INSTITUTIONAL AND SOCIO-ECONOMIC FACTORS INFLUENCING ADOPTION OF CONSERVATION AGRICULTURE WITH TREES IN KARATU AND MWANGA DISTRICTS, TANZANIA

ELISARIA SAMWEL NASSARI

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF THE SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

A study was carried out to assess institutional and socio-economic factors influencing adoption of Conservation Agriculture with Trees (CAWT) in Karatu and Mwanga districts in Tanzania. Ten (10) villages practicing CAWT were purposively sampled 5 from each district and a total of 100 respondents were randomly selected for household survey from village register. In addition Focus Group Discussions in PRA and desk reviewing of major policies related to CAWT were employed. Logistic regression model was used to determine the influence of socio-economic factors on CAWT adoption and results indicate farmer's age influences CAWT packages adoption. Age was found statistically significant ($P<0.05$) on Minimum Tillage/No soil Turning signaling an indicator that socioeconomic factors contribute to slow CAWT adoption rate. Sex and education level were found to be statistically insignificant ($P<0.05$) but significant ($P<0.1$) for Cover Crop and Crop Rotation implying less influence to CAWT adoption. Education level and farm size did not vary much from one household to another due to elite rural-urban migration and women are highly dominated by men. Content analysis and in-depth review of the major policies showed that, Agricultural and Livestock Policy 1997, Livestock Policy 2006, National Land Policy 1997 and National Forest Policy 1998 do not have provisions on CAWT. Implementation of policy provisions however, mention pillars of CAWT as Minimum Tillage, Use of cover Crops, Crop Rotation and Farm-Trees integration in their statements. Policy analysis shows few SSFs with title deed, weak market links with less access to CAWT inputs which are not affordable. Institutional frameworks analysis shows poor coordination of CAWT amongst stakeholders and political support. The study recommends that, policy improving interventions be made, formation of CAWT coordinating body at national level, and farmers and extension officers be trained to increase awareness and knowledge on CAWT for speeding up its adoption rate.

DECLARATION

I, Elisaria Samwel Nassari, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my original work and that it has neither been submitted nor concurrently being submitted for degree award in any other institution.

Nassari, Elisaria Samwel
(M.Sc Candidate)

Date

The above declaration is confirmed by

Prof John F Kessy
(Supervisor)

Date

Prof Said Iddi
(Supervisor)

Date

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DEDICATION

I dedicate this dissertation to my father Samwel Nassari and my mother Dora Sumari and to my girlfriend Regina Domonko.

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ACT	Agricultural Council of Tanzania
AGITF	Agricultural Inputs Trust Fund
AGRA	Growing Africa's Agriculture
ANSAF	Agricultural Non-State Actors Forum
ASDP	Agriculture Sector Development Programme
ASDS	Agriculture Sector Development Strategy
ASLMs	Agricultural Sector Lead Ministries
AU	African Union
CA	Conservation Agriculture
CAADP	Comprehensive Africa Agriculture Development Programme
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology
CARE	International Development, Relief Services
CAWT	Conservation Agriculture with Trees
CIMMYT	International Maize and Wheat Improvement Center
CIPAR	Canadian Physician for Aid and Relief
DADPs	District Agriculture Development Plans
DALDO	District Agricultural and Livestock Development Officer
DANIDA	Danish International Development Agency
DFID	Department for International Development
ENVIROCARE	Environmental Human Rights Care and Gender
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field Schools

GTZ	German Agency for Technical Cooperation with Developing Countries
ICRAF	International Centre for Research in Agroforestry
IFAD	International Fund for Agricultural Development
JICA	Japan International Cooperation Agency
KDA	Karatu Development Association
KDC	Karatu Development Cooperation
LAMP	Land Management Programme
LSFs	Large Scale Farmers
MAFSC	Ministry of Agriculture, Food Security and Cooperatives
MARI	Mikocheni Agricultural Research Institute
MIFIPRO	Mixed Farming and Irrigation Improvement Programme
MVIWATA	Mtandao wa Vikundi vya Wakulima Tanzania
Nandra Eng.	Nandra Engineering Works Ltd.
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organization
Non-CAWT	None Conservation Agriculture With Trees
NORAD	Norwegian Agency for Development Cooperation
NSGRP	National Strategy for Growth and Reduction of Poverty
OXFARM GB	Oxford Committee for Famine Relief Great Britain
PADEP	Participatory Agricultural Development and Empowerment
RECODA	Research, Community Organizational Development Associates
SARI	Selian Agricultural Research Institute
SCAPA	Soil Conservation and Agroforestry Programme in Arusha
SFI	Soil Fertility Initiative

SIDA	Swedish International Development Cooperation Agency
SPSS	Statistical Package for Social Sciences
SSFs	Small Scale Farmers
SUA	Sokoine University of Agriculture
TFA	Tanganyika Farmers' Association
TFSC	Tanzania Farmers' Service Center
TOSCI	Tanzania Official Seed Certification Institute
TPRI	Tanzania Pesticide Research Institute
UDSM-IRA	University of Dar es Salaam Institute of Resource Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
URT	United Republic of Tanzania
WB	World Bank
WVT	World Vision Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Soil degradation has caused agricultural yields in many parts of Africa to fall by up to 50 % (UNEP, 2009). One of the main causes of soil degradation identified in Africa is inappropriate methods of soil preparation and tillage (FAO, 2000), characterized by intensive soil preparation using hand hoe or plough combined with removal or burning of crop residues (Rockström *et al*., 2009). Tillage-induced soil erosion is responsible for 40 % of soil losses which amount to/reach 150 tonnes/hectare annually in Africa (FAO, 2001). It also results in mining soils of plant nutrients by removing crop residues and leaching (Smaling *et al*., 1997, Quinones *et al*., 1997). Thus, the intensive and continued use of the plough has proven to be unsustainable in several climatic zones (FAO, 2001). According to Elwell *et al.* (1998) cited by Shetto and Owenya (2007), agriculture in East Africa is characterized by extensive ploughing, which has proved to be one of the major causes of soil degradation. In Tanzania, accelerated erosion has occurred since the pre-colonial period (Kaihura *et al*., 1999).

Conservation Agriculture (CA) is gaining acceptance as an alternative to both conventional agriculture and organic agriculture as a means of ensuring sustainability in soil/land resource use. CA is an agricultural practice that combines, in a locally adapted sequence, the simultaneous principles of reduced tillage or no-till; soil surface cover and crop rotations and/or associations. It is a practice that advocates the concept of sustainable intensification of production (FAO, 2009). It is not based on maximizing yields while exploiting the soil and agro-ecosystem resources. Rather, CA is based on optimizing yields and profits, to achieve a balance of agricultural, economic and environmental benefits (Dumanski *et al*., 2006).

Small scale farmers (SSFs) in Tanzania face daunting challenges in their soil replenishment efforts (Sanchez *et al*., 1997). Farmers who are willing, or obliged by circumstances, to reassess their farming practices and follow the path to more sustainable agriculture through CA, embark on a long journey that takes them several years and no journey appears to be linear. This is because there are various factors that motivate farmers to try specific CA practices, or which prevent them from trying the practices or from achieving success with them (Shetto and Owenya, 2007). Constraints facing SSFs need to be considered, since these challenges may not be experienced by Large-Scale Farmers (LSFs). An equally special category of SSFs are women. The constraints facing women SSFs may be an important part of the problem as women represent on average 46% of the agricultural labour force in the country (Gladwin *et al*., 1997).

The alleviation of these constraints through improved government policies will provide SSFs with more incentives to undertake soil replenishment investment. These policies may not, however, address the urgent short-term needs of resource-poor farmers (Sanchez *et al*., 1997). The vision now is of combined Agroforestry and CA as an integrated land use policy that addresses increase in yield and income generation, with environmental rehabilitation and the diversification of agro-ecosystems (Sanchez and Leakey, 1996). A practice such as Agroforestry that promotes soil cover and crop rotation greatly promotes Conservation Agriculture with Trees (CAWT) (FAO, 2009; FAO, 2010). CAWT is a practice that combines the practices of CA with those of Agroforestry. CAWT adds to the fourth principle of CA which is tree-crop intercropping, hence promoting good management practices (Mowo and Kiwia, 2009). Hence, CAWT may hold the long term key for solving the problems of soil degradation and for adoption to be successful, enabling policies and institutional frameworks need to be in place.

1.2 Problem Statement and Justification of the Study

1.2.1 Problem statement

According to FAO (2009), one of the reasons for the slow adoption rate of CA and Agroforestry practices is socio-economic factors and unfavorable policy environments. If for example land tenure is insecure farmers are likely to have little motivation to sustainably invest in managing crops, livestock and land resources, instead their main concern will be the maximum extraction of resources (Kaumbutho and Kienzle, 2007). For CAWT to become a reality for smallholder farmers in Karatu and Mwanga districts in Tanzania, understanding the extent to which the existing National Forest Policy (1998), Agricultural and Livestock Policy (1997), National Land Policy (1997) and Livestock Policy (2006) policies offer incentives or disincentives to the adoption of CAWT is important (Shetto and Owenya, 2007). Also, there is no documentation on how institutional and socioeconomic factors influence the adoption of CAWT in Tanzania despite a study carried out by Shetto and Owenya (2007) on the application of CA principles, making use of natural processes, how is CA responding to local climatic conditions and soil qualities as well as technological conditions and how CA is being practiced in the study sites which has not articulated issues related to CAWT. The focus of the study was hence to identify, analyze and document institutional and socioeconomic factors influencing adoption of CAWT.

1.2.2 Justification of the study

According to GTZ Sustainet (2006), to be able to accelerate the adoption and reap the benefits of CAWT, institutional and socio-economic constraints need to be known by all responsible stakeholders. In many instances, CAWT activities are carried out in isolation by various actors and institutions. This suggests that CA can best be promoted in collaborations with the existing CBO structures active at the community level hence the

need for formal institutional frameworks to incorporate existing local institutions in the efforts to scale-up adoption of CAWT. Institutional mechanisms are required to ensure that CAWT is seen as a concept beyond agriculture and promote it as a theme ensuring effective linkages between Research and Development (R&D) activities. CAWT needs to aim at broad sense of contributing to livelihood strategies and move towards forming more structures/ frameworks with appropriate commercial/agribusiness strategies to create environment for increased rural employment in areas where it is adapted. There is also no coordination among all the various actors and stakeholders that develop and promote CAWT technologies. The study results therefore, forms a basis for wide adoption of CAWT in the study sites and also make a useful tool for decision makers in fast tracking the adoption of CAWT.

1.3 Objectives

1.3.1 General objective

The general objective was to assess the existing institutional and socio-economic factors influencing widespread adoption of CAWT by small scale farmers in Tanzania.

1.3.2 Specific objectives

The specific objectives were:

(i) To identify and analyze the institutional frameworks and major policies that influence CAWT adoption in Tanzania;

(ii) To identify major existing agricultural development initiatives that integrate CAWT focused intervention among small scale farmers in Tanzania;

(iii) To understand the communities' perception and knowledge of CAWT.

(iv) To analyze socio-economic factors affecting the adoption of CAWT.

1.4 Research Questions

(i) What is the extent of adoption of CAWT?

(ii) What are the major institutional and socio-economic factors influencing CAWT adoption in Tanzania?

(iii) Are there specific policy incentives and disincentives existing for small scale farmer investment in CAWT in Tanzania?

(iv) What are the major agricultural development initiatives that can integrate a CAWT focused intervention among the small scale farmers?

(v) What is the local communities' perception towards conservation agriculture?

(vi) How do institutional and socio-economic factors influence the adoption of CAWT?

1.5 Conceptual Framework

There are various institutional and socio-economic factors that contribute to adoption of CAWT in Tanzania as shown in Fig. 1. If these institutional and socio-economic factors are addressed, they can contribute to widespread adoption of CAWT. The key to reversing the slow adoption rate of CAWT trend is by considering institutional incentives such as bottom-up extension support structures, regular farmer trainings on CAWT and farmer-tailored research strategies. Empowering policies to both SSFs and LSFs have the potential to increase adoption of CAWT, as the existing policy benefits are mainly confined to the latter. Market development where output prices offer higher profit margins as compared to input prices also have the potential of motivating SSFs, who mostly have a low capital endowment to adopt CAWT. Resource security including land tenure, affordable credit facilities, provision of goods and materials such as CA equipment (i.e. rippers, subsoilers, direct planters) and seedlings are other factors that can highly motivate the SSFs to adopt CAWT. Moreover, socio-economic factors for example

age, education level, farm size, farmer's age and sex in the family can significantly affect the CAWT adoption.

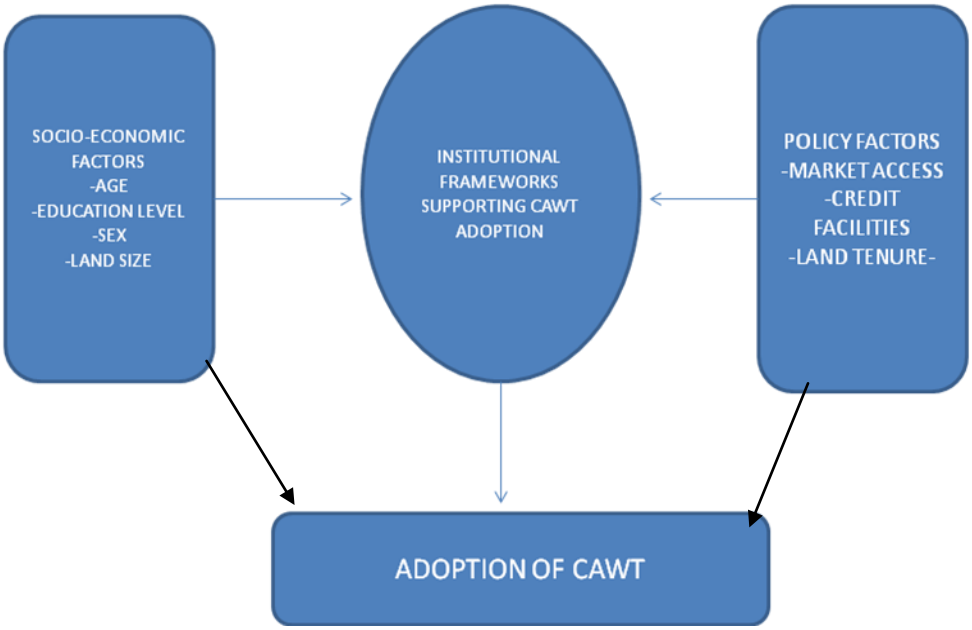

Figure 1: Conceptual framework for CAWT Adoption

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Agricultural Strategy and Policy Context in Tanzania

Much of the published work on the deteriorating food situation in Africa highlights increasing nutrient depletion as a cause of declining soil fertility and therefore low productivity (Cobo *et al*., 2010; Haileslassie *et al*., 2005; de Jager *et al*., 2001; van den Bosch *et al*., 1998a; Smaling and Fresco, 1993). Other studies suggest that the deteriorating African food situation at this stage may not be so much a problem of soil nutrient depletion and declining soil fertility but of low external inputs accompanied by a rapidly growing population hence the need to scale-up fertility replenishment practices from ten thousands to millions of African farm families (Sheldrick and Lingard, 2004). Land-related problems are often seen in terms of specific issues such as desertification, deforestation, nutrient depletion, pollution, biological diversity or climate change. The use and husbandry of land are complex and many-faceted, which demand a holistic and integrated approach to address the broad range of goals and objectives of the multiple users that are perceived to be important (FAO, 2001). Many projects and teams tend to focus on technical issues such as tillage, cover crops, weed control and implements at the field scale. This focus often implies less attention is given to non-technical issues, for example rural finance, marketing and value chain development, organizational or policy issues (Shetto and Owenya, 2007).

The agricultural development strategy in Tanzania has the primary goal of self-sufficiency in basic food needs (URT, 1998). The focus of agricultural policy reforms has been to produce more food to enhance food security, and then to alleviate poverty. The reforms improved conditions for the markets to perform, but there has been insufficient

support to allow the huge number of SSFs to use the new opportunities. Both structural and policy factors contribute to the generally poor performance of the agricultural sector and the rapid rise in poverty and food insecurity (URT, 1997). Sustainable agriculture offers solutions to many of the problems facing agriculture in Tanzania. For these solutions to be effective, policy changes are needed (GTZ Sustainet, 2006). In the long-run, the alleviation of these constraints through improved government policies will provide farmers more incentives to undertake soil replenishment investment (such as cost-sharing, local access to credit with affordable interest rates) FAO (2001). Policies that influence prices, for example by raising farm-gate prices, can influence increased farmer investment in land management, especially in smallholder areas with secure tenure (Koning and Smaling, 2005).

2.2 Conservation Agriculture Practices in Africa

CA is being practiced in a number of countries as traditional soil and water conservation practices by specific communities or at the pilot project scale throughout Africa. The simultaneous application of the three principles of conservation agriculture started recently and has emerged in several places, most notably in South Africa, Zimbabwe, Zambia, Kenya and Tanzania. CA has spread rapidly in Ghana from a handful of farmers in 1996 to 350 000 by 2002 through Monsanto and GTZ (Kaumbutho and Kienzle, 2007). Malawi is beginning to have renewed interest and has currently 47 000 ha under “some form” of CA involving 5 407 groups of farmers. Out of the 47 000 ha at least 1000 ha can truly be said to be under CA (FAO, 2009). In Tanzania, CA is being promoted especially in Arusha region through indigenous and nonindigenous technologies, as a combination of crop and crop–livestock production practices that make land more productive even as it improves the resilience of natural resources. According to Clare Bishop-Sambrook (2004) who conducted a study on CA in Karatu and Babati districts, the results showed that the

two districts have had varied experiences with regard to the introduction of CA through both indigenous and nonindigenous technologies, although both originated from concerns about the impact of conventional tillage practices on land degradation. Both districts commenced with sub-soiling in the latter part of the 1990s. In Karatu this was followed by the introduction of cover crops while Babati placed more emphasis on reduced tillage systems. Key stakeholders have played a major role in driving these initiatives forward: Selian Agricultural Research Institute (SARI) and Tanzania Farmers' Service Centre (TFSC) in Karatu, and the Land Management Programme (LAMP) together with Soil Conservation and Agroforestry Programme in Arusha (SCAPA).

Most of the indigenous and non-indigenous technologies are intended to improve the soil organic matter content and enhance the moisture retention characteristics of the soil through increased vegetative cover. The resulting organic matter accumulation plays an important role in maintaining the quality of the soil through greater biological activity. It improves the soil structure, contributes to better aeration and determines to a large extent the capacity of the soil to hold water and to exchange nutrients for optimum plant growth. Some of these technologies that have been developed include:

i. **Mulching:** Mulch farming maintains surface residues on tilled land. Crop residues are useful in conserving the soil, controlling water runoff, improving soil physical conditions and increasing soil fertility. In situ mulching is fairly commonly practiced in the country. The practice has declined as a result of the other competitive use of the crop residues such as feed for livestock, fuel and building materials. Mulching however is still practiced in banana and coffee areas and in horticultural crops, in areas of high rainfall such as Arusha, Kagera, Kilimanjaro and Mbeya Regions.

ii. **The Iraqw system:** This is an intensive crop management system practiced by the Iraqw tribe in northern Tanzania. In this hilly area, the entire crop residues in the field and manure from stall-fed cattle is incorporated into cultivated ridges. Terraces are made to control soil erosion, and fodder is cropped on the edges of the terraces for the cattle, being supplemented with grass from fallow fields. Trash lines and cut off drains are also used to slow down surface runoff and to increase infiltration.

iii. **The Wachagga homegardens:** The Wachagga homegardens are characterized by an intensive integration of numerous multipurpose trees and shrubs with food crops and animals simultaneously on the same piece of land. A typical Mchagga homegarden consists of a three storey arrangement, with large trees such as *Albizia* and *Gravillea* forming the uppermost storey, banana and coffee canopies forming the next lower storey and fodder, herbs, and grasses forming the lowest layers (Fernandes *et al.,* 1981). The system provides a continuous ground cover protecting the soil against erosion, and a high degree of nutrient cycling through the accumulated mulch while the trees provide fodder, fuelwood and fruits.

iv. **Improved Fallow Systems:** Improved fallows consist of deliberate planting of selected fast growing trees or shrub, usually leguminous species to improve the fertility of the soil largely through Biological Nitrogen Fixation. Improved fallow species such as *Cajanus, Tephrosia, Gliricidia, Sesbania* grow very fast providing a fast cover and protection to the soil. In some areas such as Mbulu, Karatu and Arumeru farmers relay the maize crop and pigeon peas so that when the maize is harvested the pigeon peas remains in the field to protect the soil. Livestock is prevented from feeding on the pigeon pea and consequently the maize residue is also retained in the field. Therefore, the soil is better protected through this combination.

v. **Green manure crops:** Green manure crops refer to plant species that can be incorporated into the soil while green to allow for fast decomposition and release of plant nutrients particularly nitrogen. Green manure crops are usually legumes that fix atmospheric nitrogen and the litter accumulated adds on organic matter to the soil.

vi. **Legume -Cereal Crop Rotations**: Legumes form an important component of smallholder farming systems in Tanzania (Koinange, 1988). Inclusion of legumes in farming systems involving rotation of crops benefits the cereal crops through biologically fixed nitrogen contained in the legume residues. Other advantages of crop rotations include more efficient use of moisture and soil nutrients, since different crops exploit different layers of the soil for moisture and nutrients. In addition to soil fertility improvement, legumes grown in rotation with other crops will enhance control of some pests and diseases, which is also an important feature of CA (Calegari, 2002).

Ryoba, (1996) revealed various CA practices in Mwanga District. The technologies seem very useful for water and soil management in semiarid areas. These practices were; traditional cultivation methods, biological measures, water harvesting technologies and soil harvesting and conservation technologies. When Ryoba asked farmers how they manage their soil and water explained that the best method of the effective soil and water management was to adopt suitable tillage practices for soil, crop and climatic conditions. Generally, large clods increase infiltration capacity. For this purpose, the indigenous practices of Ichimba (deep digging with a hoe or ploughing with ox-drawn ploughs), increase the infiltration capacity of the field whenever it rains. Ploughing, manuring and mulching improve moisture supply to the crop. Residue management e.g. Trash lines and piles protect bare soils. However, they reported that crop residue has greater value for

feeding livestock. The study also observed that farmers were preparing the land with minimal disturbance of the soil surface (making holes for planting without tilling the whole land unit a practice called *Kitang'ang'a* also known as *Zero/Minimum Tillage***.** The practice is used when farmers are late in land preparation before the rains. They make use of the rains that have already wetted the soil by direct sowing the seeds in the field. Soon after the germination they start weeding. Kitang'ang'a discourages rapid surface run-off during heavy rains protecting washing away of the topsoil thus conserving the soil. It also reduces gully formation in the field due to rapid run-off. Grass strips between planting lines hold the silt and discourages erosion. In the eastern and western lowlands resided by the pare farmers, they have traditionally made wide planting holes called *Kitengo*, adding farm yard manure at each planting time making a suitable depression for concentrating run-off where the seeds are and enhances infiltration and germination. Other useful technologies that were observed are the use of stone bunds, grass strips, barrier hedges and trash piles. These technologies are both important for water and soil management (Critchley *et al*., 1992).

2.4 Agroforestry Practices in Tanzania

Agroforestry system has been practised in Tanzania since time immemorial (Otsyina *et al.*, 2010). The system has the ability to improve soil fertility and communities' livelihood by ensuring soil nutrients availability and food security. Agroforestry technologies like Homegarden practiced by Wachagga in Kilimanjaro and fallowing experiment in Morogoro by SUA, agrosilvopastral practiced by Wameru in Arusha and others which just involve integrating trees (woody perennials) with herbaceous crops, livestock, bees, or aquatic life in the country have proved increased yield productivity with soil conservation. In Mafiga, Morogoro, Tanzania relay cropping of *Sesbania sesban* with maize, have shown to multiply crop yields more than 3 times (1.2 – 3.5 tons/ha per year)

with woody perennials harvested at two intervals (Lulandala, 2009). The 2004 National Agroforestry Strategy envisions four million rural households adopting and benefiting from Agroforestry practices by 2025. Its goal is that by 2020, Agroforestry technologies are adopted and contribute to improving the livelihoods of 60 % of the country's resource-poor households. This goal complements the National Strategy for Growth and Reduction of Poverty (NSGRP), which aims to increase household income while conserving the environment.

2.5 Conservation Agriculture With Trees Practices

The vision in Tanzania National Agroforestry strategy (2004) by 2025 is of Agroforestry as an integrated land use policy that combines increases in productivity and income generation, with environmental rehabilitation and the diversification of agro-ecosystems (Sanchez and Leakey, 1996). CA should be integrated with previous practices, such as soil and water conservation and Agroforestry (Shetto and Owenya, 2007). Some components of Agroforestry have been fully compatible with CA especially by integrating trees in the three pillars. The "fertilizer tree", *Faidherbia albida*, is remarkable in that it sheds its leaves, which are rich in nitrogen, at the start of the rainy season, just when the crop will benefit most from the added nutrients. During the growing season the tree is bare, therefore it does not block light and warmth to the crops. The roots of the tree reduce soil erosion. Its pods are used for fodder, the thorny branches are used for firewood and fencing, and it is even used as medicine (FAO, 2010).

In Tanzania, Agroforestry and contour construction is traditionally widely used, especially near Mt Meru (Kaihura *et al.*, 2001). They have been practiced since colonial times and integrate well with CA in conserving water and soil (Shetto and Owenya, 2007). In Meru Central District in Kenya, farmers are willing and able to plant a wide

variety of tree species, particularly when their direct benefit to the household is clear. There is a heavy reliance on *Grevillea robusta* and other exotics such as *Eucalypts* to respond to market demands for firewood and timber. Farmers' tree planting activities are also limited by the lack of coordination of germplasm supply, leading to a limited diversity and quantity available at the farm level (Carsan and Holding, 2006).

2.6 National and Regional Agricultural Development Initiatives

The Government of the United Republic of Tanzania has adopted the Agricultural Sector Development Strategy (ASDS, 2001) as the framework for achieving the sector's objectives and targets for the mainland. The objective of the ASDS is to achieve a sustained agricultural growth rate of at least 5 % per annum, primarily by transforming the predominantly subsistence to commercial agriculture. This transformation is geared towards increased productivity and profitability of agriculture and implemented by the private sector through an improved enabling environment for enhancing the participation of investors in particular the private sector. An Agricultural Sector Development Programme (ASDP), developed jointly by the Agricultural Sector Lead Ministries (ASLMs) and Development Partners, as an instrument to implement the ASDS, provides the overall framework and processes for implementing the ASDS. Development activities at national level are based on the strategic plans of the ASLMs, while activities at district level are being implemented by Local Government Authorities (LGAs), based on the District Agricultural Development Plans (DADPs).

Within the framework of the Soil Fertility Initiative (SFI) in Kenya, the World Agroforestry Centre has been identified and evaluating options for soil fertility replenishment in East and Southern Africa. Two years after introducing identified options in farmers' fields, 8700 small scale farmers in western Kenya had adopted two of them:

biomass transfer with the use of the wild sunflower *Tithonia* as a green manure to high-value crops such as French beans, tomatoes and kales, as well as improved fallows with *Crotalaria* sp., *Tephrosia vogelii* and *Sesbania sesban* (FAO, 2001). The CAWT Programme is spearheaded by the New Partnership for African Development NEPAD (Comprehensive Africa Agriculture Development Programme pillar 1), in collaboration with ICRAF, African Conservation Tillage Network and other stakeholders. The programme aims at working with national partners in Kenya, Tanzania, Zambia, Malawi, Ghana, Mali, Niger, Mozambique, Ethiopia and Uganda in order to scale up CAWT to reach 2 million households by 2012, five million by 2015 and 10 million by 2020. In Phase I, the focus is on 4 countries namely Kenya, Tanzania, Zambia and Ghana (Mowo and Kiwia, 2009).

The Comprehensive Africa Agriculture Development Programme (CAADP) provides the framework for African countries to achieve economic growth and food security through the transformation of the agricultural sector. This reflects the commitment of African leaders to broad-based agricultural development by directing the necessary resources to the sector and involving a broad range of stakeholders, but with a strong African leadership. CAADP was endorsed by all African Heads of State at the African Union Summit held in Maputo in July 2003. CAADP aims at promoting interventions that respond to the widely recognized problems that face agriculture in Africa. It recognizes the importance of prioritizing investments, opportunities and interventions, and of using new and innovative ways of addressing Africa's longest standing problems facing the agricultural sector. To achieve these goals CAADP focuses on four main pillars:

Pillar I: Extending the area under sustainable land management and reliable water management systems;

Pillar II: Improving rural infrastructure and trade-related capacities for improved market access;

Pillar III: Increasing food supply, reducing hunger and improving responses to food emergency crises; and

Pillar IV: Improving agricultural research, technology dissemination and adoption

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Areas

The study was carried out in Karatu and Mwanga Districts Fig. 2 and 3 respectively. These sites were selected as they form part of a larger research project being carried out by World Agroforestry Centre (ICRAF) on areas with potential for CAWT. Further, they represent contrasting sites with different agro-ecological zones hence an attempt to capture local views representing the country in semi- arid and humid areas.

3.1.1 Karatu district

Karatu is one of five districts in Arusha Region, in the northern part of Tanzania. It is located between latitudes 3°10'–4°00'S and longitude 34°47'E. The district covers 3300 km^2. Land use is classified as follows: arable land 102 573 ha; pastureland 155 808 ha; forest, bush and tree cover 61 218 ha; and Lake Eyasi 1060 ha. Karatu district borders Mbulu district to the west side, Ngorongoro district to the north, Babati district to the south-east and Monduli district to the east. It is the traditional home of Wairaqw. Other minor ethnic groups are the Wabarbaig, who are pastoralists, and the Wahadzabe who are hunters and gatherers. Rainfall in the district is bimodal: short rains fall between October and December and long rains (‘masika’) between March and June (KDC 2001). Rainfall may range from less than 400 mm in the Eyasi Basin to over 1000 mm in the highlands with rain zones classified as semi-arid (300–700 mm/year) and sub-humid (700–1200 mm/year) respectively. The wettest month is April. Rainfall varies considerably between years, especially in the semi-arid region, where the coefficient of variation of annual rainfall is 30–40 percent (Meindertsman and Kessler, 1997). Duration and intensity of individual storms are unpredictable. Rainfall intensity can be very high, causing erosion, particularly at the onset of the rainy season when soils are bare.

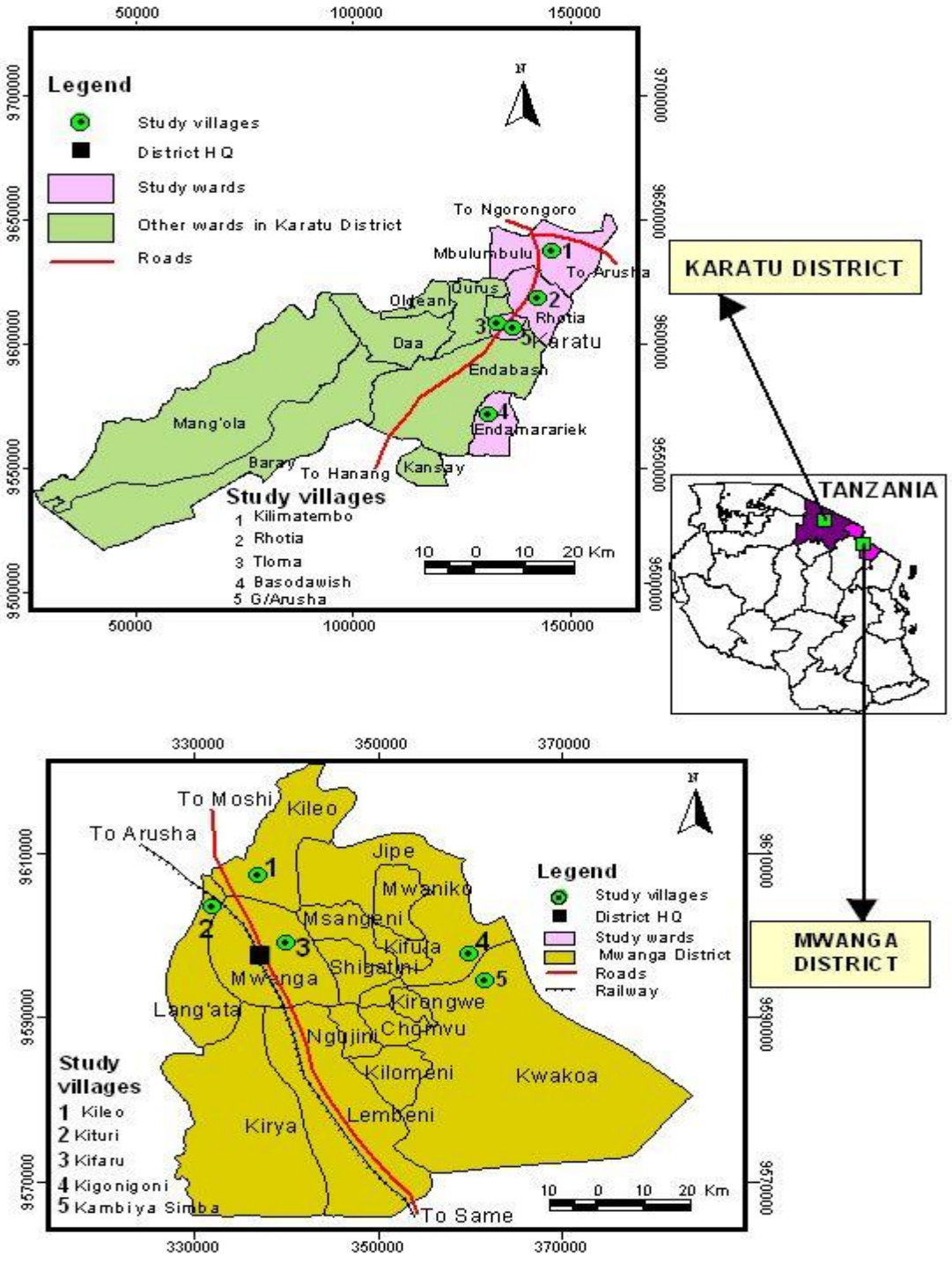

Figure 2: The Map of Karatu and Mwanga Districts showing study villages

Source: Sokoine University of Agriculture GIS Laboratory generated in September 2012.

3.1.2 Mwanga district

Mwanga district in Fig. 2 is one of the six districts of Kilimanjaro Region. The district covers 2641 km^2 and lies between the latitude 3°46' to 3°47' South and longitude 37°35' to 37°50' East. It is bordered by Same district in the South, Simanjiro district in the West, Moshi Rural district to the North, and Kenya and Lake Jipe in the Northeast. The district mainly comprises of the Eastern and Western Lowlands (700-1000 m ASL) and the North Pare Highlands (1300-2200 m ASL). The Eastern and Western Lowlands occupy 600 km^2 (22.72 %) and 1233 km^2 (48.21 %) respectively. The lowland areas include the water bodies of Lake Jipe and Nyumba ya Mungu Dam. The highland occupies only 808 km^2 (29.7 %). A number of small rivers, streams and springs originate from the mountains. Mwanga district has a population of 115 620 people, of which 55 666 are men and 59 954 are women (URT 2002).

The climate in Mwanga district is generally semi-arid which makes the district experience predominantly easterly winds which cause more precipitation (700-1000 mm/year) in the mountains and at the Eastern slopes because they are on the windward side of the highlands. In contrast, the Eastern and Western Lowlands are on the leeward side and receive less annual rainfall (500-650 mm) with occurrences of severe droughts. The effects on the leeward side where Lake Jipe is found are worse. On average precipitation is relatively low, with about 60 % of the yearly rainfall in less than three months (period mid-March to May). September is the driest month with, on average, less than 10 mm of rainfall (FAO, 1986 in Soil Appraisal, 1992). Temperatures range from a minimum of 16°C, between July and August, and 32°C between January and February.

3.1.3 Research design

Research design was cross sectional which allows data to be collected only once.

3.1.4 Sampling and sample size determination

Purposive sampling was used to get a sample a total of 30 key informants from local, district, regional and national levels which included government officials and NGOs key informants from the relevant sectors. Key informants were conceptualized to be individuals conversant with conservation agriculture.

To get respondents for household survey, a purposive sampling was adopted to get 3 divisions out of 4 and 4 wards out of 14 in which 5 villages engaging in CAWT in Karatu. These villages were Kilimatembo, Gekrum-Arusha, Tloma, Rhotia Kati and Basodawish in Karatu district and Kambiyasimba, Kituri, Kifaru, Kigonigoni, and Kileo in Mwanga district. The 5 villages from Mwanga were also purposively sampled from 4 out of 20 wards of which these wards were also selected purposively from 3 divisions out of 5. Random sampling was adopted to obtain respondents at village level using the village register. In empirical research, it is recommended to use large sample size in order to minimize errors in generalizing the findings. But according to Bailey (1998), such sample size is justified when facing time, financial resources constraints and for accuracy. A sub sample of 30 respondents is the bare minimum for studies in which statistical data analysis can be done (Bailey, 1998). Therefore, 50 respondents were sampled from each district making a total of 100 respondents for the study.

3.2 Data Collection

3.2.1 Primary data collection

The methods used to collect the data from the field depended on the research objective to be addressed as indicated in Table 1. This study combined various methods which helped the researcher to understand the communities' perception and knowledge on CAWT.

3.2.1.1 Desk reviewing of national policies

Desk reviewing of the Agricultural and livestock policy, National Livestock policy, National Land policy and National Forest policy documents provided very useful data on the effectiveness, efficiency and compatibility of national policy provisions in promoting or hindering the adoption of CAWT. A thorough analysis of policy subsections and statements through in-depth interviews with key informants from the respective ministries after going through the literature analysis of both the policy documents and other relevant documents was done.

3.2.1.2 Household survey

The household survey was conducted by administering questionnaires as a tool for data collection. Most of the questions in the questionnaire (Appendix 2) for the survey were closed and a few were semi-structured questions. The questionnaire was administered to 100 respondents. The researcher administered the questionnaires which were useful in identifying some people among the respondents for a follow-up and more in-depth interview on issues that appeared to be relevant and which were not originally accommodated in the questionnaire. During the interviews, all the respondents received the same questions in the same order, delivered in more or less the same manner. The open-ended questions were used to get different opinions from different respondents as Punch (2005) argues that closed questions in structured interviews would give little room for variation in responses.

3.2.1.3 Focus group discussions

The researcher in this case remained a facilitator, with a group of 20 participants in each district who are CAWT practitioners. He then introduced himself and the topic of concern in this case CAWT intervention then gave the floor to the participants to introduce

themselves and gave their background information and how they engage in CAWT. Then the facilitator started offering probing questions like what could be the socio-economic factors affecting CAWT in Kiswahili which was conversant to every participant. Every participant was given an equal chance to participate with an avoidance of verbal dominance when gathering the data on the socio-economic factors affecting CAWT in the study area, the extent of effect and suggesting solutions.

3.2.1.4 Participant observation

In this method as the researcher was conducting the household survey he was also observing different levels of each household engagement in the CAWT different pillars in their farmlands and gardens.

3.2.1.5 Checklists

The researcher administered checklists (Appendix 1) to Key informants from 6 NGOs, 4 government ministries and local government representatives. The NGOs were ANSAF, ENVIROCARE, OXFARM GB, CIPAR, Policy Forum and MIFIPRO. The ministries involved were Ministry of Agriculture Food Security and Cooperatives, Ministry of Tourism and Natural Resources Management, Ministry of lands Urban Planning and Settlements and Ministry of Fisheries and Livestock Development. During the interviews with these key informants the researcher focussed on identifying and analyzing the policy factors which are acting as incentives or disincentives for adoption of CAWT. In this case the researcher had to visit each particular office, meet the policy experts in these institutions and set an appointment for a thorough interview.

Table 1: Methods of data collection with respect to research objectives

Research Objective	Method for Data Collection
To identify and analyze the institutional frameworks and major policies that influence CAWT adoption in Tanzania.	Desk Review of National Policies of land, Agriculture, Forestry and Livestock, Household survey, Focus Group discussions
Identification of institutions and structure	Key informant interviews and office visits
To identify major existing agricultural development initiatives that can integrate a CAWT focused intervention among small scale farmers in Tanzania.	Household survey Participant observation
To understand the communities' perception and knowledge on CAWT.	Household Survey
To analyze socioeconomic factors affecting the adoption of CAWT	Focused group discussions Household survey Unstructured interviews

3.2.2 Secondary data collection

The secondary data was mainly obtained from SUA library, the government and NGOs offices, and sources of information were the policy briefs, manuals, books and journals.

3.3 Data Analysis and Presentation

The quantitative data collected during the field survey were at first coded, entered in the computer and analyzed using SPSS (Version 16). Descriptive statistics and frequencies were calculated for some variables and presented in the form of tables and percentages. Binary logistic regression analysis technique (logit model) Equation (1), allows the estimation of the probability that an event occurs or not, by predicting a binary dependency of the three pillars of CAWT (Minimum or No Tillage, Use of Cover Crops and Crop Rotation) from a set of independent variables (Socio-economic factors and institutional factors). Content analysis was used by the researcher when desk reviewing the policy documents and in the semi-structured interviews to have an in-depth

understanding of whether the policies are acting as incentives or disincentives for SSFs practicing CAWT.

Logistic regression Model

Logistic regression connects event probability (Adoption of CAWT variables) with independent variables (predictors). Considering that the dependent variable is measured by probability mass, and independent variables include continuous and category parameters, it is necessary to make a functional transformation of the independent variables into the interval 0–1(Prance *et al.*, 1987; Fanuel, 2000). Such functional transformation is done by function (1) which is called logistic, with Z parameter.

$$Yi = \frac{1}{1+e^{-z}} \qquad \text{...(1)}$$

i.e. $Z=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots\ldots\ldots+\beta_nX_n$

Where;

Y_i = is the binary variable with a value of '1' if the response in participation of a respondent in CAWT activities is yes and '0' if otherwise.

X_k = the independent variables (both socioeconomic and institutional factors)

X_1 = Education level of a respondent plays important roles in socio-economic development of a particular society as a tool for transferring knowledge and experience. Education tends to create awareness, self-reliance, stimulate self- confidence, motivation and positive attitude. So it was assumed to increase participation of respondents in CAWT activities since educated people have more access to technical information that enable

them to participate in new innovations compared to illiterate ones. Dummy variable with value 1 assigned for formal education or 0 if otherwise. Education was assumed to have a positive sign of the estimate β

X_2 = Age of the respondent in years is an important parameter in social analysis. Age differences can also be seen as a function of knowledge and experience as well as a measure of maturity of the individual. The age of an individual has an influence on the productivity as well as in the management of resource decisions. The age was assumed to have a positive sign of the estimate β. It was assumed that the increase in the age of the respondent increases participation in CAWT activities.

X_3 = Farm size, cultivated land size is an indication of the level of economic resource availability to farmers and the probability that a farmer would get better yield as the land size increases. It was assumed to have a positive sign of the estimate β because large land size is an indication of having enough space to practice the three pillars of CAWT activities.

X_4 = Respondents Sex (Male or Female)

X_5 = Market output and input prices control

X_6 = Access to credit facilities

X_7 = Land Ownership security

X_8 = Farmer tailored research approaches

X_9 = Number of times an extension expert visits the farmers

X_{10} = Existence of institutions promoting CAWT adoption

B_0 = Constant term of the model without the independent variables

$B_1$to β_n = Coefficient of independent variables showing the marginal effect (positive or negative) of the unit change in the independent variables on the dependent variables and these were used in developing prediction equations on participation of respondents in CAWT activities.

e = natural logarithm base (2.718)

i = 1 2 ……n; where n is the number of variables

Z = the combination of independent variables i.e $\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots\ldots+\beta_nX_n$

For interpretation of logistic regression results the researcher looked carefully at the behavior of the following:

(i) Wald statistic (t-value) to see whether the effect of a particular independent variable is statistically significant,

(ii) Sign of the effect of the logistic regression coefficient (β) to see whether the increase in independent variable increased or decreased the probability of success.

(iii) The magnitudes of the similarly measured variables to determine which of the independent variables seem to have greater impact on the Adoption of CAWT and,

(iv) The Exp (β) to see how much a unit change in Xi changes the odds of success

(v) Lastly assessed the results of different values of independent variables and made mathematical calculations to see how a change in the value of a particular independent variable affects the probability of success.

To assess the goodness of fit of the regression model to the data, three methods were used namely the model chi-square, the log likelihood ratio-test denoted by –2LL and the classification tables. By using the model Chi-square test, the significance level of the model was tested at 0.05 probability level. The magnitude of the –2LL value also

determined the goodness of fit of the model to the given data set, the smaller value of –2LL, the goodness of fit of the model.

The hypotheses tested were:-

Ho: β = 0 indicate that the regression coefficients are equal to zero and thus the dependent variables (adoption of CAWT activities) and the independent variables (socio-economic factors); against.

Hi: β ≠ 0 implying that the regression coefficients are not equal to zero and thus therefore there is either positive or negative effect between the dependent (adoption of CAWT activities) and the independent variables (socio-economic factors).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents and discusses the findings on socio-economic and institutional factors which influence adoption of CAWT.

4.1 Respondents' Characteristics

4.1.1 Age

Table 2 presents the age distribution of two categories of farmers that is those who practice CAWT and those who does not practice CAWT. The results show that the mean age was 54.5 and 44.5 years for SSFs practicing and not practising CAWT respectively. About 31 % of 78 % of the farmers who belonged to age category of 50 – 75 years practised CAWT while 5 % of the mentioned 22 % were NonCAWT practitioners. At the age category of 20 - 49 years, 17 % were not practising CAWT and 47 % were CAWT farmers.

The study aimed at assessing whether age differences affects the adoption of CAWT which then in this case the findings show that there is little difference in age composition amongst SSFs practicing CAWT and not practicing CAWT. Majority (32 %) of the respondents in the two farmers' category belonged to the age category of 40-49 years which is middle age (Table 2). These findings differ from Mazvimavi *et al.* (2009) who suggested that, older farmers are likely to have experience and will to practice Conservation Farming. However, this changes as they grow older as they become more risky avert which then brings the middle age to the best experience. The explanation for this could also be due to the fact that there were few youths involved in the agriculture including CAWT intervention due to scarcity of land in the study area. As the findings,

most of the youth left for paying jobs at a nearby Ngorongoro CA and Arusha town leaving behind the mid to old aged people.

Table 2: Age of respondents in the study areas (n = 100)

Characteristic	CAWT (%)	NONCAWT (%)
Age		
20-29	4	3
30-39	19	6
40-49	24	8
50-59	25	2
60-69	3	0
>70	3	3
Total	78	22

4.1.2 Farm size

Table 3 shows the respondents farm size. The table shows that 57 % of the farmers practising CAWT had farm whose size is less than 1.6 acres and those not practising CAWT with the same farm size were 18 %. Twenty one (21 %) and four (4 %) percent of the farmers practising and not practising CAWT respectively had farms with an area between 6 ha and 40 ha.

Majority of CAWT farmers (41 % of the 57 %) confirmed to have small farms which were less than 1.6 ha. With these results farmers who were practicing CAWT had their land pieces under different ownership and most of them were found at low elevation as different blocks. The farm size in this case does not support very well the integration of different components of CAWT at one block. The findings support earlier findings by Per Assmo (1999), who found that more than 69 % of the farmers in Arumeru district have a land size of less than 2.5 ha. Due to this fact land is highly fragmented. This land size

may be too small to consider incorporating Agroforestry trees, cash crops, and food crops on the same piece of land. However, farmers still practice individual component of CAWT in their small land pieces.

Table 3: Farm size distribution (n = 100)

Characteristic	CAWT (%)	NONCAWT (%)
Farm Size (ha)		
$0 \geq 2$	57	18
$2.4 \geq 4$	15	3
$4 \leq 16$	6	1
Total	78	22

4.1.3 Education level

Table 4 shows the respondents' education level. It indicates that the majority of the CAWT farmers (74 %) and of Non-CAWT farmers (20 %) had primary education, 2 % of both CAWT and Non-CAWT farmers had secondary education, 1 % of CAWT farmers and none of the Non-CAWT farmers had college educations and 1 % of CAWT and none of Non-CAWT farmers had informal trainings. Despite the fact that there were no persons with University education, the respondents were considered literate enough to be able to assimilate the lessons and techniques required for CAWT adoption. Machumu (1995) argued that education level is considered as one of the factors influencing the adoption rate of technologies in a society. The author further argues that years of formal education are associated with the highest level of comprehension of new technology. The implication here is that traditionally as Tanzanians acquire more of the advanced education levels they tend to do away with agricultural as their survival means and rather turn over to business or other administrative works hence the lower education level holders utilize this opportunity to invest in these technologies.

Table 4: Education level of respondents (n = 100)

Characteristic	CAWT (%)	NONCAWT (%)
Education level		
Primary	74	20
Secondary	2	2
College	1	0
Informal	1	0
Total	78	22

4.1.4 Sex

The findings in this study show that sex involved in the study was both male and female. CAWT farmers made 53 % males 25 % females whilst Non-CAWT farmers made 14 % males and 8 % females. Although most technologies are considered gender neutral but it is important to consider in what degree is the technology reaching female farmers. The turn-out of female farmers when asked for interviews and focused group discussions was small and showed to be less involved with research activities and issues related to family decision making. This could have a large negative impact on the adoption of CAWT. These findings are in-line with CIMMYT (1993) who argued that because women play a key role in most of agricultural systems, it is important that adoption studies consider the degree to which a new technology reaches female farmers. Similarly most of the food producers in Africa are women yet most technologies are promoted for men. Also Moshi (1999) contended that if women are endowed with equipment and or resources they can increase productivity through innovations utilization and can ensure a greater return on their labour. Therefore, there should be a way that female sex can be more involved for wide adoption in the study area.

4.2 Institutional Frameworks and Major Policies That Influence CAWT Adoption in Karatu and Mwanga Districts in Tanzania.

4.2.1 Institutions influencing adoption of CAWT

A number of institutions that influence adoption of CAWT were identified. These institutions range from the government research agency SARI (Selian Agriculture Research Institute), Seed Agencies and Agro-Input companies. Also NGOs seemed to have their part in promoting the adoption of this technology. Table 5 shows institutions identified during the study and the role they play in promoting the adoption of CAWT. As shown on Table 5, some institutions are active and others are inactive in promoting the CAWT adoption as a technology. The engagement of an institution in an activity which is CAWT-related was the baseline; farmers had to rank on the likert scale how best the institution has been engaging in a period of the past two years. The ranks were very poorly engaging (---), poorly engaging (--) moderately engaging (-), engaging (+), well engaging (++) and very well engaging (+++). As suggested by likert (1932), the typical justification is that Likert scale data are assumed to be interval scaled. The study finding are in line with (Fredrick *et al*., 2009) who suggested that for CA to become a true venture for SSFs the diverse providers of information and their investors need to be involved in broad programmes to develop the science and technology for CAWT. Such institutions include international agencies, multi-donor programmes, NGOs, national government staff, academic institutions, commercial organizations and agribusiness. Therefore without inclusion and appropriate assumption of responsibilities by these institutions in promoting CAWT, the adoption rate will still be slow.

Table 5: Institutions and their roles in promoting CAWT in the studied districts

Institution	The role played in Promoting CAWT	Status
SARI (Research Institute)	Conduct Training on the CAWT	+++
	Manage demo plots	+
	Conduct research on Seed and CAWT Tools	+
CIPAR (NGO)	Support SSFs through FFS trainings	+++
	Organize the SSFs groups and monitor CAWT	+
	Manage Demo plots in Karatu villages	+
MIFIPRO (NGO)	Promote Irrigation agriculture	
	Promote Agroforestry Activities in Mwanga District	+
		++
Karatu District Office (DALDO)	Coordinate tree planting programmes	
	Promote organic farming	+
	Provide extension services at ward and villages	+
		+
Karatu Development Association (KDA)	Support micro-finance project through trainings	--
	Had demo plots on varieties of crops e.g. Lab	+
	Promote sustainable energy activities	+
Tanzania Farmers Service Centre (TFSC)	Had demonstration plot with cover crops	---
	Sells agricultural machinery and spare parts	+
Tanganyika Farmers Association (TFA)	Main supplier of inputs e.g. Seeds, pesticides and fertilizers	++
	Promotes use of improved varieties e.g. Lab	+
Village(s) office	Promote the formation of bylaws	
	Implement the formed bylaws	+
	Translate the government policies to farmers	+
		–
Ministry of Agriculture, Food Security and Cooperatives (MAFC)	Make policies	+
	Promote the research on CAWT	++
	Ensure political audience and support	– – –

Key; (+ or -) indicates positively or negatively engaged in promoting CAWT currently

4.2.2 Institutional structure for promoting CAWT

Wide spectrums of actors who are responsible for implementation of CAWT as a technology were found in place. These actors include the Ministry of Agriculture Food Security and Cooperatives through different departments (Department of Agro-Mechanization, Seed department) which is centrally located in Fig. 3, The government through the prime minister's office linking to the local government authorities which govern the execution of laws and bylaws at the village level, different public research agencies for example (DRD, ICRAF, TAFORI, CIMMYT and SARI) which are the leading pioneers of CAWT in Karatu and now introducing it in Mwanga districts. Other actors are international development agencies and multi-donor programs (IFAD, WB, JICA, IRISH AID, AU, UNDP, DFID, GTZ, EU, DANIDA, SIDA, AGRA, and NORAD), NGOs (CPAR TZ, WVT, RECODA, CARE (TZ), and ACT (TZ), national government staff like extension officers and other service providers who provide inputs and CAWT equipment (TOSCI, TPRI, ACT, MVIWATA, Intermech, NANDRA Eng. and CAMARTEC), academic institutions (SUA, UDSM-IRA and MATIs), commercial organizations and agribusiness for instance seed suppliers. One missing component in the existing system is the National CAWT Coordinating Body which is indicated in Fig. 3 which will link local government with the ministry of agriculture to ensure effective institutional functionality.

4.2.2.2 Approach and regulatory mechanisms

The mode of operation is still Top-Down Approach whereas the policies are still made at the Ministerial level and enforced at the village level. The institutions that are set up to promote and support CAWT need to be dynamic since CAWT is not static so that they can respond to farmers' varied and changing needs of which doesn't seem to be the case. Policymaking departments (agricultural policy, land policy, livestock policy and forestry

policy, environmental policy, water policy), research institutions and development program initiatives on which much of the technical knowledge of CAWT is based are engaged directly in overseeing what happens to CAWT in their plans, strategies and briefs. Since the extension officers are directly working with the farmers, sometimes the farmers raise issues of concern which takes a long time to get to intended sectors. This triggers a tremendous effect since in both Karatu and Mwanga Districts; extension officers play a big role in promoting CAWT at the village level. The extension officer-farmer interaction should be working effectively to ease the technology adoption. In this case that is regulated by what is called DAFTARI YA KILIMO which is a logbook/register to be at the village level signed by the extension officer every time he/she attends to farmers issues. This study didn't find any of those logbooks at all villages visited during the study.

These results are consistent with Shaxson (2006) who argued that, whatever technological combinations are used by farmers, R&D activities must help to assure that good husbandry of crops, land and livestock can occur simultaneously for the system to function well. Both the technical and social sciences must be combined with the views and opinions of stakeholders to develop technologies and systems that can be adapted to varying conditions facing farm families adopting CAWT as a way of farming. This means that the diverse providers of information – and their investors – need to be involved in broad programmes to develop the science and technology for CAWT. Such institutions include international agencies, multi-donor programmes, NGOs, national government staff, academic institutions, commercial organizations and agribusiness. Each brings a different expertise and understanding to the table. However, unless these are tied together within a common framework of understanding of the principles and benefits of CAWT, their potential synergy cannot be felt. One way forward would be to develop common

indicator sets to assess progress towards the environmental, economic and social benefits of CAWT which should be monitored and evaluated by the National CAWT Coordinating Body linking to the local government as shown in Fig 4. This would help promote CAWT as the sustainable alternative to tillage-based agriculture techniques, and to build a common basis for understanding the potential of CAWT for both large and small-scale farming communities.

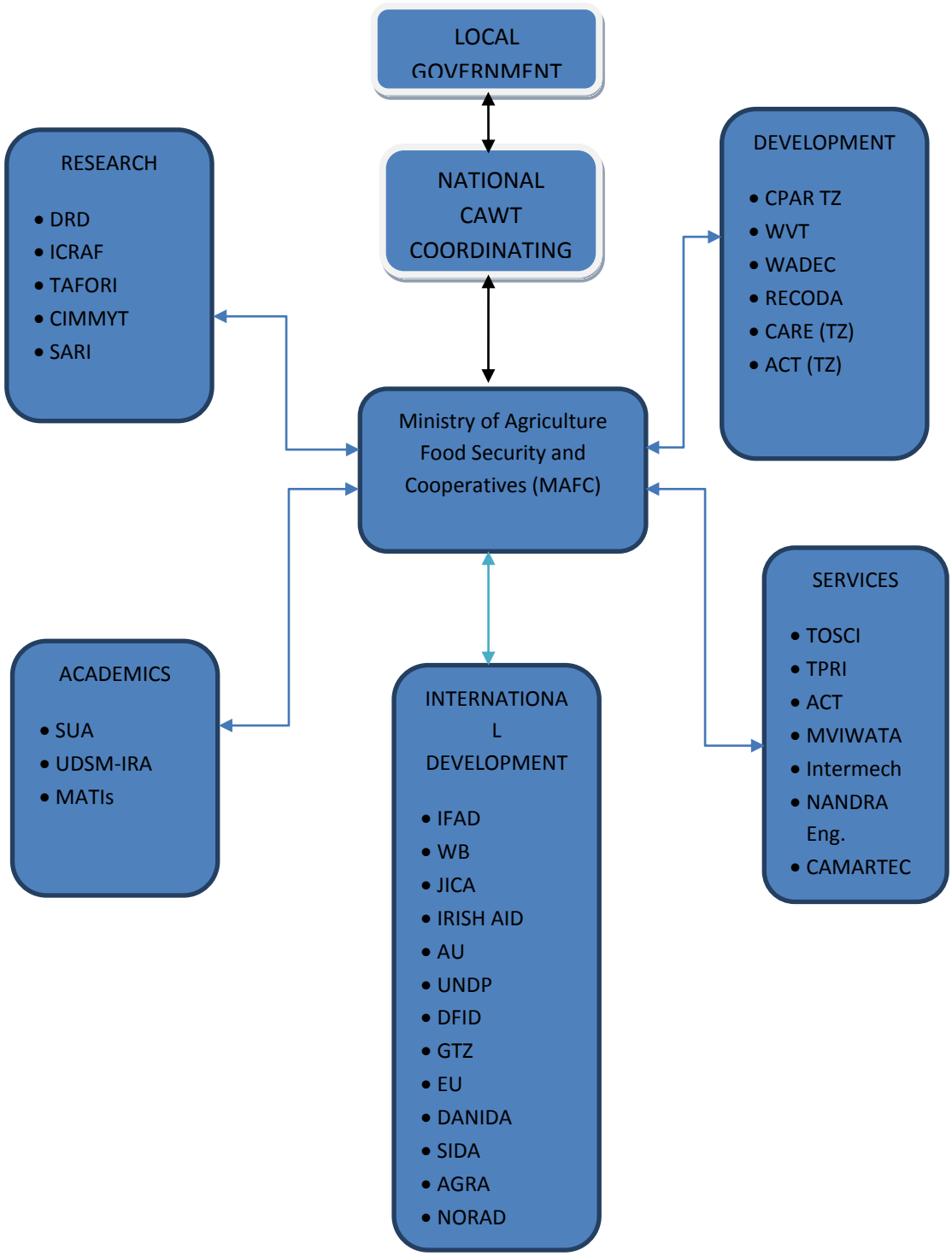

Figure 3: Proposed institutional framework for speeding up CAWT Adoption

4.2.3 Policy factors influencing the adoption of CAWT

4.2.3.1 National livestock policy

It was revealed when reviewing the livestock policy (2006) that the policy realizes that main cause of the problem of land tenure system, water and pasture resources is lack of proper arrangement to allocate land and give ownership of grazing areas according to traditional or legal procedures which is under section 1.3 (i) on Constraints to livestock development provision on land, water and pastures. Other causes are frequent changes of livestock grazing areas into crop cultivation, game reserves and the migration of livestock farmers that limit them to develop their areas. In this case the policy is working well as an incentive to CAWT on objective (iv) as it talks about *promoting integrated and sustainable use and management of natural resources related to livestock production in order to achieve environmental sustainability* (URT 2006). Also under section 3.5 Rangeland Resource Management in Pastoral and Agro-Pastoral Areas subsection 3.5.1 the policy well says; Range Utilization Communal grazing encourages free and uncontrolled movements of livestock from one area to another in search of pastures and water.

Such movements may lead to spread of animal diseases, social conflicts between livestock farmers and other land users, social delineation, environmental degradation and pollution, which is a good incentive if the animal random movements get controlled. However, the livestock policy acts to render a disincentive to CAWT when it talks about converting the crop residue and forages into edible products without specifying the level at what the crop residue and forages will be left for CAWT intervention. The implication of these findings is that although the livestock policy does not implicitly promote CAWT it still has some elements that talk about CAWT. For instance, objective (iv) on the Policy Objectives section states on promoting integrated and sustainable use and management of

natural resources related to livestock production in order to achieve environmental sustainability. This statement stands as an incentive to CAWT by itself but further the policy mentions Bio-gas utilization which is environmentally friendly as it reduces use of fuel wood thus minimizing deforestation, and fosters organic farming under section 3.8.3 on Manure and Bio-gas. This is compatible to CAWT in the aspect of integrating trees on farms.

The policy is of 2006 which came out a long time after the introduction of CA in 2002 in both Tanzania and Kenya. This indicates lack of proper policy coordination at the Ministerial level to mainstream sensitive cross cutting issues on the policy. *Policy statement (iv)* under section 3.5.4 on Forage conservation, the policy states that, appropriate forage conservation practices for dry season feeding will be promoted. *Policy statement (i)* under Draught and Animal Power section 3.8.1 it is well stated that, efforts will be undertaken to promote production and use of draught animals which is again another incentive for CAWT. Sensitization of CAWT awareness and formulation of a CAWT coordinating body at national level will promote coherence in policy and solve farmers' problems through CAWT. These findings are similar to Rodger (2006) who argued that national agricultural policy should support agricultural technology adoption, particularly where synergies between initiatives in research and extension, as well as in agricultural education, could be further enhanced. Therefore, since access to agricultural technology is moreover justified not purely on grounds of social equity but also on the basis of economic efficiency in resource use and, importantly, environmental sustainability, then there is a need for the livestock policy review to accommodate CAWT implicitly and not explicitly as the technology depends heavily on how things can be conducted between farmers and livestock keepers.

4.2.3.2 National land policy

The overall objective of the National Land Policy (1997) is to promote and ensure secure land tenure system, to encourage the optimal use of land resources and facilitate the broad-based social and economic development without upsetting or endangering the ecological balance of the environment. Narrowing down to specific objective 2.8 it is well said that the policy aims to protect the land resources from degradation for sustainable development (URT, 1997). This fits very well as an incentive to CAWT. The policy is however concerned with protection of only sensitive areas which include watersheds, wildlife, national parks, Areas of national heritage, seasonal wildlife migratory routes, beaches, border areas, small islands, mountains, forests, river basins and banks and areas of biodiversity. Conservation of soil degradation should be offered a due consideration irrespective of sensitivity unless the activity benefits outweigh the collateral soil damage. Since the policy does not include conservation of public and private lands it acts to be a disincentive to CAWT as a technology.

4.2.3.3 National forest policy

Policy statement *(5)* of Section 4.1.2 of the National Forest Policy (1998) on Forests on Public lands states that; *'on enabling sustainable management of forest on public lands clear ownership of all forest and trees on those lands will be defined. The allocation of forests and their management responsibility to villages, private individuals or the government will be promoted. Central, local and village government may demarcate and establish new forest reserves* (URT, 1998).' This section well acts as an incentive to CAWT although explicitly when it narrates about the tree tenure rights. Local people are afraid of losing the rights to use the trees on their farms with freedom. However since trees needs to be in farms constantly according to CAWT, tree management systems can be promoted at the local level by making the permits to cut and use trees in woodlots

available at the village office currently un-available. Policy statement (7) under section 4.1.3 the policy further talks about Private and Community Based Forestry *which states that private and community forestry activities will be supported through harmonized extension services and financial incentives. The extension package and financial incentives will be designed in a gender sensitive manner. Policy statement (9)* under subsection 4.2.1.2 on wood fuels under section 4.2 Forest-Based Industry and product wood fuels the policy realizes that the wood fuel is a constraint to local people and that situation endangers the existence of forests as most trees are converted to firewood and the forest lands converted to other land uses for example agriculture, therefore *the statement states that there will be establishment of private woodlots and plantations for wood fuels that will be encouraged through research, extension services and financial incentives* which again works as an incentive to CAWT if implemented.

Policy Statement (20) under section 4.3.2 of the National Forest Policy (1998) that talks about Watershed Management and Soil Conservation states that, *watershed management and soil conservation will be included in the management plans for all protection and production forests. Involvement of local communities and other stakeholders in watershed management and soil conservation will be encouraged through joint management agreements* (URT, 1998). Under this section, the policy act as a disincentive to CAWT as it does not include conservation of soil in the woodlots but rather in the watershed parse. However, the policy just realizing the importance of soil conservation is an incentive to any technology being implemented whether inside the forest area or outside.

4.2.3.4 Agricultural and livestock policy

Policy statement (v) under section (4) on Agriculture information and marketing of inputs and outputs, of the Agricultural and Livestock policy of (1997) *it is stated that, during the*

transition period the Ministry will continue to strengthening the input Trust Fund to facilitate availability of soft loans for local distribution of inputs. This is well working as one of the incentive for small scale farmers who are practicing different new technologies; however, since it is not implied to work directly for CAWT it is found to stand as un-explored opportunity. There are costs involved in making the transition from tillage-based agriculture to CAWT. The farming patterns which preceded a farmer's decision to switch production techniques may not have produced enough saved resources to allow him or her to accept all the potential risks associated with the changeover. Nor may it be possible for him or her to make the necessary investments in unfamiliar seeds (e.g., of cover crops) or to hire new equipment such as manual, animal-drawn or larger tractorized direct seeders. Once CA has become established on a farm, it has lowered costs and the higher and more stable yields then begin to generate sufficient resources to pay full commercial costs of these new inputs.

These findings concur with Salami *et al.* (2010) who did a research on opportunities and constraints for smallholder farmers in east Africa and found that at the local to national level, weak institutions, restricted access to markets and credit. These factors, including inadequate infrastructure, have constrained productivity growth of SSFs. Measures needed to improve productivity of smallholder farmers include ease of access to land, training to enhance skills and encourage technology adoption and innovation, and removal of obstacles to trade.

Ministry of Agriculture Food Security and Cooperatives, has a programme to modernize and mechanize agricultural sector called KILIMO KWANZA, the study finds out that the first items introduced under such a mechanization programme are tractors with ploughs or disk harrows. This does not only give the wrong signal, but it works directly against the

introduction and promotion of CAWT, while at the same time an opportunity is missed to introduce the tractors with no-till seeders instead of the plough, helping in this way to overcome this technology constraint.

4.2.3.5 Political support on CAWT

During the interviews with farmers who are practicing CAWT, almost 90% said that CAWT is lacking political support. The same incidence was observed again during an interview with one of the policy experts and a pioneer of CA since 1980s at the Ministry of Agriculture Food Security and Cooperatives Agro-Inputs unit. Without a government's high-level political commitment to favoring spread of CAWT, it will suffer from insufficient backup of positive support to the pioneer farmers who begin the changeover, such that increases in interest could falter or fail. Fredrick *et al*. (2009) argued that most countries in the continental Eurasia have not mobilized that high-level political commitment towards CAWT. Kazakhstan appeared to be the exception, and it is likely that other neighboring countries may soon follow suit.

Further, successes and failures in agriculture depend on the decisions and actions of individual farmers and how they manage the soil resource base on their farms. It is in this context that off-farm laws, policies, decisions, advice, market-prices and other forces are responding to or ignored. It is also the context in which changes in such forces aiming to favor the uptake of CAWT will be considered, ignored again, or be responded to and acted upon. This means that farmers everywhere need to take a leading role in the process of introducing and implementing CAWT practices on a large scale. But to take up this role they need a supportive policy environment and the backing of some key public and private sector institutions responsible for providing financial services, production inputs

including CAWT machinery and Agrochemicals, post-harvest processing, and operational research and know how.

4.2.3.6 Market development for farm produce and research

The study findings are that, the marketing systems of both agricultural and livestock commodities and inputs have mostly been liberalized in Tanzania. *Government roles are confined to provision of market information and monitoring market performance* and this is according to Agricultural and Livestock policy of (1997). These findings are consistent with Richard Shetto *et al*. (2007) who argued that agricultural business is currently operating under a free market system. Prices have to be negotiated and this has disadvantaged farmers, who are no match for private traders, who skillfully negotiate low prices. Prices may be extremely low during the peak season but could also be high during the off season. Sometimes during a year of bumper yields, farmers are forced to sell their crops at cheaper prices because the crop does not store well. But when food is scarce produce fetches high prices. Under the current system of free marketing, while there are always buyers, prices are often extremely low, especially at the farm gate where the price can be a half of what is obtained from markets in town centers.

4.2.3.7 Land ownership security

Land ownership security is an issue of concern. In our case most people proved to have less than 5 acres of land which was about 70 % of the entire sampled population. As observed during the household survey only 12 % of the sampled population of SSFs holds the title deeds. About 3 % just survive for hiring the farms on a seasonal basis so they are not in a position to possess the title deeds. During the review of the policy documents, according to the Agricultural and Livestock Policy 1997 section 3.2 Cross Sectoral Services (A) land it is said that;

"The agricultural sector is the main user of land resources in the country. The sector is characterized mainly by smallholder farmers. About 3.8 million smallholder farmers are in rural areas cultivating about 4 180 000 hectares. In order to modernize and develop agriculture it is of paramount important that the land tenure system assures smallholder farmers and livestock keepers' access and ownership of land. It is further well explained on a policy statement iv and v as follows; *Policy statement (iv) Right of occupancy shall include all rights over land acquired through direct grants, relevant customary procedures and alienation by legally designated allocating authorities. Policy statement (v) A right of occupancy as a title to the use and occupation of land shall be confirmed by a certificate of Title for the statutory right of occupancy. Customary right of occupancy will be confirmed by Hati ya Ardhi ya Mila which will be issued by the village council and registered at the corresponding district land registry"*

The findings of this study are in line with a study conducted in Kenya by Oscar *et al.* (2011) who argued that Land ownership with title deeds accords the farmers the right to use (security of tenure) thus creating an incentive to the farmers to adopt new, long term and even riskier technologies. Similar results were found by Arellanes and Lee (2001) where they concluded that farmers with security of tenure were four times more likely to employ more of the new techniques due to security of land access and usage.

In this study the lack of legal titles deeds (whether customary or the formal legal ones) to land and effective bylaws to regulate communal resources, as well as resource constraints among farmers have partly made it difficult to practice CAWT effectively. Communal bylaws regarding grazing make it difficult for CAWT farmers who want to maintain permanent soil cover as neighbors' livestock feed on the crop residues. Unless this cultural behavior change and local bylaws are amended to protect CA farmers, it will be

difficult for smallholder farmers in Tanzania to effectively implement this new farming practice. It is not much about words said about the policy; it is about how implementable are the commands said of the policy documents to help SSFs match with time and the changing environmental challenges.

4.3 Agricultural initiatives for integrating CAWT amongst SSFs in Tanzania

4.3.1 Agricultural input trust fund

The existing agricultural development initiatives that were identified were of a different nature and kind. There is what is called AGITF which is an acronym for Agricultural Input Trust Fund which is a national initiative aiming to help SSFs reach the inputs. It has a function of importing and distributing the agricultural inputs to the village level.

4.3.2 District agricultural development plans

Another initiative which could be of use and helpful in integrating CAWT focused intervention amongst SSFs is the (DADPs) District project development initiative whereby farmers do gather in groups and write up a project under the supervision of the extension officers and when it is ready submit to the district for funding. This could work properly as the CAWT farmers are also in groups and can do write ups which will enable them in purchasing the CAWT tools. As witnessed by the farmers in the Gekrum Arusha village in Karatu District, they said since the planting season is short, it is a challenge for them to be able to utilize the CAWT tools owned by the group effectively to each group member. They can only have a small piece of land done and let the tools go to another member. This has a large impact on them as they can only try the technology but not fully practice it. If the development project fund will focus on helping CAWT farmers they can make their dream come true.

4.3.3 Participatory agriculture development and empowerment program

Participatory Agriculture Development and Empowerment Program (PADEP) have planned that through the Community Investment Subprojects and Farmer Group Investment Subprojects of PADEP communities and farmer groups will request financing for sub-projects. Some of these sub projects may involve the construction of irrigation infrastructure, such as small dams, water retention ponds and other water management schemes, as well as those related to improved agricultural technology and marketing of inputs and output. Within the context of integrating livestockers and sole farmers this initiative may help foster CAWT amongst SSFs.

4.4 Communities' Perception of CAWT and Knowledge on CAWT

The understanding of the SSFs on the three pillars of CAWT varies enormously as shown on the table below. Minimum/No Soil turning here again scored a lower ranking of 78 % which indicates that it is less practised by the farmers in both districts. Again this could be because of the difficulties farmers face in accessing the CAWT tools required for this particular pillar. Crop rotation fetched 89 % whilst cover crops ended up with 85 %. The findings are well indicated on Table 6. Farmers admitted that their understanding has somewhat been shaped by the trainings they received during the implementation of the intervention in Karatu but also in Mwanga District there existed what they called Kitang'ang'a which means ''No Soil Turning'' for quite a long time. It follows the same principle of the CAWT pillar and was meant to serve the same purpose according to the interviewed farmers. When further asked whether they are willing to practice CAWT in their land, 84% of the farmers in both districts responded yes, and 16 % responded no. The major reasons for those who responded yes were accruing to the ability of CAWT to increase yield, preserve soil moisture, conservation of soil nutrients and reduced labor. For those who said no, some said they have never tried the technology and not willing to

try, some said have tried the technology and it is risky and costly as the tools for CAWT are not affordable. When farmers asked a sole question whether they have heard of CAWT 55 % admitted to have awareness and knowledge about it and 45 % of the sampled population denied having knowledge and awareness. The implication in these results is that contrary to negative conceptualization of the researcher prior to undertaking the study that there would be a negative perception on CAWT, things went otherwise and found out that farmers positively perceive the technology and consider it a breakthrough and a warrant to having enough yield with less human labour, access to fertilizers and seeds if they are participating in the program.

These findings clearly show that despite the fact there is variation on the communities' perception and general understanding on the three different pillars of CAWT; however their general understanding is high. The finding support the earlier findings by Mararike (1999) and Crush (1995), opine that adopting universally applicable programs, such as conservation farming to rural development, is neither feasible nor desirable. For these scholars, it is imperative for rural development practitioners to move away from the orthodox position where rural farmers are perceived as pathetic, unknowledgeable, and conforming individuals to the realization that they are not historical and homogenous, but instead they are heterogonous and are characterized by multiple realities. Given such a scenario development interventions are therefore not transferable, each condition requires its own solutions and such solutions must be embedded in society's make up.

Table 6: Farmers' perception on the Three Pillars of CAWT (n = 100)

CAWT Practice	Response	Percentage
No Soil Turning		
	Yes	78.0
	No	22.0
Cover Crops	Yes	89.0
	No	11.0
Crop Rotation		
	Yes	85.0
	No	15.0

4.5 Effect of Socio-economic Factors on Adoption of CAWT

Adoption of CAWT seems mostly insignificantly influenced by the socio-economic factors which included farm size, education level, age and sex. Although most of these factors were found insignificantly affecting the adoption of CAWT the researcher strongly think they need to be taken into consideration. The reason for this thought lies on the fact that socio-economic factors are normally volatile and liable to change in different scenarios and locations with different ethnic groups. In this study most people found in the villages had primary education level, whereas the educated or people with higher education level would normally move and invest in either entrepreneurship or administrative fields in Karatu or Mwanga towns. The logistic regression model was observed to fit to the data shown by a significant level of 0.05 (Table 7). The Model Chi-squares 17.160 (cover crops), 12.592 (Crop Rotation), were not statistically significant ($P<0.05$) and Model Chi-Square 13.851 (No Soil Turning) was statistically significant ($P<0.05$) indicating that the independent variables slightly affected the adoption of CAWT technology. The -2log likelihood (-2LL) values of 99.492, 92.785 and 120. 751 also implied the model to have fitted the data well. The predictions were corrected showing the goodness of the fit at 73 %.

Table 7: Effect of socio-economic factors on CAWT adoption (n = 100)

	Dependent Variable: Adoption of Minimum or No Soil Turning					
	B	S.E.	Wald	Df	Sig.	Exp(β)
Education level	-.905	1.078	.705	1	.401NS	.405
Age	-3.137	1.565	4.020	1	.045S	.043
Farm size	.021	.045	.220	1	.639NS	1.021
Sex	.078	.215	.133	1	.715 NS	.925
Constant	-1.813	1.582	1.313	1	.252	.163
Dependent Variable: Crop Rotation						
	B	S.E.	Wald	Df	Sig.	Exp(β)
Education level	-.592	.514	.553	1	.249NS	1.326
Age	2.172	1.261	2.967	1	.085NS	8.772
Farm size	1.255	.120	3.600	1	.058NS	.227
Sex	.280	.576	1.323	1	.627NS	.236
Constant	-.739	1.400	.478	1	.598	.278
Dependent Variable: Cover Crops						
	B	S.E.	Wald	Df	Sig.	Exp(β)
Education level	1.383	.863	.141	1	.707NS	.324
Age	-.803	1.009	.633	1	.448NS	.426
Farm size	.050	.055	.827	1	1.052NS	.363
Sex	-.862	.588	3	1	.142NS	.422
Constant	.816	2.262	.368	1	.544	1.346

Key: Overall percentage of classification 1 percent, Model Chi-square17.160 (cover crops), 12.592 (Crop Rotation), and 13.851 (No Soil Turning) Negelkerke R square .229, .182 and .175 following the above order -2LL = 99.492a, 92.785a and 120.751a following the above order. p= 0.05; Ex (β) = Odds ratios (probability of success/ probability of failure), SE=standard error of the estimate, p-value or sign= significance, e=2. 718, β= regression coefficients which stands for the odds ratio of the probability of success to the probability of failure, *statistically significant at p<= 0.05 level of significance, NS= statistically non-significant at P > 0.05 and Wald statistics= $\beta/(SE)^2$ (Norusis, 1990 and Xie, 200).

4.5.1 Age

From Table 7, of all the socio-economic factors that were expected to influence the adoption of CAWT, age was found to be statistically significant at ($P < 0.05$) on Minimum/No Soil Turning pillar. Age of the respondents in this case was found to have a negative regression coefficient of value -3.137 and the odds ratio of 0.043 (Table 7). The finding show that, the increase in age decreases the odds of adoption to Minimum/No Soil Turning by a factor of 0.043 (Table 7). These findings were supported by participant observations whereby the respondents who agreed to participate in Minimum/No Soil turning amounted to 60 %. When cross tabulated the results between age of respondents and adoption of Minimum Tillage were 32 % of the respondents were

at the age of 40 – 49 categories of which 21% admitted to being CAWT- adopters whilst 11 % were Non-CAWT adopters. The respondents of 27 % were in the age category of 50 – 59 of which 15 % were CAWT- adopters and 12 % Non-CAWT adopters. Age of the respondent on adoption of crop rotation has a positive regression coefficient value of 2.172 and the odds ratios of 8.772 (Table 7).

These findings indicate that the likelihood of adoption of crop rotation increases by a factor of 8.772 for every unit change. This implies that an increase in respondents' age increases the participation in CAWT activities. The increase in odds ratio of the age of the respondents on Crop Rotation Adoption was not statistically significant ($P < 0.05$) but statistically significant at ($P<0.1$). These findings differ from Baidu-Forson (1999), who concluded that age negatively influenced the adoption of land enhancing technology in the Sahel. The difference in this case is because as farmers' age increases the more farming experience they gain, they see changes in soil fertility and their understanding on the role of crop rotation in solving this kind of problem. In the case of crop rotation and Cover Crop age of the respondents was found to be statistically insignificant at both ($P < 0.05$) and ($P<0.1$).

A study on the adoption of soil conservation in uplands in the Philippines, Lapar and Pandey (1999) showed that age influenced adoption decisions of contour hedgerows both positively and negatively in Cebu and Claveria respectively. In this analysis age effect could have been influenced by the changing life cycle of the farmer with time, and the effect on adoption of CAWT practices. As farmers grow older, they become more skillful, through learning by doing. But this trend attenuates as they reach middle age and their physical strength begins to decline. Also, with age farmers become more risk averse and less willing to adopt new farming technologies.

4.5.2 Farm size

Farm size has a positive regression coefficient value of 0.021 and the odds ratios of 1.021 (Table 7) on Minimum/No Soil Turning. These findings indicate that the likelihood of adoption of Minimum/No Soil Turning is affected by a factor of 1.021 for every unit change in this variable. This means that household with larger farm size is likely to have more space to practice Minimum /No Soil Turning comfortably than farmers with small farm sizes. The increase of odds of adoption of Minimum/No Soil Turning was however not statistically significant ($P < 0.05$). Farm sizes also have a positive regression coefficient value of 1.255 and the odds ratio of 0.227 on crop rotation (Table 7). These findings indicate that the likelihood of adoption of Crop Rotation activities influenced by a factor of 0.227 for every unit change in this variable. This implies that an increase in farm size increases the chances of a CAWT farmer to integrate the Crops on different seasons than the farmer with small farm size. The increase of odds of farm size on adoption of Crop Rotation was not statistically significant ($P < 0.05$) but significant at ($P<0.1$)

It was also found that the farm size has a positive regression coefficient value of 0.050 and the odds ratio of 0.363 (Table 7) on cover crops. This variable was found to be statistically insignificantly affecting CAWT adoption at ($P<0.05$). These findings are similar to a study by Korsching and Nowak (1983) that identified farm size as having significant bearing on decisions by farmers to adopt CAWT practices. Although most promoting agents initially determines the plot size, farmers subsequently change the size of their CAWT plots in response to observed productivity gains from the technology and possibly the need to intensify farm production. However, during the household survey it was also observed that, CAWT farmers tend to remain with small farm size as they do not

have enough CAWT tools to help them manage large CAWT farm sizes in a short season since most tools were to be shared by CAWT group members. Similar results were reported by Nowak (1987) who stated that the smaller farms have lower levels of diversification of land use, as competition and conflicts arise since there is a limitation to the number of uses applicable on the piece of land unless the uses are complementary.

4.5.3 Education level

Similarly the results in the Table 7 show that the education level has negative regression coefficient value of -0.905 and the odds ratio of 0.405, indicating that the likelihood of adoption of Minimum/No Soil Turning activities decreases by a factor of 0.405 for every unit change in this variable. However, the decrease in the odds of education level was not statistically significant ($P < 0.05$). Education level was found to have a negative regression coefficient of value -0.592 and the odds ratio of 1.326 (Table 7) on Crop Rotation. This means that the likelihood of adoption of crop rotation activities decreases by a factor of 1.326 for every unit change in this variable.

The implication is that an increase in the education level decreases the chances of a person to practice Crop Rotation. People in this region tend to switch to small business, trade and other options like white collar jobs in Moshi, Arusha which offers good tourism opportunities and other regions of Tanzania as they become more exposed to education. May be it is because of climatic conditions which makes it risky to invest in agriculture. The decrease of odds of education level was found to be statistically insignificant ($P <0.05$). Also education level was found to have a positive regression coefficient of value 1.383 and the odds ratio of 0.324 on Cover Crops (Table 7). The findings indicate the increase of adoption of Cover Crops by a factor of 0.324 for every unit change in this variable. The implication here is that the higher the educations level the more the

understanding of different uses of cover crops and how to integrate them with other crops to maximize yield. The increase of the odds of education level on cover crops was however not statistically significant (P <0.05).

The study findings are similar to different adoption studies such as Mbwambo (2000) who argued that education has a direct influence on peoples' participation in natural resources management and promote sustainable utilization of natural resources. Katani (1999) argued that an increase in the education level increases the awareness level and thereby creating a positive attitude towards adoption of technologies. Similar findings were reported by Faturoti *et al*. (2006) who argued that farmers' education level is a human capital variable used as proxy to indicate the ability to acquire and process information. The plausible explanation for a negative coefficient in education level in this case might be due to the fact that an increase in the education level tends to raise awareness, competence efficiency and self-reliant on other areas not related to agriculture for example business management and tourism. This was well supported by the respondents in the group discussions as the respondents said that farming in their communities was women and less educated people.

4.5.4 Sex

Sex was found to have a positive regression coefficient of value 0.078 and the odds ratio of 0.925 on Minimum/No Soil Turning (Table 7). The findings indicate that the likelihood of adoption of Minimum /No Soil Turning increases by a factor of 0.925 for a change in this variable. This implies an increase of adoption of Minimum Tillage activities by male farmer than when it is a female farmer. The increase of the odds of the male adopting Minimum Tillage over-female was, however, found to be statistically insignificant (P < 0.05). Sex was also found to have a positive regression coefficient value of 0.280 and

the odds ratio of 0.236 in Crop Rotation (Table 7). These findings indicate the likelihood of adoption of Crop Rotation by a factor of 0.236 for a change in this variable. Similar findings were found for adoption of Minimum Tillage in the above paragraph which is another pillar of CAWT. The likelihood of adoption of Crop Rotation was however found not statistically significant (P<0.05). The study findings for the case of Minimum Tillage and Crop Rotation are in-line with (Mazvimavi *et al.*, 2009) a study conducted in Zimbabwe for CF who argued that the male-headed households (sex) were more likely to adopt most of the eight components of the CF package. In Table 7 the findings reveal that sex has a negative regression coefficient of value -0.862 and the odds ratio of 0.422 (Table 7) on Cover Crops. The findings indicate the likelihood of adoption of Cover Crops decreases by a factor of 0.422 for a change in this variable.

The implication is that female farmers adopt more easily the cover crop technology than it is for men farmers. The decrease of the odds of female adopting cover crop technology was however not found statistically significant (P<0.05). These findings differ from Matlon (1994) and Adesina (1996) who concluded that men are more willing to participate in conservation agriculture than women as a result of sex based wealth differences. However the findings differ from the above authors in the case of Cover Crop adoption. However, the findings are similar to another study in Kenya by Oscar *et al.* (2011) who argued that the probability of females accepting a Conservation project is 0.03% higher than males, all other factors held constant. This implies that female headed families have a higher probability of accepting the projects. The analysis in this study is possibly because of the differences in the CAWT packages, which ultimately require different resources to be able to adopt them. Women are entitled to fewer resources in most places in Tanzania which implies less capacity in adoption of CAWT packages.

However, women are more involved in agricultural production system but less included in decision making on use of the net gain.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The aim of the study was to identify and analyze institutional frameworks and major policies that influence CAWT adoption. The institutions and their role in promoting CAWT were identified. The existing institutional structure was analyzed showing weak linkage that contributes to the slow adoption rate of CAWT. Major policies were reviewed and they were found to offer more disincentives than the incentives for CAWT adoption. Analysis of institutional frameworks reveals a weak stakeholders collaboration and coordination in promoting CAWT from local to national level which needs to be worked out for easy adoption of CAWT.

This study also intended to identify existing major agricultural development initiatives that integrate a CAWT focused intervention amongst SSFs in Tanzania. The major existing agricultural development initiatives for integration of CAWT focused intervention among SSFs in Tanzania remains which are still underutilized and unexplored opportunities were identified.

The study also aimed to find out the communities' perception and knowledge on CAWT. Although farmers and extension officers perceive CAWT as a good technology that they would wish to fully practice, their knowledge on CAWT is generally poor and also varies within the CAWT packages. Since analysis of Socio-economic factors affecting the adoption of CAWT was one of this study' prime objective, in this case these factors were found to have little influence on the slow adoption rate of CAWT. However, they still show signs of positive contribution to the slow adoption rate for CAWT intervention.

5.2 Recommendations

The study has drawn attention that can guide policy towards influencing CAWT adoption in recognition of its potential benefits. The study therefore, recommends the following:

A policy improving intervention for advocacy to address the major national policies to offer more incentives for CAWT adoption. The issues to be addressed are: Good market linkages and access; Land ownership security especially by offering the recommended title deeds and not just dwell on customary ownership which is of no much use when to be used as collaterals; input and output prices control aiming to increase the farm gate prices, avoiding middlemen and lowering input price through effective cost sharing schemes. The so called Voucher System apparently just considers farmers of certain income level and intended crop type for instance grain growers only which then automatically exclude growers of other types of crops.

The study further recommends formation of national CAWT coordinating body that fits in as proposed in Fig 4. of the institutional frameworks. This will help to coordinate all sensitive CAWT issues that cannot be solved at local level, forge the political audience and influence policy. This body should also monitor and evaluate CAWT progress in the country for proper implementation and success of CAWT adoption as a technology in case there are some specific difficulties on a particular CAWT package.

The major existing agriculture initiatives identified for instance AGITF, PADEP, and DADPs if utilized can support the integration of CAWT focused intervention amongst SSFs technically and resourcefully. Therefore the study recommends a strong need to

start linking up with these interventions as some of them are executed right in the study sites but remain so silent that farmers do not recognize that they can be very useful.

The study also recommends a need to keep up with training farmers and extension officers to improve their awareness and knowledge on CAWT to speed up the adoption. The modality of training should be farmers tailored approaches applied to encourage best practices sharing and equal participation. The composition of these trainings should include both farmers and extension officers in one room which will help regulate the farmer-extension officer gap which is a killer disease for perfect extension services

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APPENDICES

Appendix 1: Checklist for Key Informants from Government and NGOs

Checklist No….

CHECKLIST FOR GOVERNMENT INSTITUTIONS & NGOs HEADS OF DEPARTMENTS/SECTIONS/PROGRAMMES

Introduction

Hello, my name is **Nassari, Elisaria S**…I am working in collaboration with ICRAF within the CAWT Project. Part of this project involves conducting interviews with policy experts, small scale farmers, aimed at understanding local perspectives and needs for Conservation Agriculture.

Your sector/organization has been selected from all the sectors/organizations in the country. I would like to ask you some questions related to conservation agriculture. The interview may take between 45 to 60 minutes and participation is voluntary, so you may choose either to take part in it or not. All the information you give will be confidential and no specific names will be included in generating the final report.

Interview Start Time……

Name of respondent……

Title……

Institution/Agency/Agency……

Section/Programme……

Address…….Phone number……Email……

Date……..……..

PART A: BACKGROUND

1. How long have you been working with this organization/department/sector?
2. What is the scope or vision of the ministry/organization/sector?
3. What are the main activities that you execute under your section?
4. Have you participated in the project that promotes CA? if yes how long?

PART B: POLICY ISSUES

Policy as a tool for promoting or hindering the adoption CA & Agroforestry.

1. What are the opportunities offered by the ministry/sector/organization to CA?
2. How does the ministry/sector/organization communicate policy for the implementation of CA from national to village level?
3. Are there specific strategies and efforts that have been taken by the sector/ministry to promote CA?
4. What are the major challenges facing CA widespread?
5. Are there any bylaws related to the Conservation Agriculture in districts? If yes which ones? If no why?
6. What are the existing institutions which support CA and what is their framework of operation?
7. Are our laws, policies and institutions frameworks adequate for the CA adoption promotion?
8. What are the policy specific incentives or disincentives for adoption of CA in Tanzania?
9. What specific provisions in the policy that promotes or hinders CA adoption to SSF?
10. Do we have any Local Government laws in Tanzania passed by the chief/village head that talk about agriculture?

Yes ☐ **Give an example** ……

No ☐ ……

11. Have you heard of any National Government rules that talk about agriculture?

	Which are they?
On trees on farms	☐ ……
On soil erosion	☐ ……
On planting crops near rivers	☐ ……
On land issues	☐ ……
Any other (specify) ……	☐ ……
Don't know	☐

12. a) Would the following Government rules discourage SSF (in any way) to practice CA?

Rule on…….	**Specific rules**	**Yes**	**No**	**How?**
Trees on farms	The need for a permit to cut trees	☐	☐	…….. …… ……
	10% tree cover	☐	☐	…… …… ……
	Restriction on cutting and transporting specific trees	☐	☐	…… …… ……
	Any other rule on trees on farms (specify) …….	☐	☐	…… ……
Land ownership	No restriction of minimum land sizes	☐	☐	…… …… ……
	Any other rule on land ownership (specify) …… ……	☐	☐	**.....** …… ……
Crop farming rules	Promotion of irrigation agriculture	☐	☐	…… …… ……
	Extension officer-farmer trainings	☐	☐	…… …… ……
	Any other rule on crop farming (specify) …… ……	☐	☐	…… …… ……
	Any other rule on crop farming (specify) ……	☐	☐	…… …… ……
Any other agricultural rule? …… ……	……. …… …… …….	☐	☐	…… …… ……

(b) Do Government rules have any of these motivations for SSF to practice CA?

Examples of motivations	**Yes**	**No**	**In what way?**
Farm inputs not taxed	☐	☐	…… …… …… ……
Provision of goods &services at lower prices eg fertilizers	☐	☐	…… …… …… ……
Provision of good infrastructure eg roads, factories	☐	☐	…… …….. …… ……
Availability of grants (money that farmers don't need to pay back)	☐	☐	…… …… …… ……
Subsidized loans (cheaper loans)	☐	☐	…… …… …… ……
Cost-sharing arrangements (eg farmer contributes50%, Government contributes 50%)	☐	☐	…… …… …… ……
Accessibility to resources eg seeds, farm chemicals	☐	☐	**.....** .....…… ……
Input prices controlled	☐	☐	……

eg cost of seeds, farm chemicals			…… …… ……
Output prices controlled eg price of maize in the market	☐	☐	…… …….. …… ……
Land ownership security	☐	☐	…… …… ……
Accessibility& availability of basic inputs	☐	☐	…… …… ……
Support services for farmers	☐	☐	…… …….. …… ……
Market development for farm produce	☐	☐	…… …… …… …….
Credit facilities (farmer can pay later)	☐	☐	…… …… …… …….
Research &development	☐	☐	…… ……..
Extension services	☐	☐	…… ……
Any other (specify) …… …	☐	☐	…… …… ……
Don’t know	☐	☐	

13. On a scale of 1 to 5 (1 as the lowest and 5 as the highest), rate how these Government rules can best encourage SSF to:

(a) lower their investment cost to practice CA (e.g. lower their input costs)

Encouragement	Scale
Cost-sharing arrangements	
Provision of good infrastructure (eg roads, factories)	
Tax relief	

(b) increase returns on SSFs farms (e.g. increase their profit margins)

Encouragement	Scale
Input and output prices controlled	
Other people taxed so that CA farmers can benefit (special taxes)	
Managing foreign exchange rates	

(c) decide to practice CA

Encouragement	Scale
Extension services	
Land Ownership security	
Market development for farm produce	

Conclusion:

Thank you very much for your time.

Interview End Time……

Appendix 2: Household survey Questionnaire for Farmers

SOCIOECONOMIC AND INSTITUTIONAL FACTORS AFFECTING ADOPTION OF CONSERVATION AGRICULTURE WITH TREES (CAWT) IN TANZANIA

Introduction

Hello, my name is……I am working in collaboration with ICRAF within the CAWT Project. Part of this project involves conducting interviews with small scale farmers, aimed at understanding local perspectives and needs for Conservation Agriculture.

Your household has been selected by chance from all the households in this area. I would like to ask you some questions related to conservation agriculture. The interview may take between 45 to 60 minutes and participation is voluntary, so you may choose either to take part in it or not. All the information you give will be confidential and no specific names will be included in generating the final report.

Can we continue with the interview? No……..Yes….....

If 'No', Why?.....;
If 'Yes', Continue.

For easier communication, I will refer to Conservation Agriculture as CA.

General Information

Questionnaire No.: …….
Enumerator's name:……. Date of interview:……../ ……/ ……/2011

East co-ordinate (from GPS)…… North co-ordinate (from GPS)……

Village:……. Location:…….. Division……..
District……

Respondent's name:……..... ☐ Gender: M☐ Female

Contact phone no.:…….

Age: 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ Above 70 ☐

Highest education level: Primary ☐ Secondary ☐ College ☐ University ☐ O ☐ (specify)……..

Interview Start Time……

PART 1: BACKGROUND

1. (a) What have been your three most important crops in the last one year?(crops that provided the highest income to your household)

..……..., ……., ……..

(b)How do you prepare your farm? (Tick all that apply)

		For how long have you done this (years)?
1) Digging (jembe, panga)	☐	……..
2) Animal drawn plough	☐	……..
3) Tractor	☐	……
4) Burning	☐	……..
5) Use of chemicals	☐	……..
6) Any other (specify) …….	☐	……..

2. (a)Do you know of the following practices?

	Yes	No
1) Minimum or no soil turning	☐	☐
2) Use of cover crops eg beans, sweet potatoes	☐	☐
3) Crop rotation	☐	☐

3. (a) Have you ever practiced any of the following:

	Yes	No
1) Minimum or no soil turning	☐	☐
2) Use of cover crops eg beans, sweet potatoes	☐	☐
3) Crop rotation	☐	☐

(b) Have you heard of Conservation Agriculture (CA)?

Yes ☐ N☐

(c) If 'Yes' above , what does CA mean to you?

1)	Use of organic inputs (eg cow,goat&chicken manure, vegetable remains)	☐
2)	Minimum or no soil turning	☐
3)	Trees on farms	☐
4)	Any other(specify) ……	☐
5)	Don't know	☐

NB: <u>CLEARLY explain</u> CA (using the 3 principles in Question.2a) before proceeding to next question.

4. (a) Do you practice CA (using its 3 principles)?
   Why?

Yes ☐……
……
……
……

No ☐……
……
……
……

(b)Do you think there is need for CA to be practiced by small scale farmers?

For what reason(s)?

Yes ☐	creased yields	☐
	Improved soil fertility	☐
	Improved water retention	☐
	Reduced labour cost	☐

Any other (specify) ☐
……..

No ☐ costly farming practice ☐

Risky(increased crop yields not guaranteed) ☐

Any other (specify) ☐
……..

Don't know ☐

(c) In your opinion, what is the **most important** way that small scale farmers in this area (Mwanga/Karatu) can be motivated to practice CA?

	In what way?
Trainings on CA practice	☐…… …… ……
Provision of inputs	☐…… …….. ……
Extension services	☐…… …… ……
Provision of indirect motivations (eg land security,market for produce)	☐…… …….. ……
Any other (specify) …… ……	☐…… ……

(d) Do you think including trees in farms can promote CA among the small scale farmers?

For what reason(s)?

Yes ☐ ……
……
……

No ☐ ……
……
……

Don't know ☐ ……
……..

PART 2: EXISTENCE OF POLICY AND INSTITUTIONAL ENCOURAGEMENTS & DISCOURAGEMENTS

6. (a) (**FIRST GIVE A STORY** eg Ghana story) Then ask…Do you know of any community rules passed by the village headman/chief/any other local leader that affects your crop farming systems? (for example, livestock allowed to graze in neighbours' farms at certain times of the year etc)

Give an example

Yes ☐ ……
……
……

No ☐ ……
……
……

(b) Who interprets Government rules for you?

Chief ☐

Agricultural officers ☐

Provincial administration ☐

Neighbours ☐

Local leaders (specify) ☐
……..

Media (Radio, TV) ☐

Any other (specify) ☐
……

(c) Do you know of any Local Governmnet laws in this area (Mwanga/Karatu) passed by the chief/village head that talk about agriculture?

Give an example

Yes ☐ ……
……

No ☐ ……
……

7. Have you heard of any National Government rules that talk about agriculture?

		Which are they?
On trees on farms	☐	……
On soil erosion	☐	……
On planting crops near rivers	☐	……
On land issues	☐	…… ……
Any other (specify) ……	☐	…… ……
Don't know	☐	

8. (a) Would the following Government rules discourage you (in any way) to practice CA?

Rule on…….	**Specific rules**	**Yes**	**No**	**How?**
Trees on farms	The need for a permit to cut trees	☐	☐	…… …… ……
	10% tree cover	☐	☐	…… ……
	Restriction on cutting and transporting specific trees	☐	☐	…… ……
	Any other rule on trees on farms (specify) ……	☐	☐	…… ……
Land ownership	No restriction of minimum land sizes	☐	☐	…… ……
	Any other rule on land ownership (specify) ……	☐	☐	**……** ……
Crop farming rules	Promotion of irrigation agriculture	☐	☐	…… ……
	Extension officer-farmer trainings	☐	☐	…… ……
	Any other rule on crop farming (specify) ……	☐	☐	…… …… ……
	Any other rule on crop farming (specify) ……	☐	☐	…… …… ……
Any other agricultural rule? ……	…… ……	☐	☐	…… ……

(b) Do Government rules have any of these motivations for you to practice CA?

Examples of motivations	**Yes**	**No**	**In what way?**
Farm inputs not taxed	☐	☐	…… ……
Provision of goods &services at lower prices eg fertilizers	☐	☐	…… ……

Provision of good infrastructure eg roads,factories	☐	☐	…… ……
Availability of grants (money that farmers don't need to pay back)	☐	☐	…… ……
Subsidized loans (cheaper loans)	☐	☐	…… ……
Cost-sharing arrangements (eg farmer contributes50%, Government contributes 50%)	☐	☐	…… ……
Accessibility to resources eg seeds, farm chemicals	☐	☐	..... ……
Input prices controlled eg cost of seeds, farm chemicals	☐	☐	…… ……
Output prices controlled eg price of maize in the market	☐	☐	…… ……
Land ownership security	☐	☐	…… ……
Accessibility& availability of basic inputs	☐	☐	…… …… ……
Support services for farmers	☐	☐	…… ……
Market development for farm produce	☐	☐	…… ……

Credit facilities (farmer can pay later)	☐	☐	…… ……
Research &development	☐	☐	……
Extension services	☐	☐	……
Any other (specify) ……	☐	☐	…… ……
Don't know	☐	☐	

9. On a scale of 1 to 5 (1 as the lowest and 5 as the highest), rate how these Government rules can best encourage you to:

   (d) lower your investment cost to practice CA (eg lower your input costs)

Encouragement	Scale
Cost-sharing arrangements	
Provision of good infrastructure (eg roads, factories)	
Tax relief	

   (e) increase returns on your farms (eg increase your profit margins)

Encouragement	Scale
Input and output prices controlled	
Other people taxed so that CA farmers can benefit (special taxes)	
Managing foreign exchange rates	

   (f) decide to practice CA

Encouragement	Scale
Extension services	
Land Ownership security	
Market development for farm produce	

PART 3: MAJOR POLICY AND INSTITUTIONAL CONTEXT OF CAWT

10. Do you know of any initiatives promoting agricultural development in this area (Mwanga/Karatu)?

Initiative		**How do they promote agriculture?**
SARI	☐	……
TFSC	☐	……
LAMP	☐	
SCAPA	☐	
Sida	☐	
Equity Bank Farmer Loans	☐	
Agricultural Finance Fund	☐	
AGRA	☐	
NEPAD	☐	
Any Other (specify) …… …….	☐	

11. In your opinion, how do you think Government support can help motivate small scale farmers to practice CA?

		In what way?
Provision of inputs	☐	…… ……
Provision of basic needs eg food	☐	…… ……
Tax reliefs	☐	…… ……
Any other (specify) ……	☐	…… ……

12. (a) Do you know of any established organizations that help promote CA among small scale farmers?

		Who are they?	**How do they promote CA?**
Private companies	☐	……	……
		……	……
Research organizations	☐	……	……
		……	……
Government ministries	☐	……	……
		……	……
Church organizations	☐	……	…….
		……	……
NGOs	☐	……	……
		……	……
Volunteer groups	☐	……	……
		……	……
Any other (specify) ……	☐	……	……
		……	……
Don't know	☐		

(b) Do you know of any grassroots groups in this area (Meru/Karatu) that help promote CA among the small scale farmers?

		Who are they?	**How do they promote CA?**
Farmer groups	☐	……	……
		……	……
Community Based Organizations (CBOs)	☐	……	……
		……	……
Women Groups	☐	……	……
		……	……
Church groups	☐	……	……
		……	……
Any other (specify) ……	☐	……	……
		……	……
Don't know	☐	……	……
		……	……

PART 4: POLICY MAKING PROCESS

13. (a) If there is any agricultural issue, which decision making body do you address so that the issue reaches the people at the national level?

Agricultural issue at the….		**Which decision making body?**
Village level	☐	……
Location level	☐	……
Division level	☐	……
District level	☐	……

(b)Have any of the agricultural issues been addressed at the national level?

Agricultural issue at the….		**Which agricultural issue?**
Village level	☐	…… ……
Location level	☐	…… ……
Division level	☐	…… ……
District level	☐	…… ……

14 (a) Has anyone ever asked your opinion during writing of any Government Agricultural rule?

	When?
Yes ☐	……
No ☐	……

(b) Do you think it is important to involve farmers in developing Government rules related to agriculture?

	Why?
Yes ☐	……
No ☐	……

(g) If 'Yes' above, what is the best way that farmers can be involved so as to encourage CA in the existing:

	How can farmers be involved?	
Government rules	Farmer meeting to express their needs	☐
	Successful CA farmers be highlighted in media	☐
	Any other (specify) ……	☐
Established organizations	Farmer training workshops	☐
	More time allocation for CA projects	☐
	Any other (specify)…….	☐
Grassroots groups	Frequent follow-up of CA activities	☐
	Increased farmer support groups	☐
	Any other(specify)……	☐

15 (a)What is your (total) land size? (in acres)……

(b) What kind of ownership is your land under (tick all that apply)

Inherited ☐
Bought ☐
Borrowed ☐
Hired (leased) ☐
A gift ☐
Communal land ☐

(c) Do you have a title deed?

No ☐

Yes ☐ : Under your nam☐ Under family nar☐

(d)Would you be willing to practice CA in your land?

	Why?
Yes	☐……
No	☐……

16. (a) Should we continue subdividing land to smaller pieces?

	Why?
Yes ☐	…… ……..
No ☐	…… ……

(b) Can combining land with your relatives/family work?

	How?
Yes ☐	……
No ☐	……

Conclusion:

Thank you very much for your time.

Interview End Time……