ISSN 1020-4555

Integrated Crop Management Vol. 17–2012

Conservation Agriculture and Sustainable Crop Intensification

A Zimbabwe Case Study

Integrated Crop Management Vol.17-2012

Conservation Agriculture and Sustainable Crop Intensification:

A Zimbabwe Case Study

Lungowe Sepo Marongwe[1], Isaiah Nyagumbo[2], Karsto Kwazira[3], Amir Kassam[4], Theodor Friedrich[4]

[1]Conservation Agriculture Coordinator, Ministry of Agriculture, Mechanization and Irrigation Development, Harare, Zimbabwe

[2]Regional Cropping Systems Agronomist for Southern Africa, CIMMYT, Harare, Zimbabwe

[3]Assistant Crops Officer, FAO Emergency Unit, Harare, Zimbabwe

[4]Plant Production and Protection Division, FAO, Rome

PLANT PRODUCTION AND PROTECTION DIVISION
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2012

ISBN 978-92-5-107448-0

FOREWORD

Plant Production and Protection Division (AGP) in the Agriculture and Consumer Protection Department has elaborated its vision and concepts regarding sustainable crop production intensification that follows an ecosystem approach in which the enhancement of output and productivity go hand-in-hand with the delivery of ecosystem services. This is elaborated in the book *Save and Grow: The New Paradigm of Agriculture* launched by FAO in July 2011 as a policymaker's guide to the sustainable intensification of smallholder crop production.

The theme of sustainable crop production intensification is also embedded in the Objective 'A' in FAO's strategic framework for enhancing food security, alleviating poverty and addressing other global challenges such as environmental degradation and climate change. Conservation Agriculture (CA) is considered to be a core element of FAO's strategy for sustainable production intensification, and more field projects dealing with small-scale farmers are introducing CA as an essential production system base for enhancing production of crops and livestock, livelihood and quality of life.

As a result of increased demands for food due to growing population, agriculture in Sub-Saharan Africa (SSA) needs to grow by four percent per year to meet the food requirements of the growing population. The expansion of cultivated areas to compensate for low yields, exploitation of low nutrient status soils without restoration of soil fertility, changing climatic patterns including low and erratic rainfall and the lack of well-adapted technologies are identified as some of the major problems of soil fertility management in SSA. The conservation, recapitalization and maintenance of soil fertility are therefore essential to improve efficiency of input use and increase productivity.

Future food security relies not only on higher production and access to food but also on the need to address the destructive effects of current agricultural production systems on ecosystem services and increase the resilience of production systems to the effects of climate change. CA addresses the problem of low and erratic rainfall through the use of practices that reduce water losses and increase infiltration, and low soil nutrient status by increasing soil carbon and nitrogen through the use of organic soil cover and legumes in rotations and interactions. CA enables the sustainable intensification of agriculture by conserving and enhancing the quality of the soil, leading to higher yields and the protection of the local environment and ecosystem services.

This publication describes the experiences of introducing and promoting CA as a practice for sustainable crop production intensification in farming communities across Zimbabwe by various stakeholders such as the Ministry of Agriculture, NGOs, FAO, CIMMYT and ICRISAT. The case study explains the adoption process and shows the impact of CA in terms of agricultural production, environment and ecosystem services, livelihoods and other socio-economic factors. The case study is directed to policy makers, scientists and environmentalists and should help decision making towards sustainable intensification concepts for agriculture.

Shivaji Pandey
Director
Plant Production and Protection Division (AGP)

ACKNOWLEDGEMENTS

This paper is the outcome of findings from activities implemented by many stakeholders working in the area of food security who have been involved in CA work in Zimbabwe. The Department of AGRITEX in the Ministry of Agriculture, Mechanization and Irrigation Development is highly recognized for the financial and logistical support provided for data collection and availing of data from previous work.

The FAO, Zimbabwe office deserves special recognition for hosting the CATF, which has been the platform through which most of the information in this paper has been shared and for providing financial and technical support for data collection and other CA-related work to stakeholders.

The continuous efforts to promote CA in Zimbabwe by the following individuals are highly valued and recognized:

Dr. Kizito Mazvimavi (ICRISAT), for his commitment in leading the annual CA panel study surveys, whose findings form a major source of data for this paper.

Dr. Isaiah Nyagumbo, (CIMMYT), whose research work on CA in Zimbabwe has provided answers to many research questions, has contributed immensely to the information in this paper.

Dr. Christian Thierfelder, (CIMMYT) whose efforts in promoting mechanized CA have enlightened many stakeholders on the adaptability of CA to different farming sectors and has been a source of data on the performance of mechanized CA option.

The contributions of all CATF members and stakeholders, and the interactions during meetings are highly appreciated as these have provided direction for CA activities in the country and have directly and indirectly contributed to the information presented in this paper.

Valuable assistance with editing of the report by Mr. Alastair Stewart and with graphic design and formatting by Ms. Magda Morales is gratefully acknowledged.

CONTENTS

LIST OF FIGURES AND TABLES

ACRONYMS AND ABBREVIATIONS

ACT	African Conservation Tillage network
AGRITEX	Agricultural, Technical and Extension Services Department
AMID	Ministry of Agriculture, Mechanization and Irrigation Development
ARC	Agriculture Research Council
AU	African Union
CA	Conservation Agriculture
CAADP	Comprehensive African Agriculture Development Programme
CADS	Cluster Agriculture Development Services
CAPNET	Conservation Agriculture Promotion Network
CATF	Conservation Agriculture Task Force
COMESA	Common Market for Eastern and Southern Africa
Contill	Conservation Tillage
CTDT	Community Technology Development Trust
CIMMYT	International Wheat and Maize Improvement Centre
EMA	Environmental Management Agency
FAO	Food and Agriculture Organization
FCTZ	Farm Community Trust of Zimbabwe
GTZ	Germany Agency for Technical Cooperation (now GIZ)
IAE	Institute of Agricultural Engineering
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IOM	International Organization for Migration
IRCS	International Red Crescent Society
MLARR	Ministry of Lands, Agriculture and Rural Resources
NEPAD	New Partnership for African Development
NGO	Non-governmental organization
SAT	Sustainable Agriculture Trust
SSA	Sub-Saharan Africa
ZCFU	Zimbabwe Commercial Farmers' Union
ZFU	Zimbabwe Farmers Union
Zimpro	Zimbabwe Project Trust

SUMMARY

Agricultural productivity in Zimbabwe, like in many other countries in SSA has been declining over the years despite the numerous advancements made in agricultural technology development. Yield levels usually averaging below 1t ha^{-1} have resulted in persistent cereal deficits despite the large area put under production each year. Declining soil fertility, erratic precipitation patterns, high input costs and unstable market conditions have all affected the profitability and therefore the sustainability of the small holder farming sector, which provides livelihoods for the majority of the rural population.

Conservation Agriculture is increasingly being seen as a farming system that can reduce the negative impacts of some of the factors that are limiting agricultural productivity. Its component technologies of minimum soil disturbance, maintenance of organic ground cover and the use of suitable crop rotations and interactions have shown the potential to mitigate some of the production constraints experienced in the country's agricultural production. The potential for CA to reduce soil erosion and water runoff and increase economic returns in production systems have been shown by local research.

Several initiatives to increase and sustain agricultural productivity have been reported in the past and provide an important reference point for current CA programmes. The early work by Brian Oldrieve in North Eastern Zimbabwe, The Contill project by AGRITEX and GTZ from the late eighties to early nineties and the "Conservation Tillage for Sustainable Production" workshop in Harare in 1998, all provide important reference points for current CA programmes.

Current CA initiatives were initiated in the country as humanitarian intervention programmes around 2003 as a response to donor calls for the need to improve food security among communal farmers. As a result the focus of these early programmes were vulnerable farming communities, hence the concentration on manual CA systems. This approach meant that more resource-endowed households as well as other farming sectors were not catered for in the CA programmes, resulting in farmers and other stakeholders perceiving CA as a technology for the poor. Uptake of CA has been slowed through perceived high labour demands in manual CA systems and challenges in maintaining adequate mulch cover due to competition between livestock and CA fields. As a result of these challenges, many farmers in the country are unable to implement the full CA package, thereby reducing the benefits that they can derive from the system.

Continued support of CA programmes by both government and the donor community have started to yield results with farmers now seeing the benefits

of CA in terms of intensification of production through improved management (early planting, improved weed management), increased resilience to dry spells and more efficient use of both organic and inorganic fertilizers. Current statistics indicate a total of over 300,000 communal farmers implementing some components of CA over an area just above 100,000 hectares. In recognition of the increased uptake it is important for current CA programmes to recognize and address the challenges in implementing CA to enhance the benefits and increase the impact on food security at household and national scales.

CHAPTER 1

Overview of the case study

The case study has four parts as follows:

BACKGROUND AND CONTEXT

- The role of agriculture in Zimbabwe and physical characteristics of agro-ecological zones I-V.
- The link between extensification and tillage based farming to land and soil degradation.
- Erratic rainfall and high water loss leading to water stress in rain-fed farming systems.
- High cost, inaccessibility and ineffectiveness of agricultural inputs including fertilizer and pesticides.

DETAILS OF THE CASE STUDY

- Objectives of the case study.
- Objectives of the promotion of Conservation Agriculture in Zimbabwe, and approach and methodology.
- The history of Conservation Agriculture in Zimbabwe, and recent developments in areas of sustainable intensification.
- Key stakeholders involved in promoting Conservation Agriculture in Zimbabwe.

ANALYSIS

- Restoration of degraded lands and preservation of land that is still fertile.
- Increased resilience of agricultural production systems, especially from the threat of climate change.
- Increased efficiency of resources used in production.

CONCLUSION

- Review of the main outcomes of the case study.
- Barriers faced and suggestions for future up-scaling.

CHAPTER 2

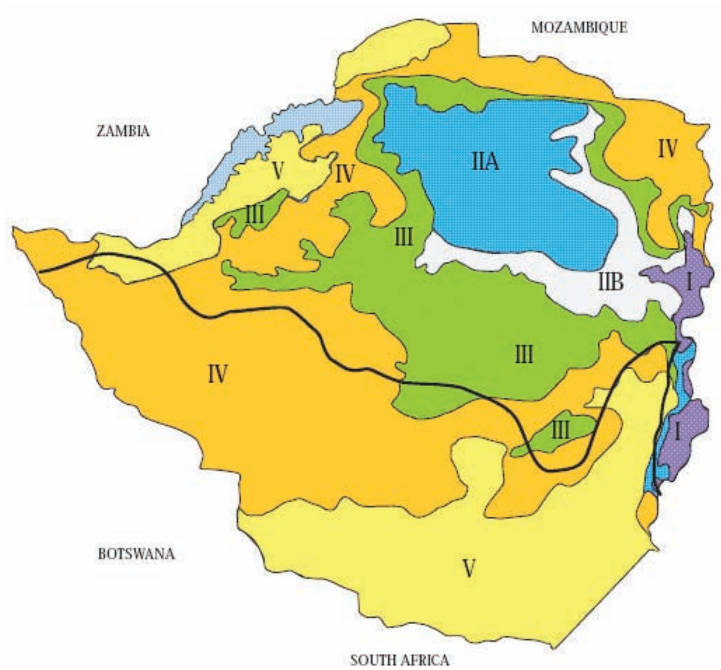
Background and context

2.1 AGRICULTURAL PRODUCTION IN ZIMBABWE

Zimbabwe has a diversified agriculture sector with 11 to 20 percent of the country's annual gross domestic product being generated by agriculture as well as 45 percent of exports. Over 70 percent of the population directly and indirectly depend upon agriculture for employment and among those who are directly linked to farming about 75 percent rely on rainfed farming systems. The agricultural sector is composed of large scale commercial farming and small scale farmers, with the latter occupying more land area but located in regions where land is less fertile with more unreliable rainfall. Zimbabwe is a tropical country which generally experiences a dry savannah climate. There are a range of notable micro climates within the country that make it possible to divide the country into five agro-ecological zones known as Natural Regions I to V (Figure 1). These are classified with regard to rainfall amounts, temperature and soil types (Table 1) (Vincent and Thomas, 1962).

FIGURE 1

Map of Zimbabwe showing Natural Regions I-V



Source: ZCATF (2009)

TABLE 1
Physical characteristics of Natural regions I-V in Zimbabwe

Natural Region	Soil type	Average annual rainfall (mm)	Rainy season	Number of growing days
I	Red clay	1000+	Rain in all months of the year, relatively low temperatures	170-200
II	Sandy loams	750-1,000	Rainfall confined to summer: October/November to March/April	120-170
III	Sandy, acid, low fertility	650-800	Relatively high temperatures and infrequent, heavy falls of rain, and subject to seasonal droughts and severe mid-season dry spells	60-120
IV	Sandy, acid	450-650	Rainfall subject to frecuent seasonal droughts and severe dry spells during the rainy season	60-120
V	Sandy, infertile	>450 mm	Very erratic rainfall. Northern low veldt may have more rain but the topography and soils are poor	>70-135

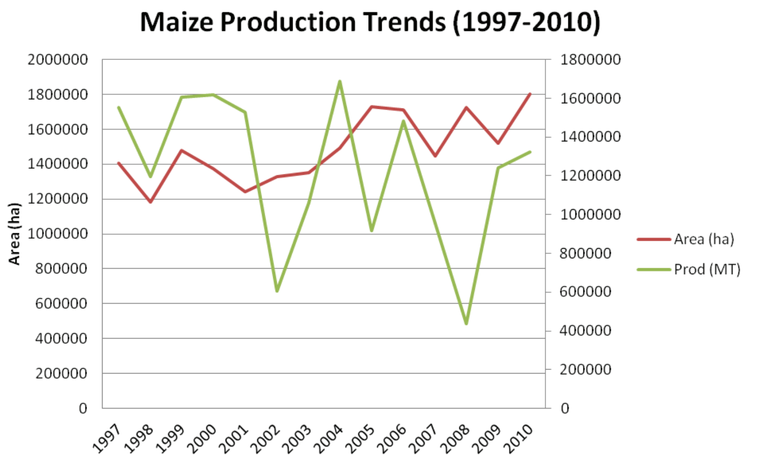
Source: ZCATF (2009); Vincent and Thomas (1962)

Large scale commercial farmers generally focus on export production whereas the small scale farmers are the major food producers and account for over 80 percent of staple crop production (Moyo, 2005). The agriculture system is highly diversified with the production of a wide range of crops and livestock. Crops include maize, tobacco, cotton, a variety of horticultural crops, coffee, tea, groundnut, soybean, barley, wheat and livestock. Over the years there has been a decline in crop productivity that is strongly associated with rainfall deficits and reduced soil fertility.

2.2 SOIL AND LAND DEGRADATION

The expansion of cultivated areas to compensate for declining yields and the lack of well-adapted agricultural technologies are identified as major factors in declining soil fertility in SSA (FAO, 2001; Marongwe *et al.*, 2010). The higher population densities in the low potential areas as a result of population growth, diminishing land base and lack of employment opportunities have increased the use of marginal lands which has futher increased the rates of land degradation (Mahretu and Mutambirwa, 2006). Current evidence continues to show declining cereal crop yields over the years, with annual averages not exceeding 1 t h^{-1}, despite the large areas that are planted each year (Figure 2). The resulting low yield levels in the smallholder farming sector impact on food availability at national level as smallholder farmers produce over 60 percent of national maize production. The conservation and maintenance of soil fertility is therefore essential to increase and sustain productivity (FAO, 2001) whilst maintaining focus on increasing yields per unit area.

FIGURE 2
Total production (metric tonnes) and area planted (hectare) for the main staple cereal in Zimbabwe



Source: Adapted from Ministry of Agriculture, Mechanization and Irrigation Development (2010)

2.3 WATER STRESS

Annual rainfall in Zimbabwe is between 450mm and 1500mm but more than 60 percent of the country is situated in Natural Agro-Ecological Regions IV and V, which are characterized by low rainfall (below 650 mm) and poor soil fertility (Table 1). Though theoretically sufficient, this rainfall is not capable of sustaining crop growth over the growing season as much of the precipitation falls over a short period of time (Dennett, 1987). High water loss in rain-fed agriculture results in only 10-30 percent of seasonal rainfall being used productively and up to 50 percent lost as non-productive evaporation (Falkenmark and Rockstrom, 2005). Low moisture content within the soil means that the crops have very little moisture reserves to tap from during prolonged dry spells, leading to increased incidence of crop failure.

CHAPTER 3

Details of the case study

3.1 OBJECTIVES OF THE CASE STUDY

This case study reviews the development of Conservation Agriculture (CA) in Zimbabwe as a whole and discusses the approaches used in the efforts to promote sustainable agriculture practices. The study shares the experiences of CA farmers in Zimbabwe, the challenges that have been experienced and proposes ways of addressing such challenges. To show the impact of sustainable crop production intensification on the ground, the study will give examples of farmers in parts of the country where CA has spread rapidly after a few years of introducing the technology to farmers.

3.2 OBJECTIVES OF THE PROMOTION OF CA IN ZIMBABWE

The main objective of promoting CA in Zimbabwe is to contribute to food security, improve profitability of agriculture and enhance the economic wellbeing of communities dependent on agriculture. This is expected to be achieved through:

- Restoration of degraded lands and preservation of land that is still fertile;
- Increased resilience of agricultural production systems, especially from the threat of climate change;
- Increased efficiency of resources used in production.

Activities involved working directly with farming communities, coordinating the activities of stakeholders and advocating for the increased promotion of CA through interaction with policy makers in order to institutionalize CA and increase and sustain its uptake.

3.3 APPROACH AND METHODOLOGY

The information used is based on data from surveys implemented by various stakeholders promoting conservation agriculture across the country. Annual Government reports from crop and livestock surveys carried out by the Ministry of Agriculture, Mechanization, and Irrigation Development have been a major source of data. Results from a national CA inventory carried out by Government in November 2011 provide the latest statistics in this report. Research findings from CIMMYT, ICRISAT, AMID and reports from an annual CA Panel Study implemented by ICRISAT in collaboration with the FAO and other stakeholders have also been used. Routine M&E reports from surveys implemented by FAO and shared through the Conservation Agriculture Task Force have all been important sources of data.

The sustainable agriculture initiatives discussed in this study include the early efforts to promote conservation tillage in North-eastern Zimbabwe by Brian Oldrieve; the Contill Project led by the Institute of Agricultural Engineering in the late eighties to early nineties; the Conservation Tillage for Sustainable Agriculture initiative and the current Conservation Agriculture Programme as promoted in Zimbabwe since 2004. The case study tries to analyse the development of CA in Zimbabwe and evaluate approaches used with the view of learning lessons that can be used in current and future programmes to improve impact of sustainable crop production initiatives.

3.4 CONSERVATION AGRICULTURE IN ZIMBABWE

Conservation Agriculture aims at increasing agricultural productivity per unit area allowing farmers to produce more from a smaller area, increase profitability and leave more land under natural vegetation, contributing to environmental sustainability (Marongwe *et al.*, 2010). CA addresses a wide range of agricultural production challenges that include declining soil fertility, increasing production costs, climate induced erratic rainfall patterns and increased demand for food production against severely reduced production capacities of agricultural lands. Three major principles are promoted in CA systems: minimum mechanical soil disturbance, maintenance of soil organic cover, and the use of crop rotations and associations that are suited to local environments.

The beginnings of the non-tillage approach in Zimbabwe can be traced back to the establishment of no-ploughing trials in tobacco in the 1920s. Increased land degradation, soil fertility decline and the high cost of diesel and spare parts as a result of the sanctions imposed on the Northern Rhodesian government accelerated the demand for reduced tillage equipment in the commercial farming sector (Smith, 1988). The demand continued to grow such that after Independence in 1980 and before the Land Reform programme, it was estimated that up to 30 percent of the commercial farmers in Zimbabwe were using conservation tillage systems (Nyagumbo, 1998).

CA in the form of Conservation Farming basins was first implemented in Musana communal lands in the North-eastern part of the country by Brian Oldrieve. During these years of implementation, the farm and the surrounding areas were able to increase yields and reduce soil erosion (Oldrieve, 1993) which led to the components of reduced tillage and 30 percent mulch retention being promoted to the smallholder and the commercial farming sector, through the production of conservation tillage hand books.

Conservation Tillage for Sustainable Crop Production Systems, also known as the Contill Project, was a collaborative project between AGRITEX and GTZ implemented from 1988 to 1996 with the aim of developing a number of tillage techniques to address problems related to soil loss, water run-off, and declining yields (Vogel, 1992). The project tested three reduced tillage systems (mulch ripping, clean ripping, and tied ridging) against two traditional systems (mould board ploughing and hand hoe holing out) on two research sites; one in the high rainfall areas of Northern Zimbabwe and the other in the low rainfall areas of Southern Zimbabwe. On-farm trials were also set up to allow farmers to choose from the several tillage options that were being tested. After five seasons of research, Moyo and Hagman (1994) concluded that mulch ripping with its higher water-use efficiency appeared to be the most viable conservation tillage treatment in the semi-arid areas of Zimbabwe.

However, numerous on-station and on-farm research activities on conservation tillage and erosion by the Institute of Agricultural Engineering (IAE), Agricultural Research Trust Farm (ART Farm) and Henderson Research Station had failed to see any significant uptake of conservation tillage technologies by the smallholder farming sector in Zimbabwe. In 1998, an International workshop on Conservation Tillage for Sustainable Agriculture was convened in Harare, Zimbabwe by FAO, GTZ, ARC South Africa, FARMESA and ZFU. The overall objectives of the workshop were to enhance the adoption of conservation tillage through the exchange of existing knowledge and by the initiation of partnerships between national and regional stakeholders (Benites *et al.*, 1998; Nyagumbo, 2008). The first part of the workshop had the following objectives:

- To establish an inventory of the technologies and approaches in use in different regions and countries.
- To identify factors contributing to the success and failure of conservation tillage adoption.
- To determine methods whereby conservation tillage options can be successfully disseminated.
- To come up with national and regional action plans.

The second part of the workshop addressed specifically the development of international guidelines for environmentally sound tillage practices for the protection of the soil. The most significant outcome of the workshop was the formation of the African Conservation Tillage (ACT) Network in 1998. The objectives of the network are:

- To create fora for, and stimulate the sharing and exchange of information and experiences among researchers, extensionists and practitioners and encourage farmers to apply methods of soil and water conservation that are environmentally sound and economically viable;
- Encourage the formation of national networks to promote an institutional and policy environment conducive for the dissemination and implementation of conservation tillage practices.

Initially with offices in Eastern and Southern African regions, ACT now operates an additional office in West Africa and has initiated and implemented regional training programmes which target trainers who are then expected to cascade the training.

3.5 RECENT CONSERVATION AGRICULTURE DEVELOPMENTS

Renewed efforts to promote Conservation Agriculture as it is defined today (see: fao.org/ag/ca) were initiated in Zimbabwe in 2003, after substantial donor funding targeting improved food security for vulnerable households. Three components were now being promoted: minimum mechanical soil disturbance, maintenance of soil cover with organic materials and diversifying crop rotations/sequencing or associations adapted to local environments (Figure 3). It is important to note that these initial efforts largely focused on the use of manual systems and left out the mechanized forms of CA mainly because the donor funds involved were meant to target only those communities considered to be vulnerable due to lack of access to draft power, labour, and those affected by chronic illnesses including HIV/AIDS. A local faith-based organization, Foundations for Farming, has been the major training agent and recently government departments have started conducting training sessions. The training offered by Foundations for Farming focused exclusively on hand-hoe based systems meaning that the extension workers trained (over 2,000) between 2004 and 2008 were only exposed to manual hand hoe-based CA systems. This has however changed with massive importation of CA machinery into the country and initiatives to encourage local production of CA machinery. The private sector has participated in research and

FIGURE 3
Conservation Agriculture in action in Zimbabwe

Source: The Ministry of Agriculture, Mechanization and Irrigation Development, Harare, Zimbabwe development of CA machinery and have led to the development of proto types (Jab planters, rippers, and direct seeders, herbicide sprayers, hoes,) by HASST Zimbabwe, AGVENTURE, ZIMPLOW and GROWNET.

Increased involvement by government saw the launch of the Conservation Agriculture Promotion Network (CAPNET) in 2008 which brought together different government departments and ministries (Ministry of Agriculture, 2008). The CAPNET membership included the Departments of Research, Extension, Agricultural Education and Farmer Training, and Mechanization in the Ministry of Agriculture. The Environmental Management Agency (EMA) from the Ministry of Environment, the Ministry of Education and the Zimbabwe Farmers Union were also represented in the network. Due to lack of resources within government departments and to avoid parallel efforts, CAPNET has since been absorbed into the main CA Task Force.

In 2010, two CA reviews were commissioned by COMESA and the FAO with the aim of reviewing the status of CA in Zimbabwe and coming up with a national framework for implementation in order to improve the impact of CA technologies. Major challenges identified included the:

- Absence of a comprehensive National Implementation Framework to guide implementing agencies;
- Focus on manual CA systems which are labour demanding;
- Limited involvement by government at district, and provincial level;
- Sector approach which has seen major farming sectors left out; and
- Limited involvement of the private sector in CA programmes which has slowed the development of CA machinery.

The major output of the workshop was a commitment to develop a compressive National CA Implementation Framework for Zimbabwe to guide CA implementation by various stakeholders, who agreed on a target of at least 500,000 farmers practicing CA on at least 250,000 hectares by 2015, with the doubling of yield on CA fields in comparison to conventional fields (Ministry of Agriculture, Mechanization and Irrigation Development, 2010).

Increased interest by the Zimbabwean government has seen budget allocations for CA for the first time during the 2010/2011 agricultural season and these allocations have been confirmed for the next three years. The governments' extension department (AGRITEX) has set up CA demonstrations across the country and CA issues have been included in the annual National Crop and Livestock Assessment. A CA module for colleges delivering the Diploma in Agriculture was launched in October 2010. This will ensure that all students graduating from these colleges will have been introduced to CA and many of these students will later join the agricultural extension department. As well as policy support from national programmes, CA has also seen increased policy support from regional initiatives, like the AU-CAADP programme, in which the first and third pillar focusing on sustainable land and water management and increasing food supply and reducing hunger (NEPAD, 2003) have provided an important entry point for CA.

3.6 KEY STAKEHOLDERS

Key stakeholders involved in the promotion of CA in Zimbabwe are shown in Table 2. Farmers constitute the main beneficiary stakeholders, and the case of a CA field of a farmer, Mr. Mafusine, in the Bikita District is outlined in Box 1.

TABLE 2
Stakeholders involved in the promotion of CA in Zimbabwe

1	AMID	21	GTZ
2	Christian CARE	22	ACF
3	CARE INTERNATIONAL	23	ACT
4	CAFOD	24	ADMA
5	CONCERN WORLD WIDE	25	ZIMPLOW
6	CRS	26	GROWNET INVESTMENTS
7	FCTZ	27	World Vision
8	CTDT	28	Lead Trust
9	DABANE TRUST	29	ZCFU
10	ICRISAT	30	CADS
11	GAA	31	HELP GERMANY
12	ZIMPRO	32	University of Zimbabwe
13	Action AID	33	IRCS
14	FOUNDATIONS FOR FARMING	34	IOM
15	GOAL ZIMBABWE	35	DP Foundation
16	CIMMYT	36	Midlands State University
17	Ministry of Education	37	Ministry of Gender
18	Ministry of Environment	38	Africa University
19	ZFU	39	HASTT ZIMBABWE
20	SAT		

BOX 1

A HOMESTEAD CA FIELD OF MR. MAFUSIRE, BIKITA DISTRICT, MASVINGO

Mr. Mafusire started using manual planting basins in 1980 after he lost all his livestock due to disease. However, he received very little information pertaining to CA from the local extension system. In recent years, increased information from both NGO and government extension has seen him improve his yield. He harvested 18 x 50 kg bags of maize from his 0.1 hectare field during the 2010/2011 agricultural season. This translates to 9 t ha^{-1}. Mr. Mafusire no longer digs planting basins but has now devised his own direct planting method, using a three-legged metal implement that marks three planting holes in each planting station. The use of a protected homestead field by this farmer allows him to keep adequate soil cover in his CA field as opposed to the use of unprotected fields, away from the homesteads.

CHAPTER 4
Analysis

The objective of Conservation Agriculture for food security, profitability and economic wellbeing of communities dependent on agriculture can be achieved through focusing on the sub-objectives of:

- Restoration of degraded lands and preservation of land that is still fertile;
- Increased resilience of agricultural production systems, especially from the threat of climate change;
- Increased efficiency of resources used in production.

These sub-objectives form the basis of the analysis section and will be explored using evidence from the activities and programmes described in the previous chapter.

4.1 RESTORATION OF DEGRADED LANDS

Environmental benefits have become evident from the application of CA techniques. Lower bulk density of 1.41g cm^{-3} were observed in CA fields in Musana communal lands compared to 1.5g cm^{-3} in non CA fields (Nyagumbo *et al.*, 2009). The same author also found higher organic matter content in CA fields (0.61 percent), compared to 0.40 percent in conventional fields. Mulch ripping treatment is one CA option practiced in Zimbabwe that has a lower cumulative soil loss compared to the other treatments of conventional tillage, clean ripping, and the hand hoe (Nyagumbo, 1998). CA has also been proven to reduce water runoff and increase infiltration rates (Table 3).

TABLE 3
Reduction in seasonal water runoff in CA systems

Tillage System	Five year means as % of rainfall	
	Seasonal run-off	Seasonal infiltration
Conventional tillage	20%	80%
Conservation Agriculture	1%	99%

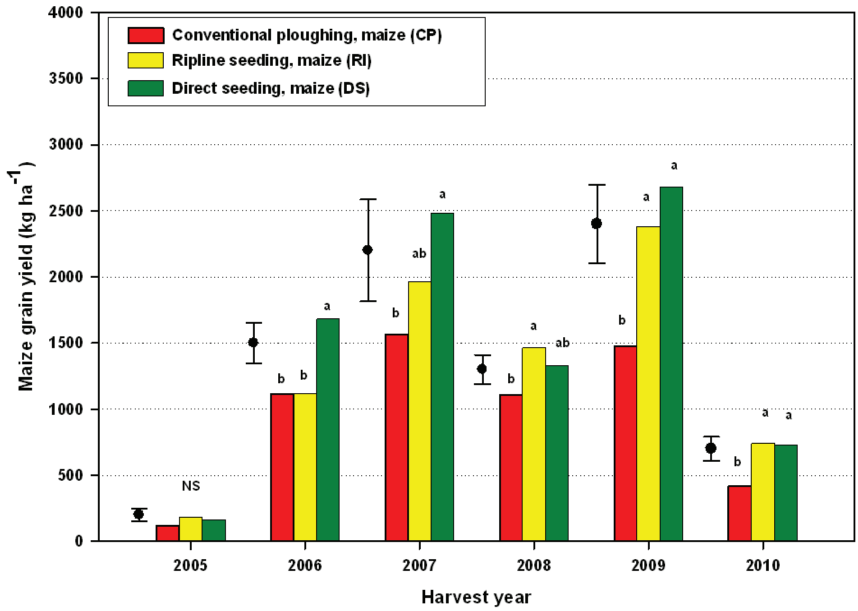
Source: Nyagumbo (1998)

4.2 INCREASED RESILIENCE OF AGRICULTURAL PRODUCTION SYSTEMS

Local research and farmer perception has proven increased yield levels of the main cereal staple crops under CA systems compared with conventional ploughing. Mean maize yields of crops under CA on sandveld soils in Zimuto communal lands in southern Zimbabwe have shown increases up to about 1 t ha^{-1} (Figure 4). Average yield increases from 0.8 t ha^{-1} in 2006 to 3.7 t ha^{-1} in 2007 were also observed by Nyagumbo *et al.* (2009) compared to a national average of 0.4 t ha^{-1} that year. The observed yield benefits of CA have resulted in the technology spreading across the whole country, although farmers have maintained parts of their farms under CA citing labour constraints for preparing planting basins, and in some cases for weeding (Figure 5). These constraints can be overcome when planting basins are prepared early before the onset of the rains to spread the labour smaller planting pits are used, or when animal-drawn or tractor-drawn direct seeders are used. An integrated weed management approach that includes use of adequate mulch covers, effective use of cover crops, and the appropiate use of herbicides can also reduce the labour required for weeding and enable farmers to put larger areas under CA when mulch cover and cover crops are used effectively to control weeds.

FIGURE 4

Mean average maize yields at Chikato School, Zimuto communal lands, Masvingo



Source: Thierfelder and Wall (2011)

According to survey reports from the Ministry of Agriculture, the total number of farmers practicing CA options during the 2010/2011 agricultural seasons, has increased tremendously, with a significant proportion implementing CA without any input support (Table 4) showing increasing appreciation of CA benefits by farmers in the country. Although the total number 372 000 constitutes about one third of the communal farmers who grow most of the staple food, the area (141 334 ha) only constituted (2001) about 5 percent of area planted to maize during that year. However, farmers still face challenges in maintaining adequate ground cover due to the communal grazing systems that are observed in most areas and high labour demands of hand-based CA systems for land preparation and weed management.

FIGURE 5
Planting basins

TABLE 4
Number of farmers and area of land dedicated to CA

	With Input Support	Without Input Support	Total
Number of farmers	232,465	139,735	372,200
Area (Ha)	84,893	56,441	141,334

Source: Ministry of Agriculture Mechanization and Irrigation Development, CA Status Report, January, 2012

The intensification resulting from precise application of organic and inorganic fertilizers in planting basins, the comparatively early planting achieved by CA farmers and the increased resilience to dry spells of CA fields due to mulch cover have resulted in most CA farmers increasing their maize production from relatively small areas. This observation has encouraged many farmers to adopt manual CA systems on their own accord without any input support from donor funded programmes. These farmers are realizing the possibility of attaining adequate production levels from very small areas as opposed to the traditionally accepted practice of extensification, where farmers put large areas of land under cropping resulting in poor management of the fields due to inadequate labour and fertilizers.

One of the major challenges in implementing CA in the low rainfall areas of Zimbabwe has been the maintenance of soil mulch cover. This is especially difficult for farmers implementing CA over large areas and on fields that are unprotected from free roaming livestock (Figure 5). Results from the 2010 CA panel study show that, the major reason for farmers not maintaining crop residues is that they are used as livestock feed (Table 5).

TABLE 5
Reasons for not applying crop residues as mulch

Reasons	%
Gave residues to livestock	31.2
Crop residues destroyed/burned	18.5
Labour constraints	17.0
Did not practice CA this season	17.0
Lack of knowledge	16.3
Burnt weeds and crop residues	1.5

Source: Mazvimavi *et al.* (2010)

According to the 2010, CA Panel Study (Mazvimavi *et al.*, 2010), only 56 percent of the farmers surveyed rotated their crops (Table 6). Cereals crops, which are the staple food, are normally planted on the homestead plot for easier monitoring and are usually used for CA as they are often protected from livestock with fencing.

TABLE 6
Reasons for not rotating crops in CA fields

Reasons	%
Yet to practice. Just started CF practice	32.2
Prefer cereals to legume, cereal is staple crop	30.6
Lack of knowledge	17.0
Lack of alternative seed for rotation	10.7
Did not practice CA this season	6.5
Changed plot	1.5
CA spacing not suitable for legumes	1.5

Source: Mazvimavi *et al.* (2010)

4.3 INCREASED EFFICIENCY OF RESOURCES USED IN PRODUCTION

The intensive promotion of CA in Zimbabwe was initially characterized by the supply of fertilizer and seed to those farmers who were selected to participate in CA programmes. This approach has affected farmers' perception on the source of the benefits of adopting CA, exacerbated by the critical shortage of farming inputs in Zimbabwe meaning farmers not implementing CA had little access to farm inputs and therefore extremely low crop yields, whereas those farmers implementing CA had access to inputs from donor programmes and generally attained higher yields. This targeting of vulnerable households by most implementing agencies and the exclusive promotion of manual CA systems created a perception that CA is a technology meant for the poor (Ministry of Agriculture, Mechanization and Irrigation Development, 2007).

During the 2010/2011 agricultural season a CA equipment evaluation programme was initiated by the FAO Zimbabwe office to identify suitable machinery for local conditions (Table 7). Major highlights from these evaluations included the need for training for both the extension staff and the animals that are used for draft power. Challenges in working with ungraded seed were also experienced as many companies sell ungraded seed which is not uniform in size and shape therefore affecting the seeds movement through the direct seeders. Some farmers in the evaluation have preferred to use jab planters for application of top dressing fertilizer in CA fields but identified the clogging of the holes, especially in wet soils as a major problem. However, some of these problems may be related to inadequate capacities among the farmers and extension agents, hence the need for training in the use of CA machinery (FAO, 2011a).

TABLE 7
Equipment evaluated during 2010/11 agricultural season

Type of CA Equipment	Quantity
Animal- drawn rippers	100
Tractor- drawn rippers	2
Jab planters	200
Animal-drawn direct seeders	90

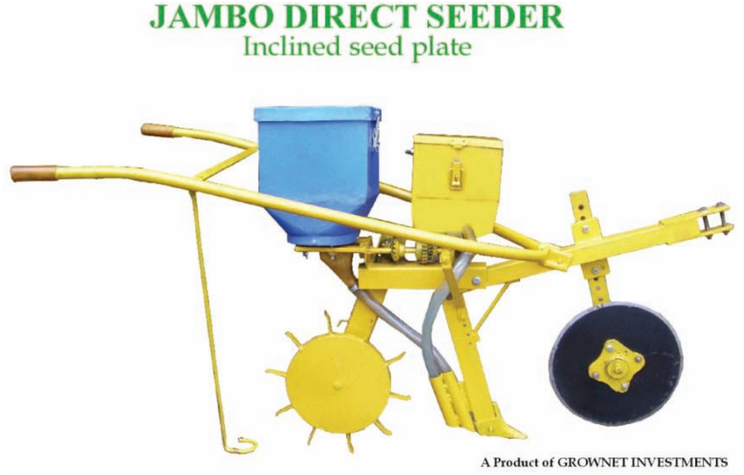
Source: FAO (2011a)

Despite the inadequacies in capacity as a result of limited training, evaluations have been very successful with the adaptation of existing machinery, i.e., the addition of a cutting disc to enable planting in mulch-covered fields to a conventional planter (Figure 6), by the Institute of Agricultural Engineering (IAE) and Zimplow, a private company. The successful adaptation of an imported CA direct seeder to suit local conditions by a local engineering company, GROWNET, is one of the major outcomes of the evaluation process while the new Jambo direct seeder has an inclined seed plate to facilitate easier seed movements, metal drive gears to enhance durability, and a narrower ripper tine tip which reduces the amount of draft power that is required for ripping (Figure 7) (FAO, 2011a).

FIGURE 6
A conventional planter which has been adapted to CA through the addition of a cutting disc

Source: Ministry of Agriculture, Mechanization, and Irrigation Development (2011)

FIGURE 7
A direct seeder produced by GROWNET, based on local evaluation of a Brazilian direct seeder



Source: GROWNET Investments (2011)

Cost benefit analysis indicates better gross margins per hectare in CA systems, with increased productivity related to length of time since adoption, the adoption of the full CA package and being situated in high potential regions (Mutiro *et al.*, 2011). Despite challenges experienced in CA systems, the higher gross margins in CA systems still make CA a viable option for smallholder farmers. A socio-economic analysis of CA in Zimbabwe by

FAO, indicated a higher production cost for CA systems in the initial years of implementation but the higher yields obtained made the production per unit input cheaper than the conventional system (Table 8) (FAO, 2011b).

TABLE 8
Comparisons of gross margins for CA and conventional farmer practice

	CA system	Conventional farmer practice
Cost of producing 1 ton of maize	US$146 in the first three years, US$126 per ton for more experienced farmers	US$239 per ton
Returns per labour hour	10.4 US cents for the inexperienced CA farmer 15.7 US cents for the more experienced farmer	9.8 US cents
Returns to fertilizer use	79 US cents per dollar invested	7 US cents per dollar invested

Source: Adapted from Mutiro *et al.* (2011)

High labour requirements for digging planting basins, weeding and sourcing mulch have been cited by many communal farmers implementing manual CA systems as a major deterrent (Mazvimavi *et al.*, 2010). As a response to these issues, many CA farmers are concentrating on small areas, however, some households within villages work in groups when undertaking labour intensive activities such as digging planting basins (FAO, 2011). Efforts to extend the impact of CA to reflect at national level are ongoing through the promotion of mechanized CA options. Several training programmes on the use of CA machinery were initiated last year by the Ministry of Agriculture, FAO and other stakeholders involved in CA up-scaling efforts in the country.

CHAPTER 5
Conclusion

As a result of increased demands for food due to growing population, agriculture in SSA needs to grow by 4 percent per year to meet current food requirements (FAO, 2001). The expansion of cultivated areas to compensate for low yields, exploitation of soils without restoration of soil fertility, changing climatic patterns and the lack of well-adapted technologies have been identified as some of the major problems of soil fertility management in SSA. The conservation, recapitalization and maintenance of soil fertility are therefore essential to improve efficiency of input use and increase productivity (FAO, 2001).

Available evidence shows continuously declining cereal crop yields during the past decade despite the large areas that are planted each year and this can be attributed to the major constraints of low and erratic rainfall, inherently low soil nutrient status, limited inputs and lack of appropriate technologies (Van Engelen *et al.*, 2004). It is therefore important to note that intensification of crop production systems should aim at increasing crop productivity per unit area through the use of technologies that address moisture management issues, increase the efficiency with which both external and natural recourses are used, while maintaining and improving soil fertility.

CA addresses the problem of low and erratic rainfall through the use of technologies that reduce water losses from runoff and soil evaporation and increase infiltration and soil moisture holding capacity, and improve low soil nutrient status by increasing soil carbon and nitrogen through the use of organic soil cover and legumes in rotations and interactions (Marongwe *et al.*, 2010). The precise application of fertilizers increases the efficiency at which fertilizers are used. It is evident from the case study that stakeholders in Zimbabwe have realized the benefits of CA. Challenges in residue availability in mulch-ripped CA systems and high labour demands for weeding in hand based systems were identified in the Contill Project, which concluded in 1998. Limited lesson learning and lack of reference to these earlier findings by the current CA programmes may have slowed down the adoption rate of similar systems. There is therefore need for current programmes to make reference to previous work and not to "re-invent the wheel" as this will result in programmes that are more responsive to the client, in this case the farmer. Current programme designs need to address the livestock-crop conflict in CA residue management through the inclusion of fodder production and other alternative livestock feeds and appropriate attention to labour issues in manual

CA systems. Despite these challenges, farmers have realized the benefits from the intensification of production that is achieved through implementing CA.

BENEFITS AND CHALLENGES OF IMPLEMENTING CA AS PERCEIVED BY FARMERS IN WARD 14, MASVINGO DISTRICT, SOUTHERN ZIMBABWE

Benefits

- Better yields and improved food security.
- Timely planting since there is no longer need to wait for hired draft (for farmers without draft animals).
- CA saves on inputs, particularly fertilizer and manure since the inputs are placed precisely near to the plant roots, resulting in lower requirements.

Constraints and challenges

- Manual CA systems (digging planting basins) is labour intensive
- Appling manure and multiple weeding (including winter weeding) is also laborious
- The hoe that is appropriate for basin digging is very heavy

Early operations

- Since CA fields are prepared early, they are also planted before the conventional fields. At this time, animal restriction arrangements may not yet be in place, leading to CA crop damage by the uncontrolled animals.
- Winter weeding competes with other household chores that farmers might need to do during the pre-planting season.

Crop residue problems

- The presence of crop residues causes termite infestation on the field
- Leaving crop residues in the field compromises the cattle's feed.
- Leaving crop residues on the fields leads to field invasions by cattle and the cattle trample on the crops. There is therefore need for fencing of the CA plots, but the farmers do not have adequate fencing material.

Despite the challenges in manual CA systems, some communal farmers outside NGO programmes have adopted CA indicating that farmers are seeing the benefits and are not exclusively influenced by the input support associated with many CA donor programmes (Figure 8). According to a post harvest survey by FAO, 64.9 percent of all input beneficiaries and 17.3 percent of non-beneficiaries were practicing CA. Out of all the households practicing CA, 13 percent were practicing CA exclusively, i.e. on all their fields (FAO, 2011b). Zimbabwean farmers are slowly realizing the benefits of implementing CA, as communal farmers who are the most affected by food insecurity begin to intensify their production systems. The cultivation of extensive fields traditionally reflects high status and it therefore takes a lot of courage and conviction for farmers to concentrate their production resources on smaller areas. In the future it is important to address the challenges that are limiting the expansion of CA area in the country. The farming systems in Zimbabwe are mostly mixed crop-livestock systems so methods of integrating CA with livestock should be sought through consultations with farmers.

A value chain approach should be used to ensure sustainability and profitability for the CA farmer. Future CA programmes should include commercial crops and develop market linkages for CA farmers to ensure markets for the farmer's crop. Most CA programmes have focused on maize but farmers have cited the unavailability of markets and unfavourable prices for their harvested crop. Value addition is an aspect that could increase adoption if included in CA programmes.

FIGURE 8
A well managed CA field in Manicaland, Eastern Zimbabwe

Source: Ministry of Agriculture, Mechanization and Irrigation Development, Zimbabwe.

References

Benites, J., Chuma, E., Fowler, R., Kienzle, J., Mapolang, K., Manu, J., Nyagumbo, I., Steiner, K. and van Veenhuizen, R. (eds) (1998). *Conservation tillage for sustainable agriculture*, Proceedings from an International Workshop, Harare, 22–27 June, Part 1 (Workshop Report).

Dennet, M.D. (1987). *Variation in rainfall- the background to soil and water management in dry land regions*. Journal of Soil Use and Management **3**, 47-51.

Falkenmark, M. & Rockstrom J. (2005). *The New Blue and Green Water Paradigm*. Editorial, SIWI, SEI.

FAO (2001). *Soil Fertility Management in Support of Food Security in sub-Saharan* Africa pp 1, 2, 11. Rome.

FAO (2011a). *CATF Presentation on machinery evaluation updates*, FAO, Harare, Zimbabwe, 15th April, 2011.

FAO (2011b). *Socio-Economic Analysis of Conservation Agriculture in Southern Africa*. Network paper No.2 FAO Regional Emergency Office for Southern Africa (REOSA).

Marongwe, L.S., Kwazira, K., Jenrich, M., Thierfelder C., Kassam A. and Friedrich, T. (2010). *An African Success: The Case of Conservation Agriculture in Zimbabwe.* INTERNATIONAL JOURNAL OF AGRICULTURAL SUSTAINABILITY 9(1) 2011PAGES 153–161, doi:10.3763/ijas.2010.0556 # 2011 Earthscan. ISSN: 1473-5903 (print), 1747-762X (online). www.earthscan.co.uk/journals/ijas.

Mazvimavi, K., Marongwe, L.S., Musitini, T. and Ndlovu, P. (2009). *What Influences Spontaneous Adoption of Conservation Farming in Zimbabwe: The Case of Ward 14, Masvingo District.* A survey carried on behalf of ICRISAT and Ministry of Agriculture. Unpublished.

Mazvimavi, K., Ndlovu, P., Nyagumbo, I. and Dimes, P.J. (2010). *CA Panel Study Report prepared for ICRISAT, GRM, and FAO.*

Mehretu, A. and Mutambirwa, C.C. (2006). *Social Poverty Profile of rural agricultural areas.* In Zimbabwe's Agricultural Revolution Revisited (Rukuni, M., Tawonezvi, P., Eicher, C., Munyuki-Hungwe, M. and Matondi, P., eds. pp 119-140).

Ministry of Agriculture, Mechanization and Irrigation Development (2007). *Report on a National CA workshop hosted by FAO and Ministry of Agriculture for AREX provincial officers to raise awareness on CA* , Holiday Inn. October, 2007, Harare, Zimbabwe.

Ministry of Agriculture, Mechanization and Irrigation Development (2008). *Proceedings on the launch of the Conservation Agriculture Promotion Network.* Harare, Zimbabwe.

Ministry of Agriculture, Mechanization and Irrigation Development (2010). *A Report on the National Conservation Agriculture Review Workshop* , organized by AMID in collaboration with FAO and COMESA, 29th to 30th June, 2010, Pandhari Lodge, Harare, Zimbabwe.

Ministry of Agriculture, Mechanization and Irrigation Development (2012). A CA STATUS REPORT for November, 2011. Harare, Zimbabwe.

Moyo, A. and Hagman, J. (1994). *Growth -Effective Rainfall in maize production under different tillage systems in semi-arid conditions and granitic soils of southern Zimbabwe*. In Jensen, B.E./Schjoning,P./ Mikkelsen. S.A./Madsen, K.B. (eds.) (1994):Soil Tillage for Crop Production and protection of the Environment, Proceedings of the 13th International Conference ,International Soil Tillage Research Organization, Aalborg, Denmark, pp 475-480).

Moyo, S. (2005). *Land Policy, Poverty Reduction and Public Action in Zimbabwe*. Paper presented at the ISS/UNDP conference on: Land Reform and Poverty Reduction. Hague Netherlands. 17-19 February 2005.

Mutiro, K., Mvumi B. and Keogh, E. (2011). *Protracted Relief Programme (PRP)*, Harare, Zimbabwe. A paper presented at the World Congress for Conservation Agriculture. 26th to 29th September, 2011, Brisbane, Australia.

NEPAD (2003). *Comprehensive Agriculture Development Programme.*

Nyagumbo, I. (1998). *Experiences with conservation tillage practices in southern and Eastern Africa: A regional perspective*. In "*Conservation Tillage For Sustainable Agriculture: International Workshop*" (J. Benites, E. Chuma, R. Fowler, J. Kienzle, K. Molapong, J. Manu, I. Nyagumbo, K. Steiner and R. van Veenhuizen, eds.), pp. 73-86. 22-27 June 1998, GTZ, Eschborn, Harare, Zimbabwe**.**

Nyagumbo, I. (2008). *A Review of Experiences and Developments Towards Conservation Agriculture and Related Systems in Zimbabwe. In " No-Till Farming Systems"* (Goddard, T., Zoebisch, M.A, Gan, Y.T., Ellis, W., Watson, A. and Sombatpanit, S. eds.) pp 345-372. Special publication No.3, World Association of Soil and Water Conservation, Bangkok.

Nyagumbo, I., Mvumi, B. M. and Mutsamba, E. F. (2009). Conservation Agriculture in Zimbabwe: Socio-economic and Biophysical Studies. In "*Sustainable Land Management Conference, Country Pilot Programme UNDP, GEF.*" 7-10 September 2009, unpublished, Windhoek, Namibia.

Oldrieve, B. (1993). *Conservation Farming – A Farm Management Handbook for Communal, Small-Scale, Resettlement and Co-operative Farmers of Zimbabwe*, Mazongororo Paper Converters, Harare, Zimbabwe, 77.

Smith, R. D. (1988). *Tillage trials in Zimbabwe: 1957 to 1988*, Consultancy report, November 1988. Institute of Agricultural Engineering (Agritex and GTZ), Harare, Zimbabwe.

Thierfelder, C. and Wall, P. C. (2011). *Effects of conservation agriculture (CA) on soil quality and productivity in contrasting agro-ecological environments of Zimbabwe*. Submitted to Soil Use and Management.

Van Engelen, V. W. P., Mantel, S., Dijkshoorn, J. A. and Hunting, J. R. M. (2004). The I*mpact of Desertification on Food Security in Southern Africa: a case study of Zimbabwe.* Report 2004/02, ISRIC-World Soil Information, Wageningen.

Vincent, V and Thomas, R G. (1962). *The agro-ecological survey* Government Printer: Salisbury, Southern Rhodesia.

Vogel, H. (1992) -Morphological and Hydrological characteristics gleyic graniti soils and their potential for crop production, A case study from Zimbabwe, Soil technology 5:303-317.

ZCATF (2009). *Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe.* Zimbabwe Conservation Agriculture Task Force, Harare.

Conservation Agriculture and Sustainable Crop Intensification: A Zimbabwe Case Study

Future food security relies not only on higher production and access to food but also on the need to address the destructive effects of current agricultural production systems on ecosystem services and increase the resilience of production systems to the effects of climate change. CA addresses the problem of low and erratic rainfall through the use of practices that reduce water losses and increase infiltration, and low soil nutrient status by increasing soil carbon and nitrogen through the use of organic soil cover and legumes in rotations and interactions. CA enables the sustainable intensification of agriculture by conserving and enhancing the quality of the soil, leading to higher yields and the protection of the local environment and ecosystem services. This publication describes the experiences of introducing and promoting CA as a practice for sustainable crop production intensification in farming communities across Zimbabwe by various stakeholders such as the Ministry of Agriculture, NGOs, FAO, CIMMYT and ICRISAT. The case study explains the adoption process and shows the impact of CA in terms of agricultural production, environment and ecosystem services, livelihoods and other socio-economic factors. The case study is directed to policy makers, scientists and environmentalists and should help decision making towards sustainable intensification concepts for agriculture.

ISBN 978-92-5-107448-0 ISSN 1020-4555

9 789251 074480

I3160E/1/12.12