CONSERVATION AGRICULTURE PROGRAMMES AND PROJECTS IN MALAWI: IMPACTS AND LESSONS

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Source: Total LandCare

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EXECUTIVE SUMMARY

The conservation and enhancement of the quality of soil, environment, and livelihoods are a common concern. Malawi has employed agriculture based largely on small scale annual maize-based cropping practices that has promoted ridge tillage for a long period. This form of agriculture has continued to play a central role in defining livelihoods and economic development of the country with varying levels of success. Routine annual tillage of the soil with associated removal or burning of plant residues has the potential to contribute to the deterioration of the physical quality of soil. This also includes a strong potential to increase the impacts of droughts as the soil becomes less fertile, less responsive to fertilizer and less able to infiltrate rainfall or irrigation water. Presently, Malawi's agricultural productivity, particularly among the majority of the smallholder farmers remains below its potential given the available biophysical resources and technology. Maize remains the main staple accounting for 50-90 per cent of calorific intake. It is cultivated on over 70% of Malawi's arable land but a wide gap remains between actual farmer yields and on-farm experimental yield. For example, while the potential yields for hybrid maize range from 5 to 8 tons per hectare, the average actual yields range from 1.5 to 2.5 tons. The domestic production has fluctuated widely from one year to the next over the recent 16 years with the average standing somewhere between 1 million and 2.5 million tones.

There is need to strive to promote policies, approaches and technologies that will improve the care of soil and rainwater resources, eliminate unsuitable land use practices, and enhance stability in crop production. Conservation agriculture entails the application of wise soil and water management practices that will improve and safeguard the quality of land and rainwater resources so that they continue to meet the needs of agriculture, society and nature. The three main principles of conservation agriculture are: maintaining soil cover with plant residues, reducing mechanical soil disturbance (tillage), and the use of rotation and cover crops. The study noted that the principles and practice of conservation agriculture have not been consistent across the spectrum of disseminators and users. The formulation and adoption of a well informed National Conservation Agricultural Strategy that treats conservation agriculture based on the premised principles different from the usual soil and water conservation measures is recommended.

The study proposes that the functions of the National Task Force for Conservation Agriculture be enhanced. The Task Force brings together researchers, developers and policy-makers to share information and advance conservation agriculture to new frontiers. The continuing expansion of CA depends on having support of a cadre of experts who can ensure appropriate support mechanisms are in place. Clearly the job of disseminating this technology at grassroots and technical levels will require a broad knowledge of agriculture and the effects of CA under different environments, access to support (e.g. information), social skills to communicate and work with farmers and above all commitment.

The study noted the involvement of learning and research institutions alongside development partners, farmer organizations, and NGOs, and the efforts of farm input suppliers in divulging this technology. The impetus of farmers who have shown untiring quest for progress and willingness to try new practices even in the absence of mentoring and material support was evident. Unfortunately, despite nearly a decade of development and promotion by the national extension program and numerous other projects, it appears adoption has been extremely low in the smallholder sector. Some of the constraints identified included but are not limited to the following: a lack of application of appropriate soil fertility management options; lack of application of effective weed control regime under no-till systems; access to credit for seed, fertilizers and herbicides; a lack of appropriate technical information for change agents and farmers; blanket introduction of conservation agriculture that ignore the resource status of rural households; and competition for crop residues in free range communal grazing livestock systems.

The point of entry for conservation agriculture has been project focused, site specific, and with the support of hired or resident extension staff, planning is based on local conditions and farmers' experience with commercial standard applications of practices. Other efforts have built on the earlier seed and fertilizer relief and subsidy programs by government and other agencies focused on households that have been classified as vulnerable. They are in receipt of seed and fertilizer relief or subsidy investments distributed through government and a range of NGOs. Elsewhere in the country, conservation agriculture has also been introduced as an asset through work-for-asset programmes or financed through credit and/or revolving funds in support of livelihood programmes. These initiatives have in varying ways laid the foundation for conservation agriculture. However, the tenets of conservation agriculture require a strong and comprehensive extension support and a measurable growth period which remains wanting in many of the efforts.

The study recognizes the role that initial government-led projects on conservation agriculture have played and the new impetus from development partners. However, it calls for increased public and private investments to sustain the natural resource base, enhance economic productivity, and reduce the risks for poor farmers particularly urgent in areas with widespread degradation of soil resources and the advent of increased rainfall variability. Research is needed to identify practices and technologies that adhere to the three principles of CA and are affordable to small-scale farmers who have limited income and market access and cannot afford inputs. Research can provide insight into socio-economic issues, local knowledge-sharing networks and participatory learning approaches, such as farmer field schools, for dealing with agro-ecological issues such as pests, weeds, soil and organic matter. The study proposes establishment of an agricultural knowledge management triangle for conservation agriculture made up of the research, extension, and higher education agricultural institutions.

The study concludes that the shift from conventional to conservation agriculture will require implementation of several aspects:

(a) Situating conservation agriculture based on a socio-ecological framework in order to avoid potential mismatch between the technology and the target biophysical and socioeconomic environment.

(b) Exposure of farmers to different CA practices, particularly through participatory activity and on-farm demonstrations to show the benefits and practicality of cropping techniques, tools, and equipment;

(c) Training in the practical use of new technologies, combined with flexible funding mechanisms and incentives, particularly during the period of transition;

(d) Fostering cooperation and dialogue between scientists, suppliers and farmers, and between government and educational institutes; and

(e) Achieving and publicizing improvements in land productivity, reduction in farming costs and environmental benefits.

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I. INTRODUCTION AND METHODOLOGY

1.1 Introduction

This report documents experiences in conservation agriculture (CA) in Malawi. It is based on the work commissioned by the National Conservation Agriculture Task Force in Malawi with the support of the Food and Agriculture Organization (FAO) of the United Nations to provide the basis for understanding the level of knowledge and practice on conservation agriculture from various past and present interventions by Government and other stakeholders. The report also presents the advantages and disadvantages of conservation agriculture, the challenges for scaling up CA and other resource conserving technologies (RCTs) and other issues as perceived by those practicing and promoting them. Both smallholder and commercial farmers in Malawi have been practicing resource conserving technologies in one form or another; it is the packaging of these technologies to constitute what is now known as conservation agriculture which is relatively new and is now receiving attention through programmes of government and various none-state actors with varied success.

The report gives the approach and methodology taken to generate data and information on various aspects of CA and RCTs from the research institutions, government extension agencies, projects and from the farmers themselves. Chapter 2 gives the social and physical challenges for human development and crop production that CA can be called to address; the current approaches to address the challenges and gives the rationale for CA in Malawi. Chapter 3 defines the concepts of CA and RCTs and goes on to explain how CA is understood, adapted and practiced under different programmes and projects prior and after year 2000.This is followed by Chapter 4 where focus is shifted to CA as practiced under different programmes and projects during the same time horizons.

Chapter 5 dwells on RCTs and Chapter 6 gives an analysis of challenges faced by different players in CA and how these are being addressed and lessons learned that would inform policy and practice. It also gives the opportunities that can be harnessed in furthering research and development in CA. The last chapter, Chapter 7 provides recommendations for policy, research, extension and support to farmers to enable them appreciate the value of CA and the need to invest in it.

1.2 Methodology

The study was based on literature review of relevant documents on policy, strategies, research agenda, programmes and projects, field manuals, training materials and implementation progress reports from various sources. This was followed by consultations with key stakeholders that included government departments in the Ministry of Agriculture and Food security, research and training institutions, National Task Force on Agriculture, project management units, Farmers Organizations, NGOs and input suppliers. These consultations involved asking relevant questions on CA issues as guided by an instrument (a checklist of questions) that was developed based on a framework provided for a national and regional inventory on CA.

To complete the picture field visits were made to discuss with farmers on various aspects of CA implementation. Of particular interest to the researchers was to follow the farmers who adopted the technology under the Sasakawa Global 2000 initiative in the early 2000s; those who are continuing and those who dropped out. Similarly, under the old Promotion of Soil Conservation and Rural Production (PROSCARP) and its successor, the present Farm Income Diversification Programme (FIDP), farmers were identified to find out why they are continuing or not. Lastly the researchers visited farmers who adopted CA on their own to find out what motivated them and the challenges they are facing. The information from literature review, stakeholder consultations and field observations was analysed to draft a report based on the format provided by the client.

To get a national picture on CA annual progress reports for the Land Resources Conservation Department (LRCD) were used on the assumption that they consolidate figures from the Districts, the Agricultural Development Divisions (ADD) activities of various stakeholders in their respective jurisdictions.

1.3 Limitations of the study

1. The study noted that CA in Malawi is implemented as part of other programmes and projects; projects purely on CA are rare. As such it is difficult to estimate the level of investment in conservation agriculture within those broader programs and projects;
2. The study was limited by low willingness of respondents to release data and information;
3. Need for harmonization of country CA synthesis reports guided by a regional format provided by FAO that did not exactly speak to the TORs provided for the study.

2. BACKGROUND ON MALAWI AND AGRICULTURE SECTOR

2.1 Physical and Demographic Characteristics of the Country

Malawi has a territorial area of slightly over 118,000 square kilometers of which about 20% is taken up by the lakes. Malawi lies between 09^{o} 25' and 17^{o} 08' latitude South and 32^{o} 40' and 34^{o} 55' longitude East. Forest, wildlife reserves, settlement and infrastructure cover about 19% leaving 61% land area with varied potential and limitations to agricultural use based on physiographic, soils, agro-climate and other social and cultural factors. Topography is heterogeneous with altitudes ranging from 33 meters above sea level (m.a.s.l) in the rift valley floor where Lake Malawi and Shire River lie as part of the East African Rift Valley system to as high as over 3000m.a.s.l at the Peak of Mulanje Mountain.

The country can be divided into four broad physiographic units:(i) the Highlands which are extensive tracts at 1600-3000 m.a.s.l; (ii) the Plateaux at 1000 to 1600 m.a.s.l with gently undulating extensive tracts in the northern and central regions of the country; (iii) the Rift Valley Escarpment at 600-1000 m.a.s.l, a highly dissected zone with precipitous slopes; and, (iv) the Rift Valley Plain at 33 to 600 m.a.s.l. formed in large part by the deposition of material and characterized by subdued relief and gentle slopes (Fig. 1).

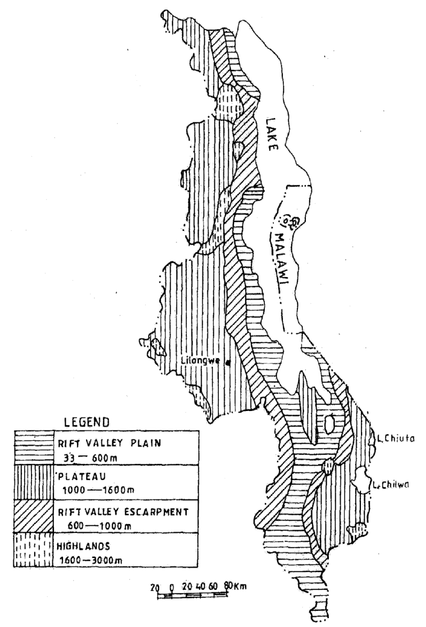


Fig. 1: Major physiographic regions of Malawi

According to the land appraisal studies done from 1987 to 1992, Malawi's soils are predominated by three major soil types: the Eutric leptisols (lithosols); the Chromic luvisols (latosols); and the Haplic lixisols. The lithosols are known to be shallow stony soils associated with steep slopes while the lixisols include alluvial soils, vertisols and mopanosols that prevail in riverine and lowland dry areas of Malawi, respectively. The latosols are known to be widely distributed in the Plateaux zone, generally of good structure, deep and well drained, but they also include the weathered ferrallitic soils (Malawi Government, 2002a).

The 2008 Census estimated Malawi's population at 13.08 million people of which 11.07 million, representing about 85% live in rural areas depending mostly on agriculture and exploitation of natural resources for their livelihoods. Malawi is one of the most densely populated countries in Sub Saharan Africa with only 0.23 hectares of land per person living in the rural areas - compared to 0.86 in neighbouring Zambia and 0.40 in Sub Saharan Africa as a whole (GOM 2009). The high population density exerts enormous pressure on the land based resources in meeting the demands for the ever increasing population for food, fibre, income and other livelihood activities. These pressures have reduced the ability of the land to produce or provide goods and services.

2.2 Agro-Climatic Conditions

Malawi's climate is hugely influenced by the heterogeneity of the topography and its proximity to the influence of westerly frontal systems which move eastwards from the Indian Ocean. The rainy season from November to March and the dry season from April to October constitute the two main seasons. The mean annual rainfall ranges from 500 mm in the dry and hot valleys to 3000 mm over highlands. It is often interspaced with one to two weeks midseason dry spells that often cause drastic reductions in crop yields. The main characteristic of Malawi's rainfall is that it falls within a short period at erosive intensities that can cause devastating soil erosion especially where ground cover has been removed as is often the case in most cultivated areas. The annual mean temperature ranges from 12 ^{o} C to 32 ^{o} C. (Malawi Government, 2002a).

Malawi is prone to extreme weather events such as droughts, floods, tropical cyclones, tornadoes that often have far reaching negative impacts on human health, agriculture infrastructure and many other key socio-economic sectors. Of all these extreme weather events it is drought that has far reaching negative effects on the food security of the country thereby compromising on poverty reduction policy of Malawi Government. Good examples of the climate hazards have been confirmed by the impacts of the 1948/49 and 1991/92 droughts. The two eminent droughts had harsh negative impacts on agriculture, livestock, wildlife, tourism, water resources and hydroelectric generation. From these, a number of initiatives in soil and water conservation were initiated dating back to the colonial agricultural period. While the premises for their promotion and adoption may have metamorphosed overtime, the various technologies and practices remain more important to day in the face of water deprivation from climate change and ecosystem degradation. In dry lands, CA brings just that extra drop of water the crop needs through in situ water harvesting.

2.3 Significance of the Agriculture Sector

The importance of agriculture in Malawi cannot be overemphasized; it is the central nerve of the economy employing 80% of the national workforce, contributes over 80% of foreign exchange earnings, 39% of the gross domestic product (GDP) and contributes to national and household food sovereignty and security. The smallholder and the estate sub-sectors contribute more than 70 per cent and less than 30 per cent respectively to agricultural GDP (GoM, 2007). Agriculture is dominated by smallholder farmers who in 2006 were estimated at 6 million cultivating on fragmented customary land often with limited investments in land improvements and other productivity enhancing technologies. The commercial subsector comprises 30,000 estates cultivating 1.1 million hectares with an average landholding of between 10 to 500 hectares (World Bank, 2003a). This sub-sector contributes only about 20% to total national agricultural production, but provides over 80% of the agricultural exports. Smallholders cultivate mainly food crops such as maize, cassava and sweet potatoes to meet subsistence requirements while estate subsector focuses on high value cash crops for export such as tobacco, tea, sugar, coffee and macadamia.

Malawi's agriculture has benefited from substantial donor programmes over many years but, until very recently[1], has suffered from chronic food insecurity at both household and national levels. Agricultural exports have remained undiversified, with little value addition. Most Malawians are desperately poor, with 52.4 per cent of the population living below the poverty line (MK44 per person per day) with 22.4 per cent barely surviving. Socio-economic indicators illustrate the depth and intractability of poverty. For example, the levels of malnutrition remain high, with 43.2 per cent of under-five children stunted and 22 per cent underweight in 2004 (NSO, 2005).

Crop yields have been too low and stagnant to provide adequate national growth due to a number of reasons including over dependency on rain fed agriculture, limited use of improved seeds, and limited use of organic and inorganic fertilizers, impoverished soils and inadequately resourced agricultural extension system. This is exacerbated by weak links to markets, high transport costs, few and weak farmer organizations, poor quality control and inadequate information on markets and prices. Due to high risks in agricultural production and poor access to credit, investment and re-investment have been poor. Agriculture growth has varied since independence with the first 15 years registering some gains and later declining, the growth was narrowly confined to the estate sector and to smallholders with larger landholdings. The poor were excluded from many development programmes.

Yields of maize, which is the country's main staple food, under the dominant smallholder unimproved level of management has been very low (Fig. 2). Average yields of 1.3 tones ha^{-1} have been reported (Smale, 1992; CIMMYT 1999) although maize yields of 6-7 t ha^{-1} are possible under farmer's conditions (Zambezi *et al.*, 1993). Low or declining soil fertility is cited as the major reason for low yields (Zambezi *et al.*, 1993, Kumwenda *et al.*, 1997). Other constraints include recurrent droughts, poor management, diseases such as grey leafspot (*Cercospora-zea-maydis*), leaf blights and rusts and pests such as stalk borers, witchweed and termites. The pronounced fall in unfertilized maize yields provide a clear testimony of declining soil productivity.

[1] The implementation of broad-based intervention - the input subsidy programme - since 2005/06 season has led to remarkable growth in food and cash crop production leading to improved food self sufficiency during the 2004/05 to 2006/07 seasons

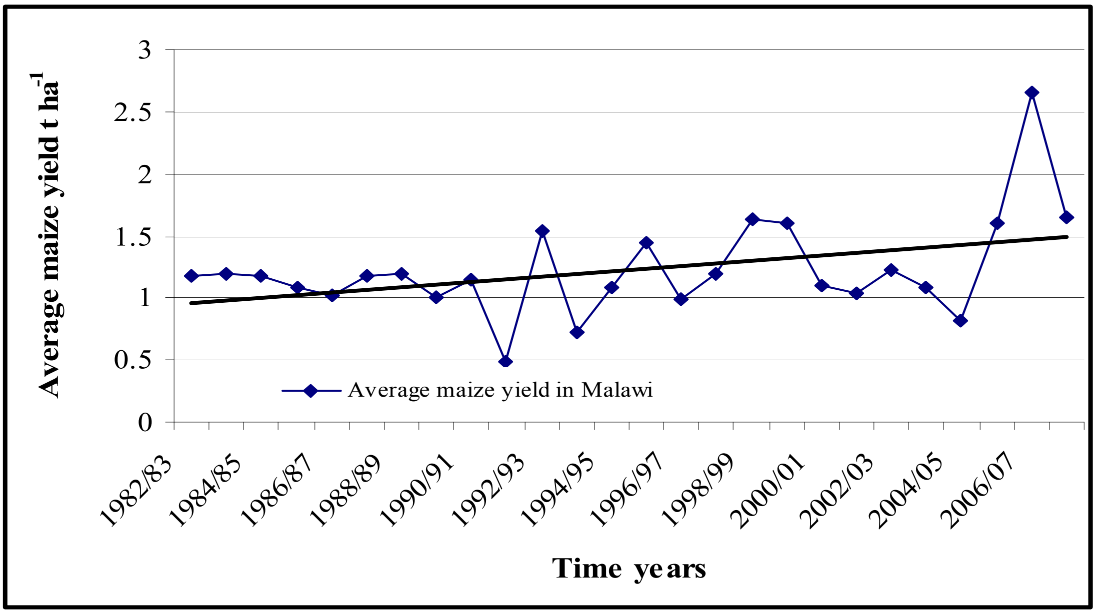


Fig. 2. Average maize yields in Malawi (t ha^{-1}) from 1982-2008 (MoAFS, 2008)

2.4 Land Preparation and Effect of Annual Ridging

The most dominant feature of Malawi's agriculture in terms of tillage is the annual construction of planting ridges which has evolved as an integral part of subsistence farming. However several traditional methods of seedbed preparation including flat cultivation, mounds, and other forms of raised beds do exist (Kumwenda. 1990). The ridge on contour has since colonial times been used as a first line of defence against soil erosion; a number of programmes and campaigns have been launched to promote its adoption. Although labour intensive, ridging has become so popular that it is most often synonymous to land preparation for crop production. If properly designed, contour ridging reduces runoff by temporarily storing excess rainfall behind ridges and thus reducing soil erosion and increasing moisture storage. In spite of these benefits, when improperly designed or used on unsuitable sites, contouring causes serious soil erosion (Plate 1).

Plate 1 : Soil erosion under annual ridge tillage in Lilongwe, Malawi (Source: Douglas et al. 1999)

Slash and burn cultivation is still being practiced in some areas to open up new areas for cultivation. This practice has often been practiced on environmentally fragile slopes exposing the soil to devastating impacts of rain drop leading to serious soil erosion. Agriculture has encroached areas marginally suitable or not suitable for cultivation often without proper biological and physical conservation practices and this has contributed to forest and soil degradation.

There is a growing body of opinion that cultivation using the hand hoe to the same depth for the purpose of splitting and reforming planting ridges has resulted in the formation a compacted horizon (hard pan) immediately below the ridge. This hard pan severely restricts infiltration of the rainfall and development of the root system besides promoting accumulation of overland flow subsequently leading to soil erosion. Douglas *et al*., (1999) conducted a rapid field investigation to provide evidence of a compacted hoe pan in Malawi. The investigations revealed that the hoe pan problem existed on a variety of soil types (notably Lixisols, Cambisols and Luvisols) based on evidence from field observations of the shape and distribution of roots, and laboratory determination of bulk density, porosity and hydraulic conductivity (Table 1.). Douglas *et al.,* (1999) argued that, under normal circumstances, hydraulic conductivity will usually decrease gradually with increasing depth. The very significant change in rate immediately below the cultivated layer was suggestive of induced soil compaction.

Table 1. Average figures from the physical analysis undertaken on all soils sampled

Depth (cm)	Bulk density, g cm^{-3}	Porosity (%)	Hydraulic conductivity cm hr^{-1}	Silt (%)	Clay (%)	Textural class
0-15	1.41	46.5	19.2	8.44	16.9	Sandy loam
15-30	1.50	43.4	7.1	8.87	22.4	Sandy clay loam
30-45	1.52	43.1	6.9	9.56	23.4	Sandy clay loam
45-60	1.57	40.9	6.4	9.36	24.3	Sandy clay loam

Source: Douglas, M.G. *et al*., 1999.

2.5 Effects of Land Degradation on Agriculture and other Sectors

The consequences of land degradation tend to snowball. There already are indications of a negative supply balance, e.g., extensive household utilization of agricultural and animal wastes for energy. Forest cover, for instance, contributes indirectly to agricultural production through soil fertilization, effective soil hydrology, stream flow moderation and soil erosion control, and long-term degradation or disappearance of forests has an inevitable effect on the productivity of extensive agricultural systems, which most rural folk rely on.

The immediate impact of soil degradation is either a decline in crop yields or an increase in the level of inputs needed to maintain or improve yields. Responses to applied plant nutrients are a strong indication of a degraded soil. Although other factors like shortage of rainfall are highly contributing to low agricultural productivity, the major one is low soil fertility due to excessive degradation of soils. Evidence for declining soil productivity is provided by a pronounced fall in unfertilized maize yield and a parallel decline in the response of crops to fertilizer. Douglas *et al*., (1999) reported that during the 1960's, unfertilized local maize typically yielded 1,700 kg ha, but the national average yields dropped to 1,000 kg ha in 1999 and are at 800 kg ha, at present (Malawi Government, 2002b). Across the country, the maize response to fertilizer has also declined. For example in Lilongwe, it fell from an average of 23 kg ha (local) maize per kg of nitrogen in 1957-62 to 13 kg per kg of nitrogen in 1983-85 (Douglas *et al.*, 1999).

During the rainy season, many rivers transport large loads of sandy sediments that are deposited over fertile alluvial soils along the lakeshores rendering them less fertile. Large areas of previously fertile rice fields have been made unproductive due to deposition of sand and silt. Siltation has also reduced the water carrying capacity of many water bodies in Malawi. Fish catches from Malawi's lakes and other water bodies are declining every year due to alteration of aquatic environment arising from siltation (Malawi Government, 2003b).

The impact of soil degradation also includes water pollution from eroded soils containing N, P, and other nutrients which may trigger algae bloom which can reduce water clarity and cause deficiency in oxygen leading to fish mortality and odour. Perhaps one of the most important consequences of nutrient enrichment of water bodies is the intractable problem of the noxious weed, the water hyacinth, particularly on the Shire River, the outlet of Lake Malawi (Malawi Government, 2003b).

Malawi's power supply is mainly generated from hydro power stations located along the Shire River. However, Shire River is now experiencing unprecedented environmental degradation which has resulted in trash from aquatic weeds and silt being swept into it. Upon reaching the generation stations, trash tends to block water flow into the turbines while siltation has reduced the water-holding capacity of intake dams of power stations by about 50% (Mloza-Amri, *et al*, 2008)

In general, soil erosion by rainwater arising from reduced vegetative protection, tends to deteriorate the ecological balance of the catchments. The shortage of water due to decrease in the discharge of springs and wells can be expected. Since this phenomena is due to improper land and water uses, particularly inability in optimizing the use of available rainwater at early stage in the hydrological cycle, it is the management of rainfall and resultant runoff which seems to be a key to many aspects of ecological control, as well as supplying water, raising production, and increasing incomes of rural or watershed dwellers (Mloza-Banda and Makwiza, 2007)

2.6 Rationale for Conservation Agriculture in Malawi

Mussa (2007) articulated the premises for CA in Malawi by noting that "the country is witnessing severe degradation to its agricultural lands. Much of this degradation can be attributed to common, but exploitive farming practices such as ploughing that destroys the soil structure and degrades organic matter, burning or removing crop residues, monocropping and continuous cropping. Smalling (1998) reported that Malawi soils have been depleted of essential nutrients as a result of increased pressure on land and insufficient inputs. Malawi's soils were shown to lose on average 40.0, 6.6, and 32.2 kg per hectare per year in nitrogen, phosphorous and potassium, respectively. On the other hand, results from spot trials of soil erosion under different cover and farming practices have shown that the estimated soil loss in Malawi can be up to 50 tonnes per hectare per year (Bishop, 1990; Eaton, 1996). Soil and water management practices that sustain and enhance the productivity of arable soils are therefore a must for Malawi. They are a vital part of the long-term solution to food insecurity and poverty.

Mussa (2007) further noted that studies worldwide have proved that where labour is limiting, CA offers opportunities to reap more by reducing or spreading the labour to avoid bottle necks. In Malawi, off-farm income generating opportunities (e.g. vending) has drawn young men away from the farms, leaving women, children and the elderly to cope with all farm operations, even the most arduous, such as hoeing. This trend is also influenced by the high incidence of HIV and AIDS, which is resulting in increasing numbers of the elderly- and children-headed households. Yet, in 2002, the cost of labour under CA based on national on-farm trials was only 40% that of conventional farming (Sasakawa, 2006). The Malawi Poverty and Vulnerability Assessment Report reported that over 90% of the total agricultural value added comes from about 1.8 million smallholders who own on average less than 1.0 ha of land (Malawi Government, 2007). Yet recent work suggests that in Malawi, the small size farms tend to be more efficient than large ones based on analysis of causal factors explaining an inverse relationship between land holding size and crop production (Tchale, 2009). There is need to demonstrate production system that enhance farm-level efficiency under declining land holding size.

Numerous studies have shown a close correlation between agricultural sector performance and overall economic performance (Tchale, 2009). Malawi's agricultural sector is dominated by smallholder farmers who comprise over 90% of the sector and operate under low-input rain-fed system. It is thus argued that how the country's economy performs is dependent on how its smallholder farmers perform. Malawi's agricultural productivity, particularly among the majority of the smallholder farmers has fallen below its potential given the available technologies. For example, local maize yields remain below 1.5 tonnes per hectare while hybrid maize yields have improved but have been fluctuating between 1.5 to 2.5 tonnes per hectare with the biggest decline between1999-2005 (Tchale, 2009). However, while potential yields for hybrid maize range from 5 to 8 tonnes per hectare, average on-farm yields under conservation agriculture during its early introduction 2000-2005 averaged 5.1 tonnes across the country (Sasakawa, 2006). Conservation agriculture therefore represents a paradigm shift in Malawi's agriculture to improve and maintain high productivity in the face of production inefficiencies, unreliable rainfall, and poor soils.

In Malawi the interest in conservation agriculture was rekindled after a national workshop on conservation farming that took place at Bunda College of Agriculture in 2002(Kumwenda et al., 2002). The workshop was organized jointly by the Department of Land Resources Conservation, Bunda College, and the Department of Agricultural Research and Technical Services. It discussed a number of papers on CA showcasing work by various stakeholders and lessons learnt. It was at this workshop that the National Task Force on CA was instituted although it remained largely inactive until 2008 when it was reconstituted and started its work of providing foresight and coordinating CA activities in Malawi.

3 WHAT IS CONSERVATION AGRICULTURE?

3.1 Conservation agriculture

Mussa (2007) observed that 'conservation agriculture' is usually linked with other terms such as 'conservation tillage', 'zero tillage', 'conservation farming' and 'reduced tillage'. He further contextualized the 'conservation' terms above and stated that 'conservation tillage' is about land use or land preparation practices; conservation farming involves adopting a number of husbandry practices that together comprise a complete farming system; while conservation agriculture, is a production system.

Conservation agriculture is defined as "a resource saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. It is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to absolute minimum and the use of external inputs such as agrochemicals and nutrients of mineral or organic are applied at an optimal level and in a way and quantity that does not interfere with, or disturb the biological processes" (FAO, 2007). From this definition the three cardinal principles of CA emerge:

- Continuous minimum mechanical soil disturbance.
- Permanent organic soil cover, particularly through the retention of crop residues.
- Diversified crop rotations and associations.

Plate 2: Mulch cover practices in Salima, Malawi (Source: Mloza-Banda, 2007)

Plate 3: Young maize crop under CA (Source: Total LandCare)

This definition is known and appreciated by the stakeholders consulted; this is from the various interactions and trainings they have had. The Chichewa (Malawi's local language) translation of CA which has been adopted by the National Conservation Agriculture Task Force is "*ulimi wa mlera nthaka*". This literally means "farming that aim at nursing the land." It clearly draws distinction between CA and other resource conserving technologies. There are other local names for CA such as "*ulimi wa* *mbwezera*" which still serves to explain the understanding and interpretation that the technology is intended to revert back soil quality.

However, as the Land Resources Conservation Department (LRCD) of the Ministry of Agriculture and Food Security admits through its draft National Conservation Agriculture Strategy (July 2008) "much of what has been achieved on the ground is (however) far from the above definition; such that it becomes more realistic to call what the farmers are practicing as 'some form' of CA." The draft strategy further points out that the most commonly adopted technologies are permanent planting ridges and planting basins, with some form of mulching; a very small percentage of the farmers are practicing crop rotation, and crop mixing largely due to their limited land holding sizes.

The LRCD and the projects' reports include farmers practicing 'some form' of CA not complete package as farmers who have adopted CA. The LRCD aggregate figures on CA include four aspects; reduced tillage, use of herbicides, crop residue management and pit planting in isolation. There are no aggregate figures for those adopting the whole package that ensures minimum soil disturbance, ground cover and crop combination in space or time. It is not surprising then that the definition of CA by some farmers and extension agents include use of herbicides or fulfilling any of the three principles of CA.

A question then arises as to whether those practicing one or two of these technologies can be said to be practicing CA. Yet, the figures under "all conservation farming" are just a summation of individual technologies. Another element to note is that on the activities reported under CA crop rotation is not one of them. Most framers practicing CA in Malawi plant maize each year without rotation due to limited land holding sizes. It has also been noted that extension messages on CA do not emphasize on rotation. Most stakeholders, and from experience from the neighboring Zambia, think that continuous cropping of maize on minimum tillage, ensuring adequate cover, good fertilization, and effective weed management will make it up for the lack of rotation.

There is also a debate on whether you can do CA without spraying herbicides. The argument centers on the belief that minimum or zero disturbance to soil during weeding is only possible with herbicides. While others argue that it is possible to suppress weeds with adequate ground cover using crop residues, live mulch plus light hand weeding. This debate is still inconclusive and research related to this subject is being conducted at Chitedze Research Station. It must however be noted that agriculture with reduced mechanical tillage is only possible when soil organisms are taking over the task of tilling the soil. This leads to other implications regarding the use of chemical farm inputs. Synthetic pesticides and mineral fertilizer have to be used in ways that do not harm soil life.

3.2 Resource Conserving Technologies vs. Conservation Agriculture

In the Malawi context, Resource Conserving Technologies can be defined as all those technologies that aim at soil and water conservation and soil fertility enhancement for agricultural purpose (crops and livestock). This terminology is synonymous to those in use now or before that refer to the technologies that ensure sustainable use of soil and water either by providing cover through better husbandry and/or providing physical barriers to promote capture and storage of rainwater in the soil profile. These technologies have been demonstrated and adopted in isolation, address specific problems and in the circumstances have served Malawi well.

Malawi has a very long history of implementing these resource conserving technologies; agroforestry, soil fertility enhancement, soil and water conservation technologies although there are a number of them which have entered the list in the last ten years. These include technologies in the realm of *in-situ* rainwater harvesting such as planting pits, swales or infiltration trenches (Table 2).

Table 2: Examples of resource conserving technologies practiced in Malawi.

Soil and water management technologies	Soil fertility enhancement technologies
Contour ridging Box/ tied- ridging Raising of footpaths and garden boundaries Contour stone lines Contour vegetative hedgerows Gully reclamation Stream bank protection Terracing Basin planting Storm drains Swales	Agroforestry Organic and inorganic fertilizers Liming Residue incorporation Legume intercropping Crop rotations Improved fallows

The history of soil and water conservation related extension is well documented in Evans et al., 1999. From pre-colonial times farmers have been practicing some form of physical and biological conservation measures. The colonial period was characterized by enforcement by law of physical conservation structures mostly in the form of graded bunds, water ways and storm drains particularly in tobacco growing areas and contour bunds elsewhere. The graded bunds were to drain excess rain water away from the fields at non erosive velocities while the contour bunds with the accompanied ridges in between were to keep rainwater and improve infiltration and moisture retention. The structures were pegged by government staff and constructed by government using heavy machinery; expecting the farmers to do the maintenance in the subsequent years. The performance of these structures was poor as they lacked constant maintenance and this caused them not to function as designed, as a result they caused more serious erosion.

The approach to soil and water conservation extension has changed overtime to less of machine constructed physical structures to pegging of marker ridges, ridge re-alignment and planting of vegetative hedgerows along the markers first to stabilize them and later to also work as independent barriers against overland flow and erosion. Use of low cost technologies for pegging was promoted along with mobilization of communities to do the marker ridges and other conservation measures through the annual conservation campaigns.

Other low cost technologies for fertility enhancement came on the scene in the form of crop residue incorporation, making and using compost manure, legume intercropping, and various agroforestry technologies. The most popularized of these has been the use of compost manure through promotion by government and other stakeholders. On soil and water conservation front, the activities promoted include marker ridging, ridge re-alignment, box ridging, gully control and reclamation and vetiver establishment. The late entrants to this list include some in-situ rain water harvesting technologies such as pit planting, retention ditches, infiltration trenches and swales.


Plate 4: Infiltration trenches. (Source: Nthara, 2005).

The rationale for promoting these various technologies vary; agroforestry technologies aimed at improving soil fertility, providing a source of fuel wood, shelter, materials for construction, livestock feed and sometimes rehabilitation of degraded areas. The compost manure making is to supplement the inorganic sources of plant nutrients and improve the soil physical properties that encourage movement of water and nutrients. The promotion of organic sources of plant nutrients has been to improve the soil carbon that is limiting in most soils due to continuous nutrient mining. Likewise, the various physical and biological soil and water conservation measures have been used either to prevent or control loss of water and soil.

The strong conservation drive in Malawi spearheaded by the Land Resources Conservation of the Ministry of Agriculture is based on the realization that soil erosion in the context of overall land degradation poses the greatest threat to sustainable agricultural production as well as the physical contamination of water resources. Deteriorating soil structure, reduced moisture retention capacity, depletion of nutrients and organic matter, and decreased micro-fauna and flora characterize soil erosion. Thus soil erosion threatens soil fertility, crop productivity, and general agricultural production and available surface water resources. The World Bank in 1992 estimated soil loss in Malawi to average at 20 tons per hectare per year, and contributing to crop yield losses of between 4% and 11%.

The distinction between CA and other RCTs is therefore that CA emphasizes on the synergies of the various components of the system that provide conditions for minimum soil disturbance, maximum soil cover, effective weed and pest management and crop mixes both in space and time. The technologies that are practiced in isolation or in combination but are not compliant to CA principles, important as they may be, are not CA.

4. CONSERVATION AGRICUTURE PROGRAMMES AND PROJECTS

The following are some of the initiatives in CA for which information is available and have been used to provide evidence based experience in CA in Malawi. Annex 2 gives a list of CA projects or those with CA components, the implementing agents, and sources of funding and other information.

4.1 Sasakawa Global (SG) 2000[2]

SG 2000 in partnership with Extension Department of the Ministry of Agriculture and Food Security implemented a project with different components and activities. One of the activities was to demonstrate through Management Training Plots (MTPs) tool across the country the technologies for improving maize productivity per unit area. This activity was implemented in Mzuzu; Kasungu; Salima; Lilongwe; Machinga and Blantyre Agricultural Development Divisions (ADD). The implementer of the demonstration was the farmer assisted by the field assistant (FA). The aim of SG 2000 was to assist the government of Malawi to improve the agriculture sector productivity. SG 2000 and the ADDs were collaborating with MONSANTO in this goal. Under this partnership Farmers and field extension staff established MTPs demonstrations in 6 ADDs. The rationale of this work was to demonstrate the value of CA against conventional farming and create demand for the technology. The demonstrations compared three treatments as follows:

- **Traditional way of producing maize.** This was what most farmers were using and comprised; (i) use of un-improved varieties; (ii) planting of 3 seeds per hole at 90-100 cm on a ridge 90-120 cm apart; (iii) application of unknown rate of fertilizers when the maize is in reproductive phase; (iv) weeding once or none at all by using hoe; (v) harvesting of the maize after drying in the field and (vi) the storing of the cobs with husks containing high percentage of humidity in a basket (Nkhokwe), or seed without chemical treatment in sacks or in a traditional granary that host insects.

- **SG 2000 conventional technology.** The SG 2000 conventional technology MTP package for the maize demonstration was as follows: (i) use of hybrid maize seed; (ii) till the soil and make ridges at 75 cm apart; (iii) plant one seed at 25 cm apart per hole along the ridge. SG 2000 also promoted the use of two seeds per hole at 45 cm between even though it was not demonstrated to farmers; (iv) fertilize with 92 kg N and 21 kg P per hectare. From the total rate recommended of fertilizer, the basal application was composed of 50% of the N and 100% of the P. The top dress was composed of the remaining 50% of N. The top dress was applied at knee high; (v) maintain the plot weed free by weeding 2 to 3 times;(vi) harvest when the ears have reached physiological maturity and (vii) before drying the cob remove the husks, thresh the cob after the seed is dry and apply super Actellic to

[2] Also Mr. J. Lupenga, Lilongwe ADD (personal communication)

control weevils and Large grain borer. Store the grain treated in sacs or in improved cement granary.

- **Conservation agriculture technology.** This aimed at maintaining the field weed free, increase retention of moisture in the soil and reduce erosion by maintaining the residue of maize on the surface and reduced cost of production to farmers. Under this technology, farmers did not till the soil and weed control was accomplished through use of herbicides namely post emergence Roundup and the pre/post emergence Bullet. The recommendations were that Roundup be applied 7 days before planting and the residual herbicide Bullet within 3 days after planting in order to maintain the field weed free. No clearing and no burning of crop residues was allowed. The technology for plant population and fertilizers used in the conservation agriculture demonstrations was the same used in the conventional technology explained above.

Before the implementation of the two improved technologies on farmer's fields, all the participating farmers, and field extension staff in project areas were trained in maize morphology, production technologies, crop management, crop protection, weed control methods, crop storage techniques and conservation agriculture concept. The fertilizers and the maize were provided to farmers on credit for both technologies demonstrated. The plot size for each one of the technologies demonstrated was 0.1 ha. The 0.1 ha farmer plots were harvested for crop yield evaluation. The farmers paid for roundup and bullet herbicides before implementing the conservation agriculture demonstration. Field days were conducted at different stages of the maize growth for farmers and the general public, as a training tool and also to make farmers participate with extension agents and officials.

The yield from each demonstration was determined after weighing the harvested grain from the whole plot from the conventional and Conservation agriculture plots. The national crop production and yield estimates were used to come up with the yield for the traditional way of farming. This estimation was used to compare both technologies with the farmer way of growing maize. Economic analyses were also conducted for the three systems of maize production to determine the profitability of the introduced technologies.

Maize grain yields from the MTPs for the 1998/99; 1999/00, 2000/01and 2001/2002 cropping seasons is presented in Table 3. Maize grain yields for the conventional and conservation agriculture technologies were two to three folds over the traditional way of farming. These results show that the conventional technology out-yielded the traditional system of farming by more than three times in Blantyre, Machinga, Lilongwe, Salima, Kasungu and Mzuzu ADDs. It is important to emphasize that both the traditional and the conventional technologies used hand weeding. Being the main difference between both technologies the plant population, the quantity of fertilizer used, the time of planting and the number and frequency of weeding. The total number of farmers participating in the demonstration of the conventional technology across the country was 4,161 farmers and 273 farmers in the conservation agriculture technology. The traditional way of farming used for comparison, is the national average yield of total maize cultivated in the country as given by the National Statistical Office.

TABLE 3. Maize yields under farmer way, conventional and conservation agriculture technologies from 1998/99 to 2001/02 in six ADDs.

[1]*CA* = Conservation agriculture; Farmers way = National average.

Agricultural Development Division	Type of Technology training plot	Average grain yield per technology			
		1998 / 99	1999 / 00	2000 / 01	2001/ 02
		kg / ha	kg / ha	kg / ha	kg / ha
Blantyre	Farmer way	1,712	1,652	1,137	1,002
	Conventional	4,600	4,920	4,868	5,311
	CA	-	-	*4,982*	*6,098*
Machinga	Farmer way	1,712	1,652	1,137	1,002
	Conventional	4,600	4,920	4,910	4,790
	CA	-	-	*4,291*	*4,718*
Lilongwe	Farmer way	1,712	1,652	1,137	1,002
	Conventional	4,750	5,688	4,658	5,660
	CA	-	-	*5,384*	*4,623*
Salima	Farmer way	1,712	1,652	1,137	1,002
	Conventional	-	-	4,702	4,204
	CA	-	-	*5,425*	*3'944*
Kasungu	Farmer way	1,712	1,652	1,137	1,002
	Conventional	-	-	-	4,947
	CA	-	-	-	*4,040*
Mzuzu	Farmer way	1,712	1,652	1,137	1,002
	Conventional	5,267	7,343	4,769	5,648
	CA	-	-	*3,340*	*4,967*

[2]Total of farmers that participated in the conventional technology in 2000/01 and 2001/2002 demonstrations across the country = 273 and 4,161, respectively.
Source: Valencia & Nyirenda, 2003

A comparison of maize grain yield obtained from conservation agriculture (CA), farmer way and those from conventional MTPs demonstrations (Tables 3 & 4), reveal the following: maize grain yields from conservation agriculture MTPs are between 294% to 477% higher than traditional farmer way system in 2000/2001 and 394% to 609% in 2001 / 2002 across ADDs. Generally, the conventional and the conservation agriculture technology performed similarly, but both technologies were better than the traditional way of farming by farmers.

The cost of producing maize in the farmer way has been very costly for the country. The cost of maize has been very much correlated to the low fertility in the soil and problems related to erosion. The perseverance of the government to promote compost fertilizer has deceived the farmers not to use inorganic fertilizers. Gilbert (2002) reported in his study of a comparison of best bet soil fertility technologies that by using half of the blank fertilizer recommended yield increase up to 2.5 t/ha from 600 kg obtained in the traditional way of farming. He indicated that fertilized maize remains a powerful option for improving food security in Malawi. Organic fertilizer or compost fertilizer is not sufficient to increase productivity per unit area. This was proved in the conventional and conservation agriculture technologies in the Sasakawa Management Training Plots demonstrations across the country.

TABLE 4. Comparison of maize yields under conventional and conservation agriculture technologies and their percentage over the farmer way of farming in different years and ADDs (2000/01 – 2001/02).

Agricultural Development Division	Type of Technology training plot	Average grain yield			
		2000 / 2001		2001 / 2002	
		Kg / ha	% Over FW	Kg / ha	% Over FW
Blantyre	Farmer way (FW)	1,137	100	1,002	100
	Conventional	4,868	428	5,311	530
	CA	*4,982*	*438*	*6,098*	*609*
Machinga	Farmer way (FW)	1,137	100	1,002	100
	Conventional	4,910	432	4,790	478
	CA	*4,291*	*377*	*4,718*	*471*
Lilongwe	Farmer way (FW)	1,137	100	1,002	100
	Conventional	4,658	410	5,660	564
	CA	*5,384*	*474*	*4,623*	*461*
Salima	Farmer way (FW)	1,137	100	1,002	100
	Conventional	4,702	414	4,204	420
	CA	*5,425*	*477*	*3,944*	*394*
Kasungu	Farmer way (FW)	1,137	100	1,002	100
	Conventional	-	0	4,947	494
	CA	-	*0*	*4,040*	*403*
Mzuzu	Farmer way (FW)	1,137	100	1,002	100
	Conventional	4,769	419	5,648	564
	CA	*3,340*	*294*	*4,967*	*496*

Source: Valencia & Nyirenda, 2003

Regardless of the ups and downs of the maize price, a comparative cost of production for the three production systems was done for year 2002/2003 and year 2004/2005 (Tables 4 and 5). For this purpose estimations were done with farmers at Blantyre and Salima ADDs whereby two hundred and fifty five farmers were interviewed. The comparison indicates that farmers expect at least a price of 12 Kwacha per kilogram at the end of the season 2002 / 2003. Under this estimation, they expect a higher net income in the conservation agriculture technology followed by the conventional one. Farmers were surprised to find that in their traditional way of farming they are losing. The higher net income from the conservation agriculture technology is a result of savings accrued from labour for ridging and weeding, indicating that the use of herbicides in conservation agriculture technology is cost effective (Tables 5 and 6)

Sasakawa Global 2000 programme was perhaps the first attempt to promote CA at broad scale at smallholder level and it remains the reference point for serious CA promotion. Some elements of the Sasakawa Global 2000 package in particular the one seed per planting station 25 cm apart was widely adopted by farmers across the country practicing conventional farming and still remains popular. From these demonstrations a number of farmers adopted the CA, and this study followed up some of these farmers to find out why they are still practicing the technology or why they stopped practicing it.

TABLE 5. Estimations of cost (Malawi Kwacha) of production for maize production under farmers' traditional way, SG 2000 conventional and conservation agriculture technologies (2002/03) in Blantyre and Salima ADDs.

Activity	Farmers' way	Conventional	CA
Clearing	162.50	162.50	0.00
Ridging	212.50	212.50	0.00
Seed cost	62.50	146.25	146.25
Roundup + Labor	0.00	0.00	175.00
Roundup application cost	0.00	0.00	40.00
Planting Labour	37.50	75.00	75.00
Fertilizer cost	350.00	603.00	603.00
Fertilizer application cost	62.50	125.00	125.00
Weeding twice labor cost	375.00	375.00	0.00
Bullet Cost + Labour	0.00	0.00	295.25
Bullet cost of application	0.00	0.00	40.00
Banking up	175.00	175.00	0.00
Harvesting	175.00	212.50	212.50
Cost / Plot (0.1ha) Kwacha	1,612.50	2,086.75	1,712.00
Cost per one hectare Kwacha	16,125.00	20,867.50	17,120.00
Yield per hectare kilograms	800.00	5,311.00	6,098.00
Price of maize per kilogram	12.00	12.00	12.00
Gross Income Kwacha	9,600.00	63,732.00	73,176.00
Net Income Kwacha	(6,525.00)	42,864.50	56,056.00

Rate of exchange to USD = 85 Malawi Kwacha per USD.
Source: Valencia & Nyirenda, 2003

TABLE 6. Estimations of cost (Malawi Kwacha) of production for maize production under farmers' traditional way, SG 2000 conventional and conservation agriculture technologies (2004/05) in Lilongwe ADD.

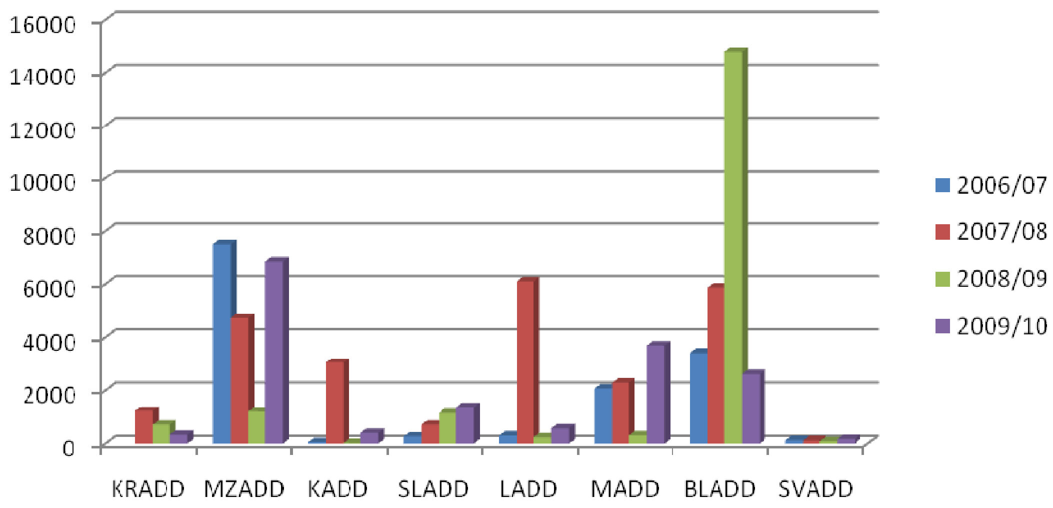
Operation	Farmers' way	Conventional	CA
Clearing	170.00	170.00	0
Ridging	308.33	400.00	0
Seed price	150.00	400.00	400.00
Planting	125.00	270.83	270.83
Fertilizers	750.00	1503.00	1503.00
Application	162.50	516.67	516.67
Weeding	275.00	350.00	0
Banking	308.33	400.00	0
Round-up	0	0	255.00
Spraying	0	0	100.00
Bullet	0	0	390.00
Spraying	0	0	100.00
Harvesting	687.50	800.00	800.00
Cost/Plot (0.1h) Kwacha	2936.66	4810.50	4335.50
Cost/Plot (1.0ha) Kwacha	2936.66	48105.00	43355.00
Total reduction 1.0ha	800	5113	6235
Maize price at harvest	MK15.00/kg	MK15.00/kg	MK15.00/kg
Gross income	12000.00	76695.00	93525.00
Net profit 1.0ha	-17366.60	28590.00	50170.00
Net Profit 0.1ha	-1736.66	2859.00	5017.00

Source: Lupenga, 2010 (personal communication)

4.2 Land Resources Conservation Department (LRCD)

Land Resources Conservation Department (LRCD) in the Ministry of Agriculture and Food Security (MoAFS) is responsible for the coordination, planning, implementation, monitoring and evaluation of land resources conservation policy, legislation, programs and projects in the country. It has programmes in all eight Agricultural Development Divisions funded on revenue budget and projects funded on development budget. LRCD is at the forefront of promoting CA and is presently the secretariat of the National Conservation Agriculture Task Force. On CA it promotes activities in a number of areas such as reduced tillage, use of herbicides, crop residue management and pit planting whose reportage is in the form of components as shown in Annex 5.

In the year 2008/2009 LRCD reported 110% achievement rate on planned targets on CA activities; this was twice what was achieved the previous season. This was as a result of the efforts made in up scaling the technology. Area under conservation farming registered 18,471 hectares out of the target of 16,789 hectares and participation was 60,758 of the 73,336 farmers planned. For 2009/2010 area under conservation farming registered fell down to 16,028 ha and the participation was 37,594 farmers comprising 16990 males and 20604 females. For four consecutive seasons; 2006 to 2010 the cumulative hectarage under CA is reported as 102, 363 ha done by 270,598 farmers of which 151,376 were males and 119,222 females representing 44% female participation. Details of achievements on CA from 2006/07 to 2009/10 are given in Appendix 5 and some of the highlights are presented below in Figures 3 and 4.



Legend:
Agricultural Development Divisions (ADDs), KRADD: Karonga ADD, MZADD: Mzuzu ADD, KADD: Kasungu ADD' SLADD: Salima ADDD, LADD: Lilongwe ADD, MADD: Machinga ADD, BLADD: Blantyre ADD, SVADD: Shire Valley ADD

Figure 3.Total hectares under CA in the ADDs from 2006/07 to 2009/10

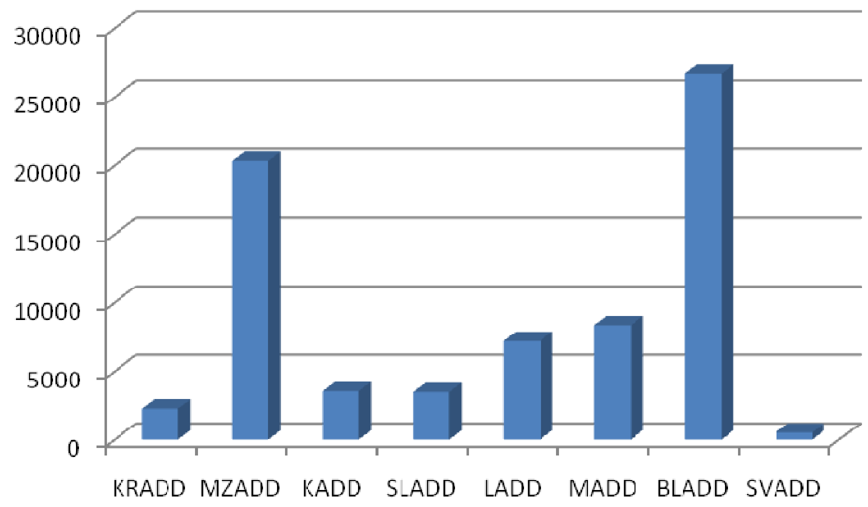


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Figure 4. Cumulative hectares under CA per ADD for the period 2006/07 to 2009/10

LRCD has implemented a number of soil and water conservation projects some of them with elements of CA as detailed in the following sections:

4.2.1 Malawi Agroforestry Extension Project/Promotion of Soil Conservation and Rural Production Joint Research and Demonstration Trials.

Malawi Agroforestry Extension (MAFE) Project was implemented by the Department of Land Resources in partnership with Washington State University with the financial assistance from the United States agency for International Development in the 90s. The primary objective of MAFE was to improve household food security through better land husbandry and agroforestry practices.

Promotion of Soil Conservation and Rural Production (PROSCARP) was implemented from May 1997 to June 2002 with the support of the European Union amounting to ECU21.2 million. The overall objective of PROSCARP was to reduce land degradation and to contribute towards the improvement of the nutritional and health status of smallholder farmers throughout Malawi. These objectives were to be achieved through a set of integrated activities specifically soil and water conservation, soil fertility enhancement, crop diversification, water supply and sanitation.

The above two projects in the Department of Land Resources Conservation teamed up in 1996/97 to mount 195 demonstration /trials. The trials were on soil conservation, grain legumes and agroforestry practices while on farm demonstrations were on reduced tillage compared with annual manual ridging. In addition, on-station reduced tillage trials were begun at five research stations in Malawi. This was motivated by government and

PAPPPA[3] contract staff visit to Zimbabwe in May 1996 which concluded that reduced tillage might hold promise for Malawian smallholder farmers.

The model for smallholder reduced tillage required that marker ridges be constructed and vetiver hedgerows be planted in the furrow behind. This was considered necessary to protect the ridges from increased runoff and erosion. Crop residues were retained on the surface to decompose and to improve soil condition by increasing soil microbial activities. Added to this was the under sowing of *Tephrosia* because of its deep rooting habit that was expected to assist in breaking any hardpan that may have been developed due to long years of using a hand hoe prior to the start of reduced tillage. Despite the enthusiasm by the project staff, the Ministry doubted its readiness to promote reduced tillage to smallholder farmers until proper trials could be undertaken.

On station trials between 1997/98 and 2001/2002 produced inconclusive results; there appeared to be no significant difference of grain yield between maize grown with reduced tillage and that under conventional tillage although there was a slight but statistically insignificant improvement in yield with minimum tillage. The on station reduced tillage trials managed by research staff had a number of logistical problems that led to late planting and poor weeding and yielded similar results as those obtained from the on-farm trials.

However, it was reported that reduced tillage provided benefit in terms of reduced labour requirement, estimated as 43% less. Farmers who tried this technology described two main constraints from their point of view; first, maize stover left on the ground did not readily decompose and attracted termites that had the potential to damage the following crop, and secondly the fields were overtaken by weeds which under conventional tillage they could have been buried deep and suppress their germination. In this reduced tillage trial regime weeds were removed by hand as the herbicides were beyond the financial resources of most farmers and had limited access to sprayers.

One of the major lessons cited from these demonstrations was that although they were meant to be farmer managed, they were sort of imposed on them as they were done with little consultations or explanations. Farmers were unaware of what was to be demonstrated and they managed the sites under instructions from government extension agents or the project staff. The situation was made worse when later other technologies were added to the demonstration sites. It became so complicated even for project staff that the added technologies confused rather than clarified the situation (PROSCARP, 2002).

[3] Prior to PROSCARP there was Poverty Alleviation Programme-Pilot Project Agroforestry (PAPPPA) which was concluded in 1997. It was working in 176 sites in all eight Agricultural Development Divisions. Before PAPPPA there was ADDFOOD that started in Salima ADD in 1989/90 and continued expanding eventually into six Agricultural Divisions in 1995. All these were supported from the European Development Fund.

4.2.2 Farm Income Diversification Program (FIDP)

As a follow up to PROSCARP the European Union is funding a six year programme divided into two phases of three years each that started with an inception phase in August 2006 and the first operational programme estimate in 2006/07. The total cost of the project is Eur 36.5 million and the first phase was completed in October 2009 and for the Large Grants component ends in December 2010. FIDP's objective is to contribute towards sustainable improvement of livelihoods of rural Malawian communities through interventions aimed at diversifying farmers' incomes. The specific purpose is to increase food security and income levels of rural households while ensuring sustainable use of soil and water resources. Under its result area on sustainable land management and soil fertility the project continues to implement conservation agriculture, compost manure making, crop residue incorporation, marker ridge construction and ridge re-alignment.

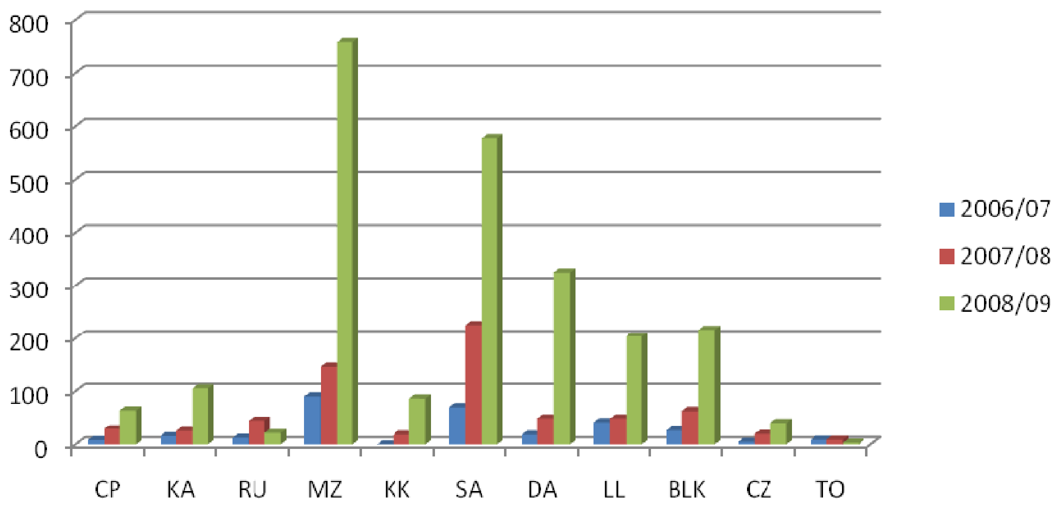
The first phase of FIDP was working in 34 selected Extension Planning Areas in eleven target Districts across Malawi; Chitipa, Karonga, Rumphi and Mzimba in the Northern region; Nkhotakota, Salima, Dowa and Lilongwe in the Central region; and Balaka, Chiradzulu and Thyolo Districts in the Southern Region.

Apart from the 11 districts where GoM was directly operating, resources are also channelled through the Large Grants. Some of the large grants beneficiary organisations are operating outside these districts. Of Relevance to CA is Blantyre district where Ricerca e Cooperazione with CURE were implementing a project funded through FIDP *"Improvement of Farmers' Productivity and Income through Soil Re-Fertilization in Blantyre District, Malawi"*. Other beneficiaries include Mzuzu Coffee and NASFAM with programme outside the 11 districts and also different EPAs from the FIDP GoM operation

'Conservation farming', as it is referred in FIDP documents, was initiated to improve soil fertility and soil conservation and also as an adaptation mechanism to climate change and uses the model as depicted in Box 1below.

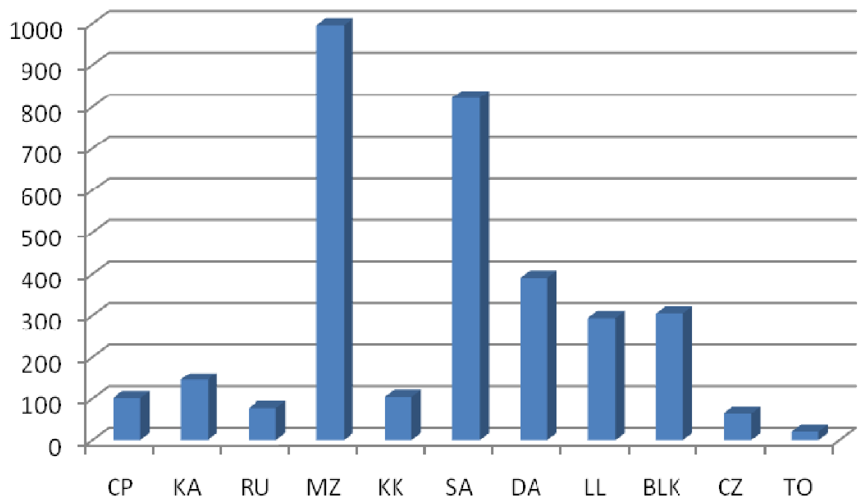
Box 1. FIDP follows a group approach in CA implementation where farmers are organized in groups for demonstrations. After sensitization and training of field staff and farmers, the target farmers are given start up inputs in the first year on a revolving fund basis.

From 2006/07 to 2008/09 area under conservation farming has increased ten times from less than 250 ha to over 2500 ha. The number of farmers adopting the technology has increased from 1528 in the first year to 3254 in the third year while the average yield over the three years is 4,500 kg/ha. This represents an additional annual production of approximately 5000 tons/year (Nyangulu, 2009). The annual achievements for the three years per each district are shown in Annex1 and are shown schematically in Figures 5, 6, and 7 below. By the third year (2008/09) of the FIDP project, 79%, 54% and 92% of farmers bought own seed, herbicides and fertilizers respectively. It is hoped that in the next phase the programme, CA will be scaled up in most districts.



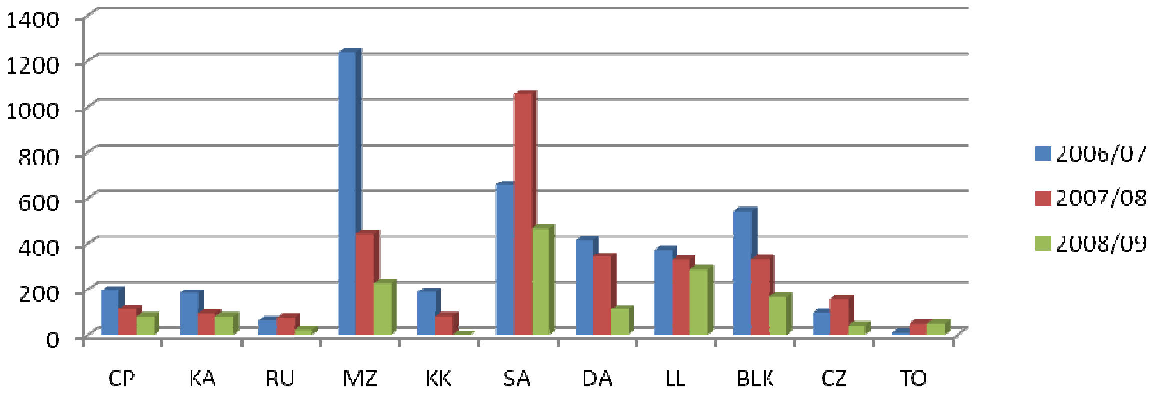
Legend:
Districts CP: Chitipa, KA: Karonga, RU: Rumphi, MZ: Mzimba, KK: Nkhotakota, SA: Salima, DA: Dowa, LL: Lilongwe, BLK: Balaka, CZ: Chiradzulu, TO: Thyolo.

Figure 5. Hectares under Conservation Farming in the FIDP participating districts in each year of the First Phase



Legend:
Districts CP: Chitipa, KA: Karonga, RU: Rumphi, MZ: Mzimba, KK: Nkhotakota, SA: Salima, DA: Dowa, LL: Lilongwe, BLK: Balaka, CZ: Chiradzulu, TO: Thyolo.

Figure 6. Cumulative total hectares under CA achieved between 2006/7 and 2008/09 for each of the participating districts under FIDP



Legend:
Districts CP: Chitipa, KA: Karonga, RU: Rumphi, MZ: Mzimba, KK: Nkhotakota, SA: Salima, DA: Dowa, LL: Lilongwe, BLK: Balaka, CZ: Chiradzulu, TO: Thyolo.

Figure 7. Number of farmers practicing Conservation Farming during Phase 1 of FIDP

FIDP produced the only available Conservation 'Farming' Field Manual in the country that defines 'conservation farming', the principles and implementation guidelines. It is estimated that 1,100 copies have been distributed to various stakeholders for use.

The picture from Machinga ADD based on the field visits by the researchers indicated that despite the fact that farmers were issued with startup materials for two successive years, in the third year one group dropped out. They started with two groups comprising 23 members and in the third year one group with 11 members remained. The remaining group continued to receive materials in the third year which speaks volumes on the sustainability of the programme. The field visits also revealed that the FIDP revolving fund for CA farmers is established with no capital from FIDP but is based on an input loan recovery from farmers. In both Lilongwe ADD and Machinga ADD, farmers that stopped practicing CA cited that loan recovery was very poor and farmers could not re-invest in the revolving fund.

Specifically for the current season, the study visits revealed that farmers faced a number of problems concerning management of mulch that included; prolonged dry season that led the mulch cover to be completely devastated by termites, damage of the crop residues by malicious fires and free range livestock feeding on the mulch. Additionally, the erratic and unpredictable rains posed problems in deciding when to plant and this necessitated replanting. Some plants have not managed to recover even after the return of the rains because the dry spell was protracted. The effect has been that there was no observable difference in performance of maize between the CA plots and the conventional plots.

4.2.3 ADP-SP/ASWAp Programme

The ADP-SP/Agriculture Sector Wide Approach (ASWAp) project represents one of the most serious intentions of Government to embrace Conservation Agriculture under the component of its Sustainable Growth Initiative.

.

The programme has three main components and these are; (a) Institutional development and capacity building, (b) Sustainable food security; and (c) Project coordination. The Department of Land Resources Conservation falls under the sustainable food security component which has three sub-components which include; sustainable productivity growth initiative, strengthening coordination and technical capacities, and strengthening market based agricultural risk management.

The Sustainable Productivity Growth Initiative will support initiatives aimed at sustainable improvement of national and household food security. Under the sub-component, the project has three activities which include *Sustainable Land and Rainwater Management*. The initiative targets increased smallholder adoption of environmentally sustainable maize-based cropping practices by adapting and up-scaling innovative conservation farming technologies, including minimum tillage and mulching with crop residues; complementary technologies include permanent pit / basin planting, intercropping and rotation with legume crops and trees (agroforestry); The critical assumptions is that smallholder farmers will efficiently manage crop residue as a main source of mulching material.

Under this initiative, the DLRC in the first year, 2008/09 reached a total of 1,329 farmers on 217.2 ha in the four pilot districts of Karonga, Kasungu, Blantyre and Thyolo. It procured inputs for CA on-farm demonstrations which included: 2,500 kg maize seed, 558 kg bean seed, 372 bags 23:21:0+4S fertilizers, 558 bags Urea, 744 litres of Bullet and Round-up herbicides. Most areas got the inputs late in the rainy season after they had already planted other crops and decided to keep them for the irrigated farming with the intention of getting crop residue that can be used as mulch for the next season.

4.3 Total Land Care

Total LandCare (TLC) is a non-government organization operating in Malawi, Mozambique and Tanzania. Its work is premised on the need to increase the production and income levels of small scale farmers in these countries through improved agricultural practices with sustained conservation and management of the natural resources base. A key focus of TLC programs is to improve rural livelihoods with emphasis on a number of areas including soil and water conservation, conservation farming, contour and box ridging, vetiver grass hedgerows and gully reclamation.

Among the many interventions in Malawi, TLC has been implementing a project around Chia Lagoon (the Chia Catchment Management Project) which has provided impetus for an expanded programme “Management for Adaptation of Climate Change (MACC): An Integrated Model for the Central Watersheds of Lake Malawi” covering ten Extension

Planning Areas in five Districts: Nkhata Bay, Nkhotakota, Ntchisi, Salima and Dowa covering a total of 580,154 ha. The underlying principles entail an integrated holistic approach with a three-point thrust:

- To reduce risks and vulnerability from erratic and unpredictable changes in climate;
- To improve food security, nutrition, and general well-being of rural communities; and
- To assist farm households in making the transition from subsistence survival to a business oriented mind-set that promotes self sufficiency and growth

> Box 2. TLC CA Model
>
> TLC has an aggressive CA demonstration programme in partnership with the International Maize and Wheat Improvement Centre (CIMMYT) where farmers get to observe the method and results of CA.
>
> Farmers interested in CA do register with the TLC field coordinators in their respective areas where they pay a deposit of MK1000 each with a commitment to pay the balance in 9 months. This is for herbicides which costs about K3000 to K3500 per 0.4 ha plot. These deposits are used to estimate demand of chemicals which are purchased centrally by TLC and distributed to Farmers. The repayment has been good estimated at about 90% and is used as a revolving fund to support farmers on CA the following season.
>
> The farmers must be those who have registered under the Government's input subsidy programme and will receive fertilizer under that programme or those who have own means of procuring fertilizer
>
> CA under TLC entails planting on old ridges, use of crop residues and weed control using herbicides. TLC also emphasizes the inclusion of soil and water conservation measures such as contour vetiver hedgerows especially in steep areas.

Source: Personal Communication with Dr. Trent Bunderson.

Under its Land and Water Management component the project addresses a number of intervention areas ranging from crop diversification, winter production, value adding, improved farm integration, agroforestry/soil fertility management and evaluation of crop/plant/soil sequestration of carbon, water run of and loss of top soil. Conservation agriculture/reduced tillage, soil and water conservation measures is also one of the priority intervention areas under land and water management component. The project motivation for CA is to target sites in the interest of conserving and improving the management and use of soils. Soil compaction, erosion and runoff are recognized as significant problems arising from tilling the soil and CA is seen as a technology that can address these problems and in addition to providing more stable yields, increasing profits and reducing demand for labour, time and production costs.

TLC's project portfolio is large and in all its projects promotes CA and tree planting and in future these will be preconditions for farmer participation in their projects. The profiles of projects they implement are included together with those of other stakeholders in Annex 2.

The CA under TLC entails maintenance of old ridges (no till), planting on the same stations each year and as yet do not promote pit planting. There is deliberate effort to keep crop residues on the surface and chemicals are used to control weeds. They also encourage intercropping with cow peas, pigeon peas or *Tephrosia* planted in the furrows. In the first year farmers are provided with inputs on loan and in subsequent years farmers are expected to procure their own inputs (Table 7).

Table 7. Input Package for Conservation Agriculture under Total LandCare

Inputs packs	Unit	Unit Cost	For 1 Ha	
			Quantity	Total MK
Seed				
Maize	Kg	350	25	8750
Legume (choice of 1)				
Pigeon Peas	Kg	250	12	3000
Cowpeas/Beans	Kg	250	80	20000
Tephrosia candida	Kg	250	5	1250
Fertilizer				
23:21:0:4	50 kg	1000	2.5	2500
Urea	50 kg	1000	2.5	2500
Herbicides				
Roundup (Glyphosate)	Litre	1200	2.5	3000
Bullet (Atrazine base)	Litre	1500	2.5	3750
Sprayer (1 per group of 10)	No.	1500	0.1	1500
Total Cost MK (depends on type of legume used)			For 1 ha	
CA with Pigeon Peas			25000	
CA with Beans or cow peas			42000	
CA with Tephrosia			23250	

Source: Bunderson et el, (2009)

Experience with TLC has been that maize yields under CA are higher and more stable than conventional practice as illustrated in Figure 8 below.

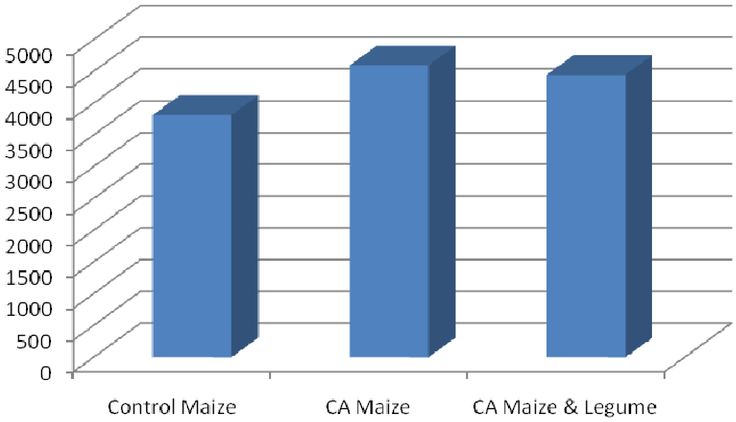


Fig 8. Maize yields from TLC CA demonstrations from 193 farmers (2006 – 2009)

TLC in partnership with CIMMYT is conducting a number of trials to evaluate the socio-economic impacts of CA under smallholder agriculture. This is also used as a vehicle to promote adoption although their main thrust is to collect data on various aspects of CA that will provide the basis for informed up scaling of the technology.

TLC also implements a number of small collaborative projects with other partners such as International Labour Organization, Phillip Morris of USA, Jack Bower, Japanese Tobacco International and others on various conservation and livelihoods issues. In all these endeavours, TLC promotes CA and results in terms of yield and improvement in soil conditions are encouraging.

4.4 Concern Universal

Concern Universal is implementing a project, **Msamala Environmental Rehabilitation & Livelihoods Project (MERLIP)**, in Balaka, Traditional Authority Msamala. The area falls in a rain shadow. One of the six thematic/output areas of the project is increased agricultural diversification and productivity. To achieve this output, improved and more efficient soil moisture techniques of farming were required. Hence, CA was identified as the appropriate technique.

The project targets small scale farmers. During the season 2009/2010 32 farmers used basins to minimize soil tillage, improved ground cover and some inter-planted with legumes. The following package is what is recommended by the project:

- Drought prone areas: Minimum tillage (basins method), 100% ground cover and more than 30% legume rotation system. Basins are very important especially in drought prone areas because they keep soil moisture.
- Normal rainfall areas: Minimum tillage (dibble stick method), 100% ground cover and more than 30% legume rotation system.

Four active farmers, two government extension staff and three project staff went to learn about CA in Zambia at GART and practicing farmers in Chilanga and Mumbwa districts in February 2008. Three farmers each assisted about 10 other farmers to adopt CA. Currently there are 32 CA farmers in the project area. Almost all of them adopted the basin type. Extension staff provided technical support during promotion of CA.

One of the challenges the unavailability of appropriate hoes for digging 30cm by 15cm by 20cm (depth) basins. As a result the project procured *Chaka hoes* from Zambia (Chipata) for the farmers. Other farmers managed to acquire similar hoes locally. The other challenge was that other farmers still felt that excavating basins in dry soils was cumbersome. However, the obvious and clear superiority of basin planting over conventional ridge planting especially under water stress condition of this year has compelled most farmers to consider trying CA in coming growing season.

MERLIP project covers 20 villages in three GVHs of Msamala, Magombera and Chitala in TA Msamala. The target is 3000 households with a population of more than 16000. Of the 32 farmers, 65% are female. The farmers were supported with maize seed, Soya bean seed and Chaka hoes. Demonstrations and video shows were very instrumental in the promotion of CA technologies. The project plans to scale out to 120 farmers for winter CA under irrigation in 2010.

4.5 Food and Agriculture Organization (FAO)

Through **Enhancing Food Security and Development Sustainable Rural Livelihoods Project** [GCPS/ MLW/030/NOR] trained 31 agricultural field staff and 220 farmers on CA in the districts of Machinga, Balaka, Mangochi. The project also targets two other districts; Kasungu and Mzimba. The FAO project promotes CA with the aim of retaining moisture in the face of the recurring dry spells and droughts, replenish nutrients through stover, save labour in terms of both cost and time and finally to control soil erosion through use of cover practices.

CA implementation starts with training of farmers on crop husbandry, soil fertility improvement, sprayer calibration, and spraying techniques. The project distributed farm inputs that included fertilizers (Urea and 23:21:0 +4S); herbicides (Round-up and Bullet); a sprayer and maize seed to enable farmers mount demonstrations on CA during the 2007/08 season.

In Machinga ADD, the study learnt that the CA project has been running for four years. The project started with 7 groups and these were weaned after two years. Six more groups were assisted in the subsequent season to make a total of 13 groups under this project. The support is based on a village revolving fund that caters not only for CA but also for other activities such as irrigation, livestock, etc as agreed in the community. The village revolving fund was capitalized by seed money provided by FAO with 20% borne by farmers themselves. Later farmers contribute to the revolving fund through loan recoveries and interest on the loan. Access and use of the fund is governed by local leaders through by-laws set by the community.

Box 3. FAO CA Model
The approach targets villages that are contiguous to one another in a given catchment – catchment approach. Farmers are then organized in groups to access CA inputs provided by the project through a village revolving fund administered by the village local leaders following locally agreed by-laws. The inputs include fertilizers (Urea and 23:21:0 +4S), herbicides (Round-up and Bullet); a sprayer and maize seed. The inputs are for 0.1 ha. The money from the revolving fund is used for other purposes besides CA such as livestock and other income generating activities.

Experience from Kasungu indicated that for the practice to be successful there is need to be flexible to allow those farmers who can manage to have more than 0.1 ha to enable visible and tangible benefits of CA and if possible practicing farmer fields must be contiguous; watershed approach to create belts of CA fields and protect the whole catchment. The project has integrated in its participatory approaches, development of village ordinances to address the question of livestock feeding on the maize stover.

The FAO is also supporting implementation of two other short term projects on CA. The first is the setting up of **Conservation Agriculture Demonstrations (OSRO/RAF/904/USA**) in four different ecological zones and these are in Balaka and Chikhwawa in the south, Nkhotakota in the Centre and Rumphi in the north. An additional fifth demonstration was set at the Natural Resources College (NRC) in Lilongwe, Central Region for the sole reason of exposing teachers and learners at the College to CA. This last demonstration was unfortunately abandoned because its management did not follow the set protocol. As it turned out, NRC does not have CA in its curriculum posing a very serious concern to capacity building. The farmers that hosted and managed demonstrations are for the current season only, 2009/2010. They were provided with CA inputs such as sprayers, maize seed, legume seed, fertilizer, rain gauges, hoes and herbicides. The CA techniques being demonstrated include crop residue retention, basin planting, use of Dibble stick, mixed cropping and use of herbicides. The project has trained a total of 68 extension staff, conducted field days for the farmers and conducted early season participatory farmer evaluation.

The second FAO project is the **Strengthening of the National Conservation Agriculture Task Force** (OSRO/RAF/810/SWE whose activities include documentation and synthesis of CA information. The Task Force has planned a number of activities under this project that include: holding regular national CA coordination meetings, developing Malawi specific CA guidelines, CA sensitization meetings, field days, participation in regional CA activities and holding national symposium. The funds for the project were disbursed late necessitating revision and prioritization of the activities. This is a one off support to strengthen capacity of the Task Team, it is envisaged that Task Force needs to sustain its activities beyond the short life of this project and continue its mandate of coordinating CA in the country.

The impact of this project is that it has given the Task Team start up funds for its kick starting activities, but its members need to integrate the activities of the group into plans and budgets of their respective institutions to sustain it. The Task Force is also considering developing its strategic plan as part of the national strategy for CA in Malawi.

The importance of the Task Team cannot be overemphasized as there is urgent need for concerted and coordinated effort to develop and promote CA in the country to avoid proliferation of conflicting and counterproductive information and approaches from members of CA value chain.

4.6 MONSANTO Projects

Some of the input suppliers have embraced the concept of conservation agriculture mostly to promote some of their products that can be used in CA. As part of its social responsibility programme, Monsanto in collaboration with some partners is implementing a number of projects on CA that include the following:

4.6.1 Dimon-Monsanto Zamwipe project

This project with Dimon Tobacco Company promotes use of Zamwipe to apply Round up in Dimon tobacco farmers' maize fields. This project is being implemented in Mchinji, Lilongwe and Kasungu districts and is targeted at 2500 beneficiaries.

The objective for the intervention is reduce time for manual work in tobacco fields particularly for those affected by the HIV and AIDS epidemic, increase yields and to allow more and more children to go to school because of the reduced labour requirements in the maize fields.

4.6.2 Monsanto – RECARPO Orphanage (CBO)

This project targets 200 orphans in Mchezi area in Lilongwe district promoting zero tillage and use Knapsack sprayers to apply bullet and round up. The expected impact is reduced work load for the orphans' care takers, improve biomass yield and soil fertility.

4.6.3 Monsanto- Lutheran Mobile Clinic

This targets 150 farmers in Lilongwe, Salima and Mzimba with the technology of zero tillage and use of Knapsack sprayer to apply Bullet and Roundup. Farmers have been able to have more time for other enterprises and get high yields. A similar initiative was done with Sasakawa Global 2000 also targeting 150 farmers in Rumphi, Mzimba, Lilongwe, Dedza and Salima.

4.7 National Smallholder Farmers Association of Malawi (NASFAM)

The National Smallholder Farmers Association of Malawi is an umbrella association of many smallholder associations and it started promoting CA in 2008. Their rationale is to promote the principles and practice of CA in the context of climate change and escalating fertilizer prices in order to achieve sustainable agricultural production, thereby achieving sustainable food and cash crop production while reversing environmental degradation. It has activities in CA and in general soil and water conservation activities in many Districts in the country as shown in Appendix 6. However, Table 8 summarizes NASFAM CA activities while Box 4 below depicts NASFAM's CA model.

Box 4. NASFAM CA Model
NASAFAM uses lead farmers to demonstrate the technologies and conduct field days. They use government extension front line staff to provide hands on training and assist capacity building of farmer trainers. They make extensive use of print and electronic media for increased outreach and currently they are producing a documentary on CA with their farmers.

The achievement of their CA programme is that just after one year of implementation they have 2974 farmers engaged practices that promote ground cover such crop residue management, 27319 farmers practicing crop rotation, 184 farmers practicing pit/basin planting and 537 farmers using herbicides. Women participation in these activities is reported to be low.

Table 8. Summary on number NASFAM farmers on CA activities in 2009

Districts	Crop residue management	Crop rotation	Pit/Basin planting	Herbicide Use
Karonga	1	69	1	74
Rumphi	-	36	1	39
South Mzimba	6	3,823	-	25
Northern Region	7	3,928	2	138
Kasungu	-	12,627	58	-
Nkhotakota	1,700	1,000	-	65
Mchinji	-	413	-	-
Lilongwe south	717	4,886	110	298
Lilongwe north	348	3,180	1	15
Ntchisi	52	179	-	-
Central Region	2,817	22,285	169	378
Ntcheu	-	7	-	2
Balaka	47	796	7	19
Zomba	-	-	1	-
Namwera	-	149	2	-

Mulanje	103	154	3	-
Southern Region	150	1,106	13	21
GRAND TOTAL	2,974	27,319	184	537

NASFAM's constraints as identified during the one year of promoting CA include:

- Lack of knowledge of CA principles and practice in smallholder farming systems
- Lack of skill within NASFAM to support implementation of CA practices
- Insufficient records 'best bet' practices in CA among smallholder farmers
- Low land productivity for food and cash crop

4.8 Bunda College of Agriculture: Evaluating Conservation Agriculture

4.8.1. Agricultural Innovation in Dryland Africa (AIDA). Specific Support Action of the International Co-operation 6th EU Research Framework Program (EU-FP6)

A number of CA activities are in the process of being evaluated by the projects promoting them. However, recently Bunda College of Agriculture, under the AIDA Project (Mloza-Banda and Makwiza, 2007), has done some evaluation work in areas where farmers have adopted CA to understand the soil physical and hydraulic impacts of CA, the social economic factors influencing CA adoption and the dynamics of farmer groups practicing conservation agriculture in those areas. The following thesis research studies were considered relevant to understand the issues and the level of development of CA in Malawi.

4.8.1.1 Evaluation of soil physical and hydraulic properties under conservation agriculture in Central Malawi - M.L. Kamwendo, 2009

Kamwendo (2009) conducted a study south of Lilongwe District on farmers' fields in Chitekwere, Mitundu, Mkwinda, and Chitsime Extension Planning Areas. The objectives of the study were to assess and compare selected soil physical and hydraulic properties under two management systems; conventional tillage (CT) and CA on sandy loam soils on the Lilongwe Plain in Central Malawi. Six small scale farmer fields at four locations practicing CA for 2 and 4 years respectively, and adjacent fields under (CT) with similar soil type and maize (*Zea mays*, L.) - based crop rotation were selected.

The rationale of the study was the observation that one of the major advantages associated with CA is greater availability of soil water, especially in years with low rainfall. Greater availability of soil water has been attributed to a mulching effect of stubble and crop residue on the soil surface that reduces water loss by evaporation and improves water infiltration by reducing run-off. However, changes in soil physical and hydraulic properties in soils under conservation agriculture have been less documented, especially with semi-arid soils, for which the technique has been promoted. This research sought to assess soil and hydraulic properties affected by conservation agriculture practices on a predominantly sandy clay loams on the Lilongwe Plain in Central Malawi.

Gradual compaction has been observed during the first few years of no-till, due to reduction in soil pore volume in the absence of tillage. Kamwendo (2009) reported that bulk density did not significantly differ amongst soil management practices at 0-15 cm soil depth. However, bulk density under 4 years of CA was significantly higher than under 2 years of practice but did not significantly differ with CT at the 15-30 cm soil depth. It is argued in literature that an increase in bulk density appears to be only temporary, with the initial compaction compensated later by the development of soil pores originating from soil biological activity. In this study, it has been shown that 4 years of CA exhibited significantly higher aggregate stability compared to 2 years of CA at 0-15 cm soil depth and compared to CT at 15-30 cm soil depth. And although the index of soil physical quality, *S*, was not significantly different amongst soil management practices, the *S* parameter was consistently higher under 4 years of CA. The modest gains in bulk density, aggregate stability and index of soil physical quality S under CA indicate that these attributes will form key components of any integrative parameter or suite of parameters indicating soil physical quality.

Short, intense rain showers followed by dry spells typify the rainy season in the central Malawi, and evapotranspiration equals and may exceed rainfall during the year. Therefore, water conservation is very important. Soil water retention characteristics were used in this study to estimate macroporosity and matrix porosity at ψ = -1 kPa, -5 kPa and -10 kPa. The results showed that in the top soil layer, CA practices compared to CT, did improve macroporosity to significantly influence soil water retention at all suctions. Matrix porosity did not significantly change at the various water suctions and under the different soil management practices.

The study however showed that CA after 4 years of practice subtended more water at field capacity in the top soil layer and at permanent wilting point in the sub-layer than CA after 2 years and less so under CT. This may explain the common observation of more resilient crop plants under CA compared to CT in the face of drought, with water reserves in the top soil layer being critical at field capacity while soil water in the sub-layer being critical at permanent wilting point.

Soils after 4 years of CA significantly subtended more soil organic carbon (SOC) than under 2 years of the practice or under CT at both soil depths. However, increasing SOC content with no-till systems may not immediately, within a 2-4 year period of conservation agriculture, lead to beneficial changes in associated soil physical and hydraulic properties. Bulk density, matrix porosity, S parameter, and saturated hydraulic conductivity are among the main parameters that did not adequately relate to the significant effect of increased SOC under CA in this study.

The study concluded that within the given small scale maize-based soil and crop management practices, several soil properties were improved as a consequence of decreased disturbance and the maintenance of cover by crop residues in conservation agriculture systems. Soil organic carbon, aggregate stability, macroporosity, volumetric soil water content at field capacity and permanent wilting point, and soil water retention appeared to be the most useful indicators of soil physical and hydraulic quality even in the early stages (2-4 years) of CA because they were significantly responsive to soil management practices encountered in this study.

4.8.1.2 Assessment of socio-economic factors influencing farmers' adoption and intensity of conservation agriculture in dry land areas of Malawi. A case study of Chinguluwe EPA in Salima District and Bazale EPA in Balaka District - S. Kamtimaleka, 2009

Kamtimaleka (2009) assessed socio-economic factors influencing adoption of CA in Chinguluwe Extension Planning Area (EPA) in Salima District, and in Nkomba Model Village in Bazale EPA.in Balaka District. This also followed a reconnaissance study that reported case studies of successful land and water management systems in dry lands of Malawi (Mloza-Banda and Makwiza (2007) under the AIDA Project.

The main objective of the study was to assess the socio-economic factors influencing farmers' adoption and the intensity of use of conservation agriculture. The specific objectives were:

- To identify the socio-economic factors influencing farmers' adoption of CA.
- To assess the intensity of use of conservation agriculture by farmers
- To assess the benefit of CA to farmers

In Salima District, conservation farming was introduced in 2005 promoted by FIDP. The initial trials attracted 39 farmers and by the study period, the number of farmers practicing conservation farming increased to more than 120. In Balaka, since the 1990s, government agencies had been advocating making and applying manure as a remedy to unproductive soils. Progress was rather slow until the FIDP in 2005 started promoting conservation farming coupled with soil and water conservation techniques like the digging of infiltration ditches, construction of contour bunds and planting of vetiver grass to maximize rain water use.

In Malawi, a number of adoption studies have been conducted. The majority of them use the binary choice models of *Logit* and *Probit.* Despite the binary choice models being widely used in adoption studies in Malawi, this type of analysis is limited to assessing the farmer's decision to adopt but not the intensity of adoption. In addition the *Logit/ Probit* cannot be used when the dependent variable is limited continuous variable. In situation where there is need to assess adoption as well as intensity of adoption decisions the *Tobit* models have been preferred. However, the *Tobit* model has a weakness in that it assumes that a farmer makes decisions simultaneous regarding adoption and extent of adoption such that factors that affect adoption are also assumed to affect intensity of adoption. However Nakhumwa, 2004, argued that smallholder farmers usually follow stepwise decision making process where first, they decide whether to participate or not and then later decide on the extent of adoption.

In responding to the household decision-making question as to whether to adopt the CA technology or not and the intensity of use, this study assumed a probability model in the analysis. The *Tobit* model was chosen because it can measure the probability of adoption and intensity of adoption. In order to find crop profitability between the adopters and non-adopters of CA, gross margins analysis was done.

A total of 138 farmers were interviewed in the study and comprised 58 and 11 adopters, and, 11 and 21 non-adopters in Salima and Balaka, respectively, A questionnaire designed to capture data on farmers' production activities and production-related socio-economic characteristics was administered to this sample. However, participatory tools that included focus group discussions and key informant interviews were also conducted

The results from descriptive analyses from household survey showed that farmers who were non- adopters had the lowest average age of household head (43.54 Vs 44.65 years), lowest education level of household head (6.09 vs. 6.81years) and lowest land holding size (<3ha vs. >3ha) than farmers practising CA (i.e. adopters). Adopters of CA were able to allocate 0.9 hectares of land to maize under CA as compared to 0.67 hectares of land for the non adopters. The results also revealed that most of the farmers who had leadership roles in the society like opinion leaders and chiefs had adopted CA as compared to just ordinary farmers.

Probit analyses results indicated that access to credit by household head (p=0.001), soil fertility perception by household head (p=0.004), education level of household level (p=0.068) and family labor availability (p=0.019) had an influence on the decision to adopt conservation agriculture by a farmer. The same variables were also found to be significant using Tobit analysis at (p=0.000), (p=0.004), (p=0.020), (p=0.025) for credit by household head, soil fertility perception by household head, education level of household level and family labor availability respectively.

Sex of the household head exhibited an elasticity of adoption of -0.14, meaning that the probability of CA adoption by women was 14% higher than that by men. And among those who already practice CA, it was expected that women would put their land under CA, on average, 0.11ha more than men.

The Gross Margin Analysis indicated that farmers practising CA had the highest gross margins, \$552 ha^{-1} yr^{-1}, compared to \$316 ha^{-1} yr^{-1} for those not practising CA. This resulted from higher yield, 4.6 t ha^{-1} compared to 3.4 t ha^{-1}, and lower total variable costs per hectare, \$217 compared to \$255 for non-adopters, respectively.

A *Tobit* model analysis indicated that at 1% level of significance a house hold head's decision to assign land to CA is influenced by age, access to credit, soil fertility perception, education level, and labour availability. The study concluded that more provisions of access to credits to farmers will result in the adopters increase land put under CA by 3.4% and non-adopters adopting CA by 4.5%. The study further concluded that a one year increase in formal education of a farmer who is currently practicing CA will result in the farmer increasing his/her land put under CA by 0.2ha and non-adopters willing to adopt by 0.26%.

4.8.1.3 An analysis of farmer groups practicing conservation agriculture in dryland areas of Malawi: a case of Chinguluwe EPA in Salima and Nkomba Model Village in Bazale EPA in Balaka District - M. Mdulamizu, 2009.

The study by Mdulamizu (2009) was premised on theories and frame works of group organization that state that many technical programs fail not because they were poorly conceived but because there was no good leadership to make things happen or that the organizational systems and structures undermined the work. The general objective of the study was to analyze farmer groups in the implementation of CA in dry land agriculture in Malawi. The specific objectives were:

- To identify organizational factors that made farmer groups effective and successful in the implementation of conservation agriculture at Chinguluwe settlement scheme and Nkomba model village.

- To assess farmers perceptions on various conservation agriculture technologies implemented.

A study population 110 households from both locations were exposed to the questionnaire during the face to face interviews. There were 27 households at Nkomba model village and 83 households at Chinguluwe settlement scheme. Out of the twenty seven respondents at Nkomba model village, ten were women while at Chinguluwe settlement scheme there were twenty nine women out of eighty three and the rest were men. Participatory methods were also employed and included: focus group discussions, face to face discussions, key informant interviews and general observations.

Mdulamizu (2009) reported that in Chinguluwe Settlement Scheme 57.8% were men and 42.2% were women while at Mkomba Model Village 33.3% were men and 66.7% were women respectively. The maximum age for the farmers at Chinguluwe was 79 years while the minimum was 19 years of age and the average age was 40.63 years. Nkomba model village farmers had their age ranges from 22 to 67 with the mean at 39.81 years. Further results revealed that each household at Chinguluwe Settlement Scheme had a mean of about 6 people while the average household size at Nkomba was 5 people. The majority of the farmers at both Chinguluwe (78.3%) and Nkomba (63%) had attended primary education. This latter factor, coupled with training, tours, and field days appeared to have contributed to rapid uptake of CA at the two sites. In fact, farmers were proud to reveal their literacy and comprehension of modern farming practices.

Group members valued being identified as members of the groups and associated activities. Members were clear and conversant with group purposes and their monthly executive committee meetings marshaled by democratically elected leaders ensured review of their project plans. Apart from main executive committee, farmers at both locations were in sub committees organized for the implementation, monitoring and even evaluation of various activities as agreed. There was segregation of duties which ensured participation of larger number of group members. The relationships and trust among the group members was cordial as it was manifested through their collective actions such as merry-go-round field practices (e.g. mulching, herbicide application etc.).

The findings revealed that use of herbicides was the most preferred conservation technology at Chinguluwe Settlement Scheme while at Nkomba Model Village the use of herbicides was the least preferred technology. Face to face discussions revealed that use of herbicides was the least preferred at Nkomba Model village because of the nature of the terrain in the area. The area subtends steep slopes and therefore farmers pointed out that the chemicals easily get washed away rendering them ineffective. Further to that it was also reported that the rainfall pattern which tend to exhibit erratic onset, did not match well with the use of herbicides.

Zero tillage was also the most preferred technology at both Chinguluwe Settlement Scheme and Nkomba Model Village. Apart from controlling run off and conserving soil and water, farmers argued that the technology helped in improving and replenishing both the soil structure and its nutrients. Farmers at Chinguluwe Settlement Scheme revealed that by practicing zero tillage, they were able to make manure right in situ. Nkomba Model Village farmers indicated that because of the steep slope of their fields, zero tillage helped to control run off in their fields. The fact that technology did not require use of cash could also be one reason for the farmers' active involvement in implementing zero tillage. "Zero tillage does not require use of cash", one farmer said. Another farmer said, "we lay the maize stalks in our fields together as a group".

Mdulamizu (2009) concluded that organizational factors such as leadership, social networks, systems and structures, competencies, purpose of the group, group' identity, values and beliefs and group size were pre-requisites for the effectiveness and success of farmer groups in implementing a technology. The study therefore recommended a need to pay attention to both internal and external organizational factors if farmer groups were to be effective and successful in implementing development programs.

4.8.2 **Evaluation of Jab Planter for Cereal Crop Planting and Fertilizer Application in Malawi**. University of Malawi, Bunda College, Agricultural Engineering Department - Singa, D.D. 2010

Crop planting and fertilizer application technologies to improve on plant establishment efficiency and enhance plant growth respectively, under the unreliable rain fed as well as irrigated agriculture, have been recognized (Singa, 2010). Thus, for farmers to take advantages of conservation agriculture to conserve labour and soil resources, suitable crop planting technologies need to be fully employed. The project evaluated the Ftarelli No 5 e No 6 hand operated Jab planter and fertilizer applicator. The sites included the sandy, loam and heavy soils at Bunda College Lilongwe and predominantly heavy (vertisols) soils at Lifuwu Research Station, Salima, in Central Malawi. The sites included the sandy, loam and heavy soils at Bunda College Lilongwe and predominantly heavy (vertisols) soils at Lifuwu Research Station, Salima, in Central Malawi (Singa, 2010).


Plate 5: Commercial Jab planter. (Source: Singa, 2010)

Singa (2010) reported that planting capacity, in terms of area covered in an hour, was higher on moist flat land than on dry flat land (Table 9). This was due to the fact that the dry ground surface hardness posed more difficulties in planter beak penetration. Planting was slower on ridges than on flat fields due to extra effort to follow the ridge configuration. Although hand planting was slightly faster than use of the jab planter, which also demonstrated high planted seed efficiency and seed number precision, extreme power requirement and long rest time associated with hand planting make this slight field capacity advantage worthless. Jab planter operation efficiency and seed planting precision were at par with hand operations when a marker was attached to the planter and seed drop sound were respectively were devised.

Table 9: Performance Evaluation of Planters on Sandy loam soil using maize seed

Test parameter	Jab Planting				Hand Planting			
	Flat		Ridge		Flat		Ridge	
	Dry	Moist	Dry	Moist	Dry	Moist	Dry	Moist
Moisture (%)	9	18	9	19	9	18	9	19
Field capacity (ha/hr)	0.015	0.023	0.014	0.013	0.012	0.024	0.012	0.017
Field efficiency (%)	60	78	69	75	49	100	100	100
Seed precision (%)	88	42	58	24	60	100	100	100
Power requirement (W)	2.2	2.7	3.0	3.5	10.3	66.4	70	68
Rest (mins)	9,758	7,94	7,140	6,11	2,037	265	249	258

Source: Singa (2010)

The planter version was also tested on vertisols (heavy clay soils) which are soils that crack when dry but are very sticky when wet (Table 10). Singa (2010) showed that, at the same moisture content, use of jab planter was much faster, in terms of field capacity, on ridged than on flat fields. Again, this was due to soil being too hard for ease of planter beak penetration on unridged land in case of dry soil frequent outlet blockage on the wet ridge soils. The planter outlet blockage was high under the heavy soils and resulted in low field efficiency (expected seed drop per station, hence per hectare). Frequent cleaning of the planter was necessary. Seed planting precision was even worse as low as 35%, on moist ridged soils.

There was no remarkable difference in application rates among the three fertilizer types, Urea, CAN and 23 : 21: 0. In fact, fertilizer application was much more reliable and precise than seed application. The study concluded that fertilizer could be applied in tandem with seed planting hence tremendously improve operational timeliness and labour saving.

Table 10: Performance Evaluation of Planters on Vertisols (Clay Soil)

Test parameter	Jab Planting				Hand Planting			
	Flat		Ridge		Flat		Ridge	
	Dry	Moist	Dry	Moist	Dry	Moist	Dry	Moist
Moisture (%)	12	16	12	16	12	16	12	16
Field capacity (ha/hr)	0.019	0.011	0.092	0.016	17	0.12	0.14	0.0171
Field efficiency (%)	70	59	69	43	90	79	89	75
Seed precision (%)	55	40	39	35	100	100	100	100
Power requirement (W)	3.7	10.1	4.4	15.6	84	92	76	96
Rest (mins)	5,78	2,08	4,85	1,32	197	175	224	165

Source: Singa (2010)

4.9 Department of Agricultural Research Services

Significant work on Conservation Agriculture is in progress in Manjawira Extension Planning Area (EPA), Ntcheu district with funding from Agricultural Research and Development Programme (ARDEP) through a project "**Conservation Agriculture in maize based systems for improving food security and adaptation to climate change**." The overall aim of this project is to develop, evaluate and disseminate improved and sustainable agricultural technologies which are compatible with smallholder farmers' conditions. On-farm trials and demonstration plots are implemented using the Mother Baby trial model. Under this approach a set of treatments are evaluated in the so called mother trial located in the centre of the farming community. A sub set of three treatments from the mother trial are allocated at random to baby trials (and in this case demonstration plots) located in various fields in the community. Two different sets of mother baby trials are being implemented as described below:

(a) *Fertilization and tillage methods:* The major objective is to evaluate the effects of different tillage and planting systems under three levels of fertilization on crop productivity and soil property changes. One mother trial is being implemented in four sections or pilot communities (i.e. Balaka market, Manjawira West, Ntonda and Sezani) in the EPA. Four baby trials surround each mother trial per section. The three tillage and planting methods under evaluation include: (1) farmers' traditional practice with conventional tillage (CT), (2) CA without tillage but with residue retention (2.5-3 t ha^{-1}) and (2) planting basins without tillage but with residue retention. The three fertilizer levels under evaluation include: (1) top dressing only at the rate of 46 kg N ha^{-1} using urea (2) basal dressing with 23:21:0:4S at the rate of 23 kg N ha^{-1} and top dressing with urea at the rate of 46 kg N ha^{-1} and (3) basal dressing with manure and top dressing with urea at the rate of 46 kg N ha^{-1}. Each baby trial receives all the three tillage treatments from the mother trial but with only one uniform fertilizer level applied to all the tillage treatments. These trials are intended to be continued on the same field and areas at least for three years. A plot size for the mother trials consists of 10 rows by 11m long and 0.1 ha for the babies. Herbicides (glyphosate and bullet) are applied in all CA plots.

(b) *Intercropping trials:* The major objective is to identify the best fit intercrop species with maize under CA in terms of crop yield, weeds suppression and soil fertility enhancement in pilot communities (i.e. Balaka market, Manjawira West, Ntonda and Sezani) in the EPA. Four baby trials surround each mother trial per section. Maize is being intercropped with the following crop species: pigeonpea, *mucuna prupuriens*, cowpea, and soybean but all under conservation agriculture. Traditional farmers practice using conventional tillage is used as a control. Each baby trial receives three treatments from the mother trial but always with traditional farmers practice included. All other practices remain the same as for the trial in (a) above.

Highest maize grain yield was obtained when 69 kg N was applied per hectare followed by a combination of manure and 46 kg N ha^{-1}. (Fig.9). Different tillage methods performed differently across sites. For example CT gave highest yield at Ntonda site (5640 kg ha^{-1}) where as basins gave highest maize yield at Manjawira West (6009 kg ha^{-1}). Manjawira West received smaller amounts of rains as such basins were able to capture and store this smaller amount of rainfall for crop growth even in drier months. Lowest maize grain yield was obtained at Senzani due to poor soils (possibly presence of a hard pan at very shallow depth and also low organic C content thereby low ability to retain moisture even if crop residues are retained). No significance differences have been obtained in terms of residue retention in early years of converting fields from CT to CA.

An evaluation study to assess farmers' knowledge about CA practices and principles and benefits and difficulties of CA practices was conducted. Income from crop sales increased from 28% in 2007/08 season to 38% for project participants during the 2008/09 season. Maize was the main crop sold to raise income. The proportion of crop sales to annual household income increased by 14% for the project participants. The average income was K81, 726.00 and K48, 426.00 for project participants and non-participants respectively. During the period of project implementation, average maize production increased to 1771 kg ha^{-1} from 826kg ha^{-1} for project participants and to 756kg ha^{-1} to 829kg ha^{-1} for non-project participants. Proportion of households with enough food throughout the year increased from 12.5% in 2006/07 season to 71% during the 2008/09 season.

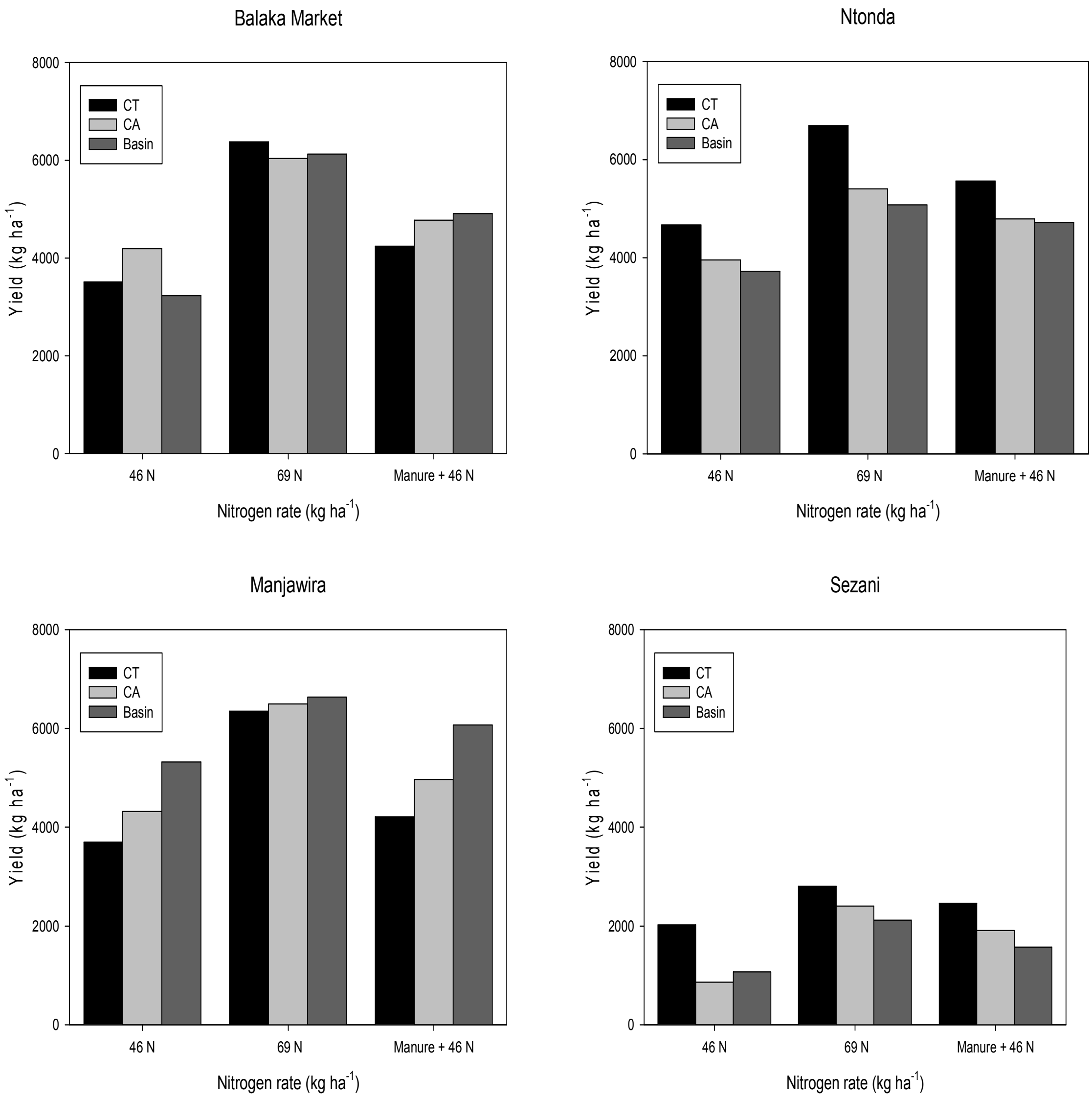


Fig. 9: Yield of maize at Balaka Market, Ntonda, Manjawira West and Sezani Sections in Manjawira EPA for 2008/09 cropping season

At least 71 % of interviewed households appreciated technologies in CA. Mulching (crop residues) and use of herbicides were the widely recognized CA component technologies as contributing largely to maize productivity in the EPA. Mulching was perceived to conserve moisture and improve soil fertility after decomposition of organic matter while herbicides were appreciated due to their effectiveness in controlling weeds. Inorganic fertilizers were seen to contribute positively to productivity. Most farmers in the area had access to the input subsidy programme being implemented by the Malawi Government. Zero tillage was recognized as being a labour saving technology however farmers feet that zero tillage lead to soil compaction and fading away of ridges hence being the least (71%) appreciated. Inadequate information, high cost of herbicides, perception that herbicides result to reduction in soil fertility and lack of sprayers were identified as the main factors affecting adoption of CA.

4.10 Farmers' Perspectives on Conservation Agriculture

This section summarizes farmers' perspectives on CA following field visits conducted under this study. The researchers followed farmers who adopted the technology under the Sasakawa Global 2000 initiative in the early 2000s and either continued or stopped. Similarly, under the new CA initiative by the Farm Income Diversification Programme (FIDP), farmers were identified to find out why they are continuing or not. Lastly the researchers visited farmers who adopted CA on their own to find out what motivated them and the challenges they are facing. Details of discussion are presented in Annexe 3.

The farmers who benefited from different initiatives gave reasons why they stopped or continued practicing CA. They all understand the context for CA and very well narrated the rationale for the technology. There are farmers who have been practicing CA for close to ten years (e.g., Mr Makwinja, Dedza, after Sasakawa Global 2000) and continue to do so up to now. There are also farmers who adopted the technology and abandoned it after years of practice both under the Sasakawa Project (e.g., Mrs Kammwamba, Lilongwe) and FIDP (e.g., Village Headman Kampila and group, Lilongwe).

The reasons cited for sustaining the practice are basically the benefit achieved through reduction in labour requirements and availability of labour for other livelihood activities, the increase in yield and production arising from strict management regime of CA even in years with lean rainfall, noticeable reduction in loss of the fertile top soil. Both Sasakawa Global 2000 and PROSCARP/FIDP farmers who are still continuing with the practice own it to the initial input support they got from the projects, the training obtained and the conviction obtained from demonstrations that CA does improve the soil status and increase yield.

Those farmers who dropped out after some years of CA did so citing some of the following problems:

- Cost of herbicide had increased
- Post-season weed growth was very profuse, neighbours were saying their land was getting barren
- Perception that herbicides destroy soils
- Lack of follow up by government extension personnel during and after Sasakawa and FIDP
- Inducements/incentives for selected farmers discouraged others who were supposed to adopt on their own

All category of farmers interviewed stated the following as some of the challenges for CA adoption in Malawi:

- Perception that herbicides are expensive, unsure supply of inputs
- Considers introduction of free technology as a disincentive to adoption

- Perception that herbicides destroy the soil
- Perception that maize crop uses more fertilizer because of planting single plant per station
- Inability to produce enough biomass to provide the required cover as a result of poor management, fires and livestock encroachment
- Long history of using hand hoe for tilling and difficulties in changing mindset to CA
- Lack of sustained support from extension staff especially when the projects are phased out
- Unclear and conflicting messages on CA
- Limited capacity for extension staff to provide technical information and mentoring

5. RESOURCE CONSERVING TECHNOLOGIES

The Land Resources Conservation Department (LRCD) as the custodian of the National Land Resources Policy and Strategy has the mandate to coordinate the implementation of soil and water conservation in the country. It provides strategic guidance on issues of sustainable land management. LRCD implements conservation programmes through the eight Agricultural Development Divisions and the 28 District Agricultural Offices throughout the country. It has representation at technical level at these levels; Land Resources Conservation Officers that work through the unified, pluralistic and demand driven extension system. It is unified in the sense that at field level all messages from different agricultural departments pass through general extension staff to the farmers through demonstrations, field days and training. Donor funded projects also use the same extension system to deliver their technologies.

Nongovernmental organizations both local and international are active in promoting soil and water conservation technologies using the same government extension system where they provide support for mobility, capacity building and materials required for the technologies.

As stated earlier Malawi has a long history of implementing resource conserving technologies (RCTs). A number of projects have been implemented both before and after year 2000 and the technologies have not changed much except that rainwater harvesting has been added to the menu of available technologies. Unlike CA, RCTs with the exception of rain water harvesting are well known and a lot of local information is available in the form of extension messages, field manuals and training materials. The same is not true for CA, although a lot of institutions are into CA in actual fact they are promoting parts and bits of elements of it and to a large extent they contribute to the implementation of RCTs. The following section describes soil and water conservation technologies commonly used.

5.1 Types of Resource Conserving Technologies Commonly Used in Malawi

5.1.1 *In-situ* land and water management technologies

5.1.1.1 Contour ridging

Contour ridging is the most commonly promoted soil and water conservation practice in Malawi. Contour ridging is defined as a conservation practice where farmers construct ridges that are parallel to the contour and interspaced with contour bunds or marker ridges and plant their crops on those ridges. If properly designed and constructed, contouring reduces runoff by temporarily storing excess rainfall behind ridges and thus reducing soil erosion and increasing moisture storage. Contour bunds which were enforced by law in the colonial days were demonized by the freedom fighters who labeled them as being oppressive.

In spite of the intended benefits, when improperly designed or used on unsuitable sites, contouring causes serious soil erosion. The effectiveness of contouring depends upon the infiltration rate of the soil, design of the contour system, and slope of the area (Schwab *et al.*, 1981). On areas with low infiltration rate soils and steep slopes, water temporarily accumulated behind ridges overtops ridges often causing destruction of ridges and formation of rills and gullies. It has also been shown that the effectiveness of contour ridging depend upon the way contours are formed and maintained. It has been observed that farmers have difficulties in constructing properly aligned contour ridges and are not maintaining ridges effectively, for instance, do not often reconstruct broken ridges (Mohamoud and Canfield, 1998).

5.1.1.2 Box /Tied ridging

The terminologies “tied ridges” and “box ridges” are used interchangeably. They refer to the construction of short and alternating barriers at right angles to the crop ridges along the furrow. These are shorter in height than the ridges and create small basins that catch rainwater and allow the excess to flow to the next basin. Boxing is an effective in-situ water harvesting technology that creates micro-catchments for capturing rain water in the field and enhance infiltration of rainwater into the root zone. They are also used to control gully formation as they limit the flow of water into adjacent gullies.

This technology is widely promoted by government, projects past and present such as FIDP, PROSCARP, PAPPPA and MAFE; other NGOs such as TLC, Concern Universal, Christian Service Committee (CSC) and many others. This is an indigenous technology which has been there even before 2000.

5.1.1.3 Raising of foot paths and garden boundaries

Foot paths across the field and along the boundaries of the fields have most times developed into deep gullies. To control this, raised paths and boundaries are recommended and this is one of the activities often reported in soil and water conservation reports. The technology is promoted by government agencies and installed by individual farmers. It is practiced throughout the country also with the support of NGOs. Family labour using hand hoes is used.

5.1.1.4 Contour Stone lines

These are stones arranged in lines along the slope to check runoff and control erosion. After long years of cultivation between theses stone lines terraces get formed and soils stabilized for crop production. This practice is common in most hill slopes and is done spontaneously without project support. Examples include well formed terraces in Thyolo/Chikhwawa escarpment.

The technology promoted by government agencies and locals with the aim of stabilizing the slopes. Sometimes it is combined with trash lines and reinforcement by vegetative perennial plants such as bananas. It is labour intensive especially at the time of collecting stones aligning them along contour.

5.1.1.5 Gully reclamation

Gullies are among the most severe forms of soil erosion which do not only affect farm land but also settlements, grazing areas, wetlands, roads and bridges. Depending on the magnitude of gullying, various types of barriers have been employed in preventing or reclaiming gullies. They include erecting trash lines, brush wood baskets, planting live barriers such as vetiver grass (*Vetiveria zizanioides*) across the gullies. In some cases planting tree-crops including fruit trees along the gullies to create vegetative barriers is done. It has been shown that as runoff flows down the gully, it infiltrates through the barriers erected or plated which trap sediment that raise the gully bed leveling the land and bringing it back into cultivation.

It is promoted by LRCD and other players in the NGO community and popularized during MAFE, PAPPPA and PROSCARP projects. It is an imported technology and requires labour to transport and plant the vegetative materials across the gullies. It is widely practiced in all ADDs. Gully reclamation is done by groups of farmers when the gully in question affects communal land or public infrastructure such as roads, otherwise individual farmers work in their individual fields to reclaim the gullies.

5.1.1.6 Vetiver hedgerow planting

Besides contour ridging, vetiver grass hedgerows remain a distinctive feature of Malawi's conservation efforts. This technology has evolved from one that aimed to stabilize the marker ridge and other conservation structures down slope, to providing protection from runoff down slope if on dead contour and well established with no gaps. Contour vetiver hedgerows have been used to rehabilitate gullies and generally degraded slopes. This has one of the most widely used and effective conservation practices for soil erosion control under ridge cultivation particularly for areas with moderate slopes (Mohamoud and Canfield, 1998). Reports from the field on soil and water conservation indicate the length planted, number of farmers segregated by gender participating and the area covered. One factor affecting the wide adoption of this technology is availability of planting materials.

This is an imported technology provided by government and NGOs and is installed by a number of projects and institutions including PROSCARP, MAFE, FIDP, LRCD, TLC, CADCOM, World Vision, Christian Service Committee.

It was introduced between 90s' and 2002 and replaced contour napier grass, buffer strips and has a life span of over 20 years. Besides controlling run off and erosion the vetiver grass is used for thatching houses.

5.1.1.7 Stream Bank Protection

Ideally, stream banks should be left under natural vegetation and not be cultivated. However most stream banks in Malawi are stripped off their vegetation and opened for cultivation because they represent pockets of deep fertile soils emanating from years of sediment deposition by regular flooding. The soils along the stream banks are very fragile and when exposed to cultivation they easily get eroded and contribute to siltation of water bodies downstream. Stream bank protection takes the form of either leaving the vegetation along the rivers undisturbed to allow for natural regeneration or / and planting trees and grasses such as vetiver, napier on both sides of the river. The width of the planting zone on each side of the river depends on the width of the stream.

5.1.1.8 Storm drains

The hill slopes and the associated rocky surfaces provide a catchment that accumulates rainwater and drain it down slope at high velocities with detrimental effects to areas down. This water can cause untold damage if not properly handled. Storm drains are constructed across the slope at a grade that allows the water to flow and lead it safely to the nearest natural water way. While the contour structures are meant for retaining water where it falls, the graded structures safely drain the water away.

The design, pegging and construction of storm drains is done by trained personnel using specialized leveling instruments while the contour structures can be done by farmers using low cost technologies such as line levels and A-frames. Storm drains also require regular maintenance because lack of it leads to deposition along the channel and gets it clogged.

Storm drains were enforced by law in colonial times. It is an old technology, imported and promoted by government, projects and NGOs. Its applicability is on the foot slopes of hills or surfaces that accumulate a lot overland flow

5.1.2 Surface runoff harvesting

5.1.2.1 Point-source water harvesting from common infrastructure.

Various infrastructures provide surfaces that generate substantial amount of runoff. These include among others, soil and water conservation structures, surfaces of roads, paths and iron sheet roofs. Second, the drainage systems of these structures do not integrate management of the runoff beyond the structures. As a consequence, the concentrated runoff is left to cause gully erosion. A good example are the gullies that form downstream of road culverts. The main reason for failure to use this water resource is inadequate awareness among infrastructural developers and potential end users of water.

5.1.2.2 Retention ditches/ infiltration trenches/ swales

These perform unique functions in semi-arid and high rainfall areas. They are dug along the contour with the scooped soil being thrown on the lower side (*fanya jii*) or upper side (*fanya juu*). In high rainfall areas, they act as cut-off drains which discharge excess runoff while in dry areas, they are intended to harvest runoff and allow infiltration into the soil profile.

5.1.2.3 Check dams

Work elsewhere has shown that from an environmental perspective, small-scale water harvesting structures such as check dams, seem to be the best choice since first, they are more efficient catchment system when widely used in a watershed than large dams (Development Alternatives, 1999). They have been shown to help counter some of the adverse effects of rains by allowing more percolation of water into the soil; helping to increase soil moisture and vegetation, and even reducing damage from flush floods. Evidently, check dams area decentralized form of irrigation under the control of farmers, allowing them to make adjustments to their watering regime in response to local factors and thereby to improve their yields. Runoff collection immediately adds water to the field scale water balance by replenishment of nearby groundwater reserves and wells.

5.1.3 Agroforestry technologies

Malawi Agroforestry Extension Project (MAFE) has been instrumental in developing, testing and adapting prototype agroforestry technologies with farmers under different farm and environmental conditions. Based on the results recommendations were made on best bet technologies which have been beneficial to the farmers. This with the research and dissemination work by World Agroforestry Centre, the research on agroforestry at government research stations has formed the basis for agroforestry interventions in Malawi. The technologies that have been promoted include systematic interplanting with *Faidherbia albida* which is naturally occurring in some landscapes, short term fallows with leguminous shrubs, homestead planting, woodlots, fodder banks and boundary planting (live fences). Details of agroforestry and soil and water conservation technologies developed by MAFE are documented in a manual "LandCare Practices in Malawi" by Bunderson *et al* (2002)

5.2 Adoption of Resource Conserving Technologies

Despite years of promoting resource conserving technologies, cumulative achievement is difficult to quantify. First, the achievements of various players are not aggregated together with government's achievements. Reports from the District Agricultural Offices often do not include activities of other players such as NGOs. Visual evidence suggests that not much has been achieved.

In a study done in the late 90's on adoption of these technologies, Evans et al. (1999) concluded that:

- Around 5% of Malawian smallholders are engaged in good soil and water management of which one third are supported by donor funded projects;
- The level of effective soil management extension coverage is low;
- Economic factors "shocked" farmers into looking for alternatives to inorganic fertilizers for maintaining soil fertility;
- Adoption of better soil management was catalyzed and supported by external assistance rather than being spontaneous;
- There are no socio-economic barriers to participation; and,
- When correctly applied, recommended soil conservation and soil improvement practices had striking and very rapid production benefits.

In the estate sector there is very little CA practiced, their first line of defense against loss of topsoil is to leave the land uncultivated with the natural resources intact as they possess large farms therefore long fallows. Once the land has been opened for cultivation, it is protected physically or biologically. Most of the estates in Malawi grow tobacco and maize. Tobacco is generally said to be a poor cover crop. The conservation techniques deployed here will therefore tackle the problem of running water and can be hardly considered to fall in the realm of CA. There are no latest statistics on resource conserving technologies in the estate sector and the study considers the table below cited by Nyangulu (2002) as still valid (Table 11).

TABLE. 11. Percentage of estates visited with different conservation measures by estate size category

Conservation technologies	Estate size categories					
	0-<20 n=172	20-<40 n=125	40-<100 n=119	100-<500 n=95	>=500 n=60	Total n=571
Contour marker ridges or bunds	5%	6%	5%	8%	8%	5%
Vetiver hedges	1%	2%	0%	0%	0%	1%
Graded bunds	9%	8%	11%	23%	38%	10%
Storm drains	1%	2%	1%	2%	8%	1%
Vegetated (stable) waterways	8%	10%	18%	21%	38%	9%
Faidherbia albida interplanting	5%	4%	3%	3%	0%	4%
Raised footpaths	13%	13%	8%	9%	0%	13%
Tied ridges	8%	6%	6%	1%	0%	7%
Windbreaks and shelterbelts	8%	16%	11%	26%	20%	10%
% of respondents with no measures	67%	59%	66%	51%	37%	64%

There appears to be distinct differences between estates of different size. A considerably larger proportion of the 100 to 500 and greater than 500-hectare estates had measures (49% to 63%) compared to the small estates (33% to 41%). As expected, a greater proportion of large estates tend to use graded bunds, storm drains and vegetated waterways. The same appears to hold for windbreaks.

The large estates' level of investment is high. The use of tractors enables them to deep plough. Apart from breaking the hard pan, this is a mode of water harvesting which enables rainwater to be captured and made available to crops. This is therefore bound to reduce running water.

In general bigger estates especially those from 100 hectares and above, do implement better conservation agriculture practices than the small to medium estates. This may explain why some of these estates continue to produce good quality tobacco from the same estate over a long period.

6. LESSONS LEARNED, CHALLENGES AND OPPORTUNITIES FOR CONSERVATION AGRICULTURE IN MALAWI

6.1 Conservation agriculture

The term 'Conservation Agriculture' is widely used and often misused or misunderstood. Wall (2007) described conservation agriculture as comprising a suite of technologies which when used together are able to limit, arrest or revert many of the causes of unsustainable agricultural practices, such as soil erosion, soil organic matter decline, soil physical degradation and excessive pesticide and fuel use. Many soil and water conservation technologies such as minimum tillage, terracing, ridge tillage, tied ridging, contour bunds and barriers, or live barriers such as vetiver grass can be combined to restore the soil and improve its quality for crop production. However, 'conservation agriculture' is the approach that conserves and even regenerates soil properties and the ecological processes and functions of the soil and its biota. The biotic community is essential as it provides a 'biological tillage' that serves to replace the functions of conventional tillage (FAO, 2001).

The understanding in this study is that 'conservation agriculture' refers to a system of crop production based on enhancing natural biological processes. Above and below the ground interventions such as mechanical soil tillage are reduced to an absolute minimum and the use of external input such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with or disrupt biological process (FAO, 1993). Conservation agriculture, a term introduced in the 1970s, was adopted by the U.N. Food and Agriculture Organization (FAO) in Rome in the 1990s (FAO CA web site, 2004).

It has further been argued that the term 'conservation agriculture' is preferably used today to replace the name 'no-tillage (no-till) agriculture' to shift the focus away from the tillage component towards the system components of this alternative form of agriculture. The distinction between conservation agriculture and no-tillage agriculture is deemed important because no-tillage alone, whilst attractive in the near-term, may prove unsustainable in the longer term. An example is cited where under some circumstances the use of no-tillage without residue retention and without suitable rotations can be more harmful to agro-ecosystem productivity and resource quality than a continuation of conventional practices (Harrington and Erestein, 2005; Erenstein *et al*.,2008).

The conservation agriculture practice adopted for smallholder farmers in Malawi entails managing crop residue on the soil surface with no tillage, change to high maize plant density, fertilizer use, and herbicide use amongst other inputs (Sasakawa, 2007) and is schematically illustrated below (Fig.10).

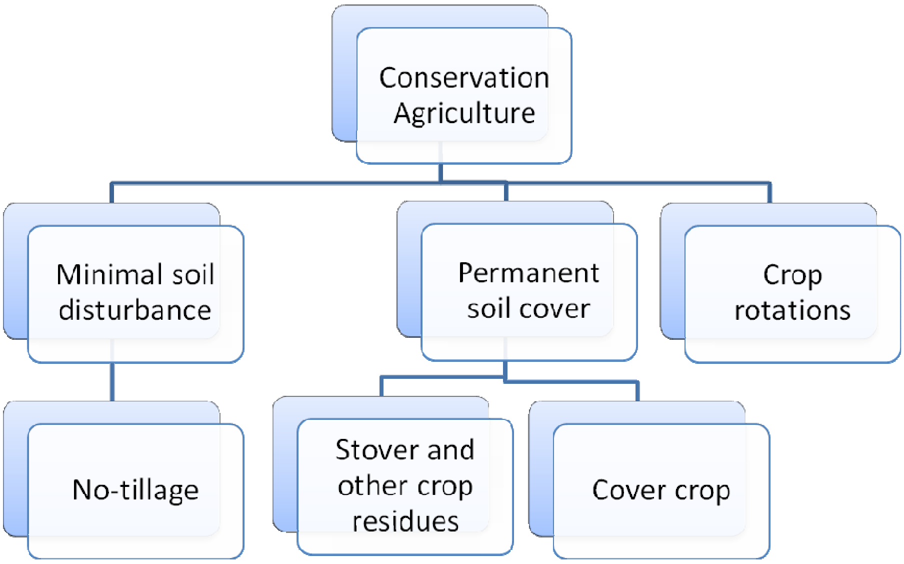


Fig 10. Schematic representation of the pillars of Conservation Agriculture adopted in Malawi.

The number of actors subscribing to CA is big and growing, but a close look reveals that most are involved in conventional soil and water conservation technologies and few in CA based on the principles of minimum soil disturbance, maximum soil cover and crop mixes in space and time. If the benefits of CA are to be fully exploited by all farmers, regardless of their crop production system, changing tillage is not in itself sufficient. This is the position adopted in this study. All three principles must be considered and implemented flexibly according to each individual situation in time and space. Invariably, statistics on areas of particular cultural practices are difficult to obtain and it is likely that any figures may mask very different system practices, some of which in fact might not classify as CA, such as those areas where the land is tilled for one crop and the following crop seeded without tillage.

Information on the extent and practice of CA in Malawi has been described by the degree of tillage (minimum and zero tillage) or the use or non-use of herbicides. Often data is disaggregated according to the components of the CA system or is not in sufficient detail to determine whether the work described fulfils all the CA principles. Reporting on CA is not harmonized; each player reports on activities they are involved in and the figures are not consolidated. It is reported that, except for Karonga ADD and Shire Valley ADD, the LRCD reports activities supported by government under revenue budget as well as those under different projects.

6.2 Potential for adoption of CA in Malawi

Soil and water conservation technologies have been barely implemented by farmers (in many cases only during periods when direct incentives were provided) because such practices do not always result in soil erosion reduction or do not increase yields (Giller et al., 2009). Conservation agriculture has that win-win combination of being a soil and water conservation technology that can also increase productivity in most cases. Higher yields demonstrated under CA by various partners in Malawi are the result of an increase in soil quality, especially in the topsoil (Kamwendo, 2009). The increased production profitability (Kamtimaleka, 2009) can be the major driving factor for farmers to implement conservation agriculture and thus go beyond ineffective and expensive direct incentives.

However, with small landholdings and therefore limited food production entitlements (they produce only a portion of household food consumption needs), many smallholders are risk averse and avoid introducing new practices with the perceived additional risk to household food security (Tchale, 2009). With its added management requirements, conservation agriculture may often be perceived as more risky than improved varieties or fertilizer. Indeed, in this study, farmers that have continued practicing CA long after withdrawal of support focused non-adoption by others on their lack of experience with the technology. In particular, the transition period from an intensively cultivated system, whose planning has always been at the instance of rain clouds and thunder at the onset of the rains, to the forward planning that CA demands. Many farmers however, cited a better quality of life as a major advantage of CA. With less time spent on land preparation, they were able to take on additional hectares and divert labour and resources to other crops and enterprises. They acknowledged that indeed, CA challenged their technical and management skills, including the often pernicious curiosity of their neighbours.

Langyintuo (2005) conceded that the challenge to scientists has been to accurately identify factors limiting the uptake of improved technologies for the design of appropriate intervention strategies. To achieve that goal, they have relied on three paradigms to explain technology adoption decisions, namely the innovation-diffusion, the adopters' perception, and the economic constraints models. The innovation-diffusion model emphasizes the use of extension, experiment station visits, on-farm trials and other vehicles to transmit technical information. The adopters' perception paradigm suggests that even with full technical information, farmers may subjectively evaluate the technology differently than scientists necessitating understanding whether or not their perceptions of a given technology are important in the adoption process. The economic constraints model contends that input fixity in the short run, such as access to credit, land, labour or other critical inputs limit production flexibility and condition technology adoption decisions.

While Langyintuo (2005) reported that recent studies have shown that neither hypothesis can fully explain the adoption decision independently, it is critical for implementers of CA to be cognizant of the method of evaluating the CA initiative *a priori*. Perhaps more importantly, the first question prior to socioeconomic analysis is how to define an adopter of CA. Socioeconomic studies have not been explicit on who an adopter is (Kabuli and Nakhumwa, 2004). There is a need to develop a common understanding of who an adopter of CA technology is and what constitutes adoption. There will be a need to ascribe a set of rules and standards to characterize whether adoption has taken place or not across the different agro-ecological zones.

In fact, assuming that farmers have enough information regarding CA, the decision of farmers to adopt them, like any other investment decision on the farm will often be driven by profit motive. Kamtimaleka (2009) evaluating FIDP-led CA work in Salima and Balaka reported Gross Margin Analysis results that showed highest gross margins, \$552 ha^{-1} yr^{-1}, for farmers practising CA compared to \$316 ha^{-1} yr^{-1} of those not practising CA. This resulted from higher yield, 4.6 t ha^{-1} compared to 3.4 t ha^{-1}, and lower total variable costs per hectare, \$217 compared to \$255 for non-adopters, respectively. However, it is argued that for smallholder farmers, cash benefits per unit of land as demonstrated in this study, may not be the only important measure; labour productivity and risk reduction are likely more important factors. Labour savings with CA are very evident where chemical weed control replace land preparation, ridge tillage, and weeding. The issues of risk reduction are yet to be addressed in many research works.

Further, Eaton (1996) using data sets from Malawi to determine no-till as a profitable alternative system concluded that while empirical analysis of soil erosion and conservation is complicated in physical and agronomic respects, economics has an important role to play in analyzing the trade-offs involved in soil conservation. Unfortunately, little empirical work has been carried out on the economics of soil conservation on small farms in developing countries. Eaton emphasized the importance of looking at soil conservation measures as alternative cropping systems with separate production functions. He noted that an examination of some of the theoretical models in this area suggested that omitting this critical feature may result in misleading predictions of farmer behaviour. In particular, his analysis confirmed the importance of ongoing costs (such as additional inputs or maintenance costs) of any alternative cropping system, as well as the key role played by the discount rate. In addition, the study found support for the hypothesis that agricultural pricing policies may play a significant role in determining incentives facing farmers regarding conservation agriculture.

6.3 Surface mulch management

Conventional land preparation practices in Malawi have been those where ridges are remade every season, and where plant residues are covered with inverted soil, removed, or burnt and in which growth of all vegetation is prevented, except for the desired crop (Materechera and Mloza-Banda, 1995). In most parts of southern Malawi, favoured by higher rainfall regime, incorporation of crop residues is a long-standing traditional practice. In contrast, conventional tillage practices associated with removal or burning of residues remain regarded as the trademark of successful land preparation elsewhere in the country (Mloza-Banda, 2002).

The effect of residue management on crop yields appears variable with yield decreases, little or no effects on yield, and yields increases having reported in some of the studies conducted in Malawi. In a trial that included various combinations of residue management, Mloza Banda and Materechera (1995) reported first season results which showed significant differences in maize yield between plots where residues were incorporated (4,519kg ha^{-1}) or mulched (4,618 kg ha^{-1}) and those where residues were burnt (4,150 kg ha^{-1}) or removed (4,148 kg ha^{-1}).

The water-conservation benefits of a mulch tillage system have been ascribed to reduced run-off and lower evaporation. Maintenance of crop residues on the soil surface during non-crop period is also seen as a way of increasing soil water storage. Evaporation accounts for the major loss of water from many cultivated soils especially in semi-arid regions. The effect of a surface mulch to reduce evaporation of soil water has long been recognized.

A major deterrent to successful implementation of surface mulch cropping systems is the limited amount of residues available for management on the soil surface for water conservation and erosion control. In Malawi, in general common grazing rights apply after crop harvest where livestock are left to roam across field terrain. Thus an individual farmer does not have exclusive rights to the residues on his land, and attempts to conserve them can lead to being alienated by the community or confrontation. There is evidence presented in this study of malicious setting of fire to CA fields in Machinga ADD, for example.

Residues may be limited because of low amounts produced, high decomposition rates (under hot, humid conditions), and removal for other purposes, burning, or destruction by termites. It is noted that in regions where farmers own few livestock, such as in southern Malawi, crop residues are traditionally incorporated or burned as a fast way to clear agricultural land. Where competition for residues exists, use for water conservation or fertility improvement will generally be of much lower priority. Moreover, consistent data is lacking that show the economic value of crop residues for soil improvement relative to other uses for which they are removed from the land. In addition, crops such as soybean, sunflower, groundnuts and cotton do not produce enough residues for effective restoration of fertility or soil and water conservation although they may be important for rotation.

The study has reported observations in Machinga ADD, that the mulch is often removed rapidly within weeks by termites. At the same time, farmers reported that where the maize crop was often damaged by termites during the growing season, CA practices appear to eliminate termite infestation. The mulch provides an alternative material. This dichotomy is a recipe for site-specific on-farm research.

The study determined the proportion of land area under crop residues management compared to total land area under CA from disaggregated data provided by the Department of Land Resources Conservation from each ADD as shown in Table 12 below based on reportage in Annexe 5. Data from Kasungu ADD was incomplete to be used in the computation and the study acknowledges possibility of technical errors in reporting.

Table 12. Proportion (per cent) of land area under crop residue management compared to total land area under CA for the Department of Land Resources Conservation

Season	KRADD	MZADD	SLADD	LADD	MADD	BLADD	SVADD	ALL
2006/07	-	84.0	32.8	98.3	89.4	55.6	39.4	91.3
2007/08	87.0	87.0	35.5	98.2	89.3	86.1	22.1	77.0
2008/09	27.1	45.9	55.2	50.4	50.2	98.8	65.2	88.3
2009/10	80.4	49.4	70.2	21.0	5.4	52.8	34.7	39.8

Legend:
Agricultural Development Divisions (ADDs), KRADD: Karonga ADD, MZADD: Mzuzu ADD, SLADD: Salima ADDD, LADD: Lilongwe ADD, MADD: Machinga ADD, BLADD: Blantyre ADD, SVADD: Shire Valley ADD

The trend however shows better soil cover practices across the ADDs in the first two seasons, 2006/07 and 2007/08 with inconsistent and generally low percentage of soil cover in the last two seasons, 2008/09 and 2009/10. The disaggregated data from DLRC is illuminating in that it provides a window through which factors preventing adoption of the three keys to CA, among which is surface residue management can be identified. The lower per cent surface residue coverage in the dryland areas of Salima and Shire Valley ADDs compared to other areas is a subject of interest. The study still emphasize that conservation agriculture is not a one-component technology but the cumulative effect of all three components it is comprised of.

6.4 Tools and Implements for CA

Under annual ridge-tillage in Malawi, ridges are constructed by hand using a broad bladed hoe, and, in the following season, the ridge is split and remade in the previous furrow. It is known that this practice date back to the 1930s during the colonial era and was aimed as a primary strategy for erosion control where farmers were forced to align the ridges along the contour (Douglas *et al.,* 1999). However, without functional equipment for direct seeding of crops it becomes a protracted exercise to properly test, and, more importantly, demonstrate the benefits of CA, particularly in improving efficiency of crop establishment operations. Recent work by the Agricultural Engineering Department at the University of Malawi at Bunda College and the Department of Agricultural Research Services, and Department of Land Resources Conservation evaluated the Ftarelli No 5 e No 6 hand operated Jab planter and fertilizer applicator. The work reported that the jab planter, once properly adjusted, can be used to plant cereals and large grain legumes in Malawi. The planter cuts down labour demand, improves on timeliness. However, planting efficiency and precision tend to be lower than hand planting. Improvisation of planting station marker improves planting efficiency. Fertilizer application was much more reliable and precise than seed application.

The jab planter is one of two pieces of equipment, in addition to the sprayer used in the application of herbicides for weed control that appears integral to the practice of CA. The study argues that the tenets of CA recognize minimum soil disturbance or zero tillage therefore use of both inversion and non-inversion tillage equipment is alien to its principles. Sprayer equipment is available at most commercial outlets including rural trading points through agro-dealers while the jab planter is yet to be tested under CA and released by government.

This study further suggests that an important equipment integral to an agricultural farming system but often unattainable by most smallholder farmers is a cart, whether ox-drawn or manual drawn. The argument is relevant here because of the often cited argument about competition for crop residues between livestock and need for soil cover. Livestock production and management must be integrated into the CA system to make them mutually supportive. This is where livestock provides manure and is carted to the fields to enhance economic and biomass yield with the latter providing adequate stover that is in turn carted to the homestead for feed while the remainder provides an excess of 30% ground cover requirement for CA. A cart should be considered as an integral farming technology requiring investment support. The transfer of manure from animal pens to the fields has remained a challenge and a formidable missing link in crop-livestock integration. CA provides an opportunity for crop-livestock production systems integration rather than the two systems being viewed as diametrically opposed.

6.5 Crop rotations under CA

It appears that the change in tillage has been the most readily researched and reported of the CA principles. This may mean that other modifications to the crop production system, like changing rotation, may be less significant or accepted as a consequence of CA rather than as an integral part of the system itself. Data on rotations are lacking. Yet, appropriate sequences of crops will reduce the impact of weeds, pests and diseases on a single crop type and give opportunities for alternative methods of control or reduce the need for external inputs.

The study received questions regarding the inclusion of root crops or even the more important groundnut crop, in CA rotations. The investigators noted that emphasis during the introductory phase of CA has been on maize but rotation crops such as beans and soybean can been included. These crops have the advantage over other legumes in that they provide a direct economic yield for food or for sale.

Comparisons of a range of soil fertility improving technologies, including grain legumes, green manures, fodder legumes and legume tree fallows have indicated smallholder farmers invariably choose grain legumes due to the immediate provision of food (Giller *et al*., 2009). Although green manures and agroforestry legumes are much more efficient in provision of N and mulch for subsequent crops, they do not provide the immediate benefits sought by farmers.

One approach under CA that has proved inherently attractive to farmers and is the standard practice in much of Malawi is intercropping maize with grain legumes such as pigeon peas, cowpeas and beans. For instance Sakala *et al*. (1998) reported that if pigeon pea is sown between planting stations on maize rows, the plant population and yield of maize can be maintained, whilst reaping the benefits from the pigeon pea harvest.

The addition of decomposable organic matter annually, as with grain legumes and stover, can also have negative effects such as the stimulation of white grubs and cutworms that was evidenced in Machinga ADD. It was noted however that seed used was not protected with seed dressing chemical Gaucho^{TM}, by seed companies. This study also documented the incidence of stalk borer under long-term CA in Dedza, Central Malawi. Stalk borer in maize is a major problem throughout Malawi particularly in the cool wet zones. The farmer lamented lack of knowledge on the logistics of obtaining the correct insecticide and timing of insecticide control measures. More importantly, he turned on the mulch tillage practice as the problem.

6.6 Conservation agriculture, rainfall and drought

Maize cultivation is mostly rain fed, which necessarily leads to substantial fluctuation in production from one year to the next. Any unfavourable weather condition such as drought creates the need to import the crop. In this sense, a high self-sufficiency ratio recorded at a year with good weather does not provide protection against the impact of international market prices (JAICAF, 2008). Malawi is subject to high risk of meteorological droughts and intra-seasonal dry spells that lead to low crop yields and sometimes-total crop failures. The Southern Africa region has a probability of complete crop failure every 5 years and risk of below average yields once in every 2 years (Rockstrom, 2000). In Malawi, frequent drought since 1990 have seriously destabilized maize production, often failing to meet the minimum requirement of 2 million tones to satisfy the needs of the population. Any production below 1.5 million tones indicates famine, which occurs with varying magnitude every two to three years (JAICAF, 2008).

Various strategies to circumvent drought have been recommended that range from breeding more drought tolerant maize varieties, changes in land surface configurations, and changes in cropping systems and practices. For example, Langyintuo (2005) reported that the Southern African Drought and Low Soil Fertility (SADLF) has developed hybrids and open pollinated (OPV) varieties of maize that are stable, high yielding, and suitable for both favourable and marginal areas (i.e., characterized by frequent drought stress and low soil fertility). It is expected if adopted, such varieties would increase maize productivity and hence the livelihoods of millions of farmers and consumers depending on maize for their living. In his work in Malawi, Langyintuo (2005) observed farmer strategies that are intended to minimize crop failure. These included where crops are grown on up to four different plots or where up to three different maize varieties are planted each season, the choice of which is often influenced by extension staff from government, NGOs or input suppliers through field days and demonstrations.

However, this report argues that evidence from farmers suggest that CA seems to be highly effective in enhancing soil water recharge and water conservation, in years with much lower than average precipitation as was evident from farmers' responses in the current season. There is sufficient evidence to show that good aggregation, abundant surface crop residues and a biologically active soil are keys to drought-proofing a soil. The study by Kamwendo (2009) showed that with incremental additions of mulch, soil hydraulic properties significantly improve even through the 7-8 month dry season that the Lilongwe Plain experiences.

The results showed that CA, after 4 years of practice, subtended more water at field capacity in the top soil layer and at permanent wilting point in the sub-layer, than CA after 2 years and less so under conventional farming. This may explain the common observation of more resilient crop plants under CA compared to CT in the face of drought, with water reserves in the top soil layer being critical at field capacity while soil water in the sub-layer being critical at permanent wilting point. Second, the saturated hydraulic conductivity, which is an indicator of the soil's ability to imbibe and transmit plant-available water to the root zone, as well as drain excess water out of the root zone, was higher for soils under CA than for soils under annual ridge tillage.

6.7 Soil erosion control

In spite of the application of contour farming as a common conservation practice in Malawi, when improperly designed or used on unsuitable sites, contouring causes serious soil erosion. The effectiveness of contouring depends upon the infiltration rate of the soil, design of the contour system, and slope of the area. On areas with low infiltration rate soils and steep slopes, water temporarily accumulated behind ridges overtops ridges often causing destruction of ridges and formation of rills and gullies. In Malawi, farmers have difficulties in constructing properly aligned contour ridges and farmers are not maintaining ridges effectively (Mohamoud and Canfield, 1998). In addition, residue removal or burning evident in Malawi results in a general decline in soil organic matter content, which decreases aggregates stability. Increased compaction has also been noticeable in Malawi under annual shallow hoe tilled soils.

There are scanty studies in Malawi on CA effects on erosion except for work by Total Land Care under a CIMMYT initiative whose results were unavailable. However, since water infiltration is usually more rapid into course than into fine-textured soils, it is surmised that soil erosion by water in coarse textured soils should be more easily controlled by less surface residue. The study however observes that environmental benefits achieved from the adoption of CA may be negated by use of incomplete CA practices. This includes for example, poor ground cover arising from stubble grazing or use of crop residues for other activities. This would leave the soil bare and predispose it to erosion even under moderate slopes where under annual ridge tillage; the ridge was effective at soil erosion control.

There are some challenges under CA that were reported in this study. Under incessant rains experienced during crop establishment, some CA fields experienced ponding and slow germination and early crop growth. This may be attributed to covered soils that warmed and dried up more slowly.

6.8 Soils fertility amelioration

It is reiterated here that although planting area to maize has increased in Malawi from 1.4 million hectares in 1990s to 1.6 million hectares and the yield has improved slightly to 1-1.8 t/ha since 2000, it still trails far behind the world average at 4.2 t/ha (JAICAF, 2008). This is largely attributed to lack of a "soil replenishment' system to compensate for the loss of fertility after cultivation. Many farmers do not apply fertilizer as they can afford neither fertilizer nor new varieties. However, the view of 'lack of fertiliser' is considered to be a traditional concept of soil fertility which maintains that fertility is largely a reflection of the overall quantities or concentrations of nutrients in the soil. The new concept of soil fertility emphasizes not the concentrations of nutrients in the soil but rather the maximization of the access of plant roots to soil nutrients. This new focus is much broader and stresses the interactions that occur in the soil-water-plant system, considering the dynamics of nutrients, which is clearly intensified through the principles of CA, especially the increase of soil organic matter (Benites, 2008).

In one of few studies on changes in soil quality under different tillage management treatments in Malawi, Kamwendo (2009) established, under small scale field conditions, that CA after either 2 or 4 years of practice significantly showed higher total soil nitrogen and phosphorous in both the top (0-15 cm) and sub-layers (15-30 cm) of the soils compared to conventional ridge tillage (CT). Similarly, soil organic carbon was consistently and significantly higher under CA and after both 2 and 4 years of practice than under CT. However, the opposite was observed for potassium which showed that conventional farming subtended soils with significantly higher levels of potassium than soils under CA. These findings are also contrary to arguments where lack of soil mixing under CA has been reported to lead to increased stratification of organic matter and nutrients in the topsoil. Further, it has also been reported that soil N availability decreases under CA with a mulch of crop residues.

The results from the study by Kamwendo (2009) based on two and four years of CA are in contrast to these assertions. First, the benefits of enhanced SOM and soil fertility with CA are more a function of increased inputs of OM as mulch. Second, if repeated additions of crop residues lead to a greater soil C content in time this may lead to a greater net N mineralization. Invariably, availability of OM inputs is critical for productivity on farms in Malawi.

A longstanding soil fertility amelioration strategy supported vigorously by various government instruments has been the generation and use of manure by farmers, 'the compost manure campaign'. Malawian farmers have been encouraged to practice a unique composting technique called *chimoto*, where compost materials (weeds and crop residues) are coated with plugged soil to retain moisture into a dome-like structure that have conspicuously been seen over the recent years along roads. Water is added as necessary through a hole at the top of the dome to facilitate fermentation. Other composting methods include the Chinese method where an enclosure is made and materials are piled up in layers, and the pit method which involves composting in a dug pit.

The critical issues here are varied. However, a piece of evaluation work at Bunda College done to assess the adoption of *chimoto* compost manure technology in Mpilisi and Rivirivi Extension Planning Area in Machinga ADD (Mustafa-Msukwa, 2009) showed for example that farmers had low knowledge of the recommendations for composting, farmers applied only 28% of the recommendations in practice, and farmers were able to make manure that on average only covered 5% of land allocated to maize. The main reasons for low adoption for the practice in order of importance were: high labour demand, lack of interest, and scarcity of water.

This report would like to contrast composting with *in situ* plant residue management under conservation agriculture which by far eliminates all the reasons cited for low adoption of composting including area of coverage. The practice has been viewed as being at variance with conservation agriculture even by farmers interviewed in Lilongwe who reported resorting to removing residues under CA fields toward the generation of *chimoto* compost manure under the government sponsored campaign to the detriment of the former practice.

6.9 Labour, gender and the practice of Conservation Agriculture

In Malawi, the prevailing practice of remaking ridges requires a lot of man-days to accomplish. Most smallholder farmers lack resources of cash, chemical inputs, farm power, and motorized equipment. A hand hoe and family labour are the most they have at their disposal such that labour constraint limits their effectiveness as producers. Because of this limitation, seedbed preparation may go on until later after the rains have started resulting in delayed planting and improper weed control. Frequently a decision has to be made whether to control weeds in the already planted crops or to plant the remaining area. All this has serious consequences in reducing crop yields. Thus, CA represents a management technology that reduces or shifts the timing of labour requirements for seedbed preparation and weed control.

Sibuga (1997) citing data from Malawi (Table 13) argued that hand weeding, which is the most common practice of weed control in smallholder farming systems, is predominantly done by women and children. Further, there still exist some distinctions between what is considered male crops (mostly staple food crops and cash crops) and female crops (minor subsistence crops). Yet, women and children are responsible for weeding not only the ‘female crops’ but the ‘male crops’ as well. It is thus axiomatic that the impact of chronic diseases such as HIV/AIDS is much severe on women and girls because of their triple role as mothers, wives, and farmers. It has been reported that women spend 39 days in a year caring for the sick or being sick themselves (Malawi Government, 1994).

Apart from contributing time and energy to agricultural production tasks, women also manage household activities including the care of family members. Malawi Government (1994) reported studies which showed that women in Malawi spent almost as much time in farm work (20%) as in domestic activities (23%).

TABLE 13. Labour inputs for maize and pulses per crop activity (hour and per cent per hectare) in Malawi

Source of labour	Time	Land preparation		Weeding	
		Maize	Pulses	Maize	Pulses
Men	Hours	35.8	151.4	63.2	38.5
	%	37.8	37.7	36.0	20.7
Women	Hours	36.8	157.1	90.0	142.3
	%	38.9	39.2	51.3	76.5
Hired labour	Hours	22.0	92.6	22.2	5.2
	%	23.3	23.1	12.7	2.8

Excerpted from Sibuga, 1997 after Carr, 1991.

Yet, domestic responsibilities are often viewed as deterrent for women in increasing agricultural production. Perhaps what is further critical to note is that most of the woman's tasks include odious physical work and distance, which must be performed daily with the crudest tools, under the toughest conditions. There is thus a limit to how far women's time and energies can be stretched. When the limit is reached, agricultural production or household needs suffer. In view of the fact that not much has been achieved in the area of work load reduction, the employment of CA for labour reduction under rainfed agriculture is of particular interest to ease the pressure of work on women and the girl child.

Farmers interviewed in this study acknowledged that with good ground cover from mulch off-season and from the crop planted single-hill at 25 cm apart within row and 75 cm between rows, there is less weed pressure with CA compared to ridge tillage. Invariably however, herbicide use has been an important practice for effective weed control. The study argues that from experience herbicide use such as the pre-plant application of Roundup, (a) can decrease as management systems become established, (b) can be omitted where effective planting rains fall in the absence of a worrisome weed flora and, (c) can decrease where the weed flora declines with time due to CA.

However, there are situations where herbicide use will need R & D attention. For example, the study documented the non-response to chemical control or the emergence of some weed species such as *Commelina*. In Lilongwe West, the farmer interviewed reported post-season profuse growth of grass weeds that led to wonder by neighbouring farmers. For this and other reasons, the farmer subsequently stopped practicing CA. The study also learnt that some herbicides, in particular Bullet, if not applied correctly (time, rate), may express residual effect even on the subsequent maize crop. The latter problem is also ascribed to failure to integrate the various practices under CA.

6.10 Adjustment and impact mitigation of HIV and AIDS through CA

The challenge today is for researchers and policy makers to understand the changed needs and nature of the farmer and provision of an AIDs response to farming operations. The study learnt that presently, farming families have developed their own survival strategies. Many have made the change to less labour intensive crops that are easier to plant and maintain, and to crops that are also drought tolerant. In some farming systems, such the Lilongwe Plains, the impact of HIV/AIDS has resulted in a shift away from cash crops (tobacco and groundnuts) in order to concentrate all available labour on the production of subsistence crops like sweet potato and cassava. These coping mechanisms developed by farmers are not long term solutions. In fact, some of these shifts in agricultural practices are already beginning to show drawbacks: for example, a narrowing of the range of crop-based sources of income.

The study learnt that in Salima ADD, farmers affected by HIV/AIDS have been trained in CA and the initiative continues. Elsewhere this has been called 'red-ribbon farming'. The programme was successful in drawing at least thirty farmers per week during a two-month training period covered during the off-season. Farmers are issued 5 kg seed of quality protein maize (QPM) as they graduated from the training sessions. This initiative needs amplifying.

6.11 Access to Inputs

It has been observed that in land-constrained countries such as Malawi, agricultural production is mainly constrained by the quantity and quality of land input (Edriss et al, 2004). The ranges of possibilities for land utilization and agricultural production therefore are reported to be delineated by the major geo-environmental parameters of topology, climate, and soils. Within this range, the actual patterns of land use are determined by a number of factors, such as the demand for agricultural products, available technologies and land/labour ratio. Edriss et al (2004) argued that although it is possible to increase production through increased labour input, the effect on production has been shown to be normally low. Use of off-farm inputs, such as fertilizers, pesticides and other chemicals typically provide greater potential for increased production and productivity.

This report argues that CA principles entail change towards less dependence on off-farm inputs through crop residue management practices and releasing labour (rather than increasing) toward enhancing total farm productivity. Various pro-farmer literature also argue that because of the inclusion of an additional external input, herbicides (in addition to fertilizer) CA is not applicable to small-scale farmers, or that adoption will be limited (see Giller et al., 2009). Further, although results from small scale farmer practice generally show significant economic returns from CA systems using herbicides, the sustainability of promoting such a system among resource-poor farmers has been questioned, due primarily to problems of access and affordability.

This study found that farmers were ignorant of prevailing prices and hectares covered per unit cost. They were all in unison in arguing that compared to conventional tillage operations which involve land preparation, ridging, weeding, and earthing-up ridges, CA, was by far the cheaper option. The study thus finds that it is the lack of knowledge about price of chemicals or the cost of the practice per unit area that is detraction amongst farmers.

It has also been argued elsewhere that limited access to capital of small-scale farmers often means that access to input and output markets is limited–the volumes of sales or purchases would simply not be sufficient to attract entrepreneurs to establish local businesses that stock the necessary inputs or buy the production. In Malawi in order to address access to relevant inputs at reasonable prices, agro-dealership has been established and is functional in many areas. Further, the study learnt from farmers that if they buy in bulk up to an agreed value, chemical companies are willing to transport inputs to their location. Perhaps an illuminating observation with respect to scope for use of improved seed as an integral input under CA is given by Edriss et al (2004). They reported studies by the Agricultural Inputs Markets Development Project (IFDC 2003) which showed that although the prices of both hybrid maize seed and fertilizer have increased, hybrid maize is considered less expensive than fertilisers and farmers have continued to grow more hybrid maize rather than local maize even if they could only apply sub-optimal levels averaging between 25-50 kg per hectare while the economically optimal level of fertilizer application ranges from 35-92 kg per ha depending on the area. The IFDC (2003) reported that the production of hybrid maize had jumped from 43% in 1992 to 61% in 2002.

This study has learnt that one way to stabilise the agroecosystem and provide for a wholesome human ecosystem is diversifying the economies of small farming communities. Farmers in Nkomba Model Village, Balaka, unlike those at Chinguluwe in Salima, under FIDP, are practising a suite of market-led farm enterprises that include livestock such as chickens, goats and pigs. The FAO CA projects thrive on a revolving fund that caters for inputs for other farm and off-farm enterprises. While these holistic approaches are commendable, it is pertinent to argue whether there is no danger of relegating CA activities in favour of the apparently familiar quick paying income generating enterprises.

6.12 Incentives to innovate

Whereas most farmers, including scientists and extension officers, have gained experience, knowledge, and skills for crop production by traditional methods, experience regarding the reduced tillage system is limited. Interested farmers must be willing or be given an incentive to assume the risks to gain the necessary experience. It is however doubtful whether the motivation for change can be primarily that of protecting the soil without the incentive of increased yield or any other financial incentive. This is especially true for the low-income producer beset with limited farm size, land availability, land productivity, and availability of other suitable conservation measures.

First, it has been observed that farmers whose fields have poor conservation practices often cause serious erosion elsewhere and have little incentive to adopt better conservation practices (Mohamoud and Canfield, (1998). Thus, despite individual farmers' efforts to conserve soil, unless soil conservation practices are collectively planned and managed by all farmers cultivating adjacent fields, there is less chance to see adoption of better conservation practices and reduction of soil erosion. The FAO work on CA in Kasungu is reported to have followed a catchment approach where CA fields are contiguous to one another.

The study learnt that there are various incentive frameworks that have been employed to introduce CA and other resource conserving technologies. For example, full input subscription to an individual or to a group for a demonstration of CA for varying periods but often not more than 2 years. Other projects have introduced technologies through asset for work programmes where inputs for CA implementation are used as payment. Village revolving funds have also been established but either with start-up capital being provided by the project or arising from farmers themselves after paying for inputs at the end of the season. Other projects have extended input loans administered by themselves or through other agents such as the Malawi Rural Finance Company. The contribution of end-users/ communities to the investment and external costs, even if they be in-kind, have been touted as a major instrument for anchoring ownership of projects both in the short- and long-term.

All these credit financing mechanisms have varying implications for any technology adoption and various post- and ex-ante studies have been conducted. Total Land Care expressed fear of the possibility for too many players joining the race for CA promotion sometimes with conflicting messages. Misleading messages from different proponents of CA, most emphasising on the start up inputs the farmers would get not the added value of adopting CA. This has resulted in most farmers dropping out after the projects have phased out and the support not coming.

It is a truism that communities and local governments often have no guaranteed sources of revenue, and little or no power to raise local resources. However, it is observed that social funds that circumvent empowerment of local government in the administration or management of projects would represent community development without institutionally sustainable empowerment (World Bank (undated)). Two main types of project costs have been identified; these are investment and maintenance costs. Often, the tendency is for development agencies to invest in implementing technological projects at full cost then depart leaving the farmer or end user to meet operating or maintenance (external) cost. This has tended to result in failure of initiatives.

In this study, work by Kamtimaleka (2009) reported that although there is evidence that farmers were weaned from a start-up project-led credit facility, a period of two years was deemed too short and the numbers of beneficiaries were too few to inculcate the CA technology wholesomely. Farmers supported by a CA initiative under FIDP also lamented lack of synergy for CA sustenance between FIDP and government agricultural offices at the EPA level, particularly in guiding the village revolving fund established for project initiatives.

Work that has addressed problems of soil fertility and productivity of smallholder farmers in Malawi and elsewhere in the region has shown that options for soil management that show great promise under controlled conditions gain little foothold in practice (Giller et al, 2009). Most often this occurs because farmers are constrained in resources such that investment in a new technology not only influences what must be done in one field but involves trade-offs with other activities from which farmers generate their livelihood. Farmers interviewed at Malingunde EPA in Lilongwe argued that at the time the FIDP CA project weaned them from inputs, the decision had to be made either to use money available to purchase herbicides or revert back to hired labour for land preparation that gets paid later. Their choice was obvious but to the detriment of continued practice of CA.

6.13 Government policies

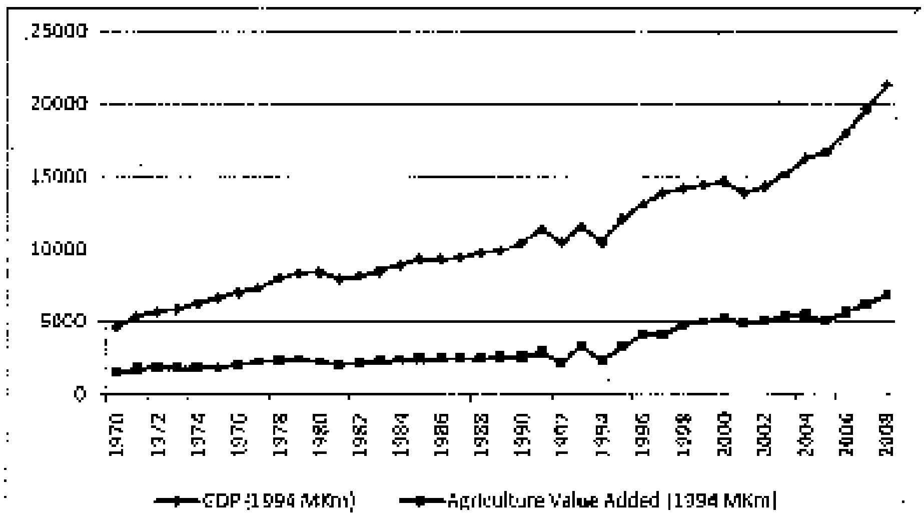
6.13.1 Policy and investment projects

Various studies have examined the effect of major policy changes and investment projects in Malawi with the aim of improving the overall economic structure and sectoral productivity where agriculture remains the key economic sector and within it, maize production and productivity remains the driver of policy and investment changes. This study does not intend to provide an exhaustive historical economic policy literature survey, but rather to emphasize and alert the CA initiative in that it needs to establish conceptual links between farm-level interventions and macroeconomic and policy drivers of change. Only a few pieces of accessible work are cited.

The work by Edriss et al (2004) reported that Structural Adjustment Program (SAP) which begun in 1981 and market liberalization implemented in 1994 are among a number of major policy changes and investment projects that influenced maize production and productivity in the country. Measurement of both total factor productivity and technical efficiency indicated that labour market liberalization contributed to the decline of maize productivity through its impact on labour availability at crucial times of cultivation, as well as unaffordability and decline in fertilizer use among most smallholder farmers. Farmer's success to operate on the production frontier was found to be on average 61% during pre-liberalisation period (1985-1994). After market liberalization, farmers' success to produce maize declined to 55%. Prior to market liberalization (1985-1995), total factor productivity in the maize sector increased at 2.0% per annum, but declined constantly by 2.8% per annum after market liberalization in 1995. The sharp maize productivity decline between 1995 and 2000 was attributed to sharp decline in input use, i.e. labour (-6.7%), fertilizer (-1.5%) and land (-3.5%). The authors suggested that the negative attributes were due to the impact of labour market liberalization, removal of fertilizer subsidies, higher fertilizer prices and the control of maize produce prices resulting in low maize productivity in the country.

In order to inform agricultural policy in Malawi, Tchale (2009) determined the level and key determinants of inefficiency in the smallholder farming system that need to be addressed to raise productivity. He observed that while potential yields for hybrid maize range from 5 to 8 tons per hectare, the average actual yields range from 1.5 to 2.5 tons. This gap between potential and actual farm crop yields suggests abundant scope for improvements in productivity. However, evidence from past studies looked mainly at technical efficiency which is derived from an agronomic view. It is thought that this kind of efficiency can be achieved by farmers but at a cost that can kill an innovation. An economic view, however, considers economic efficiency which shows use of inputs in optimal quantities while keeping their cost in proportion to the price the farmer receives for the outputs. Allocative efficiency is the ability to use the inputs at disposal in optimal proportion given their respective prices and the available production technology. He found average technical, allocative, and economic efficiency levels of 53%, 46%, and 38%, respectively. These figures showed that allocative efficiency is worse than technical efficiency which implies that the low level of overall economic efficiency at 38% is the result of higher cost inefficiency. He therefore suggested that solving allocation problems may be more critical for improving smallholder efficiency than solving technical problems. However, in the same study, Tchale (2009) showed that all area specific biophysical soil characteristics positively affected technical and cost efficiency. Higher variation in the water requirement index was shown to lower production efficiency; a critical factor for hybrid maize which is very susceptible to both the intensity and intra-seasonal distribution of rain.

This report therefore argues that given climate variability and potential climate change, conservation agriculture represents a viable technical option towards improving smallholder efficiency; in particular, through lessening expected impact of the high risk environment which makes farmers who face uncertain rainfall patterns choose low-input low-returns activities to minimize their exposure to risk. Tchale (2009) noted as shown in Fig 11 below, that agriculture determines the pace and direction of overall economic growth for Malawi. In particular, where growth in agriculture slumped, growth in the overall GDP was also markedly reduced as it did in 1991, 1993, 1995 and 2005 following periods of exceptional droughts. If sustainability of maize productivity is eroded through prolonged neglect of tasks intended to restore production efficiency, it leads to food insecurity and increased poverty observed for almost a decade post-liberalisation era (Edriss et al, 2004; Tchale, 2009).



Source: Tchale (2009)

Fig. 11. Malawi's agricultural value-added and total GDP, 1980-2008 (MK million)

The work by Edriss et al. (2004) and Chirwa (2007) recommended that government resume fertilizer subsidies for smallholder farmers to boost maize production and productivity in order to increase food security and alleviate poverty in rural households. In 1998, up to 2004, the Malawi Government launched a Starter Pack Program to distribute large amounts of free inputs to smallholders (JAICAF, 2008). Even in the program implementation period, however, maize production fluctuated widely due to bad weather, thus causing a serious food shortage every few years. The government wound up this free input distribution program in 2005 and replaced it with a Fertiliser Subsidy Programme to distribute vouchers to poor farmers so that they may purchase chemical fertilizer at subsidized prices. Gilbert et al, (2009) observed that indeed, despite the strain on government and donor budgets, fertilizer subsidy have once again become policy tools in several Sub-Saharan countries as a potential way to increase yields in staple crops like maize. The authors argued that policy makers assume, however, that farmers who receive the subsidy will achieve yield responses that are similar to those obtained by farmers who pay commercial prices for the input.

Based on panel data from Malawi, Gilbert et al. (2009) compared maize yield response to fertilizer from farmers who received subsidized fertilizer with yield responses from those who paid commercial prices for the input. Descriptive results from this work indicated that maize plots using commercial fertiliser obtained higher yields per kilogram of fertilizer than maize plots that used subsidized fertilizer. Conversely, the results obtained when a fixed-effects estimator was used indicated that once other factors ate controlled for, maize plots that used subsidized fertilizer obtained a higher yield response than other plots. According to the investigators, the results indicated that in order to be effective, government officials should specifically target fertilizer subsidies to farmers who lack access to commercial markets or would not have otherwise find it profitable to purchase the input.

The lesson from this work is the question of *if*, *when* and *for whom* conservation agriculture is a useful and appropriate technology that is distinguishable from the quick-fix policy solutions that policy makers are ready to implement. Being a primary calorie source for the population, maize production has traditionally been subject to various forms of government support in terms of seed and fertilizer (JAICAF, 2008). Can conservation agriculture be demonstrated to be a serious and long-term alternative production system in conjunction with future subsidy programs which remain socio-political strategies for food and income security and poverty alleviation? This report argues in the affirmative if it can be demonstrated that it is a stable production system at farm and national levels and all weather even in the face of intermittent drought.

6.13.2 Institutional capacity

Malawi is facing human capital degradation and institutional decay arising from the AIDS pandemic, the decline in the quality of its education, and the on-going brain drain (African Development Bank 1998). The question arises whether the country possess the political commitment and the minimum threshold of scientific capacity to benefit from, and contribute to, the information and biotechnology revolutions that are now being thrust upon it and the rest of Africa.

The challenge now is to merge, reshape, and craft a coherent system of public and private agricultural support institutions towards CA. Building effective institutional linkages is an onerous task because of the plethora of donors and NGOs that are awkwardly trying to make the transition from their proven role in food relief to becoming effective agents of agricultural development. Yet, whereas one of the most important tasks for agricultural economists is to convince ministries of finance to invest some of the taxes collected from farmers back into rural infrastructure and basic agricultural institutions in the short run in order to enhance the productivity of agriculture in the medium to long term, in Malawi, the current government is well ahead of the game on the former to allow an enabling environment for transit of inputs and products of a CA innovation system.

It is important to inject the time dimension into the analysis of capacity building for CA. Because of time optimism it is easy to downplay the time and resources that will be required for building scientific and managerial capacity for CA. Most policy reform packages are ineffective in addressing the critical issue of "political and institutional failure." But success stories of CA are not the product of a mere project period of 2 or 6 years of toil. Effort must be sustained over a longer period across generations as has been the case with conventional annual ridge tillage and this requires extraordinary and sustained leadership at various levels.

Although individual farmers, researchers and extension agents cited in this study have been quick to see the benefits of CA and involve themselves in the new system, their respective institutions appear generally much slower to evolve. Malawi has adopted CA as part of their agricultural programming policy and strategy as manifested by its inclusion in ASWAp under the subcomponent of sustainable land management. There is still need to integrate CA principles in other agricultural policies notably the Land Resources Conservation Policy and Strategy besides developing a strategy for CA in Malawi.

6.14 Education and training in agriculture

The study argues that there is an urgent need for national thrust on CA in Malawi to experiment with different agricultural institutions and to craft national "agricultural knowledge triangles" that include research, extension, and agricultural higher education.
It has also been noted in this study that many community-based organizations, NGOs, farmer organizations have been pushed into the role of providing services for natural resources management. While they may be well placed, a question arises whether these organizations well equipped to do so in support of sustained innovations under CA.

The study learnt that the curriculum at Natural Resources College does not have courses that cover CA. However, they are ready to adopt CA in courses currently being offered. The agricultural undergraduate curriculum at Bunda College of Agriculture covers CA under a number of courses listed in Table 14. The Crop Management Course is a core course for 60% of students enrolled at Bunda in the Faculty of Agriculture and the Faculty of Development Studies while the Soil and Water Conservation Course is a core course for almost 90% of the students enrolled in all three faculties that includes the Faculty of Environmental Sciences at Bunda College.

Table 14. Courses at Bunda College that cover Conservation Agriculture principles and practices.

Department	Year 2	Year 3	Year 4
Agricultural Engineering	Soil and Water Conservation	Watershed Management	Farm Mechanisation
		Farm Power and Machinery	
Crop Science Department	Crop Management		Crop Ecology
	Cropping Systems		

It is recommended that agricultural higher education institutions create self-perpetuating training courses in CA. The availability of appropriate training courses that are specifically targeted to augment their traditional training are critical to meet the needs of CA. It would be expected that many of the courses to be presented will be in the form of "training of trainers" courses.

Kamtimaleka, (2009) observed that there is need to promote other means of educating farmers, such as adult literacy classes, other than just early formal education attained. These would help to alleviate the problem of lack of information consequently improving the farmers' understanding of gains or losses associated with adopting new technologies as well as assess the new technology in terms of reasonable rate of returns.

Particular attention for education and training should be devoted to women, as they play an important role in conservation agriculture adoption as shown in the study by Kamtimaleka (2009). In Malawi, land preparation and weeding respectively use 21% and 49% of total labour for maize production. Of this 70-90 % is provided by women and children. CA was shown (Kamtimaleka, 2009), as being favoured by women and it appears a technology that shifts the labour burden away from women and children

6.15 Society and culture

In Malawi like elsewhere in Southern Africa, farming has long been a family enterprise with heirs assuming the responsibilities from their parents so that they tend to employ systems similar or identical to those of their parents. Some of these conserve resources while others do not. For example, in most parts of southern region, favoured by higher rainfall regime, incorporation of crop residues is a long-standing practice. In some regions of the country, tradition plays a major role in the type of tillage system practiced. For example, clean tillage was or is regarded as the trademark of the successful farmer in particular, for the ethnic Phokas in Northern Malawi. Socio-cultural influences can make farmers reluctant to accept new or unusual crop production practices but when properly directed, can also accelerate the acceptance on alternative farming practices. This reluctance is also shared with some extension staff who are ill equipped to advise on CA which they have very little knowledge about.

This study agrees with the contention advanced that encouraging adoption of CA is less a technology challenge and more relates to mindset and the way people think. In the local language, Chichewa, the most widely spoken language in Malawi (and substantially in Zambia and Mozambique and partly Zimbabwe), the word used for farming and ploughing is the same ‘kulima’. The lack of land preparation and associated tillage in CA does not fit the supposed practical context of farming or ploughing. People will need to learn to dissociate the two concepts: farming does not depend on ploughing.

Peer pressure and community norms can also be important impediments to the adoption of practices that go completely against conventional wisdom. Virtually all farmers gave evidence where planting a crop in fields under mulch cover or the use of chemicals for weed control were associated with nothing less than being crazy; or not wishing your children well by making the soil sick.

The work by Mdulamizu (2009) in Salima and Balaka showed that there appears two routes to farmer empowerment in CA which appear complementary and had been realised under the FIDP CA project. There is a direct empowerment through higher income and greater management flexibility, allowing more time for homestead or communal contributions and, indirectly, through participation in farmer organisations which demand collective leadership. However, of more relevance here is that the study showed farmers received project-led training in farmer organisations and consequently demonstrated presence of intense exchange of knowledge and information amongst themselves through their committees. Interchange between clubs or farmer to farmer visits were also evident with the result of professionalising farmers in CA and its requirement for organisation and leadership. Similarly, farmers trained by Sasakawa Global 2000 intimated the importance of farmer-to-farmer interactions.

This study suggests that this intense farmer exchange remains pivotal in circumventing peer pressure and community norms. The adoption of CA requires courage from the farmer to risk implementing a technology with a totally different logic from conventional principles and to absorb criticism of neighbours.

6.16 Capacity building and information

One of the reasons for failure is lack of viable partnerships between government institutions that oversee R & D and other stakeholders. Experience shows that adoption of CA practices is influenced by the nature and performance of the input value chains that deliver inputs and services to the farm gate. They comprise CA service providers, the extension agents (formal and informal, e.g. farmer-to-farmer) and often, providers of complimentary inputs such as credit and fertiliser. Availability of these inputs also influences the rate of technology adoption and level of intensification. In this study, it is noted that at varying times and scope, various individuals and institution have taken up the role of championing CA. However, in most instances, efforts have remained short-term and farmers have been left asunder, like orphans.

Tchale (2009) reported that the availability of an extension worker in the community and the usefulness of the extension messages (as perceived by the respondents) are significant determinants to technical efficiency. Farmers who are members of extension/ market/ credit related organizations were shown to exhibit higher levels of production efficiency. Informal sources of learning and information sharing has also been shown to increase efficiency. Tchale (2009) also demonstrated a positive and significant relationship between technical efficiency and the cumulative percentage of farmers adopting various crop technologies within the farming community. An increase in the number of farmers who adopt improved technology directly lowers the transaction costs associated with improved technology adoption, and thus a positive effect in attracting more farmers to adopt the technology and so improve their productivity.

The problem of poor access to extension information on crop production technological options whose lack of transmission is attributed to poor extension services, resulting from inadequate extension workers in the field, remains intractable. In order to expand extension services on CA, programmes have been launched to make these small-scale farmers aware of no-till technology. With the skills and resources required, no single organisation can successfully introduce new technology to small-scale rural farmers and the introduction of these technologies is best arranged as a partnership.

In this study, farmers lamented the absence of extension workers in providing support both during and after CA projects implemented by Sasakawa or FIDP. Farmers noted that public extension agents appeared to lack access to CA information, and appeared too slow to assist farmers appreciate the feasibility and benefits of the CA system. In fact some of the farmers applauded the farmer-to-farmer visits under the Sasakawa programme as being instrumental in entrenching the practice of CA. Indeed, in small-farm communities, information sharing within the community is often the primary source of new knowledge, and thus knowledge tends to be far more based on traditional concepts and practices than in the large farm sector where farmers tend to look outside their community for new knowledge to be able to give themselves an advantage in the market.

It is argued (World Bank, undated) that considerable institutional capacity already exits in local governments or communities. Often, it is a lack of local empowerment to use it where capacity is *inter alia*, defined as the ability to solve problems. Thus for a people that have survived by trying to solve problems in difficult ecological, economic and political conditions, they do possess considerable capacity to put their experience and skills to work, once they are empowered. So it is argued, the process of capacity creation can be described as learning by doing, learning by use of power, learning by solving problems, and learning by making mistakes. Vibrant community structures constitute social capital, a much-neglected asset that can yield high economic dividends.

In the study sites visited, there were differences in the centralization and administration of development or innovation agendas. On the one hand there are government or development partner-led innovations while on the other, projects have either created parallel extension structures to deliver their priorities or let the government extension system implement projects while they disburse funds according to an agreed framework. Which of these delivery mechanisms has led to sustained CA innovations?

Another observation comes in the wake of target clientele for capacity building. Should capacity building or projects aim at those that have been identified as 'lead farmers,' or the 'lead farmer approach', or should it be delivered to a 'target group' of farmers? Target group defined in this case as a group of farmers who will adopt the same recommendation given equal access to information, or a group of farmers whose circumstances are similar enough so that the same recommendation is applicable for all. A third approach encountered in this study is that of the 'model village'; where a village(s) is/are identified and capacity building is initially concentrated. Models are touted as one way to explain a phenomenon, whether physical, biological, agricultural or environmental, but there is the added aspect of encouraging exchanges between farmers and experience of new knowledge as the phenomenon is unraveled in a participatory manner.

Much as extension agencies now follow an approach known as 'demand driven approach', a method which strengthens a community's inventiveness, this study argues that the identification of target clientele for entry of technologies and requisite delivery of capacity building remain critical to sustained success of innovations and their scaling out. There is needed to be wary of potential mismatch between the technology and the target users. The study argues that the 'demand driven approach' may not be suitable for introgression this new practice for farmers in Malawi. This is so because CA is more knowledge-intensive than input-intensive: success depends more on what the farmer does (management) than on the level of inputs he applies. This is also bearing in mind that the farmer in Malawi already practices and is aware of plant density intensification (fondly called Sasakawa method) and the role of hybrid seed and fertilizer in improving maize crop productivity (from the subsidy programme).

7. RECOMMENDATIONS FOR POLICY, RESEARCH, EXTENSION, TRAINING AND FARMER SUPPORT

7.1 National Strategy for CA

It has been argued that CA is a complex technology: it involves a complete change in the farming system, not simply change from ridge to zero tillage. CA implies changes in weed control practices, in seeding dates, seeding times, crop residue management, crop rotations, harvest procedures and many other facets of the production system. As such, it is almost impossible for research and extension systems to develop appropriate "packages" that fit the circumstances of all farmers and farmer groups–the adaptation of the principles to local conditions requires large levels of farmer participation. This study therefore recommends formulation and adoption of a well informed National Conservation Agricultural Strategy that treats CA unlike the usual projects in soil and water conservation. The study has looked at the draft strategy and concludes that it runs the risk of treating CA just as the other resource conserving technologies.

Why a national strategy, it may be asked? The answer lies in the realization that Malawi has employed agriculture, based largely on small scale annual maize-based cropping practices that promote ridge tillage for a long period. The multiple challenges facing the agricultural sector explain why ridge tillage agriculture has been entitled to a large claim on public resources in order to build roads, research stations, colleges of agriculture, and other essential components of a modern, science-based agriculture which in this study is being asked to accommodate a production system change. But this four-decade time frame for post-independence ridge tillage agriculture may be at sharp variance with the time horizons of most projects and programmes that view CA as epitomizing projects that would generate "high visibility and quick returns." The report proposes an 8-year CA strategy beginning the agricultural calendar of 2010 based on the evolution scale of conservation agriculture demonstrated in Malawi and elsewhere. The first four years will be the initial phase that would concentrate on project level platforms while the last four years will be the consolidation phase that brings CA to the national level economic development platform.

The study further noted that the many CA activities by government, NGOs and other stakeholders can be considered to fall under the ASWAp concept and are within the Sustainable Land and Rainwater Management sub-component within the Sustainable Productivity Growth Initiative. The study recommends that the National CA Strategy which the National CA Task Force is preparing should be within the ASWAp framework so that all CA activities are within it.

7.2 Agricultural knowledge management

In Malawi, the three core institutions in the agricultural knowledge triangle—research, extension, and higher education—continue to face daunting paradigms to remain useful.

The public agricultural extension services in Malawi are now in crisis because of their ineffective coverage. This has helped fuel the search for a diversity of approaches, including increased participation of the private sector and NGOs. Agricultural research is now moving in the same direction as extension, and a search is underway for a wide range of public and private models that are demand-driven and fiscally sustainable. Agricultural higher education has suffered a sharp cut in real budgets, a decline in the quality of the educational experience, and a brain drain.

The consequences of these observations are first, because of the immensity, diversity, and complexity of CA, and the path-dependence that is embodied in its annual ridge tillage heritage, it is foolhardy to assume that a single entity (stakeholder) or research or extension model will be effective throughout Malawi. Second, imported CA institutions from other cultures and other continents may have a high failure rate in Malawi if they are replicated before the satisfactory completion of a pilot phase. The work being conducted by CIMMYT to test the feasibility of CA in partnership with a number of players such as Total Land Care, the Challenge Programme, and Chitedze Research Station is therefore commendable. Indeed, testing and modifying imported models requires public and foundation resources to finance pilot projects and independent evaluation teams that have the freedom to collect benchmark data and evaluate the performance of alternative organizational models. This is exemplified by the work postgraduate students at Bunda College tried to accomplish based on FIDP CA implementation models and sites in Salima and Balaka Districts, respectively.

This study therefore recommends that the National Conservation Agriculture Task Force, build its strength based on the agricultural knowledge triangle (or what has also been termed agricultural knowledge system, or agricultural knowledge information system) as a way of integrating research, extension, and education activities and ensuring the sequential continuity of investments in CA in these core institutions. Basically, the approach argues that public and private managers of separately governed institutions should come together and "coordinate" decisions on the size and sequencing of complementary investments, because the payoff has been found to be higher if they are planned and executed as a joint activity rather than pursued as freestanding extension, research, or education projects.

It is noted, among other factors that the issues in strengthening agricultural knowledge triangles in Malawi appear complex but not intractable largely because of the institutional preferences of a multiplicity of donors, and the fragmentation of agriculture and natural resources units in government and education institutions. Invariably, the task before us is to figure out how to build country-level agricultural knowledge triangles for CA that are operationally linked to farmer organizations, the private sector, and the regional and global scientific communities.

7.3 Changing roles of public and private institutions and NGOs

What are the most productive roles for public, private, and NGO institutions in supporting CA amongst farmers, traders, and agribusiness firms? There are many ideological positions on this issue, but there is little hard evidence on the performance of various types of public, private, and NGO partnerships given the short time of implementation of CA in Malawi. However, Malawi's experience in soil and water conservation in particular and agricultural development in general leads us to recommend that Government should take the leading role in providing strategic guidance on CA research, extension and credit services to smallholders. Fast adoption of CA will create demand for CA inputs that will attract private sector participation. NGOs including farmer associations should play an advocacy role and provide support to CA extension and investment. The state has been the organizer and risk-taker in developing Malawi's all-weather road network, agricultural research system, and its extension service in support of agriculture. Malawi's private sector has slowly taken on a greater role in the sector in maize breeding, seed distribution, and the marketing of new high-value export crops. Avoiding dogmatism is critical when considering what should be done by the state or the private sector and when examining the sequencing and changing roles of the public and private sectors and NGOs over time.

7.4 Strengthening the Role of the National Conservation Agriculture Task Force (NCATF)

In other countries where conservation agriculture is flourishing, its adoption was fostered by the emergence of functional, multi-agent networks focused on this system of agriculture. These networks did not evolve spontaneously but required the efforts of catalysing agents – "conservation agriculture champions" – who encouraged applied research and advisory services and the development of the modified farm equipment that conservation agriculture needs. Currently in Malawi that role played by a multiplicity of players presently networked by the NCATF.

Second, the adoption of any new technology implies a cost, and the investment in acquiring new knowledge of a complex system, such as CA, may be high for a risk-averse smallholder farmer. Given the important off-farm effects of the adoption of technologies that reduce or revert land degradation, there is a good argument for other beneficiaries to support CA adoption and to compensate farmers for their efforts in land stewardship. This study recommends that the National CA Task Force should review its roles and functions with the aim of positioning itself for a stronger catalytic role in CA research and development and to engender investment support. While not being prescriptive, the Task Force needs to reform itself institutionally to take up the challenge and perform the new tasks that may include:

1. Facilitate interaction, cooperation and links among its members;
2. Provide a forum for the discussion and dissemination of good soil, water and crop management practices under conservation agriculture;

3. Convene and hold conferences and meetings and conduct commissioned field studies connected with the development of better soil, water and crop management under conservation agriculture;
4. Produce, publish and distribute policies, guidelines, books, papers and other information that promote better conservation agriculture practices;
5. Encourage and develop awareness, discussion and consideration of good conservation agriculture practices among associated members; and
6. Liaise, consult and work in conjunction with global, regional and national partners on the development and promulgation of conservation agriculture policies, strategies and standards.

The report observes that the review process needs to be linked to the outcomes within a conceptual framework (which may be a strategic plan for the National CA Task Force). The competence development in CA, the iterative reflective learning in CA, and action in CA must be linked conceptually and in action to the framework. This presupposes more of a process reform rather than a structural reform to take advantage of the founding champions of conservation agriculture in Malawi within and without the National CA Task Force.

7.5 Conservation Agriculture Information System

The study noted discrepancies in data gathering and reporting of CA activities. This emanates from lack of agreed definition of CA; lack of systematic format for reportage; and inability of the Land Resources Conservation Department to collate CA information from other players. The study suggests an informed consensus on definition and practice of CA and coordinated collation of national data and information on CA.

7.6 Other emerging issues

7.6.1 Conservation agriculture and efficiency of smallholder agriculture

Despite the long history of government investment in the agricultural sector through extension services and promotion of technology, smallholder maize farming has largely remained uneconomic and technically inefficient even under circumstances of favourable weather conditions. Most studies have emphasized research on maize varieties and technological adoption, the impact of structural adjustments programs, liberalization of food produce pricing and marketing, and analyses of the relationship between farm size and productivity. CA needs to demonstrate that it comprises the three tenets of efficiency (technical, allocative and economic) among smallholder maize farmers whose enhanced productivity will place CA on the table of policy makers that are in search of a lasting solution to improved incomes and food security at the household level and a robust export-led but agro-based economy at the national level.

7.6.2 Estate and smallholder farmers

For many years tremendous efforts and resources have been placed on improving the agriculture production of smallholder farmers. The idea behind this was that the total hectarage covered by smallholders was a lot more than estates. In addition it was assumed that estates would easily get any information they want. The study recommends aggressive promotion of CA technologies with equal emphasis both in the smallholder and estate commercial sector. The missing out of the estate in the current CA drive fails to take advantage of their ability to acquire the necessary inputs easily

7.5.3 Soil Cover

This study acknowledges that where crop productivity is lower, and in Malawi with a protracted 7-8 months long dry season, crop residues may be scarcer and competition for them between livestock, homestead needs, and the CA practice greater. In Malawi, in general common grazing rights apply after crop harvest where livestock are left to roam across field terrain. Thus an individual farmer does not have exclusive rights to the residues on his land, and attempts to conserve them can lead to being alienated by the community or confrontation. Yet, the retention of mulch is the defining aspect of CA. Where livestock is part of the farming system the study recommends integration where the two components are seen to be mutually supporting; the livestock providing the manure to boost biomass production in excess of CA requirements that can be used as feed for the animals. Movement of animals needs to be controlled through locally instituted byelaws. Use of live fences, such as that of Jatropha or thorny tree species can be effective; however their wide adoption by farmers is questionable.

The study recommends that it remains important to demonstrate to farmers that leaving at least part of the residues on the soil surface (minimum 30% ground cover at planting) gives a greater benefit to system productivity than other uses. Further, that productivity levels might need to be raised to achieve sufficient levels of stover for both ground cover and feed through the practice of CA. It still remains critical to establish production levels overtime that provides stover yield to meet minimum requirements for animal feed, other uses, and soil cover.

This study recommends provision of community awareness, and community involvement in the issue of land degradation and the place of CA beyond increased yield for individuals practicing it to stem jealousy and other ills. This will call for considerable investment in information sharing and knowledge development in rural communities across the country through various fora including mass media.

7.5.4 Crop rotation

The study emphasizes that the change in tillage has been the most readily researched and reported of the CA principles with soil cover and rotations taking the back stage. In designing rotations, the most profitable, market driven crops for the area need to be identified and prioritized and their potential role in biological, physical and chemical terms identified in order to fulfill a multifunctional set of demands. Use of crop rotations is a well-recognized approach to reducing the risk of building up pests and diseases which may be exacerbated when crop residues are retained in the field. More importantly, the long-term profitability and environmental impact over perhaps several turns of the rotation is important, not any one crop.

The study recommends that the movement towards conservation agriculture–based technologies should comprise a sequence of stepwise changes in cropping system management to improve productivity and sustainability. The principles of marked tillage reductions are initially applied in combination with the retention of sufficient amounts of crop residue on the soil surface, with the assumption that appropriate crop rotations can be included or maintained after an initial phase of at least 5 years to achieve an integrated, sustainable production system.

7.5.5 Agroecological indexing

The old and highly leached soils in Malawi, damaged through lengthy exploitation without adequate fertility replacement have ever presented a formidable challenge for fertility management. The efficiency of fertilizer use is typically unsatisfactory and often related to inadequate levels of soil organic matter and nutrient imbalances caused by past farming practices. This study argues that lack of response to soil water management is sometimes compounded by poor soil fertility. Thus there is need to exploit synergies between water and soil fertility management under CA as this would increase water and crop productivity. The study recommends that research will need to provide advice on how to manage the trade-offs between conventional ridge-tillage systems and CA in this regard across agro-ecological conditions in Malawi in order for CA to garner the importance of greater investments in drought risk management instruments given smallholders' very high reliance on rainfall.

The reduction in water erosion with conservation farming, such as surface mulch tillage systems or no-till, are related to reduced run-off and to the surface cover provided by the residues, which reduce soil detachment and transport due to raindrop impact and flowing of water. Although surface mulch tillage is thought to be adaptable to all types of soils, this study argues that it remains pertinent to study the long-term response of different soils to CA in Malawi. For instance, given that erosion rates are greatest under high rainfall intensity, on steep slopes and on more erodible soils, it seems likely that these are precisely the conditions where CA can have the greatest benefits. However, on very steep slopes, mulch retention alone will be insufficient to control erosion and other physical control measures such as contour bunds and vegetative barriers are needed to reduce the slope length and control runoff and soil erosion. This needs to be enunciated.

7.5.6 Access to inputs

Although small-scale farmers have limited capital, and limited access to it, generally they are prepared to invest in inputs not so much if the expected returns are sufficient and the risk of failure is low, but more importantly if they knew the cost of production and planned a farm budget. The study argues that one of the benefits of CA is generally a reduction in the risk of crop failure, related to an improved crop water balance. This reduction in risk is especially important for small farmers who have little savings to weather a bad harvest and will tend to modify their willingness to invest in production inputs, including herbicides and N fertilizer.

Second, the adoption of any new technology implies a cost, and the investment in acquiring new knowledge of a complex system, such as CA, may be high for a risk-averse smallholder farmer. Given the important off-farm effects of the adoption of technologies that reduce or revert land degradation, there is a good argument for other beneficiaries to support CA adoption and to compensate farmers for their efforts in land stewardship. This support may take many forms, from subsidies on CA equipment (possibly counterbalanced by higher taxes on tillage equipment), direct payments to farmers for environmental services, such as those envisaged in payments for carbon credits, or simply credit schemes for farmers linked to the adoption of conservation practices. However, to achieve this type of support, there is a need for education of policy makers in the costs of land degradation, the existence of technologies to overcome this and the expected benefits that would accrue to the region or nation from the widespread adoption of CA and related technologies.

7.5.7 On-farm model for introducing CA in Malawi

Major changes are needed in land, livestock and water management in line with traditional lifestyles and customs to remedy the agricultural system in Malawi. Obviously, major, abrupt changes, especially in crop management activities, will not be possible in most cases. A more step-by-step, empirical approach is needed that involves intimate farmer participation throughout the initial research on possible strategies/ technologies, the testing and modification of the most relevant possibilities and finally the extension of the final products.

The introduction of a structured farmer demonstration programme based on the concept of clustering plots in close proximity to each other (better still under catchment approach) under the facilitation of an extension officer, has proven to be a successful technique for the transfer of conservation agriculture technology to small-scale farmers. Other partners such as the FAO, Total LandCare have successfully used tenets of demand driven technology adoption by employing farmer-led revolving funds that requires new farmers to deposit into the fund as an expression of intent to try CA.

The use of certified seed, fertilisers and herbicides ensure that the farmers are able to obtain highly significant improvements in crop yields as well as income with a reduction of labour and time in achieving this. In this manner, farming is no longer for individual food security only, farmer adoption of the technology leads to the development of the overall farming support infrastructure (e.g., agro-dealers in the input supply chain) creating a modest local input and output flows for sustenance of the innovation.

8 CONCLUSION

The study concludes that the shift from conventional to conservation agriculture will require implementation of several aspects:

(a) Situating conservation agriculture based on a socio-ecological framework in order to avoid potential mismatch between the technology and the target biophysical and socioeconomic environment;

(b) Exposure of farmers to different CA practices, particularly through participatory activity and on-farm demonstrations to show the benefits and practicality of cropping techniques, tools, and equipment;

(c) Training in then practical use of new technologies, combined with flexible funding mechanisms and incentives, particularly during the period of transition;

(d) Fostering cooperation and dialogue between scientists, suppliers and farmers, and between government and educational institutes;

(e) Achieving and publicizing improvements in land productivity, reduction in farming costs and environmental benefits; and

(f) Integrating conservation agriculture in agricultural development frameworks, strategies and policies to facilitate a shift from conventional farming practices.

9. BIBLIOGRAPHY

AFRICAN DEVELOPMENT BANK 1998. African Development Report 1998. New York: Oxford.

BENITES, J.R. 2008. Effect of no-till on conservation of the soil and soil fertility. Pages 59-72. In: Goddard, T., Zoebisch, M.A., Gan, Y., Ellis, W., Watson, A. and Sombatpanit, S. (Eds.). No-till farming Systems. Special Publication No. 3, World Association of Soil and Water Conservation, Bangkok. 544 pp.

BISHOP, J. 1990. The Cost of Soil Erosion in Malawi. Draft Report for Malawi Country Operations Division, World Bank.

BODNAR, F. & BUNDERSON, W.T. 1998. Reduced tillage/ Agroforestry/ legume demonstration trials. 1996-97 Season. PROSCARP/MAFE/ Land Resources Conservation Department, Ministry of Agriculture & Irrigation. Lilongwe, Malawi.

BUNDERSON, W.T. & JERE, Z.T. 2008. Management for adaptation to climate change. An integrated model for the Central Watershed of Lake Malawi, Total LandCare, Lilongwe, Malawi.

BUNDERSON, W.T. & JERE, Z.T. 2009 Integrating Agroforestry with Conservation Agriculture: Experience of Total LandCare

CHIRWA, E.W. 2007. Sources of technical efficiency among smallholder maize farmers in Southern Malawi. African Economic research Consortium . AERC research Paper 172. Nairobi, Kenya.

CIMMYT, 1999. CIMMYT 1997/98 world maize facts and trends. Mexico DF, CIMMYT. pp 235240. In: G.O. Edmeades, M. Banziger, H.R.Mickelson, and C.R. Pena-Valdivia (Eds.). Developing Drought and Low N-Tolerant Maize. Proceedings of a symposium, March 25-29, 1996, CIMMYT, El Batan, Mexico. Mexico D.F., CIMMYT.

DEVELOPMENT ALTERNATIVES. 1999. Check dam evaluation study – Sustainable Livelihoods and DA.[On line] [Accessed 4 Dec, 2005]

DOUGLAS, M.G., MUGHOGHO, S.K., SHAXSON, T.F. AND EVERS, G., 1999. Malawi: An Investigation into the Presence of a Cultivation Hoe Pan under Smallholder Farming Conditions. TCI Occasional Paper Series No. 10, Food and Agriculture Organisation of the United Nations, Rome, Italy.

EATON, D. 1996. The economics of soil erosion: a model of farm decision-making. Environmental Economics Programme. International Institute for Environment and Development. The Hague, The Netherlands .

EDRISS, A, TCHALE, H. & WOBST, P. 2004. The impact of labour market liberalization on maize productivity and rural poverty in Malawi. Working Paper, Policy Analysis for Sustainable Agricultural Development (PASAD). Centre for Development Research, University of Bonn, Germany.

ERENSTEIN, O., SAYRE, K., WALL, P., DIXON, J. & HELLIN, J. 2008. Adapting no-tillage agriculture to the conditions of smallholder maize and wheat farmers in the tropics and sub-tropics. Pages 253-277. In: Goddard, T., Zoebisch, M.A., Gan, Y., Ellis, W., Watson, A. and Sombatpanit, S. (Eds.). No-till farming Systems. Special Publication No. 3, World Association of Soil and Water Conservation, Bangkok. 544 pp.

EVANS, J., BANDA, A AND T. SEYMOUR, T. 1999. Opportunities for better soil fertility management. Land Resources Conservation Department.

FAO. 1993. Soil Tillage in Africa: Needs and Challenges. FAO Soils Bulletin No. 69. FAO, Rome.

FAO. 2001. Conservation agriculture – Case studies in Latin America and Africa. In FAO Soils Bulletin No. 78. FAO, Rome.

FOOD & AGRICULTURAL ORGANISATION (FAO). 2007. Conservation Agriculture Website --http://www.fao.org/ag/ca/ (verified 16.04.07)

GILLER, K., WITTER, E., CORBEELS, & TITTONELL. 2009. Conservation agriculture and smallholder farming in Africa: the heretic's view. Field Crops Research 114, 23-34.

GOSSAGE, S. J. 1997. Land use on the tobacco estates of Malawi, Estate Land Utilisation Study. Lilongwe, Malawi

HARRINGTON, L. & ERENSTEIN, O. 2005. Conservation agriculture and resource conservation technologies: a global perspective. Agromeridian 1(1), 32-43.

JAICAF (JAPAN ASSOCIATION FOR INTERNATIONAL COLLABORATION OF AGRICULTURE AND FORESTRY). 2008. The Maize in Zambia and Malawi. JAICAF, Tokyo, Japan. Sozosha LTD.

KABULI, A. & NANKHUMWA, T. 2004. Synthesis of Socioeconomic, Adoption and Policy studies on Integrated Soil Fertility Management Technologies in Southern Africa: The Case of Malawi. A Draft synthesis report of study findings submitted to Soil Fertility Consortium for Southern Africa (SOFECSA). Lilongwe, Malawi

KAMWENDO, M. L. 2009. The effect of conservation farming on soil physical properties in Malawi. M. Sc. Thesis. Interuniversity Program on Physical Land Resources. Ghent University, Belgium.

KANTIMALEKA, S. 2009. Assessment of socio-economic factors influencing farmers' adoption and intensity of conservation agriculture in dryland areas of Malawi. A case study of Chinguluwe EPA in Salima District and Bazale EPA in Balaka District. Agricultural Innovation in Dryland Africa (AIDA). Specific Support Action (SSA) of the International Co-operation (INCO) 6th EU Research Framework Program (EU-FP6). (SSA Africa 2006). CIRAD, France/ CTA, Netherlands.

KUMWENDA, W.F. 1990. Tillage and water management on small rainfed farm of Malawi. In: Pushpananjah, E. Latham, M. & Eliot, C.R. (Eds.) Organic matter management and tillage in humid and sub-humid Africa, Bangkok, Thailand. International Board for Soil Research and Management (IBRAM) Proceedings No. 10.

KUMWENDA, J.D.T., WADDINGTON, S.R., SNAPP, S.S., JONES R.B. AND BLACKIE, M.J. 1997. Soil Fertility Management in Southern Africa. Pp 157-172. In: Byerlee and C.K. Eicher (Eds.). Africa's Emerging Maize Revolution. Lynne Reiner Publishers, Colorado

KUMWENDA, W.F, MLOZA-BANDA, H.R., MANDA, M, & BWALYA, M. 2002. National Workshop Conservation Farming for Sustainable Agriculture. Report. 20-24 October 2002, Lilongwe, Malawi.

LANGYINTUO, A.S. 2005. Maize production systems in Malawi: setting indicators for impact assessment and targeting. International Maize and Wheat Improvement Center. CIMMYT, Harare.

MALAWI GOVERNMENT. 1997. Nutrition needs assessment. National Economic Council. Lilongwe, Malawi.

MALAWI GOVERNMENT. 2000. An Action Plan for Developing Sustainable Agricultural Input Supply for Malawi. Draft Report, May 2000. Ministry of Agriculture and Irrigation, Lilongwe, Malawi.

MALAWI GOVERNMENT. 2002a. Malawi Poverty Reduction Strategy Paper. (http://poverty.worldbank.org/files/Malawi_PRSP.pdf)

MALAWI GOVERNMENT. 2002b. Malawi National Land Policy, Lilongwe: Ministry of Lands, Physical Planning and Surveys.

MALAWI GOVERNMENT 2002c. State of the Environment 2002. Ministry of Natural Resources and Environmental Affairs. Environmental Affairs Department. Lilongwe, Malawi

MALAWI GOVERNMENT. 2003b. Vulnerability and Adaptation Assessment to Climate Change Impacts in Malawi. Ministry of Natural; |Resoiurces and Environmental Affairs. Environmental Affairs Department. Lilongwe, Malawi.

MALAWI GOVERNMENT. 2007 a. Status of conservation agriculture in Malawi. Land Resources Conservation Department, Ministry of Agriculture. Lilongwe, Malawi.

MALAWI GOVERNMENT. 2007 a. Malawi: Poverty and Vulnerability Assessment – Investing in Our Future. GoM/World Bank, Lilongwe, Malawi.

MALAWI GOVERNMENT. 2008. National Conservation Agriculture Strategy. Draft. Land Resources Conservation Department, Ministry of Agriculture & Food Security. Lilongwe, Malawi.

MALAWI GOVERNMENT. 2009. The Agriculture Sector Wide Approach (ASWAp). Ministry of Agriculture & Food Security. Lilongwe, Malawi.

MDULAMIZU, M. 2009. An analysis of farmer groups practising conservation agriculture in dryland areas of Malawi: a case of Chinguluwe EPA in Salima and Nkomba Model Village in Bazale EPA in Balaka District. Agricultural Innovation in Dryland Africa (AIDA). Specific Support Action (SSA) of the International Co-operation (INCO) 6th EU Research Framework Program (EU-FP6). (SSA Africa 2006). CIRAD, France/ CTA, Netherlands.

MLOZA-BANDA, H.R. & MATERECHERA, S.A. 1999. Influence of tillage, residue management, and weeding practices on maize, wed composition and biomass under low-input cropping system in Central Malawi. Pp. 49-55. In: Chivinge, A.O., Tusiime, G., Nampala, P. and Adipala, E. Proceedings of the 17th Biennial Weed Science Society Conference for Eastern Africa.

MLOZA-BANDA, H.R. 2002. Development and application of conservation agriculture in Malawi's smallholder subsistence and commercial farming systems Pp. 1-8. In: Mloza-Banda, H.R., Kumwenda, W.F., Manda, M. & Bwalya, M. (2003). Proceedings of Workshop on Conservation Farming for Sustainable Agriculture. Lilongwe, Malawi, 20-24 October 2002.

MLOZA-BANDA, H.R., KUMWENDA, W.F., MANDA, M. & BWALYA, M. 2003. Proceedings of Workshop on Conservation Farming for Sustainable Agriculture. Lilongwe, Malawi, 20-24 October 2002.

MLOZA-BANDA, H.R. & C. MAKWIZA. 2007. Case studies of successful land and water management systems in drylands of Malawi. Unlocking the Potentialities of Agriculture in Africa's Drylands for Fighting Hunger: Agricultural Innovation in Dryland Africa (AIDA). Specific Support Action (SSA) of the International Co-operation (INCO) 6th EU Research Framework Program (EU-FP6), Lilongwe, Malawi.

MLOZA-AMRI, G., C. MAKWIZA, AND MLOZA-BANDA, H. R. 2008. Vulnerability and adaptation assessment report for the energy sector. National Vulnerability & Adaptation Assessments, Malawi's Second National Communication to the IPCC. Component: Programmes Containing Measures to Facilitate Adequate Adaptation to

Climate Change. Ministry of Natural Resources & Environmental Affairs. Environmental Affairs Department, Lilongwe, Malawi

MOHAMOUD, Y. & H. E. CANFIELD. 1998. Development of a rapid assessment and monitoring technique for soil erosion in Malawi based on analysis of the occurrence of broken ridges. II. Testing of a method for qualitative assessment of soil erosion from smallholder farmers' fields in Malawi. Malawi Environmental Monitoring Programme, Lilongwe, Malawi.

MUSSA, J.J. 2007. Status of conservation agriculture in Malawi. Presented at the launching Ceremony of the Malawi National Conservation Agriculture Task Force. 11 December 2007, Lilongwe, Malawi.

MUSTAFA-MSUKWA, A.K. 2009. An assessment of the adoption of compost manure by smallholder farmers in Balaka District. M.Sc. Thesis, University of Malawi, Lilongwe.

NAKHUMWA, T.O. 2004. Dynamic costs of soil degradation and determination of adoption of soil conservation technologies by smallholder farmers in Malawi. PhD Thesis, University of Pretoria, South Africa.

NGWIRA, A. 2010. Conservation Agriculture in maize based systems for improving food security and adaptation to climate change. Chitedze Research Station. Ministry of Agriculture and Food Security, Lilongwe, Malawi

NYANGULU, J.E.S. 2003. Conservation farming in estate agriculture in Malawi In: Mloza-Banda, H.R., Kumwenda, W.F., Manda, M. & Bwalya, M. (2003). Proceedings of Workshop on Conservation Farming for Sustainable Agriculture. Lilongwe, Malawi, 20-24 October 2002.

PROSCRAP (Promotion of Soil Conservation and Rural Production). 2002. Final Evaluation Report. Ministry of Agriculture, Lilongwe.

ROCKSTROM, J. 2000. Water resources management in smallholder farms in Eastern and Southern Africa: an overview. Phys. Chem. Earth (B). 25(3): 275-283.

SAKALA,W.D, J.D.T. KUMWENDA, A.R. SAKA AND V.H.KABAMBE. 1998. The potential of green manure to increase soil fertility and maize yield in Malawi. Chitedze Agricultural Research Station. Lilongwe. Malawi.

SASAKAWA AFRICA ASSOCIATION. 2006. Sasakawa Global 2000 Programme. Country Profile, Malawi. Sasakawa Africa Association. Mexico City, Mexico.

SIBUGA, K. P. 1997. Weed management in Eastern and Southern Africa: Challenges for the 21st Century. In: Adipala, E., Tusiime, G. and Okori, P. Proceedings the 16th East Africa Biennial Weed Science Conference. Kampala: WSSEA.

SINGA, D.D. 2010. Evaluation of Jab Planter for Cereal Crop Planting and Fertilizer Application in Malawi. University of Malawi, Bunda College, Agricultural Engineering Department

SMALE, M, Z.H.W. KAUNDA, H.L.MAKINA, M.M.M.K MKANDAWIRE, M.N.S MSOWOYA,. D.J.E.K MWALE, AND P.W. HEISEY. 1991." Chimanga Chamakolo", Hybrids andComposites: Analysis of Farmers' Adoption of Maize Technology in Malawi, 1989-89.CIMMYT Economics working paper 91/04.CIMMYT, Mexico,D.F.

SMALLING, E.M.A. 1998. Nutrient flows and balances as indicators of productivity and sustainability in Sub-Saharan Africa agroecosystems. Agriculture, Ecosystems and Environment, 71, 13-46.

TCHALE, H. 2009. The efficiency of smallholder agriculture in Malawi. AFJARE 3(2), 101-121.

VALENCIA, J.A. AND N. NYIRENDA. 2003. The impact of conservation tillage technology on conventional weeding and its effect on cost of production of maize in Malawi. In: Mloza-Banda, H. R. and Salanje, G.F. Proceedings of the 19th Biennial Weed Science Society Confrence for Eastern Africa. Lilongwe: WSSEA.

WALL, P. C. 2007. Tailoring conservation agriculture to the needs of small farmers in developing countries: an analysis of issues. J. Crop Improvement 19 (1/2), 137-155.

WORLD BANK. 2003. Memorandum of the President of the International Development Association and the Executive Directors on a Country Assistance Strategy of the World Bank for the Republic of Malawi, Report No. 25906 MAI, May 14, 2003.

WORLD BANK. (Undated). Community Driven Development in Africa. Community driven development: a vision of poverty reduction through empowerment. Washington, D.C.

ZAMBEZI, B.T., KUWENDA, J.D.T. AND JONES, R.B. 1993. Closing the yield gap in Malawi. Pp 137-154. Proceedings of a Conference on Agricultural Research for Development. June, 1993. Mangochi, Malawi.

10. ANNEXES

Annex 1. FIDP Conservation Farming Achievements: 2006/07 TO 2008/09

2008/09												
	CP	KA	RU	MZ	KK	SA	DA	LL	BLK	CZ	TO	TOTAL
Area under CA (Ha)	**64**	**105**	**21**	**759**	**86**	**578**	**324**	**203**	**216**	**41**	**2.6**	**2399.6**
Average yields (Kg/ha)	4500	4000	5000	5000	4000	5000	5000	4500	4000	4500	4000	4500
Production (kg)	**288000**	**420000**	**105000**	**3795000**	**344000**	**2890000**	**1620000**	**913500**	**864000**	**184500**	**10400**	**10798200**
Farmers involved	**194**	**183**	**64**	**1239**	**187**	**656**	**414**	**372**	**541**	**95**	**9**	**3954**
2007/2008												
	CP	KA	RU	MZ	KK	SA	DA	LL	BLK	CZ	TO	TOTAL
Area under Conservation Farming	**29**	**25**	**45**	**147**	**18**	**224.8**	**49**	**49**	**63**	**19.4**	**8.7**	**677.9**
Average yield (Kg/ha)	5000	4500	5000	5000	4000	5000	5000	5000	4500	4000	4000	
Production (kg)	**145000**	**112500**	**225000**	**735000**	**72000**	**1124000**	**245000**	**245000**	**283500**	**77600**	**34800**	**3299400**
Farmers involved												
Men	70	53	50	243	54	756	268	182	152	73	7	1908
Women	43	40	25	201	27	298	74	146	178	84	43	1159
TOTAL	**113**	**93**	**75**	**444**	**81**	**1054**	**342**	**328**	**330**	**157**	**50**	**3067**
2006/2007												
	CP	KA	RU	MZ	KK	SA	DA	LL	BLK	CZ	TO	TOTAL
Area under Conservation Farming	**8**	**15**	**12**	**90**	**0**	**70**	**18**	**42**	**26**	**4.7**	**8.7**	**294.4**
Average yield (Kg/ha)	4500	4000	5000	5000	4000	5000	5000	4500	4500	4000	4000	
Production	**36000**	**60000**	**60000**	**450000**	**0**	**350000**	**90000**	**189000**	**117000**	**18800**	**34800**	**1405600**
Farmers involved												
Men	53	46	12	169	0	256	83	157	83	21	7	887
Women	27	34	8	56	0	209	29	131	82	22	43	641
TOTAL	**80**	**80**	**20**	**225**	**0**	**465**	**112**	**288**	**165**	**43**	**50**	**1528**

Key: CP: Chitipa, KA: Karonga, RU: Rumphi, MZ: Mzimba, KK: Nkhotakota, SA: Salima, DA: Dowa, LL: Lilongwe, BLK: Balaka, CZ: Chiradzulu, TO: Thyolo

Annex 2. Profiles for Projects on CA and Resource Conserving Technologies

ID	Name of the Project	Implementing Agent(s)	Donor	Geographical Coverage	Farmers Targeted	Brief Description of the Project	Financial Resources Expended	Period of Implementation/ completion date	CA Principles /RCTs
1	Farm Income Diversification Program	MoAF/LRCD	EU	11 Districts; Chitipa, Karonga, Rumphi and Mzimba, Nkhotakota, Salima, Dowa, Lilongwe , Balaka, Chiradzulu and Thyolo Districts	Smallholder farmers both men and women in targeted catchments	Increase food security and income levels of rural households while ensuring sustainable use of soil and water resources by encouraging agribusiness development, employment and marketing	NA	Phase1: 2006 - 2009 Phase 11: 2010 - 2013	Minimum soil disturbance, maximum soil cover, crop mixes
2	Malawi Agroforestry Extension Project	LRCD	USAID	Five pilot sites in Dowa, Mzimba, Ntcheu, Chikhwawa, and Machinga Districts	Catchment basis; all farmers in the catchment	Testing on farm fields research proven agroforestry technologies.	NA	1992 -97	RCTs
3	ADDFOOD	Planning Division/LRCD	EU	Started in Salima ADD late expanded into six ADDs	Chronically food deficit households	A soil and water conservation and agroforestry project that targeted chronically food deficit households that issued food to farmers to avoid them spending their time working elsewhere for food.	NA	1989/90 -1995	RCTs
4	Poverty Alleviation Programme, Pilot Project Agroforestry (PAPPPA)	LRCD	EU	NA	Promotion of aagroforestry	An EU funded soil conservation and agroforestry project the precursor to PROSCARP	NA		RCTs
5	PROSCARP	LRCD	EU	11 Districts; Chitipa, Karonga, Rumphi and Mzimba, Nkhotakota, Salima, Dowa, Lilongwe , Balaka, Chiradzulu and Thyolo Districts	To reach 200,000 households in 1,180 catchment areas and conserving 295,000 ha.	The objective was the reduction of land degradation and the improvement of the nutrition and health status of smallholders through promotion of soil and water conservation technologies and promotion of crop diversification.	Eur 21.2 million	1997 -2006	RCTs & Minimum soil disturbance, maximum soil cover, crop mixes

6	ADP-ASP/ASWAp	MoAF	Multi-donor basket funding, earmarked funding and discrete funding	National wide. Four pilot districts of Karonga, Kasungu, Blantyre and Thyolo.	Both small holders and commercial farmers and the whole value chain	Prioritised and harmonised Agricultural Development Agenda addressing: Agriculture and Food Security, Irrigation and Water Development and Integrated rural development	**US$1,330.6 million**	2008/9 - 2011/112	Minimum soil disturbance, maximum soil cover, crop mixes
7	Agro forestry and Food Security Project	DAES/LRCD/ICRAF	World Agroforestry Centre	Chiradzulo, Mchinji and Kasung	3000 households by 2011	Research on CA	NA	Since 2009	CA
8	Sasakawa Global (SG) 2000	MoAFS	Sasakawa	Mzuzu; Kasungu; Salima; Lilongwe; Machinga and Blantyre ADDS	Smallholder farmers	Demonstrating increased plant population, residue management, herbicide use	NA	1998-2006	Minimum soil disturbance & maximum soil cover
9	Enhancing Food Security and Development Sustainable Rural Livelihoods	MOAF/FAO	FAO	Kasungu, Mzimba, Machinga, Balaka and Mangochi.	Stallholder farmers	NA	NA	NA	RCTs
10	Conservation Agriculture Demonstrations (OSRO/RAF/904/USA)	FAO	FAO/USAID	Chikhwawa, Nkhotakota, Balaka and Rumphi	Stallholder farmers	NA	NA	NA	CA
11	Strengthening of National Conservation Agriculture Task Force (OSRO/RAF/801/SWE)	NCATF	FAO/SIDA	National	National Conservation Task Force members	NA	NA	NA	Institutional/ Capacity building
12	Management for Adaptation of Rural Communities to Climate Change	Total LandCare	Norway	In Selected EPAs in Nkhata Bay, Nkhotakota, Ntchisi, Salima and Dowa Districts. Total area: 580,154 ha.	Overall 20,000 households, 35% women 1,000 hh targeted for CA 1,000 hh targeted for adoption of S&W conservation measures	Integrated rural livelihoods program: NRM, Farm Diversification, Irrigation, Sustainable Ag Practices, Enterprise Development	5 year total budget US$5755707	NA	RCTs/ Minimum soil disturbance & maximum soil cover
14	Rural Livelihood Support Programme	Local Government and Rural Development	IFAD	In selected TAs in Chiradzulu, Thyolo and Nsanje	NA	The programme activities aim to reduce poverty sustainably through the promotion of on-farm, off-	NA	NA	RCTs

						farm and wage-based incomes. Implemented under the national decentralization framework			
15	Community Partnerships for Sustainable Resource Management in Malawi (COMPASS) 1 and 2	Development Associates, Inc.	USAID	NA	NA	NA	COMPASS 1: US$5 million COMPASS II: US$15 million	COMPASS 1: 1999 -2004 COMPASS II: 2005- 2009	RCTs
16	Improved Forest Management for Sustainable Livelihoods Programme	Department of Forestry	EU	16 impact areas in 12 Districts across the three regions	Forest dependent communities	Improve the livelihoods of forest dependent communities through improved sustainable collaborative management of forest in forest reserves and customary land	Eur 9.0 million (Phase 1)	Phase 1: 1st Sept. 2005 – 31 Aug 2009. Phase 2: 2010 – 2013	RCTs
17	Kulera Biodiversity Project	Total LandCare	USAID	Kasungu and Nkhotakota Districts	Smallholder land users	Conservation of Protected Areas to ensure biodiversity through integrated CBNRM and interventions to improve livelihoods of communities in the border zones of targeted areas.	$ 7 million	Oct 2009-Sep 2012	CA: minimum soil disturbance, cover , herbicide use
18	Enhancing Rural Livelihoods (ENRL)	Total LandCare	Altria Group & Philip Morris	Malawi, Tanzania, Mozambique	1399 Households	Enhanced rural livelihoods through reforestation, sustainable agricultural practices, irrigation, enterprise development, water and sanitation.	$17 million	2005-13	CA: minimum soil disturbance, cover , herbicide use
19	Enhancing Food Security in Cassava based farming systems in Malawi	Total LandCare	FAO	Nkhotakota, Salima & Lilongwe Districts	Smallholder farmers	Enhance food security and incomes in Cassava Based Farming Systems in Malawi with a focus on production, value added processing and marketing.	$230,000	2007- 2010	CA: minimum soil disturbance, cover , herbicide use
20	Sustainable Enterprises and Livelihoods (SURELIVES)	Total LandCare	Altria Group	Lilongwe, Dowa, Ntchisi, Salima, Nkhotakota	Smallholder farmers	Improved livelihoods through reforestation, sustainable agricultural practices, irrigation,	$1.25 million	2006-2010	CA: minimum soil disturbance, cover ,

						enterprise development, water and sanitation			herbicide use
21	Integrated Child Labor Elimination Project (ICLEP)	Total LandCare, CRECCOM, Life-Line , Livingstonia/ Nkhoma Synods	ECLT	Dowa & Kasungu Districts	80 Households	Improving the environment of rural households to reduce child labor by improving education, food security, nutrition, incomes, sustainable farming, and NRM.,	$900,000	2002- 2010	CA: minimum soil disturbance, cover , herbicide use
22	Reforestation and Community Support Program (RCSP)	Total LandCare	Japanese Tobacco Group	Rumphi, Mzimba, Ntchisi, Mchinji;	Smallholder farmers	Enhance rural livelihoods through reforestation, sustainable agricultural practices, irrigation, enterprise development, water and sanitation	$2.2 million	2007-2010	RCTs
23	Rural Livelihoods Diversified (RLD)	Total LandCare	USAID	Rumphi, Mzimba, Ntchisi, Mchinji	Smallholder farmers	Improve rural livelihoods – food security, NRM, nutrition, health and incomes.	$840,000	2004-2008	RCTs
24	Chia Lagoon Watershed Management Project (CHIA)	Total LandCare	USAID	Nkhotakota District	Smallholder farmers	Community-Based Management of Chia Lagoon Watershed to improve rural livelihoods and incomes through the economic and sustainable use of natural resources and enterprise development	$4.7 million : $0.75 million	2004-2008	CA: minimum soil disturbance, cover , herbicide use
25	Agroforestry Partnership Project (APP)	TLC	Altria Group:	Lilongwe & Dowa	Smallholder farmers	Reforestation and irrigation to improve household food security, nutrition, incomes, and NRM.	n$605,000	2001-2006	RCTs
26	Conservation Agriculture in maize and sorghum farming systems in Malawi	Agricultural Research and Development Programme (ARDEP)	Norwegian Government	Manjawira EPA, Ntcheu	Smallholder farmers	CA demonstrations	NA	2005-2010	CA
27	Breaking the Unholy alliance of food insecurity, poverty and environmental degradation: Empowering farmers with soil, water and nutrient enhancing productivity technologies	Agricultural Research and Development Programme (ARDEP)	Norwegian Government	Chitekwere EPA, Lilongwe	Smallholder farmers	Promotion of soil, water and nutrient enhancing productivity technologies	NA	2010 - ?	RCTs
28	Msamala Environmental Rehabilitation & Livelihoods	Concern Universal, Balaka Sustainable	EU	Rivirivi EPA, GVHs Msamala,	3000 Households	An environmental rehabilitation and	€982 990	5 years (2006 – 2010)	CA : residue management,

	Improvement Project (MERLIP)	Livelihoods Program (BSLP)		Magombera and Chitala in TA Msamala, Balaka		livelihoods improvement project with output areas of community capacity development, sustainable natural resources management, agricultural diversification, agribusiness, HIV/AIDS & gender, and nutrition education.			herbicide use' minimum tillage
29	Community Based Rural Land Development Project	Ministry of Lands, Housing and Urban Development	World Bank	Four Districts; Mulanje, Thyolo, Mangochi and Machinga	15000 families to acquire land with secure tenure	Support land poor farmers from densely populated Districts in the South to acquire land and settle in other Districts with secure tenure arrangements	$27,000,000	Originally 5 years 2004 -2009. Granted a one year extension	RCTs
30	Malawi Food Security Project	World Vision (Malawi)	EU	NA	NA	NA	€ 2,999,996	24/09/2010	RCTs
31	Mkhumba Boundary Communities Livelihood Improvement Project	Concern Universal	EU, Irish aid & CU	NA	NA	NA	€ 1,173,541	31/10/2011	RCTs
32	Chingale Area Development Programme	World Vission Malawi	World Vision USA	NA	NA	NA	$2669669	9/30/2011	RCTs
33	Msamala Environmental Rehabilitation and Livelihoods Improvement project	Concern Universal	EU, Irish aid & CU	NA	NA	NA	€ 737,424	31/12/2010	RCTs
34	Enhancing Food Security and Developing Sustainable Rural Livelihoods	MoAFS	Norwegian Embassy & FAO	NA	NA	NA	NOK 30,000,000	31/07/2011	RCTs
35	Improving the Livelihoods of Malawian Smallholders	NASFAM	Norwegian Embassy			NA	NOK 80,000,000	16/02/2012	RCTs
36	Food Security and Community based Disater risk reduction mitigation project	Evangelical Association of Malawi and others	DFID & Tear Fund (UK)	NA	NA	NA	£1,400,000	30/09/2010	RCTs
37	Sustainable Rural Enterprise and Livelihood (SURELIVES)	TLC	Philip Morris International (USA)	NA	NA	NA	$608,646	30/05/2010	RCTs

38	Rainwater harvesting Project	World Vision (Malawi)	World Vision (USA)	NA	NA	NA	$90,000	30/09/2010	RCTs
39	Livelihood Security Programme	ELDS & others	OXFAM	NA	NA	NA	£4,000,000	31/12/2010	RCTs
40	Support to Vulnerable Groups to Achieve Food Security	CARE (Malawi)	EU	NA	NA	NA	€ 1,124,655	31/12/2010	RCTs
41	Kasumbe Food Security Improvement Project	Concern Universal	EU	NA	NA	NA	€ 750,000	31/12/2011	RCTs
42	Namachete ADP - Rain water Harvesting	World Vision (Malawi)	World Vision (USA)	NA	NA	NA	$143,962	30/09/2015	RCTs
43	Regional dissemination of Knowledge, information and experiences on Conservation Agriculture in Southern Africa	FAO	USAID	NA	NA	NA	$85,900	30/06/2010	Capacity building
44	NASFAM - Promoting conservation agriculture in smallholder farming systems	NASFAM	Irish Aid	NA	NA	NA	€ 150,000	31/03/2010	RCTs
45	ICRAF - Agro-forestry food security programme	ICRAF	Irish Aid	NA	NA	NA	€ 1,000,000	31/03/2010	RCTs
46	Enhancing quality of life through management of Natural Resoruces around the Mpira Dam	Africare	Malawi Environmental Endowment Trust	NA	NA	NA	MWK 7,017,500	30/08/2009	RCTs
47	Integrated Food Security Programme	Save the Children (US)	DFID	NA	NA	NA	$891,774	30/09/2008	RCTs
48	Improvement of farmers productivity and income through soil re-fertilisation in Blantyre District	Ricerca e Cooperazione and CURE	EU	NA	Blantyre District, TA Somba	To increase food security and income levels for rural households with sustainable use of soil and water resources through the enhancement of the level of soil fertility and the reduction of soil degradation	€ 811,071	31/12/2009	RCTs

Note: NA- No response or information not available

Annex 3. Farmers' Perspectives on Conservation Agriculture

MRS CHIKAZUMA LILONGWE ADD

Context

- Started CA on own initiative
- Practicing CA for 6 years now
- Cultivates 1 acre
- Uses herbicides against weeds
- Adds goat manure
- Grows only maize, no rotation or other crops
- She used to get 12 bags from all her land, but today with 1 acre she gets 18 bags with other piece of land free/fallow
- She does not have a sprayer, she rents from other farmers

Benefits

- Stable farming which generates and conserves fertility
- High yields – less weeds, less weed competition for water and
- Soil water storage improvement – crop more resilient under dry spells
- Retention of maize stover improves fertility
- No more termites
- No more witchweed
- Cheaper cropping system than conventional farming,
- Labour for weeding is exorbitant under conventional farming
- Cost under 1 acre of CA for this year was only K3,300 while the rest of her farm under CF, 1 acre, was K5,000
- She has been able to sell surplus maize and improved her income for various household uses

Source of technology

- Invited to a field day mounted by Sasakawa Global 2000, November 2004
- Was not given any start-up inputs
- Whole village was targeted but only her remains
- MONSANTO assisted her this year with 4 kg (K1400) of maize seed as a demonstration plot for their variety
- Government extension workers have assisted with advice

Achievements/ challenges

- Her whole land will be under CA from this year
- She has 4 farmers who started practicing CA with her assistance this year
- She has trained Catholic Nuns at Mtendere Mission, Dedza on the practice which they have started this year
- She now intends to install a modern maize crib
- Why others were not copying her:
  - Perception that herbicides are expensive

    - Perception that herbicides destroy the soil
    - Perception that maize crop uses more fertilizer because of planting single plant per hill

MRS KAMMWAMBA, NSALU, LILONGWE ADD
Context

- The late Mr Kamwamba, visited by late Norman Bourlag during period of Sasakawa Project
- Stopped practicing CA in 2006/07
- Used herbicides, 5 bottles/ 1 hectare of Bullet and Roundup, respectively
- Retention of maize stover
- Added cattle manure, orchard manure
- Grows other crops: burley tobacco, groundnuts, soy beans and dry beans

Source of technology

- Sasakawa Global 2000; started 2001
- Sasakawa provided inputs for one year only
- Started with 0.1 ha under Sasakawa, expanded to 2 ha in year 2
- Practiced for 4 years and stopped in 2006 after Sasakawa closed programme
- Why?
    - Cost of herbicide had increased from K720 to K1400
    - Post-season weed growth was very profuse, people were saying that the land was getting barren
- Possible that grass weed-seeds from khola manure were responsible for this growth

Benefits

- Crop withstands dry spells
- Termite damage to maize crop stopped
- Only using a portion of their maize to pay labourers
- Yield under CA was 800 bags/ 2 hectares
- Yet, under conventional farming (CF), yield has gone down to 400-500 bags/ 2 ha

Achievements/ challenges

- Only her and another farmer, an MP, were trained and supported by Sasakawa
- The MP stopped practicing CA after the initial year of Sasakawa support
- Other farmers did not adopt CA; why?
    - Perception that herbicides destroy soil
    - Lack of follow up by government extension personnel during and after Sasakawa
    - Inducements/incentives for selected farmers discouraged others who were supposed to adopt on their own

    - Considers introduction of free technology as a disincentive to adoption
- Considers farmer-to-farmer visits practiced during Sasakawa as pivotal in technology dissemination
- Conceded that CA was cheaper production method and already did consider to resume this year

MR MALAYA, TA MALIRI, LILONGWE ADD
Context

- 2006 Global Sasakawa Cup winner
- Visited by the late Norman Borlag
- Concedes that using same land that forefathers used, soil is exhausted

Source of Technology

- Sasakawa Global 2000 provided technology based on a suite comprising of single maize seed per hill, mulching and herbicide use
- In 2004, started with 0.1 ha, 1 ha in 2005, 3 ha in 2006 and presently close to 5 ha

Benefits

- Maize resilient under drought stress
- Labour demand extremely lower
- Yield higher, produces 500-620 bags on 4.4 hectares of land

Achievements

- Has acquired 4 sprayers that he hires out
- Has trained over 50 farmers (both local farmers and Lilongwe City dwellers that rent land) that are practicing chemical weed control, although not CA

Challenges

- Stover removal from field for other purposes remains a problem
    - Hires people to watch over fields towards mid-dry season when stover starts become scarce to next planting
    - Sensitization of the people through local leadership has worked
- Laments conflicting extension messages about manure making versus CA

BATUMEYO DAVIDE, MICHAEL DAVIDE, MARILIENI POLISA, DAVISONI NDODO, V.H. KAMPILA, LILONGWE ADD – FOCUS GROUP DISCUSSION
Context

- Practiced CA for 2 years then stopped; 2007/08, 2008/09

Source of Technology

- FIDP; provided inputs on loan to be repaid to a village revolving fund

Benefits

- Natural way of growing crops
- Labour-saving
- Even after stopping, alleged fears of sick soil from herbicides not there

Achievements/ challenges

- FIDP stopped support without advance notice
- Village revolving fund collapsed
- Livestock foraging on stover a main problem; sensitization by Village Headman to all subjects about preventing livestock from encroaching CA fields
- Manure making campaign provided recipe for mixed messages from government,; maize stover used for manure making
- Perception of high price of herbicides
- Decision-making on available income at time of land preparation and planting critical; farmers often decide to invest in the old practice than the new practice which requires extra monetary inputs (herbicides, hiring sprayer)

MR MAILOSI, LILONGWE ADD

Context

- Uses CA technology suite comprises of single maize seed per hill, mulching and herbicide use
- Started with ¼ acre in first year, then ½ second year of CA
- Employs mulch from maize stover and groundnut haulms
- Uses herbicides: Roundup, Harness and Bullet
- Grows other crops, paprika and groundnuts, but main income crop is maize, easy to grow and sell

Source of Technology

- Sasakawa Global 2000 provided technology and inputs for 2 years and farmers were weaned
- More than 10 farmers were trained by Sasakawa, only 5 from the old group still practicing in the area
- Reason why they left or others are not practicing CA:
    - Used to the two-year of support, dropped after being weaned
    - Perception that herbicides will destroy soil
- Sasakawa left a sprayer which he maintains and charges not more than K100 for its use

Benefits

- High yields, able to get 15 bags of maize from ¼ acre
- Is aware that if farmers buy herbicides in bulk, it is cheaper and Monsanto is able to carry to destination

Achievements /Challenges

- Taught other farmers, formed a club of 70 farmers only 23 are remaining in their first or second year of CA, loose alliance
- Weather has been a problem this year, but the crop withstood dry spells
- The CA field was disturbed by the DO at Chitekwere EPA who came dug planting pits on the CA field; came back to report that the planting pits project was not meant for the farmer
- Lack of rotation no problem;
- Farmer experienced chiwawu with material from SeedCo in 2009, changed to DK 3033
- Monsanto used the field to demonstrate their varieties in 2007/09, provided seed, fertilizer

MR MAKWINJA, DEDZA

Context

- The first Sasakawa Global 2000 farmer to practice CA
- In the 10th year of CA, uses CA technology suite comprises of single maize seed per hill, mulching and herbicide use
- Grows 1.6 ha of maize under CA, started with 0.1 ha in 1st year, 0.2 ha in 2nd year
- Employs mulch from maize stover, groundnut haulms and cattle manure
- Uses herbicides: Roundup and Bullet. Tried to use Harness this year, his perception is that it is of inferior performance compared to Bullet
- He was visited by the late Norman Bourlag

Source of Technology

- Sasakawa Global 2000 provided technology and inputs for 2 years and farmers was weaned
- Reason why others are not practicing CA:
    - Used to handouts, free things
    - Zeal to ease one's suffering differs
    - Perception that growing crops in un-tilled and unkempt fields
- Does not purchase herbicides and seeds from Agrodealers to prevent being cheated

Benefits

- Fields are on the rolling Dedza landscape prone to erosion, early conservation measures such as buffer strips did not work, but CA has stopped soil erosion
- Water is being stored in the field, soil water storage has improved
- Crop has never experienced stress from dry spell including this year where others were complaining
- He says he is an old man (80+), yet he has his own field which he grows maize, less laborious, less work, his children have their own fields

Achievements

- Kasina Mission Farm has adopted CA based on his mentorship
- His children started but stopped. They have concentrated on other crops in particular potatoes

Challenges

- High incidence of stalk borer and traces of maize streak virus this year, farmer grew SeedCo 627
- Information from AEDIC states that Dedza is prone to stalkborer, farmer practices early harvesting to avoid the pest
- Removal of maize stover by people for brewing beer big problem
- He has cattle and goats but are kept away from Ca fields through what he called "malamulo" –rules.
- Availability of herbicides at Monsanto – disappointed that Bullet runout
- Government extension workers have never bothered to visit him
- He needs advice on crop rotation
- Timing of spraying Roundup – waiting for weed emergence to spray, results in late planting, as it happened this year with erratic rains. Yet field under CA for such a long time has reduced weed incidence, could dispense with Roundup if proper advice was available at crop establishment.

Annex 4. List of Contacts

LIST OF CONTACTS

NAME	DESIGNATION	INSTITUTIONAL ADDRESS	FORMAT
Mrs Chitanje	Farmer	Mkwinda EPA	Interview
Mr Malaya	Farmer	Mpingu EPA	Interview
Mrs Kammwamba	Farmer	Kabudula EPA	Interview
Mr Mailosi	Farmer	Chitekwere EPA	Interview
Mr Makwinja	Farmer	Kaphuka EPA	Interview
Mrs Chikazuma	Farmer	Chitekwere EPA	Interview
Mr Batumeyo Davide	Farmer	Malingunde EPA	Focus Group Discussion
Mr Michael Davide	Farmer	Malingunde EPA	Focus Group Discussion
Mr Marilieni Polisa	Farmer	Malingunde EPA	Focus Group Discussion
Mr Davisoni Ndodo	Farmer	Malingunde EPA	Focus Group Discussion
Mr Kampila	Village Headman	Malingunde EPA	Focus Group Discussion
Mr J Msangambe	FAO	Machinga ADD	Briefing
Ms Kalinde	Programme Manager	Machinga ADD	Briefing
Mr A Kawejere	LRCD	Machinga ADD	Field Visit, Key Informant
Mr A F Jangiya	AEDC, Mpilisi EPA	Machinga ADD	Field Visit, Key Informant
Mr S N'goma	FAO	Machinga ADD	Key Informant
Mr P. Kapondamgaga	Chairman, National CA Task Force	Farmers Union of Malawi	Briefing
Mr J J Mussa	National CA Task Force	Director, LRCD	Briefing
Mr S Kankhande	National CA Task Force	FAO	Briefing
Mr D D Singa	National CA Task Force	Bunda College	Briefing, Key Informant
Mr Mlozi Banda	National CA Task Force	Total Land Care	Briefing
Mr P Fatch	National CA Task Force	DAES	Briefing
Ms I Ligowe	National CA Task Force	Chitedze Research Station	Briefing
Mr B Botha	National CA Task Force	Irish Aid	Briefing
Mr F Masankha	National CA Task Force	NASFAM	Briefing, Key Informant
Mr I M Chavula	National CA Task Force	Concern Universal	Briefing, Key Informant
Mr S Mkwinda	National CA Task Force	LRCD	Briefing
Mr G Kalungwe	National CA Task Force	Zodiak Broadcasting Station	Briefing
Mr A B S Singini	National CA Task Force	LRCD	Briefing
Mr W Kumwenda	FAO	Kasungu ADD	Interview
Mrs T. Msiska	EU	Lilongwe	Briefing
Dr. M. Mwinjiro	National CA Task Force	Bunda College of Agriculture	Briefing

Mr Nkunika	LRCD	Kasungu ADD	Briefing, Key Informant
Mr M Nthara	LRCD	Karonga ADD	Interview
Mr Chisuwi	Total Land Care	Kasungu ADD	Briefing, Key Informant
Dr G. Sileshi	World Agroforestry Centre	Chitedze Research Station	Interview, Key Informant
Mr J. Lupenga	AEDC	Chitsime EPA	Field Visits, Key Informant
Mr. P. Chimimba	Monsanto	Lilongwe	Key Informant
Mr M Ching'amba	Natural Resources College	Lilongwe	Key Informant
Mr. M. Phiri	District Land Resources Conservation Officer	Lilongwe District Agriculture Office	Interview
Ms. Linda Chauluka	Senior Land Resources Conservation Officer	LRCD Hqs	Interview
Mr. Simon Kwinda	Deputy Director	LRCD Hqs	Interview
Ms Kayuni	Deputy Director	DAES	Interview
Mr. E. Chagunda	Assistant District Land Resources Conservation Officer	Lilongwe District	Interviews
Mr. Nyengani	Press Supervisor	DAES	Interview
Dr. B. Chimera	Deputy Director	Livestock Development Department	Interview
Mr. Zwide Jere	Country Director	Total LandCare	Interview
Dr. Trent Bunderson	Executive Director	Total LandCare	Interview
Ms. Gertrude Kambauwa	Chief Land Resources Conservation Officer	LRCD Hqs	Interview
Ms. Kufasi Shela	Senior Land Resources Conservation Officer		Interview
Mr.Matthews Manda	Deputy Director/ FIDP Imprest Administrator	LRCD	Interview

Annex 5. Achievements on Conservation Agriculture by ADD

A. 2006/07

Sub-program / Output / activity / indicator	KRADD	MZADD	KADD	SLADD	LADD	MADD	BLADD	SVADD	National	
	No report	Achieved	Achieved	Achieved	Achieved	Achieved	chieved	Achieved	Target	Achieved
Total CA (ha)		7,517	57	268	30,311	2,074	3,419	127	22,318	43,772
3.0 Area Under Conservation Farming										
3.1 Reduced tillage										
Hectarage		588	7	136	210	19	215	1	1,514	1,177
No of male farmers involved		1,001	35	227	1,431	458	1,027	3	4,077	4,182
No of female farmers involved		353	35	58	1,094	311	978	-	2,522	2,829
Total no of farmers involved		1,354	70	285	2,525	769	2,005	3	6,599	7,011
3.2 Phased out ridging										
Hectarage		40	-		10	24	24	-	1,328	98
No of male farmers involved		104	-		59	106	76	-	2,358	345
No of female farmers involved		84	-		43	96	83	-	1,459	306
Total no of farmers involved		188	-	-	102	202	159	-	3,817	651
3.3 Use of herbicides										
Hectarage applied with herbicides		557	6	41	282	167	180	120	1,188	1,354
No of male farmers involved		2,146	9	76	760	858	835	58	4,763	4,742
No of female farmers involved		445	2	18	236	681	805	28	1,987	2,215
Total no of farmers involved		2,591	11	94	996	1,539	1,640	86	6,750	6,957
3.4 Crop residue management										
Hectarage		6,315		88	29,796	1,854	1,902	5	16,968	39,959
No of male farmers involved		6,440		144	6,615	8,216	12,056	15	86,440	33,486
No of female farmers involved		819		49	5,137	7,392	10,436	5	75,500	23,838
Total no of farmers involved		7,259	-	193	11,752	15,608	22,492	20	161,940	57,324
3.5 Pit planting										
Hectarage		17	44	3	12	10	1,098	1	1,320	1,185
No of male farmers involved		50	512	14	45	126	132	2	11,765	881
No of female farmers involved		25	269	7	27	93	207	-	3,860	628
Total no of farmers involved		75	781	21	72	219	339	2	15,625	1,509

B. 2007/98

Sub-program / Output / activity / indicator	NATIONAL	KRADD	MZADD	KADD	SLADD	LADD	MADD	BLADD	SVADD
	Target	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
3.0 AREA UNDER CONSERVATION FARMING INCREASED									
3.0 All conservation farming									
Hectarage	44,082	24,089	1,223	4,725	3,051	704	6,100	2,290	5,873	122
No of male farmers involved	161,810	57,976	1,232	5,710	8,856	1,655	19,104	3,277	17,736	406
No of female farmers involved	140,611	32,021	377	3,943	4,168	802	6,027	1,867	14,690	147
Total no of farmers involved	302,421	89,997	1,609	9,653	13,024	2,457	25,131	5,144	32,426	553
3.1 Reduced tillage									
Hectarage	2,122	2,001	143	558	65	389	49	174	609	14
No of male farmers involved	6,348	5,320	113	1,554	204	878	270	357	1,877	67
No of female farmers involved	4,311	4,269	18	782	93	281	850	332	1,886	27
Total no of farmers involved	10,659	9,589	131	2,336	297	1,159	1,120	689	3,763	94
3.2 Phased out ridging									
Hectarage	1,862	341	10	42	24	65	56	54	90	-
No of male farmers involved	6,032	511	29	32	71	71	22	87	199	-
No of female farmers involved	4,201	409	10	21	37	20	51	129	141	-
Total no of farmers involved	10,233	920	39	53	108	91	73	216	340	-
3.3 Use of herbicides									
Hectarage applied with herbicides	2,138	1,756	74	458	186	250	46	174	445	123
No of male farmers involved	7,830	5,166	286	2,387	298	700	172	357	775	191
No of female farmers involved	4,741	2,875	75	1,202	108	450	109	332	529	70
Total no of farmers involved	12,571	8,041	361	3,589	406	1,150	281	689	1,304	261
3.4 Crop residue management									
Hectarage	35,200	18,547	1,064	4,110	4	250	5,993	2,045	5,055	27
No of male farmers involved	154,090	42,670	1,067	4,084	346	700	18,154	2,801	15,424	94
No of female farmers involved	124,819	22,813	344	3,115	217	500	4,830	1,339	12,422	46
Total no of farmers involved	278,909	65,483	1,411	7,199	563	1,200	22,984	4,140	27,846	140
3.5 Pit planting									
Hectarage	4,898	3,200	6	16	2,959	0	2	18	119	81
No of male farmers involved	15,340	9,475	23	40	8,235	6	658	32	236	245
No of female farmers involved	7,280	4,530	5	25	3,821	1	296	67	241	74
Total no of farmers involved	22,620	14,005	28	65	12,056	7	954	99	477	319

C. 2008/2009

Sub-program / Output / activity / indicator	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
3.0 All conservation farming									
Hectarage	18,474	702	1,196	30	1,135	236	305	14,778	92
No of male farmers involved	32,774	2,768	4,297	255	2,031	1,162	1,110	16,857	1,247
No of female farmers involved	36,781	1,301	5,627	111	767	809	785	20,787	844
Total no of farmers involved	64,285	4,069	9,924	366	2,798	1,971	1,895	37,644	2,091
3.1 Reduced tillage									
Hectarage	1,944	478	523	8	504	107	150	147	27
No of male farmers involved	5,643	1,435	1,875	106	976	340	493	347	71
No of female farmers involved	6,551	755	4,419	51	403	179	365	365	14
Total no of farmers involved	2,194	2,190	6,294	157	1,379	519	858	712	85
3.2 Use of herbicides									
Hectarage applied with herbicides	3,047	405	1,525	158	139	289	163	291	77
No of male farmers involved	5,750	967	1,933	301	624	837	557	421	110
No of female farmers involved	3,527	419	1,360	98	290	536	279	506	39
Total no of farmers involved	9,277	1,386	3,293	399	914	1,373	836	927	149
3.3 Crop residue management									
Hectarage	16,304	190	549	-	626	119	153	14,607	60
No of male farmers involved	22,244	481	2,003	-	1,015	724	600	16,284	1,137
No of female farmers involved	23,713	240	1,066	-	348	578	411	20,253	817
Total no of farmers involved	45,957	721	3,069	-	1,363	1,302	1,011	36,537	1,954
3.4 Pit planting									
Hectarage	226	34	124	22	5	10	2	24	5
No of male farmers involved	1,840	852	419	149	40	98	17	226	39
No of female farmers involved	767	306	142	60	16	52	9	169	13
Total no of farmers involved	2,607	1,158	561	209	56	150	26	395	52

D. 2009/10

	National	KRADD	MZADD	KADD	SLADD	LADD	MADD	BLADD	SVADD
	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
3.0 All conservation farming									
Hectarage	16,028	332	6,881	402	1,366	566	3,693	2,615	173
No of male farmers involved	16,990	798	-	1,498	2,170	2,692	2,718	5,726	1,388
No of female farmers involved	20,604	429	-	880	4,480	2,709	2,900	8,274	932
Total no of farmers involved	37,594	1,227	-	2,378	6,650	5,401	5,618	14,000	2,320
3.1 Reduced tillage									
Hectarage	1,356	57	121	121	255	107	232	436	27
No of male farmers involved	4,406	154	-	639	838	340	715	1,649	71
No of female farmers involved	3,967	73	-	440	433	179	743	2,085	14
Total no of farmers involved	8,373	227	-	1,079	1,271	519	1,458	3,734	85
3.2 Use of herbicides									
Hectarage applied with herbicides	1,139	-	-	451	-	289	65	257	77
No of male farmers involved	2,497	-	-	885	-	837	135	530	110
No of female farmers involved	1,599	-	-	374	-	536	130	520	39
Total no of farmers involved	4,096	-	-	1,259	-	1,373	265	1,050	149
3.3 Crop residue management									
Hectarage	6,387	267	3,400	-	959	119	201	1,381	60
No of male farmers involved	6,003	602	-	-	517	724	738	2,285	1,137
No of female farmers involved	9,557	322	-	-	3,554	578	688	3,598	817
Total no of farmers involved	15,560	924	-	-	4,071	1,302	1,426	5,883	1,954
3.4 Pit planting									
Hectarage	609	8	360	27	32	10	123	45	5
No of male farmers involved	1,339	42	-	363	365	98	231	201	39
No of female farmers involved	868	34	-	166	193	52	193	217	13
Total no of farmers involved	2,207	76	-	529	558	150	424	418	52