ABSTRACT

This study was on conservation agriculture, an agriculture system that employs a set of techniques that aim to protect the soil from erosion, increase the fertility of soils and its profitability, in a sustainable way contributing to protect the environment. This research examined the extent to which conservation agriculture practices can alleviate poverty in Mozambique. The problem was: How Conservation Agriculture help to alleviate poverty? It is a qualitative study that used a case study design and non-probability sampling technique. Data were gathered through interviews, direct observation, focus group discussions and the analysis of “Caritas” reports. It is a comparative study between conservation agriculture and traditional agriculture methods for the production of maize, sorghum and bean from 1997 to 2012. The research interviewed and observed conservation agriculture farmers (participants) from two rural communities those that practice conservation agriculture and those that practice traditional farming. Data were analyzed through tables and calculations made in accordance with the results presented. Findings indicated an increase in maize production of 477% /ha/ harvest since 1997 – 2012; an increase in sorghum production of 246% /ha/ harvest, with an average annual increase of 15% /ha/ harvest; and an increase in bean production of 183%, with an average annual increase of 11% /ha/ harvest. Finding also shown that conservation agriculture farmers are able to sell greater quantities of surplus products produced than traditional agriculture farmers who are only able to commercialize a small percentage of their agricultural bean surplus. The study recommends and presents a model of training in AC that must be integrated in the curriculum of secondary school programs, adult education and agricultural schools.
DEDICATION

To Sofía and Dr. Amália Dickie:

This thesis is dedicated to Sofía, my daughter, for all the time that I was not present as a mother and for her unwavering support in writing this document. I also dedicate this thesis to Dr. Amália Dickie for the strength and moral support that she has always giving me and all the explanations and advices in the current study.
ACKNOWLEDGEMENT

I owe my deepest gratitude to God for the gift of life and for the opportunity He gives me, always being by my side giving me health and strength to be able to do my PhD. This thesis would not have been possible without His guidance.

My enormous gratitude goes to my supervisor who always gave me the greatest force, encouraging me and always sending me appropriate material for my thesis and making corrections and giving many great recommendations during the preparation of the work. Thank you, Dr. L. T. Nyaruwata! May God enlighten you always! I am also grateful to the entire management of Zimbabwe Open University-Higher Degrees Directorate especially the Director Dr. Adolfo Silas Chikasha for the opportunity they gave me to complete my thesis on time.

Very special thanks go to Mr. Lino Agostinho Miguel coordinator of Caritas program and Mr. António Gonçalves Peia, field officer at Caritas; for creating all the conditions in the field where research was done.

A very special thank you go to my Director Alfandega Manjoro and my Rector Padre Alberto Ferreira for the encouragement, assistance and support during this research study. I would also like to thank my English Teacher Victory and also my colleagues at Universidade Católica de Moçambique (UCM) especially Dr. Amália Dickie.
Lastly but not least, special thanks to my daughter Sofia who helped me in translations, financially and morally to complete my thesis.
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<th>Description</th>
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<tbody>
<tr>
<td>ADMARC</td>
<td>Agricultural Development and Marketing Corporation</td>
</tr>
<tr>
<td>AMCEN</td>
<td>African Ministerial Conference on Environment</td>
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<tr>
<td>APRAP</td>
<td>Action Plan for the Reduction of Absolute Poverty</td>
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<tr>
<td>CA</td>
<td>Conservation Agriculture</td>
</tr>
<tr>
<td>CARE</td>
<td>Cooperative for Assistance and Relief Everywhere</td>
</tr>
<tr>
<td>CARITAS</td>
<td>Catholic Organizations</td>
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<tr>
<td>CFU</td>
<td>Conservation Farming Unit</td>
</tr>
<tr>
<td>CIRAD</td>
<td>Centre de Coopération Internationale en Recherche Agronomique pour le Développement</td>
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<tr>
<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
</tr>
<tr>
<td>Dr.</td>
<td>Doctor</td>
</tr>
<tr>
<td>DRC</td>
<td>Democratic Republic of Congo</td>
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<tr>
<td>EPWS</td>
<td>Equitable Payment for Watershed Services</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FDR</td>
<td>Field Demonstration Results</td>
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<td>FISP.</td>
<td>Farm Input Subsidy Programme</td>
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<td>FFS</td>
<td>Farmer Field Schools</td>
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<tr>
<td>GDM</td>
<td>Governo de Moçambique</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GFP</td>
<td>Government's Five-year Plan</td>
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<td>GM</td>
<td>Government of Mozambique</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>HDI</td>
<td>Human Development Index</td>
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<tr>
<td>HICAP</td>
<td>Hillside Conservation Agriculture Project</td>
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<tr>
<td>IARM</td>
<td>Institute of Agricultural Research of Mozambique</td>
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<tr>
<td>IIED</td>
<td>International Institute for Environment and Development</td>
</tr>
<tr>
<td>MERCOSUR</td>
<td>Mercado Común del Sur</td>
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<tr>
<td>MISERECOR</td>
<td>Mercy German Catholic Organization</td>
</tr>
<tr>
<td>MZN</td>
<td>Mozambican currency Metical</td>
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<tr>
<td>NADPRO</td>
<td>National Agriculture Development Programme</td>
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<tr>
<td>NEPAD</td>
<td>New Partnership for Africa’s Development</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
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<td>NWP</td>
<td>National Water Policy</td>
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<tr>
<td>PhD</td>
<td>Doctor of Philosophy</td>
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<tr>
<td>PRSP</td>
<td>Poverty Reduction Strategy Paper</td>
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<td>RDC’s</td>
<td>Results Demonstration Centers</td>
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<td>RDP</td>
<td>Rural Development Program</td>
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<td>RDPM</td>
<td>Rural Development Program in Mozambique</td>
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<tr>
<td>RELMA</td>
<td>Regional Land Management Unit</td>
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<tr>
<td>RUEL</td>
<td>Right of Use and Enjoyment of Land</td>
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<tr>
<td>SADEC</td>
<td>Southern Africa Development Community</td>
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<tr>
<td>SGR</td>
<td>Green Revolution</td>
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<tr>
<td>SRD</td>
<td>Sustainable Rural Development</td>
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<td>TA</td>
<td>Traditional Agriculture</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Program</td>
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<tr>
<td>UNFAO</td>
<td>United Nations Food and Agricultural Organization</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<td>----------------------------------</td>
</tr>
<tr>
<td>USD</td>
<td>United States Dollars</td>
</tr>
<tr>
<td>WWF</td>
<td>World Wildlife Fund</td>
</tr>
<tr>
<td>ZOU</td>
<td>Zimbabwe Open University</td>
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INTRODUCTION

1.1. Background to the Study

Conservation agriculture (CA) is more resilient to climate variations. The components comprising CA include a trifecta of no-till or minimum-till farming, permanent soil cover and crop rotations which have existed for nearly a century, but the uptake has generally been slow and uneven (FAO, 2011a; Knowler and Bradshaw, 2007). The rates of adoption of no-till farming have remained particularly low in sub-Saharan Africa, including South Africa (McCarthy et al., 2012).

The southern province of Zambia has a lot of experience in conservation agriculture, producing under this agricultural method since 1997; and the regions of Karatu, Arumeru and Mbeya in Tanzania have been applying conservation agriculture techniques since 1990 (Shetto and Owenya, 2007). The Zambian Land Policy Document (Moyo, 2000,1) boldly declared that “land is the biggest asset and forms the basis for all human survival in terms of social and economic development”. More than 60 per cent of the population in countries like Angola, Lesotho, Mozambique, Namibia, Tanzania and Zimbabwe reside in the rural areas while in Lesotho, Madagascar and Malawi the percentage exceeds 70 per cent. Various arguments generally conclude that land is at the center of rural livelihoods (Moyo, 2000).

About 70 per cent of Mozambicans live in rural areas, where most survive on subsistence agriculture. However, recurrent droughts and floods in the interior regions of the country have
led people to migrate into urban and coastal areas with adverse environmental consequences such as desertification and over exploitation of soils and pollution of the surface waters (Mosca, 2011).

The land in Mozambique was nationalized since 1975. Mosca, (2011, 202) says that “the land and the natural resources located in the soil and underground waters, territorial waters and the continental shelf of Mozambique are the property of the State. The State determines the conditions of their use…”

In Rome, in 1992, Food Security has been defined by the International Conference on Nutrition, as the access by all people at all times to the food needed for a healthy life (Moyo, 2000). There are three main important aspects in the discourse on food security. These include availability of adequate food supplies in relation to quantity, and quality and variety; maintaining stability in the flow of food supplies; and a secure access to available food supplies (Ibid).

In 2004, the Government of Mozambique elaborated the Action Plan for the Reduction of Absolute Poverty (APRAP II) which was based on the five year plan for the years between 2005 and 2009. APRAP II defined poverty as "the inability of individuals to provide for themselves and their dependents asset of basic conditions for minimum survival" (Maússe, 2009, 24 apud GDM, 2004, 12). This concept takes into account patterns of food consumption, measured in kilocalories minimal, estimated at about 2,150 calories per person per day. The poverty line, measured in terms of consumption was set in 1997 in MZN 5,43 (the equivalent to US$0.18) per person per day (Maússe, 2009).
What triggered the interest in studying this topic is the fact that Mozambique is a poor country. According to the Human Development Index (HDI) by the United Nations Development Program (UNDP), Mozambique ranks as the fourth poorest country in Africa (UNDP, 2011). The current study is a case study in Mucheve village, in the Chibabava district, in the Sofala Province, comprising the period from 1997 - 2012 and focusing specifically in the cultures of maize, sorghum and beans. This is due to the fact that a great majority of the population of Mucheve Village is practicing conservation agriculture, supported by CARITAS (a Mozambican non-governmental organization) since 1997.

Conservation agriculture (CA) is based upon three principles:

Minimum disturbance of soil – not removing soil tilling;
Keeping the soil covered as much as possible, if possible throughout the whole year, with crop residues (a form of mulch) and mulch derived of decomposing organic matter from legumes, cereals and dried grass;
Mixing or consorting and rotate crops (FAO, 2012; Taimo and Calegari, 2007).

The main crops produced in Mucheve village are maize, sorghum and beans, essential to feed their families. Local farmers produce these three cultures simultaneously and each family farm comprises in average of one to one and a half acre of land.
1.2. Statement of the Problem

Mozambican peasants in Mucheve area/ Chibabava district in Sofala Province Mozambique of the Ndau ethnic group have been practicing conservation agriculture since 1997. There is a group of 700 farmers supported by Caritas who practice conservation agriculture and have a profit of over 50% in production compared to traditional agriculture (TA). Despite all the benefits there are in conservation agriculture many people still practice methods of agriculture, contrary to the problem of food insufficiency.

With regard to the description previously given, the study will be conducted taking into account the level of production of conservation farming practiced since 1997, and production based on traditional agriculture since 1997 until 2012. The study aims to examine “how conservation agriculture leads to the eradication of poverty”.

This study is a case study of Mucheve area. The study will be a comparative study of those practicing CA and those who are not. This will be done in order to understand whether CA reduces poverty. Therefore the problem for this study is stated thus: How does conservation agriculture help to reduce poverty?

1.3. Purpose of the Study

The conservation agriculture has been practiced in Mucheve since 1997 with 700 farmers in the following crops: maize, sorghum and beans (basic food crops); The study aims to examine “how conservation agriculture leads to the eradication of poverty”.

The thesis aims to answer the following questions: “To what extent does conservation agriculture alleviate poverty?”

1.4. Research Questions

The thesis aims to answer the following questions:

In order to answer the central question the following sub questions drove the thesis:

1. To what to extent does CA improve in maize, sorghum and beans production more than traditional agriculture (TA)?

2. How do CA techniques applied help communities to produced better yields?

3. What challenges do the communities who implement CA face?

4. How does the production levels of CA of maize, sorghum and beans compare with those of (TA)?

5. How can (TA) farmers be encouraged to implement (CA)?

Only after answering all these questions, we will be able to know whether conservation agriculture is in fact the best technique to follow to alleviate poverty.
1.5. Assumptions of the Study

Conservation agriculture in rural communities will be away to help alleviate poverty in Mozambique; To produce the system of conservation agriculture in rural communities in large amounts can end food insecurity in Mozambique;

If we end up with food insecurity in rural communities in Mozambique is a net exporter of agricultural products of excellent nutritional quality market SADEC and of globalization and open market.

But for all of these assumptions will need to work to change attitudes of rural farmers who practice traditional farming, giving them training and perhaps some government agricultural policies should be improved or adapted in conservation agriculture.

1.6. Significance of the Study

This study of paramount importance as it may lead to rethinking on ways to institutionalize conservation agriculture in order to reduce or eradicate poverty in Mozambique. Studies of successes, failures and challenges related to adoption and adaptation of conservation agriculture are still very rare in Southern African Development Community and Mozambique in particular. This study could be of interest to the Mozambican academics, agricultural community and to Mozambique as a country. This issue is of great importance for the Mozambican society, because it will contribute to the social, economic and cultural development of its people.
This study is significant because it could help the participants to understand the importance of CA in the process of poverty alleviation. The study could also help the policy makers in agriculture ministry to craft policies that encourage the rural communities who still practice traditional agriculture to change to CA. The study could also help the agricultural experts to better understand CA principles and practices and design training programmes for more communities to adopt CA with the hope for poverty alleviation. The study is important in the sense that it could add on to the knowledge of conservation agriculture in the context of Mozambique. Undertaking this study will certainly increase the research skills of the researcher.

1.7. Brief Review of Related Literature

The United Nations Food and Agricultural Organization (UNFAO, 2010) estimate that Sub-Saharan countries lose up to forty percent of their agricultural produce after harvest. In order to reduce such post-harvest food losses, Malawi decided to construct modern silos in Mangochi, Mzuzu, and Luchenza. The total storage capacity for maize of all the Government silos is 240,000 metric tons. As of 2011 Government of Malawi had a stockpile of 216,000 metric tons of maize in the Strategic Grain Reserves and Agricultural Development and Marketing Corporation (ADMARC) depots. The government of Malawi also introduced small metallic silos for smallholder farmers to improve food security at village level (African Leaders, 2011).

In Zimbabwe the Conservation Agriculture (CA) is increasingly being seen as a farming system that can reduce the negative impacts of some of the factors that are limiting agricultural productivity (Marongwe et al. 2012, Xi). 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.” (Marongwe et al. 2012, Xi). “According to survey reports from Zimbabwe Ministry of Agriculture, the total number of farmers practicing CA options during the 2010/2012 agriculture seasons, had increased tremendously, with a significant proportion implementing CA without any input support showing increasing appreciation of CA benefits by farmers in the country” (Marongwe, et.all. 2012,16).

Malawi, Madagascar and South Africa are net exporters of some cereals. They are therefore classified as countries with low vulnerability (Africa Development Bank, 2009)

With regard to the production of corn using conservation farming Malawi has a profit of over 50% in production compared to traditional farming (Haggblade, 2009)

For the Mozambican government, agricultural development is the priority objective of economic development, by increasing agricultural productivity and helping it to become competitive in world markets (PRSP, 2010).

Concerning approaches, policies and strategies for rural poverty alleviation in Mozambique the strategy of the Government of Mozambique to reduce poverty is in the Action Plan for the Reduction of Absolute Poverty 2006-2009, extended until the end of 2014 (GFP,2010). These plans were prepared with the aim of reducing levels of absolute poverty and to promote rapid, widespread and sustainable economic growth. Helping to generate a steady increase in production efficiency, the program aims to boost incomes and increase security of subsistence
farmers, especially families headed by women. The program promotes a new approach based on the provision of demand-driven extension services that aim to ensure the quality of services provided to farmers. The program aims at families of small farmers, especially in poorer localities, and ensures that disadvantaged groups such as women, youth, and seniors participate in project activities (GFP, 2010). Since 2006 the government has been preparing for political stabilization but this time the poverty debate continues.

1.8. Theoretical Framework - The Trofobiose Theory

The Trofobiose Theory (Francis Chaubossou) is based on the understanding that the use of fertilizers and pesticides causes inhibition of protein synthesis in the plant, making them susceptible to pests and diseases (Wolff, 2008).

The conservation agriculture uses the same principles as that of the Trofobiose theory. A set of agricultural practices based on ecological principles can be quite effective to management of environmental complexity and contribution to the trophobiotic balance, resulting in less vulnerability of plants to pests and diseases. Some main practices can be highlighted by your effectiveness to Trophobiosis are:

Efficient use of irrigation; formation of windbreaks; organic fertilizing; nutritional management of planting; use of bio-fertilizers; maintenance of ground cover (Altieri, 2002).

In trying to address the problem of poverty through conservation agriculture the government of Mozambique developed a policy on conservation agriculture and introduced the system to
communities with the help of NGOs (PRSP, 2010). Despite the implementation of the policy and help from NGOs some people and communities continue to use traditional or conventional agricultural methods. It is against this background that this study is grounded on examining CA production function model on maize, sorghum and beans in a location where conservation agriculture has been since 1997.

1.9. Delimitations

The study will be delimited to Mucheve, an administrative post of Muchungué, Chibabava district, located south of Sofala province (334km from the city of Beira). The case study will be conducted in Mucheve locality between the years 1997-2012, with special reference to land use and food production, only to maize, sorghum and bean crops cultivated under aspects of conservation agriculture. The study is delimited to the study of staple foods and not to commercial crops such as cotton and tobacco.

1.10. Limitations

The results of this study will be based on the performance and responsibility of the researcher’s assistant. The limitation of research assistance will be mitigated through training of the research assistance in data collection techniques. The finding from this study could be limited to the study location Mucheve area and will not be generalized to the other areas not under study found in the district. The study could be limited due to lack of literature on CA agriculture from
the continent and SADC countries. This limitation will be mitigated by searching for related literature from the global village.

1.11. Research Methodology

This research will be based on qualitative research paradigm and adopt the interpretivism philosophy (Creswell, 2007). Interpretivism philosophy postulates that qualitative research paradigm framework is made up of philosophy, ontology, epistemology and methodology. Qualitative paradigm is chosen because it is used to help researchers understand how people feel and why they feel as they do. This paradigm is concerned with collecting in-depth information from people who have experience in the phenomenon being studied (Creswell, 2007). Cohen and Manion (1994) assert that qualitative research approach refers to situations where the researcher generates data in an unstructured way. For this study there will be a direct relationship between the researcher and the social world, i.e. the families practicing conservation agriculture in Mucheve. As human experiences are key to understanding the factors behind conservation agriculture and poverty reduction, qualitative research is then the most appropriate approach to this study. The researcher will elicit accounts of meaning, experience and perceptions from interacting with the participants.

1.12. Ethical and Legal Implications

To deal with the relevant ethical and legal implications, I will:

(A) Request authorization from ZOU to conduct the research.

(B) Request the necessary authorizations to conduct the research.
(C) Explain to the participants of the study the meaning and importance of the study, as well as the importance of their contributions / experiences for the development of the country.

(D) Ask the respondents to respond willingly, honestly and objectively.

(E) Assure respondents that their right to anonymity, confidentiality, freedom of choice and expression will be respected.

1.13. Budget and Plan of Action

Budget: The researcher has set aside a minimum of U.S. $10,000,00 to cover transportation costs, stationery, food, logistics and others during the course of the study.

1.14. Definition of Special Terms and Expressions

Climate Change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years because the effects of natural processes and human action.

Conservation Agriculture is a type of agriculture that not only promotes conservation of natural resources (soil, water and biodiversity) but that is also economically viable and promotes social equity.

Food security is a guarantee of the right of everyone to have access to quality food in sufficient quantity and permanently, based on healthy eating habits.
Poverty is the scarcity, dearth, or the state of one who lacks a certain amount of material possessions or money.

Productivity is a ratio of what is produced and what actually should be produced.

Receipt is income that a company/family receives from ordinary activities.

Traditional / Conventional agriculture is a type of agriculture that uses primitive techniques, craft and ancestral. Its destination production auto consumption and family subsistence that practice them. Supported by Caritas in that area, there.

1.15. Summary

At the beginning of this chapter, the study background was presented. The concept of agriculture was defined having as basis some of the authors of the global area and a brief description of the situation of poverty in Mozambique was made. The objective of the thesis is to respond the following question: at what stage does the agriculture alleviate poverty? To respond to this question, the objectives of studies were elaborated as well as the study importance. The researcher chose a study case in Mucheve locality and district of Chibabava, between the years 1997-2012 and placed the focus on maize, beans and sorghum crops. There are 700 farmers in this locality who make their production using conservation agriculture, being helped by Caritas and MISEREOR funder.
A brief presentation of literature was presented to understand the existence of Conservation Agriculture in some African countries and try to understand better what way should be followed to alleviate poverty in Mozambique, using this system of cultivation. There was only a brief explanation of trophobiosis theory followed by delimitation, study limitation and ethnical and legal implications which were also discussed in this chapter. In the following chapter, the Review of Related Literature will be presented.
CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1. Introduction

Conservation Agriculture CA principles are increasingly gaining momentum throughout the world as a new farming pattern for the 21st century. The global observational evidence clearly supports the idea as CA systems are currently being practiced worldwide on about 125 M ha in all continents and all environmental natures even in those environments that experience various temperatures.

Due to its minimum use of agrochemicals, CA promotes minimum soil disturbance, organic mulch cover, and crop species diversification, in conjunction with other good practices of crop and production management. While in 1973/74 CA systems covered only 2.8 M ha worldwide, the area had grown in 1999 to 45 M ha, and by 2003 to 72 M ha (Friedrich, et al., 2012). Farmers and some governments have welcomed this alternate agriculture production method with a keen interest as the CA systems have vastly expanded at an average rate of more than 7 M ha per year in the past 11 years. North and South America have keenly adopted the systems as well as in Australia and New Zealand, and more recently in Asia and Africa where the awareness and adoption of CA is on the increase (Ibid).
In this chapter we explain the theory of Trophobiosis where every vegetal organism is vulnerable to the infection of diseases when they are not healthy.

We will explain later in the chapter that conservation agriculture is a strategy for rural sustainability in Africa. Since the continent currently faces quite a number of severe challenges associated with land degradation, rapid population growth, and climate change and the technique of traditional agriculture doesn’t help in developing the community with necessity.

2.2. Conceptual Framework

This study is based on the conservation agriculture conceptual framework.

2.2.1. Definition and Description of Conservation Agriculture (CA)

Conservation Agriculture (CA) is a type of agriculture that is based on the decomposing of matter, proper usage of microorganisms for breaking down the matter, exclusive usage of manure, recycling of nutrients in the soils, and on crop rotation principles (Taimo and Calegari, 2007). Conservation Agriculture can be explained as a type of agriculture that does not only promotes the preservation of natural resources (soil, water and biodiversity) but it is also economically profitable and promotes equal opportunity. in a safe and healthy environment. Not only does it serve the health and biodiversity sectors but it is also known as a viable, organic or ecological agriculture. It has been in existence for almost a century, but acceptance has been rather slow and uneven (FAO, 2011a; Knowler and Bradshaw, 2007).
According to FAO (2011) and Friedrich et al. (2012) while sustaining and enhancing the resource base and the environment. CA is regarded as a better way to manage agro-ecosystems for better and worthwhile productivity, increased benefits and food provision. CA is made up of three linked principles, namely:

1. Very limited or no mechanical soil disturbance (i.e., no-tillage and direct sowing or scattering of crop seeds, and direct placing of planting material in the soil; least possible soil disturbance from cultivation, harvest operation or farm traffic, in exceptional limited strip tillage);

2. Permanent organic soil cover, especially by crop residues, crops and cover crops; and

3. Growing various kind of crops in rows or assortment by means rotations of crops or, in case of perennial crops assortments of plants, including a balanced mix of legume and non-legume crops.

The principles of Conservation Agriculture are universally suitable to all kinds of farming landforms and usages and can accommodate local farming practices. Conservation Agriculture improves biodiversity and natural biological processes above and below the ground surface. It really lessens or does away with soil pollution such as mechanical tillage while external inputs such as agricultural chemicals and fertilizers or compost are used perfectly and in such a way and quantities that do not disturb or interfere with, the biological processes (FAO, 2011b; Friedrich et al., 2012).

According to Haggblade (2009) in Zambia, conservation agriculture is an agriculture system developed by farmers which allows them to make better use of the land in a more sustainable
way with better impact to the environment and in a more productive way. The following tools are commonly used by Zambian conservation agriculture farmers:

Strong hoes, axes and pickaxes used to prepare the soil that is very hard and make large basins (holes) in the ground where seeds are later dropped into during the sowing process that occurs right after the first rainfalls. During maize sowing four seeds are dropped per basins (large hole in the ground);

A rope with plastic bottle tops tight in intervals of 70 cm each. The rope is then screwed with bolts to the wooden poles that ensure it is held in the respective position;

Two sticks of 90 cm each to assist in measuring the spaces between the rows of basins;

A cup of 12.5 g (famously known by Zambian farmers as the “number 8 cup”) to apply liquid and organic fertilizers with precision;

An empty soda can to apply organic compost and lime to the basins;

Minimum tillage of the furrows or basins;

Preparation of the soil during the dry season;

Residue retention in crops without intentional burnings;

Rotation of crops with leguminoseae vegetables.

This African country is a very good example of conservation agriculture and its methods. Zambian farmers started following these techniques in 1996 and in 2007 due to its success there were already 150,000 farmers producing under CA.
In Tanzania due to over exploitation of the soil causing massive soil degradation, Conservation Agriculture (CA) has been the selected path farmers adopted to improve and enhance agricultural production and ensure the security of food supply. For Tanzanian farmers, the covering of soils is one of the most important conservation agriculture methods utilized; despite the fact that farmers frequently face challenges with their cattle that often tries to eat the organic matter covering the soil. A combination of mixed crops is made by farmers integrating crop and livestock production in order to capitalize and monetize farmlands. Consequently, the manure obtained from livestock production together with the coverings of soil ensures the long-term conservation and sustainability of the natural resources of this region. However, if the soil is not well covered, problems of growing weeds arise, especially within the first two years. In order to avoid the cattle eating the organic matter covering the soil, fences must be provided to isolate the cultivated area (Shetto and Owenya, 2007).

Eventhough Tanzanian farmers following conservation agriculture methods still face a lot of constraints they are happy with its results and how they successfully managed to increase the production of maize and beans. Concurrently, the number of farmers adopting conservation agriculture methods is increasing significantly whilst the degraded agricultural soil of Tanzania is improving.

In line with the present study and according to the experience of Mozambican farmers following conservation agriculture in Mozambican soils, a set of ten techniques are recommended, as follows:
• 1st: mulch or humus made of grasses, legumes, cereals and crops waste and by-products (dead coverage);
• 2nd: fighting against soils erosion using dead coverage for soil improving and direct sowing or planting without ploughing the fields;
• 3rd: Applying liquid compost and organic manure during plants growth stages;
• 4th: Applying organic compost during the growth of crops;
• 5th: Using intercropping which is mixing and rotating two or more different crops (such as maize and beans) to ensure and maintain the fertility of soils;
• 6th: Rotation of different crops to maintain the soil fertility (for example in the land where peanut has been produced, maize can be cultivated in the following year);
• 7th: Use of leguminousae to enrich the soil with nitrogen such as: peanut, bean and leucaena (it type of shrub used for pasture);
• 8th: no burning of ground or the forest in order to protect the soil from erosion and its nutrients and properties;
• 9th: Minimum farming, to avoid soil erosion;
• 10th: Continuous production

Sowing of all crops is made in lines also know as row-seeding (or dibbling) which is a process of making narrow furrows into which seeds are dropped at regular intervals, as per each plants requirements. This is the easiest way to ensure even distribution of the seeds. Row-seeding is is normally made with the use of a specific equipment called matraca or with a sharpened stick as shown in Figure 2.1. The matraca is a manual machine that helps putting the right quantity of seeds in each furrow without damaging the soil.
Liquid fertilizer and organic compost are essential for the growth of plants and the fertility of soils. To produce liquid fertilizers and organic compost, it is necessary to have the availability of the following elements:

Organic compost production in layers:

- The 1\textsuperscript{st} layer is made of leaves of leguminousaeae (such as different bean varieties) and food left-overs.
- The 2\textsuperscript{nd} layer is made of sand or soil
- The 3\textsuperscript{rd} layer is made of animal excrement and
- The 4\textsuperscript{th} layer is made of ashes

These layers must attain a meter in height and should be watered once a week and kept wet. It is important to ensure that they never dry up. After 45 days, the compost is ready to be used and can be applied to soils of crops and fruit-trees. It is normally used during the growing stage of the plant and when it reaches 3-4 leaves (20 cm in height). It should be applied once a month to the soil and measured by hand. After the plant reaches a meter in height it no longer needs fertilizer.

Liquid fertilizer production is made putting a sack of 4-5 kgs of manure into 20 liters of water. It takes 15 days for the fertilizer to be ready to use. Both liquid fertilizer and organic compost can be applied to the plant’s soil simultaneously. The measurement commonly used to apply liquidi
fertilizer to the soil is a coca-cola can: one coca-cola can per plant. The organic liquid fertilizer should be used every fortnight.

Figure 2.1: Use of the sharpened stick or *matraca* in sowing

![Image of people using sharpened stick](image)

*Source: Adapted from Taimo and Calegari, 2007*

### 2.2.2 Economic Rationale for Promoting Conservation Agriculture

According to Friedrich et al. (2012) conservation agriculture facilitates good agronomy, such as timely operations, and improves overall land husbandry for rain fed and irrigated production. Together with other known good practices, which include the use of quality seeds, and integrated pest, nutrient, weed and water management, and so on. Conservation agriculture promotes good cultivation, such as on time operations and all in all improves land husbandry for rain fed and irrigated production. Conservation Agriculture is the basis for sustainable agricultural production growth (Ibid).
The production levels of conservation agriculture systems can be compared with and even exceed those under conventional intensive tillage systems, which means that Conservation Agriculture does away with yield penalties. At the same time, conservation agriculture conforms to the generally accepted ideas of sustainability (Friedrich et al. (2012)).

Due to the increased system diversity and the stimulation of biological processes in the soil and above the surface as well as due to reduced erosion and leaching, the use of agrochemicals is reduced in the long term. Ground water resources are refilled through better water infiltration and reduced surface runoff. The reduction of contamination levels from agricultural chemicals and soil erosion has improved the water quality (Laurent et al., 2011). By doing so the carbon in soil is cut off at a rate ranging from about 0.2 to 1.0 t/ha/year depending on the agro-ecological location and management practices (Corsi et al., 2012). This practice has seen the general reduction of labour requirements by about 50%, which helps farmers to save on time, fuel and machinery costs (Saturnino and Landers, 2002; Baker et al, 2007; Lindwall and Sonntag, 2010; Crabtree, 2010). Fuel savings in the order of around 65% are in general reported (Sorrenson and Montoya, 1984; 1991).

From the farmer’s point of view, the benefits of implementing CA can be either private (on-site) or off-site (carbon sequestration, reduced sediment pollution, etc). There are limited empirical studies considering the economic benefits of implementing CA in tropical agro ecological zones, so the majority of evidence is conducted in regions such as North America. In studies conducted in Canada, it was found that CA offered higher on-farm benefits than conventional tillage
practices, however the inability to gather off-site benefits meant that fewer farmers were willing to adopt CA. Other studies found a trade-off between environmental integrity and economic returns of the intensive use of conservation agricultural methods. Kelly et al. (1996) found that strict no-till practices produced higher economic returns and reduced the environmental hazard indexes taking into account soil erosion risks, nitrogen and phosphorous losses and pesticide contamination.

Global concerns of soil degradation help promote intervention at an international level. This is due to what is currently occurring within singular nations and the potential regional and global costs inflicted by soil degradation. As a result economists may found global benefits in the adoption of Conservation Agriculture practices. Furthermore, in the absence of management practices for soil sustainability, soil degradation will lead to livestock and crop losses, with local, regional and global consequences. Therefore, good soil management and conservation not only benefit the individual farmer but has real and noticeable implications for the global environment.

2.2.3. A Conceptual Framework for Studying the Adoption of Conservation Agriculture

Figure 2.2. demonstrates the detection of feedback mechanisms. (FAO 2001; Bradshaw and Smit, 1997). CA is just one of many options available to farmers facing changes in their production environment. For instance all or some active family members may relocate or take up some jobs away from the farm, or remain behind and alter farming practices (Ibid).
Critically, the impact on soil productivity can be either positive or negative, depending upon numerous factors. In case of household migration, they may reduce the degree with which they farm existing plots, or totally leave their old lands and cultivate virgin land in marginal areas. The latter can have serious effects if farmers continue practicing unsustainable soil management to new areas. CA is one of many technical alternatives available to producers if they opt for change in current management instead of migrating (FAO 2001; Bradshaw, and Smit, 1997).

The working of the feedback mechanisms as demonstrated in (Figure 2.2.) closes the loop and there is the potential for either a self-reinforcing series of improvements in soil productivity, or spiraling degradation. Figure 2.2. shows that conservation agriculture has a strong impact on the economical, development and social levels of groups practicing this activity. Due to the fact that conservation agriculture protects the soil from erosion and increases fertility it simultaneously ensures yields high productivity. With the increase of productivity in agriculture and the creation of surplus for internal commercialization and exportation, the country stops importing goods, improves the state of the country’s economy and its development. Agricultural production increases eliminate hunger and famine in vulnerable communities and with the commercialization of surplus goods people are able to improve their lives. It is then possible to conclude that conservation agriculture contributes positively to the development of a country.
Figure 2.2: Conceptual Framework for Conservation Agriculture Adoption Studying

Source: adapted from Bradshaw and Smit, 1997; and FAO, 2001.
2.2.4. Financial Analysis of Conservation Agriculture and Traditional Agriculture

Generalization of financial returns from Conservation Agriculture may hide its financial analysis complexity. For example it might appear that conservation agriculture is less profitable in flatter temperate regions (like in North America) than in steep-sloping regions with high tropical rainfalls due to the fact that the first are more subject to soil erosion risks with the use of conventional agriculture practices. However, more recent studies conducted in North America have reinforced that CA has small cost advantages over TA but that region specific conditions could alter results in various ways. A list of input costs form the basis for these general conclusions.

*Machinery costs and fuel costs*

Machinery and fuel costs are the most important expenditures to consider in large farm productions, so the impact of CA in these costs is crucial. Most studies suggest that CA reduces machinery expenditures due to minimum or zero tillage practices. However, many farmers may look at CA practices as a complement rather than a full substitute practice. As a result if only partially of the field applies conservation agriculture techniques, than equipment costs may increase as they have to provide for two crop systems or use the existing machinery in their CA cultivation fields inefficiently. Similarly, fuel costs are expected to be lower in conservation agriculture than in conventional tillage and may encourage to CA adoption. However, recent studies in the United States have found that the 10 per cent increase of crude oil price is linked with the expansion of CA planted hectares (Uri, 1998a).
Pesticide costs

Pesticides are a substitute for machinery use to manage weed control and pesticide application costs and the ability to fully fight weed problems under conservation agriculture practices is still controversial and a continuous research study. Due to the fact that most herbicides are petroleum based, crude oil costs will tend to affect farmers costs. If so, higher oil prices would imply higher pesticide costs which would partially offset conservation agriculture’s relative cost advantages (Uri, 1997).

Labour costs

Research studies concluded that labour requirements under conservation agriculture practices are significantly less, sometimes up to a reduction of 50 to 60 percent during land preparation at the beginning of the sowing season. In large mechanized farms in developed countries the savings impact is small, however there is an increase trend of off-farm work that showed relatively labour savings under CA practices. Labour savings represent a great motivation for CA adoption.

Fertilizer and other costs

The use of fertilizers under CA is still a controversial debate. There is evidence that the fertilizers adoption affect nitrogen use by crops and leaching, therefore increasing productivity and the quality of plants. Even though fertilizer rates are not high, application costs and greater management skill requirements may increase the final cost.
Also important to analyse in a financial comparison is the risk factor. It is crucial to acknowledge that different cultivation methods may impact differently on crop production. Research studies have contradictory results. Some studies suggest that CA adoption increases productivity and thereby reduces the risk factor for farmers adopting this practice. In contrast, researches in Australia showed reduced variability in yields under conservation agriculture (Kirby et al., 1996) while in Canada studies indicated considerably higher net returns under CA than in conventional agriculture practices in bad years, but lower averaged over time. There is more certainty of CA impact on cropping intensity. Various studies conclude that CA practices have more efficient land use of fixed resources and results have higher annual net returns per ha.

2.2.5. Factors Influencing the Adoption of Conservation Agriculture

Some of the factors that hinder conservation agriculture practices include initial investment costs, perceived risk of adopting an “unknown practice”, long waiting periods to observe conservation agriculture benefits and production results and barriers related to culture and history. In terms of maximising financial results and net returns, studies suggest that conservation agriculture can offer better net returns than other conventional practices and technologies. Farm-level factors vary from field to field operation and policy related activities to share and disseminate the information as well as social processes play an important role in conservation agriculture adoption.

Farmer characteristics, such as age and experience are difficult factors to relate to the adoption of conservation agriculture as studies shown contradictory correlations. In the research study of Gould et al. (1989) in Wisconsin, older farmers with more experience were more likely to
identify soil problems than younger farmers. However, younger farmers were more likely to react and address those problems than older farmers. Nevertheless, various studies found evidence that farmers income correlates positively with CA adoption and soil protection practices.

Within farm characteristics, several studies suggest that farm sizes correlate positively with CA adoption. Farmers concern over soil erosion and soil degradation are the most important factor contributing to CA adoption as well as its positive impact on soil fertility and productivity.

Information and knowledge are key variables for the implementation of conservation agriculture practices. Information sources include media, meetings, government and extension officers or agricultural technicians and other farmers following CA.

The characteristic and availability of technical terms are important factors for conservation agriculture adoption, and farmers must believe that CA technology will work. Biophysical factors interact with technical factors, such as types of soils, rainfall and topography can facilitate/encourage or limit/discourage the adoption of conservation agriculture techniques.

Social factors such as culture and history play a significant role in CA adoption. Moreover, studies in Canada showed that farmers tend to improve their agricultural practices only under high levels of concern. Several studies argue that farmers’ decision-making process frequently
reflects a compromise between collective economic utility and private utility. Farmers look at the first interest as “the right thing to do” in communities where stewardship plays a strong cultural role. Cooperative organizations rule numerous activities within community agricultural systems such as stone lines, contour ploughing and structural and construction works that require the cooperation amongst various farmers. Cooperative models are a perfect fit for CA practices enabling information dissemination from farmers to other farmers, pest controls, purchase of seeds, machinery or agrochemical inputs (Roseland, 1999).

Another important factor is the social capital role used to promote and encourage CA adoption. In a broader sense, social capital is defined in the interconnectedness among the individuals of a society considering relationships as a form of asset. Various studies suggest that kinship, farmland inheritance and higher degrees of social capital help explain the adoption of conservation agriculture practices in either developing or developed countries. These institutions and organizations are crucial catalysts to diffuse and promote CA adoption (Sobels and Lockie, 2001).

2.2.6. A Definition of Conservation Agriculture for Sub-Saharan Africa

Many practitioners, researchers, and promoters of the concept have defined the term “conservation agriculture” in different ways (Milder, 2011, 3). Most of the definitions differ mainly in overall level of inclusiveness or circumspection such that the different conceptions of Conservation Agriculture may be understood generally as a coordinated set of domains (see
Figure 2.3). To come up with a befitting definition of this study a brief review of the commonly used definitions is beneficial (Ibid).

In Zambia, conservation agriculture is based in three interrelated principles: minimum disturbance of the soil, permanent soil coverings and rotation of crops with the usage of leguminous to nourish the soils with nitrogen. Zambwian soil is very dry, so the method used includes large basins (holes) in the ground that are then used to drop the seeds when sowing takes place after the first rainfall. Zambian conservation agriculture farmers apply specific quantities of organic compost and organic liquid fertilizer to the soil for the successful development of the plant (Haggblade, 2009).

Zambia is a great case study of conservation agriculture practices. Extensive land usage and improper use of the soil and the abandonment of previously intensely used areas caused soil erosion in Zambia. Soils were very dry and poor and hardly suitable for agriculture. With conservation agriculture systems Zambian farmers made miracles, increasing agriculture production, preserving the soils and improving the sustainable environment and development of the country.

In Tanzania, in the District of Babati, conservation agriculture is based on coverings of soil with harvesting crop residues (such as barks, branches and leaves), dead coverage and mixing and rotation of crops often of beans and pigeon peas (Lofstrand, 2005). However these crop harvest residues are frequently eaten by cattle invading the agricultural fields. Conservation agriculture
farmers also use traditional crop covering such as: pumpkin, calabash gourd and watermelon. Grazing practices have negative impact to Conservation Agriculture farmer’s soils. To minise its impact on the exisiting land and still ensure productivity increase conservation agriculture farmers apply organic liquid fertilizer and organic compost (Ibid).

Farmers following conservation agriculture practices in the District of Babati (in Tanzania) are on the right path and the number of farmers adopting this agriculture system is increasing crops productivity excellent results. Farmers are grateful to conservation agriculture as their surplus of chick peas have been externally commercialized to India and simultaneously their once degraded soils have considerably improved, are more fertile, retaining a lot more moist and humidity and there was a considerable reduction of labour force expenses in the field.

Taking into account the experience of other countries, Mozambique has also developed experience in working with Conservation Agriculture. Mozambican conservation agriculture farmers produce pure clean grass (panicum maximum) to cover the soil before sowing. They also produce leucaena to serve as a covering material of the soil using its leaves and at the same time protecting the soil from erosion (Keck, 2011). Crop rotations are frequently used with maize, sorghum and bean cultures. Rotation of crops with leguminouseae is very important to improve the quality of soil. Animal breeding facilitates the production of fertilizers such as compost and organic liquid fertilizers. Its use on soil is crucial during the plant growth to increase soil fertility and plants resistance to diseases and guarantee better quality and a more profitable harvest.
Mozambique is on the right track as the number of farmers adopting conservation agriculture is increasing annually and this means improved and increased crop production while preserving and sustaining the environment which will generate positive economic impact and social development.

Figure 2 shows up different representations of conservation agriculture and their extensive focal point and level of performance. According to the commonly used definition, Conservation Agriculture covers a set of resource-conserving plot-scale agricultural practices (inner-most box). On small scale settings (middle box) CA is seen to have taken a more combined approach to management through a number of plots, including evergreen trees and shrubs, livestock, virgin lands, and wooded areas (Milder, et al., 2011). At larger scale (outer-most box), conservation. The food security and land regeneration are addressed by Eco-agriculture, integrated watershed management, and other landscape scale approaches in the ambience of ecological mosaics, wildlife habitat, protected areas, and watershed functions. This was considered a closer perspective the level: political market, economic, institutional, which can also be profitable. The factors shown in each scale are figurative examples, not an all-inclusive list (Milder, et al., 2011).

This basic definition is still commonly used by the majority of researchers and practitioners all around the globe. (e.g., ACT, 2009; Kassam et al., 2009; Derpsch et al., 2010; FAO, 2010a). The same has been well received and effectively practiced to develop appropriate environments for agricultural practices in specific regions of the world.
Zambia is one good example where the principles have seen an expansion of up to six basic conservation farming “technologies” that include retaining crop residues, concentrating tillage and fertilizer application in a permanent grid of planting basins or series of planting rows (Milder, 2011, 4; CFU, 2010). This includes preparations of land preparation in the dry season, excessive weeding to lessen plant competition, and inter-cropping or rotating nitrogen fixing legumes on up to 30% of the cultivated area (Ibid).
The Protracted Relief Program in Zimbabwe, CA involved on time weeding and application of both manure and chemical fertilizers (Mazvimavi and Twomlow, 2009). In dry regions of East Africa, the Regional Land Management Unit (RELMA; now defunct) came up with an “African-style” (Milder, 2011, 5; RELMA, 2007). In this approach CA has seen the devaluation of the importance of year-round soil cover (which is sometimes infeasible in dry environments) and rather developed practices on good water usage, improving soil fertility through recommended fertilizer applications (Ibid).
All in all agriculture is meant to nourish and enhance the natural biological process that promotes soil fertility, nutrient cycling and hydrological cycling. These are the CA fundamental ethics and practice. These ecosystem services, in turn, benefit farmers by stepping-up a good yield, minimizing the need for external inputs, increasing farm profitability, and undoing land degradation. CA is thus closely aligned with the concept of agro ecology, in which farms are deliberately managed to foster beneficial ecological processes and disrupt detrimental ones (Milder, et al., 2011).

Zambia and Malawi have taken a successful agro ecology and agroforestry systems respectively and drawing from their experience. The World Agroforestry Centre has promoted a form of CA called “Evergreen Agriculture” that combines the basic agronomic principles of CA with a progressive introduction of diverse perennial vegetation, especially fertilizer shrubs and trees (Milder, 2011, 5; ICRAF, 2009).

### 2.2.7. Definition and Description of Traditional or Conventional Agriculture

Traditional or Conventional Agriculture is a type of agriculture that practices inherited old art of farming. Its final production is meant for consumption by the practicing households. It’s made up of mainly manual task as weeding and weed control. It uses the burning of crop stubble and they are removed from the fields, and often practice monoculture plantations (Taimo and Calegari, 2007). At the same time, conventional farming practices were leading to progressively worse soil degradation, erosion, and deforestation (Mider, et al., 2011).
Zambia, Malawi and Zimbabwe are countries that faced a major decline in the agricultural sector for several years due to incorrect soil use and traditional agriculture practices such as excessive burnings of the forest and the ground, continuous ploughing contributing to soil degradation and land abandonment. This was followed by cattle loss in many farms due to diseases (Haggablade, 2009).

Plantation furrows and tillage made with a hoe or ploughs of animal traction are common in Zambia and Malawi and are used to align the soils in a vertical way instead of horizontal which causes enormous soil erosion. These furrows work as drains that concentrate water but due to intense soil fracture and disurbance caused each time the plough passes through the ground it increases soil erosion. Countries following traditional agriculture practices waste a lot of time, energy, work, labour force and money (to buy household and farm products) and obtained results are low quality harvests with low productivity, quick soil degradation and erosion with negative impacts to the environment and a lot of sacrifice in vain (Keck, 2001).

In Malawi, traditional agriculture farmers practicing tillage and ploughing the fields move up to 600 tones of soil each year on furrow openers (GAIA, 2009). Despite the extensive work it requires, it is unnecessary as it causes low productivity and increases the degradation of soils up to a stage when soils are not able to carry out their functions and reach a turning point of becoming desert.
Due to constant practices of traditional agriculture it is calculated that 30 per cent of the cultivated land in Zimbabwe is totally degraded (GAIA, 2009). In Malawi, due to intensive tillage and ploughing in soils and on the mountains, the situation tends to get worse. Due to great land abundance in Zambia, the farmers abandon the farms that no longer produce and migrate to areas where the land is still virgin. In these new areas, they start to cut down trees, burning and starting the process of soil destruction process once again.

In Mozambique, the system of Traditional Agriculture is similar when it comes uncontrolled burnings and abandonment of fields that are no longer producing enough. The farmers begin a new traditional sowing cycle, in a new field, until it produces the quantity of a normal production. If not, this field of production will be abandoned and the cycle of soil destruction continues to increase environmental degradation.

2.2.8. Definition and Description of Climate Change

The greenhouse effect is a natural phenomenon that preserves life on planet earth. The global heat is caused by the increase of concentration of greenhouse gases (GEE) and is highly increasing. This increase of gases started with the burning of fossil fuel from Industrial Revolution. The burning of fossil fuel is responsible for more than 75% of emission of CO$_2$ in the atmosphere (Gore, 2006). The soil occupation, deforestation and degradation of forest are responsible for the rest.
At this present moment, the GEE effect is so high so much that it is giving origin to “tragedies or natural disasters” (Jacobi, 2011, 2). At Cúpula conference on climate changes in Copenhague, in December 2009, it was concluded that education should also be responsible to disseminate and help change this scenario with its research and researchers. There should be much sensitized attention and academic environment on our part to this vulnerability in to be minimized. “This is a question of responsibility and global citizenship” (Jacobi, 2011, 2).

Countries like: South Arica, Australia, Brazil, Canada, China, South Korea, Denmark, United States, United Kingdom and Singapore developed what we call “Climate Changes and Sustainable Development” (Lobosco and Penella, 2010, 1) in a way to create strategies to be applied in their countries on the education level to reduce this problem which all contribute to the economy and health (Nobre, et al., 2012, 28).

Agriculture is an activity that depends on climate factors such as: temperature, rainfall, soil humidity and solar radiation. If these factors are not effective or if they are excessive, they will affect the sowings and the agricultural production. If the agricultural production is affected, the economy, health and development will also be affected. On the other hand, these negative climate factors bring along with it a lot of plagues and diseases, brought by floods and strong winds.
Not only does CA reduce the negative impacts of tillage, builds soil carbon, it improves soil health, water utilization and it has promoted an increased farm yield in many regions. This has become one of CA’s far reaching accomplishment. As agricultural production and food security is being critically affected by climate change many people tend to focus more on the potential of CA as the role of agriculture and productive landscapes in climate mitigation that is more widely recognized (Milder, et al., 2011).

2.2.8.1. Conservation Agriculture as a means to Mitigate Climate Change

The technological development worldwide, mainly in highly developed countries, has destroyed the soil for several years and is still destroying it. This destruction is due to the systematic use of chemical fertilizers, pesticides, herbicides, utilization of enormous agricultural machines such as: sowers, and tractors which destroy the soil, causing the plants to become more fragile, decreasing the fertility of soils and also the production or cost-effectiveness.

For the plant to produce photosynthesis it gives out oxygen and absorbs CO$_2$ (one of the main greenhouse gases). This atmosphere, due to global heat, is also saturated, affecting the plant and the crops making them more vulnerable to plagues and diseases. With the climate change brought by strong winds, rains, floods for example, these plants continue suffering even more and affecting their cost-effectiveness. At the same time, those plants which resist these factors are not healthy plants for human consumption, because they were produced with a lot of chemicals that are toxic to human health.
But for the plants to be strong and healthy and not suffer a lot due to greenhouse effects in the environment, it is necessary to provide them with a natural environment, whose production system is using Conservational Agriculture. This system avoids soil disturbance, because it is covered with dead matter or grass; use of organic compound and organic liquid fertilizer for the plant to grow healthly and at the same time fertilize the soil. The consortium of plants is also used mixing grasses and leguminous and after that, there will a rotation of crops.

When most of these countries are aware that the global heat and is the cause of their negative effects in the production, economy and people’s health, they change their mechanized production system to Conservational Agriculture System. Mozambique is also a country that has begun to worry about climate change.

### 2.2.8.2. Climate Change in Sub-Saharan Africa

Sub-Saharan Africa, including Mozambique, being poor countries, rarely uses high technologies for the development of agriculture. But on the other hand, they have been practising a lot of irregularities in their traditional production system. The soil on its own is very arid and semi-arid and that means that it does not maintain a lot of humidity, because it is a tropical climate.

For the plants to produce photosynthesis they absorb CO₂ (one of the main greenhouse gases) and on its turn, it is already saturated in the environment. Due to global heat, this atmosphere is also saturated, affecting crops with plagues and diseases. The climate changes bring for example:
strong winds, rain and floods, these plants continue suffering even more and affecting their cost-effectiveness.

But if these plants are strong or healthy, it will be difficult for them to suffer the greenhouse effects and therefore, the cost-effectiveness of plants will start increasing progressively when we cultivate them according to the nature’s modules using the CA techniques.

On the other hand, the Sub-Saharan Africa farmers have the habit of practicing uncontrolled burning. These burnings will increase greenhouse effects in the environment that therefore become saturated due to climate changes. Besides increasing greenhouse effects, soil erosion is also increased at the same time. As a result, when the soil has already suffered a lot it loses its capacity to retain humidity when there are rains. Since they are regarded as arable soils, there will be difficulties to find water and this will hinder the plant’s growth. The burned soils also lose their fertility. Therefore, the whole reproductive cycle of the plant becomes affected decreasing the cost-effectiveness.

In Sub-Saharan Africa, including Mozambique, the climate is tropical and is constituted by large areas of arid and semi-arid climate and this worsens the situation with the climate changes, creating difficulties in the development of agriculture (EMA, 2014). To improve this situation, the best way is to follow the sustainability of existing resources in order not to disturb the soil and make it more productive. This is the reason why production must be according to Conservation
Agricultural system, where there is no burning but covering of soil. For instance organic compound and organic liquid fertilizer are used for the plant to grow healthy and at the same time fertilize the soil. The consortium of plants mixing grasses and leguminous are also used and then that there will be rotation of crops.

CARE USA and the World Wildlife Fund (US) got together with Eco Agriculture Partners to take a closer look at the potentials in the context of African food crop farming under the ambience of “climate smart agriculture” approach to farming (Milder, et al., 2011, II). There is therefore a need to frame conservation agriculture more extensively and applying it strategically as part of integrated for food production, improved livelihoods and conservation (Ibid).

As a response to results and future goals of CA in sub-Saharan Africa, there is increasead food security, alleviating poverty, preserving biodiversity and ecosystem services, supporting climate change adaptation and mitigation at local to global scales (Milder, et al., 2011).

Among other factors CA promotes soil fertility and structures, captures and maintains rainwater, and reduces erosion. It is through these methods that, CA is equipping small-scale farmers to adapt to climate change and improving the local natural base source where a good yield depends (Milder, et al., 2011).

These organizations that are concerned with climate changes are the ones that are in a position to help the development of poor countries such as Mozambique to move out of poverty. It should be taken into consideration that agriculture is the basis for the development of a country,
provided that it is done in a sustainable manner that does not harm the environment. All this is possible when farmers are duly oriented by these organizations that have a better knowledge.

2.2.9. Definition and Description of Food Security

According to Kepple and Segall-Corrêa (2011) food security allows every human being to have regular and permanent access to quality food, in sufficient quantities and without compromising the access to other essential needs. The objective is that these food practices are the basis for a healthy citizen. Cultural diversity should be respected and the social and economic environment should be protected.

The International Conference on Nutrition that was held in Rome in 1992 has defined food security as the guarantee to supply people with food necessary for a healthy life (Moyo, 2000). The three main important factors under food security include: availability of adequate food supplies in relation to quantity, quality and variety; a maintained balance in the course of food supplies and a secure access to the available food supplies (Ibid).

The quality of any food may be determined by controlling the microbiological level that has the function of providing hygienic and sanitary food (De Sousa, 2006). For there to be access in the quality of any necessary food, it is necessary to invest in equipment and skilled people to control food quality. On the contrary, we might consume products that are in conditions not good enough for human consumption, provoking several diseases such as diarrhea among others. If we consume CA produced food we are certain these do not contain any chemical and are healthy.
2.2.9.1. Conservation Agriculture and Food Security

This is a situation which may be improved if policies of these countries could be concerned in incentivizing farmers to produce using the system of Conservation Agriculture (CA) and at the same time creating improved granaries to store the produced seeds.

Only some few costs are involved with The CA system yet it improves the environment and enhances the profitability of soils. This profitability factor is important in production because besides the farmers having enough products for their food they can as well sell the surplus therefore reducing imports and lowering the selling prices in the market, thus food insecurity will be reduced.

If they have good barns, they will farther more improve the quality of food and can stow the crops to sell in the months when these products are scarce in the market. By doing this they will make more money selling in times of scarcity, because they can raise prices. But even with the prices being raised the rates will still be much lower than the sale rates of imports. On the other side the community is consuming a product that is grown by the citizens themselves. They know under which conditions the products were cultivated, and that they have no contents of chemical or toxic products. A well fed person is usually healthy and the body builds immunity against diseases.

Whilst the imported products nobody knows where they come from and under which conditions they were produced, maintained and actually whether they are in excellent condition for
consumption. Often these products are of poor quality, not fit for human consumption and in addition to being expensive can cause disease.

If we sell what we produce we are contributing to people's health. At the same time with sales of the acquired products people can improve their living conditions. By so doing so the economy of the country will be growing and the development also grows in a sustainable manner.

In the case of Mozambique, besides what has already been mentioned earlier, the government should improve the access routes. Many rural communities have difficulties moving in order to sell their products. The roads are of poor quality and access to them is scarce, in the rainy season they become impassable.

2.2.9.2. Food Security in Sub-Saharan Africa

More than 30% of about 200 million people in Africa suffer from severe hunger and malnutrition. Rural families across Sub-Saharan Africa live a precarious survival, highly exposed to droughts, pest outbreaks, and market fluctuations that can mean disaster (Milder, et al., 2011).

The production of cereals has been on a standstill, at an average of about 1.2 tons in Africa, against 3 tons per hectare annually in the developing world as a whole; On the other hand, there has been rapid population growth in many parts of the continent (Milder, et al., 2011).
In a bid to ensure national food security, most countries still depend on the importation of cereals as demonstrated in Table 2.1. makes reference of the period between 1990-1999, with exception of Angola, Mozambique and Namibia all countries imported cereals. The most countries export a greater percentage of their maize only to import later in the year when stocks are depleted. This is a result of lack of insight and strict loyalty to policies (e.g. Zimbabwe) (Moyo, 2000). In this scenario, given the shortage of foreign currency and the poor status of most currencies against the US Dollar, it becomes expensive to ensure food availability (Moyo.2000).

Table 2.1: Import and Export of Cereals in Southern Africa (1990-1999)

<table>
<thead>
<tr>
<th>Country</th>
<th>Average Exports (Mt) 1990-1994</th>
<th>Average Imports (Mt) 1990-1994</th>
<th>Average Exports (Mt) 1995-1999</th>
<th>Average Imports (Mt) 1995-1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mauritius</td>
<td>12833</td>
<td>226434.6</td>
<td>32388.4</td>
<td>258351.4</td>
</tr>
<tr>
<td>Seychelles</td>
<td>1.6</td>
<td>12257</td>
<td>0.4</td>
<td>14980.6</td>
</tr>
<tr>
<td>Madagascar</td>
<td>20139.6</td>
<td>119401</td>
<td>5171.2</td>
<td>134980.6</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>562466.4</td>
<td>450859.2</td>
<td>401840</td>
<td>265424</td>
</tr>
<tr>
<td>Botswana</td>
<td>3881.4</td>
<td>128746.8</td>
<td>3041.8</td>
<td>150244</td>
</tr>
<tr>
<td>Malawi</td>
<td>6505.8</td>
<td>378096.8</td>
<td>5557.6</td>
<td>264841.4</td>
</tr>
<tr>
<td>Mozambique</td>
<td>0</td>
<td>665690</td>
<td>0</td>
<td>446064.8</td>
</tr>
<tr>
<td>Angola</td>
<td>0</td>
<td>355778.8</td>
<td>0</td>
<td>452679.6</td>
</tr>
<tr>
<td>Namibia</td>
<td>0</td>
<td>129364</td>
<td>0</td>
<td>177104.2</td>
</tr>
<tr>
<td>South Africa</td>
<td>1529907</td>
<td>2157655</td>
<td>1515896</td>
<td>1730908</td>
</tr>
<tr>
<td>Swaziland</td>
<td>30</td>
<td>77641.8</td>
<td>1953.4</td>
<td>56625</td>
</tr>
<tr>
<td>Zambia</td>
<td>5171.8</td>
<td>267204.4</td>
<td>656</td>
<td>196077.6</td>
</tr>
</tbody>
</table>


The United Nations Food and Agricultural Organization (UNFAO) estimates that sub-Saharan countries lose up to forty percent of their agricultural produce after harvest (African Leaders, 2011).
Countries like the Democratic Republic of Congo (DRC), Zimbabwe and Mozambique which belong to the highly vulnerable economies category depend heavily on imports (African Development Bank Group, 2009). This is a situation which may improve if policies of these countries are concerned in encouraging farmers to produce using the system of Conservation Agriculture at the same time creating improved granaries to store the seeds produced.

The CA system gets few costs, improves the environment and enhances the profitability of soils. This profitability factor in production is important because farmers instead of having enough products for their food, they can sell the surplus by reducing imports and lowering the selling prices in the market, reducing like this food insecurity.

If they have good barns, they will far more improve the quality of food and can stow the crops to sell in the months that these products are scarce in the market. If they do this they, will earn more money selling in times of scarcity, because they can raise prices. But even rising prices purchase will still be much smaller than the sales amount of imports. On the other side are consuming a product that is grown by the citizens themselves. They know under what conditions were cultivated without chemicals and without toxic products. A well fed person is usually healthy and the body builds immunity against diseases.

Therefore the imported products come from where nobody knows the conditions that they were produced, conserved and if they are in excellent condition for consume. Oftentimes these products are of poor quality, out of time for human consume and besides being expensive can cause disease.
If we can sell what we produce we are contributing to people's health. At the same time with sales of the produced products people can improve their living conditions. Like this the economy is growing and development also grows in a sustainable way.

In the case of Mozambique, beyond what has already been mentioned earlier, the government should improve the access routes. The rural communities have many difficulties moving to go sell their products. The access to roads is scarce, of poor quality and in the rainy season become impassable.

2.2.10. Definition and Description of Community

The community is a creation of Man. It is the protector of the individual; therefore the individual must go where the community goes, also known as the "community centre" (Onwubiko, 1969, 14). The community center is the village square which acts as a social, judicial, religious and political center. It is a traditional place of community gatherings, where the communal meetings take place for political discussions, public tribunals, games and sports; and all members are aware of all the important events in and around the community (Ibid).

A community can be considered as a "place that has a story, and transforms itself" (Charles, 2007, 26) is where men are together, living together, exchanging ideas and analyzing certain important situations for the development of the place. A comparison is made in most cases between "town and country" but the importance is that each of them contributes to the development of the country itself (Santos, 2009, 17).
Often the relationship between rural and urban and the understanding of these two worlds create contradictions, due to the interdependence between them. But truly they are complementary and together form a single space. As it is with countryside, the city consolidates the international division of labor (Siqueira and Dos Santos, 2010).

The researcher agrees with all these definition of community. In fact they are all inter-related and complementary. The research project is a case study in Conservation Agriculture, which is conducted in two rural communities.

2.2.10.1. Community in Sub-Saharan Africa

In this frame of reference, Conservation Agriculture comprises of low external inputs and locally adapted agricultural strategies that can be embraced by the most vulnerable and poorest farmers, as well as by those communities that can afford different levels of mechanization and external inputs. In most regions where it has been implemented, Conservation Agriculture has brought great benefits for farming communities. As a result, Conservation Agriculture should be considered to be a preferred approach to agricultural development for smallholder farmers in many African regions (Milder, et al., 2011).

Furthermore, CA essentially increases profitability, while decreasing labor and making it less toilsome with HIV/AIDS patients. In our midst these benefits are really important especially to women and vulnerable groups in the society (Baudron, et al., 2007; FAO, 2010 d).
Often the adoption of Conservation Agriculture in the communities depends on a donor project programs (Baudron, et al., 2009). This donor creates conditions for education and offers few incentives. This helps farmers in the community to reintegrate these project programs, and envisage CA as the best way of monetization of their fields without harming the environment, contributing to the development of the community itself.

In communities of Kenya, for a woman to practice CA she must ask the permission of male relatives (Kaumbutho and Kienzle, 2007) and in Ghana, in some communities the size of the field is smaller for women compared to men (Boahen, et al., 2007)

But usually those who practice CA more in communities of Africa Sub-Saharan Africa are women. Women are usually the leaders of this type of agricultural activities and Malawi is an example (Mloza-Band and Nanthmabwe, 2010); Lesotho (Silisi, 2010).

In Mozambique who leads the farms are women. In this research in question the researcher observed that the greater number of those practicing AC is women, as their husbands work in South Africa. On the other hand these women are also leaders because they are chosen by the community to lead the AC groups.

2.2.11. Definition and Description of Land

According to the Dictionary (Vilela, 1990) means the ground on which you walk; the soft part of the soil produces agriculture; land that belongs to someone; Land is at the centre of rural livelihoods.
The United Nations Food and Agriculture Organization (FAO) urged the world leaders to regulate land ownership as a first step to fight hunger and poverty. "A legal system for the use of land ownership is key to fighting hunger," (Verdade, 2012,1; FAO, 2012) Caldeira (Newspaper Editor) he said in a statement to the FAO, the organization that initiated consultations in the world to develop international guidelines on the ownership of land and other natural resources such as water, fisheries and forests. "A secure land access is the best safety net for the poor and this is because a good land governance is necessary to ensure such access and the rights of tenure status," explained Paul Munro-Faure, Head of Unit management and Land Tenure FAO (Verdade, 2012,1).

Through the appeal of governments and the international community a proposal was launched in an office in Rome. The intention was to coordinate the needs of the private sector, poor farmers, indigenous groups, local authorities, academia and independent experts. Laws were set in place in favor of the farmers and residents of the forests, as well as foreign and local investors, who are chased away or confiscation of such an unreasonable way. However, these laws are not regarded seriously by some influential individual entities. "The growing demand for land threatens to foster social exclusion, because the rich and powerful are able to acquire land and other natural resources at the expense of the poor and vulnerable"( Verdade, 2012,1; FAO, 2012).

Also according to FAO’s report (2012), there is growing interest to improve the governance of tenure of land and all other natural resources and it is essential to establish guidelines. The launched proposals have also highlighted the way governments should address and deal with the
growing trend of foreign investors in large scale power and biofuels, along with investor countries with limited arable land and water resources.

2.2.11. Land in Sub-Saharan Africa

The Zambian Land Policy Document (Moyo, 2000, 1) boldly declares, “land is the biggest asset and forms the basis for all human survival in terms of social and economic development”. At the household level, Food Security is achieved through direct production from the land and their access is essential for the subsistence of the people. The land when properly used can provide food security of the people. “More than 60% of the population in countries like Angola, Namibia, Zimbabwe, Tanzania and Mozambique reside in the rural areas while in Lesotho, Madagascar and Malawi the percentage is more than 70%” (Moyo, 2000: 1). Despite the fact that South Africa and Seychelles have more than 50% of their population living in the urban areas, it is possible to conclude that land is at the centre of rural people’s source of income in this region of the continent (Ibid).

According to a which government publication, the land is state owned since 1977. The publication reads, “The land and the natural resources located in the soil and underground waters, territorial waters and the continental shelf of Mozambique are the property of the State. The State determines the conditions of their use…” (Mosca, 2011, 202).

In this context, the development of rural areas and the continued survival of the majority of urban populations rely on agricultural production. For this it reason is important to know how to
effectively the land to ensure food security of the population of any country of the SADC (Moyo, 2000).

According Moyo (2000, 2) not only rural but also urban areas depend on agricultural production, i.e., depend on the land. This requires action that:

“Access to good quality-land;
Secure land rights over the land;
Efficient agricultural production;
Appropriate land utilization rates, and responsive land administration structures.”

Therefore, the development of rural areas and the continued survival of the majority of urban populations rely on agricultural production. For this reason it is important to know cultivate the land to ensure food security of the population of any country of the SADC (Moyo, 2000).

2.2.12. Definition and Description of Poverty

One of the main causes of hunger is poverty. Poverty is scarcity, shortage, or the state of lacking a certain amount of material possessions or money; it is the unbalanced economic status of people in society (FAO, 2013). The terms of absolute poverty or extreme poverty refer to the deprivation of basic human needs which include food, water, shelter, clothing, sanitation, health care and education. Poverty is a vicious circle where hunger causes poor health inducing low levels of energy and mental defectiveness; hunger can lead to even greater poverty by reducing people's work force and learn, thus resulting to even greater hunger (Ibid).
Poverty is usually associated with developing countries; these are part malnutrition, hunger, lack of clean water at the same time social exclusion. "Poverty leads to social exclusion of an individual resulting in the impoverishment of an entire society" (Rego, 2010, 5). The measurement of poverty is based on the average income of a citizen. It is calculated through economic and macro-economic analyzes.

Technological development also affects poverty, because people don’t often get better work because they have no professional qualifications. Then they are affected by unemployment, will not have money to access or purchase food in order to have a basic supply. This is a problem that came up with the technology and are known as the new poor (Costa, 1998). This kind of poverty leads to social exclusion.

According to the World Bank data in April 2013, Figure 2.4 it was noticed that in 1981 there were 1.938 billion people living on less than $ 1.25 / day in developing countries, representing 52.2% of the population of these countries. But these numbers have been decreasing. The most significant decrease was between 2003 and 2008, where extreme poverty in 2010 was 1.2 billion people representing 21% of the population in these developing countries (Alves, 2013). Extreme poverty means that many people die because they lack access to basic sanitation.
These are very good figures that prove that poverty is significantly decreasing. Which means we should continue to fight, each one of us doing his part to further improve this scenario of poverty in developing countries. Therefore Conservation Agriculture is something that should be practiced in these poor countries to help them reduce extreme poverty; without harming the environment, producing in a sustainable and profitable manner.
2.2.12.1. Poverty in Sub-Saharan Africa

The main cause of hunger is poverty. Poverty and food security are interlinked. A combination of factors is conducive to the state of food insecurity and poverty in the area. A fundamental cause is policy failure in terms of skewed trading systems, poor production incentives, poor access to productive lands and poor marketing. Low productivity and recurrent droughts and floods have led to food insecurity in the sub-region (Moyo, 2000).

According to Moyo (2000) he does a very detailed reference:

Firstly, the relative decline of agricultural production for domestic food and industrial requirements, vis-à-vis the growing needs in relation to demographic changes (population growth and urban relocation of vast segments) led to increased food insecurity and impoverishment.

Secondly, the increasing cost of food for the majority of the poor and the concentration of consumption among the relatively wealthier and better accepted in countries, regions and social groups.

Thirdly, the continued relative or proportionate decline in food production vis-à-vis production for exports and even for local agro-industrial activities, as a result of concentrated allocation of resources towards raw materials exports and because of the de-industrialization
Fourthly, the earnings from agricultural exports due to failing terms of trade and the protection of western markets have negatively affected the performance of African agriculture. This has lessened African earnings from agriculture and constrained foreign currency and incomes.

The HIV Aids pandemic has worsened the food security problems; especially at the community level where it has down away with active members of the family while at the same time the sick sucking the little family resources available (human, financial). Thus data available indicates that a combination of poor economic policy, water scarcity, changing climate, incessant natural disasters, deteriorating soils and a burgeoning population have all contributed to poverty (Moyo, 2000).

The gravity of food insecurity varies between countries (see also table 2.2) and within localities in specific countries. An important feature is that food insecurity is acute during periods of drought.

**Table 2.2: The Extent of the Food Crisis in Selected Countries in Southern Africa (September 2002 to March 2003)**

<table>
<thead>
<tr>
<th>Country</th>
<th>% Pop. In Need of Food Aid</th>
<th>Malnutrition in Children Under Five (%)</th>
<th>Wasting</th>
<th>Stunting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesotho</td>
<td>34</td>
<td>7.5</td>
<td>34.7</td>
<td></td>
</tr>
<tr>
<td>Malawi</td>
<td>31</td>
<td>6</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Mozambique</td>
<td>3</td>
<td>5.5</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>Swaziland</td>
<td>28</td>
<td>2.2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Zambia</td>
<td>28</td>
<td>4.4</td>
<td>39.9</td>
<td></td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>52</td>
<td>7.3</td>
<td>49.3</td>
<td></td>
</tr>
</tbody>
</table>

*Source: SADC-FANR 2002a, 2002b.*
In 2004, the Government of Mozambique elaborated the Action Plan for the Reduction of Absolute Poverty (APRAP II) which was based on the five year plan for the years between 2005 and 2009. APRAP II defines poverty as "the inability of individuals to provide for themselves and their dependents a set off basic conditions for minimum survival"(Maússe, 2009, 24). This concept takes into account patterns of food consumption, measured in kilocalories minimal, estimated at about 2,150 calories/per person/day. The poverty line, measured in terms of consumption was set in 1997 in MZN 5,43 (US$0.18) per person/day (Ibid).

In 1995 Zambia passed through a food crisis due to degradation of its soil, caused by the use of fire in traditional farming, using up much land to produce very little. At that time the Conservation Farming Unit (CFU) organization was created. This together with the Zambian government, created strategies to encourage the poorest farmers by offering them seeds, giving them training on techniques of Conservation Agriculture. All this was being done all over the communities. In the beginning farmers found themselves skeptics to believe such techniques. For, they had never heard of them but experienced many other techniques known to them that they believed would improve the soil, but was actually worsening as time passed by. But gradually they believed in CA as their production yields began to increase without making major physical effort and investing in a lot of money on labor. Gradually they began to adhere to the CFU program and in 2001 there were already 20,000 farmers producing in CA which means that they were satisfied with the existing productions. And in 2009 there were up to 180,000 farmers cultivating in AC. (Giller et al, 2009).
The example of Zambia has made its neighbors: Malawi and Zimbabwe, Kenya, Tanzania, Angola and others to take a deeper thinking on the practice and also start shifting from the traditional production system and follow the experience of Zambia. Nowadays the farming communities of these countries are having increased incomes, have food and are contributing to the improvement of soil and at the same time the environment. Mozambique should also follow the same example, to reduce poverty.

2.3. Theoretical Framework – The Trophobiose Theory

The term Trophobiosis originates from the Greek: *trophos* (food) and *biosis* (existence of life). In congruence with this theory, every organism plant is vulnerable to pest infestation and diseases where excess amino acids and reducing sugars are present in the system metabolic (Vilanova and Silva Junior, 2009,40; Polito, 2005). The trophobiosis is directly related to agro ecological cultures management and is, contributing to resistance physiological plant and sustainability agro ecosystem (Vilanova and Silva Junior, 2009).

From a systemic focus, agro ecology adopts the agro ecosystem as a unit analysis and provides the scientific basis (principles, concepts and methodologies) to support the process of transition from the current conventional agricultural model to sustainable agricultural styles. Agro ecosystem is the fundamental study unit in which mineral cycles, energy transformations and biological and socioeconomic relation processes are seen and analyzed as a whole. Their goals are not to particularly maximize production, but to optimize agro ecosystem altogether. In this perspective it is necessary to have greater emphasis on information analysis and interpretation of
existing complex relationships between people, crops, soil, water and animals. It is evident that there is need to adopt holistic and systemic approaches in all interventions aiming to transform ecosystems in agro ecosystems (Altieri, 2002; Caporal and Costabeber, 2004).

The systemic approach aims to study the overall system performance, instead of focusing on the agriculture parts alone. It has become increasing necessary due to complex organized growing systems being handled by men and the emergence of the sustainability concept (Pinheiro, 2000). Thus, the health of an agriculture organization should take into consideration a balanced dynamic striving to achieve sustainability within ecosystems (Vilanova and Silva Junior, 2009).

Ecosystems are regarded as natural samples as opposed to agro ecosystems and due to being kept by men in favor of cultigens interest, it is essential to develop compensating measures that constitute the Organic Farming Techniques (Deffune, 2007).

The health and quality of animals, plants and their products rely on the adoption and conscious application of technical knowledge responding to the vital processes involved with the nature of the problems such as pests and other diseases and their respective solutions (Deffune, 2007).

Analytically speaking, agriculture technologies have been considered to be a mechanism on the agro ecosystems sustainability. As Hippocrates, the father of medicine has recommended: “Sublata causa tolitur effectus” (removing the cause shall cease the effect to occur) source.
With this premise taken into consideration, French scientist Francis Chaboussou laid the foundations of the Trophobiosis theory. As a result, pest attack and diseases in crops are an effect whose cause is the metabolic imbalance of plants (Vila Nova e Silva Junior, 2009, 40; Pinheiro and Barreto, 1996).

In order to obtain sustainability, organic culture must use two main pillars of any ecosystem - soil - as “an area inhabited by thousands bodies, with endless interactions with each other and non-living components, behaving as a living component within the ecosystem, affecting and being directly affected by cultural practices used in the production process” (Vila Nova e Silva Junior, 2009, 40; Feiden, 2001).

According to Chaboussou (1999), not every plant is attacked by pests and diseases; only those that serve as food for insects or pathogens. In other words, pests will only attack the cultivated plant when it provides sufficient quantity and availability of substances or food for these pests and diseases. This occurs when the plant has not been cultivated in an optimal way. Thus, for a plant to be resistant, it is important to manage its growth in the correct manner; and recognize the factors affecting a plant’s internal balance and functioning which lessen or increase its susceptibility to pest and disease attacks. There are factors related to the plant, such as its adaptation to the local climate, age, grafting; and factors related to the environment such as light, climate, temperature, humidity and wind; or factors associated with management practices such as soil fertility, time of planting, spacing, tilling, pruning and type of fertilizers used (Vilanova and Silva Junior, 2009).
A set of agricultural practices based in agro ecological principles can be quite efficient in the management of environmental complexity and contribute to trophobiotic balance, resulting in lesser plants vulnerability to pests and diseases. As claimed by Altieri (2002) and Vilanova and Silva Junior (2009), these practices should always include:

Vegetation covers as an effective measure in the conservation of soil and water, through tillage, mulch, living mulch, etc.;

Regular supply of organic matter (manure, compost) and activity biotic soil promotion;

Nutrient recycling mechanisms through the use of crop rotation systems, integrated plants and animals production, agro forestry and intercropping systems;

Pest control, with greater activity of biological control agents, achieved through biodiversity management and introduction and/or conservation of natural enemies;

Increased habiliy to use multiple landscapes.

Production maintenance without the use of chemical inputs that degrade the environment not disregarding a number of cultural practices recommended in agro ecological management and organic agriculture. Some of the leading practices below can be recognized for their trophobiosis effectiveness:

- Efficient use of irrigation;
- Formation of windbreaks;
- Organic fertilization;
- Nutrient planting management;
- Use of biofertilizers and grout fertiprotectors;
- Lime and gypsum;
• Use of appropriate species and varieties to local environmental conditions;
• Maintenance of soil cover;
• Removing the use of pesticides.

As previously mentioned trophobiosis is related to a management system as a whole, in which various factors, and interactions between them, contribute to appropriate trophobiotic balance conditions. Therefore, only through a technological systemic approach, in which the structure and agro ecosystem functions are holistically analyzed, is possible to achieve trophobiosis balance that generates and increases sustainability (Figure 2.5). Consequently, it is possible to conclude that trophobiosis characteristics are perfectly interlinked with conservation agriculture characteristics.
2.4. Review of the Empirical Literature

2.4.1. History, Development and relevance of CA

According to Friedrich et al. (2012), tillage was questioned for the first time in the 1930s, particularly in fragile ecosystems, when the dust bowls devastated extensive areas of the mid-west in the United States. Concepts for reducing tillage and keeping soils covered came up and the term conservation tillage was introduced to reveal such practices aimed at the protection of the soil. In the 1940s seeding machinery developments allowed to seed directly without any soil
tillage. Concomitantly, Edward Faulkner with the “Ploughman’s Folly” (Friedrich et al., 2012, 3; Faulkner, 1945) and Masanobu Fukuoka in his book “One Straw Revolution” (Friedrich et al., 2012, 3; Fukuoka, 1975) elaborated theoretical concepts similar to today’s CA principles. But it was not until the 1960s that no-tillage entered into farming practices in the USA.

No-tillage farming reached Brazil in the early 1970s, where scientists together with farmers transformed the technology into the system which today is called CA. Alongside, no-tillage and mulching were also tested in the 1970s in West Africa (Greenland, 1975; Lal, 1977, 1976). Yet it took about 20 years for CA to reach significant adoption in South America and other places of the world.

During the 1990s this development progressively attracted other parts of the globe, including development organizations and international research like FAO, Centre de Coopération Internationale en Recerche Agronomique pour le Développement (CIRAD) and a few centers Consultative Group on International Agricultural Research (CGIAR) (Friedrich et al., 2012).

Study tours for farmers and policy makers were created in Brazil; and regional workshops, research and development projects were organized in various parts of the world resulting in increased levels of awareness and adoption in several African countries including Zambia, Tanzania and Kenya, and in Asia predominantly in Kazakhstan and China (Friedrich et al., 2012).
After the end of the millennium, conservation tillage and no-tillage improvement practices within an integrated farming concept – such as CA - also generated increased adoption in industrialized countries such as Canada, Australia, Spain and Finland (Friedrich, et al., 2012).

Nowadays CA crop production systems have received increased interest around the world. There is only a limited amount of countries where CA is not practiced by farmers, and where there are no local research results available. In 2011, there was an estimate of a total of 125 million hectares adopting CA around the world (FAO, 2011c).

CA is practiced by farmers from the arctic circle, such as Finland; over the tropics particularly in Kenya and Uganda; to about 50° latitude South in the Malvinas/Falkland Islands; in several countries of the world from sea level to 3,000 m altitude like Bolivia and Colombia; in extremely dry conditions from 250mm /year – like Morocco and Western Australia – to heavy rainfall areas with 2,000 mm/year (Brazil) or 3,000 mm a year (Chile) (Friedrich, 2012).

No-tillage is practiced on all farm sizes; from less than half a hectare in countries like China and Zambia; to thousands of hectares such as those in Argentina, Brazil and Kazakhstan. It is practiced on soils that vary from 90% of sand like in Australia; to 80% clay common in Oxisols and Alfisols of Brazil (Friedrich, 2012).
Even though soils with high clay content are extremely sticky this has not been an obstacle to no-till adoption when appropriate equipment is available. Soils which under tillage farming are eagerly prone to crusting and surface sealing do not present this problem under CA due to the fact that the mulch cover avoids crusting formations (Friedrich, 2012).

CA has equally allowed expansion of agriculture to land areas viewed as marginal in terms of fertility and rainfall common in land extensions in Australia and Argentina. All crops can grow adequately in CA; and there is still no evidence found of a crop that has not successfully grown and produced under this system, including tuber and root crops ((Friedrich, 2012; Derpsch and Friedrich, 2009).

However, the main barriers of CA practices’ adoption remain: the know-how (or the knowledge on how to do it properly); people’s mindset (tradition, habit, culture, prejudice); inadequate policies like commodity based subsidies in the EU and the US and direct farm payments (in EU), lack of availability of appropriate machines and equipment in many countries of the world; unavailability of suitable herbicides to assist on weed and vegetation management – especially for large scale production farms in developing countries (Friedrich, 2012; FAO, 2008; Friedrich and Kassam, 2009).

Throughout these years and all these mentioned countries above, it was clear that the method used in Conservation Agriculture has always been based on the direct planting, mulch the soil to
prevent soil degradation and soil fertility. All these features are similar to those used in the present study.

2.4.2. Global Area and Regional Distribution in CA

There are no officially reported global data of CA adoption. All information is collected from local farmers and interest groups. The data is then assembled and published by FAO (Friedrich, 2012; FAO, 2011c). For the data collection, CA definition is quantified as per the following:

1. Minimum Soil Disturbance which refers to low disturbance, direct seeding and no-tillage soils. The area that has been disrupted must not exceed 15 cm wide or the equivalent to 25% of the cropped area (whichever is lower). There should be no periodic tillage that disrupts a greater area than the above-mentioned limits. Strip tillage is acceptable if the disrupted area is less than the set limits.

2. Organic soil cover with three distinguished categories: 30-60%, >60-90% and >90% ground covers, measured right after direct seeding operations. Areas with less than 30% cover are not considered as CAs.

3. Crop rotations/associations that should involve not less than 3 different crops. Despite the fact that repetitive wheat or maize cropping is not a prohibited factor for the purpose of data collection, rotation/association is recorded where practiced.
Table 2.3. shows the worldwide spread of Conservation Agriculture in 2011, ranking countries according to area adopted. As shown in the table 2.3. Conservation Agriculture has become a fast growing production system. While in 1973/74 the system was used only on 2.8M hectares worldwide, the area had grown to 6.2M hectares in 1983/84 and to 38M hectares in 1996/97 [18]. In 1999, worldwide adoption went up to 45M hectares and by 2003 up to 72M hectares. In the past 11 years Conservation Agriculture systems have expanded at an average rate of 7M ha/year from 45 to 125M hectares showing an increasing interest of farmers using this production system (Friedrich, et al., 2012).

**Table 2.3: Extent of Adoption of Conservation Agriculture Worldwide (countries with > 100,000 ha)**

<table>
<thead>
<tr>
<th>Country</th>
<th>CA area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>26,500,000</td>
</tr>
<tr>
<td>Argentina</td>
<td>25,553,000</td>
</tr>
<tr>
<td>Brazil</td>
<td>25,502,000</td>
</tr>
<tr>
<td>Australia</td>
<td>17,000,000</td>
</tr>
<tr>
<td>Canada</td>
<td>13,481,000</td>
</tr>
<tr>
<td>Russia</td>
<td>4,500,000</td>
</tr>
<tr>
<td>China</td>
<td>3,100,000</td>
</tr>
<tr>
<td>Paraguay</td>
<td>2,400,000</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>1,600,000</td>
</tr>
<tr>
<td>Bolivia</td>
<td>706,000</td>
</tr>
<tr>
<td>Uruguay</td>
<td>655,100</td>
</tr>
<tr>
<td>Country</td>
<td>Area</td>
</tr>
<tr>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>Spain</td>
<td>650,000</td>
</tr>
<tr>
<td>Ukraine</td>
<td>600,000</td>
</tr>
<tr>
<td>South Africa</td>
<td>368,000</td>
</tr>
<tr>
<td>Venezuela</td>
<td>300,000</td>
</tr>
<tr>
<td>France</td>
<td>200,000</td>
</tr>
<tr>
<td>Zambia</td>
<td>200,000</td>
</tr>
<tr>
<td>Chile</td>
<td>180,000</td>
</tr>
<tr>
<td>New Zealand</td>
<td>162,000</td>
</tr>
<tr>
<td>Finland</td>
<td>160,000</td>
</tr>
<tr>
<td>Mozambique</td>
<td>152,000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>150,000</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>139,300</td>
</tr>
<tr>
<td>Colombia</td>
<td>127,000</td>
</tr>
<tr>
<td>Others</td>
<td>409,440</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>124,794,840</strong></td>
</tr>
</tbody>
</table>

Source: FAO, 2011c

The growth of the area under Conservation Agriculture has been specifically significant in South America where the Southern markets (MERCOSUR) countries which include Argentina, Brazil, Paraguay and Uruguay, are using this system on about 70% of the total cultivated area. “More
than two thirds of no-tillage practiced in MERCOSUR is permanently under this system”, which implies that once it is introduced to the soil it is never tilled again (Friedrich, et al., 2012,5).

As shown in Table 2.4., “45% of the total global area under Conservation Agriculture is in South America, 32% in the United States of America and Canada, 14% in Australia and New Zealand and 9% in the rest of the world including Europe, Asia and Africa. The latter are the developing continents in terms of Conservation Agriculture adoption” (Friedrich, et al., 2012, 5). Despite good and long lasting results in Africa and Asia showing positive results for no-tillage systems, CA has experienced small rates of adoption (Ibid).

Areas under CA systems have been growing exponentially, largely as a result of initiatives developed by farmers and their organizations and due to CA systems benefits. These benefits include yield, land use sustainability, incomes, ease of farming and ecosystem services and appropriateness of cropping practices (Friedrich, et al., 2012).

<table>
<thead>
<tr>
<th>Continent</th>
<th>Area (ha)</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South America</td>
<td>55,464,100</td>
<td>45</td>
</tr>
<tr>
<td>North America</td>
<td>39,981,000</td>
<td>32</td>
</tr>
<tr>
<td>Australia &amp; New Zealand</td>
<td>17,162,000</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 2.4: Area under Conservation Agriculture by continent
### 2.4.3. Conservation Agriculture Adoption in Sub-Saharan Africa

Innovative partaking approaches are being used to develop supply-chains for creating CA equipment supporting small holders in the Sub-Saharan Africa. “Similarly, participatory learning approaches such as those based on the principles of Farmer Field Schools (FFS) are being encouraged to strengthen farmers’ understanding of the principles underlying CA and how these can be adapted to local situations” (Friedrich, et al., 2012,9).

CA is spreading to the Sub-Saharan Africa region, predominantly in the eastern and southern part of Africa as shown in Table 2.5. Building on scientific and indigenous knowledge, Latin America equipment design, and more recently with the collaboration from Bangladesh, China and Australia, there are now at least 14 African countries using conservation agriculture: Sudan, Kenya, Tanzania, Malawi, Zambia, Zimbabwe, Mozambique, Madagascar, South Africa, Lesotho, Swaziland, Ghana, Uganda, and Burkina Faso. Additionally, CA has been integrated by

<table>
<thead>
<tr>
<th>Region</th>
<th>MA ha</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>4,723,000</td>
<td>4</td>
</tr>
<tr>
<td>Russia &amp; Ukraine</td>
<td>5,100,000</td>
<td>3</td>
</tr>
<tr>
<td>Europe</td>
<td>1,351,900</td>
<td>1</td>
</tr>
<tr>
<td>Africa</td>
<td>1,012,840</td>
<td>1</td>
</tr>
<tr>
<td>World total</td>
<td>124,794,840</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: FAO, 2011c*
NEPAD (New Partnership for Africa’s Development) into the regional agricultural policies (Friedrich, et al., 2012).

In the specific circumstances surrounding Africa where farmers have limited resources, CA systems are relevant for focusing at the challenges of climate change, environmental degradation, high energy costs, and labor insufficiencies. Even though the area under CA is still relatively small, there is a steady growing movement that comprises more than 400,000 small-scale farmers for a total area of approximately 1M ha (Friedrich, et al., 2012).

Table 2.5: Conservation Agriculture adoption in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>CA area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana</td>
<td>30,000</td>
</tr>
<tr>
<td>Kenya</td>
<td>33,000</td>
</tr>
<tr>
<td>Lesotho</td>
<td>2,000</td>
</tr>
<tr>
<td>Malawi</td>
<td>16,000</td>
</tr>
<tr>
<td>Madagascar</td>
<td>6,000</td>
</tr>
<tr>
<td>Mozambique</td>
<td>152,000</td>
</tr>
<tr>
<td>Namibia</td>
<td>340</td>
</tr>
<tr>
<td>South Africa</td>
<td>368,000</td>
</tr>
<tr>
<td>Sudan</td>
<td>10,000</td>
</tr>
<tr>
<td>Tanzania</td>
<td>25,000</td>
</tr>
</tbody>
</table>
CA is equally expected to increase food production in the In Sub-Saharan African region while reducing environmental negative effects and energy expenses. This will contribute to the development of locally-adapted technologies congruent with CA principles (Friedrich, et al., 2012).

According to Milder, et al. (2011) in 1995, the Zambian Conservation Farming Unit (CFU) was established in an effort to address the acute challenges of small farmers in Zambia, with the hypothesis that Conservation Agriculture (CA) could help relieve problems of environmental degradation and food insecurity. The initial acceptance was slow. Farmers were hesitant towards the new practices, and there were no immediate availability of indispensable tools and machinery. The new approach often required initial labor investment, and there were not always immediate positive results. But as gradually farmers acquired higher yields and profits, especially during dry season, word spread and adherence to this system increased. “The number of small farmers practicing CA in Zambia rose from 20,000 in 2001 to 180,000 in 2009” (Milder, et al., 2011,2; Giller et al., 2009). By the end of 2011, CFU goal was to increase adoption of CA to 250,000 families, the equivalent to 30% of Zambia’s small farmers. “Most of these farmers have boosted grain yields, while in many cases reducing farm labor demands and decreasing susceptibility to drought” (Milder, et al., 2011,2; Giller et al., 2009).
Considering the Zimbabwe Case Study Marongwe et al. (2012, Xi), report that 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 per ha 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. Thus, 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. Sixty percent of Zimbabwe is based in Natural Agro-Ecological Regions.

According to survey reports from Zimbabwe Ministry of Agriculture, the total number of farmers practicing Conservation Agriculture options during the 2010/2012 agriculture seasons, has increased tremendously, with a significant proportion implementing Conservation Agriculture without any input support 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) in (2001) only constituted about 5 percent of area planted to maize during the year. “However, farmers still face challenges in maintaining an adequate ground cover due to the communal grazing systems
that are observed in most areas and high labor demands of hand-based CA systems for land preparation and weed management” (Marongwe, et al., 2012,16).

In accordance with the African Leaders State Africa Report (2011) with regards to food security Malawi is a globally recognized success. The Malawian Government has rendered an overruling priority to agriculture development and food security. It has have heavily invested in the agriculture sector, especially in the Farm Input Subsidy Programme (FISP). Despite the fact that Malawi was experiencing prolonged dry seasons in some regions threatening food security it managed to harvest 3.2M metric tons of maize in 2011 with a surplus of 800,000 metric tons above the country’s annual food requirements.

With regard to Mozambique, the knowledge about Conservation Agriculture is limited as compared to other countries. This is one reason why the researcher wants to do this study. So at the end of the research it will be possible to make a comparative study with the facts and ideas presented in order to draw conclusions regarding Conservation Agriculture. At the end of the research, the researcher wants to find out if it actually yielding using the methods of Conservation Agriculture, and if it is possible to reduce poverty in Mozambique.

2.4.4 Conservation Agriculture and Organizations that support their policies

Cooperative for Assistance and Relief Everywhere (CARE) has supported projects of Conservation Agriculture-based agricultural development in the African continent, including Ghana, Sierra Leone, Mali, Liberia, Tanzania, Angola, Zambia, Zimbabwe, Mozambique and Lesotho with the goal of increasing crop harvests and farmers’ incomes, reversing the land
degradation process and improving the lives of more vulnerable families, especially women. Furthermore, CARE has launched new important initiatives focused on adaptation to climate change in order to assist rural communities face the challenges to food security, drinking water availability, human health and decreasing natural resources triggered by climate changes (Milder, et al., 2011).

As to this project, two locations of Mozambique were beneficiciated which are the Quirimbas Park and some communities in the province of Inhambane. The Quirimbas Park benefited of supports in order to improve the viability of sedentary, reducing the pressure of the conflict between fauna, with the aim of preserving the two without harming them. In Inhambane the project is quite ambitious, involving extension workers, community demonstrators, farmers, agricultural technicians and it has benefited about 15 thousand families, with a strong involvement in women. The aim of the project is to teach farmers to use the Conservation Agriculture system to have better incomes without impairing soil fertility. With the support of the project there were built warehouses to stow the crops and some markets were improved for farmers to sell their products in the future (Milder et al., 2011).

In the Uluguru Mountains, in Morogoro, Tanzania, the Equitable Payment for Watershed Services (EPWS) project encourages Conservation Agriculture, agroforestry, and farm terracing to support increase food security, decrease erosion and promote reforestation in a crucial sub-catchment responsible to supply public water to Dar-Es-Salaam. Despite the relatively low density of the population in the valley, changing cultivation of very steep inclinations led to serious erosion, sedimentation and land degradation. Moreover market connections were weak
and local communities had low possibilities to earn cash income. With the intensification of sustainable permanent farm plots (such as terracing, small livestock raising, composting and better nutrient management) and enhanced market linkages, the EPWS project focused on reducing forest cutting and burning, and shifting cultivation in the upper spreads of the watershed. The project also recruited and trained local professionals to deliver training and outreach activities after the formal project ended. EPWS project partners included WWF, and International Institute for Environment and Development (IIED) and CARE was providing support and training for better-quality agricultural practices (Milder, et al., 2011).

Also in the Uluguru Mountains, in Morogoro, Tanzania, CARE led the Hillside Conservation Agriculture Project (HICAP) supporting 4,400 households (20,000 persons) to implement Conservation Agriculture and related community development functions to improve food security while protecting neighboring forests and watersheds. The project prioritized participatory and gender-sensitive approaches – including farmer field schools establishments, building of facilities for training and demonstration of sustainable agriculture and development of community savings and loan groups – to build village capacity to increase crop harvests and livelihood security. The projects duration was 2009 until the end of 2012, at which a support services with training involved made the transition to local farmer groups and district staff (Milder, et al., 2011).

The United Nations Food and Agricultural Organization (UNFAO) “estimate that sub-Saharan countries lose up to forty percent of their agricultural produce after harvest” (African Leaders, 2011, 121). Malawi has opted to build modern silos in Mangochi, Luchenza and Mzuzu to
ensure the reduction of such post-harvest food deficit. The total maize storage capacity of the Malawian Government silos is 240,000 metric tons. In 2011, it had a stockpile of 216,000 of maize in the Strategic Grain Reserves and Agricultural Development and Marketing Corporation (ADMARC) depots. The Government had also launched small metallic silos for small holder farmers in order to improve food security at the villages. In 2011 they expected a production of about 102,000 metric tons of rice, 2.3 million metric tons of sweet potatoes, 3.7 million metric tons of cassava, 37,000 metric tons of sorghum, 409,000 metric tons of pulses and 26,000 metric tons of millet (Ibid).

In Mozambique the Institute of Agricultural Research of Mozambique (IIAM) has some knowledge about the cultivation system in Conservation Agriculture. But still are not sure whether this system will reduce poverty in Mozambique. They think research should be done in this area to take the doubts that still exist about the Conservation Agriculture system. If it is or not profitable for Mozambique to adopt the agricultural production system, using the techniques of AC (Mouzinho and Grabowski, 2013). This is an excellent reason for the researcher to do this research study. For the data collected here will help improve IIAM decisions regarding the adoption of the use of the Conservation Agriculture system in Mozambique.

This study is a case study done in communities of Nhafenga Rupsinhe in locality Mucheve, in maize, sorghum and beans crops, basic food products in Mozambique. These communities practice Conservation Agriculture since 1997. The study will be done from 1997 to 2012. Also the comparison of production will be taken not only of farmers who use the Conservation Agriculture system, but also farmers of Traditional Agriculture. This comparison will be taken to
make sure their results in terms of profitability, for the productions made over the years. Also will be assessed the environment protection system and the profitability of soil.

This locality of Mucheve was encouraged to produce in the Conservation Agriculture system by several programs of a Sustainable Rural Development project. This was implemented by the Diocesan Caritas of Beira, but funded by the German Organization MISEREOR. The farmers in these communities that adhere to the program had some perks such as: free seed, financial support for organic liquid fertilizer tanks, financial support for organic liquid fertilizer tanks, opening wells, rehabilitation of barns, producing seedlings with fruit trees, and more. These farmers had much training in Conservation Agriculture, and are required to have a field for demonstrating the results, where they practice Conservation Agriculture. The project is still up to date with the consolidation programs and with technical support of an Agricultural Technician.

2.4.5. Recent Food price trends in African

As stated by FAO, in the majority of the sub regions in Africa, cereal prices have remained high or are rising compared to previous years. The main cause of this price increase is a reduction in cereal production in this region (AFDBBrief, 2011).

“Southern Africa sub region’s food price movements in the second half of 2011 have largely went downward, although there were good harvests of maize, which is the main food crop. The generally low prices have helped to stabilize food security in the sub region. The record harvests in countries like Zambia and Malawi were the result of favorable rainfall patterns and the increased availability of agricultural inputs. However, countries like Zimbabwe and Swaziland,
which suffer from irregular rains, recorded lower outputs. In Angola, Lesotho, and Namibia, localized flooding negatively impacted on crop development and reduced national cereal production. South Africa registered a decline in maize production, but this was due to reduced plantings in response to high level of stocks and the low prices that maize was achieving at the time of planting (“AFDBBrief, 2011, 5-7).

2.4.5.1. Countries Experiencing severe Localized Food Insecurity.

There are many and varied reasons for localized food insecurity in Benin, Burundi, Chad, Central African Republic, Congo, Democratic Republic of Congo, Côte-d’Ivoire, Guinea, Uganda, Ethiopia, Sudan, South Sudan, Kenya, Malawi, Mozambique and Madagascar. These include: reduced early yields, low stocks of food, a combination of deep poverty and crop failure, continuous high prices, civil conflicts causing insecurity and limiting access to agricultural lands and food, arrival of refugees, persons internally displaced, insufficient rains, floods, poor health due to HIV/AIDS, malaria, etc. (AFDBBrief, 2011).

This study wants to prove that Conservation Agriculture can help solve some problems concerning the productivity and sustainability, at the same time protecting the environment. If all these countries can produce in sustainable ways poverty will tend to decrease. The Conservation Agriculture uses a set of production techniques that do not use chemicals. The products used are organic. These do not provide diseases. On the other hand you do not lose a lot of time in manpower cultivation on this system; it is not a very difficult job to do. This can facilitate patients of HIV / AIDS, to produce on their farms, even in ill health. If food is produced by CA method, it indicates that there will be profitability, income, better standard of life of the farmers and by the same token reducing poverty.
In September 2012, Ministers of environment of over 40 African countries conducted the 14th regular session of African Ministerial Conference on Environment (AMCEN). It was held in the city of Arusha, Tanzania, and it was the first main conference to talk about actions and programs to address and meet the environmental challenges of Africa such as climate change, land degradation, deforestation, poor agricultural productivity and its impact on poverty (Tauya and Tazvitya, 2012).

We welcome the attitude of these 40 countries. It means that they are concerned with the degradation of the environment and they want soil sustainability, they do not want destruction of tree anyhow, in an uncontrolled way, but they want agricultural productivity to reduce poverty. Probably one of the way to contribute, to reduce poverty is using the CA system. It doesn’t only increase the production and protects the environment but increases the fertility of the soil.

2.4.5.2. Crop Yields and Conservation Agriculture

According to Milder, et al. (2011) various studies have compared CA yields systems to those of traditional farming systems. Recent evaluations of researches conducted in Latin America, Africa and Asia have concluded that Conservation Agriculture can raise yields by 20-120% in comparison to traditional farming practices (Kassam et al., 2009; Derpsch et al., 2010). In Africa, there is evidence of many studies documenting harvest increases for CA adopters. For instance:
• On the report of Shetto et al. (2007), in Tanzania crops increased by 93-360% in sunflower and maize CA systems following the usage of conservation tillage (ripping) and a mucuna cover yield.

• In Uganda, conventional grain farming systems had yield about 2,500 kg/ha and increased to 3,000-3,100 kg/ha with the adoption of CA methods (Nyende et al., 2007).

• FAO (2010b) found significant crop increases in Zimbabwe across several yields, including maize, millet, sorghum, cowpea, and soybean.

• In 2000/2001, Malawi (Mloza-Banda and Nanthambwe, 2010) found that maize crops from CA were between 294% and 477% higher than crops in traditional systems; and 394% to 609% higher in 2001/2002 over six different divisions of agricultural development.

• In 2003, Zambia, farmers practicing CA doubled maize harvests and achieved 60% higher cotton production in comparison to traditional plowing systems (Haggblade and Tembo, 2003).

The aim of this study is to try to prove that Mozambique is able to reduce poverty if farmers stop producing traditionally and begin to produce using the CA system. For such an issue this study will focus on production of the farmers who produced in Conservation Agriculture from 1997 to 2012, in only the production of corn, sorghum and beans. Making a comparison against
production in Traditional Agriculture. This is a case study that will be done in communities of Nhafenga Rupsinhe in location of Mucheve.

2.5. Review of the Localized Literature

In line with the Strategic Plan for the Development of the Agricultural Sector (SPDAS), 2011-2020, the main pillar of the Mozambican economy is the agricultural sector. In 2010, it represented 23% to the Gross Domestic Product (GDP). Additionally, agriculture employs the majority of workforce in the country (90% being female and 70% male); resulting in 80% of the total labor force being employed in agriculture (SPDAS, 2011).

What triggered the interest of this topic of the in the current study is the fact that Mozambique is a poor country. The report of Human Development Index (HDI) by the United Nations Development Program (UNDP), Mozambique ranked as “the fourth poorest country in Africa” (UNDP, 2011).

Furthermore, around 70 per cent of Mozambicans live in the rural areas and the majority survives on subsistence agriculture. Conversely, recurrent flooding and droughts have led people to migrate to urban and coastal areas with aggressive environmental consequences such as water surface pollution and desertification (Mosca, 2011).

To try and minimize the problem of poverty and land degradation due to uncontrolled fires, the researcher wishes to prove that in Mozambique is possible to reduce poverty, if they produce following the AC system.
2.5.1. Laws of Land and Land Territorial of Mozambique

In conformity with Law No. 19/97 of 1 October land is defined as a universal means of social well-being and society’s wealth, and every Mozambican has the right to use it.

As stated by Article 1 of Law of the Land Territorial of Mozambique (2007, 1) “local community is a group of families and individuals living in a territorial district-level location or lower” aiming to safeguard shared interests via protection of agricultural and residential areas, whether cultivated or not, water sources, pastures, forests, locations of cultural importance and areas for future expansion.

This study is a case study that will be done in communities of Nhafenga Rupsinhe in locality of Mucheve, administrative post of Muchungué District of Chibabava. The law is then presented previously integrating in these local communities.

According to a government publication, land was nationalized in Mozambique since 1977. The publication reads, “the land and the natural resources located in the soil and underground waters, territorial waters and the continental shelf of Mozambique are the property of the State. The State determines the conditions of their use…” (Mosca, 2011, 202).

These laws and regulations were created for the Right of Use and Enjoyment of Land. Legal or natural persons and local communities have the right to occupy the land, taking into
consideration the limitations and requirements of the present law. Land ownership is an exclusive State right protected and integrated in the Constitution of the Republic of Mozambique to regulate and control the conditions of natural and legal land use and enjoyment by Mozambicans (Mozambique, Law Nr. 19/97 of 1 October).

Sustainable development is achieved through environmental management that should meet the needs of current generations without compromising the balance of the environment and the capacity of future generations to achieve their needs (Mozambique, Art. 1, 2007). This law aims to preserve the ecological balance of fertility and quality of the soil and protect fragile ecosystems and habitats, air purity, forests, water resources, coastal regions and seafront; harmonizing the immediate needs of persons and local communities with the main objective of safeguarding the environment. Therefore this study seeks to examine how communities are using CA and the land to eradicate poverty and improve food security in their communities.

2.5.2. The Fight Against Poverty

Reducing poverty is the main development goal of the Government of Mozambique (GM). In order to achieve this goal it is necessary to implement successful transformation of the agricultural sector due to the fact that poverty and agriculture are interrelated. About 80 percent of the Mozambican population depends predominantly on agriculture as their prime source of livelihood. Nowadays, there is a relatively low agricultural production in Mozambique in comparison to other developing countries in Southern Africa (Mozambique, 2011; see also Figure 2.6.). Nevertheless, the low level of agricultural productivity is not surprising due to the
reliance on rain-fed agriculture and restricted use of improved seeds and fertilizers (Mozambique, 2011). as well as resistance to practicing Conservation Agriculture.

Despite the reduction in quantity of Mozambicans living below the poverty line – from 69 percent (1996/7) to 54 per cent (2002/03) – poverty remains prevalent and concentrated in the rural regions of Mozambique.

In 2006 government of Mozambique (GM) launched the second Action Plan for the Reduction of Absolute Poverty (APRAP II ) and the second National Agriculture Development Programme (NADPRO II) This was in recognition of the importance of agriculture for economic growth and poverty alleviation and highlighting the necessity to increase agricultural productivity as a process to sustainable growth and food security. In 2008 the GM introduced the Strategy for Green Revolution (SGR), which among other things stressed the need to concentrate on sustainable increase constraints in agricultural productivity (Mosca, 2011).

In 2004, the GM developed the first Reduction of Absolute Poverty (APRAP II) action plan based on the plan for the years between 2005 and 2009. APRAP II defined poverty as "the inability of individuals to provide for themselves and their dependents asset of basic conditions for minimum survival". This concept took into consideration patterns of food consumption, estimated at about 2,150 calories/per person/day and measured in kilocalories minimal. The poverty line concept was measured in terms of consumption and was set MZN 5,43 (US$0.18) per person/day in 1997 (Maússe, 2009,24).
This study may help clarify the ideas for both the leaders and the farmers in the communities. The study wants to try to prove that producing using Conservation Agriculture techniques can reduce poverty by increasing the profitability of production, improving soil fertility and protecting the environment. This is how we can reduce poverty in Mozambique.

**Figure 2.6: Mozambique Maize Yield and Selected Regions**

![Maize Yield Graph](source FAOSTAT (2009))

The fact that majority of the population lives in the rural regions and relies on subsistence agriculture to survive, it is possible to assume that poverty mitigation and economic growth require productivity increases in agriculture (Mozambique, 2011) hence the need to examine how CA could help in this area.
Though, on one hand when externalities arise the private sector generally invests less in preventive measures (such as public goods); on the other hand, agricultural production is intrinsically characterized by production prices and risks frequently beyond the control of small undercapitalized farmers to implement strategies of risk management (Mozambique, 2011).

Mozambique still relies heavily on donor funding for the agricultural sector. Within the agriculture sector budget 80 percent represents the capital expenditure. The capital expenditure is mostly financed by external funds and between the 2005 and 2007, 70 percent of this capital came from external sources (Mozambique, 2011). This study seeks to verify how external funds are positively or negatively affecting the implementation of CA in the community of Nhafenga e Rupsinhe, in Mucheve locality.

As stated by the World Bank (2007), sustainable agricultural growth needs an all-inclusive strategy entailing policies, innovations, institutional reforms and focused investments to enhance agricultural productivity and develop competitiveness. Experimental evidence (Fan et al., 2000; Fan et al., 2004; Benin et al., 2008) have shown that the main path for achieving agricultural growth, poverty reduction and competitiveness is when governments invest in public goods. It is difficult to obtain large agricultural growth when a government is not committed to offer agricultural research, institutional mechanisms, extension services, transport and market infrastructures that are indispensable to promote and increase agricultural productivity and reduce poverty (Inocencio and David, 2000; Haggblade, 2007). Therefore this study will examine the levels of involvement by the government in encouraging CA on Mozambique rural farming areas with the aim of sustaining food security and poverty alleviation.
Small farmers who are considerably poor and cannot afford to invest in themselves or in productive assets get stuck in a perpetual state of poverty as they are forced to face innumerous other adversities, such as illness or loss of livelihood. The fact that small undercapitalized farmers have also access to weak and precarious networks forces them into a trap of low food security that generates poor nutritional levels causing health problems and weakening their ability to escape their extreme poverty (Mozambique, 2012).

2.5.3. Conservation Agriculture in Chemuve

During 1976 and 1992 Mozambique was at a civil war and in the course of these 16 years the country was desolated with famine and suffering especially in the rural areas and inland provinces. Due to the intense tension in the country, many families were forced to abandon their original communities to safer regions leaving their homes and lands behind. The war ended with the Peace Agreement signed in Rome on the 4th October 1992.

In 1995 CARITAS introduced the Rural Development Program in Mozambique (RDP or RDPM). This project was financed by MISEREOR and all farmers who participated to the program adhered to Conservation Agriculture. The project included field training programs to enhance local farmers' skills and improve their capabilities and know-how in developing effective CA production systems.
During and after the war there were the Agricultural Cooperatives (known as *Casas Agrárias*) offering basic commodity food items and some included domestic hygiene goods. Nevertheless the majority of families had no food access and due to country instability and distrust within communities farmers did not feel safe to develop their agricultural fields. The Rural Development Program was a considerable aid to the country, helping reduce famine to very impoverished families with no access to basic consumption goods.

Still in 1995, a drought desolated the country causing severe consequences to the communities living in regions with no access to water supply. CARITAS in partnership with MISEREOR developed a complementary project to CA: the Water Supply Project aiming to minimize the drastic living conditions of these communities with no drinking water access. Despite existing many water supply methods, due to the National Water Policy only wells were recommend.

This project targeted specially communities living in the rural areas. With the implementation of the project the Results Demonstration Centers (RDC’s) were created. These were testing fields training and teaching farmers to apply CA system techniques and increase production. Initially RDC’s occupied large areas, equal or superior to 5 ha, and there were no supervising technicians residing in the area. Only one single agricultural project technician provided support to all communities, including Chemuve.

In 1997 all families adhering to the RDP had to compulsory produce in a 20 sqm testing field applying only CA method techniques. There were groups composed of 20 to 25 families
monitored by a group leader. The group leader was elected by the group of families and similarly had to have a 20sqm testing field where he/she applied only CA production system techniques. A total of 100 families followed the Rural Development Program in this year.

To improve diet the project distributed seeds and seedings of different species of the family leguminosae, cassava, pineapple and banana trees. The distribution of seeds was initially offered free of charge at the early stage of the program. The main goal of this project was to develop and increase culture diversity contributing to the nutrition levels of rural families.

The project introduced agri-silvicultures and drought resistant plants like orange pulp sweet-potato and others; seedings of fruit trees and leguminosae; animal production with main focus on rabbits and ducks; the construction of improved barns and phitosanitary protection; and the drilling of more wells in the communities. This location has many problems of water shortage among others.

2.6. Gaps identified from review of related literature

One of the gaps from the reviewed related literature is the silence of the methods that have been used in the studies reviewed. The review has also exposed lack of gendered literature with regard to CA programmes in Sub Sahara Africa. How the governments have been involved in the training of farmers has not been well explained in the literature reviewed. Mauch of the training however has been undertaken by the Non-Governmental organisations. This study will
try to fill the gaps identified in the literature concerning the use of CA in improving food security and poverty alleviation in Mozambique.

2.7. Summary

Initially definitions of the key theme concepts were introduced, such as Poverty, Food Security, Land, Conservation and Traditional Agriculture, among others. It was also presented the concept of conservation agriculture by FAO using its principles for a successful production system. As different concepts were discussed an analogy between Mozambique and the Sub-Saharan region was offered; and to better understand specific notions some tables and figures were presented.

The Theory of Trophobiosis which was invented by the French scientist Francis Chaboussou who laid the foundations for the theory that for a plant to have a healthy growth cannot be attacked by pests and diseases was also examined. As well as the comparison between the techniques used in the production system with Conservation Agriculture and Chaboussou’s principles, arriving at the conclusion that both complement each other.

Furthermore, a brief background about Conservation Agriculture in the world was reviewed, together with a comparison amidst producing countries and areas produced per hectare. There was evidence backing up that this type of technique is known for decades and there are already countries in Africa using it.

A brief analysis was made on policies applied by some African countries to succeed with their cultivated crops and ensure food security of their population. Very often high food prices for basic commodities are attached to the policies and strategies adopted by governments.
Countries like Mozambique import almost all their products including basic commodities which increase food insecurity and therefore poverty. Chapter three describes the methodology used in this study.
CHAPTER 3

RESEARCH METHODOLOGY AND DESIGN

3.1. Introduction

Throughout the history of social research there are different paradigms, designs and methods of data collection and analysis of generated data. For such, different research methods can be used, presented or combined such as qualitative and quantitative methods and positivist and constructivist paradigms.

For this study the researcher chose a qualitative paradigm based on the inductive approach, using the case study design. The researcher will also give description of the study site, entry to the site, physical access to the site and access to participants.

The selection of the target population shall be in accordance with the topic under study, using non-probabilistic sampling procedure for convenience. The study will follow a set of procedures of data generation through: personal interviews, observations, tasks that were done daily, and there will also be a focus group discussion. Furthermore, a description of ethics and its legal implications will be given.

Data will be analysed using the techniques of the coding, paraphrasing and summarizing the responses. The issues of trustworthiness, credibility and confirmability will be addressed using.
prolong the involvement of locals and participants. The study will also use the triangulation method of data source and instrument of data generation. The technique of member-checking will be used for data verification as well as the thick description of data and events in order to make the study findings creditable.

3.2. Research Paradigm

In the history of social research we can use different paradigms of research such as positivist, post potivism, interpretivism and constructivist.

3.2.1. Positivism

Positivism originated in the nineteenth century, with the philosopher and "father" of sociology Auguste Comte. Positivism is based on its knowledge solely on observable facts. Lincoln and Guba (1994, 2003) and Duarte (2009,4) attribute several principles / features of positivism such as:

- There is one reality that is knowable only using methods that prevent the human "contamination" human (ontology) (Ibid);

- The subject and object of research are mutually independent (epistemology);

- Facts and values are independent, with no interference of the researcher (axiology);

- The generalization of time and context is possible, and it is also possible to formulate general laws (generalization);
- There are still real causes that can be temporally preceding or concurrent with the effects, and may be isolated (causal relationships).

Throughout the 50s and 60s of the twentieth century, there were some criticisms of the principles of positivism (including ontology, epistemology and axiology) which led to the rise of post-positivism (Guba and Lincoln, 1994; Lincoln and Guba, 2003; Duarte, 2009). In this connection the following statement is very clear: “(...) The gendered, multiculturally situated research approaches the world with a set of ideas, a framework (theory, ontology) that specifies a set of questions (epistemology) that he or she then examines in specific ways (methodology, analysis) (...) Every researcher speaks from within a distinct interpretative community that configures, in its special way, the multicultural, gendered components of the research act " (Denzin and Lincoln, 2003, 29-30; Duarte, 2009,5).

The gradual "discredit" positivism led to the emergence and dissemination of paradigms more "radical" than the post-positivism. Among these paradigms (include the naturalism and interpretativism (Tashakkori and Teddlie, 1998; Duarte, 2009, 5), the most widely accepted is constructivism. The researcher therefore chose to use the constructivism paradigm and the qualitative research approach.
3.2.2. Qualitative Research

In qualitative research model, although the theory also be present, this is not so clearly “a priori" in the investigation, but the theoretical assumptions will be discovered and formulated as it is in the field, and which will then analyze the data (Duarte, 2009, 7).

More than testing theories, it qualitative research seeks to discover new theories empirically rooted; selection of cases emphasizes its importance to the subject study rather than their representativeness (Brannen, 1992; Duarte, 2009). Therefore the selection of cases cannot be planned in advance or. Similarly, there is no choice of a predetermined number of cases, the main research instrument is the researcher himself; generalization here has a different status (Ibid).

Flick, (2005a, 6) and Duarte, (2009, 7). say that unlike quantitative research, qualitative methods face interaction with the field investigator and its members as an explicit part of the production of knowledge, rather than to exclude at all costs, as intervening variable. The subjectivity of the researcher and the subjects studied is part of the research process. A brief explanation of quantitative research is given below in order to justify the choice of qualitative research for the study.
3.2.3. Quantitative Research

In quantitative research model, the researcher gives the existing theoretical knowledge or previous empirical results, so the theory precedes the object of research. Hypotheses are derived from theory, these hypotheses are operationalized and tested in the face of new empirical conditions; instruments for collection data are predefined; ideally, they want to build a sample that is a representative of the population, the observed phenomena are ranked in terms of frequency and distribution of data analysis to back up hypotheses proceeding to the validation or non-validation of their results, the final result is equal to the entire population (Duarte, 2009). Thus for this study this approach could not be possible since the researcher seeks to understand the phenomenon from the experiences of CA by the participants.

3.3. Methods of the Study

Method in research means the choice of systematic procedures for describing and explaining phenomena. There are three methods: Quantitative, Qualitative and Mixed which is the combination of quantitative and qualitative method. This study will use the qualitative research method.

3.3.1. Qualitative Method

This method does not want to number or measure units or homogeneous category. It is concerned with in depth analysis of the phenomena observed. It is essential to assess the understanding of
the particularities of individual behavior according to the phenomena being studied. The study will employ a case study design. The study will generate data using the methods of observation, interviews and consultation of examining diaries and document.

Interview is a technique used by the researcher who performs in front of the interviewee and you put questions with the aim for obtaining data that interest the investigation. The interview is a form of social interaction and asymmetrical dialogue in which a party seeks to collect data and introduces himself as another source of information (Gil, 1995).

3.4. Rationale for Selection of the Method

The researcher used the qualitative method which is a paradigm that is based on the understanding and interpretation of the data collected in a perspective to explore the experiences of farmers in conservation agriculture and conventional agriculture. There was a great willingness on the part of the researcher to identify these behavioral phenomena and explore under what conditions these phenomena worked with farmers in conservation farming compared to conventional farming.

This method was used "because of its unique qualities in probing cultural behavior, values and traditions" (Chisaka, 2007, 28). The method was suitable for interacting with farmers living in rural areas whose cultural values and traditions are well known day by day.
Case study design and grounded theory for data analysis were used in this study. The truth is not universal, but that it is dependent on context. There are no two contexts that may have the same qualities or values. They may be similar (in form), but they are not the same (in essence or content). This theory was proposed by Glaser and Strauss (1967) in the discovery of grounded theory: as a strategy for qualitative research. It is a theory based on systematically collected and analyzed data (Strauss and Corbin, 1990; Pinto, 2012, 2).

Qualitative research is also based on the inductive method that starts from particular to the general (Kurasha, 2013). Thus only after the researcher interviews the farmers, and observing how they produce their crops that is when she can interpret and analyze the results.

3.4.1. Case Study

The study is a case study on conservation agriculture among traditional communities in Chibabava Sofala province, Mozambique, with special reference to land use and food production, in maize, sorghum and beans from 1997 to 2012. The researcher chose Mucheve locality because in that area there are farmers who practice conservation farming, supported by Caritas (commission of the Catholic Church in Mozambique, which aims to promote social dimensions in local communities) since 1997.

The researcher is the main research instrument. The study was undertaken through in-depth interviews, observations, focus group discussion and daily diaries. This is an effective way of
explaining a specific situation. It is used for exploratory purposes to gain better insight into the relationships that are inherent in this specific situation. It is a case study because it provides a chronological chain of events and lessons that are to be learned from the case.

The case study method has three important characteristics: the nature of experience as a phenomenon to be investigated, the knowledge to be achieved and the generalizability of studies from the method (Stake, 1995). The depth of the experience of the participants which is found in the method is precisely the most interesting aspect of its nature. (Denzin and Lincoln, 2000).

Thus nature is epistemologically in harmony with the experience of those involved with it, and therefore these people constitutes a natural basis for generalization. This is especially important in the social sciences where studies are based on the relation between the depth and type of life experience, the expression of this experience and an understanding of it. Thus the researcher will interact with the farmers who use Conservation Agriculture to gain their experiences.

This method includes a wide variety of empirical materials, which may be personal experiences, life stories, stories of insights, productions and cultural artifacts, interactions and finally, materials that describe routine and the meaning of human life in groups. This approach has been presented as *soft science*, especially by those who adopt positivist positions in social reality (Denzin and Lincoln, 2000).
3.4.1.1 Rationale for Choosing a Case Study

A case study can be defined as a phenomenon of nature occurring right in a given context (Miles and Huberman, 1994). A case is a unit of analysis that can be performed by a person, an organization, a small group, a community or even a nation. All these types of cases are social units. It can also be set temporarily (the study of a phenomenon that occurs in a given location) (occurring in a given period), or spatially. Thus, a case can be a simple or complex phenomenon, but could be considered if it needs to be specific (Denzin & Lincoln, 2001).

The researcher chose a case study because the study provides a chronological chain of events and links learned either with conservation agriculture or traditional agriculture. This is the best way to explain a specific situation, in a given location of Mucheve within a given time period of 1997-2012; and specific crops like maize, beans and sorghum. She used this method with exploratory purposes to obtain a better understanding of the relationship between conservation agriculture and traditional agriculture in relation to their productions, so as to be able to determine the best production method for attaining food security and alleviating poverty in Mozambique.

The researcher was the main research instrument. There was a direct relationship between the researcher and the social world, ie families who practice traditional agriculture and conservation. She attached great emphasis on interviews, direct observation, understanding the focus groups for discussion; the life histories of groups of farmers in question.
3.5. Description of the Site of the Study

The study was conducted in the locality of Mucheve, which belongs to the administrative post of Muchungué, Chibabava district, located south of Sofala province (331.5 km from the city of Beira). Chibabava borders to the east with the District of Buzi, in the southeast with Machanga district; and to the west and north with the province of Manica. Mucheve is a town located south of the District of Chibabava. Mucheve is a town located south of the District of Chibabava. The locality of Mucheve has an area of 850Km2 and has 14,153 inhabitants of Ndau ethnic background, according to the 2007 census; of whom 5,930 are men and 8,233 are women.
Figure 3.1: Map of Mozambique showing the position of Sofala Province

Figure 3.2: Map of Mozambique showing the position of Chibabava District

Source: in. Wikipedia.org
Figure 3.3: Map of Mozambique showing the position of Muchungue and Mucheve in Chibabava District

3.6. Entry in to the Site of the Study

3.6.1. Physical Access to the Site

Different roads and means of transport were used to reach the participants, i. e. conservation agriculture farmers in Mucheve. From Beira using a 4x4 vehicle to the locality of Mucheve you go along the National Road Nr. 6 to Inchope. At Inchope turn left, following the National Highway Nr. 1 southbound to Muchungué Administrative Post. From Beira to Muchungué is 300 Km. In Muchungué turn right towards the Chibavava District Headquarters, drive for just 1.5 Km then turn left towards Mucheve locality that is plus 30km. From Muchungué to Mucheve there is no tarred but dusty road.

In Mucheve you will find the local Administration and next to it a health post, a police center, a school and a Caritas Agrarian Technician’s house. At this location 200 meters from the Administration there is also a Center of Statement of Results (CSR) where families come to learn the techniques of conservation agriculture.

3.6.2. Access to Participants

The fields of farmers are at a distance of 5km from the headquarters location. To get to Rupsinhe and Nhafenga community one can only be on foot, by bicycle or motorbike.
3.7. Population

According to Pestana and Velosa (2006) population is the set of objects, individuals (not necessarily people) or experimental results, about which we intend to study some common characteristic describing a phenomenon that interests the researcher. Populations may be finite or infinite, existing or conceptual.

The elements of population give the name of statistical units that is a process of obtaining information about a whole by examining only a portion (Vieira, 2008).

When it comes to studying only a part is ready before the sampling process, which is a technique by which a sample is selected not clear here. This process of selection is done on a sample basis of the existing population to serve a product or result obtained from an analysis of data collected along a search. This process applies in numerous areas of knowledge, being a way of obtaining information about a certain reality to know (Vieira, 2008).

According to Caritas its working population in conservation agriculture in 2012 was 700 farmers, and in 1997 only 100 were farmers. They are men and women of Ndau ethnicity. The farmers are organized into 35 groups and each group has 20 families. All of them belong to Mucheve locality, more specifically the communities of Nhafenga and Rupsinhe.
3.7.1. Sampling Procedure

After identifying the population on which you want to collect the data, it is necessary to define an appropriate sampling procedure in accordance with the type of data that needs to be collected, this is a plan to define which steps should be followed to obtain the data of a sample according to the target population (from which the sample will be taken). For such, one should start by defining the proceedings being conducted, i.e., if they are: global, national, regional, urban, rural, group of individuals; which method of sample selection or sampling method and sample size (Vieira, 2008).

According to Martin (2002) there are two groups of methods for selection and collection of samples which are probabilistic and non probabilistic.

Probabilistic sampling is the selection of elements or group of elements of the population is made randomly, i.e., in a way that each element of the population has a probability of inclusion in the sample, calculated and different from zero. They are rigorously scientific methods.

Non-probability sampling is where there is a deliberate choice of the elements of the sample. i.e. the selection of elements of the population allows the choice of subjects to be included in the sample, according to a certain criterion, more or less subjective, depending on the opinion and judgment of the researcher (Martin, 2002)
The researcher chose an intentional or convenient non-probability sampling which is characterized by:

- Selecting a sub-group of the population, based on the information available, can be considered representative of the entire population; In this case the researcher formed three sub-groups of 10 participants each. Of these 10 participants were 5 of conservation agriculture (CA) and the others 5 for traditional agriculture. Because it is a convenience sampling the selected participants were those with the best knowledge. In this case (CA) selected group chiefs and they are all members of the Rural Development program of Caritas and all have a Field Demonstration Results ((FDR) in their fields.

- Requires knowledge of the population and selected subgroups; In this case the researcher went to the local production of maize, sorghum and beans and remained there for a long time, often going to the site to see closely and create friendship with farmers and group leaders to see how agricultural activities were undertaken, from land preparation, sowing until the end product, harvest.

- For example, the researcher conducted interviews to the chief groups of conservation agriculture.

3.7.2. Sample

The sample unit shall be defined according to the interest of the study and may be a number, an individual, a family, a farm, etc. The choice must be made early in the investigation. The sample is a set of elements formed starting part of the population of the target group of the survey.
According to Vieira (2008), to research or make the study on the basis of a sample brings advantages such as:

- It is more economical than the entire study population;
- Resources or assets available for any work required to study structure are lower than if had to study the whole population;
- Also throughout the study process, it is faster when analyzing a sample than an entire population.

The researcher used a sample of 30 farmers of which 15 are of conservation agriculture and other 15 are of traditional agriculture. This sample was divided into 3 sub-groups of 10 people / group:

- Group interviews with 10 people: 5 farmers are of conservation agriculture and the other 5 are of traditional farming;
- Group of observations with 10 people: 5 farmers are of conservation agriculture and the other 5 are of traditional farming;
- Focus group discussion with 10 people: 5 farmers are of conservation agriculture and the other 5 are of traditional agriculture.

The study sought to examine “how conservation agriculture can alleviate poverty”. The thesis aims to answer the following questions: “To what extent does conservation agriculture alleviate poverty?”
The aim of the research was to prove the extent to which conservation agriculture can alleviate poverty in Mozambique. In this case the target group of the researcher was conservation agriculture. Because this was a convenience sample the researcher felt that conservation agriculture guided by monitors Caritas is very well organized. There are agricultural technician’s workers who work directly with the monitors and these in turn work directly with the heads of groups of families of farmers.

Therefore the research in the field targeted the chiefs of groups for interviews and observations of conservation agriculture, monitors who participated in the focus group discussion (with the heads of the groups) for they are the best with the knowledge on how to interpret and find solutions for doubtful questions that the researcher encountered in the field.

3.8. Data Generation Instruments and Procedures

In qualitative research the researcher is the main research instrument. There is a direct relationship between the researcher and the social world, i.e. families who practice conservation agriculture, in Nhafenga and Rupsinhe communities in Mucheve area.

To reach Mucheve it required the researcher to move to the "Caritas" located in the area of Inhamizua belonging to the District of Beira, where the researcher presented her research project and asked them if she could be helped both in terms of human resources in the field of access, and in terms of file documentation in the office.
"Caritas" liked the idea, because it was the first time that someone from any university has wanted to do a research paper on conservation agriculture. Caritas opened all doors to the researcher, and provided all the means that were within their reach as: a house in Mucheve, a car for commuting to Mucheve and Beira, and coordinated travel according to the visits made by the Mucheve Agricultural Technician so that the researcher and the Agricultural Technician would travel together.

The Agricultural technician in turn organized and prepared the head of the local office. This in turn helped in sensitizing monitors and group leaders, so they had the knowledge of the research that would take place, and that in future they would have access to their very own PHD thesis. That would be an asset to the development for their own locality, district and the province in general.

Within the field research, the researcher through Caritas infused an assistant who was an Agricultural Technician himself and works directly with the Mucheve monitors. He speaks Ndau language very well and translated all information and the researcher carefully took notes. With the same assistant interviews were conducted, monitored the activities done with the group of observers for the researcher to understand everything in detail and was also present in the focus group discussions.
Besides this the assistant researcher had two more, in which a researcher helped in the preparation of tables and figures, with computer knowledge. And another helped in correcting the English language.

All kinds of material were facilitated by the researcher through Caritas as: books and reports, photographs and maps about everything that was done in Mucheve on conservation agriculture, water and literacy, from 1995 to 2013 agriculture seasons, the researcher selected the most important material for their study which included only the years 1997-2012, and only in corn, beans and sorghum.

3.8.1. Personal Interviews Face to Face Interviews

In Interview technique, the researcher is presented in front of the interviewee and puts questions in order to obtain data of interest to the investigation. It is a form of social interaction and “a form of asymmetrical dialogue in which a party quest to collect data introduces himself as another source of information” (Gil, 1999, 113).

The interview is a great tool for obtaining a portion of the data collected during the research in the field. It is a method used frequently in qualitative research, which brings a valuable wealth with its data (Hood, 2009).
This research had the main question: “How does conservation agriculture help alleviate poverty?” With the main objective to examine how conservation agriculture can alleviate poverty.

The research was to examine specific objectives:

- The levels of production: maize, beans and sorghum, both for conservation agriculture or traditional agriculture;

- Techniques used in Conservation Agriculture (CA) and Traditional Agriculture;

- The challenges in implementing (CA).

The research study focused on an area of minimal production by cultured 1ha-1, 5ha in period 1997-2012.

Before starting any interview the researcher explained the purpose of the interview, and how much their opinions were important to the success of the search, only in maize, sorghum and beans. The researcher made an appointment to meet with the interviewee, The researcher allowed the interviewee to select the date, time and venue suitable for them.
The interviews were conducted by the researcher but always accompanied by her assistant, the Caritas land surveyor. They always used a tape recorder throughout the interviews to record important information. Most farmers in conservation farming spoke Portuguese which gave the researcher the ability to understand what the participants meant.

10 farmers were interviewed (5 farmers in conservation farming and 5 farmers in traditional agriculture). Farmers in conservation farming were also heads of groups. The researcher chose this sample type for it is a qualitative research whose sampling process is for convenience. Which means for the result of the research to be fruitful it was important to choose the group had the best knowledge that is why the researcher chose group leaders. They interviewed 3 Nhafenga group leaders and the other 2 group leaders from Rupsinhe community.

The interviews were based on an interview guide to take a broader view of activities. The questions were open to have a more detailed explanation of the phenomenon of crop production, including life histories. The questions were asked by the researcher as if it were a dialogue or conversation with the participants. The questions were asked in detail so that the researcher would understand well what the interviewee was explaining. When the interviewee could not explain in Portuguese the assistant spoke in Ndau and translate for the researcher.

The interviews were conducted in the respondents' yard, near his dwelling and adjacent agricultural fields, near the animals, tree shades, and a naturalistic environment. In general the responses were very similar to conservation agriculture.
The interview was considered the heart of a qualitative research, although it was accompanied by other research instruments such as observation as well as the focal discussion, giving the researcher a variety of data, generation instruments and creating a triangulation.

3.8.2. Observation

Observation is a research instrument that provides many details to search through the use of the 5 human senses based on the description. According to Richards (2009) participant observation is perhaps the most important because it is fundamental to develop a specific understanding. It is comprised of four main components: space and objects, systems (procedures), people and behaviors (Heigham and Sakui, 2009).

Because this was a qualitative study and a convenience sample, the researcher used the same method that was used by the group interviews. First chose 5 heads of group of conservation agriculture of which 3 were from the Nhafenga and two from Rupsinhe community. Before the researcher made any observation, she spoke individually with each selected farmer explaining what the purpose of the research was, and wanted to visit them to observe some activities undertaken during site preparation, seeding, fertilization with liquid manure and organic compost. The researcher also wanted to see how the organic compost and the organic liquid fertilizer was formed and utilised. Then she asked for permission to attend and coordinated according to the activities of farmers being observed, and the best moments to attend such activities were found to be the most important to understand the whole process of cultivation in conservation agriculture
We followed the same method with traditional agriculture, but this observation had no enthusiasm, because the field activities were very weak and not protecting the soil in any way, but just destroy it with fire and increasing rate of soil erosion and degradation.

The observer who was also the researcher was on the field for several times to monitor and closely observe, on site, together with farmers as all activities were carried out from land preparation, sowing and almost to their harvest. She also noted how they prepared liquid fertilizer and organic compost to fertilize the earth and growing plants in conservation agriculture.

Through observation the researcher was able to see the behavior of the participants getting to understand better all the procedures and how to make the liquid compost, discovering new skills that they were previously unaware of.

The Caritas technical assistant was always there to help whenever there was a question and translate if necessary. With regard to the observation in conservation agriculture was an activity that the researcher liked so much for she learnt a lot whilst everything was being done in a good working environment and well naturalistic open air.

This was also another given factor which facilitated the study and research in conjunction with other instruments which were to facilitate the triangulation of data generation.
3.8.3. Daily Diary Study

The diary is one more element that facilitates the procedure of data generation. It comprises of informal conversations, field observations and behaviors of the participants throughout their daily activities in the field. (Minayo, 2010)

Some interviews were recorded, this being a given diary that has been registered for later use. Throughout the observations photos were taken in agricultural fields where participants executed some agricultural activities such as preparing organic compost and liquid fertilizer. These photos availed the researcher a more daily log of farm activities.

The researcher also had to plan all of her daily activities in the field according to participants' choices.

3.8.4. Focus Group Discussion

The central aim of the discussion with a focus group is to identify attitudes, behaviors and ideas of the participants in relation to a topic presented for discussion. In this case the aim of the researcher was to learn how participants interpret their ideas, based on their knowledge, resulting from day to day practice. This was one more data which was to facilitate triangulation.
According to Calder (1977) in qualitative research, it is important that there are several different research tools such as interviews, observations including focus group. Thus become more consistent and validates the search results.

According to Johnson (1994), the participants of a focus group bring a great dynamic in the exchange of ideas; there is greater depth and diversity of responses. There is more information with richness in detail than in individual interviews.

The researcher talked in advance with group leaders selected for the focus group discussion, with the aim of forming this discussion group and asking for their participation. Acceded without problem and they marked a date, place and time in which everyone agreed to.

In the same way there was a group of interviews and focus group observations containing 10 farmers or participants was created two groups, one of conservation and the other for traditional agriculture. Each group had 5 farmers or participants. The focus group of conservation agriculture was formed by 5 heads of groups and one monitor. The other group had 5 farmers in traditional agriculture.

Both groups belonged to the town of Nhafenga. This type of activity requires a moderator to control the discussion and give guidelines. In this case the researcher was the very moderator. The assistant gave all necessary support in the language translation.
3.9. Ethical and Legal Implications

To deal with the ethical and legal implications pertinent, the researcher visited the "Caritas", located in the area of Inahamizua belonging to the District of Beira, where the researcher presented her research project. The researcher has requested authorization of Caritas for her to be facilitated in the study throughout the research, both in terms of human resources in the field of access, and documentation.

The researcher explained to Caritas that the study report would be submitted to ZOU in meeting the requirements for the doctoral degree. The researcher just could not go to the places involved, without a written permission from the authorities. The "Caritas" liked the idea because it was the first time that somebody from any university had shown interest to undertake a research about conservation agriculture. Caritas opened all doors to the researcher, and provided all the means that were within their reach such as: a home in Mucheve, a car to travel to and from Mucheve Beira and an agricultural technician.

Before the researcher started work with the target groups of the study she explained to them the purpose of the research and that the results were part of the doctoral thesis.

All participants in the group interviews, observations and focus group discussion were not obliged to give any kind of information, they were always ethically and morally respected. The will of the participant was always preserved.
During the interviews some recordings were made with the permission of the participants. Through the observation of the target group also several photographs were taken with the permission of the participating farmers.

The researcher was conscious that the participants had the right to refuse to participate in any activity. The researcher did nothing to those who have refused to answer questions. In case the participants provided some confidential information such as religious conviction, political affiliation, etc. the researcher ensured strict confidentiality with all due respect.

3.10. Analysis and Interpretation of Data

Minayo (1994, 17) considers that "nothing can be a problem intellectually If you have not been in the first place, a problem of practical life." This means that research arises in the background of a problem that exists in a particular society. As of this problem appear many ideas and arises a language based on concepts, propositions, are usage of study techniques, methods and procedures done with their own particular rhythm. Then appear at a certain work that started due to a problem and ends with a product that can be the resolution of this problem.

According to Merriam (1998) the researcher during the research in the field should have the ability to be tolerant, be an excellent communicator and intuitive, all this in order to facilitate access of your data acquisition when is communicating with the participants during the research.
The procedures for analysis and interpretation of data are different from quantitative and qualitative data. In qualitative research, analysis and interpretation of data are considered as one processed (Chisaka, 2001). Qualitative research is not done only at the end to collect the data but throughout the whole process that starts in the exploratory phase and accompanies the researcher throughout the whole research process.

3.10.1. Analysis of Data
According to Merriam (1998) in a qualitative research besides the need for the researcher to have a vision of the world, she must also know how to select her sample and know to collect data during the research in the field; these collected data must be truthful, trustworthy and obtained through ethical standards.

Through data analysis, the researcher tries to justify their data at the same time the achieving objectives of the research. They are only achieved after this data collection and interpretation. To analyze the data, these can be presented in different forms such as through tables or tabs, coding, establishment of categories (Gil, 1999; Teixeira, 2003)

a. Coding
Coding allows the researcher to organize the answers into themes so obtaining a data analysis and an easier elaboration. Coding is the process of assigning numeric or alphanumerical to respond to certain categories codes. Coding is an important process, since the interviews in a case study for a qualitative research questions are usually open. This interpretive analysis has to do with trying to get the best meaning of the responses in relation to the objectives and management of research time.

b. Paraphrasing and summarizing responses

This can be done through the rephrasing statements in a clear condensed form. It can also be used when choosing keywords. That's what the researcher did in this study, choosing only the important information.

3.10.2. Interpretation

Interpretation of data is done through an analytical narrative from which the researcher proposes to defend a position of a significant interpretation given phenomenon. This is what people said, what the researcher has seen and read, giving meaning to the phenomenon researched.

"The interpretation aims to the search the broadest sense of the responses, what is done through its connection to other knowledge previously obtained." (Gil, 1999, 168).
Merriam (1998) point out that in qualitative research there is: ethnographic analysis, narrative analysis, phenomenological analysis, constant comparative method, content analysis and analytic induction

The researcher in her study used narrative to describe the phenomena that are used to apply the techniques in the Conservation Farming System. She used the comparative method making the comparison between the Conservation Farming and Traditional Agriculture. She was applied the inductive method where the researcher first made the interviews farmers, she observed very well how they produce for later to interpreter and to analyze the results.

Data interpretation involves the process to explain and give meaning to data which is being analyzed. According to Chisaka (2000) interpretation of the data is a way to make sense to data gathered, discovering what the analysis could not do. This implies the researcher to analyze in depth and trying to read between the lines as an interpretation can be superficial. In this study, the researcher explained her findings on personal experiences, contextualized the findings and made comparisons. The data were interpreted in relation to each question. This is a process that was always continuous and permanent throughout the study.

3.11. Trustworthiness Considerations

In quantitative research the credibility of research depends on the construction of the instruments, but in qualitative research, the researcher is at the same time the search tool for data
generation. This increases the subjectivity of the research in the study because the researcher imposes her own meanings on the findings. In quantitative research the validity and reliability are treated separately. In qualitative research reliability and validity both refer to the credibility of the findings. Patton (2001) noted that reliability and validity are considered credible, ensuring the accuracy and quality in qualitative paradigm.

Lincoln and Guba (1985) consider the credibility and reliability, as something that suggests veracity and are a criteria of a qualitative research. Credibility is the principal, but to have better veracity of results it is important that there is a prolonged engagement and persistent observation and focus group discussion, in the field, to achieve the triangulation. Intimate ambiance of friendship with farmers or participants in the field was created to ensure credibility, veracity and reliability of the results.

3.11. 1. Prolonged engagement of sites and participants

A qualitative researcher has always the characteristic of being interpretive at the same time the subjectivity of the searcher is always present along the entire study. On the other hand research has a characteristic also to use the inductive method of the particular to the general based on a theory and open to discovery in the search field.

A qualitative researcher has also to do with a small sample (Leininger, 1994) but at the same time it is concerned with a detailed description of all the relative activities of the generated data. Thus
it is important to analyze, describe and know how to interpret the understanding of participants in relation to your activities in the working field through the observation of the researcher in the targeted group, in the responses given by the group interviews and also the answers that were given by the focus group.

But, for there to be credibility, veracity and reliability of research it is important that the researcher remain in the search field for a long time and at the same time spend much time with the participants. For the researcher to be in the field for a long time it will ensure a better knowledge of all the activities that are carried out in the field such as the cultivation of corn, beans and sorghum. For the researcher to be with participants for a long time will ensure that they create a familiarity between the researcher and the participants. Thus participants will trust the researcher, giving the entire opening of transmitting their knowledge confidently with veracity in the researcher.

The researcher didn’t only go to the field for interview but observed and attended the focus group discussion. Everything was being done after agreeing with the participants. She lived with the participant farmers. She had been in the communities of Nhafenga and Rupsinhe several times, following all the activities that were done directly in the fields. She watched the mulching for seed planting and growth. She saw closely how the liquid fertilizer and compost is done. She created a relationship with the farmers, to the point that they confided some issues with the her. This procedure helped in the veracity of the search results, because it is assumed that the
participants were very honest and did not hide anything but provided all the information that the researcher asked them.

3.11.2. Triangulation of sources of data and instruments of data generation

Triangulation is a research activity contributes to the veracity and reliability in a convergent validity (Paton, 2002), using technique of multiple data generation relating to phenomenon treatments (Jick, 1979).

Due to the use of techniques for multiple data collection the researcher begins to take a more holistic view, ie. begins to thoroughly understand a phenomenon responsive to its surroundings (Morse, 1994; Duarte, 2009). Triangulation is one of the methods most used by several authors as a methodological central concept. It does not only combines various qualitative methods together (Flick, 2005a and 2005b; Duarte, 2009) as articulated quantitative and qualitative methods (Fielding and Schreier, 2001; Flick 2005 a; Duarte, 2009), but can as well as made them cease to exist one method or the single method (Tashakkori and Teddlie, 1998; Duarte, 2009).

The researcher used various techniques for obtain triangulation using three different sub groups, but the same number of participants of which is for interviews, one for comments and one for the focus group discussion. With these results, the researcher makes the triangulation. And also made a comparison with different cultivation techniques (conservation and conventional agriculture), using the same method and the same research techniques.
3.11.3. Member Checking/Data Verification

Another technique for establishing credibility is a member check. According to Lincoln and Guba (1985) member checking is an important technique that helps to have credibility in the data. In member checking a report is given (or part of it rewritten and given to the lay reader) for informants who make the sample commenting or interpreting it. These checks can be made verbally, because not every informant may want to do this activity.

The researcher in the field was to do the interviews, observations and discussion in the focus group, the questions were asked in different ways but with the same objective in order for the researcher to check for consistency in responses. This is a form of verification and confirmation of data giving it credibility.

3.11.4. Thick Descriptions of data/Events

In an analysis of data from a qualitative research we use an inductive process and theory often called "grounded theory" (Fragoso, et al., 2011). This data is essentially textual. The verification of the data is based on the understanding or comprehension, the interpretation of their data and their description. While in quantitative survey data is numerical and have variables and hypotheses. In qualitative research the data is analyzed as it is collected by exploring the experiences of participants’ to understand the phenomenon.
The researcher is the main instrument because there is a direct relationship between the researcher and the social world, ie participants who practice traditional and conservation agriculture. The research is ongoing and interactive. Therefore there is a dense analysis of descriptive data or events that occur during the course of generating data.

The researcher made use of the characteristics of "Grounded Theory" because it was the main instrument that guided the research according to the availability of the participants. There was a direct relationship between the researcher and the social world (participant farmers of the communities of Nhafenga and Rupsinhe) who practice traditional and conservation agriculture. The research was continuous and interactive, because the researcher remained in the field for a long time exploring the experience of the farmers and better understanding the phenomenon of production using the system of Conservation Agriculture. The data was always analyzed by the researcher as it was collected. There was a dense analysis of descriptive data or events which occurred during the generation of data.

3.12. Summary

Throughout the history of social research there are different paradims, designs and methods of data collection and analysis of generated data. For such, different research methods can be used, presented or combined such as qualitative and quantitative methods and positivist and constructivist paradigms.
In this case the researcher selected and justified the choice of qualitative method of study based on the inductive method, using the case study method, explaining also in detail the use of this method. The description of the place of study, entry to the site, physical access to the site and access to participants was given.

A target population was chosen according to the subject under study, using a non-probabilistic sampling procedure for convenience. There followed a set of procedures for data generation through: personal interviews, direct observations, focus group discussion and analyze documents. There was a talk on the issue of ethics and its legal implications.

There was talk of some technique to be used as: coding, paraphrasing and summarizing the answers. Value was given to the credibility (validity and reliability) on the research. It is important to the prolonged involvement in locals and participants. So the triangulation method of data source and instrument of data generation will be used. There will be need for member-checking / data verification. We shall now present the Chapter 4 will be the presentation, analysis and interpretation of data.
CHAPTER 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1. Introduction

Chapter 3 discussed the research design and the methodological approach that was adopted as a means to fulfill the purpose and the questions of the current research study. The rationale for the choice of qualitative research paradigm was given and the data generation methods used was explained. This chapter looks at data presentation, analysis and interpretation. The chapter is divided into five sections based on the research questions:

1. To what extent does conservation agriculture improve in maize, sorghum and beans production more than traditional agriculture?
2. How do conservation agriculture techniques applied help communities to produced better yields?
3. What challenges do the communities who implement conservation agriculture face?
4. How does the production levels of conservation agriculture of maize, sorghum and beans compare with those of traditional agriculture?
5. How can traditional agriculture farmers be encouraged to implement conservation agriculture?

The study is a comparative of conservation agriculture with traditional agriculture, where a lot of tables are presented.

The data presentation starts with a brief background history of informants on Conservation and Traditional Agriculture. This is followed by a detailed profile of participants from Conservation and Traditional Agriculture. The questions that were used are the same, in maize, bean and
sorghum crops between 1997 and 2012. The data were obtained from Riofenga and Sinheve communities, in the locality of Chemuve. Besides detailed explanation, data will be presented in tables.

After that a history background of information about the head of groups, agrarian technician, Caritas coordinator and consultants and MISEREOR funder of Chemuve Rural Development Program and at the same time, Chumuve background will be presented.

4.2. Background Information of the Key Informants

For ethical and confidentiality purposes and to safeguard the integrity of all participants and persons involved with the present study and contributing to its success, pseudonyms were given to the participants; using capital letters of the alphabet for CA interviews and numbers for traditional agriculture interviews. Pseudonyms were also given to the names of the communities and the village inquired. One community was designated as Riofenda and the other Sinheve; and the village, Chemuve.

During 1976 and 1992 Chemuve was one of the Mozambican villages hugely affected by the civil war. There were 16 years of suffering in most inland communities living in the rural areas. Most villages were abandoned as people were forced to abandon their lands and homes in search of safer locations in nearby towns and cities. The war ended with the Peace Agreement signed in Rome in 4 October 1992.
After the Peace Agreement most of the people returned to their communities but there was still a lot of uncertainty and insecurity as new conflicts could rise. There was no food and they had to walk long distances to find water. There were Agricultural Cooperatives ("Casas Agrárias") selling some agricultural and food goods and hygiene and personal care products.

CARITAS along with MISEREOR completely changed Chemuve’s scenario in 1995 by developing an emergency support to the Agricultural Cooperatives ("Casas Agrárias") selling food, hygiene products and primary needs goods; and giving even more benefits for those joining the Rural Development Program. And so came the RDCs contributing greatly to the development of Chemuve village.

RDCs brought the development of Conservation Agriculture and literacy and technical trainings to all families joining the program. Today, there is no hunger in this community. Families can vary their meals with agricultural, horticultural and livestock production as well as fruit production. Simultaneously, degraded soils are being rehabilitated and restored with conservation agriculture methods. The village now accounts for a rehabilitated hospital, a school and a Meteorological Station opened in 2005 (see Figure 4.1), with community members trained and managing the Station.

The meteorological station added value in helping analyze sustainable agricultural works and water supply in this rural area. The station owns the following tools:
- Dry-bulb thermometer;
- Wet-bulb thermometer;
- Maximum bulb thermometer;
- Minimum bulb thermometer;
- Jáche Evaporimeter;
- Pluviometric;
- Windmill.

Figure 4.1.: Meteorological Station

Source: The Author, 2013
The village also owns a couple of wells providing drinking water for the community for whole year; and cysterns harvesting rainwater that once treated is used for human consumption for a period of 6 months.

However, Chemuve still needs to overcome many challenges:

- Increasing water supply for the community. Current water supply only caters for basic human necessities of few communities; with more water reservoirs farmers will be able to achieve higher maize, bean and sorghum productions.
- Installing electrical energy; it is essential for the development of any community.
- Improving the access roads; it is very hard to access the village during the rainy season affecting the commercialization of produced goods.
- Increasing hospitals; communities are set very far apart from each other.
- Improving education; the school only offers up to Primary School. If children want to further their education the nearest Secondary School is 10km away from the village; which is very far and almost impossible for children to walk to every day.

Throughout the interview the participant were asked to explain on how they did conservation or traditional agriculture; how often they: watered, hoed, pulled weeds; fertilize and how they did the fertilization; productions obtained by culturing / ha / year; what they made as a harvest, and the challenges encountered when switching to conservation agriculture and how they solved these challenges; what advice can they give to farmers in traditional agriculture; why not change
to conservation agriculture; and finally tell a life story. All questions are well detailed in the appendices, and were organized and made a long time ago.

Data was gathered from five (5) conservation agriculture farmers, three (3) women and two (2) men. Data was also gathered from traditional agriculture farmers who comprised three (3) women and two (2) men. They were owners of the small farms. Most of these farms are 7 hectares long.

4.3. Extent to which CA improve in maize, sorghum and beans production more than traditional agriculture (TA)

Question 1: How have you been doing conservation agriculture in the production of maize, sorghum and beans?

Answers the researcher got from the female CA farmers and the CA male farmers were very similar. Both male and female CA showed keen interest in CA farming by their readiness to answer the questions concerning how they were involved in this type of farming. The researcher noticed that CA farmers are mainly young families who have young children living with them on the farms. CA farmers gave the following as the activities that they have been carrying out conservation agriculture:

- Soil preparation
• Sowing of seeds
• Watering of the plants
• Production of organic manure
• Harvesting the crops
• Storing the harvested crops
• Selling of the surplus crops

4.3.1. Soil Preparation by CA farmers

It was possible to note during the research conducted that conservation agriculture farmers practice very minimal soil disturbance. In other words, conservation agricultural farmers do not clear the land of the foliage but turn the foliage into the soil to prevent soil erosion, as shown Figures 4.2 and 4.3 below.

The farmers prepare the soil after the harvest of maize, sorghum and beans as shown in Figure 4.2. The soil is prepared by cutting stems and leaves of plants cultivated after harvest, and placed on the same ground, in a way that maintains it covered. In table 4.1 we can see that the farmers in AC use materials such as axes, machetes, hoes and sickles to cut the leaves after harvest and cut grass to cover soil when necessary to prepare the ground (answer to question 1.a. questionnaire in Appendices). It is noticed in the same figure; that the stems and leaves of corn were cut as well as some banana leaves and tossed to the ground to protect it by keeping coverage. Banana plants in the fields protect the soil from erosion while giving fruit to farmers to improve their diet. They also provide shade to plants and to the farmers when they are in the
field, giving them better working conditions. This coverage can be made of different plants, including elephant grass and others. The important thing is to keep the soil covered with mulching (dead vegetation). This vegetation will protect the soil from erosion at the same time increasing the fertility of soil and plants that will grow in it. When the soil mulch is scarce it is augmented with grass before sowing and the coming of the first rains. This is done so that when it starts to rain it will soon begin the process of decaying, giving fertility to the soil and sustains the plant that will be sown later. In table 4.1 we can notice that the farmers in CA do not use traction animal to prepare the soil (answer to the question 1.b. questionnaire in Appendices). In Figure 4.3 Someone can verify mulch that the soil has at the time of sowing but can not see any soil but only the mulch that the farmer is stepping on during sowing.

**Figure 4.2: Preparation of the soil for sowing**

*Source: The Author, 2014*
4.3.2. Sowing of the seeds by CA farmers

Sowing of maize (Figure 4.3) begins just after the first rains (mid-October to mid-November) when the soil is moistened to 15 cm deep. The seeding being done in Figure 4.3 uses a *matraca*. The rattle is a hand-held device that contains a reservoir of seed. The farmer uses it to make holes in the ground while he or she puts the seed in quantity and at the right depth in the ground to be sown. In case there is no *matraca*, a sharpened stick is used to open up holes in the ground and pour the seeds manually to the ground. In table 4.1 we see that in CA seeds are in a line when we do not know how to measure the distances between seeds (1.d. answer to the questionnaire in Appendices). But as it is a habit people start to know exactly the exact measurements between different plants, according to its kind. These distances between plants are important to ensure the profitability of the soil, depending on the number of plants that are produced from the seed.

The measurement for the corn is between 90 x 50 with 3-5 seeds per hole to a depth of 5cm. Sorghum is sown (December - January). The measurement for sorghum is 90x50 cm with a depth of 3 cm, placing 3-5 seeds in each hole.

Normally beans are intercropped with maize or sorghum. It is sown in intermission with corn or sorghum. There are two varieties of beans that are grown in intercropping with maize or sorghum that are pigeon-pea and nhemba or mucuna. Any of these varieties is sown from 4 to 6 weeks after sowing maize or sorghum. The average seeds to sow is 2 per hole in the intermission of corn or sorghum. These two bean varieties can be intercropped at the same time with the cultivation of maize or sorghum culture.
Maize, beans and sorghum can also be intercropped. Thus is made the sowing of maize at first hand and one month after follow the sorghum and then the beans. The nhemba or macuna beans have climbing like features. So when sown it should be closer to sorghum than the beans so that it may creep on the sorghum plants, protecting the maize so that it may develop better. If pigeonpea is sown, it is just intercalated between corn and sorghum.

Table 4.1 shows that maize and beans are sown in the same area and they go on growing and producing together with a consortium form on the same plot of land (answer to question 1. questionnaire in Appendices) in the same table 4.1. CA farmers acquire seed through conservation, stored in the barn from the previous harvest (l.c. answer to question. questionnaire in Appendices).

In Figure 4.3 it is noted that the seeding of corn is being done on a field where there are already some pineapples planted. This aim to improve the diet of farmers while preventing soil degradation.

Sorghum is sown (December - January). Compass for sorghum is 90x50 cm with a depth of 3 cm, placing 3-5 seeds in each hole.

Normally beans are done in intercropping with maize or sorghum. It is sown in entrevals with corn or sorghum. There are two varieties of beans that are grown in intercropping with maize or sorghum that are pigeon-pea and cow-pea and mucuna beans.Any one of these varieties is sown 4-6 weeks after sowing maize or sorghum. The average seeds to sow is usually 2 per hole in the
intermission of corn or sorghum. These two bean varieties can be intercropped for the cultivation of maize or sorghum.

Intercropping can be done with maize, beans and sorghum. You start with the maize sowing and one month after the sorghum and then the beans respectively. The cowpea or nhemba bean has climbing like features. So when sown it should be closer to sorghum than the beans to climb much stronger plants of sorghum, maize and so protecting the mucuna bean so that it develops better. If pigeon-pea is sown, it is just in intermission between corn and sorghum.

Table 4.1 shows that maize and beans are sown in the same area and are growing and producing together with an intercropping form on the same plot of land. (answer to question 1. questionnaire in Appendices) in the same table 4.1. Conservation Agriculture farmers acquire seed through conservation, stored in the barn from the previous harvest. (1.c. answer to question, questionnaire in Appendices)

Figure 4.3 shows seed corn being produced in a field of pineapples. These aims to improve the diet of farmers while preventing soil degradation.
Figure 4.3: Seeding with *matraca*

*Source: The Author, 2014*
Table 4.1: Soil preparation, sowing and watering take the table to the appropriate section in Conservation Agriculture

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Materials Used in Soil Preparation</th>
<th>Usage of Animal Traction</th>
<th>Seed Acquisition</th>
<th>Sowing Development</th>
<th>Irrigation System Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>No line, no spaces defined and monoculture</td>
<td>Waiting for the rains</td>
</tr>
<tr>
<td>2</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Exchanging seeds with neighbours</td>
<td>No line, no spaces defined and monoculture</td>
<td>Waiting for the rains</td>
</tr>
<tr>
<td>3</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>Sowing is done with no visible pattern</td>
<td>Through the rain</td>
</tr>
<tr>
<td>4</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Exchanging seeds with neighbours</td>
<td>Sowing is done several times in the same land</td>
<td>Waiting for the rains</td>
</tr>
<tr>
<td>5</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>No line, no spaces defined and monoculture</td>
<td>By rainwater</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.3.3. Watering of the plants by CA farmers

Table 4.1 shows that CA farmers do not water sown plants (see answers to question 1.e., f. and g. at the questionnaire in the Appendices) watering is made by rainfall and farmers normally face many difficulties to access water. Water supply is one of the communities biggest challenges. Part of this challenge has been overcomed as the community is now able to produce organic compost and liquid fertilizer (see answers to question 1.p at the questionnaire in the Appendices).
In order to conquer this obstacle many CA farmers have been trained to drill boreholes for water extraction and create wells. As a result many local CA farmers have drilled boreholes and constructed small wells in their farms. More economically stable farmers have built water cisterns to cater for rainfall and try to minimize this problem. The majority of the rainfall water collected is used in the production of organic and liquid fertilizer which contributes for soil fertilization and better crops. The remaining water is disinfected and treated for human consumption. In average, rainfall water stored in cisterns last for approximately 6 months.

There were wells in the community that were built before the war in Mozambique. Most of the wells were destroyed during the war. The existing wells need to be rehabilitated and a few do not produce sufficient water for the community. An example is the well shown in Figure 4.4.; the well was poorly constructed and not properly drilled and the central watercourse does not intercept the main watercourse crossing. The tripod shown in the Figure is being used to remove the existent washers which will then be reused in the construction of the new open hole. The containers shown in the figured will be utilized to collect the remaining water of the old well, which shows how precious and scarce this resource is to the community.
4.3.4. Production of organic manure by CA Farmers

CA farmers produce organic manure and liquid manure at Figure 4.5

The liquid fertilizer and organic compost are fundamental for the growth of plants and the fertility of the soil. To produce it, the following elements availability is essential:

Organic compost in layers:
• The 1st layer is made of leaves of leguminous such as bean, wacky bean or food left-overs.
• The 2nd layer is made of sand or soil
• The 3rd layer is made of animal dung and
• The 4th layer is made of ashes

These layers must attain a meter height and should be watered once a week; it is important to ensure that the compost is kept wet and never dries up. After 45 days, the compost is ready to be used and applied in crops and fruit-trees. It is normally applied to the soil when the plant has reached 3-4 leaves (20 cm height); and is used once a month and measured by hand. Once the plant is a meter height it no longer needs the fertilizer

Figure 4.5. shows a structure and the products used to prepare and produce organic compost. The process consists of first organizing small layers of leguminosae leaves of various plants commonly found in the fields (such as bean, trapoeraba and bidens pilosa leaves among others) and food left-overs; second, alternating these layers with coatings of soil, ash and domestic animals dung. Third, tieing more than a meter high ground stakes with sisal ropes around the compost to secure it. Finally, the structure is covered with trees leaves. The tieing process will increase bacterial fermentation speeding the production of the organic compost and should be watered once a week. The farmer shown in the example below (Figure 4.5.) used rainwater from his cistern to weekly water the organic compost. Concurrently, animal farming such as duck and chicken keeping were two integrated systems highlighted by the farmers in the community to obtain natural manure and improve the food diet of their families. Improving the quality of food
and diet was another challenge successfully overcome by CA farmers in this community (see answer to question 1.p by a CA farmer/participant at the questionnaire in the Appendices).

**Figure 4.5: Production of organic compost**

![Production of organic compost](image1.png)

*Source: The Author, 2014*

Figure 4.6. below features the famous dovecote of a CA farmer in the village. This dovecote was rehabilitated for manure production and received financial support by MISEREOR. There are
over 20 doves living and breeding in this dovecote and the manure is used for the production of organic compost and liquid fertilizer. Dove farming was one of the challenges successfully mastered by this CA farmer/participant (see answers to question 1.p., at the questionnaire in the Appendices).

Figure 4.6: Improved dovecote

Source: The Author, 2014
The liquid fertilizer production process consists of putting a sack of manure into 20 liters of water for 4-5kgs of animal dung. The liquid compost can be used and applied in plants’ soils in 15 days. Concurrent to organic compost, liquid fertilizer can also be used to provide nutrients and correct any soil deficiency in crops cultivation. A can of Coca-Cola of liquid fertilizer per plant is the normal measurement used by CA farmers in Chemuve village. The organic liquid fertilizer may be applied every fortnight.

Figure 4.7 shows an example of how liquid fertilizer is produced. MISEREOR assisted CA farmers followers with training programs and financial support for the purchase of necessary construction materials. The CA farmer shown in Figure below followed MISEREOR’s program and personally built the tank with MISEREOR’s financial support. The tank was filled with water and a sac of domestic animal manure, as per quantities and measurements previously explained. The farmer has equally used rainwater from his cistern to produce the fertilizer. The tank shown in Figure 4.7 produces a total capacity of 200 litres of liquid fertilizer.
Figure 4.7: Production of organic liquid fertilizer in Conservation Agriculture

Figura 4.8 shows a CA farmer who’s simultaneously a group leader. She is happy to have successfully produce a small portion of liquid fertilizer with chicken manure and the clay pot method. The farmer and group leader has conquered the great challenge of producing liquid fertilizer at zero costs. This is an old traditional method without major expenditures and with effective results. Both organic compost and liquid fertilizer productions were challenges that have been overcome by CA farmers and participants (see answers to question 1.o.) and p.), at the questionnaire in the Appendices).
4.3.5 Harvesting of Crops by CA farmers

The method used in this research study were interviews, direct observation and focus group discussions with participants practicing conservation agriculture since 1997 until 2012 on maize, sorghum and bean crops, in the communities of Riofenga and Sinheve, in the village of
Chemuve. The following tables show the data collected from the participants in relation to the production of harvests (1.j. answers the question that is in the questionnaire in Appendices).

4.3.5.1 Maize harvesting in Conservation Agriculture

Table 4.2 shows maize production evolution between 1997 and 2012. Farmers started following conservation agriculture methods and techniques for cultivation in 1997.

Table 4.2: Annual production in Kg / Hectare maize crop 1997-2012 in CA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.700 Kg</td>
<td>2.500 Kg</td>
<td>3.500 Kg</td>
</tr>
<tr>
<td>B</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.500 Kg</td>
<td>2.000 Kg</td>
<td>3.000 Kg</td>
</tr>
<tr>
<td>C</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.500 Kg</td>
<td>2.500 Kg</td>
<td>3.250 Kg</td>
</tr>
<tr>
<td>D</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.600 Kg</td>
<td>2.400 Kg</td>
<td>3.000 Kg</td>
</tr>
<tr>
<td>E</td>
<td>600 Kg</td>
<td>800 kg</td>
<td>1.500 Kg</td>
<td>2.000 Kg</td>
<td>2.500 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.3.5.2. Sorghum harvesting in Conservation Agriculture

Table 4.3 shows sorghum production evolution between 1997 and 2012. Farmers started following conservation agriculture methods and techniques for cultivation in 1997.
Tabel 4.3: Annual production in Kg / Hectare sorghum crop 1997-2012 in CA

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.000 Kg</td>
<td>1.200 Kg</td>
</tr>
<tr>
<td>B</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
</tr>
<tr>
<td>C</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
<td>1.200 Kg</td>
</tr>
<tr>
<td>D</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
</tr>
<tr>
<td>E</td>
<td>600 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
<td>1.300 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.3.5. 3 Beans harvesting in Conservation Agriculture

Tabel 4.4 shows bean production evolution between 1997 and 2012. Farmers started following conservation agriculture methods and techniques for cultivation in 1997.

Tabel 4.4: Annual production in Kg / Hectar bean harvest de1997 to 2012 in CA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>700 Kg</td>
</tr>
<tr>
<td>B</td>
<td>300 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
</tr>
<tr>
<td>C</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>700 Kg</td>
</tr>
<tr>
<td>D</td>
<td>300 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
</tr>
<tr>
<td>E</td>
<td>400 Kg</td>
<td>450 kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>700 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014
4.4. How CA farmers store the harvested crops

CA farmers use barns to store their crops and protect their harvest from plagues, pests, insects, diseases and insure full germination power is preserved in the seeds. Barns also ensure continuous availability of seeds in good state of conservation for the following sowings. Figure 4.9. shows an example of a traditional barn used for seeds storage by CA farmers in Chemuve village.

MISEREOR, via CARITAS, financially supported the construction of the barn shown in Figure 4.9.. This barn was built with grass surplus and mud and the wall thickness comprises of at least 13cm. The combination of a thick-wall and the materials used help maintain the interior temperature of the barn. Seeds should always be preserved in grains and it is recommended to store them in sacs and only open them for sowing. A good selection of seeds is crucial before storage. It is important to ensure that seeds affected with diseases, insects or larvaees are not stored as they can easily reproduce, propagate and destroy all the seeds stored in the barn.

Traditional agriculture farmers do not use this form of barns. Seeds are stored in plastic containers.
Table 4.5 shows the quantity of products that CA farmers are able to store for future sowing in a traditional barn. The Table also shows farmers/participants answers to question 1.n. during the research conducted in 2012 (see question at questionnaire in Appendices).
Tabel 4.5: Quantities of maize, sorghum and bean produced for seeding per Hectare and per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum for Seeding</th>
<th>Beans Produced</th>
<th>Beans for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.700 Kg</td>
<td>100 Kg</td>
<td>800 Kg</td>
<td>50 Kg</td>
<td>800 Kg</td>
<td>20 kg</td>
</tr>
<tr>
<td>B</td>
<td>2.800 Kg</td>
<td>100 Kg</td>
<td>800 Kg</td>
<td>50 Kg</td>
<td>800 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>C</td>
<td>3.100 Kg</td>
<td>120 Kg</td>
<td>700 Kg</td>
<td>60 Kg</td>
<td>700 Kg</td>
<td>30 Kg</td>
</tr>
<tr>
<td>D</td>
<td>2.700 Kg</td>
<td>80 Kg</td>
<td>750 Kg</td>
<td>40 Kg</td>
<td>700 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>E</td>
<td>2.250 Kg</td>
<td>100 Kg</td>
<td>700 Kg</td>
<td>50 Kg</td>
<td>700 Kg</td>
<td>20 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.5. How CA farmers sell the surplus crops

Table 4.6 shows quantities of product sold per harvest, per hectare after 2012 yields. This Table was made taking into account participants answers to question 1.1. (see questionnaire in the Appendices). Conservation agriculture farmers sell their goods in local markets due to access roads and transport constrains to the nearest villages and cities. The lack of good access roads and infrastructures conspicuously hinders commercialization of produced goods and increases poverty in remote villages like Chemuvu. The only product that is successfully commercialized outside their communities is sorghum. Main buyers are Indian/Pakistanian traders that travel to Chemuwe frequently to purchase this product.
Tabel 4.6: Quantities of maize, sorghum and beans produced and sold per Hectare and per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.700 Kg</td>
<td>300 Kg</td>
<td>800 Kg</td>
<td>400 Kg</td>
<td>800 Kg</td>
<td>400 Kg</td>
</tr>
<tr>
<td>B</td>
<td>2.800 Kg</td>
<td>200 Kg</td>
<td>800 Kg</td>
<td>300 Kg</td>
<td>800 Kg</td>
<td>500 Kg</td>
</tr>
<tr>
<td>C</td>
<td>3.100 Kg</td>
<td>200 Kg</td>
<td>700 Kg</td>
<td>300 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
<tr>
<td>D</td>
<td>2.700 Kg</td>
<td>300 Kg</td>
<td>750 Kg</td>
<td>400 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
<tr>
<td>E</td>
<td>2.250 Kg</td>
<td>250 Kg</td>
<td>700 Kg</td>
<td>300 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

4.6. Traditional Agriculture Farmer Activities

The methods used in this research study were the same used for CA: interviews, direct observation and focus group with farmers practicing traditional agriculture since 1997 on maize, sorghum and bean crops, in the communities of Riofenda and Sinheve, in the village of Chemuve.

Question 1

a) How have you been doing traditional agriculture in the production of maize, sorghum and beans?

b) Why have you not adopted CA farming model?
From these two questions it was noted that Traditional Agriculture female and male farmers across the ages show no interest to practice Conversation Agriculture. TA farmers described their farming activities as follows:

- Soil preparation
- Sowing of the seed
- Harvesting the produce
- Storing the harvested crops
- Selling of the surplus produce

4.6.1. Soil Preparation by Traditional Agriculture farmers

Traditional agriculture farmers set fire to the forest so that land can be utilized for farming. This practice however removes all green and dry vegetation, organic matter and residues impoverishing the soils. After intentional burning for ground clearance traditional agriculture farmers use hoes to prepare the soil. Machetes and axes are also used to chop down the remaining vegetation and prepare the soil for planting.

4.6.2. Sowing of the seeds by Traditional Agriculture farmers

After the first rainfall sowing begins and traditional agriculture farmers follow a form of dibbling which involves the use of a hoe (instead of a sharpened stick) to make holes in the soil into which seeds are dropped. Drilling or row-seeding are only used by conservation agriculture farmers to ensure an even distribution of the seeds; traditional agriculture farmers do not follow
any specific pattern. Traditional agriculture farmers normally drop 2 seeds per hole. Due to insufficient technical knowledge it frequently occurs that plants do not germinate after sowing; as a result traditional agriculture farmers conduct a second sowing which consists of repeating the process in all the holes where plants have not germinated. Their techniques do not include mixing and rotation of crops. Sowing is done more on an ad-hoc basis, with no specific structure or measurements. Some farmers try to copy conservation agriculture methods but due to lack of background knowledge there is no management control over farms costs and goods quality. A lot of time is spent removing weeds four to five times per culture. Traditional agriculture farmers await rainfall to water their fields. Seeds for sowing are acquired from the surplus of previous harvests or sometimes exchanging with neighbours. They do not use animal traction. Tabel 4.7. shows obtained results through answers given from traditional agriculture farmers to questions 1.a) b) c) d) e) f) g) e h) (see answers to the questionnaire in the Appendices).

**Table 4.7.: Soil preparation, sowing and watering in Traditional Agriculture**

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Materials Used in Soil Preparation</th>
<th>Usage of Animal Traction</th>
<th>Seed Acquisition</th>
<th>Sowing Development</th>
<th>Irrigation System Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>No line, no spaces defined and monoculture</td>
<td>Waiting for the rains</td>
</tr>
<tr>
<td>2</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Exchanging seeds with neighbours</td>
<td>No line, no spaces defined and monoculture</td>
<td>Waiting for the rains</td>
</tr>
<tr>
<td>3</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>Sowing is done with no visible pattern</td>
<td>Through the rain</td>
</tr>
<tr>
<td>4</td>
<td>Hoe, machete, ax and fire to burn</td>
<td>Does not use</td>
<td>Exchanging seeds with</td>
<td>Sowing is done several</td>
<td>Waiting for the rain</td>
</tr>
</tbody>
</table>
### 4.6.3. Harvesting the produce by Traditional Agriculture farmers

Maize, sorghum and bean production values are considerably low with traditional agriculture farmers. AT farmers/ participants have stated that when productions are noticeably low they migrate to new lands where the same land preparation and production model is applied. Traditional agriculture methods visibly increases soil degradation and declines soils fertility reducing agricultural yields to levels that no longer guarantee traditional agriculture farmers survival, forcing them to move to new lands frequently. This is still possible because the majority of traditional agriculture families in Chemuve Village own in average six hectares of land by way of inheritance. These data was acquired through answers to question 1.i) of the questionnaire in the Appendices.

#### 4.6.3.1. Maize harvesting by Traditional Agriculture Farmers

Table 4.8 shows maize production evolution between the years of 1997 and 2012.

<table>
<thead>
<tr>
<th></th>
<th>the straw</th>
<th>neighbours</th>
<th>times in the same land</th>
<th>rains</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Hoe, machete, ax and fire to burn the straw</td>
<td>Does not use</td>
<td>Surplus from previous harvest</td>
<td>No line, no spaces defined and monoculture</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*
Table 4.8: Annual production in Kg / Hectare maize crop 1997-2012 in TA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>600 Kg</td>
<td>700 Kg</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>900 Kg</td>
</tr>
<tr>
<td>2</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>700 Kg</td>
<td>800 Kg</td>
<td>1.000 Kg</td>
</tr>
<tr>
<td>3</td>
<td>700 Kg</td>
<td>800 Kg</td>
<td>800 Kg</td>
<td>900 Kg</td>
<td>1.000 Kg</td>
</tr>
<tr>
<td>4</td>
<td>700 Kg</td>
<td>800 Kg</td>
<td>900 Kg</td>
<td>900 Kg</td>
<td>1.000 Kg</td>
</tr>
<tr>
<td>5</td>
<td>800 Kg</td>
<td>800 Kg</td>
<td>1.000 Kg</td>
<td>900 Kg</td>
<td>1.000 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.6.3.2. Sorghum Harvesting by Traditional Agriculture Farmers

Table 4.9 shows maize production evolution between the years of 1997 and 2012.

Table 4.9: Annual production in Kg / Hectare sorghum crop 1997-2012 in TA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300 Kg</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
</tr>
<tr>
<td>2</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>500 Kg</td>
<td>550 Kg</td>
</tr>
<tr>
<td>3</td>
<td>200 Kg</td>
<td>300 Kg</td>
<td>250 Kg</td>
<td>300 Kg</td>
<td>350 Kg</td>
</tr>
<tr>
<td>4</td>
<td>350 Kg</td>
<td>300 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>450 Kg</td>
</tr>
<tr>
<td>5</td>
<td>400 Kg</td>
<td>350 kg</td>
<td>400 Kg</td>
<td>400 Kg</td>
<td>450 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014
4.6.3.3. Bean Harvest in Traditional Agriculture

Table 4.10 shows bean production evolution between the years of 1997 and 2012.

Table 4.10: Annual production in Kg / Hectare bean harvest 1997 to 2012 in TA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>150 Kg</td>
<td>150 Kg</td>
<td>200 Kg</td>
<td>200 Kg</td>
<td>250 Kg</td>
</tr>
<tr>
<td>2</td>
<td>200 Kg</td>
<td>200 Kg</td>
<td>200 Kg</td>
<td>250 Kg</td>
<td>250 Kg</td>
</tr>
<tr>
<td>3</td>
<td>250 Kg</td>
<td>250 Kg</td>
<td>270 Kg</td>
<td>300 Kg</td>
<td>300 Kg</td>
</tr>
<tr>
<td>4</td>
<td>200 Kg</td>
<td>220 Kg</td>
<td>200 Kg</td>
<td>250 Kg</td>
<td>250 Kg</td>
</tr>
<tr>
<td>5</td>
<td>200 Kg</td>
<td>250 Kg</td>
<td>200 Kg</td>
<td>250 Kg</td>
<td>300 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.6.4. How TA farmers store the harvested crops

Table 4.11 shows quantities of maize, sorghum and bean stored for seeding. Traditional agriculture farmers store their seeds in raffia bags or in 25L plastic containers. Table shows what is produced and stored per hectare and per culture in 2012. These results were obtained via traditional agriculture participants feedback to question 1.n). (see the questionnaire in the Appendices).
Table 4.11: Quantities of maize, sorghum and bean produced for seeding per Hectare and per harvest in 2012 in Traditional Agriculture

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum for Seeding</th>
<th>Beans Produced</th>
<th>Beans for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000 Kg</td>
<td>80 Kg</td>
<td>500 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>2</td>
<td>1.200 Kg</td>
<td>100 Kg</td>
<td>550 Kg</td>
<td>50 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>3</td>
<td>1.100 Kg</td>
<td>100 Kg</td>
<td>400 Kg</td>
<td>30 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>4</td>
<td>1.000 Kg</td>
<td>80 Kg</td>
<td>450 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>5</td>
<td>1.250 Kg</td>
<td>100 Kg</td>
<td>450 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

4.6.5. Selling of the surplus produce in Traditional Agriculture

Comparatively to consertaion agriculture farmers, traditional agriculture farmers sell considerably smaller amounts of products yielded. The only product traditional agriculture farmers are able to commercialize is beans due to the fact that agricultural yield levels are so low that can only be used for human consumption and securing of family subsistence. Table 4.12 shows the quantity of maize, sorghum and bean produced and sold. These results were obtained through answers given by traditional agriculture participants to question 1.1. (see the questionnaire in the Appendices).
Table 4.12: Quantities of maize, sorghum and bean produced and sold per Hectare and per harvest in 2012 in Traditional Agriculture

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000 Kg</td>
<td>0 Kg</td>
<td>500 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>2</td>
<td>1.200 Kg</td>
<td>0 Kg</td>
<td>550 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>3</td>
<td>1.100 Kg</td>
<td>0 Kg</td>
<td>400 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>4</td>
<td>1.000 Kg</td>
<td>0 Kg</td>
<td>450 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>5</td>
<td>1.250 Kg</td>
<td>0 Kg</td>
<td>450 kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

4.7. Differences and similarities of CA and TA farming activities

4.7.1. CA Challenges Found

As per answers to question 1.o. (see questionnaire is in the Appendix) all interviewed participants provided similar concerns with regards to conservation agriculture challenges. Among the various techniques used participants have stressed the use of dead ground coverage, the production of organic compost and liquid fertilizer for soil protection and improvement.

Water supply is one of the biggest challenges the community faces. Existing animal manure is not sufficient for the production of organic compost and liquid fertilizer; as a result water is also utilized for liquid fertilizer and humus production. However, existing water supply is not sufficient to cater for the needs of the population and agriculture.
There was feedback given by the participants to resolve these issues, the question 1.p) whose questionnaire is in appendices as follows:

- Introduce conservation agriculture production in small fields of 1ha or less and as rentability increases gradually expand their acreage under cultivation;
- Increase small animals breeding to ensure manure surplus for organic fertilizers production;
- Identify new locations to build more wells and reduce lack of water supply;
- Build more cisterns to collect rainwater.

4.7.2. Life Changing Stories Found in Conservation Agriculture

Changing life stories are commonly found with AC interviewed the participants in question 1.q. (whose questionnaire is in appendices) and their answers were as follows:

- Initially it was very hard to believe and accept conservation agriculture over traditional agricultural methods. Communities only started to believe in conservation agricultural techniques when increased production results were visibly noticeable;
- Group leaders were invited to visit conservation agriculture productions in Zimbabwe and South Africa. They would then report their experiences to the communinities to inspire and motivate local farmers adhering to conservation agriculture production systems. It implied a change of mindset and attitude.
- Today CA is part of their lives and their habits and they are very grateful to the Rural Development Program.
4.7.3. Conservation Agriculture Farmers Feedback and Advise to Traditional Agriculture Farmers

Through question 1.r. (questionnaire found in the Appendices) conservation agriculture participants provided in general similar feedback and recommendations to traditional agricultural farmers, as follows:

- Start implementing conservation agriculture in small yield of 1ha or less plantations; and gradually, as production results and profitability increases, give up using traditional agriculture methods;
- Build the farm near home to save time and avoid walking long distances everyday;
- Increase small animal farming to generate sufficient manure to produce organic compost and liquid fertilizer;
- Build a water cistern near the farm and the house to facilitate farming activities and save time.

4.7.4. Differences of Conservation Agriculture and Traditional Agriculture farming activities

Table 4.13 shows conservation agriculture maize production evolution achieving an average of 640Kg/ha in 1997 and 3.050Kg/ha in 2012; while traditional agriculture average results have not reached 1.000Kg/ha in 2012. Similar results occurred with bean and sorghum crops.
It is possible to conclude that only conservation agriculture farmers are able to successfully sell greater amounts of produce per ha and per culture (shown in Table 4.14). Traditional agriculture farmers, due to low production results, used mostly for subsistence, sold only an average of 50Kg of bean/ha.

Table 4.14: Average quantities of maize, sorghum and bean sold/Kg per Hectare and harvest in 2012 in CA and TA

<table>
<thead>
<tr>
<th></th>
<th>MAIZE</th>
<th>SORGHUM</th>
<th>BEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA</td>
<td>TA</td>
<td>CA</td>
</tr>
<tr>
<td>CA</td>
<td>250</td>
<td>0</td>
<td>340</td>
</tr>
</tbody>
</table>

Source: The Author, 2014
4.8 Typical cases of CA

4.8.1. Typical case 1 Mrs. A's Story

Mrs. A owns her own farm ("machamba") at Riofenda community where she lives with her husband who also helps her working the land. Tabel 4.1. shows that soil preparation is done using the following materials: hoe, machete, ax and in some cases the sickle. The hoe is used to clear the paths between the beds. The other tools are used to cut the straw to put on top of the soil, as land should all be covered with straw. The ax is used sporadically to cut the straw. Mrs. A does not use animal traction. The sowing is made in line, with defined spaces and intercropping, using seeds from the surplus of previous harvests stored in the traditional barn. There is no irrigation system in place as they wait for rainwater. Weeding is made once a harvest, twice a year. The second harvest, produces maize (300Kg) and beans (150Kg). This occurs due to the fact that the land is located near the river and land’s natural moist contributes to superior production.

From 1997-2012 production of maize, sorghum and beans have significantly increased due to the use of conservation agriculture methods and techniques achieving the following figures:

- Maize increased from 600 Kg/ha to 3.500 Kg/ha. (Table 4.2)
- Sorghum increased from 500kg/ha to 1.200Kg/ha; (Table 4.3)
- Beans increased from 400Kg /ha to 700 kg/ha (Table 4.4).

2012 registered the following maize, sorghum and bean production:

- 3.700 Kg/ha of maize; from the total production, 300Kg (Table 4.6) were sold, 100Kg stored for future sowing (Table 4.5) and 3.300Kg stored for consumption.
• 800 Kg/ha of sorghum; from the total production 400Kg (Table 4.6) were sold, 50Kg stored for future sowing (Table 4.5) and 350Kg stored for consumption.

• 800 Kg/ha of beans; from the total production 400Kg were sold (Table 4.6), 20Kg stored for future sowing (Table 4.5) and 380Kg for consumption.

4.8.2. Typical case 1 Mrs. B’s Story

Mrs. B lives and works in her own farm at Riofenda community. She is a farmer and works the land by herself. The soil preparation is done mainly with the use of the machete and the sickle to cut the straw to cover the cultivated soil. The hoe is used to clear the paths between the beds. There is no animal traction used. Sowing is done in line and intercropping. The seeds utilized are from the previous harvest’s surplus. The irrigation system is only made by rainwater. Weeding is done once a harvest, twice a year. The second harvest produces a small portion of maize (350Kg) and beans (180Kg). This occurs due to the location of the land near the river offering favorable humidity conditions to the land.

From 1997-2012 production of maize, sorghum and beans have significantly increased due to the use of Conservation Agriculture methods and techniques achieving the following figures:

• Maize, from 600 Kg/ha to 3,000 Kg/ha (Table 4.2).

• Sorghum, from 400Kg/ha to 1,100Kg / ha (Table 4.3).

• Beans, from 300Kg /ha to 600 kg/ha (Table 4.4).

2012 registered the following maize, sorghum and bean production:
• 2.800 Kg/ha of maize; where 200Kg were sold (Table 4.6), 100Kg stored for sowing (Table 4.5) and 2.500Kg stored for consumption.

• 800Kg/ha of sorghum; where 300Kg were sold (Table 4.6), 50Kg stored for sowing (Table 4.5) and 450Kg stored for consumption.

• 800Kg/ha of beans; where 500Kg were sold (Table 4.6) and 20Kg stored for sowing (Table 4.5), getting kept for consumption. 280Kg.

4.8.3. Typical case 1 Mrs. C's Story

A Mrs. C lives and owns her farm at the Sinheve community and works the field by herself. The soil preparation is made mainly with the use of the machete and sickle to cut big quantities of straw to cover the soil. There is no animal traction used and sowing is done in line and intercropping. The irrigation system is made by rainwater. Weeding is done once a harvest, once a year. Mrs. C always adds organic liquid fertilizer to the soil to increase productivity (see Figure 4.8.)

From 1997-2012 production of maize, sorghum and beans have significantly increased due to the use of Conservation Agriculture methods and techniques achieving the following figures:

• Maize, from 700 Kg/ha to 3.250 Kg/ha (Table 4.2).

• Sorghum, from 500 Kg/ha to 1.200 Kg/ha (Table 4.3).

• Beans, from 400 Kg/ha to 700 Kg/ha (Table 4.4).

2012 registered the following maize, sorghum and bean production:
• Maize, 3.100 Kg / ha; where 200Kg were sold (Table 4.6), 120Kg stored for sowing (Table 4.5) and 2.780Kg for consumption.

• Sorghum, 700Kg/ha; where 300Kg were sold (Table 4.6), 60Kg stored for sowing (Table 4.5) and 340Kg stored for consumption.

• Beans, 700Kg/ha; where 400Kg were sold (Table 4.6), 30Kg stored for sowing (Table 4.5) and 270Kg stored for consumption.

4.8.4. Typical case 1 Mrs. D's Story

Mr. D (Figure 4.10) lives and works in his own farm at Sinheve community. He prepares the soil with the use of the machete and the sickle to cut great amounts of straw that are later used to cover the cultivated soil. Mr. D does not use animal traction and the sowing is done in line and intercropping. The irrigation system is by rainwater. There is little weeding work to do in his farm and it is made once a harvest, once a year, per culture cultivated.

From 1997-2012 production of maize, sorghum and beans have significantly increased due to the use of Conservation Agriculture methods and techniques achieving the following figures:

• Maize increased from 700 Kg/ha to 3.000 Kg/ha (Table 4.2).

• Sorghum increased from 400 Kg/ha to 1.100 Kg/ha (Table 4.3).

• Beans increased from 300 Kg/ha to 600 Kg/ha (Table 4.4).

2012 registered the following maize, sorghum and bean production:

• 2.700 Kg/ha of maize; 300Kg were sold (Table 4.6), 80Kg stored for sowing (Table 4.5) and 2.320Kg stored for consumption.
- 750 Kg/ha of sorghum; 400Kg were sold (Table 4.6), 40Kg stored for sowing (Table 4.5) and 310Kg for consumption.

- 700 Kg/ha of beans; 400Kg were sold (Table 4.6), 20Kg stored for sowing (Table 4.5) and 280Kg stored for consumption.

**Figure 4.10: Mr. D with his family in his farm**

*Source: The Author, 2013*

### 4.8.5. Typical case 1 Mrs. E's Story

O Mr. E lives and works in his farm at Sinheve’s community. He prepares the soil mainly with the machete and the sickle to cut the straw. There is no use of animal traction and sowing is
done in line and intercropping. The irrigation system is made by rainwater. Weeding is done once a harvest, once a year per culture. There is very little weeding work to do in his land, and always produces and adds organic compost to the soil (Figure 4.5).

From 1997-2012 production of maize, sorghum and beans have significantly increased due to the use of Conservation Agriculture methods and techniques achieving the following figures:

- Maize, from 600 Kg/ha to 2,500 Kg/ha (Table 4.2).
- Sorghum, from 600 Kg/ha to 1,300 Kg/ha (Table 4.3).
- Beans, from 400 Kg/ha to 700 kg/ha (Table 4.4).

2012 registered the following maize, sorghum and bean production:

- 2,250 Kg/ha of maize; 250Kg were sold (Table 4.6), 100Kg stored for sowing (Table 4.5) and 1,900Kg stored for consumption.
- 700Kg/ha of sorghum; 300Kg were sold (Table 4.6), 50Kg stored for sowing (Table 4.5.) and 350Kg stored for consumption.
- 700Kg/ha of beans; 400Kg were sold (Table 4.6), 20Kg stored for sowing (Table 4.5) and 280Kg stored for consumption.

4.9. The Profile of CARITAS

CARITAS is an organization of the Catholic Church that aims to drive and promote social responsibility actions of the Church as an organization. It comprises of local action groups from nearby regions and the contribution of volunteers and professionals inspired by the Christian love. CARITAS main focus are: the poor and the oppressed; and its values include defending the
human being and helping with his/her progress promoting self-help, self-love, justice and social solidarity. CARITAS was founded on the basis of the New Commandment: “Love one another as I have loved you” (Jo 13,34).

CARITAS works with national and international organizations and receives donations to support deprived communities. MISEREOR has been financing CARITAS since 1995. MISEREOR means humanity, working for a fair world by financing programs and projects in Africa, South Africa and many other parts of the world. The organization was founded in 1958 by the German Episcopal Conference. Its main objective is to fight world hunger and disease providing moral and financial support to Catholic and Non-Catholic organizations.

The Rural Development Program was launched by CARITAS at Beira city after the 16 years civil war in Mozambique. The army conflict ended in 1992 and projects started in 1995 financed by MISEREOR – a German, Catholic and a Non Governmental Organization. Different financial stages took place culminating with the creation of various programs including the Rural Development Program that is still in place many villages of Sofala province, including Chemuve and Riofenda and Sinheve communities, which are an integral part of this study as previously referred.

However, due to the lack of water accessibility at Chemuve village and other communities financed by the program, in 1998 relationship synergies were developed with other services and organizations in the Sofala Province as well as other MISEREOR financed programs in the
center region. As an outcome the partnership network established the Water Team with 2 technically trained members.

The Water Team listed defected water source structures in various regions, including Chemuve, to improve water supply to the communities, especially where programs were implemented. A water seminar took place and was attended by the communities involved, their local traditional leaders and the dioceses of Beira, Chimoio and Chokwe.

The community of Riofenda attended the seminar and participated on motivational campaigns to open new wells, as shown in figure 4.4. The community learnt how to use water catchment probes and sensors to find and retain water. These campaigns aimed to involve the communities, create awareness and promote the construction of environmentally friendly wells and its benefits interlinked with the project’s main activities.

In 1999 two projects were founded financed by MISEREOR; one for sustainable agriculture, literacy and standard education (project № 146-002/34); and the other for water infrastructure (water supply project № 146-002/32). These two projects were implemented in vulnerable communities offering technical solutions for agriculture and drinking water abstraction. With the help of the literacy program and the village council it was possible to promote and create awareness to the existing projects increasing adherence numbers in each community; hence providing not only knowledge but also deeper understanding of the technical agriculture solutions.
In 1997 all families adhering to the RDP had to compulsory produce in a 20 sqm testing field applying only CA method techniques. There were groups composed of 20 to 25 families monitored by a group leader. The group leader was elected by the group of families and similarly had to have a 20sqm testing field where he/she applied only CA production system techniques. A total of 100 families followed the Rural Development Program in this year.

RDCs field sizes decreased between 1999 and 2001 to a maximum of 2 ha. Farmers adhering to the project had access to animal production increase programs introducing a more beneficial rotational credit system to the communities. By the end of 2001 there were 150 families adhering to the Rural Development Program.

The project distributed seeds and seedings of different species of the family leguminosae, cassava, pineapple and banana trees (Figure 4.11). The distribution of seeds was initially offered free of charge at the early stage of the program, that started in 2002 and lasted until 2004. The main goal of this project was to develop and increase culture diversity contributing to the nutrition levels of rural families.

Figure 4.11 shows dried maize (zea mays) and fresh sweet maize ready for harvest; behind the maize the figure shows a lot of bóer bean (cajanus cajan); there is nhemba bean (vigna unguiculata (L) covering the soil and a banna tree with healthy fruits. Figure demonstrates conservation agriculture techniques used by CA farmers mixing and rotating different
gramineous and leguminous crops. The banana tree and other fruit trees including pineapple contribute to preserve, improve and add nutrients to the soil. Fruit trees, like the banana tree shown in Figure 4.11. also provide shade and a resting location for farmers working the fields daily. Plants growing under the trees’ shade (like maize, bean and sorghum shown in the figure) absorb more nutrients and are less vulnerable to dehydration as the soil is able to preserve its moisture for longer periods; and therefore will registrate higher production levels. Furthermore fruits, in specific banana, is highly nutritious and energetic and rich in vitamins contributing to a healthy and balanced diet to the farmers and their families

Figure 4.11: Tree Fruit in the middle of the corn and beans

Source: The Author, 2013
In 2003 the project introduced agri-silvicultures and drought resistant plants like orange pulp sweet-potato and others; seedings of fruit trees and leguminosae; animal production with main focus on rabbits and ducks; the construction of improved barns and phitosanitary protection; and the drilling of more wells in the communities. To ensure the production of liquid fertilizer the Rural Development Program introduced animal shelters of small species. Figure 4.6 shows an improved loft (doves) in Chemuve. There was also the introduction of improved barns (see Figure 4.9). By the end of 2003, 200 families were adopting CA systems and following the RDP.

In 2004, with the help of Riofenga community another well was drilled and it is serving the communities up to the present day. However, water supply is not sufficient to cater for the needs of the whole community. As a result, in 2006, 3 cisterns were built to collect rainwater in Sinheve and 2 in Riofenga. The rainwater was then treated for human consumption. It is important to mention that wells provide drinking water throughout the year for these communities, whereas cisterns only provide for half of the year.

Due to the success of the Rural Development Program by the end of 2006 there were 500 families adhering to conservation agriculture systems. Therefore a need was identified to reduce the amount of groups per group leader. Each group leader was now in charge of 15-20 families (instead of 20-25 families); and new leaders were assigned to monitor each Chemuve community.
Fruit farms were introduced (Figure 4.12) for the first time by families participating in the RDC program in Chemuve; as well as the purchase of seeds of different plants and the construction of 6 tanks for the production of liquid fertilizer, shown in Figure 4.7. Group meetings were held to discuss and debate HIV/AIDS in order to increase awareness to the disease, its causes and impact on people and society.

**Figure 4.12: Hotbed of fruit plants**

![Image of fruit plants](source: The Author, 2013)

Nurseries of fruit trees are used to manage and control the growing conditions of sowed fruit plants in plastic sacs (mangoe, avocado, guava, soursop, sugar-apple, orange and lemon). After they reach a certain growing stage they are finally planted and further grown in farmers fields, near watercourses that contribute to their rapid growth. Their main role is to provide shade for the farmers and for the growing crops of maize, bean and sorghum; supply nutrients to the
cultures and the soil, improving its fertility; protect the soil against erosion; offer fruits rich in vitamins and improve the diet of conservation agriculture farmers’ families.

There was a great drought in Chemuve in 2007. In 2008 fruit trees and leguminous farms were introduced. Chemuve RDCs purchased litchi tree seedings and motivated families to develop horticulture to improve nutrient diet.

During all these years CARITAS was concerned with the high illiteracy rate in the community and launched an education program intrinsically linked to the RDP. The teacher incorporated practical examples of conservation agriculture techniques in the literacy courses. By the end of 2011, 600 families were following the Rural Development Program. The number increased to a total of 700 families in 2012.

Since 2008 CARITAS in coordination with MISEREOR have been giving technical agricultural assistance and creating awareness to the family groups adhering to the program to:

- Avoid being nomades and become more sedentary; avoid frequently changing from land or residence. In this way families learn to maintain and protect their lands, wells and water cisterns from animals and goats;
- Explain the opportunities communities have to explore and benefit from the local markets using their human and natural resources;
- Contact local businesses to evaluate the economical activities in the region, to identify and obtain information of new market needs and demands and increase their economical

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activities consequently generating more income to the families and the communities in
general;

And simultaneously alert the families for:

- Massive land degradation and land conflict;
- Local land tenure disputes taking into consideration that each families owns in average
  by heritage 6-7 ha;

Currently, the biggest barrier is the lack of literacy. It is crucial for communities to learn
Portuguese to obtain more knowledge from sessions, seminars and meetings and become group
leaders; with literacy they will learn how to efficiently manage their field production.

4.9.1. Roles of Group Leaders, the Agricultural Technician, CARITAS Program
Coordinator and MISEREOR Financial Consultant in CA

The communities of Riofenga and Sinheve appointed their group leaders. All group leaders are
following the RDP financed by CARITAS and MISEREOR since 1995. Since they were,
selected they have been receiving professional instruction and Conservation Agricultural system
training. It is compulsory that group leaders own a testing field of at least 20 sqm, to test and
show the results to the groups of families under their responsability. From 1995-2005 each group
leader was in charge of 20-25 families. From 2006 up to date their groups reduced to 15-20
families. They are conservation agriculture farmers; provide technical assistance to the groups
under their responsabilities and report directly to the agricultural technician.
The agricultural technician receives the information from all group leaders and advises and guides the group leaders. Group leaders will then train and motivate their groups. The agricultural technician sends a report to the CARITAS Rural Development Project Coordenator. The coordenator will then present the results in a report format to the MISEREOR Financial Consultant.

4.9.2. Background Information of Group Leaders and the Agricultural Technician

The communities of Riofenda and Sinheve appointed their group leaders. All group leaders are following the RDP financed by CARITAS and MISEREOR since 1995. Since they were, selected they have been receiving professional instruction and Conservation Agricultural system training. It is compulsory that group leaders own a testing field of at least 20 sqm, to test and show the results to the groups of families under their responsability. From 1995-2005 each group leader was in charge of 20-25 families. From 2006 up to date their groups reduced to 15-20 families. They are conservation agriculture farmers; provide technical assistance to the groups under their responsabilities and report directly to the agricultural technician.

The agricultural technician receives the information from all group leaders and advises and guides the group leaders. Group leaders will then train and motivate their groups. The agricultural technician sends a report to the CARITAS Rural Development Project Coordenator. The coordenator will then present the results in a report format to the MISEREOR Financial Consultant.
4.10 Traditional Agriculture in Chemuve

Between 1976 and 1992 Mozambique was in a civil war and during these 16 years of hardship the most affected population were the ones living in the rural areas. The war ended with the Peace Agreement signed in Rome on 4th of October 1992. During the war and a few years after the war years many families did not feel safe and were forced to abandon their communities in the rural areas and migrate to safer locations in the main cities of the country.

Chemuve village was not immune to the calamity desolating the country and after the war its remaining population was living in absolute poverty. This was one of the main reasons why CARITAS, financed by MISEREOR, selected this village to launch the Rural Development Program introducing conservation agricultural techniques. The RDP started in 1995 and is currently still in place. It was not a compulsory program therefore not all farmers living in the community are following conservation agriculture methods. A few families are still practicing traditional agriculture as a respect to their ancestors and their traditional believes. However, adherence to the program and to CA methods has been increasing over the years.

4.10.1 Typical case of TA

4.10.1.1 Typical case Mr. 1.’s Story

Mr. 1 lives and works in his own farm at Riofenda community. The soil preparation is done mainly with the use of hoe, machete, ax and fire to burn the grass covering the soil. There is no animal traction used. The seeds utilized are from the previous harvest’s storage. Sowing is done
in monoculture with no specific lines or measurements. There is no irrigation system, uses rainwater. Weeding is made approximately 4 times per harvest, twice a year. The second harvest produces a small portion of maize (40Kg) and beans (20Kg). This occurs due to the location of the land near the river, favorable to production.

From 1997-2012 production of maize, sorghum and beans have increased owing to the fact that traditional agriculture farmers use some forms of CA techniques imitating their neighbours; however without any standardized process, supervision or control. The production was the following:

- Maize, from 600 Kg/ha to 900 Kg/ha (Table 4.8).
- Sorghum, from 300 Kg/ha to 500 Kg/ha (Table 4.9).
- Beans, from 150 Kg/ha to 250 Kg/ha (Table 4.10).

2012 registered the following maize, sorghum and bean production:

- 1,000 Kg/ha of maize; only 80Kg were stored for sowing (Table 4.11) and a total of 920Kg for consumption. Nothing was sold (Tabel 4.12).
- 500 Kg/ha of Sorghum; stored only 40Kg for sowing (Table 4.11) and a total of 460Kg for consumption. Nothing was sold (Tabel 4.12).
- Beans, from 300 Kg/ha, of which were sold 50kg (Table 4.11) stored 20Kg for sowing (Table 4.12) and a total of 230Kg for consumption.
4.10.1.2. Typical Case Mrs. 2’s Story.

Mrs. 2 works and lives in her own farm at Sinheve community. The soil preparation is done mainly with the use of hoe, machete, ax and fire to burn the grass covering the soil. There is no animal traction used and she exchanges seeds with the neighbours. Sowing is done in monoculture with no specific lines or measurements. Mrs. 2 uses rainwater as the irrigation system. Weeding is done multiple times per harvest. She has one harvest a year per culture. From 1997-2012 production of maize, sorghum and beans have increased owing to the fact that traditional agriculture farmers use some forms of CA techniques imitating their neighbours; however without any standardized process, supervision or control. Production results were the following:

- Maize, from 600 Kg/ha to 1.100 Kg/ha (Table 4.8).
- Sorghum, from 400 Kg/ha to 550 Kg/ha (Table 4.9).
- Beans, from 200 Kg/ha to 250 Kg/ha (Table 4.10).

2012 registered the following maize, sorghum and bean production:

- 1.200 Kg/ha of maize; only 100Kg were stored for sowing (Table 4.11) and a total of 1.100Kg for consumption. Nothing was sold (Tabel 4.12).
- 550 Kg/ha of sorghum; only 50Kg were stored for sowing (Table 4.11) and a total of 500 Kg for consumption. Nothing was sold (Tabel 4.12).
- 300 Kg/ha of beans; of which were sold 50kg (Table 4.12) stored 20Kg for sowing (Table 4.11) and a total of 230Kg for consumption.
4.10.1.3. Typical case Mrs. 3’s Story

Mrs. 3 works and lives in her own farm at Sinheve community. The soil preparation is done mainly with the use of hoe, machete, ax and fire to burn the grass covering the soil. The seeds utilized are from the previous harvest’s storage. There is no animal traction used. Sowing is done with no visible pattern. Irrigation is made with rainwater. Weeding is done several times per harvest, once a year per culture.

From 1997-2012 production of maize, sorghum and beans have increased owing to the fact that traditional agriculture farmers use some forms of CA techniques imitating their neighbours; however without any standardized process, supervision or control. The production was the following:

- Maize, from 700 Kg/ha to 1.000 Kg/ha (Table 4.8).
- Sorghum, from 200 Kg/ha to 350 Kg/ha (Table 4.9).
- Beans, from 250 Kg/ha to 300 Kg/ha (Table 4.10).

2012 registered the following maize, sorghum and bean production:

- 1.100 Kg/ha of maize; only 100 Kg stored for sowing (Table 4.11) and 1.000 Kg stored for consumption. Nothing was sold (Tabel 4.12).
- 400Kg/ha of sorghum; only 30Kg stored for sowing (Table 4.11) and 370Kg stored for consumption. Nothing was sold (Tabel 4.12).
- 300 Kg/ha of beans; of which were sold 50kg (Table 4.12) stored 20Kg for sowing (Table 4.11) and a total of 230Kg for consumption.
4.10.1.4. Typical case Mrs. 4’s Story.

Mrs. 4 works and lives in her own farm at Riofenda community. The soil preparation is done mainly with the use of hoe, machete, ax and fire to burn the grass covering the soil. There is no animal traction used and exchanges seeds with the neighbours. Sowing is done several times to the same land. Uses only rainwater as irrigation system. Weeding is done around 4 times per harvest, twice a year. The second harvest produces a small amount of maize (50Kg) and beans (30Kg). This occurs due to the location of the land near the river, favorable to production.

From 1997-2012 production of maize, sorghum and beans have increased owing to the fact that traditional agriculture farmers use some forms of CA techniques imitating their neighbours; however without any standardized process, supervision or control. The production was the following:

- Maize, from 700 Kg/ha to 1.000 Kg/ha (Table 4.8).
- Sorghum, from 350 Kg/ha to 400 Kg/ha (Table 4.9).
- Beans, from 200 Kg/ha to 250 Kg/ha (Table 4.10).

2012 registred the following maize, sorghum and bean production:

- 1.000 Kg/ha of maize; only 80Kg were stored for sowing (Table 4.11) and a total of 920Kg stored for consumption. Nothing was sold (Tabel 4.12).
- 450Kg/ha of sorghum; only 40Kg were stored for sowing (Table 4.11) and 410Kg stored for consumption. Nothing was sold (Tabel 4.12).
- 300Kg/ha of beans; of which were sold 50kg (Table 4.12) stored 20Kg for sowing (Table 4.11) and a total of 230Kg for consumption.
4.10.1.5. Typical case Mr. 5’s Story.

Mr. 5 lives and works in his own farm at Sinheve community. The soil preparation is done mainly with the use of hoe, machete, ax and fire to clean the soil. There is no animal traction used. Sowing is done with seeds from previous harvest’s storage, in monoculture, with no specific lines or measurements. Rainwater is the irrigation system applied. Weeding is done more than three times per harvest, once a year per culture.

From 1997-2012 production of maize, sorghum and beans have increased owing to the fact that traditional agriculture farmers use some forms of conservation agriculture techniques copying their neighbours; however without any standardized process, supervision or control. The production was the following:

- Maize, from 700 Kg/ha to 1.000 Kg/ha (Table 4.8).
- Sorghum, from 400 Kg/ha to 450 Kg/ha (Table 4.9).
- Beans, from 200 Kg/ha to 300 Kg/ha (Table 4.10).

2012 registered the following maize, sorghum and bean production:

- 1.250 Kg/ha of maize; only 100Kg were stored for sowing (Table 4.11) and 1.150Kg stored for consumption. Nothing was sold (Table 4.12).
- 450 Kg/ha of sorghum; only 40Kg stored for sowing (Table 4.11.) and 410Kg for consumption. Nothing was sold (Tabel 4.12).
- 300 Kg/ha of beans; of which were sold 50kg (Table 4.12) stored 20Kg for sowing (Table 4.11) and a total of 230Kg for consumption.
4.6 Summary

Throughout this chapter, all collected data obtained from interviews, direct observation and discussion of a focal group made by participants of CA and TA were presented. There was also Caritas document consulting to complete the comprehension of collected data on Conservation Agriculture. The study was comparative between the two Agricultural systems (CA and TA) based on maize, bean and sorghum crops, between 1997 and 2012 in the locality of Chimuve. It was had all the answers to questions asked in the questionnaire into consideration. Comparisons were particularly highlighted. the preparation of the soil, the productions of crops, seeds stored for seed production and sold.

A history background of informants was made on CA and TA as well as of head of groups, agrarian technicians, Caritas coordinator and of consultant and MISEREOR funder of Chimuve Rural Development Program. A detailed explanation on the relation of their functions was made. Afterwards, we will start with a new chapter that will present the summary, finding, discussion, conclusions and recommendations.
5.1. Introduction

The purpose for this study was to investigate the extent to which conservation agriculture alleviate poverty in Mozambique with special reference to Mucheve/area/ Chibabava district in Sofala Province. This was done with reference to the purpose and research questions as outlined in paragraphs 1.3 and 1.4 as follow:

Purpose

The purpose of the study was to examine how conservation agriculture leads to the eradication of poverty

Research questions

1. To what extent does CA improve in maize, sorghum and beans production more than traditional agriculture (TA)?

2. How do CA techniques applied help communities to produced better yields?

3. What challenges do the communities who implement CA face?

4. How does the production levels of CA of maize, sorghum and beans compare with those of (TA)?

5. How can (TA) farmers be encouraged to implement (CA)?
In the previous chapter, an attempt was made to present, analyse and interpret data gathered through interviews, observations and focus group discussions. Relevant information from Caritas organisation, conservation agriculture and traditional farmers was cited to provide defensible and scientifically creditable and reliable arguments. Following the related literature in Chapter 2 and the empirical findings one can deduce findings, conclusions and recommendations that can be used to encourage more farmers to practise CA for achieving poverty reduction in Mozambique. A summary of this thesis is now presented in this chapter. Major findings are highlighted based on the research questions. The researcher presents the discussion and also highlights the recommendations she hopes will be instrumental to CA and TA farmers, policy makers and non-governmental organisations as they strive to make food production and poverty reduction a reality.

5.2. Summary of Chapters

Chapter 1 presented the research problem and its context. The chapter described the following aspects of the study: the background to the study, the statement of the problem, the purpose of the study, the research questions, the assumptions of the study, the significance the study, the delimitations, limitations and definition of special terms. The chapter also gave the ethical considerations of the study.

Chapter 2 dealt with the literature related to the study to enhance understanding of the concept of CA in reduction of poverty as well as the theoretical framework of the study. The chapter went further to show that there were problems encountered by CA farmers in other countries the world over as evidenced by the different researchers cited in the context.
Chapter 3 described the research methodology and design used in the study to generate data. This was a case study of Mucheve/area/ Chibabava district in Sofala Province. A non-probability sampling technique was used. Interviews, observations, focus group discussions and documentary analysis were used to generate data. Data were analysed using the content analysis technique.

Chapter 4 presented, analysed and discussed the data that were generated during the field work. The data were then presented and analysed and categorized according to the themes.

5.3. Findings

Chapter 4 the study was done on Conservation Agriculture and Traditional Agriculture in maize sorghum and beans from 1997 to 2012 with particular attention to production. Average annual production in Kg per hectar of maize, sorghum and bean harvest 1997-2012 between Conservation Agriculture and Traditional Agriculture had the following results:

1997-2000 production of maize in CA was 640Kg and in TA was 680Kg but in 2012-2012 the production of maize was 3050Kg and in TA was 980Kg; 1997-2000 production of sorghum in CA was 480Kg and in TA was 330Kg but in 2012-2012 the production of maize was 1180Kg and in TA was 460Kg; 1997-2000 production of bean in CA was 360Kg and in TA was 200Kg but in 2012-2012 the production of maize was 660Kg and in TA was 270Kg.
About Average quantities of maize, sorghum and bean sold/kg per hectar and culture in 2012 in CA and TA was the following results:

Productin of maize in CA was 250Kg; sorghum was 340Kg and bean was 420Kg, but in TA only managed to sell 50 kg of beans.

5.3.1. Findings in Conservation Agriculture

Question 1: How have you been doing conservation agriculture in the production of maize, sorghum and bean? From this question it was found out that:

maize sowing begins right after the first rainfall and as soon as soil moisture reaches 15 cm deep. A month later sorghum is sowed and 45 days later farmers start producing bean. Two bean types are commonly produced in the community: Bóer bean and Nhemba bean also known as “mucuna”, and both are sowed at the same time. Sowing of these cultures is done under mixing and crop rotations within the same field. It was possible to observe farmer’s fields with perfect intercropping of maize, pineapple and beans.

Question a) What materials do you use to prepare the soil for sowing sowing the seeds?
From the above question it was found out that soil is completely covered with previous agrigultural harvest remainders, cutting previous crops rests and dried grass to fill in the gaps. Tools used are the hoe, the machete, the sickle and ax only used on cutting of the trees and removing bigger branches or trunks. Conservation agriculture farmers own a mixure of grass and other plants farms with the sole intention to cut and cover the soil during the sowing proccess and produce organic compost. To avoid burnings conservation agriculture farmers clean an area of 2 meters around their farms using the same tools. Their farms are located around or right next
to their homes and all conservation agriculture farms have planted fruit trees in their lands including banana, mango, papaya, orange, lemon and cashew. These trees are excellent for fruit production and to improve the food diet of the families. Simultaneously, trees provide shade and local farmers are able to work for longer periods in the farm because they can take time resting under the shade. Trees shade is also beneficial to cultivated plants as it protects them from intense heat, drought and improve productivity.

Question b) Do you use animal traction? In what way?
From the above question it was found out that none of the conservation agriculture farmers use animal traction. However, most farmers develop small animal breeding, such as chicken, ducks, rabbits and doves. Animal dung is used in the production of manure and organic compost. The use of livestock for meat occurs when families receive very important guests or in big party celebrations; in general local families follow an essentially vegetarian diet throughout the year.

Question c) How do you get the seed?
From the above question it was found out that conservation agriculture farmers acquire their seeds from agricultural surpluses of previous harvests. The best seeds are selected and stored in an improved traditional barn. Seeds are stored in bags of jute or raffia, in the barn.

Question d) How is seeding made?
From the above question it was found out that seeding is done mixing and intercropping cultures. Maize sowing begins right after the first rainfall (in the middle of October up to the middle of
November) and when the soil is moistured up to a depth of 15cm. Seeding can also be made with the use of a matraca. The matraca is a manual device that has a small portable seeds container. Farmers use the matraca to make small furrows in the ground and simultaneously put the exact quantity of seeds at the exact soil depth. Row-seeding and other agriculture techniques are used such as dibbling which include making narrow furrows with a sharpened stick into which seeds are placed at regular intervals. These techniques are not aggressive to the soil and ensure an even and correct distribution of the seeds. Row-seeding with a measuring stick is used when farmers are new to this conservation agriculture techniques and are not yet familiarized with the correct distances between seeds should have in between (answers to question 1.d. in questionnaire, in the Appendices). With many years of practice most farmers know instinctively the exact plant spacing between seeds, according to each species requirements. The spacing between plant seeds are crucial to ensure soil rentability, considering the number of plants aimed to produce per sowing.

Maize measurements are as follows: between 90 x 50 cm of plant spacing, with 3 - 5 seeds per furrow to a depth of 5cm.

Sorghum sowing begins in December or January. Measurements are as follows: plant spacing between 90 x 50 cm, to a dept of 3 cm, dropping 3-5 seeds per furrow.
Bean sowing is normally intercropped with maize and sorghum sowing. There are two types of beans produced: bóer bean and nhemba bean also known as “mucuna”. Both varieties are sowed after 4 – 6 weeks of maize or sorghum sowing. Bean seeding quantities is exactly 2 seeds per furrow intercropping with in maize and sorghum. Both bean varieties can be intercropped simultaneously with maize and sorghum cultures.

It was possible to observe in conservation agriculture farmers fields these bean varieties intercropping with maize and pineapple. Chemuve village is famously known for pineapple production.

Question e) How do you do the watering?

From the above question it was found out that farmers do not have irrigation systems they await rainfall. Plants are rainfed. Dead coverage and mulch covering the soil keep the soil damp for longer periods of time avoiding plants’ dehydration. This is another advantage of using mulch in the fields.

Questions .f) How many times a week do you do the watering?

g) How many times per production do you do watering?

From the above question it was found out that conservation agriculture farmers in Chemuve communities only water their plants when the rain falls. If there is no rain, there is no irrigation.
Lack of water sources and water supply is the farmers main problem in the communities. They have built water cisterns to cater for rainwater that is then used in the production of organic compost and liquid fertilizer. When there is no water available in the farmers’ wells they treat the rainwater in the cisterns for human consumption.

Question .h) How many times per harvest / production do you take off weeds?

It was found out that the CA farmers weed off weeds only once per harvest and very small quantities.

Question .i) How many times per year do you produce maize, sorghum and beans?

It was out that in low-lying areas where Riofenga community is located, there is a river called Mauáua. Conservation agriculture farmers produce two harvests a year and the second harvest is produced around this river. Second harvest results are considerably less from the first crop cultivation, but it represents additional productivity, surplus and profitability increase to these families. Sinheve community conservation agriculture farmers have only one harvest a year.

Question .j) What has been the annual production per harvest since you started practicing conservation agriculture?
In conformity with the data acquired during the interviews with farmers/ participants the following results were obtained for maize production between 1997 – 2012 (see Table 5.1 below):

**Tabel 5.1: Annual Production in Kg / Hectare Maize Crop 1997 – 2012 in Conservation Agriculture**

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</thead>
<tbody>
<tr>
<td>A</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.700 Kg</td>
<td>2.500 Kg</td>
<td>3.500 Kg</td>
</tr>
<tr>
<td>B</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.500 Kg</td>
<td>2.000 Kg</td>
<td>3.000 Kg</td>
</tr>
<tr>
<td>C</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.500 Kg</td>
<td>2.500 Kg</td>
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<tr>
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<td>900 Kg</td>
<td>1.600 Kg</td>
<td>2.400 Kg</td>
<td>3.000 Kg</td>
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<td>E</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.500 Kg</td>
<td>2.000 Kg</td>
<td>2.500 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

Taking into account the data presented above, it was calculated the average production for each farmers/ participants and the following results were obtained (see Table 5.2.).
Table 5.2: Annual average production in Kg of maize per Hectar per harvest 1997 – 2012 in CA

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual Average Production</th>
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<tbody>
<tr>
<td>1997 – 2000</td>
<td>640 Kg</td>
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<tr>
<td>2001 – 2003</td>
<td>840 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>1.560 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>2.280 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>3.050 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

The current study has focused only in the first harvest. In conformity with the data acquired during the interviews with farmers/ participants the following results were obtained for sorghum production between 1997 – 2012 (see Table 5.3 below):

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>800 Kg</td>
<td>1.000 Kg</td>
<td>1.200 Kg</td>
</tr>
<tr>
<td>B</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>.900 Kg</td>
<td>1.100 Kg</td>
</tr>
<tr>
<td>C</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
<td>1.200 Kg</td>
</tr>
<tr>
<td>D</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
</tr>
<tr>
<td>E</td>
<td>600 Kg</td>
<td>700 Kg</td>
<td>900 Kg</td>
<td>1.100 Kg</td>
<td>1.300 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*
Taking into account the data presented above, it was calculated the average production for each farmer/participants was calculated and the following results were obtained (see Table 5.4.).

Tabela 5.4: Annual average production in Kg of sorghum per Hectar per harvest 1997 – 2012 in CA

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual Average Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – 2000</td>
<td>4800 Kg</td>
</tr>
<tr>
<td>2001 – 2003</td>
<td>600 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>800 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>1.000 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>1.180 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

The current study has focused only in the first harvest. In conformity with the data acquired during the interviews with farmers/participants the following results were obtained for bean production between 1997 – 2012 (see Table 5.5. below):

Tabel 5.5: Annual production in Kg / Hectar bean harvest de1997 to 2012 in CA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>700 Kg</td>
</tr>
<tr>
<td>B</td>
<td>300 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
</tr>
<tr>
<td>C</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>600 Kg</td>
<td>700 Kg</td>
</tr>
</tbody>
</table>
Taking into account the data presented above, it was calculated the average production for each farmer/participants and the following results were obtained (see Table 5.6).

**Tabela 5.6: Annual average production in Kg of bean per Hectar per harvest 1997 – 2012 in CA**

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual Average Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – 2000</td>
<td>360 Kg</td>
</tr>
<tr>
<td>2001 – 2003</td>
<td>410 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>460 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>560 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>660 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

Question .k) What do you do with the harvest?

After harvesting conservation agriculture farmers store a small amount of seeds for the next sowing season. The majority of the production goes for human consumption; and the surplus is commercialized and exchanged for money that is then used to purchase goods, products and all farmers (and their families) needs, improving their life standards. During the filed conducted research it was possible to observed that seeds are stored in improved traditional barns. These
barns offer excellent storage requisites to preserve the seeds in good condition up to the next sowing season.

Question 1) How much harvest do you sell?

It was found out that CA farmers could only account for 2012 harvest results. They could not recall exact quantities of crops sold in the previous years; also taking into account that current study interviews were conducted in November 2013 at Chemuve Village. Sold quantities results in 2012 are as follows (see Table 5.7):

Tabel 5.7: Quantities of maize, sorghum and bean produced and sold per Hectare and per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.700 Kg</td>
<td>300 Kg</td>
<td>800 Kg</td>
<td>400 Kg</td>
<td>800 Kg</td>
<td>400 kg</td>
</tr>
<tr>
<td>B</td>
<td>2.800 Kg</td>
<td>200 Kg</td>
<td>800 Kg</td>
<td>300 Kg</td>
<td>800 Kg</td>
<td>500 Kg</td>
</tr>
<tr>
<td>C</td>
<td>3.100 Kg</td>
<td>200 Kg</td>
<td>700 Kg</td>
<td>300 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
<tr>
<td>D</td>
<td>2.700 Kg</td>
<td>300 Kg</td>
<td>750 Kg</td>
<td>400 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
<tr>
<td>E</td>
<td>2.250 Kg</td>
<td>250 Kg</td>
<td>700 kg</td>
<td>300 Kg</td>
<td>700 Kg</td>
<td>400 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Taking into account the data presented above, it was calculated and found out that the average quantities stored and sold per culture and the following results were obtained (see Table 5.8)
Table 5.8: Average quantities of maize, sorghum and bean produced and sold per Hectare per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.910 Kg</td>
<td>250 Kg</td>
<td>750 Kg</td>
<td>340 Kg</td>
<td>740 Kg</td>
<td>420 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Question m) And what quantity of harvest do you keep for consuming during the year?

From the data generated during the interviews with farmers, participants could only account for 2012 harvest results. They could not recall exact quantities of crops consumed in the previous years; also taking into account that current study interviews were conducted in November 2013 at Chemuve Village. Consumption quantity results in 2012 are as follows (see Table 5.9):

Table 5.9: Quantities of maize, sorghum and beans for consumption per Hectare per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize for Consumption</th>
<th>Sorghum for Consumption</th>
<th>Beans for Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.300 Kg</td>
<td>350 Kg</td>
<td>380 Kg</td>
</tr>
<tr>
<td>B</td>
<td>2.400 Kg</td>
<td>450 Kg</td>
<td>280 Kg</td>
</tr>
<tr>
<td>C</td>
<td>2.780 Kg</td>
<td>340 Kg</td>
<td>270 Kg</td>
</tr>
<tr>
<td>D</td>
<td>2.320 Kg</td>
<td>310 Kg</td>
<td>280 Kg</td>
</tr>
<tr>
<td>E</td>
<td>1.900 Kg</td>
<td>350 Kg</td>
<td>280 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014
Taking into account the data presented above, it was calculated the average quantities of maize, sorghum and bean harvest used for consumption and the following results were obtained (see Table 5.10):

Tabel 5.10: Average quantities of maize, sorghum and bean for consumption per Hectare per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Maize for Consumption</th>
<th>Sorghum for Consumption</th>
<th>Beans for Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.540 Kg</td>
<td>360 Kg</td>
<td>298 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

Question n) What quantity of harvest do you keep for seed?

From the data generated during the interviews with farmers, participants could only account for 2012 harvest results. They could not recall exact quantities of crops stored in the previous years; also taking into account that current study interviews were conducted in November 2013 at Chemuve Village. Stored quantity results in 2012 are as follows (see Table 5.9):
Tabel 5.1: Quantities of maize, sorghum and bean produced and stored for seeding per Hectare per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize Stored for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum Stored for Seeding</th>
<th>Beans Produced</th>
<th>Beans Stored for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.700 Kg</td>
<td>100 Kg</td>
<td>800 Kg</td>
<td>50 Kg</td>
<td>800 Kg</td>
<td>20 kg</td>
</tr>
<tr>
<td>B</td>
<td>2.800 Kg</td>
<td>100 Kg</td>
<td>800 Kg</td>
<td>50 Kg</td>
<td>800 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>C</td>
<td>3.100 Kg</td>
<td>120 Kg</td>
<td>700 Kg</td>
<td>60 Kg</td>
<td>700 Kg</td>
<td>30 Kg</td>
</tr>
<tr>
<td>D</td>
<td>2.700 Kg</td>
<td>80 Kg</td>
<td>750 Kg</td>
<td>40 Kg</td>
<td>700 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>E</td>
<td>2.250 Kg</td>
<td>100 Kg</td>
<td>700 Kg</td>
<td>50 Kg</td>
<td>700 Kg</td>
<td>20 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Taking into account the data presented above, it was calculated the average quantities of maize, sorghum and bean stored for seeding and the following results were obtained (see Table 5.12):

Tabel 5.12: Average quantities of maize, sorghum and bean produced and stored for seeding per Hectare and per harvest in 2012 in CA

<table>
<thead>
<tr>
<th>Maize Produced</th>
<th>Maize Stored for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum Stored for Seeding</th>
<th>Beans Produced</th>
<th>Bean Stored for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.910 Kg</td>
<td>100 Kg</td>
<td>750 Kg</td>
<td>50 Kg</td>
<td>740 Kg</td>
<td>22 kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014
Question o) Can you tell me a life story that happened to you about conservation agriculture?

Farmers/ participants shared similar life stories. Below is a general summary of collected life stories shared by conservation agriculture farmers who participated in this study.

Farming became easier with Conservation Agriculture. When practicing traditional agriculture it was very hard to cut the trees and remove grass from the soils. Intentional fires were set to ‘clean’ the land. Weeding was very strenuous as grass was constantly growing and they had to do it several times per sowing. Extra work labor was needed because it was very hard and difficult to prepare the land. Harvest results were considerably low and not enough for the families’ subsistence. There was hunger and there was never enough surplus for commercialization or to make profits and improve their lives standards.

With conservation agriculture techniques the whole scenario changed. Conservation agriculture farmers are extremely happy with their productions and CA has impacted on their lives. There is no more hunger and working their fields is not as strenuous or hard as it used to be. The introduction of fruit trees was a great innovation and their shade gives a great resting place when they are working in the fields. Famine was replaced with a more varied and balanced diet to their families with the introduction of intercropping of various cultures. Animal breeding offers chicken and duck meat (rich in protein), and fruit trees offer different fruits (rich in iron and vitamins).
Some of conservation agriculture farmers had the opportunity to visit other countries such as South Africa and Zimbabwe; and to learn, gain knowledge and work the field with conservation agriculture farmers from these parts of the world. Visiting African farmers in other countries where people were once using traditional agriculture and now were following conservation agriculture methods with amazing results was mindblowing. The experience exchange worked as great incentive to accept conservation agriculture in their lives and accept changing from traditional agriculture methods practiced by their ancestors. In the beginning they used CA techniques in small scale fields, mainly for experimenting and testing results. Today conservation agriculture is part of their lives, is healthier, environmental friendly and more profitable.

**Question p)** What advice do you give to the farmers who practice the traditional agricultural system?

It was found out that conservation agriculture farmers gave a lot of advices to traditional agriculture farmers, mostly their neighbours. Participants feedback was very similar. A summary is listed, as follows:

Water supply is crucial. Traditional agriculture farmers should create their own water supply sources in form of a well and a small cistern. The water cistern will retain rainwater that will then be used in the production of organic compost and liquid fertilizer;

TA farmers should start experimenting conservation agriculture methods in small fields of less than an hectar to test the results. Once obtained results are satisfactory they can gradually extend the methods to the bigger cultivation fields;
Production of organic compost and liquid fertilizer is very important to get better harvest results. To produce organic compost and liquid fertilizer traditional agriculture farmers should start breeding small animals for manure production.

Question q) What are the challenges you have faced in practicing conservation agriculture?

Conservation agriculture participants gave similar answers to the challenges they encountered in practicing CA. Most of the challenges were overcome as follows:

Mulch production and dead coverage of the soil is now properly done as well as organic compost and liquid fertilizer. In the beginning it was very difficult to produce due to lack of water. The main challenge for conservation agriculture farmers they still face in their communities is the lack of water to water their fields.

Another big challenge was the change in mindset. Traditional agriculture knowledge was passed from father to son for generations and changing to a new agriculture method was hard and sometimes criticized and seen as an offence to the ancestors.

Question r) How have you solved the challenges?

Conservation agriculture participants gave similar answers during the interviews. A summary of their feedback is presented below, as follows:

The mindset barrier was overcome with the use of small testing fields. Conservation agriculture farmers started producing in small fields of less than 1 ha and as results started to show they
gradually increased to bigger production fields. Now conservation agriculture is part of their life and is the only method applied to their fields;

Every conservation agriculture farmer has built a cistern in their farms; and together they built a well in the community. The water is used for the production of organic compost and liquid fertilizer. The well is also used for drinking water; and cisterns’ rain water is chemically treated for human consumption when the wells are not able to cater for the farmer’s family needs;

With the increase of small animals breeding conservation agriculture farmers increased manure, organic compost and liquid fertilizer production.

5.3.2. Findings from Traditional Agriculture

Findings from this research on Tradicional Agriculture showed that:

Question 1.: How have you been doing traditional agriculture in the production of maize, sorghum and beans?

It was found out that sometimes traditional agriculture farmers produce in monocultures; and sometimes mix maize, bean and sorghum intercropping.

Question a) What materials do you use to prepare the soil for sowing?
Traditional agriculture farmers use the hoe, the machete and the ax to remove all the grass and remainings of trunks or roots in the ground and set fire to the ground to ‘clean’ the soils from green plants, bushes and scrub.

Question b) Do you use animal traction? In what way?

No one uses animal traction.

Question c) How do you get the seed?

Like conservation farmers seeds for traditional farmers are stored from previous harvests surplus or exchanged with neighbours and friends.

Question d) How do you make a seeding?

It was found out that seeding is made right after rainfall. Two seeds are placed per furrow during maize sowing. Approximately a month later traditional agriculture farmers repeat the same process in every furrow where seeds have not germinated. After that, they start bean sowing; often they produce nhemba bean variety. Sometimes they mix bean sowing in their maize and sorghum fields. Both sowings of maize, sorghum and bean do not follow a specific structure or method. There is no row-seeding and no specific plant distances during seeding.
Question e) How do you do the watering? Traditional agriculture farmers water their fields with rainwater.

Question f) How many times a week do you do the watering?

g) How many times per production do you do watering?

There is no irrigation system in place. Traditional agriculture farmers wait for rainfalls to water their fields.

Question h) How many times per harvest / production do you take off weeds?

On average traditional farmers take off weeds four times per harvest.

Question i) How many times per year do you produce maize, sorghum and beans?

Traditional agriculture farmers have only one production a year, per culture.

Question j) What is the annual production per harvest since you started producing traditional agriculture?

Based on the data collected from traditional agriculture farmers/ participants feedback in the questionnaire (in the Appendix) the following data was compiled. Tabel 5.13 shows traditional agriculture annual maize production at Riofenga and Sinheve communities.
Taking into account the data presented above, it was calculated the average annual production of maize and the following results were obtained (see Table 5.14):

Table 5.14. Average annual production of maize per Hectar per seeding 1997 – 2012 in TA

<table>
<thead>
<tr>
<th>Period</th>
<th>Average Annual Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – 2000</td>
<td>680 Kg</td>
</tr>
<tr>
<td>2001 – 2003</td>
<td>780 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>800 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>860 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>980 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Based on the data generated from traditional agriculture farmers/ participants feedback in the interview (in the Appendix) the following data were compiled. Table 5.15 shows traditional agriculture annual sorghum production at Río Fenga and Sinheve communities.
Table 5.15.: Annual production in Kg / Hectare sorghum crop 1997-2012 in TA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300Kg</td>
<td>400Kg</td>
<td>500Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
</tr>
<tr>
<td>2</td>
<td>400 Kg</td>
<td>450 Kg</td>
<td>500 Kg</td>
<td>500 Kg</td>
<td>550 Kg</td>
</tr>
<tr>
<td>3</td>
<td>200 Kg</td>
<td>300 Kg</td>
<td>250 Kg</td>
<td>300 Kg</td>
<td>350 Kg</td>
</tr>
<tr>
<td>4</td>
<td>350 Kg</td>
<td>300 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>450 Kg</td>
</tr>
<tr>
<td>5</td>
<td>400 Kg</td>
<td>350 Kg</td>
<td>400 Kg</td>
<td>400 Kg</td>
<td>450 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

In line with the data presented above, it was calculated the average annual production of sorghum and the following results were obtained (see Table 5.16):

Table 5.16. Average annual sorghum production per Hectar per harvest 1997 – 2012 in TA

<table>
<thead>
<tr>
<th>Period</th>
<th>Average Annual Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – 2000</td>
<td>330 Kg</td>
</tr>
<tr>
<td>2001 – 2003</td>
<td>380 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>400 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>410 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>460 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Based on the data generated from traditional agriculture farmers/ participants feedback in the interview (in the Appendix) the following data was compiled. Tabel 5.17. shows traditional agriculture annual bean production at Riofenga and Sinheve communities.
In line with the data presented above, it was calculated the average annual production of bean and the following results were obtained (see Table 5.18):

Table 5.18: Average annual bean production in Kg per Hectare per harvest 1997 – 2012 in TA

<table>
<thead>
<tr>
<th>Period</th>
<th>Average Annual Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – 2000</td>
<td>200 Kg</td>
</tr>
<tr>
<td>2001 – 2003</td>
<td>150 Kg</td>
</tr>
<tr>
<td>2004 – 2006</td>
<td>200 Kg</td>
</tr>
<tr>
<td>2007 – 2009</td>
<td>200 Kg</td>
</tr>
<tr>
<td>2010 – 2012</td>
<td>250 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

Question k) What do you do with the harvest?

1) How much harvest do you sell?
It was found out the majority of traditional agriculture farmers' production is used for human consumption. Only a small part of seeds is stored for future planting. Only a very small amount of bean is commercialized, in average around 50kgs per harvest/year. Bearing in mind that data generated during the interviews with farmers/participants could only account for 2012 harvest results. They could not recall exact quantities of crops produced or sold in the previous years; also taking into consideration that current study interviews were conducted in November 2013 at Chemuve Village. Table 5.19 below shows quantities of maize, sorghum and beans produced and sold per hectar and per harvest in 2012.

### Table 5.19: Quantities of maize, sorghum and beans produced and sold per Hectare and per harvest in 2012 in Traditional Agriculture

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000 Kg</td>
<td>0 Kg</td>
<td>500 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>2</td>
<td>1.200 Kg</td>
<td>0 Kg</td>
<td>550 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>3</td>
<td>1.100 Kg</td>
<td>0 Kg</td>
<td>400 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>4</td>
<td>1.000 Kg</td>
<td>0 Kg</td>
<td>450 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
<tr>
<td>5</td>
<td>1.250 Kg</td>
<td>0 Kg</td>
<td>450 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

In line with the data presented above, it was calculated the average annual production (for consumption) of maize, sorghum and bean and average product sales. The following results were obtained (see Table 5.20).
Table 5.20: Average quantities of maize, sorghum and bean produced and sold per Hectare and per harvest in 2012

<table>
<thead>
<tr>
<th>Maize Produced</th>
<th>Maize Sold</th>
<th>Sorghum Produced</th>
<th>Sorghum Sold</th>
<th>Beans Produced</th>
<th>Beans Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.110 Kg</td>
<td>0 Kg</td>
<td>470 Kg</td>
<td>0 Kg</td>
<td>300 Kg</td>
<td>50 kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Question m) And what quantity of harvest do you keep for consuming during the year?

Taking into account the data collected during the interviews with farmers, participants could only account for 2012 harvest results. They could not recall exact quantities of crops used for consumption in the previous years; also taking into consideration that current study interviews were conducted in November 2013 at Chemuve Village. Table below shows total annual consumption of maize, sorghum and beans, as follows (see Table 5.21.):

Table 5.21: Total annual consumption maize, sorghum and beans per Hectare and per harvest in 2012 in TA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize for Consumption</th>
<th>Sorghum for Consumption</th>
<th>Beans for Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>920 Kg</td>
<td>460 Kg</td>
<td>230 Kg</td>
</tr>
<tr>
<td>2</td>
<td>1.100 Kg</td>
<td>500 Kg</td>
<td>230 Kg</td>
</tr>
<tr>
<td>3</td>
<td>1.000 Kg</td>
<td>370 Kg</td>
<td>230 Kg</td>
</tr>
<tr>
<td>4</td>
<td>920 Kg</td>
<td>410 Kg</td>
<td>230 Kg</td>
</tr>
</tbody>
</table>
In line with the data presented above, it was calculated the average stored production of maize, sorghum and bean for consumption, and the following results were obtained (see Table 5.22.):

Table 5.22: Average annual quantities of maize, sorghum and bean for consumption per Hectare and per harvest in 2012 in TA

<table>
<thead>
<tr>
<th>Maize for Consumption</th>
<th>Sorghum for Consumption</th>
<th>Beans for Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.018 Kg</td>
<td>40 Kg</td>
<td>230 Kg</td>
</tr>
</tbody>
</table>

Source: The Author, 2014

Question n) What quantity of harvest do you keep for seed?

Taking into account the data generated during the interviews with farmers, participants could only account for 2012 harvest results. They could not recall exact quantities of crops stored for seeding in the previous years; also taking into consideration that current study interviews were conducted in November 2013 at Chemuve Village. Table below shows the quantity of crops stored for seeding in 2012, as follows (see Table 5.23):
Table 5.23: Quantities of maize, sorghum and beans produced for seeding per Hectare and per harvest in 2012 in TA

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Maize Produced</th>
<th>Maize for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum for Seeding</th>
<th>Beans Produced</th>
<th>Beans for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000 Kg</td>
<td>80 Kg</td>
<td>500 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 kg</td>
</tr>
<tr>
<td>2</td>
<td>1.200 Kg</td>
<td>100 Kg</td>
<td>550 Kg</td>
<td>50 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>3</td>
<td>1.100 Kg</td>
<td>100 Kg</td>
<td>400 Kg</td>
<td>30 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>4</td>
<td>1.000 Kg</td>
<td>80 Kg</td>
<td>450 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
<tr>
<td>5</td>
<td>1.250 Kg</td>
<td>100 Kg</td>
<td>450 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 Kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

In line with the data presented above, it was calculated the average annual quantities of maize, sorghum and bean stored for seeding, and the following results were obtained (see Table 5.24.):

Table 5.24: Average quantities of maize, sorghum and bean produced for seeding per Hectare and per harvest in 2012 in TA

<table>
<thead>
<tr>
<th>Maize Produced</th>
<th>Maize for Seeding</th>
<th>Sorghum Produced</th>
<th>Sorghum for Seeding</th>
<th>Beans Produced</th>
<th>Beans for Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.110 Kg</td>
<td>92 Kg</td>
<td>470 Kg</td>
<td>40 Kg</td>
<td>300 Kg</td>
<td>20 kg</td>
</tr>
</tbody>
</table>

*Source: The Author, 2014*

Question o) Can you tell me a life story that happened to you about traditional agriculture?
The answers to this question of farmers participating in Traditional Agriculture are similar:

- Traditional agriculture farmers' life stories are not as fortunate as conservation agriculture farmers. TA farmers use a lot of labor force to cut down trees. Normally they need the assistance of younger men as most traditional agriculture farmers are now old and lack enough strength to for such strenuous task;
- Traditional agriculture farmers frequently abandon soils because they cannot produce anymore (due to extensive exploitation and soil degradation) and move to new lands;
- Traditional agriculture farmers are old in general and tired, and are not interested in expanding existing production fields due to lack of physical strength and financial resources to employ more work force.

5.4. Theoretical and Empirical CA Data Contrast and Comparision with Chemuve Village CA Systems.

5.4.1. Trophobiose Theory Comparision with CA

Trophobiose theory is directly linked to agri-environmental management of crop production; it contributes to the physiological resistance of the plant and the sustainability of the agricultural ecosystem. Ecosystems are analyzed as natural samples and agricultural ecosystems are preserved by man while using organic agriculture techniques obtained in conservation agriculture methods.

French scientist Francis Chaboussou (1999) introduced the theory of Trophobiose on the basis that plants with metabolic imbalance show signs of attack by pests and diseases. This means that
any healthy and strong plant requires good fertilized soil, with organic compost and liquid fertilizers, with no erosion (and covered with straw) and adequate quantities of moist; sowing is done at the right time according to plants variety, adapted to climate, light and wind conditions. Under these conditions metabolic disorders will hardly occur as the plant grows in an almost natural environment; along with other techniques that include judicious mixing and rotation of crops. Conservation agriculture uses methods that resemble the natural environment and it does not include agri toxics. As such, it is then possible to accomplish a trophobiose balance in the soil, enhance its sustainability and therefore possible to conclude that trophobioses’ characteristics are interlinked to conversation agriculture characteristics.

5.4.2. CA in the World and in Mozambique

Conservation Agriculture methods contribute to the increase of productivity, profitability, land sustainability and easy access to agricultural and environmental services due to appropriate land-use practices. CA adherence has been increasing exponentially around the world as the outcome of initiatives developed by farmers and organizations.

The number of industrialized countries increased after the millennium and countries like Canada, Australia, Spain and Finland adhered to CA. Nowadays CA production systems are being followed by many countries in the world. There is only a limited number of countries that have not yet adhered to CA and other locations with no collected data available. In 2011, an estimate of 125 million hectares in the world is following CA methods.
Conservation agriculture is practiced by farmers living in the Artic Circle, in countries like Finland; in the tropics, in Kenya and Uganda; around 50° degrees latitude south in Malvinas/Falkland Islands. Conservation agriculture practices are found from sea level to 3,000 m elevation in Bolivia and Colombia; in extremely dry weather conditions of 250 millimetres/year – like Morocco, and western Australia – and areas with heavy rainfall of 2,000 mm/year (Brazil) or 3,000 mm/year (Chile). CA is practiced in soils that vary from 90% of sand, in Australia; to 80% of clay, common in Brasil Oxisols and Alfisols. All cultures can be grown under agriculture conservation production systems; to date there is no evidence of cultures that have not been successfully grown under CA, including tubers and roots.

Taking into consideration that the current study aims to demonstrate that conservation agriculture practices can be used to reduce poverty in Mozambique, this empirical study shows that it is possible to produce under CA methods in any soil, any altitude and latitude, as long as its techniques are correctly applied. These contribute to soils rentability, sustainability and help protect the environment preventing soil degradation. Consequently, conservation agriculture methods lead to world poverty reduction, especially among poor countries like Mozambique.

5.4.3. Sub-Saharan Africa CA Implementation Policies Comparison with Chemuve Village CA Study

Sub-Saharan Africa has taken advantage of the support of various organizations to develop and implement conservation agriculture in its countries. Conservation agriculture systems have been integrated at NEPAD (NEPAD – New Partnership for Africa’s Development) regional
agricultural policies in Sudan, Kenya, Tanzania, Malawi, Zambia, Zimbabwe, Mozambique, Madagascar, South Africa, Lesotho, Swaziland, Ghana, Uganda and Burkina Faso.

CARE (Cooperative for Assistance and Relief Everywhere) launched agriculture development projects based in conservation agriculture methods in all african continent, including Ghana, Sierra Leone, Mali, Liberia, Tanzania, Angola, Zambia, Zimbabwe, Mozambique and Lesotho. These projects aim to increase yields and farmers’ incomes, reverse the degradation of the soils and improve the quality of life of vulnerable families, especially women.

The Equitable Payments for Watershed Services (EPWS) project in Tanzania which was implemented jointly by CARE International, WWF Country Office and the International Institute for Environment and Development (IIED) promoted support and training for CA as a better agricultural practice.

African farmers have limited resources and many households in these countries are food insecure (lack of food availability for human consumption). Conservation agriculture systems implementation are pertinent to increase productivity and sustainability. Farmers developing conservation agriculture techniques improve the food diet of their families in quantity, quality and variety and concurrently contribute to the environment, improving weather conditions and reducing soil degradation.

In analogy, Mozambique follows similar policies and benefits from CARE and NEPAD projects support organizations; as well as the Mozambican Organization CARITAS financed by the
German organization MISEREOR and providing support on conservation agriculture development at Riofenda and Sinheve communities (part of the current study). These last two organizations formed a partnership and launched in 1997 the Rural Development Project. This project brought conservation agriculture methods to these communities among financial support on training, the creation of Results Demonstration Centers and nurseries producing fruit trees, the construction of wells and cisterns to cater for water improving the lives of the families in this village. Chemuve is now a reference point for agriculture conservation methods and its positive impact on society.

5.4.4. Countries with Grave Food Insecurity and Chemuve CA Study Comparision

Most countries affected by high levels of food insecurity are located in the African continent including Benin, Burundi, Chad, Central African, Congo, Democratic Republic of the Congo, Ivory Coast, Guinea, Uganda, Ethiopia, Sudan, South Sudan, Kenya, Malawi Republic, Mozambique and Madagascar. Among the contributing factors for food insecurity are reduced initial investment returns, low levels of crop stocks, below average harvests and crop failures, high production prices, continuous civil conflicts creating social insecurity and restricting access to land and food, the arrival of refugees from neighbouring countries or the migration of people to safer locations in the country, inconstant and insufficient rainfalls, floods, poor health due to malaria, HIV/AIDS and other diseases.

Analogously Chemuve research study revealed that families following traditional agriculture systems have scarce production. Yields only meet their subsistence needs and is are enough to
sell or store. Few families have their own barns, which are in very poor conditions and unfit for crop preservation. Each family owns approximately 6 hectares of land and once the land or culture stops producing they move on to new lands. Intentional burning of the vegetation is used to prepare the new land, thus accelerating uncontroled degradation and deforestation and increase soil erosion. Sowing is done without ground covers and there is no use of mixing or crop rotation techniques. Everything is done without following a pattern. Risk of contamination of plants is higher and weed control more strenuous to manage due to the lack of organic liquid fertilizers in the soil. Some traditional agriculture farmers try to copy conservation agriculture farmers’ techniques, however without following a specific order or guideline.

As previously stated agriculture is key for economic growth and plays an important role to ensure food security for the population; traditional agriculture systems, characteristics and negative results and impact in the environment (shown above) indicate that this method increases poverty, especially among the most vulnerable communities, in poor countries. The best way to reduce poverty on developing countries like Mozambique (rich in land resources) is by developing the agriculture sector and using conservation agriculture methods. Extensive usage of traditional agriculture techniques will turn Mozambique’s rich and fertile soil into a desert due to soil degradation and erosion caused by this production method.
5.4.5 Yields Comparision in Sub-Saharan Africa and the CA Study at Chemuve Village

Chemuve.

Countries that have been producing with CA have been increasing their production, per year, per culture/ha. The following examples are shown below:

Uganda, maize production has increased to an average of 3000 - 3100 kg/ha;

Zimbabwe, maize, millet, sorghum, cowpea and soybean production have positive results.

Malawi (Mloza-Banda and Nanthambwe), in 2010 CA maize production was between 294% and 477% higher than in traditional agriculture production; and 394% to 609% higher than in 2001/2002;

Zambia, in 2003 conservation agriculture farmers doubled their maize production.

Comparing these results with the ones obtained in Mozambique, at Chemuve Village (where the present study of CA took place) there are visible similarities. Between 1997 and 2012, Riofenda and Sinheve communities had the following average production of maize, sorghum and bean crops in kg/ha/year:

Maize 1997-2000 with an average of 640kg; and 3.050kg between 2010 and 2012;
Sorghum 1997-2000 with an average of 480kg; and 1.180kg between 2010 and 2012;
Bean 1997-2000 with an average of 360kg; and 660kg between 2010 and 2012.

On the basis of the findings presented it is possible to notice a significant production increase in maize, sorghum and bean crops between 1997-2012 at Riofenda and Sinheve communities.
5.5. Discussion

5.5.1. Discussion in Conservation Agriculture

5.5.1.1. Profile of Conservation Agriculture Participants

The current study was mainly based on qualitative research and the sample was composed of 5 team members – due to their extensive knowledge and experience developing this form of agriculture practice. The group leaders belong to Riofenga and Sinheve communities, located at Chemuve village, and all are maize, sorghum and bean producers. From the 5 conservation agriculture farmers/participants, 3 were women (representing 60% of the total sample) and 2 were men (representing 40% of the total sample). This also proves that the majority of farmers working the land in Mozambique are women. The husbands of these farmers have migrated to South Africa in search of better living conditions and are currently working there and financially supporting their Mozambican families from overseas. All interviewed participants know how to work the soil, always applying mulch; mixing, rotating and combining other agricultural crops in their fields during the sowing process; and row seeding with exact plant spacing and seeds per furrow according to each species requirements. All interviewed participants have the know-how and frequently produce organic compost and liquid fertilizer to increase soil’s fertility, profitability and improve the quality of the plant; and they know how to apply it taking into account the correct quantities to apply it, when to apply it, and the growth stage of the plant. Devido à falta de água eles apenas utilizam a água das chuvas que guardam em cirternas para a produção do composto e adubo líquido orgânico. All 5 participants are following conservation agriculture since 1997 to date. The current research study comprises results from 1997 to 2012 (a total of 16 years). All participants interviewed own traditional improved barns in their lands where they store their harvests.
5.5.1.2. Average Annual Production and Rentability of Maize, Sorghum and Bean Cultures per Hectare and per Harvest in Conservation Agriculture

After analyzing the average annual production of maize between 1997 and 2012 (corresponding to a period of 16 years) it is possible to verify that maize average annual production between 1997 and 2000 was only around 640 kg (per hectare and per harvest); and between 2010 and 2012 it reached $3,050$ Kg (per hectare and per harvest). This represents an average maize production increase of 477 per cent (per hectare and per harvest) between 1997 and 2012 which means that there was a yearly average production increase of 30 per cent (per hectare and per harvest) of maize.

Following the same line of thought the average annual production of sorghum between 1997 and 2010 was of $480$ Kg (per hectare and per harvest) and between 2010 and 2012 reached $1,180$ Kg (per hectare and per harvest). This represents an average sorghum production increase of 246 per cent between 1997 and 2012 (per hectare and per harvest) which means that there was a yearly average production increase of sorghum of 15 per cent (per hectare and per harvest).

Analogously the average annual production of bean between 1997 and 2010 was of $360$ Kg (per hectare and per harvest) and between 2010 and 2012 reached $660$ Kg (per hectare and per harvest). This represents an average bean production increase of 183 per cent between 1997 and 2012 (per hectare and per harvest) which means that there was a yearly average production increase of bean of 11 per cent (per hectare and per harvest).
5.5.1.3. Average Quantities of Maize, Sorghum and Beans Produced and Sold per Hectare and per Harvest in 2012 in Conservation Agriculture

Using the data presented in Table 5.8 it was possible to calculate the average annual production of maize, sorghum and beans in 2012 and the average annual quantity produced and sold per culture and per hectare in the same year.

Average maize production in 2012 (in conservation agriculture) was 2,910 kg per hectare per harvest of which an average of 250 kg were sold. This means that farmers were able to commercialize an average of 9 per cent of the total production produced;

Average sorghum production in 2012 (in conservation agriculture) was 750 kg per hectare per harvest of which an average of 340 kg were sold. This means that farmers were able to commercialize an average of 45 per cent of the total production produced;

Average bean production in 2012 (in conservation agriculture) was 740 kg per hectare per harvest of which an average of 420 kg were sold. This means that farmers were able to commercialize an average of 57 per cent of the total production produced;

5.5.1.4. Average Quantities of Maize, Sorghum and Beans for Consumption per Hectare and per Culture in 2012 in Conservation Agriculture

Given that maize average production, per hectare, per harvest in 2012 was 2,910Kg (Table 5.8.) and the average consumption of maize per hectare, per harvest in the same year was 2,540kg (Table 5.10.); this means that an average of 87 per cent of the total maize production was used for consumption.
Taking into account that sorghum average production per hectar per harvest in 2012 was 750Kg (Table 5.8.) and the average consumption of sorghum per hectar per harvest in the same year was 360kg (Table 5.10.). This means that an average of 48 per cent of the total sorghum production was used for consumption.

On the basis that bean average production per hectar per harvest in 2012 was 740Kg (Table 5.8.) and the average consumption of bean per hectar per harvest in the same year was 298kg (Table 5.10.). This means that an average of 40 per cent of the total bean production was used for consumption.

5.5.1.5. Average of Quantities of Maize, Sorghum and Beans Produced for Seeding per Hectare and per Harvest in 2012 in Conservation Agriculture

According to Table 5.12 an average of 2,910 kg of maize was produced per hectare per harvest in 2012 of which an average of 100 kg were stored for seeding; this means that an average of 3 per cent of maize was stored for seeding in 2012.

According to same table (Table 5.12.) an average of 750 kg of sorghum was produced per hectare per harvest in 2012 of which an average of 50 kg were stored for seeding; this means that an average of 7 per cent of sorghum was stored for seeding in this year.
According to the same table (Table 5.12) an average of 740 kg of bean was produced per hectare. An average of 3 per cent of bean was stored for seeding in this year.

5.5.2. Discussion about Traditional Agriculture

5.5.2.1. Profile of Traditional Agriculture Participants

The same methodology used in conservation agriculture interviews was applied to the study of traditional agriculture in the communities of Riofenga and Sinheve. The sample of traditional agriculture farmers participating in the interviews was composed of 5 elements. All participants per harvest in 2012 of which an average of 22 kg were stored for seeding; this means that an average of 740 kg of bean was produced per hectare. An average of 3 per cent of bean was stored for seeding in this year.

5.5.2.1. Profile of Traditional Agriculture Participants

The same methodology used in conservation agriculture interviews was applied to the study of traditional agriculture in the communities of Riofenga and Sinheve. The sample of traditional agriculture farmers participating in the interviews was composed of 5 elements. All participants per harvest in 2012 of which an average of 22 kg were stored for seeding; this means that an average of 22 kg were stored for seeding; this means that an average of 740 kg of bean was produced per hectare. An average of 3 per cent of bean was stored for seeding in this year.

All participants were old, which makes it even harder to accept change and start producing with a new agriculture system (CA). Traditional agriculture participants believe that changing to conservation agriculture would be an insult to their ancestors and their form of practice is a way of honoring and respecting their traditions. Soil degradation and erosion is caused mainly by intentional fires and the cutting of trees.
5.5.2.2 Average production maize, sorghum and beans / ha / crop in Traditional Agriculture de 1997-2012

From 1997-2000 average maize production was 680 Kg and between 2010-2012 reached 980 Kg (Table 5.14.) per hectar and per harvest. This means that between 1997 and 2012 there was a maize production increase of 144 % per hectare and per harvest. Given that the current study was based in data compiled from a period of 16 years, there was an annual percentage increase of 9 per cent (per hectare per harvest).

Following the same line of thought, from 1997-2000 average sorghum production was 330 Kg per hectar and per harvest; and between 2010-2012 reached an average of 460 Kg (Table 5.16). This means that between 1997 and 2012 there was a sorghum production increase of 139 % per hectare and per harvest. Given that the current study was based in data compiled from a period of 16 years, there was an annual percentage increase of 9 per cent (per hectare per harvest).

Following the same line of thought, from 1997-2000 average bean production was 200 Kg per hectar and per harvest; and between 2010-2012 increased only to an average of 250 Kg (Table 5.16). This means that between 1997 and 2012 there was a bean production increase of 125 % per hectare and per harvest. Given that the current study was based in data compiled from a period of 16 years, there was an annual percentage increase of 8 per cent (per hectare per harvest).
5.5.2.3. Average Quantities of Maize, Sorghum and Beans Produced and Sold per Hectare and per Harvest in 2012 in Traditional Agriculture

Using the data presented in Table 5.20 it was possible to calculate the average annual production of maize, sorghum and bean in 2012 and the average annual quantity produced and sold per hectare in the same year; however, traditional agriculture farmers were only able to sell from their bean production.

Average maize production in 2012 was 1,110 kg per hectare per harvest;
Average sorghum production in 2012 was 470 kg per hectare per harvest;
Average bean production in 2012 was 300 kg per hectare per harvest; of which an average of 50 kg were commercialized. This represents an average of 17 per cent sold from the total production.

5.5.2.4. Average Quantities of Maize, Sorghum and Bean for Consumption per Hectare and per Harvest in 2012 in Traditional Agriculture

Given that maize average production per hectare per harvest in 2012 was 1,110 Kg (Table 5.20) and the average consumption of maize per hectare per harvest in the same year was 1,018 Kg (Table 5.20) then an average of 92 per cent of the total maize production was used for consumption.

Taking into consideration that sorghum average production per hectare per harvest in 2012 was 470 Kg (Table 5.20.) and the average consumption of sorghum per hectare per harvest in the same
year was 400 Kg (Table 5.20) then an average of 85 per cent of sorghum was used for consumption.

Given that bean average production per hectar per harvest in 2012 was 300 Kg (Table 5.20) and the average consumption of bean per hectar per harvest in the same year was 230 Kg (Table 5.20.) then an average of 76 per cent of bean was used for consumption.

5.5.2.5. Average Quantities of Maize, Sorghum and Beans Produced for Seeding per Hectare and per Harvest in 2012 in Traditional Agriculture

According to Table 5.24 an average of 1,110 kg of maize was produced per hectare per harvest in 2012 of which an average of 92 kg were stored for seeding; this means that an average of 8 per cent of maize was stored for seeding in 2012.

According to the same table (Table 5.24) an average of 470 kg of sorghum was produced per hectare per harvest in 2012 of which an average of 40 kg were stored for seeding; this means that an average of 9 per cent of sorghum was stored for seeding in 2012.

Still in the same table (Table 5.24) an average of 300 kg of bean was produced per hectare per harvest in 2012 of which an average of 20 kg were stored for seeding; this means that an average of 7 per cent of bean was stored for seeding in 2012.
2.5.2.6. Financial Analysis of Conservation Agriculture and Traditional Agriculture in Mozambique

Eventhough both agriculture systems in Mozambique are free of pesticide cost and machinery and petrol expenses which are the most important costs for large farms around the world, but not representative in Mozambican subsistence agriculture systems, recent reviews on the topic (Uri, 2000b) and the current research study tend to reinforce that conservation agriculture has cost advantage over traditional agriculture in Mozambique. This general conclusion is based on input cost analysis as follows.

**Labour costs**

As illustrated in the current study conservation agriculture has evident less labour requirements than traditional agriculture. This reduction is due to the decrease of labour demand in land preparation at the early stages of the growing season in conservation agriculture practices; as opposed to traditional agriculture methods that require a lot more labour to prepare the land for sowing and cutting of big trees.

**Fertilizer costs and other input costs**

Despite the fact that Mozambican traditional agriculture does not apply any form of fertilizers to the soil, thereby having no costs, conservation agriculture practices in Mozambique include the production of organic compost. In CA, organic compost is made from animal manure (breeding of small animals) and the construction of traditional structures made of old branches and layers
of leaves. Liquid organic fertilizer is produced in farmers’ old pots or in up to 200L containers. The water used on organic fertilizer production is taken from rainwater cisterns. Both organic fertilizer production methods have no additional costs to conservation agriculture farmers.

Also important to consider in a cost comparison analysis is the risk factor. It is important to recognize that crops results vary under different cultivation methods. Traditional agriculture farmers showed considerably lower production results than conservation agriculture farmers. The lack of a standardized seeding process and incorrect space measurements between plants in traditional agriculture practices increase production risks and farmers are forced to spend more seeds, time and labour replanting crops that have not germinated, especially following heavy rains. Over-exploitation of the land, increase soil degradation and reduction of soil’s fertility result in negative impact on traditional agriculture production. However, the use of organic fertilizers in the soil increases soil fertility and crops quality in conservation agriculture. Moreover, with reduced land preparation time, cropping cycles are shorter, allowing more crops in the same production period. Fully adopting conservation agriculture practices including row-seeding, intercropping and crop rotations with different cultures increase production variety and reduces the negative impact of agriculture soils. Results shown in this research demonstrate that traditional agriculture practices in Mozambique are not profitable and limited to the subsistence of the families. Conservation agriculture practices demonstrate lower risks, more profitability and higher cost savings over TA.
In general Mozambican conservation agriculture farmers experience less soil erosion and more improvements to the soil structure with the increase of organic matter and production of organic fertilizers, increase of crop yields and intensities of crops; reduced time between sowing and harvesting crops, allowing more crops of different cultures to be grown over a period of 12 months; decreased labour costs and cost savings from lack of replanting of crops; lower risks due to higher, with better quality and more stable productions and diversification into cash crops allowing commercialization and profit generation.

5.5.2.7. Factors Influencing the Adoption of Conservation Agriculture in Mozambique

Studies of the adoption of conservation agriculture practices tend to obtain contradictory and sometimes inconsistent results that suggest that the decision making process varies and may be specific to particular individuals, places and situations which makes the task of developing framework policies to promote and encourage conservation agriculture systems implementation quite challenging. Factors influencing the implementation of conservation agriculture in Mozambique are beyond net returns, profitability and minimum subsistence food requirements. Even though current research study concludes that conservation agriculture provides better net returns, financial profitability with soil conservation techniques that protect the environment, there are other factors that contribute or hinder CA adoption.

The perceived risk of adopting conservation agriculture methods is a strong barrier to Mozambican traditional agriculture farmers that have been following this practice for generations. Culture and traditional social practices are some of the biggest barriers in adopting
conservation agriculture methods in Mozambique as farmers believe they need to honor their ancestors traditions and respect their practices in fear of bad omens. Furthermore, new and younger farmers developing agriculture for the first time, with short term planning views may find the long gestation periods for conservation agriculture benefits to materialize a potential barrier.

The current study showed that the adoption of new agricultural methods are interrelated with age, education and level of experience in the field. Age and experience are strong factors linked to conservation agriculture adoption. Older Mozambican farmers are less likely to adopt conservation agriculture methods despite being more likely to recognize soil problems due to their vast experience in the fields. From the sample of farmers practicing these forms of agriculture in Chemuve village, it was visible that conservation agriculture farmers were younger than their traditional agriculture colleagues.

Education is positively correlated with the adoption of conservation agricultural practices in Mozambique; the higher the educational level of the farmer the more willing the farmer is to adopt conservation agriculture practices due to the perception of the negative impact of traditional agriculture in soils, production and profitability results.

Information is a key factor influencing conservation agriculture adoption in Mozambique. Without the knowledge of these practices via information channels, adoption is less probable.
Information availability contributes positively to conservation agriculture adoption, and becomes essential as the degree of conservation agriculture techniques complexity increases. Information sources that can influence positively the adoption of conservation agriculture in Mozambique include other farmers, meetings, training programmes, media and local government functions and activities. Training programmes alone will not promote and encourage adoption of conservation agriculture practices if the dissemination of the information is not effective, accurate and appropriate.

Social factors and collective actions also contribute to the implementation of conservation agriculture practices. Cooperative arrangements are essential to manage agricultural systems within local villages in rural communities in Mozambique. Many dimensions of conservation agriculture fit the cooperative structure including forming and operating groups of farmers, spreading information, construction of wells for the community, rainwater cisterns to irrigate the fields, purchase of new seeds, plants and fruit trees or other agricultural inputs and other collective actions related to sustainable agriculture. Due to the fact that CA promotes the creation of social organizations to help with the activities, its widespread adoption may correlate to the social capital of a society. In a broader sense, social capital is defined in the interconnectedness among the individuals of a society considering relationships as a form of asset. In developing countries, like Mozambique, this is particularly interesting, as this kinship can influence the adoption of conservation agriculture practices (Roseland, 1999). These small organization or cooperative, at the local level, operating in a rural community is an important catalyst in the adoption and dissemination of conservation agriculture practices.
5.6. Conclusion

The same sample size was used to study conservation agriculture and traditional agriculture; as well as the same location used for the interviews conducted in the communities of Riofenga and Sinheve at Chemuve village. Sample characteristics were also the same, both composed of 3 women and 2 men for each agriculture practice. The conducted research focused in the same type of crops (maize, sorghum and bean) and analyzed production results occurring in the same period of time (between 1997-2012) for both agriculture practices.

A comparative study was made between conservation agriculture and traditional agriculture, to evaluate and find out the extent to which conservation agriculture can contribute to poverty reduction in Mozambique. The main question was: “How can Conservation Agriculture methods help to alleviate poverty?”

The main objective: To examine how Conservation Agriculture can alleviate poverty.

And the specific objectives were:

To examine production levels of maize, sorghum and bean during 1997 and 2012 using conservation agriculture and traditional agriculture techniques;

To examine conservation agriculture and traditional agriculture methods and practices used; and,

To examine the challenges found by farmers adopting conservation agriculture practices.
During the research study, interviews were conducted, together with direct observation methods (with photographs) and focus group meetings and discussions with traditional agriculture and conservation agriculture participants. Focus groups were composed of 5 elements for each agriculture practice study and for each data collection method. A thorough examination of CARISTAS documents and written reports was also used.

Table 5.25: Profitability results of AC and AT in maize, sorghum and beans

<table>
<thead>
<tr>
<th></th>
<th>CA Rentability</th>
<th></th>
<th>TA Rentability</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Production Increase</td>
<td>% Annual Production</td>
<td>% Production Increase</td>
<td>% Annual Production</td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>477%</td>
<td>30%</td>
<td>144%</td>
<td>9%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>246%</td>
<td>15%</td>
<td>139%</td>
<td>9%</td>
</tr>
<tr>
<td>Bean</td>
<td>183%</td>
<td>11%</td>
<td>125%</td>
<td>8%</td>
</tr>
<tr>
<td>Sold</td>
<td>% Production Sold</td>
<td></td>
<td>% Production Sold</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>9%</td>
<td></td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>45%</td>
<td></td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td>57%</td>
<td></td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Consumed</td>
<td>% Production Consumed</td>
<td></td>
<td>% Production Consumed</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>87%</td>
<td></td>
<td>92%</td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>48%</td>
<td></td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td>40%</td>
<td></td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Stored Seeds</td>
<td>% Seeds for Storage</td>
<td></td>
<td>% Seeds for Storage</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>3%</td>
<td></td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>7%</td>
<td></td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td>3%</td>
<td></td>
<td>7%</td>
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</tr>
</tbody>
</table>

*Source: The Author, 2014*

Given the data presented it is possible to conclude that (Table 5.25):
Findings suggest that conservation agriculture system and practices can alleviate poverty in Mozambique. Conservation agriculture farmers have shown that CA has improved their lives considerably, and of their families; despite all the challenges they faced and managed to overcome to start developing this agriculture method in their fields. Some of these challenges include:

To create water reservoirs to cater for rainwater; building improved water cisterns with the financial support of MISEREOR. Rainwater is crucial to produce compost and liquid organic fertilizer that is then used to increase the fertility of the soils and improve the quality of the crops;

The construction of tanks for the production of organic liquid fertilizer applied to the soil during the crops growth stage;

Small animal breeding for manure, organic compost and liquid fertilizer production; and meat production, for a healthier food diet;

The creation of grass fields and living matter to cover the fields when necessary;

Learn to produce organic compost and liquid fertilizer.

5.7 Recommendations

5.7.1. Community Recommendations for the Agricultural Sector

It is recommended that CA farmers be provided:

With irrigation systems;

With electricity in their communities;
With roads nowadays it is only possible to access these communities on foot or with a motorbike or a bicycle;

With organized bazzars (markets) to sell their goods;

With a secondary school; the existing one is 10 kms away from Muchúngue (which is kms away from Chemuve village) and it is a very long distance for children to walk to every day;

With health posts, per community; the existing one is very far away from the communities of Riofenga and Sinheve.

5.7.2. Recommendations for the Mozambican Government

To open more community wells and to build water sources;

To develop campaigns, programs and policies to promote and encourage CA in the country;

to improve the access roads because nowadays it is only possible to access these communities on foot or with a motorbike or a bicycle;

To promote social capital benefits and the importance of farmers groups in the communities;

To improve the access roads to support the commercialization of produced goods in rural communities;

To build secondary schools in the villages and communities;

To build health posts in communities and hospitals in the nearby villages.

to build markets or fairs for farmers to sell their products, build health clinics in communities.
5.8. Contribution of this study to Knowledge of CA

5.8.1. Mozambican Government Policies to Enhance the Adoption of Conservation Agriculture

The agricultural sector has important interest and intervention from the Mozambican Government. As a result the Mozambican Government has introduced various programmes to fight poverty in Mozambique with strong emphasis in the rural communities where families live in extreme poverty. However the current study suggests that poverty reduction related programmes alone will not be able improve the life standards of Mozambican vulnerable communities.

The current study recommends new Government policies to introduce a variety of programmes to encourage and promote the adoption of Conservation Agriculture practices. The assumption that CA will develop on its own in some way is not appropriate. Government policies are important to explain conservation agriculture adoptions and the impacts of non-adoption. Much of the success of conservation agriculture diffusion is because of the support of private organizations, Non-Governmental Organizations (NGOs) and the formation of groups of farmers in rural communities. The Mozambican Government should extend to services, taxes and subsidies which in various parts of the world have achieved positive results. According to (Keck, 2011), many CA programmes in various countries have been ineffective due to contradictory signals and incentives existing in subsidy programmes sometimes not in tune with the community reality. In order to successfully achieve expected results, and taking into consideration that conservation agriculture will provide a positive net return to potential
adopters, a key concern for Mozambican Government policy makers the following is recommended.

The first step is in designing successful policies to promote conservation agriculture is likely to start with a deep understanding of farm-level conditions in rural regions of Mozambique. This will include management objectives, willingness to make trade-offs among stewardship and profits and attitudes to risk. The next step is to design a location sensitive programme that combine a range of policy tools. Policies should focus on promoting social capital benefits of group extension approaches and the importance of groups of farmers to share and disseminate their success adopting conservation agriculture to their and neighbouring communities. Efforts put by the Mozambican Government to enable and strengthen conditions for these activities can pay large dividends.

Similarly, developing sustainability and conservation agriculture indicators that can clearly highlight conservation agriculture benefits over traditional agriculture is another step. Improvements are possible to be achieved at the economic analysis level. For example, including the lack of natural capital and soil degradation in studies of traditional agriculture can help evidence the limiting factors of this technique. Finally, a whole-farm program approach is the most appropriate foundation for financial analyses of CA as this embraces the full range of responses farmers make when deciding to adopt conservation agriculture practices.
As the current study shows, education and technical support is crucial to inform, train, capacitate and offer conservation agriculture skills to Mozambican farmers as well as disseminate and promote agriculture innovations. To encourage the adoption of conservation agriculture techniques it is important to assure the long term benefits of this practice in an easy to understand and accurate information and simultaneously include multiple economic and non economic benefits. It requires an appropriate and credible information and experience communicated via correct channels. Training programmes to provide information and assistance are highly effective and public agents play a strong role in providing these services.

Financial support and Government incentives are important to overcome initial investments and transition costs of local farmers entering the agriculture sector. According to Nowak (1987) Government support contributes to the adoption of conservation agriculture, result in positive net returns for local farmers, reducing the risk faced by farmers in adopting a “new” practice and is useful to reduce barriers and misinformation for implementing CA.

Finally soil erosion regulations are difficult to control and manage therefore it is suggested a more regulatory approach that includes cross compliance measures whereby eligibility for a specific support program depend on the adoption of conservation agriculture practices. Due to the fact that compliance is made by individual’s choice, programme implementations are more economically efficient and politically feasible.
5.8.2. Conservation Agriculture Training Model to Promote Conservation Agriculture Adoption in Mozambique

With respect to education and technical support that is essential to inform, train and capacitate Mozambican farmers and promote agriculture innovations, integrating concept of whole-farm where farmers learn the benefits of CA practices, the current study developed a tailored and easy to understand Conservation Agriculture Training Model (CATM).

The Conservation Agriculture Training Model is a targeted policy approach designed to directly promote CA in Mozambique by the Mozambican Government. This model should be implemented in the rural areas where the majority of the population still lives under extreme poverty. Moreover it aims at forming successful agricultural entrepreneurs and eliminate poverty in the country.

Due to the fact State Agricultural Schools are not yet teaching conservation agriculture methods, the CATM targets initially these schools. The launching program should include recently graduated, former students and teachers in order to upgrade their skills and later involve them in promoting conservation agriculture methods. Agricultural technicians will then visit local communities and train and provide assistance to local farmers. Agricultural technicians will help the communities identify Group leaders and form small cooperatives. Results Demonstration Fields are essential for the implementation of CATM and to observe its benefits.
Taking into account that a great majority of the Mozambican population living in rural areas is still illiterate or with very limited education (primary and secondary levels) the Conservation Agriculture Training Model was designed to be integrate in adult education programmes and small farmers’ associations. It highly recommendable to be integrated as a subject in secondary schools of rural communities to teach young people agriculture techniques and develop the entrepreneur spirit; as young Mozambicans are often unable to foresee a better future with economic indepence due to the poverty cycle surrounding their families and communities.

The Conservation Agriculture Training Model aims to change the mindset of the Mozambican population living in the rural areas. Mozambique is rich is land resources. The land is fertile and bring richness. Its proper use can eliminate hunger in the communities and bring wealth and abundance. Developing agriculture in a sustainable profitable way with group extensions creating social capital to support initial investments of new farmers, create local markets, build wells and cisterns for land irrigation will give birth to a new generation of middle class mozambicans: the agriculture entreprenuers.

To increase conservation agriculture benefits awareness and promote its adoption the Mozambican Government must develop media campaings with nationwide television and radio exposure; and theater plays in the communities. Radio programs may be based on the Conservation Agriculture Training Model and presented in local stations in local native languages.
This model is divided in two sections. The first section is the Conservation Agriculture Training Program content; and the second section comprises the necessary requirements to attend and deliver the Course.

1st Section

Course Duration: 150 horas

1. Introduction

The Conservation Agriculture Training Model addresses general and specific objectives, programme contents and a thematic plan taking into account the objectives of the course. Each student should have a Results Demonstration Field of approximately 20 square meters to practice conservation agriculture techniques in maize, sorghum and bean crops and observe results. One part of the production will be used for consumption, for the students and the teachers/agricultural technicians of the school; a percentage will be stored for seeding and the other for commercialization where the profit will be split between the school and the student. School profit share will be used to improve school’s conditions. This is a specific model adequate to the reality of Mozambique and articulated to the existing conditions. The Conservation Agriculture Training Model includes sessions with local successful CA farmers and visits to their farms to exchange experience, gain more knowledge and inspire and motivate new students.

2. Objectives
2.1. General Course Objectives

The aim of the Course is to teach and train conservation agriculture practices, how to apply them in the field, and enable students to produce quality goods in a sustainable way without destroying the environment. The Program offers general principles and concepts for livestock production, associativism and trade with solidarity, marketing and advertising, accounting and financial management.

2.2. Specific Course Objectives

At the end of this programme, students should be able to know:

-What is an ecosystem

-The importance of Conservation Agriculture

-Advantages of adopting Conservation Agriculture practices

-Disadvantages of adopting Traditional Agriculture practices

-How to prepare the soil for seeding;

-How the sowing is done, as well as intercropping mixing and rotating crops, plant spaces and -
measurements and row-seeding and dibbling

- Produce organic compost

- Produce organic liquid fertilizer

- Apply correctly the organic compost and liquid fertilizer to the soil (near the plant)
- How to harvest
- How to store and manage harvest results
- Breeding small animals
- How to sell produced products
- How to be an agriculture entrepreneur and manage crop’s results
- How to identify business opportunities
- How to identify and make partnerships with other agriculture entrepreneurs
- How to develop the associativism spirit
- Accounting and financial management

Programmatic Content and Analitic Plan
<table>
<thead>
<tr>
<th>Theme</th>
<th>Content</th>
<th>Week/ Date</th>
<th>Theoretical Course</th>
<th>Practical Course</th>
<th>Assessment and Evaluation</th>
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<td></td>
<td>Traditional Agriculture disadvantages</td>
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<td><strong>Preparing the soil for seeding</strong></td>
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<td>How to apply soil coverings</td>
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<td><strong>Water</strong></td>
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<td>The importance of water for agriculture</td>
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<td></td>
<td>How to harvest rainwater</td>
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<td></td>
<td>The use of water cisterns</td>
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<th>Construction of a small cistern to collect rain water</th>
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<td>Identify watercourses</td>
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### 4 Sowing

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<td>2</td>
</tr>
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<td>Row-seeding, plant spacing and measurements</td>
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<td>2</td>
</tr>
<tr>
<td>The use of a <em>matraca</em> for seeding</td>
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<td>2</td>
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<td>Mixing of cultures</td>
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<td>Crops rotation</td>
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<td>5</td>
<td><strong>Breeding small animals</strong></td>
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<td>Animal manure and its use in agriculture</td>
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<table>
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<tr>
<th>8</th>
<th><strong>Notions of accounting, finance and management</strong></th>
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<td></td>
<td>The importance of entrepreneurship</td>
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<td>Entrepreneurship in CA</td>
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<td></td>
<td>Brainstorming and identifying good business ideas and opportunities</td>
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<td>The entrepreneur spirit</td>
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<tr>
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<td></td>
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</table>
4. Methodology and Evaluation

For the fulfillment of the envisioned objectives the Training Model will follow theoretical-practical methods offering theoretical and practical lessons. Lessons are strongly linked to field production and agriculture activities. The course will comprehend a complete agricultural season; from land preparation to sowing, to harvest, to storage and commercialization. Recommended products include maize, sorghum and bean crops. For each theoretical class there will be two practical classes. And at the end of each theme there will be a visit from a successful CA farmer to promote the farmer, his success story and inspire students. There is a continuous evaluation of the students and assessments will be based on student’s field practice results at the Results Demonstration Fields. At the end of this programme, students should be able to practice, apply and demonstrate CA techniques as per the programmatic content.

2nd Section

As previously stated, the Conservation Agriculture Training Model may be offered as a vocational training course aimed at forming young farmers and future entrepreneurs. The content is the same as the Conservation Agriculture Training Model. A Results Demonstration Field is compulsory for practical lessons as per the programme. Compliance to CA practices is a must to get selected and attend the course.

1 Identifying and describing the target audience for the Vocational Training Model
The target market includes all young people who already have some form of agriculture practice and knowledge; or want to learn more about conservation agriculture techniques; or want to improve their crop productivity; or want to become an agriculture entrepreneur. The young people comprises of men and women between 18-25 years old. Depending on the rural area demographics the age group may vary to 18 – 35 years old. Students should be interested in starting their own agriculture business, either in full time or part-time. The target market may also include agriculture farmers children that inherited land and want to give continuity to the family business following CA methods; or young people who are unemployed, with very limited financial resources and willing to join the agriculture sector to improve their lives standards and their families.

Candidates will be selected following a specific profile criteria that includes the submittion of a motivational letter explaining the rationale for doing the course, their expectations and how the Vocational Training Model will impact their lives. Motivational letters should be submitted at the time of enrollment. Only Conservation Agriculture practices will be allowed during the course.

**Training Requirements**

To ensure the success of the vocational Conservation Agriculture Training Model the following requirements are needed:
Mozambican Government support and assistance in using schools to promoting and encourage the Conservation Agriculture Training Model and form young farmers;

Advertise the course and disseminate CA practices and adoption benefits and non-adoption impacts, in a mass market Governmental campaign;

Homogeneous groups attending the training program is essential to ensure exchange and knowledge experience;

The final assessment includes the presentation of a small project to be developed in their lands after the training programme;

Agricultural technicians and Community CA Group Leaders should provide technical support to young farmers participating to the course and adopting CA practices after the course.

The development of an integration program to welcome new members to the community’s farmers association offering all necessary support to help new farmers succeed.

**Duration of the Vocational CA Training Program**

The vocational CA Training Model will have the duration of 150 hours (3 hours per day of theoretical and practical classes, plus visits to local CA farms and exchange programs with local conservation agriculture farmers), which represents approximately 55 days of training, during an entire maize, sorghum and bean production season and including storage and commercialization of produced goods.
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Maússe, M. A. (2009). Poverty, Participation and rural development in Mozambique:


RELMA (Regional Land Management Unit). (2007). Wetting Africa’s appetite: Conservation agriculture is turning rainfall into higher crop yields – and catching on. Review Series, No. 3.


INTERVIEW IN FIELD

GROUP A1 - CONSERVATION AGRICULTURAL

1. How have you been doing conservation agriculture in the production of maize, sorghum and beans?
a) What materials do you use to prepare the soil for sowing?

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b) Do you use animal traction? In what way?

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C) How do you get the seed?

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d) How do you make a seeding?

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E) How do you do the watering?

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f) How many times a week do you do the watering?

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g) How many times per production do you do watering?

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h) How many times per harvest / production do you take off weeds?

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i) How many times per year do you produce maize, sorghum and beans?

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j) What is the annual production per harvest since you started producing conservation agriculture?

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k) What do you do with the harvest?

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l) How much harvest do you sell?
m) And what quantity of harvest do you keep for consuming during the year?


n) What quantity of harvest do you keep for seed?


o) Can you tell me a life story that happened to you about conservation agriculture?
p) What advice do you give to the farmers who practice the traditional agricultural system?

q) What are the challenges you have faced in practicing conservation agriculture?

r) How have you solved the challenges?
APPENDIX II

CONSERVATION AGRICULTURE AMONG
TRADITIONAL COMMUNITIES IN CHIBABAVA, SOFALA PROVINCE,
MOZAMBIQUE WITH A SPECIAL REFERENCE TO LAND USE AND
FOOD PRODUCTION

PhD Student: M.ª Albertina Barbito

Supervisor: Dr. Nyaruwata

GROUP B1 - TRADITIONAL AGRICULTURE (TA)

1. How have you been doing traditional agriculture in the production of maize, sorghum and beans?

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a) What materials do you use to prepare the soil for sowing?
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b) Do you use animal traction? In what way?
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(c) How do you get the seed?
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d) How do you make a seeding?
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e) How do you do the watering?
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f) How many times a week do you do the watering?
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g) How many times per production do you do watering?

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h) How many times per harvest / production do you take off weeds?

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i) How many times per year do you produce maize, sorghum and beans?

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j) What is the annual production per harvest since you started producing traditional agriculture?

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k) What do you do with the harvest?

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l) How much harvest do you sell?

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m) And what quantity of harvest do you keep for consuming during the year?
n) What quantity of harvest do you keep for seed?

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o) Can you tell me a life story that happened to you about traditional agriculture?

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GROUP A1 - AGRICULTURA DE CONSERVAÇÃO (AC)

1. Como é que você tem feito a agricultura de conservação na produção de milho, mapira e feijão?
a) Que materiais é que você utiliza para preparar o solo para a sementeira?

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b) Você usa tracção animal? De que forma?

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c) Como é que você adquire a semente?

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d) Como é que você faz a sementeira?

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e) Como é que você faz a rega?

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f) Quantas vezes por semana é que você faz a rega?

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g) Quantas regas é que você faz por produção?

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h) Quantas vezes por colheita/produção você tira as ervas daninhas?

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i) Quantas vezes por ano é que você produz milho, mapira e feijão?

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j) Qual é a produção anual por colheita desde que você começou a praticar a agricultura de conservação?

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k) O que você faz com a colheita?

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l) Que quantidade da colheita você vende?
m) Que quantidade de colheita é que você guarda para consumir ao longo do ano?

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n) Que quantidade da colheita é que você guarda para semente?

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o) Pode fazer o favor de contar uma história de vida que aconteceu consigo sobre agricultura de conservação?

p) Que conselhos é que você dá para os agricultores que praticam no sistema de agricultura tradicional?

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q) Quais são os desafios que você enfrentou em praticar a agricultura de conservação?
r) Como você resolveu os desafios?
APPENDIX IV

AGRICULTURA DE CONSERVAÇÃO ENTRE COMUNIDADES TRADICIONAIS DE CHIBABAVA, PROVÍNCIA DE SOFALA, MOÇAMBIQUE, COM ESPECIAL REFERÊNCIA AO USO DA TERRA E PRODUÇÃO DE ALIMENTOS

Doutoranda: M.ª ALBERTINA BARBITO

Supervisora: Dr. Nyaruwata

GROUP A2 - AGRICULTURA TRADICIONAL (AT)
1. Como é que você tem feito a agricultura de conservação na produção de milho, mapira e feijão?

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d) Como é que você faz a sementeira?

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e) Como é que você faz a rega?

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f) Quantas vezes por semana é que você faz a rega?

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g) Quantas regas é que você faz por produção?

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h) Quantas vezes por colheita/produção você tira as ervas daninhas?

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i) Quantas vezes por ano é que você produz milho, mapira e feijão?

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j) Qual é a produção anual por colheita desde que você começou a praticar a agricultura de conservação?
k) O que você faz com a colheita?

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l) Que quantidade da colheita você vende?

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m) Que quantidade de colheita é que você guarda para consumir ao longo do ano?

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n) Que quantidade da colheita é que você guarda para semente?

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o) Pode fazer o favor de contar uma história de vida que aconteceu consigo sobre agricultura de conservação?
Para: ________________________________________________________________

Para quem julgar necessário, A Universidade Católica de Moçambique credencia a Dra. Maria Albertina Lopes da Silva Barbito Docente desta Faculdade de Economia e Gestão e estudante de Doutoramento nesta Universidade Católica de Moçambique em parceria com a Universidade Aberta do Zimbabwe para realizar um trabalho de pesquisa subordinado ao tema:

Sem mais assunto de momento, subscrevo-me com elevada estima e consideração.

Beira, aos 5 de Novembro de 2013

A Directora Pedagógica

______________________________

(Dra. Albertina Celeste Inácio Ribáuê)