Gross margin	144,347
Number of parcels: 2	***Livestock***	Livestock output	76,400
		Inputs/variable costs	4,500
		Gross margin	71,900
Average plot size(acres): 1.25	***Misc.***	Other income	20,000
		Fixed costs	-
		Other expenses	-
Family members:10	***Household***	Off-farm income	600
		Household expenses	228,600
		NET EARNINGS	**8,248**
Number of livestock:4	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	105
		NET EARNINGS PER FAMILY MANDAY	**79**

NON-CA FARMER 23: ANDREW WANYONYI

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, banana, coffee	***Crop production***	Crop output	46,051
		Inputs/variable costs	19,863
		Gross margin	26,188
Number of parcels:3	***Livestock***	Livestock output	-
		Inputs/variable costs	6,000
		Gross margin	-6,000
Average plot size(acres): 0.7	***Misc.***	Other income	-
		Fixed costs	-
		Other expenses	-
Family members:6	***Household***	Off-farm income	57,600
		Household expenses	28,460
		NET EARNINGS	**49,328**
Number of livestock:-	***Change in assets and liabilities***	*Loans/debts*	-
		Fixed assets(Buying)	-
	Family labour	*Mandays*	70
		NET EARNINGS PER FAMILY MANDAY	**705**

NON-CA FARMER 24: SHADRACK WEKESA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, coffee	***Crop production***	Crop output	44,000
		Inputs/variable costs	23,503
		Gross margin	20,497
Number of parcels: 2	***Livestock***	Livestock output	35,000
		Inputs/variable costs	2,000
		Gross margin	33,000
Average plot size(acres): 0.75	***Misc.***	Other income	-
		Fixed costs	1,000
		Other expenses	-
Family members:9	***Household***	Off-farm income	172,800
		Household expenses	88,980
		NET EARNINGS	**136,317**
Number of livestock:4	***Change in assets and liabilities***	*Loans/debts*	-1,200
		Fixed assets(Buying)	-
	Family labour	*Mandays*	35
		NET EARNINGS PER FAMILY MANDAY	**3,895**

NON-CA FARMER 25: ELIZABETH JUMA

HOUSEHOLD FEATURES	CLASSIFICATION	ECONOMIC PARAMETERS	AMOUNT (Kshs)
Main crops: Maize, beans, coffee	***Crop production***	Crop output	66,801
		Inputs/variable costs	15,550
		Gross margin	51,250
Number of parcels:3	***Livestock***	Livestock output	15,150
		Inputs/variable costs	26,000
		Gross margin	-10,850
Average plot size(acres): 0.6	***Misc.***	Other income	5,000
		Fixed costs	-
		Other expenses	-
	Household	Off-farm income	120,000
Family members:7		Household expenses	79,280
		NET EARNINGS	**86,120**
	Change in assets and liabilities	*Loans/debts*	-
Number of livestock:8		*Fixed assets(Buying)*	-
	Family labour	*Mandays*	82
		NET EARNINGS PER FAMILY MANDAY	