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CONSERVATON AGRICULTURE IN KENYA

Analysis of Past Performance and Emerging Trends

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1.0 Abstract

This report presents the status of conservation agriculture (CA) in Kenya. Its findings established that most Kenyan farmers embrace elements of CA principles and practices with the exception of tillage techniques. Common practices include mixed cropping systems related to Agroforestry/tree pruning, residue retention or cover crops. Green manure legumes such as Velvet bean (*Mucuna pruriens*) and sunnhemp (*Crotalaria ochroleuca*) have been introduced in smallholder farms for soil fertility improvement with a lot of success in Eastern Province. In this region and elsewhere including the Nzoia River Basin, farmers plant nitrogen fixing legumes and animal feeds such as *Calliandra, Luceana, Lucerne* and *Desmodium Species*. Briefly, majority of the small holder farmers in Kenya still rely on conventional approaches of farming and practice elements of CA technology to ensure they are food secure without regard to conservation tillage practices. A number of large scale farmers in Kenya still use tractor drawn ploughs. However, most of them have up to date sprayers and planters, some of which are made locally by the Jua-Kali artisans.

A broad analysis of major gaps in the policies, practices, and results across all case studies is also provided. This broad perspective allows the reader to appreciate both the commonalities and the specifics of CA as practiced in Kenya.

Table of Content

2.0 LIST OF ABBREVIATIONS

CIRAD:	Centre for International Development
CA	Conservation Agriculture
FAO:	Food and Agriculture Organization of the United Nations (FAO),
ACT:	African Conservation Tillage Network
ACZ:	Agri-climatic zones
ASCU:	Agricultural Sector Coordination Unit
CA-SARD:	Conservation Agriculture for Sustainable Agriculture and Rural Department
CFU:	Conservation Farmers Union
COMESA:	Common Market for East and Southern Africa
ERS:	Economic Recovery Strategy
ICRAF:	International Center for Research in Agroforestry
SCC-Vi:	Swedish Co-operative Centre and Vi Agroforestry
KARI:	Kenya Agricultural Research Institute
NGOs:	Non-governmental organizations
FTCs:	Farmers Training Centers
CBOs:	Community Based Organizations
NALEP:	The National Agriculture and Livestock Extension Programme
SRA:	Strategy for Revitalizing Agriculture
MOA:	Ministry of Agriculture
KCTI:	Kenya Conservation Tillage Initiative
MMUST	Masinde Muliro of Science and Technology
INSETs:	In-service Trainings
KFA:	Kenya Farmers Association
TWG:	Technical Working Groups
NEAP:	National Agricultural Extension Policy

3.0 INTRODUCTION

The Republic of Kenya covers an area of approximately 582,646 sq. km. comprising 97.8% land and 2.2% water surface. Only 16% of this land can be classified as medium to high potential while the remaining is mainly arid or semi-arid (Figure 1). Of the country's total area, forests and woodland occupy about 6.5% while national reserves and game parks together account for 10%. Briefly, Kenya has a wide diversity of agro-climatic conditions reflecting variations in altitude, temperature, soil conditions and level and reliability of rainfall. The contrasts between the highland areas with ample rainfall and rich volcanic soils and the semi-arid areas with low and erratic rainfall and poor soils are particularly marked, with the Nzoia River Basin (Covering Western, Nyanza and parts of the North/South Rift Valley) being the country's food basket producing most of the staple food crops in the country. Horticulture is concentrated mostly in Central Province and other parts of the Central Rift Valley. The various agro-climatic zones (ACZ) are as described (Jaetzold and Schmidt, 1983) and illustrated in Figure 1. In green is the arable land majority of which lie within the Nzoia River Basin.

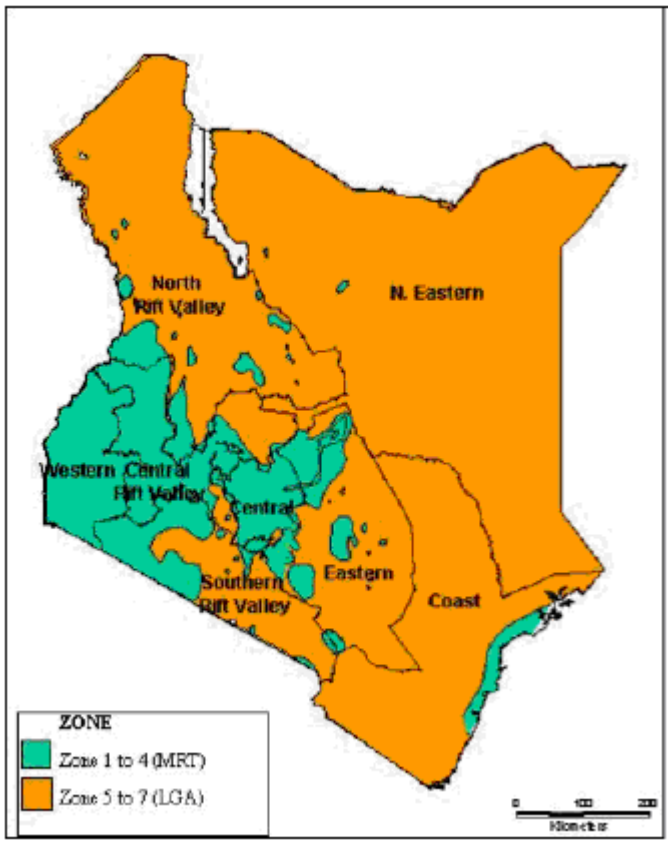

Figure 1: Agro-Climatic Zones in Kenya (Jaetzold and Schmidt, 1983); in light blue are the potential food producing Zones. Semi-arid and arid areas are shaded in orange.

About 80% of the Kenyan population lives in rural areas and derive their livelihood from agriculture. Even for the urban poor, a majority of them make a living on agricultural related activities. The sector is therefore the main source of national income and employment creation for over 80% of the population and contributes to poverty reduction and food security. Small-scale farmers, mainly in the high potential areas, dominate Kenya's agriculture. The sub-sector

accounts for 75% of total agricultural output and 70% of marketed agricultural production. Small-scale farmers produce over 70% of maize, 65% of coffee, 50% of tea, 80% of milk, 85% of fish and 70% of beef and related products. Agricultural production is carried out on farms averaging 2-3 hectares mainly for subsistence and commercial purposes. Currently, use of quality inputs and equipments such as hybrid seed, fertilizers and pesticides or machinery by the sub-sector is very low. Therefore to increase and or sustain productivity in the sub sector, there is need for enhanced efforts to encourage farmers to adopt modern farming practices that entail sustainable land development for food security.

The climate of the Nzoia River Basin and most parts of the country is mainly tropical humid characterized by day temperatures varying between 16º C in the highland areas of Cherengani and Mount Elgon to 28º C and also in in the lower semi-arid areas on annual basis. The mean annual night temperatures vary between 4º C in the highlands areas 16º C in the semi arid areas. Mean annual rainfall varies from a maximum of 1100-2700 mm and a minimum of 600-1100 mm. There are two rainy seasons and dry seasons, namely, short rains (October-December) and the long rains (March-May). The dry seasons occur in the months of January to February and June to September. However the local relief and influences of the Lake Victoria modify the regular weather pattern. The area experiences four seasons in a year as a result of the inter-tropical convergence zone. As shown Figure 1, effective farming in Kenya for maximum food production requires irrigation and other improved methods of farming such as conservation agriculture.

Conservation agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment (FAO).
Its principles entail:

- reduce the intensity of soil tillage, or suppress it altogether
- cover the soil surface adequately—if possible completely and continuously throughout the year
- diversify crop rotations

Full conservation agriculture, however, is today rarely practiced (Ekboir 2003; Derpsh 2005), and is indeed difficult to achieve right from the onset. It is therefore important to assess the level of adoption of this technology in Kenya. This report examines the extent of adoption of conservation agriculture productivity variations across households in Kenya.

The main objectives of this study were to determine: (1) the current best practices in CA; (2) the best wonder trees, for various regions; (3) available technologies, farm tools, equipment and their advancement; (4) centres for excellence for advancing technologies required for CA; (5) smallholder-based CA systems; (6) potential stakeholders and actors in up-scaling CA and (7) current mitigation measures and priority interventions.

4.0 DATA AND METHODS

The data collection techniques for the study were as described below.

4.1. Sampling Methodology

This report uses data for five transect points that are assumed to be representative of the entire farming zones. Agro-ecological zones AEZ were assigned to them using information from Farm Management Handbook by Jaetzold and Schmidt 1983.

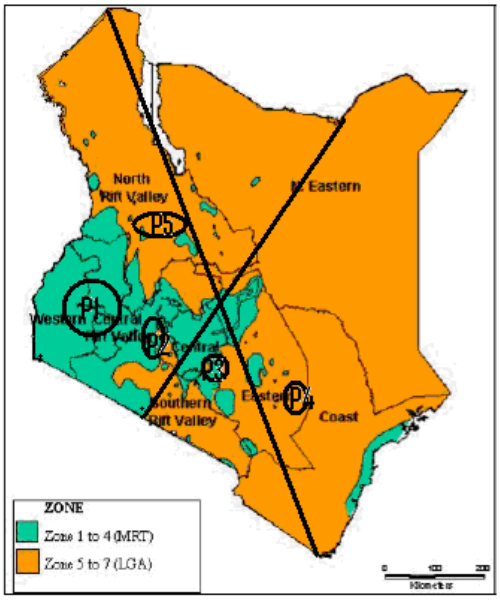

Figure 2: Selected Sampling Data Points in AEZ

The baseline survey was conducted between February 2010 and March 2010 during the land preparation period. Rural population of households and AEZ were the major factors considered in identifying the sampling frame. More data points were collected from the Nzoia River Basin which focuses mostly on the production of food crops. In every region one farmer was identified. The farmer was interviewed as farm practices observed as well as video taped. Snowballing technique was used to reach other farmers in the region until sufficient information regarding the survey obtained. In summary, the sampled households came from five out of eight provinces in Kenya. However, more attention was given to the agri-potential zones (i.e Central and the Nzoia River Basin). Data collected comprised of physical quantities of inputs used in the production process, digital video clips of the farming practices and other mixed farming methods.

5.0 RESULTS AND DISCUSSIONS

5.1 Analysis of Past Performance and Emerging Trends in CA

The first CA pilot project in Kenya (2002/03) was supported by the German Government (under German Trust Fund) and coordinated by Food Agricultural Organization (FAO). A follow-up activity, the first phase of the Regional Conservation Agriculture for Sustainable Agriculture and Rural Department (CA-SARD) project was launched. This was a 2-year project whose term lasted from June 2004 to August 2006. In some cases, the funds were utilized in the

establishment of Farmer Field Schools in districts, involving 55 individuals, with a 50-50 gender balance. In this case, Village-based facilitators were trained on the farmer field school approach and Conservation Agriculture (CA) farming practices. It was hoped that the technology will be adopted and transferred to farmers in other regions.

5.1.1 The Extent Of Adoption And Access Of Farmers To This Technology

Evidence of CA is visible in areas where CA-SARD, ICRAF, SCC-Vi, Millenium Development and KARI projects have had impact. These include the larger Nzoia River Basin covering Kitale, Bungoma, Vihiga, Bunyore, Limuru, Laikipia districts etc. In all these areas, nitrogen fixing agro-forestry crops, legumes and trees are mixed with the main crops particularly bananas and maize. Visible across the board is the inclusion of *Sesbania Sesban* and *Calliandria* species either on the hedge or within the main fields (Figure 3A). In some cases, and particularly in the SCC Vi demonstration plots, the push and pull technology is employed where by Desmodium species is mixed with the maize crop to repel the stock borers to adjacent nappier grass planted on the hedges of the farm. Results from this survey show that crop residues are usually left on the farm to increase the amount of organic matter in the soil before the next planting season. In some cases, *Calliandra species* is planted with bananas and other food crops as both animal feed and a nitrogen fixing tree (Figure 3)

Figure 3: Mixed cropping of trees and bananas (A,B) the push and pull method in which *Desmodium* is mixed with maize to repel stock borers to feed on the adjacent nappier grass on the hedge (C,D). *Calliandra species* planted with bananas.

Some of these technologies have been adopted by farmers in these regions. Small scale farmers in Bunyore and Gem (Siaya District), for example, plant *Sesbania sesban* and *Calliandra* trees with crops to boost their productivity. This is evidenced in areas where farmers have reclaimed arable land from rocky areas which largely takes up all the available land with little or no arable land left (Figure 4). Land reclaimed in these areas is used for planting maize or bananas mixed with ether beans or sweet potatoes. Regions with fertile soils such as Nandi Hills, Trans Nzoia and Cherenganyi areas have pure stands of beans (*Phaseolus spp.*) or soya beans (*Glycine max*) rotated with maize between seasons. Other farmers leave their lands fallow to accumulate biomass before the next planting seasons.

Figure 4: A farmer in Gem Siaya showing (A) Bananas and nitrogen fixing *Calliandia species* he planted in land reclamined from (B) his rocky land. Funds for this intitive were provided by the Millenium Development Project in Siaya District, Nyanza Province. This practice is also found in Vihiga and Bunyore areas in Western Province.

In Embu and its environs coffee and tea are dominant cash crops. Maize, beans, bananas, potatoes and yams are planted as food crops. Farmers also earn their living through mixed farming in which dairy animals contribute both milk and organic manure. However, the productivity of the main food crops has been continuously declining as conceded by farmers that this is due to continuous tillage without proper technology(ies) or knowledge besides the use of chemical fertilizers. This has rendered many families food insecure especially in the dry periods of November-March. Farmers in the drylands and areas with marginal rains such as Machakos, Makueni and Kibwezi districts in Eastern Province use shallow planting furrows and mulch to conserve water as part of their sustainable land management practices. Some plant *Dolichos lablab* and Pigeon pea with good ground cover to prevent evaporation during the dry seasons after the long rains or irrigation. Trees with mycorrihzae characteristics such Acacia and Fig are found all over dry lands of Eastern province (Makueni, Kibwezi, Machakos) in use as shades for planting bananas other providing the required supplementary nutrients.

Exotic trees such as gravellier, *Luceana*, *Calliandra* and *Sesbenia* are found in Central Provinces, Central and South Rift ACZ. The latter are also found extensively intercropped with

food crops in Western and Nyanza Provinces and regions within the Nzoia River Basin where mixed farming is practiced to support livelihoods.

Even then, vast areas of untilled land are found dotted within Siaya District in Nyanza Province and Busia Districts in Western Kenya. Farming in these regions is not considered as a major source of income. This has partly been attributed to poor rainfall distribution in these areas and negative attitude on the part of the people towards farming. Young energetic men in these areas have turned into cyclists-taxi or bus fare brokers (touts) between passengers and bus owners at the expense of farming.

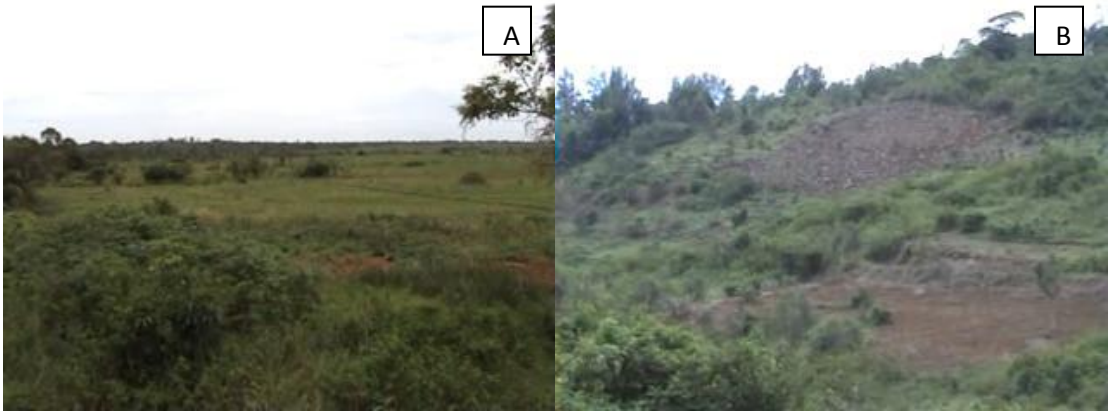

Figure 5: (A) Untilled land found in Boro Division in Siaya District (B) A similar piece of land in Bunyala area in the larger Busia District.

In other intances, as witnessed in Kadenge (Siaya District) and Bunyala (Busia District) swamps, natural wetlands are burnt down to acess fertile farmlands (**Figure 6**). However, such practices, though popular with farmers in these areas, often act as temporary mesures because sooner or later, the soils become exhausted before the next planting season or are flooded with waters before harvesting.

Figure 6A: Natural wetlands invaded by farmers in search fertile and mositened farming gruonds. Farmers clear the wetlands using poor farm practices such as burning that encourage soil erossion and destruction of sol organic matter.

Figure 6B: Cassavas and sweet potatoes planted in the cleared grounds in the natural wetlands in Budalangi (Busia District).

5.1.1.1 Principle Technologies in Use

Conservation Agriculture (CA) practices in Kenya, like in other countries, is based on integrated management of soil, water and agricultural resources. Its three essential interrelated features are: 1) minimizing tillage, whereby ploughing, harrowing, and any kind of mechanical soil disturbance operations are reduced to a minimum. It is believed these practices reduce the amount of energy consumed during farming and air pollution from fossil fuels by 30-40%. However, it is not well embraced in Kenya.

2) Maintaining soil cover using vegetative materials (live or dead) on the soil surface that protects the soil from the physical impact of rain and wind and stabilizes soil moisture and temperature in the surface layers. Such covers turn the farmlands into a habitat for soil life (plant roots, insects, worms, fungi and bacteria). Occasionally, organic wastes from Farm Yard Manure from poultry and dairy farming are added into the soil. In the process, the soil life will use the soil cover and organic matter, and recycle them into humus and nutrients that contributes to the stabilization of the soil structure. Some leguminous species, such as cow peas, Soy beans, beans, and groundnuts are mixed with the main crop (Bananas or Maize) to add nitrogen into the soils. Dairy farmers plant animal feeds such *Lucerne* and *Desmodium* mixed with the main crops. The SCC-Vi is currently promoting the push-and-pull method of mixed farming in all its farmer field schools in which Maize is mixed with *Desmodium* in a field having *Napier* grass on hedge to attract stock borers repelled by the *Desmodium*. Such a synergistic approach has cost cutting measures for the farmers while boosting the yields and is currently embraced by most small scale farmers in the Trans Nzoia District and parts of Nyanza. Other farmers mix vegetables such as kale with Bananas. A few farmers use herbicides, so knowledge of specific locations where weeds grow is very important to them. Maintaining soil cover in the long term aims to manage weeds through agronomic means (soil cover, cover crops) or minimal mechanical means (superficial weeding with hoe or cutlass) while at the same time making maximum use of the land. The net result is inhibited germination of many weed seeds, minimizing weed competition with the crop.

3) Diversified crop rotation (annual crops) or plant associations (perennial crops), enhancing the soil's rooting environment, its structure, nutrients and moisture retention capacity, while avoiding build-up of pests and diseases and controlling weeds. Crop rotations are designed to

make full use of the physical and chemical interactions between different plant species and to achieve multiple purposes: crop production for food and energy, cattle feeding, biological tillage and decompaction through different kinds of rooting systems, nutrient cycling and weed control.

In informed Kenyan farmers, an essential element of CA is to plan crop sequences over several seasons, to minimize the build-up of pests or diseases and to optimize plant nutrient use through synergy between different crop types and by alternating shallow-rooting crops with deep-rooting ones.

Smallholder farmers in the Laikipia district, Makueni District, Kibwezi District and other dryland others and Limuru in Central Province have been able to increase their yield by 30-40% by adopting in situ water harvesting methods and technologies which they have adopted as part of CA approach.

5.1.1.2 CA Inputs Availability (Equipment, Seeds for Nitrogen Fixing Plants Etc)

Seeds for nitrogen fixing plants are readily available either with the Kenya Forestry Research Institute and NGOs such as SCC Vi and ICRAF. Farmers can also get direct access to the seeds from other farmers.

As mentioned earlier, CA principles and practices (with the exception of tillage techniques) in combination with cropping systems related to Agroforestry/tree pruning, residue retention or cover crops are widely practiced in Kenya. On-farm legume green manuring trials were have been conducted in Karurina and Gachoka locations of Embu and Mbeere districts of Eastern Province, by Kenya. Green manure legumes such as velvet bean (*Mucuna pruriens*) and sunnhemp (*Crotalaria ochroleuca*) have been introduced in smallholder farms for soil fertility improvement with a lot of success. In this region and elsewhere in Kenya, farmers plant nitrogen fixing legumes and animal feeds such as *Calliandra, Luceana, Lucerne* and *Desmodium.*

Majority of small scale farmers still use the ox-drawn plough as opposed to the ripper technology. Equally, a number of large scale farmers in Kenya still use tractor drawn ploughs. However, most of them have up to date sprayers and planters, some of which are made locally by the Jua-Kali artisans. Even then, most of the CA equipments are not available in the local markets. Small holder farmers do not even know of their existence. Government efforts to avail them still remain to be seen and majority of Kenyan farmers have not adopted CA farming principles par-se even though elements of the practice are visible. As shown in **Figures 7-8**, tillage in most parts of the country still embrace the traditional methods of farming which expose the soil to continued loss of nitrogen and carbon. These include ox-drawn and tractor ploughs which result in open farm lands (**Figure 8C**). These farm practices were evident in nearly all the fields visited included agricultural research Institutes such as KARI and most Farmers Training Centers (FTCs)

Figure 7: (A) A farmer in Bunyore Luanda using an Ox drawn pough to prepare his land; (B) a picture showing the mechanism of operation of the plough

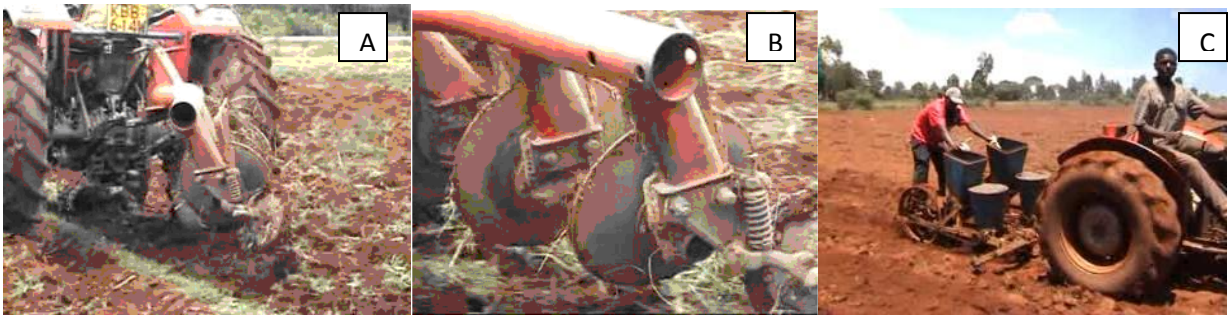

Figure 8: (A-B): Tracter drawn plough which exposes the soil to bare land (C) with no cover crops; planting done using locally designed tracter drawn planter.

5.1.2 Key CA Players, Their Roles, Capacity and Potential

In additional to previously discussed functions of specific organizations and the government, the role of key players in CA are summarized as follows:

Government: the government through the Ministry of Agriculture provides enabling environment for effective institutionalization as well as implementation of CA technology via Donor support, formulation of sound CA technology policies, provision of micro-finance institution and sufficient information collection, collation and dissemination.

Research institutions: initiate innovations/redesigning, designing CA tools and equipments. The institutions should develop seed banks as well as conducting adaptive research for crops and wonder trees they are compatible with CA policies. Such information is then relayed to the Farmers Training Centers (FTCs) for demonstrations to the farmers at the grass roots for effective implementation.

NGOs/UN-agencies/Foreign investors: these institutions are very good at sourcing for funding for effective programme implementation. Donor institutions normally gather data which are very good in training of personnel for extensive rolling out of CA technology among both small and

large scale farmers in the country. The information obtained therein is useful for bench marking CA technological adoption for effective food security as well as environmental conservation for sustainable development.

Churches/Religious groups/CBOs: these are important for information dissemination as well as reaching out to a large group of farmers. They provide fora for persuading people to adopt CA technology as vehicle for mitigating food security as well as environmental conservation strategy. The leaders of these groups tend to be more trusted by the members and thus the CA technology ideas may be easily assimilated by interested farmers in such groups.

Contact farmers: such farmers offer their fields to be used as schools for demonstrating new developments in CA technology to the member farmers. This is to ensure that the developments are achievable before they are adopted by the member farmers. It is also to ensure that the CA activities are done in the same environment where other farmers are using conventional approaches to farming thus they can observe the difference in productivity/yields as a result of adopting CA technology in farming business.

5.1.2.2 Facilitation Measures

Even though there are no government sponsored facilitation measures for CA programs in Kenya, NGOs such as SCC-VI provide farmers with incentives such seeds, fertilizers and extension services. However, CA facilitation could be structured in a similar manner the NALEP program works with the view of using it the modern electronic voucher system as practiced in Zambia.

5.1.3 Projected Potential Number of CA Farmers and Their Locations

If the Ministry of Agriculture can come up with vibrant policies on CA technology adoption in Kenya, almost all small scale farmers might wish to adopt the technology since it may make them both food secure as well as ensuring sustainable stable ecosystem. The research team believes that with effective training of CA technology personnel, provision of micro-finance and a general chain of input flow then CA technology adoption is the ultimate option for both food insecurity which is incessant in the country as well as threats posed by aridity due to destruction of both soils and water catchment areas as in the current case of Mau and Mount Kenya encroachments by conventional farmers.

5.1.4 Productivity/Yields

Productivity and yields associated with CA technological adoption are enormous. CA farming technique aims at sustaining high crop yields in the fields without jeopardizing soil resource conservation which includes both physical and chemical properties like: soil structure; water holding capacity; plant nutrient availability; air circulation; organic matter accumulation; and existence of living organism which may enable an effective soil ecosystem. A project by Kaumbutho et al. (2007) reported a case of wheat and barley farmer in Laikipia district. With conventional methods the farmer was running at losses because of high cost of production. However, when the farmer adopted CA technology the story changed. The farmer reported that

with zero-tillage he started realizing returns in the second season as there was significant build up of soil cover from crop residues. He was therefore able to restore the soil biomass by accumulating and spreading the crop residues evenly on the cropped fields after each harvest and did not allow livestock to graze freely on the field as he used to do. He allocated a field portion for grazing and was able to bale the wheat and barley stalks for livestock feed. The farmer controlled weeds immediately they emerged with herbicides to reduce seed accumulation within the soil which enabled him to reduce seed banks by 30%. Because of reduced cost of production, the farmer was able to expand the size of his field from initial 410 acres to 625 acres. The farmer's experience is an indication that with effective CA technology adoption, crop yields are increased; soil biomass accumulation raised and livestock feeds are readily available thereby controlling free grazing in the field after crop harvesting which normally result in removal of soil cover. In Siaya district the same report revealed that *Dolichos lablab* a legume that is drought resistant and is able to provide an effective soil cover is a wonder crop. The legume is able to provide edible leaves for both the farmer and his/her livestock; produce grain (beans); fix nitrogen in the soil; biologically sub-soils as a result of its deep and extensive roots. When it is intercropped with other cereals like maize and sorghum, it reduces termite attack which is a menace in the district by producing sufficient biomass for the termites to feed on. It has also been found to provide false host by producing chemicals that induce *Striga* to emerge but fails to support it to maturity. This has enabled control of the witch-weed which has seriously reduced cereal crop production in the district. In Eastern, Western, and Central Provinces, Chicken pea, *Dolichos* and Pigeon pea are grown. But *Dolichos* stands out to be the best for CA technology. In Central province, Kikuyu Community prefer it to be prepared for suckling mothers because it has high nutritive value and is very vital in milk production for babies

5.2 Analysis Of Policies, Strategies, Action Plans And Studies

In Kenya, CA policies and implementation may fall under the Agricultural Sector Coordination Unit (ASCU) established in 2005, as an inter-ministerial unit, to address the fragmentation of the responsibilities between different agriculture and rural development-related ministries tasked with implementing the Strategy for Revitalizing Agriculture (SRA) in Kenya. This was done in response to **Economic Recovery Strategy for Wealth and Employment Creation**. The SRA provides policy and institutional environment that is conducive to increasing agricultural productivity, promoting investment, and encouraging private sector involvement in agricultural enterprises and agribusiness to contribute to the reduction of poverty and hunger. Its initiatives are in tandem with stated government policies and strategies such as the draft National Food and Nutrition Policy and many others that root for sustainability in the production systems and reduction of prevalence of HIV/AIDs.

Under ASCU, the Kenyan Government has come up with AGRICULTURAL SECTOR DEVELOPMENT STRATEGY 2009 – 2020. As listed in this document, the Agricultural sector is the backbone of the national economy contributing directly 24% of Gross Domestic Product (GDP) and 65% of the export earnings. In addition, the sector provides the livelihood of over 80% of the Kenyan population and their food security. A number of guiding policies and strategies have greatly influenced the sector including Economic Recovery Strategy (ERS), the Strategy for Revitalizing Agriculture (SRA) and now the Vision 2030. Under the Vision 2030, agriculture has been identified as one of the key sectors to deliver the 10 per cent annual

economic growth rate envisaged under the economic pillar. However, Conservation Agriculture is not mentioned as part of the key strategies and action plans and is not given priority. However, elements of CA are dotted across the documents.

5.2.1 The Relevance, Lessons Drawn From The Policies, Objectives, Programs and Activities

The Kenyan approach "The AGRICULTURAL SECTOR DEVELOPMENT STRATEGY" of involving all participating ministries in the agricultural sector is an inclusive innovative approach that could be adopted by most African countries including the COMESA states. It offers an effective approach to water resource management in the Sub-Saharan Africa in tandem with the "blue revolution" where water is managed to boost the productivity and the sustainability of the agricultural sector. It redefines market access through enhanced development of co-operatives and agri-business; value addition to farm produce for future use and the involvement of the private sector in the agriculture sector. Key to its functions is the empowerment of the small holders and vulnerable households through credit facilities and microfinance systems.

5.3 Review Major Public And Private Sector Institutions And Their Responsibilities

In Kenya, the Ministry of Agriculture (MOA) has a National steering committee, under Deputy Director of Ministry of Agriculture who oversees the work of the National Coordinator and project field teams. The MOA closely backs up field work through its field officers, and the Rural Technology Development Centres with support of knowledge generated by the Kenya Agricultural Research Institute (KARI). MOA expects all donor funded projects to contribute in better capacity building and effective farm power management and utilization. After the World Congress on Conservation Agriculture organized its third Congress, based on the theme "Linking Production, Livelihoods and Conservation" from the 3rd - 7th October 2005 in Nairobi, Kenya a number CA based organizations sprung up. The congress was organized by African Conservation Tillage network (ACT), the Kenyan Ministry of Agriculture and the Kenya Conservation Tillage Initiative (KCTI) in association with the New Partnership for Africa's Development (NEPAD). Part of the results of this initiative included increased activities of non-governmental organizations in CA activities. In this case, CA-SARD expanded its initiatives in promoting improved socio-economic growth, food security and livelihoods in most parts of Kenya. As a result, a critical mass of trained farmers and extension workers and active and dynamic CA farmer field school groups were strengthened. In the long term, farmers were able to sustain increased food security in the project areas and knowledge and technologies acquired transferred by MOA to neighboring regions. Other participating Non-governmental Organizations in CA practices that improved livelihoods and the natural resources management included CIRAD (collaborating with CA-SARD), ICRAF and FAO. ICRAF, in particular, had a great impact on the agro-forestry practices in Western and other regions. Currently, it has working relationship through an MOU with SCC-Vi Agroforestry, a Swedish organization with the similar goals. Most of these NGOs provide direct financial support to the farmers through farm inputs, extension services and Farmer Field Schools. Other organizations include A Rocha Kenya, Christians working in practical community orientated biodiversity with activities centered in coastal areas such as Malindi

5.3.1 Research Institutions

The Kenya Agricultural Research Institute (KARI) is the premier national institution bringing together research program in food crops, horticultural and industrial crops, livestock and range management, land and water management, and socio-economics. KARI has branches all over the country and promotes sound agricultural research, technology generation and dissemination to ensure food security through improved productivity and environmental conservation. Research is also carried out in Farmers Training Centers (FTCs) and academic institutions such as Egerton University, Nairobi University, Maseno University and Masinde Muliro University of Science and Technology (MMUST). MMUST is coming as a leading technology centre in the production of farm tools such as ox-drawn ploughs, wheel barrows, water pumps and others. It does this using its state of the art industrial machines and the production unit that are capable of producing CA tools.

The general research themes are:

- Integrated Soil Fertility Management
- Irrigation and Drainage
- Land use planning research
- Soil and Water management
- Technology development and transfer

Work in these areas is complemented by NGOs such as Swedish Co-operative Centre and Vi Agroforestry (SCC-Vi). It operates in Nyando District, Rachuonyo District, Siaya District Kisumu District, Kitale and parts of Trans Nzoia District. Other research services are offered by the International Center for Research in Agroforestry *(*ICRAF) with regional branches but headquartered in Nairobi.

5.3.2 Institutional and Capacity Building Requirements

Successful implementation of CA activities in Kenya requires proper supply of CA farm inputs and infrastructure. The Government ought to invest heavily in the manufacture of CA equipments and proper road networks that links the farmers to the consuming markets. This will require a paradigm shift beginning with our Agricultural Policies.

5.3.2.1 National Level Requirements

Policy formulation on CA: the Ministry of Agriculture (MOA) should formulate policy on conservation agriculture that outlines training of its personnel to facilitate in CA adoption programmes; development/designing of CA tools and equipment; provision of support services to the farmers who adopt CA technology; streamlining of financial credit services to farmers; monitoring and evaluating successes made in adoption of CA; incorporation of donors, agencies, NGOs, CBOs and any other interest groups in the effective implementation of CA in Kenya.

In-service Trainings (INSETs) for extension officers on CA interventions: in-service programmes are important for agricultural officers in order to conceptualize CA technology. This may enable

them become effective while providing extension services to (contact) farmers involved in CA technology. In-service training of artisans is necessary in improving their skills in modification and designing of CA tools and equipment for effective implementation. Personnel in Agroforestry department may imbued with the knowledge and skills of identifying trees which can effectively be grown together with the crops to enhance soil cover. Seed technology experts may be enhanced with the avenues of getting acquainted with production, collection and creation of seed banks for provision of planting materials which effectively enhance CA technology adoption.

Budgetary allocation: although CA technology is not a new idea, its adoption as a food security strategy may require expansion of budgetary allocation to the Ministry of Agriculture. This is because the technology may require modification of farm tools and equipment to suit CA implementation among a large number of farmers and vulnerable households. It requires more funds to run both training and INSETs in terms of workshops/seminars in order to imbue the stakeholders with the desired knowledge, attitude, skills and values of CA technology. Provision of inputs to contact farmers is necessary in order for them to develop field schools which may enhance dissemination of CA technology at grass-root levels. This probably may be achieved by reviving Kenya Farmers Association (KFA) in the country through which a chain of inputs flow to the farmers may be achieved.

Monitoring and Evaluation: is an essential tool in bench marking the policy requirements and the extent of implementation process. Feedback is easily obtained through monitoring and evaluation that may enable the government report to the donors on how far their financial support has promoted CA programme. It also provides feedback on strengths and weaknesses in the programme for future considerations and/or correction.

Strengthening Field days and field schools via vibrant practical activities in FTCs: these are institutions which are in contact with farmers directly at grass-root levels. However; their activities are at times not sufficient as they only wait for field days. Their numbers are also few compared to the current number of the districts in Kenya. Increasing their numbers, strengthening their programmes, and providing them with right facilities for CA technology training is therefore vital for their effectiveness in handling CA programme implementation. More so, training of the personnel in the centers is imperative.

Strengthening agricultural education and extension services: once contact farmers have been identified, they need support to come up with field schools. Extension officers would of great help in enabling these farmers develop such schools which will be in turn used to train group members on CA technology.

5.3.2.2 Sector Level Requirements

Mobilization of CA interest groups like NGOs, UN-agencies, CBOs, households: CA technology implementation requires a multi-sectoral approach. Involvement of all stakeholders is therefore imperative for its success. The Ministry of Agriculture should therefore bring on board other Ministries such as Environment, Tourism and Wild Life etc to assist in the implementation. At grass-root level interest groups which include NGOs, UN-agencies, CBOs, Religious groups as well as vulnerable households should be mobilized towards CA adoption.

Promotion of CA intervention approaches like modified tools; no-till/minimum tillage; through ASK and other appropriate sectors: the Ministry of Agriculture should identify agro-based companies like Appro-tech; Universities with technology workshops; Agricultural Institutes etc in modification/renovation and designing appropriate tools and equipments for CA technology adoption. Such tools and equipments' use should be promoted via field days, Agricultural Shows and field schools.

Provision of credits to farmers who have fully adopted CA strategies: farmers may want to adopt CA technology but financial constraint becomes a hindering factor. Micro-finance organization should therefore be established which may enable farmers who are members of a field school access soft loans in terms of both cash and inputs in order to effectively adopt CA technology.

Improvement of Extension services: farmers require continuous support on new developments in CA technology. This can be achieved through effective extension services.

Establishment of field schools through contact farmers: field schools may enable organization of interested farmers into formal groups. This may be easy since the farmers may be offered both extension services as well as accessing loans from credit financial institutions. This may hasten the CA technology implementation process. Field schools also provide a ground on which any new developments are tried out first before rolling it out the rest of group members.

5.4 Design and Implementation Support

In most government activities at the national level, a National Forum of Stakeholders in the sector is organized regularly by the ministries and stakeholders. It is the highest decision making organ and it provides a platform for reviewing progress in the implementation of the strategy and the extent to which objectives are being achieved. Technical Working Groups (TWG) have been established to analyze constraints and opportunities in the SRA "fast-track" thematic areas. Membership of the TWGs includes ASCU staff, representatives of the private sector and Non-governmental Organizations, directors from the sector ministries and development partners. Typical implementation framework for sectors involved in sustainable land use management is shown I Figure 9 below.

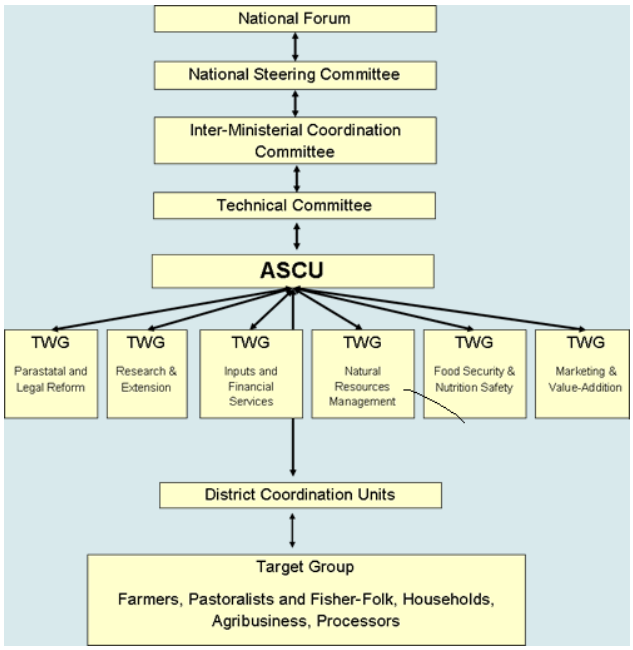

Figure 9: Organizational Structure of the Ministry of Agricultue, Kenya (Courtesy MOA website)

In this case, institutional frameworks for CA implementation are directly through existing government structures including the farm level agricultural extension–research establishments while donors take the responsibility of monitoring and evaluation as is the case with CA SARD projects. The MOA via KARI addresses regional and national agricultural constraints through on-farm, adaptive and applied research. Its implementation is typical to the Sida sponsored NALEP projects in a district. In this case, a District Stakeholder Forum selects a Division, with few or no development agencies active. An established Division Stakeholder Forum consisting of male and female farmers, project and NGO representatives, commercial representatives, and CBOs identifies a Focal Area embracing some 2000 households. The Division Extension Team, together with Field Extension carries out data collection, including poverty mapping and individual farm planning. Relevant opportunities are identified and Common Interest Groups (CIGs) formed based on farmers' choices.

The implementation matrix for CA projects in the country is not well defined. Donors are usually weary of loss of funds in the hands of MOA officials. As such, Kenya Non-governmental organizations such as SCC-VI overcome the barriers to the effective development and delivery of funds and farm inputs by dealing directly with the farmers. It has memorandum of understanding with other stakeholders such as Kenya Seed Company and others who use its plots for demonstrations. In addition, they have their own support staff that carry out extension services on model farmer plots dotted in their areas of jurisdiction. All these are in line with the Kenya Government policy on decentralization as well as on agriculture as documented in the Revitalization of Agriculture (SRA) and the National Agricultural Extension Policy (NEAP). Using this policy, interest groups, church organizations (e.g AROCHA Kenya) and CBOs channel their support directly to the farmers.

5.4.1 Proposed Model for Implementing CA

Due to constrain in CA implementation strategies a model that incorporates direct donor access to farmers and through institutional structures or interest groups is proposed. It is believed this model is in line with the current Government policy on decentralization of services and resources. However, where applicable, it will be imperative for donors to get government consent before embarking on CA projects. The proposed implementation matrix (Figure 10) is shown below.

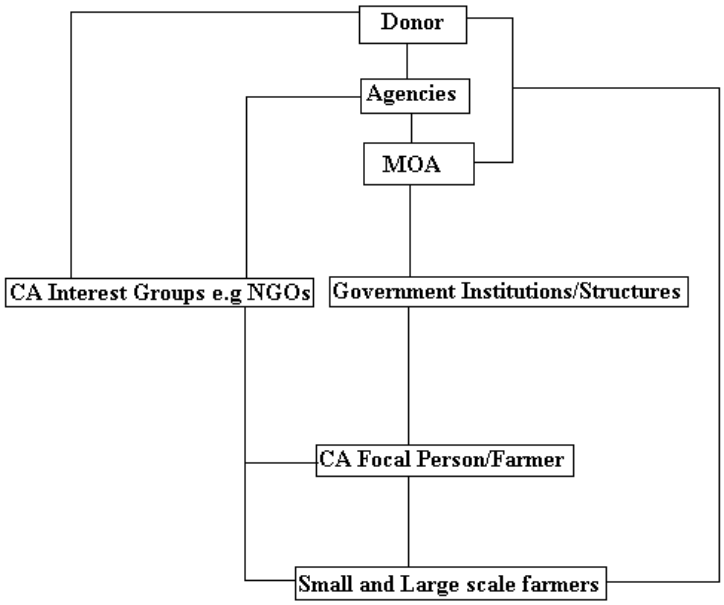

Figure 10: Proposed Organizational Structures for Implementing CA

5.5 Expected Results

It is believed that investment in CA technologies and reduced government bureaucracies in facilitating farmers will result into the following components:

Reduced release of green gases into the atmosphere: the biological processes take place in or on an effectively covered soil. Emissions of Carbon monoxide, Dinitrogen Oxide, Sulphur Dioxide (among others) which are released in the process of organic matter decomposition are therefore minimized.

High build up and sustained biological processes in the soil: the technology aims at least disturbance to the soil; this results in accumulation of organic matter; increased moisture retention; increased microbial activity as well as improved soil structure therefore enhancing a stable soil ecosystem.

High production per unit area: due to accumulated organic matter; high moisture retention; increased microbial activity, the soil has the ability to harvest *in situ* any little rainfall thereby enhancing effective provision of soil available nutrients to the crops thus high yield per unit area as opposed to conventional methods of farming.

Reduced pressure on farm land due to high population pressure: CA technology has a potential of high productivity per unit area. This implies that a small piece of land is capable of supporting a household's food security as opposed to the conventional approaches which require large tracts of land. This may be based on the argument that a fertile field can support a larger number of plants as opposed to an infertile one.

Effective purification of the atmosphere of green gases: more trees shall have been grown almost everywhere in the farm lands: reduced emission of green gases into the atmosphere implies that the air is purified of these gases which deplete Ozone layer thereby allowing Ultra-violet and Infra-red rays which are photosynthetically inactive and tend to destroy chlorophyll thereby reducing the production units within the green plants thus low pace of energy flow in the general ecosystem. CA technology adopts planting of trees together with crops. The trees normally gather dust on their leaves which would have been otherwise released into the atmosphere and hence causing air and water pollution.

Reduced pollution on both natural water sources as well as the atmosphere: as a result of eroded materials and/or emissions of green gases due to exposure of the organic processes in the soil: Some of the gases form acid rain like sulphurous acid which has decolorizing effect on leaves. In addition, eroded soil due to no vegetative cover are normally deposited in water sources thereby interfering with aquatic life as well as encouraging growth of obnoxious weeds such water hyacinth (in lake Victoria).

Conservation of wonder trees which currently face extinction: as a result of indiscriminate land clearing for conventional farming activity: leguminous trees have been found to enable fast accumulation of organic matter in the soil through direct fixing of nitrogen, dropping their leaves which contain higher amount of nitrogen compounds as well as effectively covering the soil surface. However, there are some trees which grow particularly in semi-arid and arid areas which tend to have thick mycorrhizae that assist in harvesting rain water *in situ* thereby making the regions where they grow moist to support the growth of crops. Such trees include: acacia, fig trees, *Makhamia spp*. etc.

Conservation of soil ecological status: as result of no-till/minimum tillage which disturbs least the soil living organisms: CA technology encourages no-tillage thereby causing minimum disturbance of the soil. This improves soil structure thus allows for more living organisms to infest such soil hence building an effective soil ecosystem which may be healthy for high production of crops.

Reduced cost of production which in turn leads to high farm profits: CA technology reduces the number of tillage and encourages direct planting and use of soil cover to smother weeds or use of herbicides when necessary. This tends to reduce cost of plowing, or manual labour involvement. All these are reflected in reduced cost of production. In addition, there is reduction in family labour as a result of high prevalence of HIV/AIDS among the most active population (youth), more children joining both primary and secondary schools due to their affordability in the country. CA technology therefore becomes a solution to this.

Increased production of legumes thus improving protein sources which is currently a problem since more cereals are produced at the expense of the pulses thus common food deficiency conditions among children and elder as well as people living with HIV/AIDS

5.6 Production of CA Tools

The small scale farmers have no CA tools. Marketing and distribution of these tools is not commonly reported and farmers use traditional hoe and pangas to prepare their land. However, with the advanced technology within the Jua Kali artisans, CA tools can be availed to farmers at a cheaper cost.

5.7 Concerns and Success Stories

Concerns

- Majority of Kenyan farmers lack awareness of the benefits of CA and this affects their willingness to commit to the new practices. Of particular concern is the fact that CA has been marketed in Kenya for over a decade and ground tilling methods in most parts of the country have not yet evolved to CA standards.
- Uptake of CA technologies is highest amongst wealthier farmers and commercial producers. This is partly attributable to stronger risk aversion on the part of the poor and the trend is further dampened by poor financial support to lessen costs associated with adoption. Majority of the NGOs equally identify contact farmers for purposes of running their projects in order to collect information to justify their expenditure to the donors at the expense of rolling the ideas to the venerable house holds.
- Farmers have a tendency to attribute higher yields solely to additional inputs at the expense of technology. Capacity building efforts are therefore needed to educate farmers on the synergies between CA and external inputs. Capacity building efforts should include training to minimize over dependence of farmers on handouts for CA inputs.
- A vast majority of farmlands in the lower Nzoia River Basin in the larger Siaya District and the newly created Bunyala Districts are still lying idle. Most of these lands are used for grazing animals and whose productivity is equally low. In these areas too, the presence of MOA field extension officers is not felt despite the massive investment by the government and donor agencies in sustainable land development for food security. In addition, majority of the population in these areas are laid back when it comes to farming; to them farming is not a business to rely on. The energetic groups are idlers, cyclist taxi riders or touts. Briefly, efforts geared towards CA are not visible.

Success Stories

In addition to information in section 5.1.4, a more focused CA related project sponsored by CFU is in progress. This is a follow up to COMESA sponsored CFU Kenya Pilot Planning Set up trip in Kenya (in early December 2009) carried out by an independent CFU consultant assisted by Wajibu MS – a local Kenyan NGO. The Zambian CFU had previously visited the country over the same during March and May 2009. To date, the project has several demonstration sites in Merewet in Eldoret, Kambi Ya Moto (Rongai District) and Laikipia District with 90 volunteer farmers. However, their output will be quantified at the end of the harvesting season around October 2010.

6.0 CONCLUSIONS

This case study presents the status of conservation agriculture in Kenya. Its introductory section outlines the overall background of the major ecological zones in Kenya, and conservation agriculture practices in general. It also gives a brief overview of major results and observations across all case studies.

Findings in this study established that most Kenyan farmers embrace elements of CA principles and practices (with the exception of tillage techniques). Common practices include mixed cropping systems related to Agroforestry/tree pruning, residue retention or cover crops. On-farm legume green manuring trials have been conducted in Karurina and Gachoka locations of Embu and Mbeere districts of Eastern Province, Kenya. Green manure legumes such as velvet bean (*Mucuna pruriens*) and sunnhemp (*Crotalaria ochroleuca*) have been introduced in smallholder farms for soil fertility improvement with a lot of success. In this region and elsewhere in the Nzoia River Basin, farmers plant nitrogen fixing legumes and animal feeds such as Calliandra, Luceana, Lucerne and Desmodium. Most small scale farmers still use the ox-drawn plough as opposed to the ripper technology. Equally, a number of large scale farmers in Kenya still use tracker drawn ploughs. However, most of them have up to date sprayers and planters, some of which are made locally by the Jua-Kali artisans.

Most of the CA equipments are not available in the local markets. Small holder farmers do not even know of their existence. Government efforts to avail them still remain to be seen and majority of Kenyan farmers have not adopted CA farming principles par-se even though elements of the practice are visible.

7.0 THE WAY FORWARD

The following measures ought to be taken by the government and its people:

- Mainstream the National Agriculture Policies to include CA principles and practices
- Carry out CA awareness campaigns all over the country
- Up scaling current CA practices to include minimum tillage or no till processes
- The government and its partners should encourage the manufacture and sell of CA equipments. This will require up scaling Jua Kali artisans and technology institutions
- Expanded irrigation and green house practices to be promoted in semi-rid areas
- Infrastructure and market to be provided for farm produce
- Capacity building efforts geared towards encouraging responsible management farm practices
- Farmers to be encouraged to adopt other forms of farming such as bee keeping and poultry

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The AGRICULTURAL SECTOR DEVELOPMENT STRATEGY 2009-2010

APPENDIX 1: **Sample Data Sheet on the Status of CA in Eastern and Central Provinces**

Zone: Eastern Province (Machakos and Makueni Districts- for Dry land Agriculture)

Smallholder-based C.A System (Vulnerable households)								
Farm & Region	Plot size (acres)	Types of Crops and Animals						
		Mixed cropping	Cereals	Legumes	Goats	Dairy Cows	Sweet Potatoes	Irish Potatoes
Farmer 1 (Machakos	5	nil	Sorghum & Maize	nil	nil	yes	nil	Nil
Mitigation measures and Priority Interventions								
	Remediation Measures	Organic Farming	Agroforestry	Irrigation practices	Basin tillage and shallow planting furrows	Ripper tines	Specialized no-tillage/direct planting seeder	
	Intercropping Minimum-tillage Spot-weeding Mulching	Necessary since the farmer uses fertilizers only	Acacia trees should be grown with crops instead of hedges		Should be encouraged for soil water conservation	Should used the forked jembes; ripper tines in land preparation	Ratoon should be encouraged. Slashing and direct planting; use of herbicides	
Current Best Practices In CA								
	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip cropping	Clean ripping	Open plow furrow planting followed by mid-season tied ridging	Mixed cropping and crop rotation	
	Practiced	nil	Done by applying cereal stalks	absent	Done by plowing the land using disc plows	nil	Mixed cropping nil since the farmer does not believe in the	

			to cover the soil surface				practice; crop rotation practiced by applying chicken and pigeon peas as well as maize

Available Technologies, Farm Tools, Equipments And Their Advancements					
	Hand hoeing	Hand-based and draft animal powered cropping system	No-till/direct planting seeders	Pest management practices	Soil and water management practices
	Locally made jembes (25 cm in length) Common during weeding	Used in primary cultivation	Nil	Chemical application	Mulching Ratoon cropping

Smallholder-based C.A System (Vulnerable households)								
Farm & Region	Plot size (acres)	Types of Crops and Animals						
		Mixed croppin g	Cereals	Legum es	Goats	Dair y Cow s	Sweet Potatoes	Irish Potatoes
Farmer 1 (Makuen i)	2.5	practice d	Sorghum & Maize; cassava	Pigeon peas; cow peas	yes	nil	Yes	Nil

Mitigation measures and Priority Interventions							
	Remediation Measures	Organic Farming	Agroforest ry	Irrigati on practic es	Basin tillage and shallow planting furrows	Ripper tines	Specialize d no-tillage/dire ct planting seeder
	Intercroppin g Minimum-tillage	Necessa ry since the farmer	Acacia trees; Gravellier; Mwarubai		Should be encourage d for soil water	Should used the forked jembes;	Slashing and direct planting; use of

	Spot-weeding Mulching Shallow planting furrows Direct planting(no-tillage)	uses fertilizers mainly	ne; Mukau; Luceana; Mangoes etc should be grown with crops instead of hedges		conservation	ripper tines in land preparation	herbicides should be encouraged
Current Best Practices In CA							
	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip cropping	Clean ripping	Open plow furrow planting followed by mid-season tied ridging	Mixed cropping and crop rotation
	Practiced	Developed to control soil erosion that is common in the area.	Done by applying cereal stalks to cover the soil surface	Present by intercropping pigeon peas wide spacing with maize.	Done by plowing the land using disc plows	Nil	Mixed cropping commonly practiced by growing maize and pigeon peas. Very minimal crop rotation is practiced.
Available Technologies, Farm Tools, Equipments And Their Advancements							
	Hand hoeing	Hand-based and draft animal powered cropping system	No-till/direct planting seeders	Pest management practices	Soil and water management practices		
	Commonly done during primary cultivation; planting and weeding.	Panga for spot weeding; jembes and ox-drawn plows for primary cultivation	Nil	Culturally done by early planting. Chemical application on when invaded by army worms	Mulching Growing of drought resistant pigeon peas Filter strips Shallow planting furrows		

Smallholder-based C.A System (Vulnerable households)								
Farm & Region	Plot size (acres)	Types of Crops and Animals						
		Mixed cropping	Crops	Legumes	Goats	Dairy Cows	Sweet Potatoes	Irish Potatoes
Farmer 2 Kalaba Horticultural Group (Makueni)	8	nil	Baby corn; bananas; tomatoes; pumpkins; sugar cane; sorghum; brinjals; amaranthus; yam; spinach; capsicum	Pigeon peas; cow peas	nil	nil	Yes	Nil

Mitigation measures and Priority Interventions							
	Remediation Measures	Organic Farming	Agroforestry	Irrigation practices	Basin tillage and shallow planting furrows	Ripper tines	Specialized no-tillage/direct planting seeder
	Intercropping Minimum-tillage Mulching Shallow planting furrows Direct planting(no-tillage)	Necessary since the farmers uses fertilizers mainly	Acacia trees; Gravellier; Luceana; Mangoes etc should be grown with crops instead of hedges	Furrow irrigation	Should be encouraged for soil water conservation	Should used the forked jembes; ripper tines in land preparation	Slashing and direct planting; use of herbicides should be encouraged

Current best practices in CA							
	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip cropping	Clean ripping	Open plow furrow planting followed by mid-season tied ridging	Mixed cropping and crop rotation

	Practiced	Grass leys on ridges developed to control soil erosion that is common with furrow irrigation.	Done by applying grass to cover the soil surface	nil	Done by clean hoeing of the land	Present; enables controlling water within the planting plots.	Crop rotation commonly practiced. Farmers grow crops on pure stands.
Available Technologies, Farm Tools, Equipments and Their Advancements							
	Hand hoeing	Hand-based and draft animal powered cropping system	No-till/direct planting seeders	Pest management practices	Soil and water management practices		
	Commonly done during primary cultivation; planting and weeding.	Panga for spot weeding; jembes	Nil	Purely chemically controlled	Mulching together with shallow planting furrows.		
Smallholder-based C.A System (Vulnerable households)							
Farm & Region	Plot size (acres)	Types of Crops and Animals					
		Mixed cropping	Crops	Legumes	Goats	Dairy Cows	Sweet Potatoes	Irish Potatoes
Farmer 3-Kwa-Chai Hortcultural Group (Makueni)	20	present	Sorghum; baby corn; tomatoes; capsicum; bananas; brinjals; pawpaw; kales; cabbage; pumpkin	Pigeon peas; cow peas	nil	nil	Yes	Nil

			Maize; cassava					
Mitigation measures and Priority Interventions								
	Remediation Measures	Organic Farming	Agroforestry	Irrigation practices	Basin tillage and shallow planting furrows	Ripper tines	Specialized no-tillage/direct planting seeder	
	Intercropping Minimum-tillage Spot-weeding Mulching Shallow planting furrows Direct planting(no-tillage)	Necessary since the farmers uses fertilizers mainly	Acacia trees; Gravellier; Mwarubaine; Mukau; Luceana; Mangoes etc should be grown with crops instead of hedges		Should be encouraged for since not all farmers have adopted this	Should used the forked jembes; ripper tines in land preparation	Slashing and direct planting; use of herbicides should be encouraged	
Current Best Practices In CA								
	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip cropping	Clean ripping	Open plow furrow planting followed by mid-season tied ridging	Mixed cropping and crop rotation	
	Practiced	Developed to control soil erosion that is common in the area.	Done by applying grass to cover the soil surface	nil	Done by hoeing the land using jembes; herbicides used; hand weeding applied	Nil	Only crop rotation commonly practiced	
Available Technologies, Farm Tools, Equipments and Their Advancements								
	Hand hoeing	Hand-based and draft animal powered	No-till/direct planting seeders	Pest management practices	Soil and water management practices			

		cropping system			
	mainly done during primary cultivation; planting and weeding.	Panga for spot weeding; and jembes	Nil	Chemical application commonly practiced	Mulching with grass. Filter strips Shallow planting furrows; Uprooting; under-sowing; planting on ridges; grass leys; fallowing.

Smallholder-based C.A System (Vulnerable households)

Farm & Region	Plot size (acres)	Types of Crops and Animals						
		Mixed croppin g	Cereals	Legum es	Goats	Dair y Cow s	Sweet Potatoes	Irish Potatoes
Farmer 1 (Limuru)	3	practice d	Maize	Beans; cow peas		yes	Yes	Yes

Mitigation measures and Priority Interventions

	Remediation Measures	Organic Farming	Agroforest ry	Irrigati on practic es	Basin tillage and shallow planting furrows	Ripper tines	Specialize d no-tillage/dire ct planting seeder
	Intercroppin g Minimum-tillage Spot-weeding Mulching Shallow planting furrows Direct planting(no-tillage)	A common practice	Gravellier; Calliandra ; Luceana; etc should be grown with crops instead of hedges and ridges strips only.		Should be encourage d for soil water conservati on	Should used the forked jembes; ripper tines in land preparatio n	Slashing and direct planting; use of herbicides should be encourage d

Current best practices in CA

	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip croppin g	Clean ripping	Open plow furrow planting followed by mid-	Mixed cropping and crop rotation

						season tied ridging	
	Nil	Developed to control soil erosion that is common in the area.	Done by applying cereal and napier stalks to cover the soil surface	Present by planting callian dra and luceana on wide spacing with other crops.	Done by use of forked jembes	Nil	Mixed cropping commonly practiced by growing maize and beans; cow peas and kales. Very minimal crop rotation is practiced.

Available technologies, farm tools, equipments and their Advancements

	Hand hoeing	Hand-based and draft animal powered cropping system	No-till/direct planting seeders	Pest management practices	Soil and water management practices
	Commonly done during primary cultivation; planting and weeding.	Panga for spot weeding; forked jembes for primary cultivation	Nil	Mainly Chemical application; however; cultural control is occasionally done.	Mulching Filter strips Shallow planting furrows during dry periods; drip irrigation practiced; green house production common.

Smallholder-based C.A System (Vulnerable households)

Institution Visited	Plot size (acres)	Types of Crops and Animals						
		Mixed cropping	Crops grown	Legumes	Goats & sheep	Dairy Cows	Sweet Potatoes	Irish Potatoes
Bukura Institute of Agriculture (Kakamega District)	3	practiced	Maize, Tomatoes, Capsicum, Cabbage, Carrots	Beans; Garden peas	Yes	yes	Yes	Nil

Mitigation Measures And Priority Interventions							
	Remediation Measures	Organic Farming	Agroforestry	Irrigation practices	Basin tillage and shallow planting furrows	Ripper tines	Specialized no-tillage/direct planting seeder
	Intercropping Minimum-tillage Spot-weeding Mulching Shallow planting furrows Direct planting(no-tillage)	A common practice	Gravellier; Calliandra; Luceana; etc should be grown with crops instead of hedges and ridges strips only.		Should be encouraged for soil water conservation	Should used the forked jembes; ripper tines in land preparation	Slashing and direct planting; use of herbicides should be encouraged
Current Best Practices In CA							
	Basin tillage and shallow planting furrows	No-till tied ridging	Mulch ripping	No-till Strip cropping	Clean ripping	Open plow furrow planting followed by mid-season tied ridging	Mixed cropping and crop rotation
	Nil	nil.	Done by applying cereal and napier stalks to cover the soil surface	Present by planting callindra and luceana on wide spacing with other crops.	Done by use of jembes used by manual labor	Nil	crop rotation is commonly practiced. Pure forests
Available Technologies, Farm Tools, Equipments And Their Advancements							
	Hand hoeing	Hand-based and draft animal	No-till/direct planting seeders	Pest management practices	Soil and water management practices		

		powered cropping system			
	Commonly done during primary cultivation; planting and weeding.	Panga for spot weeding; forked jembes for primary cultivation	Nil	Mainly Chemical application; however; cultural control is occasionally done.	Mulching Filter strips Shallow planting furrows during dry periods; drip irrigation practiced; green house production common.