CZECH UNIVERSITY OF LIFE SCIENCES IN PRAGUE

Faculty of Tropical AgriSciences

Department of Sustainable Technology

SUSTAINABLE AGRICULTURE FOR FOOD SECURITY IN ZAMBIA

Bachelor Thesis

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Declaration

I, **William Nkomoki**, do hereby declare that this thesis is the result of my own investigation and research and that it has not been submitted in part or full for any other degree or to any other University. All the work of other researchers has been duly acknowledged.

I remain fully responsible for any and all errors of omission, interpretation and any other shortcomings.

In Prague 2013

Student signature _____

William Nkomoki

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I am gratefully indebted to my supervisor, Prof. Ing. Bohumil Havrland, CSc. for the support rendered to me while carrying out my research project.

I wish also to express my thanks to my family, dad, mum, brothers, sisters and friends for the moral support and to whom the preparation of this work has been a relational hardship.

Annotation (English)

The overall objective of the study is to establish and examine the benefits and impacts accrued by farmers in applying sustainable agriculture systems and ways it can contribute to support food security and poverty reduction. It examines the decision making processes in farm management in Chongwe and Kafue districts of Lusaka Province of Zambia. In particular, the present study aims to develop a knowledge base on the economic, social and environmental worth of farm management options that may be pursued with or without the use of sustainable agriculture systems.

A variation in climate with reference to rainfall anomalies causes uncertainty to agriculture, in terms of revenue reduction through lost of production.

In this study, sustainable agriculture practice system is treated as just one factor, of which management could use to manipulate it in order to achieve specific objectives.

Data collected from the field by the use of a questionnaire was subjected to quantitative analysis through basic statistics. The qualitative data (discussions and general comments) were analysed and conclusions and recommendations were formulated.

The area of study falls in a low rainfall area that receives annual cumulative rainfall less than 800 mm in the season. The sustainability of their practices was measured by criteria belonging to economic, environmental and social segments of the sustainability. The findings therefore indicate that sustainable agriculture systems ultimately play a truly meaningful role in improving food security and sustainable livelihood for small-scale farmers in Zambia.

Key words: Sustainable agriculture, food security, small-scale farmers, climate, Zambia.

Annotation (Czech)

Celkovým cílem studie je stanovit a posoudit přínosy a dopady příštích období u zemědělců při aplikování trvale udržitelných zemědělských systémů a způsoby, kterými lze přispět k podpoře potravinové bezpečnosti a snižování chudoby. Práce zkoumá rozhodovací procesy v řízení farem v okresech Chongwe a Kafue v Lusaka provincii v Zambii. Tato studie si klade za cíl rozvinout znalosti založené na ekonomických, sociálních a environmentálních hodnotách řízení zemědělských podniků. Možnosti, kterých může být dosaženo s použitím nebo bez použití udržitelných zemědělských systémů. Pro zkoumání těchto jevu byl zpracován dotazník, na základě kterého byla sebrána základní informace.

Je to především klimatická variabilita s ohledem na srážkové anomálie, která způsobuje nejistotu zemědělské výroby z hlediska snížení příjmů v podobě úbytku produkce. Jedná se o oblast, která je charakteristická svými nízkými srážkami, která má roční kumulativní srážky menší než 800 mm za sezonu.

V této studii, praxe udržitelného zemědělského systému je klimat považován za jen jeden faktorů, jehož poznání může posloužit pro jeho positivní využití za účelem dosažení specifických cílů.

Data shromážděná díky použití dotazníků byla podrobena kvantitativní statistické analýze. Kvalitativní údaje (diskuse a obecné připomínky) byly analyzovány a byly formulovány závěry a doporučení.

Udržitelnost praxe malorolníků byla měřena podle kritérií, patřících do hospodářských, environmentálních a sociálních sektorů udržitelnosti. Výsledky ukazují, že trvale udržitelné zemědělské systémy nakonec hrají opravdu významnou roli ve zvyšování potravinové bezpečnosti a udržitelného živobytí pro drobné zemědělce v Zambii.

Klíčová slova: udržitelné zemědělství, potravinová bezpečnost, drobní zemědělci, klima, Zambie.

List of abbreviations

AEO	Agriculture Extension Officer
ARPT	Adaptive Research Planning Team
CSO	Central Statistical Office
DFID	Department for international Development
FFSSA	Forum for Food Security in Southern Africa
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
HDI	Human Development Index
IFRC	International Federation of Red Cross
MACO	Ministry of Agriculture and Cooperatives
NMTIP	National Medium Term Investment Programme
UNDP	United Nations Development Programme
WTO	World Trade organisation
ZMD	Zambia Meteorological Department
ZNFU	Zambia National Farmers Union

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1. CHAPTER ONE: INTRODUCTION.

Sustainable agriculture can be defined using three main components namely economic sustainability, social sustainability and environmental sustainability. It is important to note that, even though discussed separately, these are interlinked and greatly influence each other. The concept of sustainable agriculture is used in such diverse ways that it is important to make brief reference at the onset to the way it will be used here.

The main purpose of this thesis is to link sustainable agriculture, food security and crop productivity. Sustainable agriculture and food security linkages indicate that three major conditions have to be met to achieve food security.

- ✓ Fulltime involvement of farmers in issues of technology research, planning and extension services to help attain sustainable food production.
- ✓ Practices and strategies used must not deplete the resources but rather conserve the natural resource base.
- ✓ Strengthen rural economies and capacities to have access to food.

In this thesis, sustainable agriculture is taken to refer to the continuous efforts of men, women and children to adapt complex rural livelihoods to a changing environment so as to achieve food production.

Sustainable agriculture has emerged as an alternative agriculture system that addresses many of the constraints faced by resource poor farmers and at the same time ensures sustainability. It refers to the capacity of agriculture to contribute to sufficient food provision and other goods and services over time in ways that are economically acceptable and profitable, socially responsible and environmentally sound.

This study seeks to establish and understand the benefits; impacts accrued by farmers in applying the sustainable agriculture development and ways it can contribute to support food security.

A structured questionnaire was used as the main data gathering instrument (Appendix1).In addition; in-depth interviews with selected small scale farmers were conducted. Secondary resources in form of published articles and Literatures to support the survey results were made use of.

A combined approach which involved qualitative and quantitative statistical processing methods has been used. The type of analysis is descriptive and use statistical tables, pie charts and histograms.

The results in this study indicate that accessibility to sustainable agriculture systems could greatly help in the improvement of food security and agricultural productivity.

It can be concluded, that application of sustainable agriculture systems is important among other factors for general farm management. The economic benefits include overall management, food security, field optimization and increased profit from the harvest. Also, future research is needed to determine the usage and economic benefits of applying sustainable agriculture system in other nine remaining provinces of Zambia.

Consolidated practical approaches are required from farmers (small scale), government and private sector to ensure that food security and poverty reduction are sustained over a longer period of time.

The lack of many well documented examples of benefits and successful use of sustainable agriculture by small-scale farmers is among the reasons for carrying out this research in Zambia.

2. CHAPTER TWO: REFERENCE ANALYSIS AND THEORETICAL CONSIDERATIONS

This section considers the type of references on which the research work is based. It discusses the theoretical concepts that form the basis of the research.

It is noted that sustainable agriculture can have varied interpretations depending on the communities under which it is applied. However, in the context of this work, the term sustainable agriculture is used within the scope of small scale farming practices in Zambia. Zambian farming is up to now majorly practised by peasant farmers in the rural communities for their livelihood options. It is from farming that the rural communities derive their food and incomes to support their daily basic needs. By virtue of the low income levels, much of the rural farming practices are manually done with less or totally no technical machinery applied. Rural agriculture practice in Zambia is also highly climate dependent as it is wholly rain fed.

In view of the foregoing, the references applied in the discourse of this research in the subsequent chapters and sections are focussed on the farming environment among rural communities. References have been applied from a point of view that also realises that in Zambia, agriculture practices differ from one community to the other due to cultural inferences. Therefore, the reference analysis and theoretical considerations in this research work are based on the three pillars (Pretty J et al., 1996):

- ✓ Sustainable food production among the small scale farmers to attain food security.
- ✓ Environmental conservation that recognises that sustainable agriculture can only be possible in a natural environment and ecosystem that is not depleted
- ✓ Enhanced livelihood options among rural farmers that ensure that access to food is sustained.

2.1 Agro Ecological Regions and Study Area

Agro ecological regions are divided in three namely region I.II and III out of Zambia's land mass of 752 620 square kilometres. The Figure 2.1 below illustrates the division of Zambia's Agro ecological regions.

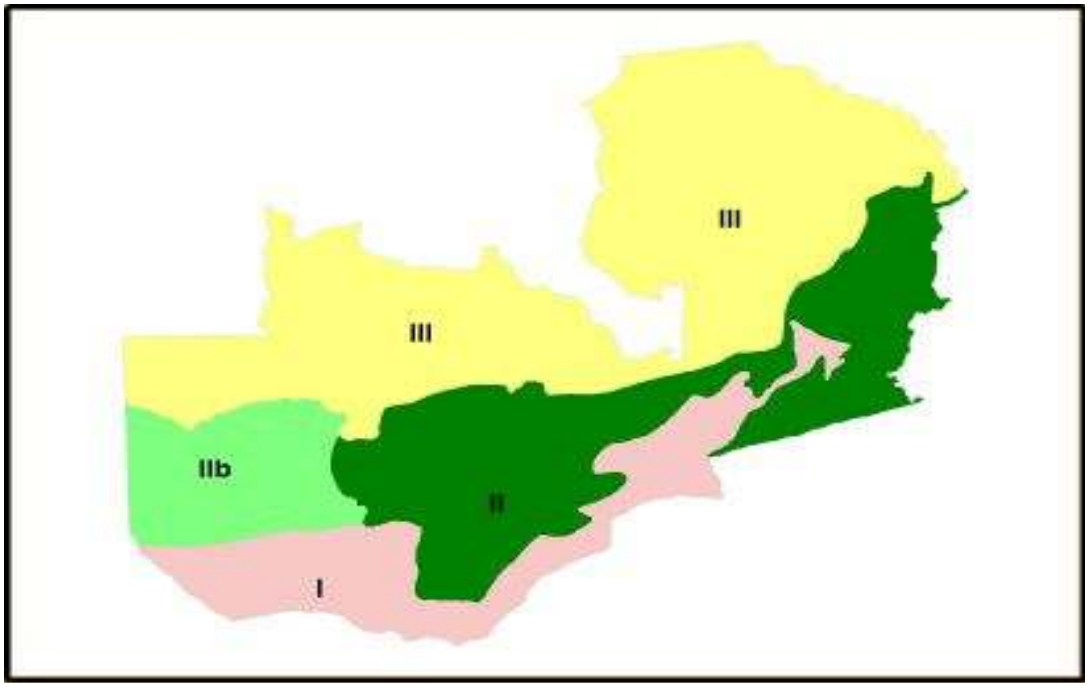

Figure 2.1: Zambia Agro Ecological Regions

Source: (CEEPA, 2006)

Region 1 covers the Southern, Eastern and western parts of the country. It constitutes about 12% of Zambia's total land and receives less than 800 mm of rainfall annually. This region consists of loamy to clayey soils on the valley floor and fine shallow soils on the escarpment. The region is suitable for production of drought resistance crops like cotton, millet, and sorghum and suitable for cattle production.

Region II constitutes about 42% of the country with annual rainfall of between 800 -1000 mm. It is sub divided into region IIa and IIb. Region IIa cover Lusaka central, southern and eastern fertile plateau. Main crops in this region include maize, groundnuts and soya beans.

Region IIb is suitable for production of rice, cassava and millet, vegetables and timber production. It is also highly suitable for beef, dairy and poultry production and consists of Sandy soils.

Region III constitutes 46% of the country's total land area comprising the Copperbelt, Luapula, Northern and North western Provinces. The Region receives more than 1000 mm up to 1500 mm of rainfall annually. With exception of the Copperbelt, the region is characterised by highly leached acidic soils and agricultural potential can be enhanced by application of lime. It has potential for production of millet, cassava, sorghum, beans and groundnuts (MACO, 2004).

Despite the relative homogeneity in agro-ecological factors within a region, differences exist among small scale farmers in terms of technology. Based on Adaptive Research Planning Team (ARPT) program, three recommendations were defined. The basis of income, risk- avoiding and level of mechanisation as follows:

- ✓ Low income, high risk- avoiding and manual tillage.
- ✓ Intermediate income and risk avoiding and manual/oxen tillage.
- ✓ Relative income, low risk -avoiding and oxen/tractor tillage

Based on these domains recommendations of appropriate technology were defined for each farmer (Bezuneh et al, 1995).

The area of study falls in a low rainfall area that receives annual cumulative rainfall less than 800 mm in the season. (Figure 2.2).

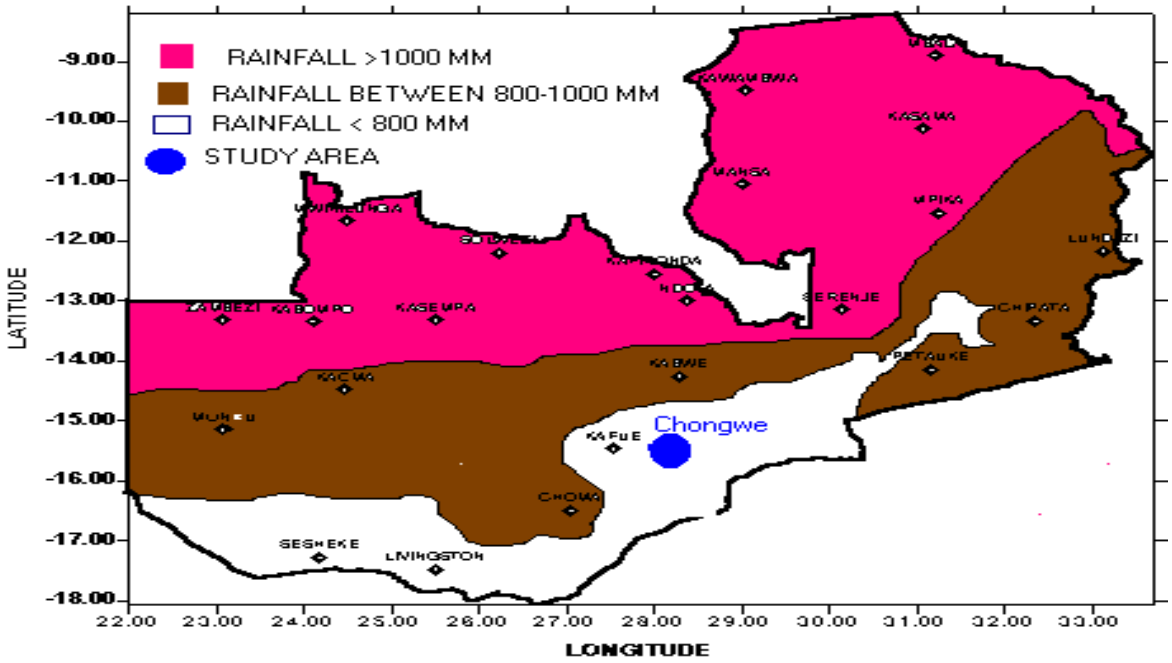

Figure 2.2: Study Area. ***Source: (MACO, 2004).***

2.2 Background to the problem

In developing regions agriculture is the main source of livelihood for 85% of the rural population (Dixon et al., 2001).To reduce poverty levels in developing countries, it is important to develop the Agriculture sector (World Bank ,2008).

The people and economy of Zambia is severely affected by food insecurity and poverty. A large number of rural people derive their livelihood from agriculture and other related economic activities.

It follows, therefore that the most direct and effective means of raising standards of living and alleviating poverty, hunger and malnutrition is through increasing the productivity and incomes of small-scale agriculture.

The Zambia National Farmers Union (ZNFU) in their bulletin estimate that 30% of the risk in grain production among the commercial and small-scale farmers is climate related.

The ability of the agricultural sector to handle climatic variability is important and greatly assists in stabilizing the country's economic performance. According to Pretty J. and Hine R. (2001), sustainable agricultural systems contribute positively to local livelihoods economically, environmentally and socially.

Agriculture production is the mainstay of the economy and plays a fundamental role for sustainable development and poverty reduction in Zambia. Agriculture generates about 22% of the Gross Domestic Products (GDP), with more than 70% of the total labour force employed. About 4.6 million poor people in a total population of about 12 million depend on agriculture. Most of these farmers are small-scale subsistence farmers (Mucavele, 2009).

Poverty can be defined in different ways by researchers. According to Wacquat L.J.O (1989) poverty is defined as a multi dimensional, embracing deprivation of income, access to services, voice to decision making.

According to Persell C. H. (1987) poverty lies behind a great many of the social and economic problems that all societies face with the content of sustainable human development. Poverty is synonymous with lack of choice.

Developing sustainability in agriculture would have far reaching impacts on poverty reduction and food security in the country.

Since most small-scale farmers depend on rain fed agriculture, the impacts of climate variability and other constraints highlighted below have resulted in food insecurity which the country has continued to experience over years.

2.3 Major Constraints to Agriculture Production

Low Productivity: The levels of productivity are too low and unsustainable .This can be attributed to poor farm management, low access to farm power and mechanization, decreasing soil fertility and variability in weather and climate change. (NMTIP, 2004).

According to Ruane and Sonnino (2011), food security can be achieved by promoting agriculture through, increase in agricultural investment, improved productivity and better access to food while conserving natural resources.

According to Vermeulen et al., (2011) to support small-scale farmers to achieve food security in the midst of climate change, action is needed. This includes better management of agriculture risks and improved climatic information services.

To make agriculture competitive there is need to consider investment to expand markets, provide adequate support services and improve technology (DFID, 2002).

Agricultural Infrastructure: Poor agriculture infrastructure possesses as the major constraints faced by farming community in the process of commercialization. It has affected production of crops, livestock and fisheries in rural areas (NMTIP, 2004).

According to (WTO, 2002) poor roads, limited credit facilities for small scale farmers, high interest rates, negatively affects the performance of agriculture.

Environment: Zambia is affected by short dry spells and droughts especially in the rain season (Nov-April) including human related problems like deforestation and soil erosion (World Fact Book 2012).

The constraints to environmental sustainability and utilization include:

- ✓ Unsustainable use of natural resources due to pollution and inadequate sanitation, soil degradation, wildlife depletion and deforestation.
- ✓ Lack of national legal environmental policy to deal with the protection of natural resources.
- ✓ Limited access to alternative (new and renewable) energy technologies.
- ✓ Low farmer awareness about sustainable use of the environment (NMTIP, 2004).

Drought: Generally Zambia has adequate rainfall but has suffered from occasional severe droughts, in the past few years. In the study area, the recurrence of droughts has resulted in reduced crop production, particularly maize and highlighted the district's vulnerability to over –dependence on rain-feed farming. This indicates the need to promote irrigated agriculture in order to improve production and food security. More than 90% of the country's irrigation potential remains unutilized (NMTIP, 2004).

Dependence on rain feed agriculture has led to variability in crop production per year. The vulnerability to droughts and in some times floods has resulted in this sector not fully developing. This can be attributed to lack of technology in terms irrigation system despite, Zambia having abundant water sources (Jayne et al., 2007).

Any climate variability in the forecasting system strongly impact agricultural productivity, affecting the food security of many small-scale farmers. With the knowledge of seasonal climate forecasting, the situation is now ripe to test the use of this new knowledge as a means of improving agricultural management for food security, protection of the resource base and profit.

2.4 Sustainable Agriculture

The word "sustain, "from the Latin sustinere (sus-, from below and tenere, to hold), to keep in existence or maintain, implies long –term support or permanence. (Gold, 1999).

Sustainability represents the durability of a productivity system under known or possible conditions (Conway and Barbier, 1990).

Conway's three properties are:

- ✓ Productivity
- ✓ Stability
- ✓ Resiliency

Sustainability is defined using the "three pillars" of social, environmental and economic sustainability (Adams W.M. 2006). For agriculture to be sustainable the three components must be respected as they are interlinked and overlap each other (Figure 2.3).

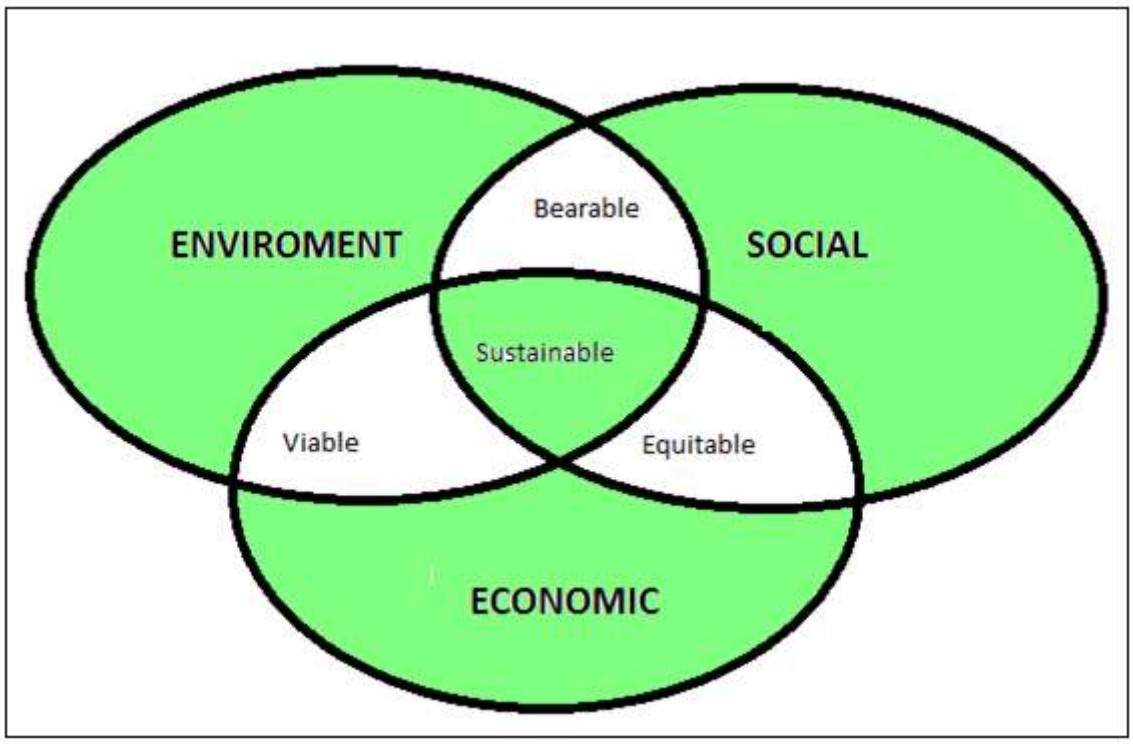

Figure 2.3: Three Pillars of sustainability

Economic sustainability involves selecting of enterprise, financial planning, markets and good overall management. Sustainability can be measured or observed.

According to ATTRA (2003) some indictors that a farm is achieving economic sustainability are:

- ✓ An improvement in savings or net worth.
- ✓ A consistence reduction in debt.
- ✓ The farm business is consistently profitable from year to year.
- ✓ Purchase of fertilizer is decreasing.
- ✓ Decreasing dependence on government payments

Environmental sustainability can be described as sound ecological practices that do not adversely affect the ecosystem. ATTRA (2003) lists some of the indicators that a farm is achieving Environmental sustainability as follows:

- ✓ There is no bare land on the farm.
- ✓ Clean water flows on the farm.
- ✓ There is abundance of wildlife.
- ✓ Fish are prolific in farm streams.

- ✓ A diverse in-farm landscape vegetation.

Social sustainability concerns the quality of life for those who work and live on the farm. It further implies decisions made on the farm that have effects in the local community. Under social sustainability, interactions between farmers play an important role.

ATTRA (2003) list of indicators of social sustainability are:

- ✓ The farm is able to support businesses and families in community.
- ✓ Circulation of money within the local economy.
- ✓ An increase or stable number of rural families.
- ✓ Younger generations take over their parents' farms and continue farming.
- ✓ College graduates return to the community after graduation.

According to Bezuneh et al., (1995) Agriculture sustainability is an intergenerational responsibility to manage agricultural resources so that future generations can continue to produce food at acceptable costs". This implies an obligation to manage farming practice that will enhance and sustain productivity.

According to Pretty et al., (1996), sustainable agriculture incorporates:

- ✓ Natural processes like cycling of nutrient and nitrogen fixation.
- ✓ A reduced usage of inputs that affect the environment.
- ✓ Involvement of farmers in the processes of problem discussions, monitoring and evaluation.
- ✓ An increased productive use of local knowledge, practices and resources.
- ✓ Diversification of natural resources within farms;

Sustainable agriculture further denotes an incorporation of current innovations from scientists, farmers or both. It does not imply a return to some form of low-technology agricultural practices (Pretty, 1995b).

Conway, Barbier (1990) highlight some examples of agricultural technology that have a high potential sustainability as described below;

- ✓ Intercropping – the practice of growing of two or more crops simultaneously on the same piece of land. Some benefits arise in that

crops explore different resources and mutually interact with one another. The interactions may also serve to control pests and weeds.

- ✓ Rotations – the growing of two or more crops in sequence on the same piece of land.
- ✓ Agro-forestry – this is a combined production of annual herbaceous crops are grown interspersed with perennial trees or shrubs on the same piece of land. Some of the benefits are that the deeper-rooted trees can explore water and nutrients not available to the shrubs. Trees further serve as shade and mulch and shrubs help in the reduction of weeds and prevent erosion.
- ✓ Green manure – the main essence of this practice is to fix nitrogen from the growing of legumes and then incorporating them in the soil for the benefit of the following crop.
- ✓ Conservation tillage – involves minimum or no soils disturbances (tillage) during soils preparation. This helps to reduce on energy use and soil erosion.

The Reports Farmers' World Network identifies five core assets categories upon which Livelihood is built. **Table 2.1** below shows these asset and specific agriculture relevance.

TABLE 2.1: An asset based model for agriculture

ASSETS UPON WHICH SUSTAINABLE AGRICULTURE IS BUILT	**SPECIFIC AGRICULTURE RELEVANCE**
Human capital is the term used to describe the skills, ability to labour and good health."At a household level human capital is a factor of the amount and quality of labour available.	Labour can be negatively affected by illness such as HIV/AIDS, Malaria, TB and migrations.
Social capital denotes the social resources upon which people draw in pursuit of their livelihood objectives	Social structures and can be disrupted by civil unrest and affect farming and agricultural trade.
Natural capital represents the natural resource stocks such as nutrients, erosion and atmospheric protection.	Fertility of soils, agricultural biodiversity, land and water access.
Physical capital constitutes of the infrastructure and producer goods needed to support livelihood	Infrastructure which deals with storage and transportation, access to market information and technology.
Financial capital concerns the action of saving and accessing credit	Trade refer to diversification strategies. This maybe local and international.

Source: Reports Farmers' World Network 2002

The desirable objectives such as food security, clean environment and economic growth can be achieved when the five assets are transformed into policies and processes.

With sustainable systems the capital base increases overtime while on the other hand unsustainable systems deplete capital, spending it as it was income and leaving less for future generations (Pretty, 2000).

According to the Government of the Republic of Zambia (1994), the agricultural sector is divided into three categories namely Small scale farmers, medium-small scale farmers and Commercial farmers.

Small scale farmers: These farmers produce mainly for home consumption and use low input level of technology. Farming system includes use of hoe, Ox cultivation which are either hired or owned. The livestock reared mostly is indigenous.

Medium farmers: These are medium scale farmers practicing semi intensive farming system that use partial mechanization, use of draught power and employ medium input level technology.

Commercial farmers: These are engaged in specialised, extensive mechanisation and use of high technology and management, rearing of mostly improved breeds.

The small-scale farmers are the major producers who use simple technology (hand hoes and Oxen) (Siegel P.B and Alwany J, 2005).

Livestock provides food, draught power and financial security. Unfortunately, the Livestock sector is negatively affected by diseases, land degradation and environmental changes among others. (Ruane J and Sonnino A, 2011).Once this industry is priotized, it can make huge contributions to food security needs and income (Mooney T, 2002).

TABLE 2.2: Classification of Zambia's Agricultural Producers

Table 2.2: shows the type of farmers in Zambia, cultivation practices, market orientation, location and major constraints faced.

Type of Agricultural Producers in Zambia	**Cultivation Practice**	**Market Orientation**	**Location**	**Major Constraints**
Small-Scale Farmers	Hand hoe, minimal inputs, household labour	Staple foods for home consumption	Entire country	Remoteness, seasonal labour constraints, lack of input and output markets
Medium Farmers	Oxen, hybrid seed and fertilizer, few with irrigation, mostly household labour	Staple foods and cash crops, market orientation	Mostly line-of-rail (Central, Lusaka, Southern Provinces), some Eastern, Western Provinces	Seasonal labour constraints, lack of credit, weak market information
Large-Scale or Commercial Farmers	Tractors, hybrid seed, fertilizer, some irrigation, modern mech., hired labour	Maize and cash crops	Mostly Central, Lusaka, Southern Provinces	High cost of credit, indebtedness

Source: *Siegel and Alwang, 2005.*

2.5 Evident cases of sustainable agriculture

According to a study in 2000 by the University of Essex SAFE- World research projects on sustainable agriculture, from 207 cases across 52 countries in the developing and developed countries, showed that 8.92 million farmers had practiced Sustainable agriculture on 28.92 million hectares. Improvement was estimated at about 95%.

Food production improvement was attained by use of one or more of five mechanisms:

- ✓ a particular farm system which involved intensification
- ✓ incorporation of new practise such as agro forestry to a farm system and this must not negatively affect cereal production
- ✓ natural resources such as land and water must be properly made use of to increase farm production
- ✓ increment of staple food yields per hectare through use of new techniques into the farm system

Per hectare yields improvement by the use of appropriate new and local crop varieties and animal breeds. (Pretty J, 2000).

According to Robertson et al., (2000), food production in agriculture can be achieved by producing more crops from less land. This is supported by Gregory et al., (2005) in that to meet the required food needs; there is need for agriculture intensification.

2.6 Food Security

Food security is a situation in which all people have access to enough, safe and healthy food to meet their dietary requirements for a productive and healthy life at all times.(FAO ,1996).The pillars in food security are Availability, Access, utilisation and stability.

According to the International Federation of the Red Cross (2007) food **availability** means that food is physically present. Availability deals with issues of production and imports. The available food must be nutritious and of good quality regardless of sources whether local, regional or international (FAO, 2008).

Food **access** refers to the way in which different people obtain available food.Some ways may be through home food production, purchase, borrowing and food relief means or food aid **(**IFRC, 2007**).**

At times, food can be available but people may have difficult to access it, making them food insecure .Food access denotes the physical and economic aspects for an active and healthy life. Some of the constraints to food access include marketing, poor transport infrastructure, food distribution system and purchasing power. (Ruan and Sonnino, 2011).

The third pillar is food **utilization:**this describes the ways how people use food. It depends on a number of factors among them the quality of the food ,the ways it is stored and the nutritional knowledge of the individual consuming the food. This deals with the healthy utilisation and safety of the food.

The fourth Pillar covers food stability, which means individuals or households at large having access to food all the time and not being at risk to lose it due to any sudden shock for example climatic change(FAO, 2006).This dimension is much of a challenge in developing countries.

At rural household level food secure needs to meet the following:

- ✓ enough supply of food,which can be accessed through purchase or farm grown.This must be measured in kcal.
- ✓ the choice of food must be a variety for a healthy diet. The contents should include protein, carbohydrate , fat, with vitamins and minerals;
- ✓ have adequate quantity especially during months of shortage (Pretty and Hine , 2001).

The effects associated with food insecurity differs depending on needs and communities.The categories of people may be classified according to demographic,social (female headed households and disabilities) and geographic which deals with rural or urban population. (FFSSA, 2004).

According to the Central Statistical Office (CSO) Surveys,Zambia's poverty has continued to increase from 69.7 percent in 1991, to 72.9% in 1998. Out of 88 developing countries, Zambia ranks number 66 on the Human Poverty Index. Under the United Nations Development Programme (UNDP) Human Development Index (HDI), it is ranked 163 out of the 175 countries covered (NMTIP: 2004).

In Zambia,generally the provinces that are not covered by the country's mainline of rail have shown higher poverty levels.Places such as remote Eastern, Luapula, Northern and Western provinces show the most extreme poverty rates.

Table 2.3 shows the incidence of poverty from the year 1991 to 2006 in the nine provinces of Zambia.

TABLE 2.3: Incidence of Poverty by Province**.**

Provinces	**1991**	**1993**	**1996**	**1998**	**2004**	**2006**
	poverty(%)	**poverty(%)**	**poverty(%)**	**poverty(%)**	**poverty(%)**	**poverty(%)**
Central	70	81	74	77	76	72
Copperbelt	61	49	56	65	56	42
Eastern	85	91	82	79	70	79
Luapula	84	88	78	82	79	73
Lusaka	31	39	38	53	48	29
Northern	84	86	84	81	74	78
North Western	75	88	80	77	76	72
Southern	79	87	76	75	69	73
Western	84	91	84	89	83	84

Source: CSO Living Conditions ,1991-2006

According to Benson (2004), the 1999–2002 the dietary energy supply for Zambia was estimated at 1,900 Kcal per person per day, which is below the recommended per capita level of daily caloric availability, 2,100 Kcal, and slightly above the minimum intake level of 1,800 Kcal.

2.7 Linking sustainable agriculture and food security

Sustainable agriculture and food security linkage show that three major conditions have to be met to achieve food security;

- ✓ Fulltime involvement of farmers in issues of technology research, planning and extension services to help attain sustainable food production.

- ✓ Practices and strategies used must not deplete the resources but rather conserve the natural resource base.
- ✓ Strengthen rural economies and capacities to have access to food.
- ✓ Figure 2.4 below, shows some of the key conditions to attain food security. These include a conserved resource base, food production and access to food.

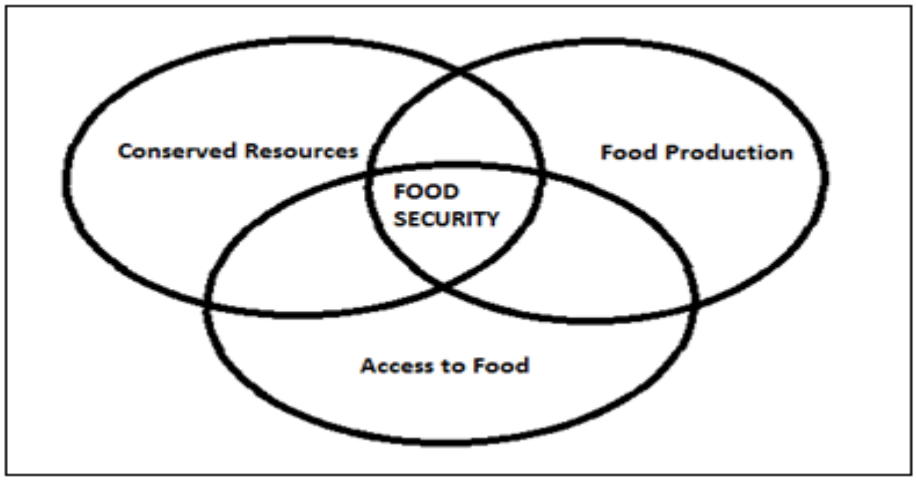

Figure 2.4: Key conditions to attain food security

Source: Pretty J et al., 1996

The results from (Pretty, 2001) on sustainable agriculture projects inidcated improvements generally in household food production.This was in terms of crop diversification and crop yields.

- ✓ about 73% increase annually on average food prodction.
- ✓ Root crops recorded about 150% increment per year in food productions.

Despite all the postive increments highlighted above, the researcher is for the motion that results will vary depending on the locality, time frame ,knowledge and skills of farmers on a specific project.

2.8 Crop productivity

According to World Trade Organisation (2002) productivity is low and output is dependent on weather conditions. Zambia's large potential in agriculture is associated to good climate for farming, abundant labour and water supplies.

According to Mooney (2008) the agriculture potential can be seen in that about only 14 percent of the total arable land is cultivated. This arable land in use must be sustained to produce more food.

Zambia's untapped potential in the agriculture sector has resulted in low food productivity. Improvements to this sector may help reduce poverty and cause sustainability in food security. However, poor access to inputs and infrastructure is a challenge to farmers (Bonaglia, 2008).

Dependence on rain-fed agriculture has led to variability in crop production per year. The vulnerability to droughts and in some times floods has resulted in this sector not fully developing. This can be attributed to lack of technology in terms irrigation system despite Zambia having abundant water sources (Jayne et al., 2007).

Variations in harvest exist in Zambia's main staple food. In times when the country receives normal rainfall, Zambia is able to produce surplus food for national consumption and export. However, in drought times, lack of proper input causes a reduction in the output. On average, one year in three years maize crop production fails to meet the demands of national consumption in Zambia (Dorosh et al., 2007).

Crops account for more than 60% of the total agriculture output in Zambia. This is dominated by maize cultivation which accounts for about 54.3%, cereals other than maize ,millet ,sorghum and rice account for 12.7%,oil seeds(groundnuts ,sunflower and soya beans 13%,Cassava at 13.1 % and others at 6.6% (Kimhi and Chiwele, 2000).

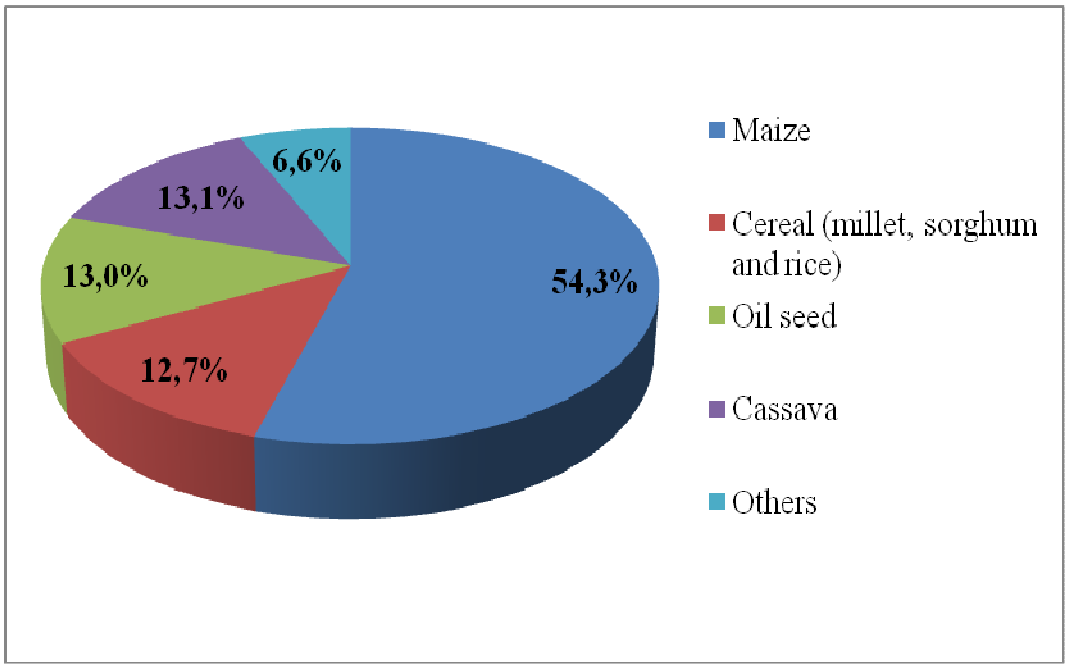

Figure 2.5: Crops for agriculture output

In Zambia, the farming community may have limitation in the interpretation and lack of appreciation of the forecasting system as well as effective utilization of it to reduce impacts associated with extreme climate events. It is envisaged in this study to ensure that climate products are converted into productive economic use for sustainable development.

Seasonal climatic forecasts are important as this helps farmers to decide on whether to choose new technologies and increase production. Small scale farmers in low income countries express high levels of interests and management response but one major constraint is the communication failure (Hasen et al., 2011).

Adams (1991) said ideally, having an accurate seasonal climate forecast at the farm level should lead to changes in crop choice, input levels, timing activities and post-season sales decisions. The above statement was supported by Shumba (1994).

The researcher supported the idea that reliable forecast information is a useful tool in crop management and yield optimization strategies.

These strategies may include selection of appropriate crop cultivars and varieties, input acquisition levels and timing of agricultural operations. However, socioeconomic conditions and attitudes may inhibit the use of seasonal climate forecasts in which case adjustments or assistance time from external sources would be necessary to guarantee adoption.

Given the dependence of the majority of the population in Southern Africa on agriculture often at a subsistence level, there are obvious food security implications of climate predictability (Cane et al., 1994). Although seasonal climate forecasts have been issued for many years, the benefits on agricultural production appear to be difficult to quantify with respect to increased and or sustainable production.

However, field studies carried out in many countries in Africa suggest that the gap between information requirements of small-scale farmers and that provided by climate experts is narrowing through constant interactions.

The literature of Chen et al., 2002; Jochec et al., 2001; Mjelde and Penson 2000; Hill et al., 2000) supported that seasonal climate forecast system has an economic impact on crop yields. The researchers also concluded that a variation in climate affects agriculture production and often results in reduced revenues.

3. CHAPTER THREE: THESIS HYPOTHESES AND OBJECTIVES

3.1 Thesis Hypotheses

On the basis of analysis of available references it was possible to formulate the following hypotheses which, if materialized, could contribute to improving the social situation of Zambian rural poor;

(a) Farmers who use sustainable agriculture practice system produce higher crop yield than those who do not;

(b) Farmers who use sustainable agriculture promotes or enhance environmental conservation, thereby sustaining soil productivity; and

(c) Sustainable agriculture promotes cost effective farm management which is economically beneficial.

3.2 Thesis Main Objective

The overall objective of the study is to establish and examine the benefits and impacts accrued by farmers in applying sustainable agriculture systems and ways it can contribute to support food security and poverty reduction. The aim of this study is also to determine the benefits, impacts and value of small scale farmers applying sustainable agriculture systems in Zambia.

3.2.1 Thesis Specific Objectives

With regard to the above hypotheses the Thesis specific objectives are:

(a) present and discuss the contributions of sustainable agriculture systems to livelihood in Zambia;

(b) highlight alternative ways through which the small –scale farmers can improve food production with sustainable agriculture ;and

(c) document the experience in the application of sustainable agriculture by small scale farmers and formulate a framework for future application of sustainable agriculture. These objectives have been listed in order of importance (Cooper and Schindler, 1998).

4. CHAPTER FOUR: METHODOLOGY

4.1 Rationale for Study

The people and economy of Lusaka Province of Zambia, Chongwe and Kafue districts in particular, have been severely affected by droughts in the last thirty years.

This study therefore, investigated the value and benefits of small-scale farmers using sustainable agriculture practices to ensure food security. The underlying source of climate variability and change affecting the economy is the fluctuations in agricultural production related to rainfall.

4.2 Target Groups

Lusaka province is divided into three (3) distinct districts, namely, Chongwe, Kafue and Luangwa. In this study the target population were the one hundred (100) small- scale farmers in Chongwe and Kafue Districts of Lusaka Province.

4.3 Sampling

The representative population in Chongwe and Kafue districts involved (100 farmers) .A random selection of ten (10) farmers accepted sampling per district. All together only two (2) village groups of ten (10) small-scale farmers were data producing to be sampled. Each small-scale farmer had 20/100 or 0.2 chance of getting selected.

The sampling fraction has been 0.2. The random sampling of small-scale farmers has been done in one (1) district of Chongwe and one (1) in Kafue using method based on random sampling numbers.

4.4 Data Collection Methods

The structured questionnaire (Appendix 1) designed with coded responses is the instrument that was used in the primary data collection, in addition to in-depth interviews with selected small-scale farmers.

The questionnaire has a list of questions to be asked and spaces in which the respondents record the answers. Each question was worded exactly as it was asked. The questionnaire is divided into three segments namely the demographic survey, sustainable practices survey and the farm management survey segment.

Saunder et al., (2003) maintained that it is generally good practice not to rely solely on questionnaire data but to use the questionnaire in conjunction with at least one other data collection instrument.

4.5 Justification of Method(s) Employed

The method of administering a questionnaire and interview employed had some advantages. These included:

- ✓ Provided face-to-face dialogue between the interviewer and the respondent. In this way questions were asked and clarified.
- ✓ Provided some co-operation between the farmers and the researcher; although at some instances, the information was difficult to come by as the farmers demanded some payments from the researcher.
- ✓ Provided a more flexible technique since based on participatory methodology

4.6 Administration of Questionnaire

The questionnaires were distributed by the researcher with the assistance of one Agricultural extension officer from each district to the one hundred small scale farmers. Questions were asked in local languages to the respondents who did not understand English for precise and confident responses. The questionnaire attempted to gather baseline data for the farmers involved in the study.

4.7 Data Processing and Analysis

In this study, data collected from the field by the use of the questionnaire was subjected to quantitative analysis by the use of computer packages (software) statistical package. The qualitative data (discussions and general comments) were analysed. After data processing, analysis was subjected to quantitative analysis by the use of basic statistics.

4.8 Limitations of the Study

Some of the constraints can be summed up as follows:

i) Created artificial situation were farmers not willing to release information at no cost.

ii) There may have been some biasness or subjectivity in the researcher (interviewer).

iii) In addition to the above limitations, it is often not possible to study the entire population of Lusaka province because of the prohibitive cost.

4.9 Conclusion to Chapter Four

In this chapter the rational for study, data collection, target population and data analysis methods including sampling were discussed. The survey questionnaire was used to interview the head of household in each case, but where that person was not at home, the second adult; usually the wife of the head of household was interviewed.

5 CHAPTER FIVE: RESULTS AND DISCUSSION OF FINDINGS

5.1 Introduction to chapter five

This chapter presents the findings from the primary research of sustainable agriculture practice. This includes analysis of social demographic characteristics, sustainable agriculture for food security information and farm management.

5.2 Demographic characteristics of respondents

5.2.1 Distribution of Households by sex of Head

In this study, there were a total of 20 respondents who were sampled randomly. There was 35% households that were headed by males while 65% were female headed. This is shown in figure 5.1 below. Most households were headed by female because most of them are widowed who settle in rural areas for farming purposes.

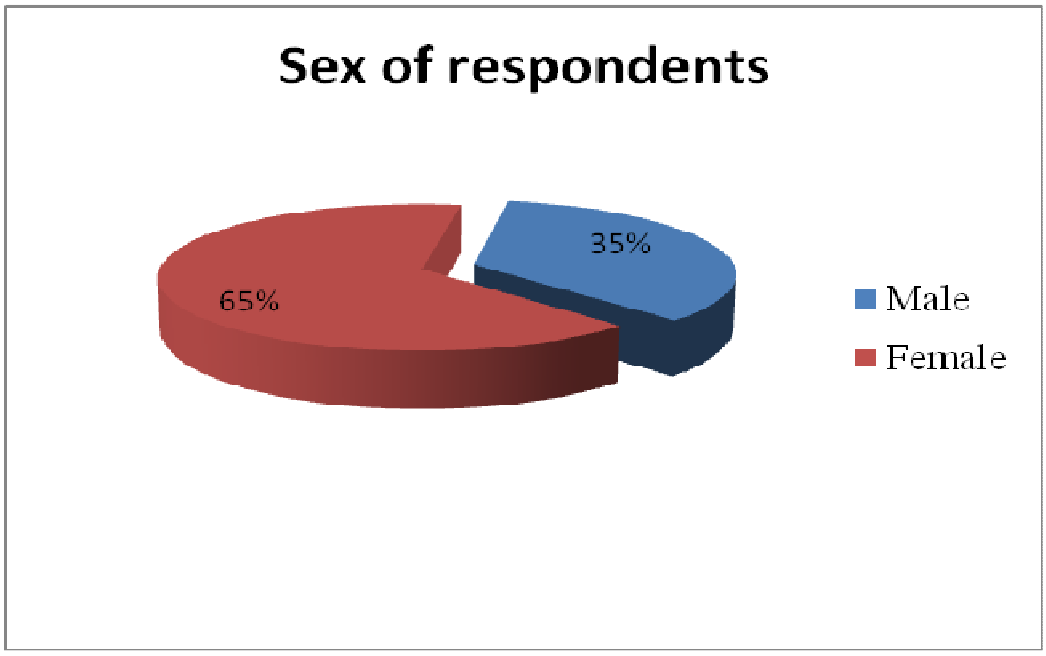

Figure 5.1: Sex of respondents

5.2.2 Age Distribution

Following the information captured and analyzed, it was found that age distribution was concentrated within the ranges of 25-30 represented 40% of the total small-scale farmers; followed by age group range of 31-36 which was 25%, while the age group range 37-42 had 20%.The age range of 43-48 had 10%.The least population age range was that of 49 years and above, who represented 5%. Figure 5.2 illustrates the age distribution. Age distribution is concentrated in the age group between 25-30 years because most of these farmers are orphaned and have settled in farming blocks. These farming blocks used to be resettlement areas for youths from Towns.

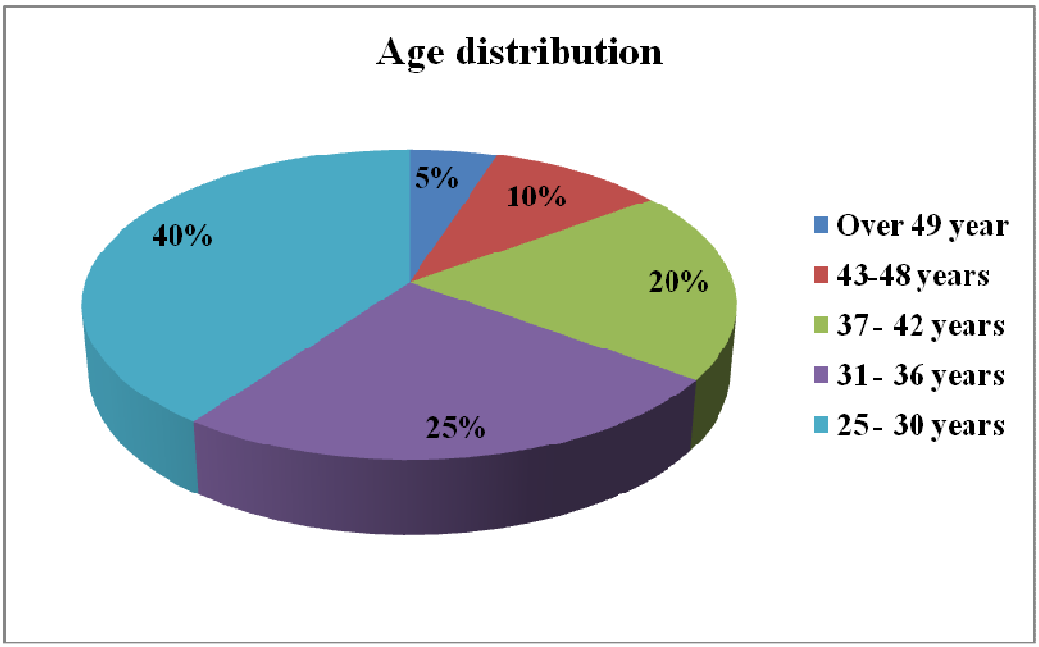

Figure 5.2: Age distribution

5.3 Sustainable Agriculture Survey Results

5.3.1 Awareness on sustainable agriculture System

Seventy percent of the farmers interviewed in Chongwe and Kafue districts of Lusaka Province said they were aware of the existence of the Ministry of Agriculture and Livestock (MAL) and sustainable agriculture system. However, 30% indicated that they did not know the existence of the MAL and sustainable agriculture system. A bigger percent of (70%) of the small-Scale farmers were aware of the sustainable agriculture information produced by the MAL (Figure 5.3).

The participation of some farmers in the agriculture forums in the districts has contributed to the awareness about the sustainable agriculture system offered by the MAL. However, to the small percentage of those who were not aware; it was to some extent lack of knowledge about what MAL offers. This may be connected to lack of listening to environmental information from radios etc.

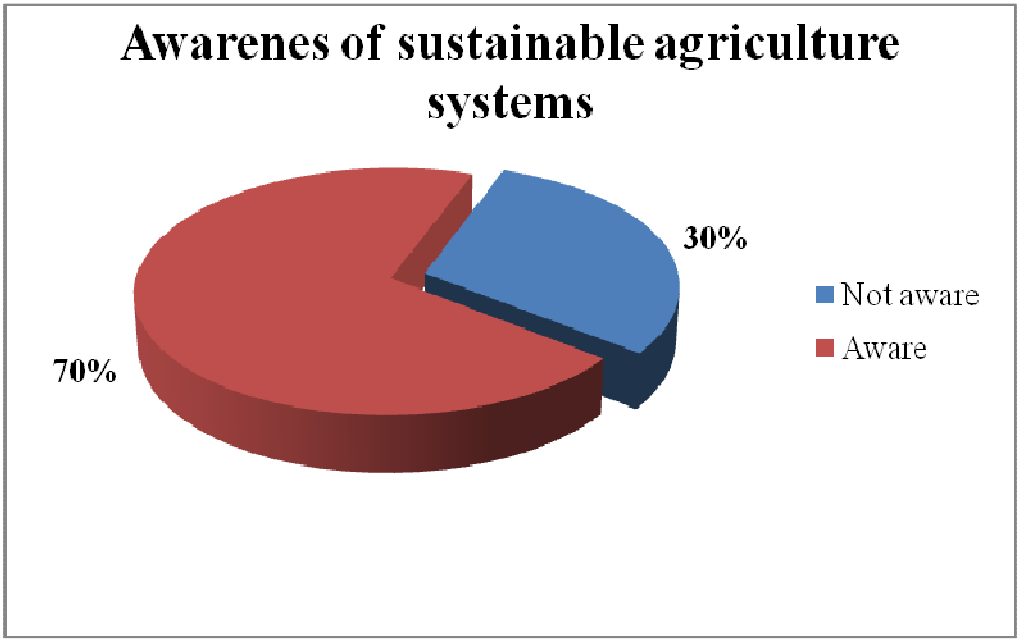

Figure 5.3: Awareness of Sustainable Agriculture System

Source: Field data, 2012

5.3.2 Farmers who used sustainable agriculture practices

Figure 5.4 below shows that 60% of the sampled respondents indicated that they used the sustainable agriculture practices in their day-to-day farm management. However, 40% said they used traditional schemes to plant their crops, as they had no much trust in the scientific sustainable agriculture system.

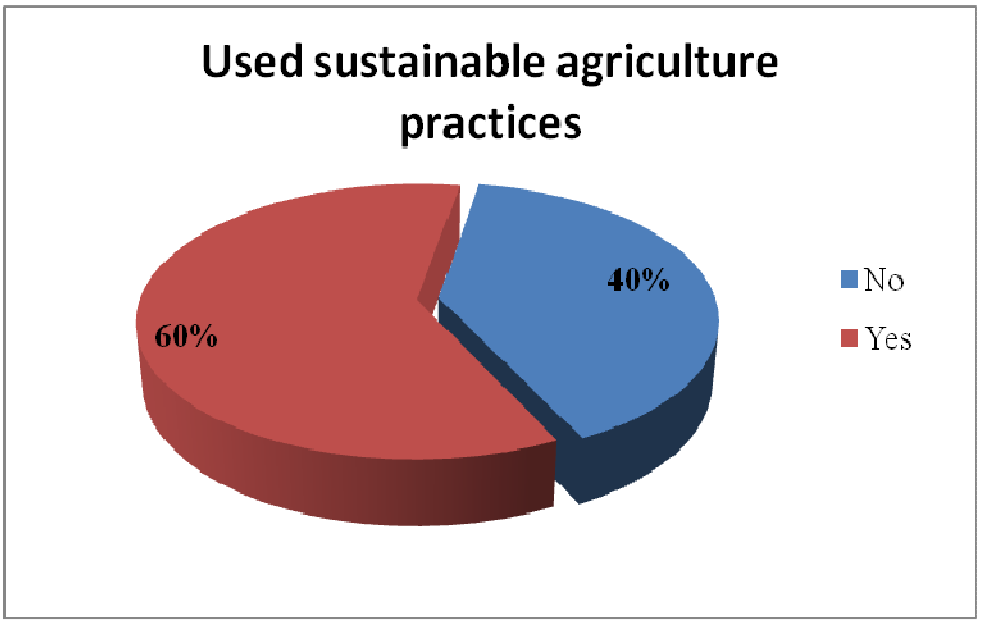

Figure 5.4: Respondents who used Sustainable Agriculture Practices

5.3.3 Practices /Strategies used to achieve Food Production

Of the 60% of the respondents who farmed, 50% indicated that they used conservation farming and 16.7% traditional farming while 33.3% did not apply any (Figure 5.5).

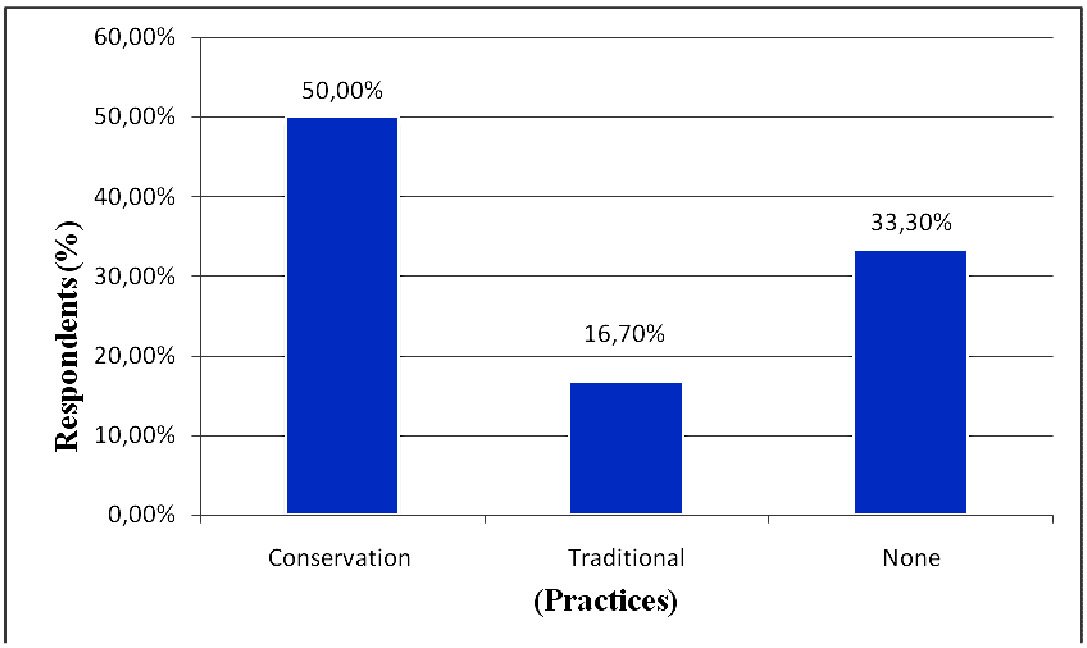

Figure 5.5: Practices used to achieve food production

5.3.4 Kind of sustainable agriculture practices trained in

Most of the farmers indicated that they are trained in:

- ✓ Intercropping
- ✓ Disease and pest resistance varieties
- ✓ Animal manure
- ✓ Pot holes(Planting basin)
- ✓ Crop rotation

5.3.5 Receipt of Information by small-scale farmers

Of the 60% of the farmers who received the information, 50% said the source was exclusively through Agricultural Extension Officers (AEO). 25% through radio and TV accounted for only 8.3% (Figure 5.6).

The mode of using the Agriculture extension officers is labour intensive and requires resources for the officers to travel from one point to the next to meet the small-scale farmers. However this mode is more appropriate because it involves proper practical demonstrations to the farmers.

The findings above contradict the surveys carried out in South Africa, Zimbabwe and Zambia by Walker (1998), Unganai (2001) and Nanja (2001), which ranked the radio as the most frequent used source for receipt of agricultural information.

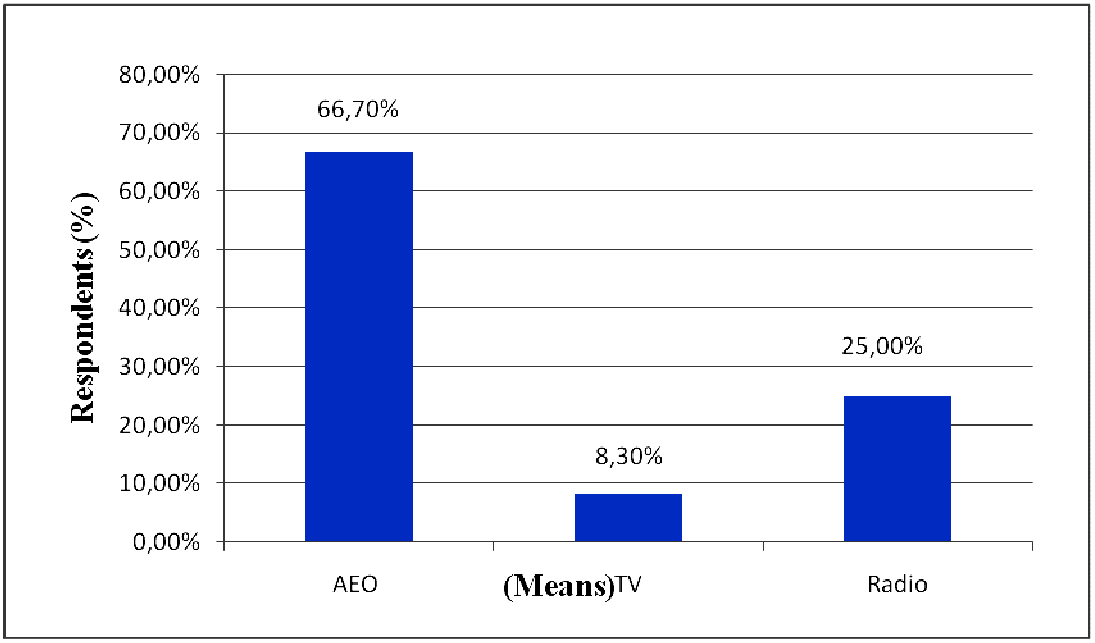

Figure 5.6: Means by which the information was received

5.3.6 Effectiveness of the 2010/2011 seasonal climate forecast

On the question of effectiveness of using the seasonal climate forecast to the harvest, about 33.3% of the respondents said the forecast was very effective, with 25% saying effective and 41.7% did not see the effectiveness of the forecast (Figure 5.7). The 41.7% did not see the effectiveness because of mainly the misperception and mistrust of forecasts.

This is in support of a study carried out in South Africa (Mellart, 2001), who looked at the usefulness of the seasonal climate forecasts for the rural small-scale farmers in Maleketu, Thulumahashe and Mangondi districts.

The study showed that there was a big difference in management practices of the farmers. For the poor farmers the seasonal climate forecast was seen to be ineffective.

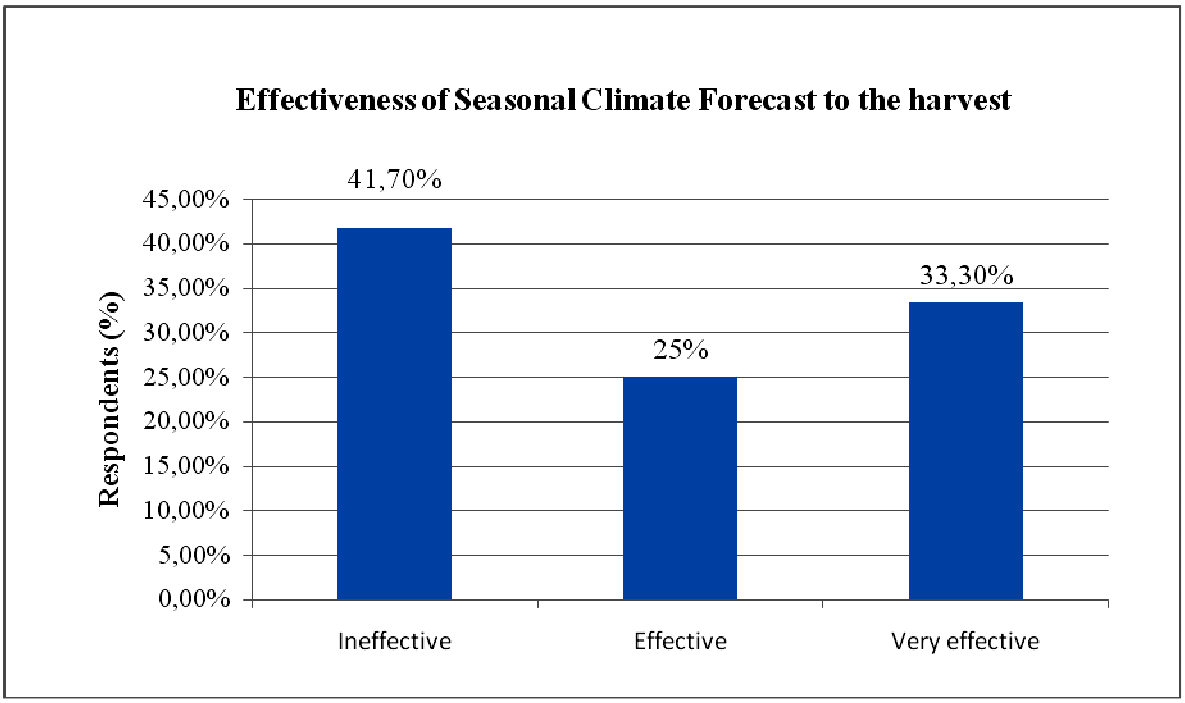

Figure 5.7: Effectiveness of the forecast to the harvest

5.4 Farm management survey results

5.4.1 Management options for production

Adams (1991) and Shumba (1994) said ideally, having a reliable seasonal climate forecast at the farm level should lead to changes in crop choice, input levels, timing activities and post-season sales decisions. The response is that most of the farmers quantified the options as follows; "General planning" (timing activities, implying that it would be useful in several as yet unidentified ways) was most important (50% of the respondents), while 33.3% of the farmers cited "Crop choice/seeds". Traditional forecast scheme had 16.7% (Figure 5.8).

From the above analysis, the researcher supported the idea that reliable agricultural information acts as a useful tool in crop management and yield optimization strategies since 50% of the respondents' went for "General Planning" and 33.3% for "Crop choice/seeds".

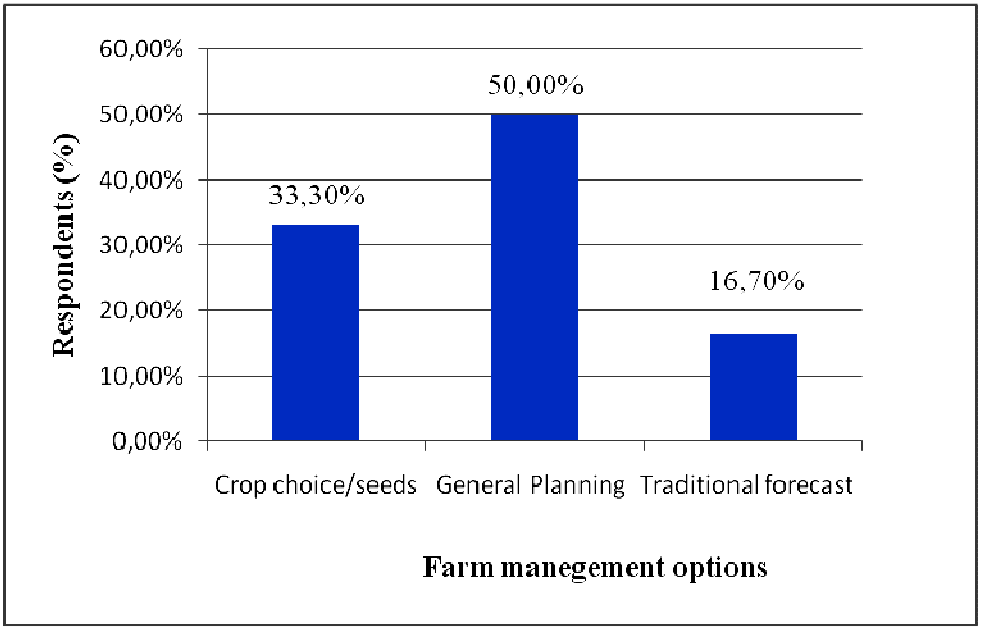

Figure 5.8: Management options for crop production

5.4.2 Ways Sustainable Agriculture improve farm management

Figure 5.9 cited the following as ways in which sustainable agriculture practices can improve farm management:

(a) General planning (33% of the respondents)

(b) Help in selecting crops to plant (25% of respondents)

(c) Knowing when to plant (25% of respondents)

(d) Take precautions and reserve food (17% of respondents)

The researcher supports that sustainable agriculture practices must be integrated into the whole decision-making process, as one of many management tools, and used consistently for many seasons to truly benefit from it.

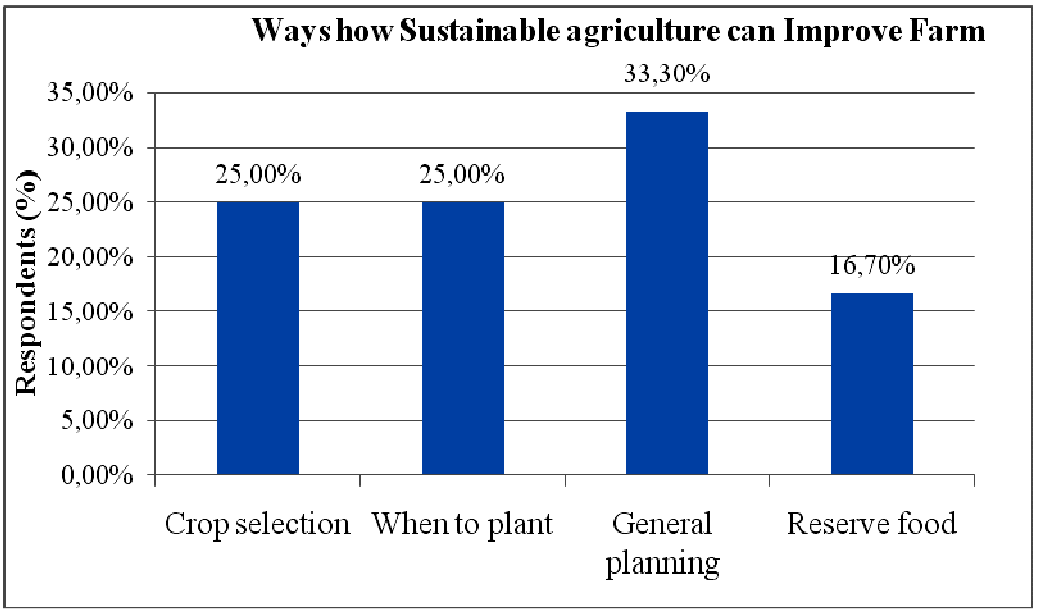

Figure 5.9: Sustainable Agriculture and Farm Management

5.4.3 Time of planting major crop

The major crop in the area was identified as maize.

About 50% of the farmers interviewed indicated that they planted their fields during start of the rains (November 2010) while 33.3% in Peak of the rains (December 2010) and 16.7% in towards end of rains (January 2011) and no one planted in October 2010 before the start of the rains. Farmers followed the forecast to plant in November and December because the forecast was going in for a "normal rainfall season" (Figure 5.10).

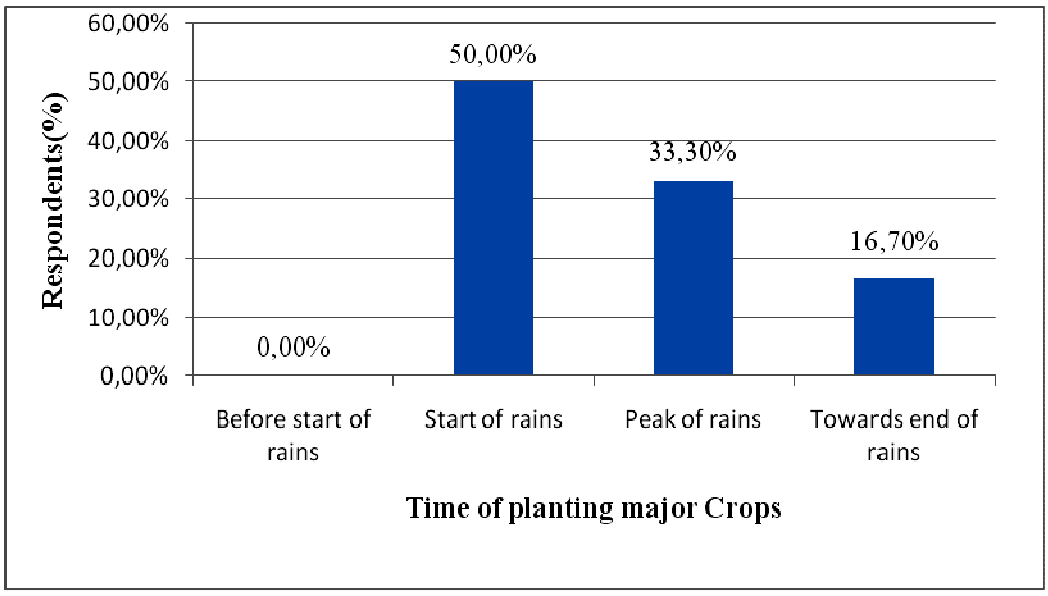

Figure 5.10: Time of planting major crops

5.4.4 Means of cultivation of field

During the season under review 60% of the farmers interviewed reported that cultivation during the season was done using mainly hoes, 30% said oxen and 10% used either hired or own tractors (Figure 5.11). The farmers managed to cultivate with the hoes since their fields were mainly small acres of 1-2 acres. Also, lack of enough resources in terms of monetary funds contributed to their not using much of tractors for cultivation of their fields.

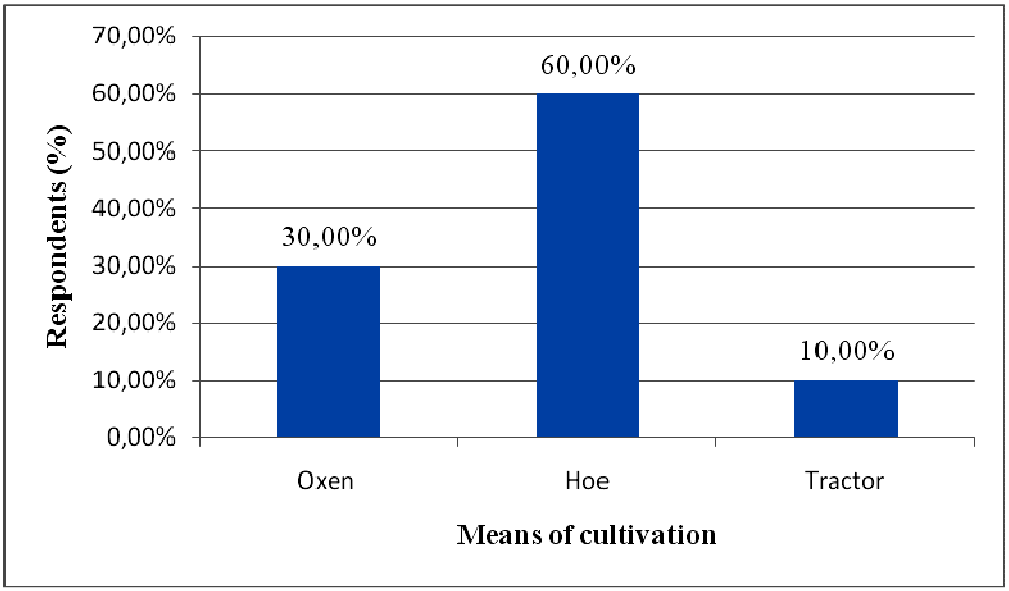

Figure 5.11: Means used to cultivate the field

5.4.5 Type of farming system used in cultivation of field

About 60% of the farmers interviewed used conventional type of farming, while 30% used organic farming with 10% saying used other means of farming without naming them. As illustrated in Figure 5.12 below.

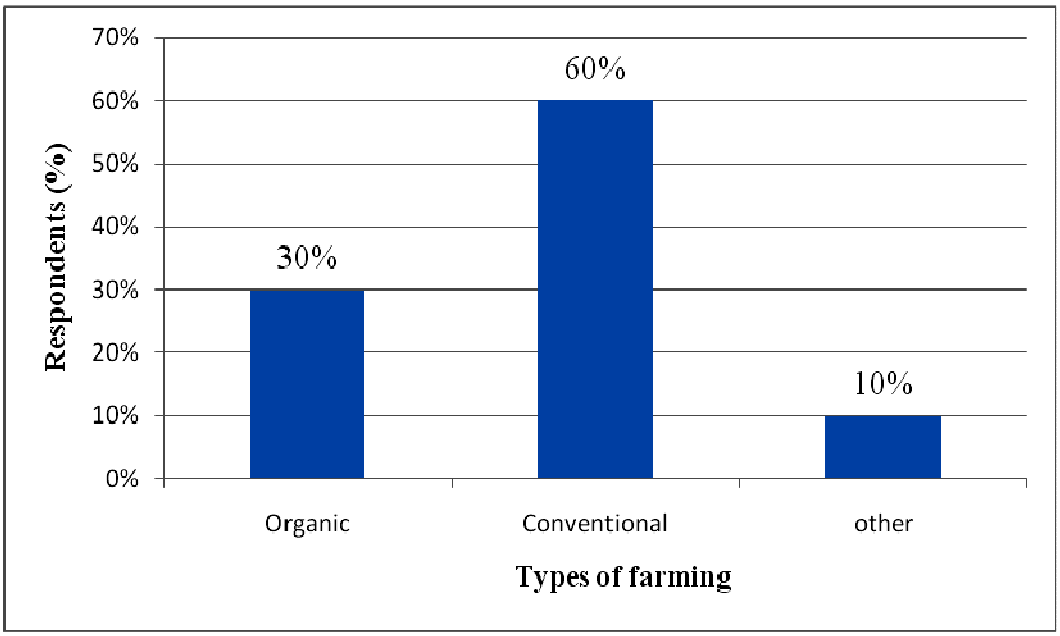

Figure 5.12: Type of farming system used in cultivation

5.4.6 Maize yield (Production)

Maize, millet and sorghum were found to be the most commonly planted crops in Chongwe and Kafue districts, and to some extent groundnuts. The largest proportion of land per farm was devoted to maize.

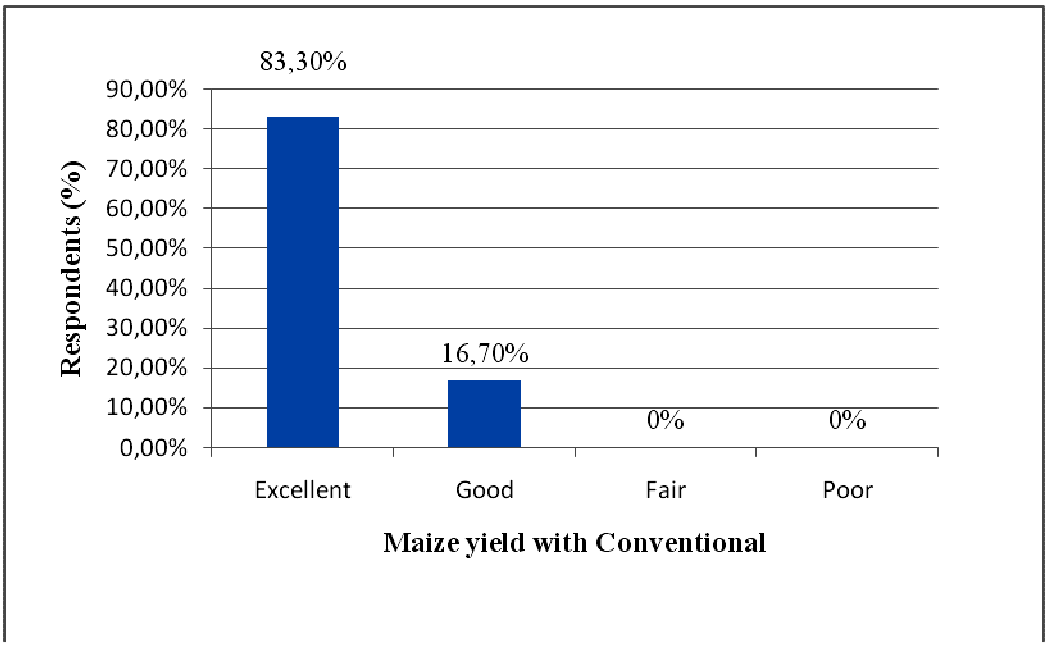

Figure 5.13 (a): Maize yield (Production) with conventional

Figure 5.13 (a) reviewed that with conventional, 83.3% produced excellent maize, 16.7% produced good maize and nobody indicated fair and poor maize production.

Conventional agriculture refers to a type of farming system that priotizes the use of synthetic fertilisers and pesticides.

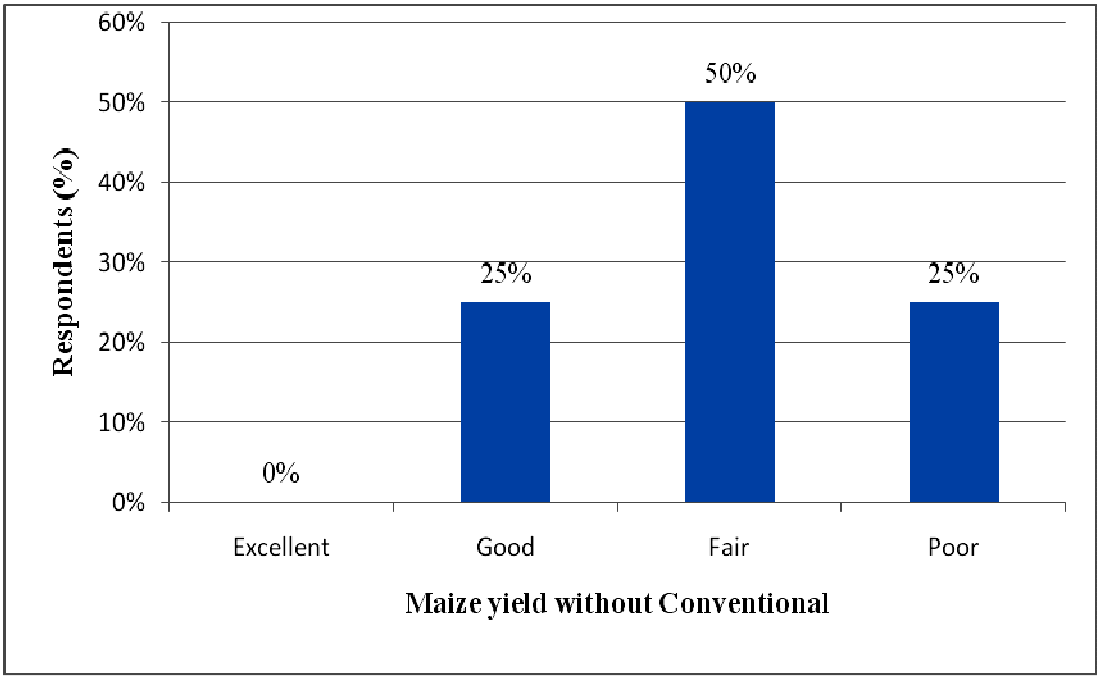

Figure 5.13(b): Maize yield (Production) without Conventional

Figure 5.13 (b) reviewed that without conventional farming, 50% produced fair maize yields, 25% said good and poor maize respectively and nobody had excellent production.

5.4.7 Economic benefits of sustainable agriculture

From this study, the economic benefits of sustainable agriculture system and practice to farm management were clarified in (Figure 5.15) in priority as follows:

i. Overall management (33.3% of the respondents)

ii. Food security (25% of the respondents)

iii. Yield optimization strategies (25% of the respondents)

iv. Increased profit (16.7% of the respondents)

Cane et al. (1994) said although seasonal climate forecasts have been issued for many years, the benefits on agricultural production appear to be difficult to quantify with respect to increased and or sustainable production.

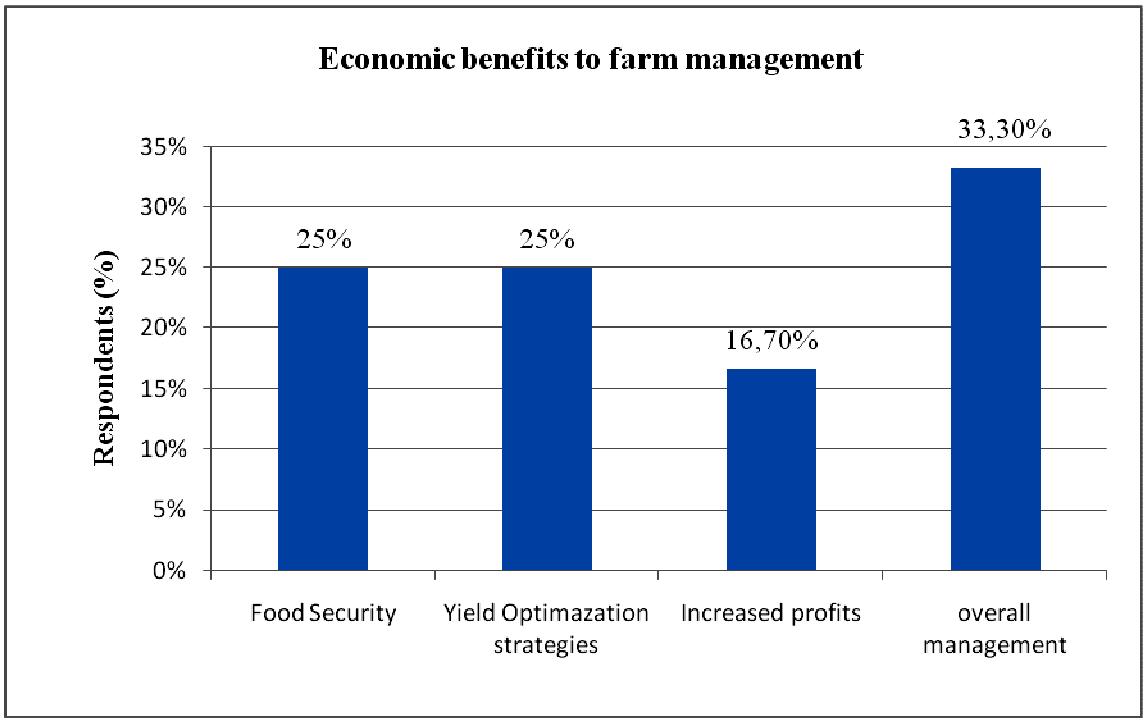

Figure 5.14: Economic Benefits of Sustainable Agriculture

5.5 Constraints

Most small-scale farmers interviewed in Chongwe and Kafue districts did not own draft power. They depend on hired draft power and the implication is that each farmer has to wait for his/her turn to plough the field. About 60% of the farmers (Figure 5.11) used hoes.

6 CHAPTER SIX: CONCLUSIONS AND RECOMENDATIONS

6.1 Conclusions

The aim of this study is to determine the benefits, impacts and value of small scale farmers applying sustainable agriculture systems in Zambia. Formulated conclusions in accordance to the hypotheses were:

Hypothesis I. Farmers who use sustainable agriculture practice system produce higher crop yield than those who do not;

The first Hypotheses was not accepted because the study showed that conventional agriculture had higher yields in comparisons to sustainable practices such as organic or conservational farming practices. About 83.3% (Figure 5.13a and Figure 5.13b) of the farmers confirmed that the maize yields were Excellent under Conventional practices with the use of synthetic fertilizers, herbicides and pesticide in crop management. There is need to analyse the sustainable agriculture practices over time and make yield comparisons on various crops.

Hypothesis II. Farmers who use sustainable agriculture promote or enhance environmental conservation, thereby sustaining soil productivity;

This hypothesis has been confirmed through published Literature. It consistently supports that the use of sustainable agriculture on the environment has more benefits which include sustaining soil productivity, reduction in chemical and fertilizer inputs, water conservation and improved soil organic matter.

Hypothesis III. Sustainable agriculture promotes cost effective farm management which is economically beneficial.

The third hypothesis is confirmed. From this study, the economic benefits of sustainable agriculture system and practice to farm management were clarified in (Figure 5.14) in priority as follows: Overall management (33.3%), Food security (25%), Yield optimization strategies (25%) and Increased profit (16.7%).It is important to note that yield optimization and increased profits cannot be achieved in one growing seasons but it has to do with stabilising the soil nutrients, growing conditions and good management practices.

Other silent findings in the study in line with objectives were that:

a) As sustainable agriculture (skills) practices continue improving, sustainable agriculture system may ultimately play a truly meaningful role in improving food security and sustainable livelihood for small-scale farmers in Zambia. However, appropriate and comprehensive policies are required to achieve these results.
b) Increase in food production requires knowledge and skills. For small scale farmers, means of production or technologies employed must meet the local needs and available at low costs. Accessibility to information by farmers can be enhanced through extension services.
c) Analysis on the experiences and application of sustainable agriculture practices shows that a bigger percent (70%) of the small-Scale farmers were aware of the sustainable agriculture information produced by the Ministry of Agriculture and Livestock (Figure 5.3). The percentage of farmers using sustainable agriculture practice is considerably increasing and this should contribute to improved and stable agricultural productivity. However, the transition to sustainable practices is still slow and requires improved capacities among small scale-farmers to adoption and incorporation of these practices in agriculture.

6.1.1 Conclusion on Future Research

Future research is needed to determine the usage and economic benefits of applying sustainable agriculture in other nine remaining provinces of Zambia. This will enable the researchers to determine the benefits in both high and low rainfall areas and check if the recommendations from this study can be applied in other studies.

6.2 Recommendations

The following are the recommendations from this study:

✓ Improve on sustainable agriculture dissemination awareness through radio and Agriculture extension staff. Although the later is labour intensive, and requires a lot of resources, for Agriculture extension officers to travel from point to point to meet farmers. In this circumstance it would be useful to develop effective radio based community information programmes.

✓ Promote irrigation agriculture to cover up on challenges in crop production especially in times of dry spells. This should target the households as the area of study

is accessible to wetlands and rivers namely Chongwe and Kafue in the two districts. Developing irrigation will enhance food production in rain-fed dependence areas.

✓ It is recommended that there must be crop diversification promotion among the small scale farmers to expand to other crops in the composition of food security such as root crops and legumes and move away from only mono-cropping maize as seen in the study area.

✓ Finally, without proper storage infrastructure the food produced cannot be available, accessed or utilized over a long period of time to meet the following growing season or sustain food security. This is to say that improved infrastructure in the districts under review will have far reaching impact on food security.

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APPENDICES

Appendix 1: Covering letter to respondents and Questionnaire

Dear respondent,

The researcher is a student of the Bachelor of Science in Agriculture finalist with the Czech University of Life Sciences Prague. He is currently carrying out a research on Sustainable Agriculture.

Your area of Chongwe and Kafue in Lusaka Province has been chosen as investigation districts. You being a small-scale farmer in the district you have been chosen to take part in the study by answering the questionnaire attached. This is an academic exercise to enable him partially fulfil a requirement for the award of his degree, therefore your honest response to the questionnaire will be highly appreciated and considered confidential.

Your views and those of other respondents who are being asked to complete the questionnaire will provide a variable input in farm management studies.

THANK YOU FOR YOUR VALUABLE CONTRIBUTIONS.

Mr. William Nkomoki
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STRICTLY CONFIDENTIAL

QUESTIONNAIRE ON SUSTAINABLE AGRICULTURE FOR FOOD SECURITY IN CHONGWE AND KAFUE DISTRICTS OF LUSAKA PROVINCE OF ZAMBIA.

A: GENERAL INFORMATION

1 Village/Locality

Name:……

2 Household Serial

Number:……

3 Name of Head of Household/Respondent:……

4 Assignment Record: Researcher……Date completed: ……/…/2012

B: DEMOGRAPHIC CHARACTERISTICS

Please tick in an appropriate box

4.1 **Sex**

1. *Male* ☐ *2. Female* ☐

4.2 **Age Distribution**

1. 25-30 Years ☐ *2. 31-36 Years* ☐

3. 37-42 Years ☐ *4. 43-48 Years* ☐

5. Over 49 Years ☐

C: SUSTAINABLE AGRICULTURE FOR FOOD SECURITY INFORMATION FOR 2011/2012 RAIN SEASON

Please tick in an appropriate box

4.3 **Are you aware that the Ministry of Agriculture and Cooperatives (MACO) provides information on sustainable Agriculture which can be used in making farm Management decisions?**

1. Yes ☐ 2. No ☐

4.4 **Did you use the sustainable strategies/practices information in the 2011/2012-rain season for your farming activities?**

1. Yes ☐ 2.Not at all ☐

4.5 **Which practices/strategies did you use to archive sustainable food production?**

1. Conservation farming ☐ 2.Promoting "traditional" food ☐

3. Crops such as cassava, sweet potatoes etc ☐

4 Non of the above ☐

4.6 **By what means did you get this information from MACO in 2011/2012 rain season?**

1. *Radio* ☐ *2. TV* ☐ *3. Agriculture Ext. Officers* ☐

4. Other (Specify) ☐

4.7 **How would you rate the 2011/2012 seasonal climate forecast?**

1. *Accurate* ☐ *2. Reasonably accurate* ☐ *3. Not accurate* ☐

4.8 **Was the seasonal climate forecast useful to what you harvested?**

1. *Very much* ☐ *2. A little* ☐ *3. Not at all* ☐

4.9 **Were you receiving the seasonal climate forecast updates during the 2011/2012 season?**

1. Yes ☐ *2. Not at all* ☐ *3. Sometimes* ☐

D: FARM MANAGEMENT

Please tick in an appropriate box

4.10 **What farm Management options did you take in 2011/2012 rainy season?**

1. *Crop choice/seeds* ☐ *2. Planning (Timing activities)* ☐

3. Early Planting ☐ *4. Traditional forecast schemes* ☐

4.11**Do you think sustainable practices/strategies are relevant to business implication**

1. Yes ☐ *2. No* ☐

4.12 **In what ways did sustainable Agriculture practices/strategies information improve your business farm management aspect?**

1. Helped in selecting crops to plant ☐ *2. Knowing when to plant* ☐

3. General planning (Activities) ☐ *4. Take precautions/Reserve food* ☐

4.13**When did you start planting your major crop?**

1. *Start of the rains* ☐ *2. Peak of the rains* ☐

3. Towards end of rains ☐

4.14 **What did you use to cultivate your field?**

1. *Oxen* ☐ *2. Hoe* ☐ *3. Tractor* ☐

4. Other (Specify) ☐

4.15**What type of farming system did you use in 2011/2012 season?**

1. *Conventional* ☐ *2. Organic* ☐

4.16**What type of farming seeds did you use during the season?**

1. *OPV* ☐ *2. Hybrid* ☐

4.17 **How was your maize yield last season?**

(a) Those that used conventional in 2011/2012 rain season

1. Excellent ☐ *2. Good* ☐ *3. Fair* ☐ *4. Poor* ☐

(b) Those that did not use conventional in 2011/2012

1. *Excellent* ☐ *2. Good* ☐ *3. Fair* ☐ *4. Poor* ☐

4.18 **What are some of the economic benefits of applying sustainable Agriculture to farm Management?**

1. *Food security* ☐ *2. Yield optimization strategies* ☐

3. Increases Profit ☐ *4. Overall Management* ☐

4.19 **Do you have access to tractor and other machines for your farming?**

Yes ☐ *No* ☐

4.20 Do you have occasions to establish a kind of support organization?

1. *Association* ☐ *2.Support group* ☐ *3.Machinery ring* ☐

4. Other ☐

4.21 Do you have access to tractors +machines?

Yes ☐ *No* ☐

4.22 Do you irrigate your field crops?

Yes ☐ *No* ☐

4.23 What type of irrigation do you use/have?

1. Bucket method ☐ *2. Furrow method* ☐ *3. Drip method* ☐

4. Others. ☐

4.24 What type of energy source do you use/have?.....

4.25 What factors determine what crops you grow in your Field?

1. Market ☐ *2. Climate /weather conditions* ☐ *3. Ability of seed* ☐

4. Management knowledge and skills ☐

4.26 Do you produce on subsistence basis or market basis?.....

4.27 **Where do you sell your produce?**

1. *Retail sale* ☐ *2.Wholesale* ☐ *3.Government* ☐ *4.Other* ☐

4.28 What are the major challenges that you experience in food production?

4.29 What kinds of sustainable agriculture practices have you been trained in?
(List in table below.)

4.30 Which of these practices, if any, have you adopted and practiced before now? (Tick the relevant boxes.)

4.29 Sustainable Agriculture System practices trained in	**4.30 Practices practiced**
Fertilizer trees	
Green manures	
Crop rotation	
Compost	
Animal manure	
Disease-and pest-resistant varieties	
Pot holes(planting Basin)	
Inter- cropping	
Crop diversification	
Cover crops	