EVALUATION OF ORGANIC AGRICULTURE PRACTICES AND RESOURCES USE AS ADAPTATION TO CLIMATE CHANGE: THE CASE OF SOFI DISTRICT, HARARI REGIONAL STATE, ETHIOPIA

M.Sc. THESIS

HANAA THARWAT MOHAMED IBRAHIM

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Hanaa Tharwat Mohamed Ibrahim

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SCHOOL OF GRADUATE STUDIES

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This Thesis work is dedicated to my parents Tharwat Mohamed Ibrahim and Nawal Abdelaleem Ibrahim.

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Date: _________________

School/Department: Natural Resources Management and Environmental Sciences

BIOGRAPHICAL SKETCH

Hanaa Tharwat Mohamed Ibrahim was born in Rufaa, Wed Medani on October 26, 1986. She graduated from Medani Secondary School in 2003. She attended Gezira University of Agriculture Science from 2004 to 2009, graduated with a bachelor of Science in Soil and Water Science. She worked as an assistant in Agricultural Research Corporation (ARC) for three years then joined as assistant lecture in Gezira University for one year. Hanaa entered graduate school at Haramaya University in 2013 to pursue the master's degree in Agrometeorology and Natural Risk Management.

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LIST OF ABBREVIATIONS

ATP	Adenosine triphosphate
BoFED	Bureau of Finance and Economic Development
CEC	Cation Exchange Capacity
CO_2	Carbon dioxide
CSA	Central Statistics Agency
DNA	Deoxyribonucleic Acid
FAO	Food Agriculture Organization
FOSAA	Forum for Sustainable Agriculture in Africa
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HPNRS	Harare People National Regional State
IPCC	Intergovernmental Panel on Climate Change
ISFM	Integrated soil fertility management
OECD	Organization for economic cooperation and development
PET	Precipitation Evapo-transpiration
RNA	Ribonucleic Acid
SAS	Statistical Analysis System
SSSA	Soil Science Society of America
SPSS	Software package used for statistical analysis
UNEP	United Nation Environment Program

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ABSTRACT

The negative impact of climate change has been striking the agricultural sector in Africa. For countries like Ethiopia, whose livelihood occupation of the nation is mainly based on subsistence agriculture that highly rely on rainfall, making an adjustment to adapt to the changing situation is very crucial. Therefore, designing contextual specific adaptation strategies are essential to moderate the negative effect of climate change. This study was intended to answer identify the agricultural practices that maximize output and conserve the natural resources and the strength, weakness, opportunities and threats in implementing the organic agriculture in the Sofi district. Three stages sampling procedure was followed in selecting the study district, villages and representative respondents. Accordingly, one kebele and 60 household heads were selected using purposive sampling and systematic random sampling, respectively. In addition to the soil data and secondary data, structure interview schedule was developed, pre-tested and used for collecting quantitative data. The soil analysis result showed that organic agriculture contribute for the improvement of soil chemical property that is the mixed farming practice was significantly different in soil PH, nitrogen, organic matter, organic carbon and available phosphors than in mono cropping farming system. The descriptive result shows that all the farmers (100%) of the sample respondent participated in land preparation and 98.3% of them participated in manure application and also 98.3% of the sample respondents in participated weeding practices. 98.3% of the sample respondents were participated in harvesting activities. 93.3% of the sample respondents were participated in the fertilizer application activities. 68.3% of the sample respondents were participated in irrigation activities. 13.3% sample respondents were participated in seed treatment activates. To adopt organic agriculture practices whereby financial institutions and other agricultural funders should extend credit or support to agricultural activities with farming practices and technologies that promote organic agriculture.

1. INTRODUCTION

Agriculture is considered a key sector in the transformation of societies to greener economies. Global crop production has more than doubled over the last 40 years and the world now produces enough food to feed six billion people, although the distribution of food is uneven. Furthermore for many countries the productions of agricultural commodities, both for domestic use and for export are an important source of economic growth and livelihoods. Approximately 2.6 billion people depend on agriculture for their livelihood, a majority of who are small holder farmers in rural areas (UNEP, 2011).

Agriculture is part of the solution, offering promising opportunities for mitigating emissions through carbon sequestration, soil and land use management, and biomass production. Climate change threats agricultural production through higher and more variable temperatures, changes in precipitation patterns and increased occurrences of extreme events like droughts and flood (Nelson, 2009).

Agriculture not only contributes to climate change and is affected by it, it also forms part of the solution. Coherent and effective policies are needed. At least 14% of global greenhouse gas emissions come directly from the farm sector. That is more than transport and not far behind the contribution from industry. One way is through farming activity itself: ploughing fields releases carbon dioxide in the soil, and rice cultivation and livestock breeding both emit large quantities of methane. Farming uses fossil fuels and fertilizers (OECD, 2010).

Agriculture in Ethiopia is the foundation of the country's economy, accounting for half of gross domestic product (GDP), 83.9% of exports, and 80% of total employment (Mia Mac Donald and Justine Simon, 2010). A potential exists for self-sufficiency in grains and for export development in livestock, grains, vegetables, and fruits as many as 4.6 million people need food assistance annually (Matous and Todo, 2013).

It has great agricultural potential because of its vast areas of fertile land, diverse climate, generally adequate rainfall, and large labor force. Despite this potential, however, the Ethiopian agriculture has remained underdeveloped because of drought, which has persistently affected the country since the early 1970, and poor economic base low productivity, weak infrastructure, and low level of technology (Matous and Todo, 2013).

In Ethiopia, climate change is expected to intensify the already high hydrological variability and frequency of extreme events. Droughts impair agricultural productivity and may lock subsistence farmers into poverty traps, whereas recurrent flooding can have long-term negative effects on agricultural GDP by directly damaging crops and by destroying roads, thereby exacerbating the inadequacy of transport infrastructure and consequently limiting access to markets (You and Ringler, 2010).

Furthermore, for many countries, the production of agricultural commodities, both for domestic use and for export, are an important source of economic growth and livelihoods. The essence of organic agriculture is in reduction or elimination of negative externalities caused by the conventional agriculture .In light of great interest to organic agriculture officials realized the importance of organic agriculture practice, where is the process of transferring knowledge from advisers and agricultural scientists of the guides and farmers a key aspect in the development of agriculture (FAO, 2004).

For every 10 percent increase in farm yields, there has been a 7 per cent reduction in poverty in Africa and more than 5 per cent in Asia. Evidence suggests that the application of organic agriculture practices has increased yields, especially on small farms, between 54% and 179% (Cattanach and Navy,1995). The Ethiopian Government has singled out smallholder agriculture as a key target area for the envisaged to transformation of the old and traditional agricultural sector and to reduction of poverty through agricultural green growth (GATE , 2013).

Agriculture has been identified as being of major importance to the Government of Ethiopia, as a result of the large contribution it makes to GDP including being the largest export earner. Whereas the agricultural sector has performed strongly over the last decade there is still substantial potential to improve productivity and production. At the same time, Ethiopia is highly vulnerable to climate change, and the mainly rain-fed agricultural production systems are susceptible to frequent climate extremes. Furthermore, Ethiopia has one of the highest rates of soil nutrient deletion and natural resources degradation in Sub-Saharan Africa (GATE , 2013).

The negative impact for the climate change has been striking the agricultural sector in Africa. For countries like Ethiopia, whose livelihood occupation of the nation is mainly based on subsistence agriculture that highly rely on rainfall, making an adjustment to adapt to the changing situation is crucial. The study focused on the evaluation of organic agriculture practices and resources use as adaptation to climate change.

Therefore, designing contextual specific organic agriculture adaptation strategies are essential to moderate the negative effect of climate change. This study was covering only sofi district which is found in Harare Regional State. Limited financial resources and shortage of time made it impossible to extend the study away from these districts.

Having a clear picture and information on the organic agriculture practices as adaptation to climate change, can provide a basis for a detailed analysis on evaluation of organic agriculture practices as adaptation to climate change in the country. In this respect, this study is important for the regional government, and other rural development actors which aim at formulating and implementing strategies for organic agriculture. The study is also expected to provide directions for further research, extension and development schemes that would benefit the farming population.

Therefore the general objective in this study was to evaluate the organic agriculture practices that enhance agriculture production and specific objective s were to investigate the organic agricultural practices that maximize output and to assess the strength, weakness, opportunities and threats in implementing the organic agriculture in the country particularly in the Sofi district.

2. LITERATURE REVIEW

2.1. Definition and Concept of Organic Agriculture

Organic agriculture is a holistic production management system which promotes and enhances agro ecosystems health including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials to fulfil any specific function within the system (The Codex Alimentarius Commission ,2001).

It refers to a variety of integrated farming practices that emphasize the use of naturally and sustainably produced soil nutrients and cultivation of diversified crops and livestock husbandry in a manner that enhances overall farm productivity in balance with local, regional and global environmental resources (Byerlee and Janvry,2007).

Organic agriculture refers to the increasing use of farming practices and technologies that maintain and increase farm productivity and profitability while ensuring the provision of food on a sustainable basis, reduce negative externalities and gradually lead to positive ones and rebuild ecological resources (soil, water, air and biodiversity) by reducing pollution and using resources more efficiently (UNEP, 2011).

These practices improve water use efficiencies and control soil erosion by promoting minimal disturbance of the top soil and maintenance of adequate ground covers of organic carbon matter. In the aggregate, organic farming practices demonstrate increased agricultural productivity of currently farmed lands; reduced vulnerability to price volatility of fossil hydrocarbon resources and improved agricultural resilience and adaptability to changing climate conditions. Green agriculture also encompasses a range of social equity benefits that improve farmer livelihoods while producing and preserving beneficial ecological services (UNEP, 2007). A primary goal of organic agriculture systems is to enable farmers to increase their efficient use of inputs to realize higher produce yields in order to meet growing consumer demand for nutritious food.

It is a concept that brings together a suite of policies to promote a transformation of consumption behavior, industry structures and technologies. This involves regulatory and fiscal measures to reduce the energy and carbon intensity as well as the land and water intensity of production and consumption in all sectors (FAO, 2004). According to the recent studies organic agriculture is capable of nourishing a growing and more demanding world population at higher nutritional levels out to 2050 (UNEP, 2011). During the transition to organic agriculture, food production in high-input industrial farming may experience a modest decline while triggering positive responses in the more traditional systems (which account for nearly 70% of global agricultural production).

UNEP's report proposes that agriculture based on sustainable farming practices and technologies, organic agriculture should become a development path alternative to two currently dominating agricultural systems, conventional and traditional agriculture. The report proposes five main principles of organic agriculture: use of naturally and sustainably produced nutrient inputs, diversified crop rotations, livestock-crop integration environmentally friendly pest and weed management practices and waste reduction through use of post-harvest storage and processing facilities (UNEP, 2011).

Authors of the report argue that organic agriculture can feed the world with food that is sufficient in terms of quantity and quality, diminish environmental damage and contribute to reducing poverty. Yet, they claim that to achieve transition to organic agriculture we need investments and policy reforms. The report identifies six main areas for investment and up scaling already existing solutions those areas are soil fertility management, efficient and sustainable water use crop and livestock diversification, plant and animal health management, mechanization and improving storage facilities. Organic agriculture should include diverse, locally adaptable techniques and practices that aim at increasing yields while simultaneously taking care of increasing return on labor, improving ecosystem services and reducing waste and inefficiency in food chains (UNEP, 2011).

Organic agriculture will require national and international policy reforms, policy changes should focus particularly on reforming environmentally harmful subsidies that artificially lower the costs of some agricultural inputs and lead to their inefficient and excessive use and promoting policy measures that reward farmers for using environmental friendly agricultural inputs and farming practices and for creating positive externalities such as improved ecosystem services and requires investment, research and capacity building in the following key areas soil fertility management, sustainable water use, crop and livestock diversification, biological plant and animal health management, appropriate level of mechanization and building upstream and downstream supply chains for businesses and trade (Sachs *et al.*,1998).

Farming practices and technologies that are instrumental in organic agriculture include: restoring and enhancing soil fertility through the increased use of naturally and sustainably produced nutrient inputs, diversified crop rotations, livestock and crop integration, reducing soil erosion and improving the efficiency of water use by apply in minimum tillage and cover crop cultivation techniques, reducing chemical pesticide and herbicide use by implementing integrated biological pest and weed management practices and reducing food spoilage and loss by expanding the use of post-harvest storage and processing facilities. It is important to acknowledge that field production systems are only one part of organic agriculture economy, other factors that play a key role in organic agriculture include water management, protection of habitats, managing emissions in the processing and transport sectors and sustainable consumption.

2.1.1 Organic agriculture and climate change adaptation

The need to adapt to climate change is one of the main challenges facing the future of agriculture even if strong and effective mitigation measures were taken, even if greenhouse gas emissions dropped to zero immediately, the climate would continue to change for decades. IPCC (2001) defines adaptation to climate change specifically as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. Climate change adaptation aims to mitigate and develop appropriate coping measures to address the negative impacts of climate change on agriculture. According to Bruin (2011) adaptation strategies include switching crops, shifting crop calendar, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies.

According to Gbetibouo (2009) suggested that smallholder farmers can adapt to climate change by changing planting dates and diversifying crops. This can be possible if government provides them with the necessary support. Smallholder farmers can also adapt to climate change by practicing soil and water conservation measures and planting trees (Yesuf *et al.,* 2008). Farmers in developed countries may include in their response to climate change increased inputs such as synthetic fertilizers and pesticides and capital investments in irrigation and greenhouses to help their crops survive. Farmers in developing countries and small holders in general have a much smaller set of options and must rely to the greatest extent possible on resources available on their farms and within their communities, without healthy soils and sufficient water, no agriculture is possible. Changes in temperature, precipitation and other atmospheric conditions due to global warming will directly change soils. While specific impacts are incredibly difficult to predict for individual areas, expected extreme weather events will almost certainly damage soils and accelerate erosion (Rounsevell *et al.,* 1999).

Organic agriculture has a role to play in climate change adaptation, including avoided damage, and many farming practices contribute to both processes. It provides management practices that can help farmers adapt to climate change through strengthening agro-ecosystems, diversifying crop and livestock production, and building farmers' knowledge base to best prevent and confront changes in climate. FAO (2004) promotes organic agriculture as an alternative approach that maximizes the performance of renewable resources and optimizes nutrient and energy flows in agro ecosystems. Life cycle assessments show that emissions in conventional production systems are always higher than those of organic systems, based on production area.

Soil emissions of nitrous oxides and methane from arable or pasture use of dried peat lands can be avoided by organic management practices. Many field trials worldwide show that organic fertilization compared to mineral fertilization is increasing soil organic carbon and thus, sequestering large amounts of CO_2 from the atmosphere to the soil. Lower greenhouse gas emissions for crop production and enhanced carbon sequestration, coupled with additional benefits of biodiversity and other environmental services, makes organic agriculture a farming method with many advantages and considerable potential for mitigating and adapting to climate change.

2.2. Sustainable Agriculture

It is the production of food, fiber or other plant or animal products using farming techniques that protect the environment, public health, human communities, and animal welfare. It is a process of developing the land, cities and communities, as well as business, provided that meets the needs of the present without compromising the ability of future generations to meet their need.
It involves the successful management of agricultural resources to satisfy human needs while maintaining or enhancing environmental quality and conserving natural resources for future generations (FAO, 2001). Sustainable farms produce crops and raise animals without relying on toxic chemical pesticides, synthetic fertilizers, genetically modified seeds or practices that degrade soil, water or other natural resources. By growing a variety of plants and using techniques such as crop rotation, conservation tillage, and pasture-based livestock husbandry sustainable farms protect biodiversity and foster the development and maintenance of healthy ecosystems.

Sustainable agricultural practices Includes the alliance for the cultivation of green in Africa, improve the health of soil through the integrated management of soil fertility (Bogota, 1985). This is done through the use of a combination of fertilizer and organic inputs, and techniques appropriate to the circumstances and local resources. It involves the successful management of agricultural resources to satisfy human needs while maintaining or enhancing environmental quality and conserving natural resources for future generations.

Sustainable farms produce crops and raise animals without relying on toxic chemical pesticides, synthetic fertilizers, genetically modified seeds or practices that degrade soil, water, or other natural resources. By growing a variety of plants and using techniques such as crop rotation, conservation tillage and pasture-based livestock husbandry, sustainable farms protect biodiversity and foster the development and maintenance of healthy ecosystems.

Integrated soil fertility management (ISFM) is a set of agricultural practices adapted to local conditions to maximize the efficiency of nutrient and water use and improve agricultural productivity (Bationo and Koala,1998). ISFM strategies center on the combined use of mineral fertilizers and locally available soil amendments (such as lime and phosphate rock) and organic matter (crop residues, compost and green manure) to replenish lost soil nutrients. This improves both soil quality and the efficiency of fertilizers and other agro-inputs. In addition, ISFM promotes improved germplasm, agro forestry and the use of crop rotation and/or intercropping with legumes (a crop which also improves soil fertility).

The Forum for Sustainable Agriculture in Africa (FOSAA) aims to promote empowerment of local farmers to become actors in the agricultural sector's value chains (especially apiary, mushroom and rice and maize value chains). FOSAA strives to foster functional linkages between farmers, technology generators, technology transfer agents, financial institutions, and markets (local or foreign), within the agriculture value chains.

2.2.1 Climate change and crop production

Climate change is characterized by droughts and floods, which destroy plants and depletes the soil. The frequent droughts that have been observed over the past decades reduce soil moisture and water resources for plants, thus resulting in severe water stress. Reduced soil moisture decreases available water for irrigation and hinder plant growth in non-irrigated plants (Aydinalp and Cresser, 2008). Drought and floods kill animals that are used by small-scale farmers for ploughing, thus leaving them with no choice, but to hire tractors. However, most rural households do not afford such services because of poor financial background.

Drought reduces soil fertility by reducing the organic component of the soil as the amount of crop residues is reduced. This tends to increase the costs of farming as households need to apply fertilizer to avoid reduction of crop yields. Floods affect crop production through water logging and soil erosion, where such conditions interfere with soil fertility and therefore reduce crop yields.

According to Aydinalp and Cresser (2008) erratic rainfall has been recorded and observed in many geographical regions in the world. Rainfall frequency, distribution and intensity have changed; rainfall is poorly distributed throughout the growing season, such that there is no rain during the maturity stage of most crops. This results in total crop failure even if the crop has been performing well during the early stages of development. Rainfall intensity has changed in such a way that the total rainfall received does not balance the water demand for most crops. Similarly long dry periods have been observed during the planting season as a result of changed rainfall intensity which affect plant growth and eventually crop yield.

In crop production, reactive adaptation strategies include control of soil erosion, construction of irrigation dams, improving soil fertility, development of new varieties, shifting planting and harvesting time. Anticipatory adaptation strategies on the other hand involve the development of tolerant cultivars, research development, policy measures on taxation and incentives.

2.3. Soil Organic Matter

Soil organic matter is plant and animal residence in the soil in various stage of decomposition (Gardiner and Miller, 2004). It has a number of positive effects such as it is a sources of 90 to 95 percent of the nitrogen in unfertilized soil, is the major source of both available phosphorous and available sulfur, contributes to the cation exchange capacity (CEC): often furnishing 30 to 70 percent, increases water content and air and water flow rate, supply carbon for many microbes that perform other beneficial functions in soil, when it is left of top of soil against changes in acidity on toxicity (Gardiner and Miller, 2004).So, that help to sustain soil fertility by improvising retention of mineral nutrients of soil flora and fauna. It's also a key factor associated with improvement of decline of soil fertility (Brawn *et al.,* 1994) which plays an important part in establishing the intrinsic property of soils.

Organic matter enhances the soil in many ways. It is also important for physical, chemical and biological soil properties. The organic matter builds and improves soil structure, thereby, improving soil drainage, infiltration of water in to the soil, aeration and water holding capacity. The improved soil structure results in well-developed plant root system and healthier, more disease resistant crops. Soil organic matter increases the cation exchange capacity of a soil and provides of neutralizing or buffering effect on soil pH (preventing rapid changes in pH). Soils that are high in organic matter contents have water stable aggregates that bind soil particles together and are resistant to being broken down by the impact of raindrops.

Organic matter depilation has been by far one of the most problems leading to soil degradation. This situation must be reversed and accumulate carbon in the soil which help preventing soil degradation). It is affected by the kind of farming and soil fertility management practices for instance; in his study reported that continuous cultivation becomes the major causes of most organic matter losses. Continuous cropping can also reduce soil organic matter or soil organic. Thus, assessment of soil organic matter is a valuable step towards identifying the overall quality of soil.

2.4. Total Nitrogen

Nitrogen (N) is one of the major nutrients required for the nutrition of plants and is often the controlling factor in plant growth. Thus, lack of nitrogen is the greatest single cause of low crop yield (Young, 1976). Of the total amount of nitrogen present in soils, nearly 95-99% is in the organic form and 1-5% in the inorganic form as ammonium and nitrates. It is a major competent of soil organic matter which contains an average of about 5 percent nitrogen (Gardiner and Miller, 2004).Total nitrogen is merely an indicator of the soil potential for the element, but not the measure in which it becomes available to the plant. Nitrogen in organic forms is not available to plants but must be converted to available forms, either the cationic form ammonium ion (NH4+), or the an ionic form nitrate (NO3-).

Even though total nitrogen is not a measure of available nitrogen to plants, but it is an important indicator of the soil potential for the element. Nitrogen contents of soils are also needed for the evaluation of C-N ratios of soils, which give an indication of the processes of transformations of organic N to available N like ammonia nitrite and nitrate-24 N. The principal cause (up to 100kg or more, in intensive cropping) come from removal in harvested crops and insufficient replenishment through manures or fertilizers. According to Barber (1984), soil total nitrogen can be classified as from very low to very high in total nitrogen.

2.5. Available Phosphorus

Next to nitrogen, phosphorus has more widespread influence on both natural and agricultural ecosystems than any other essential elements. Phosphorus- deficient plants are often severely stunted, since this element takes part in the synthesis of several essential compounds upon which all plant and animal life depends (Barber, 1984). In agricultural ecosystems, phosphorus contains are much more critical because phosphorus in the harvested crops is removed from the system, with only limited quantities being returned in crop residues and animal manures. Neither plants nor animals can grow without phosphorus. It is an essential component of the organic compound often called the energy currency of the living cell adenosine triphosphate (ATP) and an essential component of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

The principal environmental problems related to soil phosphorus are land degradation caused by two little available phosphorus and accelerated eutrophication caused by too much. The low phosphorus availability is partly result of extensive losses of phosphorus during long periods of relatively intense weathering and partly due to the low viability of phosphorus in the aluminum and iron combinations that are the dominant forms of phosphorus in these soils.

2.6. Soil pH

The term pH is from the French pouvoir hydrogen or hydrogen power. Soil reaction (pH) is an indication of the acidity or basicity of the soil and is measured in pH units. It also defined as the negative logarithm of the hydrogen ion activity in which in very dilute solution can be expressed as concentration, in gram mole per liter. The scale ranges from 0 to 14 with pH 7 as the neutral point. From pH 7 to 0 the soil increasing more acidic, from pH 7 to 14 the soil is increasing more alkaline (basic) (Purohit *et al.,* 2004). The pH is a very important property of soil as it determines the availability of nutrients, microbial activity and physical condition of the soil. Soil PH depends on a variety of factors including all five soil forming factors plus the season of the year, cropping practice, the soil horizon sampled, the water content at the sampling time and the way the pH is determined .

The soil pH is easily determined and provides clues about other soil properties. The soil pH greatly affects the solubility of minerals. For instance, in acidic soils the phosphate ions react with iron, aluminum, manganese ions to firm insoluble phosphate, since acidic soils have high amount of exchangeable aluminum, manganese and iron. On the other hand, in alkaline soils soluble phosphate ions adsorb on solid calcium carbonate surface so phosphorous is most available at about pH 6.5 by minerals soils and pH 5.5 for organic soil (Gardiner and Miller, 2004). Moreover, it influences plant growth by its effects on the activities of beneficial microorganisms. According to Tan (1996), soil pH is the most important determinant of soil chemical properties.

3. MATERIAL AND METHODS

3.1 Description of the Study Area

3.1.1. Location

The study was contucted in Sofi District, Harare Regional State. The Harari Regional State (HRS) is located in one of the upstream micro-watersheds of the Wabi Shebelle River Basin. Harare, the capital of the Region is located between 09^0 18' 43" N latitude and 42^0 07' 23" E longitudes 515 km east of Addis Ababa, and lies in the south-western part of the region just off the southern edge of the south-eastern plateau dividing the Great Rift Valley from the plains of the Ogaden lowlands.

The total land area of the Region is 343.2 km^2 (34,320 ha) of which the rural area accounts for 323.7 km^2 (94.3%) and the urban area accounts for 19.5 km^2 (5.7%). The rural areas of the Region are subdivided in to 3 districts, namely Sofi, Erer-Woldiya and Dire Teyara, while the Harare city consists of 6 districts adding up to a total of nine (9) districts for the whole Region (HPRS, 2011).

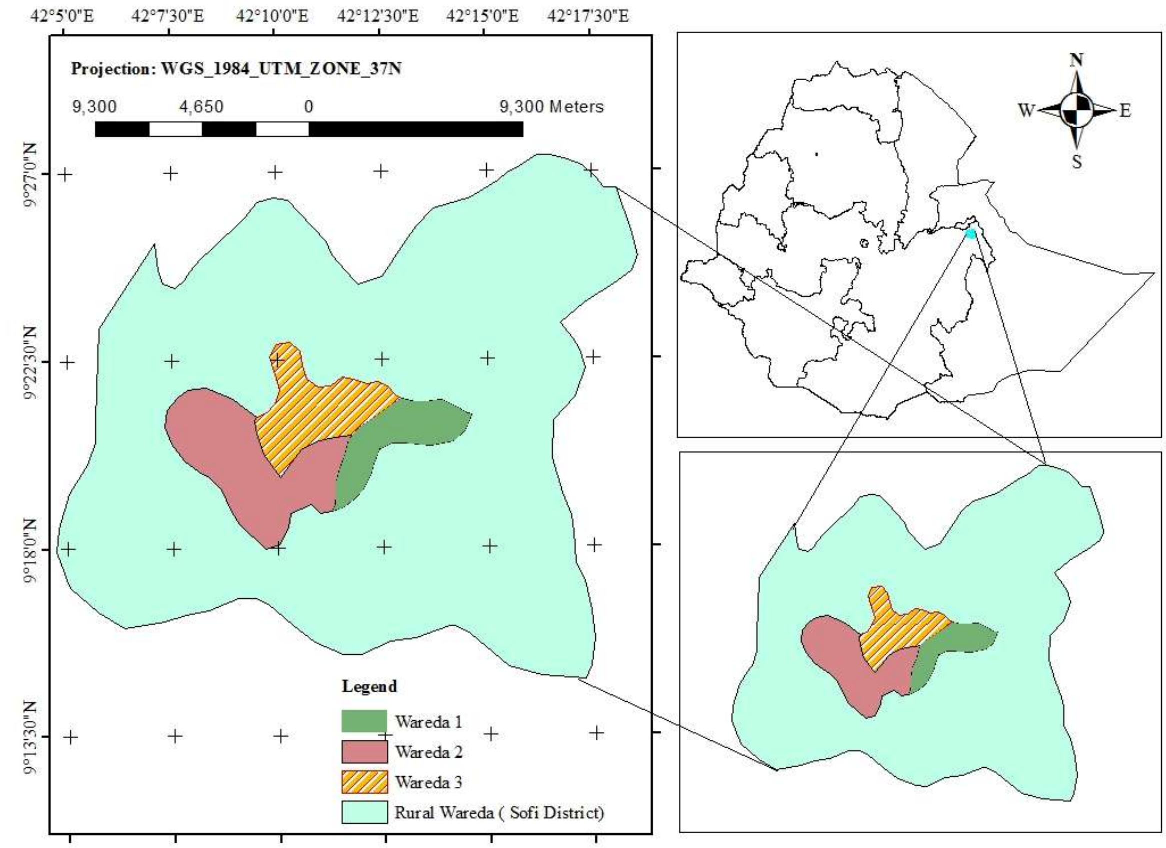

Figure 1. Study area map

3.1.2 Climate

Climate is the major natural resource influencing human endeavors in the development of agriculture and other natural resources. However, undertaking analysis of spatial and temporal variations in rainfall, temperature, PET and other climatic elements is constrained by absence of standard meteorological stations in the region.

In Hararie region the mean annual temperature varies from 10 ^{0}C in high lands and 26 ^{0}C in low lands. However generally the temperate of the region with a little variation among seasons, the metrological data of 1997 – 2000 E.C. indicates the mean annual maximum temperature of the region ranges from 22 ^{0}C in high land and 28 ^{0}C in the low lands.

The mean annual minimum temperature is 10 ^{0}C in high lands and 15 ^{0}C in low lands. The duration and intensity of rainfall in the region vary considerably. Generally it decreases from west and north west to south east wards. The last four years record of rainfall shows that it ranges from 700mm in the south east and over 900mm in the western part of the region. In Sofi the rainfall ranges from 850mm to 870mm bi-modal with peaks in April and August 60 - 90days (CSA, 2013).

3.1.3. Soil

The major soil types which occur in the Hararie region are Nitisols, Luvisols, Arnosols, and Aerosols nit sols (distinguished by their shiny pad surface) occupy 2792.5 ha and luvisols (soils which has cation exchange capacity (CEC) equal to or greater than 24 mol clay) occupy 2440 hectare Regosols (medium and fine textured) occupy 6,017.5 hectare and Aerosols (coarse textured with weak pedogenetic characteristics in the B horizon) occupy 4575 hectare. The major soil types which occur in Sofi are Limestone plateau with limestone hills to east. Vertisols on plateau and lithosols on hills. Generally, the soils of the Region have been developed in response to topographic and climatic conditions resulting in various soil types differing within and among each other in their morphological, physical, mineralogical, chemical, and biological properties. On plateau intensive cultivation with small homestead woodlots, grass and very low shrubland on hills. Land use of Sofi are intensive rainfed crop cultivation, small farm forestry and extensive grazing on hills (CSA, 2013).

3.1.4 Agriculture

Agriculture is fundamental among others to the sustenance of food security and supply of raw materials for manufacturing agro-industries and it is the major source of the country's export items. Providing adequate food to the needy Ethiopians and the Hararie people exclusively depend on the development of agriculture.

Farming system is the major agricultural characteristics of the region. A typical house hold in the rural area may grow food crops sorghum, maize, horticultural crops etc. There is no specialization in the production of particular crops.

According to BoFED of Hararie region the total area under cultivation of annual crop ranged from 9671.9 hectare, Total production ranged from a low amount of 37629 quintals in 2005 has been increased to 202888 quintals in 2010.

Table 1. Land use potential in Hararie region

No	Land use	Area in ha	In %
1	Cultivated land	16355	47.60
	1.1 Annual crop	12725	37.00
	1.2 Permanent crop	3630	10.60
2	Forest, shrub and bush land	9155	26.7
	Others	8810	25.7
	Total	34325	100

Source: Harare Bureau of Agriculture and rural development, 2009

The crops grown by the majority of the peasant holders in the Hararie Region include grain crops (cereals, pulses and oilseeds), vegetable, root and fruit crops, and stimulant crops mainly chat *(Catha edulis*) and coffee *(Coffeae arabica)*. *)*. However, the major food crops produced in the Hararie Region are cereals and oil seeds with small areas devoted to pulses, vegetables and fruit crops (CSA, 2013).

Horticultural crops in Sofi include vegetables (potato, tomato, onion), root crops and fruit crops. The farmers in Sofi producing chat and coffee crops in the 2004/2005 were 12,07 and 1,39, respectively. In fact, the number of peasant holders producing chat is greater than those growing any other crop during the same year except sorghum.

Most of the agricultural experts in Sofi District of the Harare Regional State support farmers to apply the industrial sludge on their farmlands to increase soil fertility and reduce the impact of weeds (mainly *Striga*) on crop growth and yield especially for maize and sorghum (FAO, 2006).

3.2. Types and Source of Data

In this study, both qualitative and quantitative data from primary and secondary sources were used. The primary data were collected from sampled households, extension agents, regional agricultural offices and others which have adequate information about the existing situation of the research area of interest. Structured questionnaire which were filled by enumerators and an in depth interview were held to collect the primary data. Secondary data were collected from records of the district and regional agricultural offices, and related literature prepared by government and nongovernmental organization.

3.3. Soil Sampling

Soil samples were taken with a hand trowel for the determination of chemical, physical and biological properties of soils under nine farms operating on mono cropping and mixed cropping systems. Two (2) Soil samples were collected from each of the nine sampling plots on a demarcated site of 20m by 20m quadrat. In all, a total of eighteen (18) soil samples were collected at 0 – 30cm depth to represent the average plough layer. The reason for soil sampling was to cheek the quality of the soil physical, chemical and biological properties that suitable for organic agriculture and It relies on management of natural cycles to add crucial nutrients, increase soil organic matter and protect the soil from erosion..

3.4. Sampling Design and Methods of Data Collection

A three stages sampling technique was applied to generate the required primary data. In the first stage, Sofi districts were purposively chosen among the districts found in Hareri Regional State. In the second stage among the 7 Kebeles of Sofi district Sofi Kebeles where Organic agriculture most is practiced was selected purposively. Finally, random samples of 60 households were selected randomly from Sofi kebele.

Table 2. Sample Size of Sofi kebele

District/Peasant Association(PA)	Total population (N)	Sample household (N)
Sofi District		
Sofi Kebele	110	60

3.5. Methods of Data Analysis

3.5.1. Descriptive statistics

Descriptive statistics is used to describe the basic features of the data in the study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data. Descriptive statistics is applied to describe the collected data using mean, standard deviation, percentages, frequency, charts, and chi-square test (Trochin, 2006).

3.5.2. Soil analysis

Soil samples were dried at room temperature and sieved to pass through 2 mm sieve screen. The collected soil samples were transported to Haramaya University Soil Chemistry Laboratory and subjected to analyses some selected soil physical, chemical and biological properties based on standard procedure describe in soil organic carbon was determined based on the chromate wet oxidation method (Walkey – Black,1934); Total Nitrogen (N) was determined using Macro – Kjedhal digestion distillation (Bremner, 1965); Available Phosphorus (P) was analyzed using Bray No. 1 method (Olsen and Dean, 1965). While potassium (K) was determined using the flame photometry method (chapman, 1965), magnesium (Mg) concentration were made known by the use of Atomic Absorption Spectrophotometer (chapman, 1965). pH was determined based on 1:2 Soil water suspension using pH meter (Jackson, 1973). Microbial were made by use of Fluorescein diacetate test, (2012). Soil texture was determined using Hydrometer method while the bulk densities of the soils were made by use of pycnometer.

Table 3. Soil chemical, physical and biological analysis: methods and instruments used

S. No	Parameters	Methods employed	Instrument/apparatus used
1	Texture	Hydrometer method	Bouyoucos hydrometer
2	Bulk density	Method for disturbed soils- the weight of oven dried soil filled in Pycnometer by gently tapping divided by its volume.	Pycnometer
3	PH	1:2 Soil water suspension (Jackson, 1973)	pH meter
4	Organic Carbon	Rapid titration method (Walkley and Black, 1934)	Walkley and Blank
5	Total Nitrogen	Alkaline potassium permangante method (Subbiah and Asija, 1956)	Kjeldhal distillation unit
6	Available Phosphorus	Olsen *et al*, 1954	Spectronic 20-D^+
7	Available Potassium	Neutral 1N ammonium acetate solution method (Merwin and Peach 1951)	Flame Photometer
8	Exchangeable Calcium and Magnesium	Neutral 1N ammonium acetate solution method (Merwin and Peach, 1951)	Atomic absorption spectrophotometer (Elements AS AAS4141)
9	Microbial biomass	Fluorescein diacetate test,(2012).	Spectrofluorometer

The quantitative data obtained from the soil analysis, were subjected to statistical sample analysis using SPSS computer software like; mean, standard deviation and standard error of mean for mean separation of each soil parameters. Paired samples T-Test analysis was done to detect whether the differences among the means of soil attributes studied differed significantly between the mono cropping and mixed cropping farming practices.

3.6. Crop Diversification Data Analysis

The crop diversity within the farmers land under the study area between the sample quadrats were computed by using Shannon's diversity index (Krebs1999; Magurran 2004; Wittenberg *et al*., 2004).

$$H = -\sum_{i=1}^{s} pi \ln(pi) \quad (1)$$

where H = Shannon's diversity index, pi = the relative importance value of the ith species, and s = the total number of species in the sample quadrat. The percentage cover of the species was computed from Shannon's diversity index as:

$$E = \frac{\exp(H)}{\ln s} \quad (2)$$

3.7. Economic Data collection method

A structured questionnaire was used to interview the farmers in the Sofi kebele under study. The purpose of this interview was to find the number of crop species and varieties they were growing on their farms and the specific techniques they were following in farming. Although farmers tend to adopt many new techniques and crop combinations, farmers who practices mixed cropping and mono cropping seem to follow the traditional farm management practices. Based on the data thus collected, we were able to identify the farmers who were practicing a mixed cropping and mono cropping practices. After identifying the mixed cropping and mono cropping farmers, we recorded the detailed of all farm economic activities through short-term participant observation and rotational visits to all such farms. The crop species pool, grown on the farmer's farms of Sofi kebele under study is presented in (Appendix 2) and a total of 6 mixed cropping farms and a total of 3 mono cropping farms from Sofi kebele were selected for analysis.

A trained enumerators and extension agent was involved in this study to assist in identifying parameters for comparison and valuation of different farm produce. The farmer-producers were involved in the valuation exercise to eliminate possible mistakes from perceptual bias of the enumerators and extension agent. For economic analyses, market price of all farm inputs and products were ascertained. The costs of all inputs and the benefit farmers obtained from their crop production were calculated to compare the relative gain in output value of mono cropping farms with that of the mixed cropping farms.

Both the input cost and output value (in Ethiopian Birr) were standardized by dividing the estimated figures by the respective area of the farm where the crops were grown. For example, if in a 0.5 ha farm, 0.2 ha is sown to sorghum, 0.1 ha planted to maize and 0.2 ha to ground nut, the output value of sorghum and ground nut were each divided by 0.2 ha, and that of maize was divided by 0.1 ha. Thus, the net annual farm profit (NAFP) is described here as

$$NAFP = \frac{Output\ \ value - Input\ \ \cos t}{farm\ \ area(in\ ha)}$$

and the value of $NAFP$ was compared between the two cropping system. The design of the study for comparison between mixed cropping and mono cropping farms Student's t-test was employed. Student's t-test was performed for examining statistically significant relationships between parameters.

4. RESULTS AND DISCUSSION

4.1. Demographic Profiles

Table 4. Age, sex, marital status and family size of respondent households

Variable	**Sofi**		
Age Category	Frequency	Percent	χ^2
20-30	25	41.7	34.833***
31-40	20	33.3	
41-50	10	16.7	
51-60	3	5.0	
above 60	2	3.3	
Total	60	100.0	
Family size Category			χ^2
2-3	3	5.0	14.400***
4-5	15	25.0	
6-7	21	35.0	
8+	21	35.0	
Total	60	100.0	
Education Category			χ^2
Illiterate	24	40.0	36.600***
Can write and read	8	13.3	
Lower primary (1-4)	8	13.3	
Upper primary (5-7)	9	15.0	
Secondary (9-12)	3	5.0	
High education (13 -14)	5	8.3	
College	3	5.0	
Total	60	100.0	

Age is the determinant factor for activities like organic agriculture. Majority (75%) of the sample who participated in organic agriculture belong to the age category 20-30 and 31-40 years. Nearly 41.7% were less than 30 years. On the other hand, the proportion of the sample participants above the age of 60 years compressed to only 3.3%. Between the age group 50-60 years accounted to 5%. Hence, it is good to say that most of the samples who participated in organic agriculture constituted the working age groups. There is big age variation among the sample respondents. The different in age of the farmers increased the use of improved varieties, mixed cropping , diversification to farm activities relative to soil fertility and farming system as adaptation to climate change, farmers are more likely to use mixed cropping than mono cropping systems to improve varieties with different in age.

The years of farming experience of the farmers had a positive influence on diversification to farm activities revealing that as farmers advance in years of farming experience. This is contrary to the findings of (Kebede *et al*.,1990) which posited that a positive relationship exists between the number of years of experience in agriculture and the adoption of improved agricultural technologies in the study area .

The proportion of respondents with household size of 7-8 and above 8 persons is the same and relatively higher (35%) followed by sample respondents with household size of 4-5 persons (25%). The proportions of households with household size of 2–3 persons were (5%). It is interesting to note that the great majority of the households (70%) have household sizes with six and seven and greater than eight persons. These contribute to labour force involved in organic agriculture practices. large family sizes could increase the use of mixed cropping than mono cropping and increase in farmers' diversification to farm practices . This is consistent with the findings of (Apata *et al*. , 2008) that household size had a positive influence on adaptation to climate change among the farmers in South Western Nigeria.

The study showed that farmers had information on climate change, increased their use of improved varieties diversified to farm practices relative to the use of mixed cropping more than mono cropping system . This is consistent with existing studies that access to information through extension services increases the likelihood of adapting to climate change (Maddison, 2006; Nhemachena and Hassan, 2007).

People with all kinds of educational backgrounds practiced organic agriculture. The educational level of the sample respondents, as can be seen from the Table 4. The majority (40%) of respondents were those who had never been to school, while 13.3% of them can only read and write and the other 13.3% were Lower primary school. Additionally 27.3% of the sample respondents were attended Upper primary education (5-7 grades) and 5% of sample respondents attained secondary education (9-12 grade) and 8.3% of the sample respondents attained High education (13 -14grade). The overall educational attainments of the respondents revealed that more than 50% of them did not have a basic education and very few (5%) of the respondents were attained College studies. The data shows that there is big difference in educational attainment of the sample respondent. Even if there is significant difference among the education level of the sample respondent, it is important to note that organic agriculture is practiced by people with different educational levels ranging from the illiterate ones to those who attended college level.

Evidence from various sources indicate that there is a positive relationship between the education level of the household and adaptation to climate change (Maddison, 2006). This implies that farmers with higher levels of education are more likely to adapt better to climate change. The implication of this is that increasing the farmers' years of formal education would increase their likelihood of diversifying to farm activities relative to the likelihood of using mixed cropping more than mono cropping.

4.2. Farm size, total asset and livestock holding

Table 5.Farm size, total asset and livestock holding of respondent households

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Farm size	60	0.125	4.00	1.4000	1.045511
total asset	60	2400.00	1050000	146020	159873
Herd composition (out of the total herd)					
Cattle number	60	0.00	18.00	1.9833	2.72149
Donkey number	60	0.00	6.00	0.4333	0.94540
Goat number	60	0.00	9.00	1.8500	2.29830
Sheep number	60	0.00	7.00	0.2833	1.07501
Poultry number	11	3.00	34.00	12.0000	11.10856

Land holding: Land is the most important natural capital held by sample households in the study area. Regardless of the size, all the respondents have reported that they own land. The average land holding was 1.4 ha and all the respondent farm land was cultivated during the study period.

Livestock production: In the study area, livestock serve as one of the financial asset. Table 5 shows that the entire (100 %) respondents had Cattle, goat and sheep. From the total sample respondent eleven farmers only engaged in poultry production. Finally, average livestock holding calculated using tropical livestock units (TLUs .Appendix 1) reveals that mean livestock ownership for the total sample equals 5.79. Based on this study, it is highly recommended that increase the productivity of the local breeds appropriate management practices and policy interventions should be made, especially on forage development and breed quality improvement. The mean livestock holding should be adjusted with feed availability to minimize its impacts on grazing land degradation and for better productivity (Alemayehu Mengistu, 1985).

4.3. The distribution of farmers by their choices of adaptation method

Table 6. Distributions of Farmers by Adaptation Methods

	Yes		No	
	Frequency	**%**	**Frequency**	**%**
Land preparation	60	100	0	0
Compost/Manure application	59	98.3	1	1.7
Seed treatment	8	13.3	52	86.7
Fertilizer application	56	93.3	4	6.7
Weeding	59	98.3	1	1.7
Irrigation	41	68.3	19	31.7
Harvesting	59	98.3	1	1.7

The distribution of farmers by their crop production adaptation practice presented in Table 6, revealed that all (100%) the sample respondent participated in land preparation and 98.3% of them participated in manure application and also 98.3% of the sample respondents participated in weeding practices. Moreover 98.3% of the sample respondents participated in harvesting activities. 93.3% of the sample respondents were participated in the fertilizer application activities. 68.3% of the sample respondents were participated in irrigation activities. 13.3% sample respondents were participated in seed treatment activates.

Table 7. Distribution of farmers by land preparation, compost/manure application, seed treatment, fertilizer application practice to green agriculture to adopt climate change

	Land preparation			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
Animal traction	52	86.7	8	13.3
Tractor plough	4	6.7	56	93.3
Hand hoe	42	70.0	18	30.0
Other specify	1	1.7	59	98.3
	Compost/Manure application			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
Farmyard manure	49	81.7	11	18.3
Compost/manure	51	85.0	9	15.0
Other specify	1	1.7	59	98.3
	Seed treatment			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
Fungicide	5	8.3	55	91.7
Other specify	4	6.7	56	93.3
	Fertilizer application			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
40-60Kgs N/ha	22	36.7	38	63.3
90Kg P/ha split application	34	56.7	26	43.3
Others specify	1	1.7	59	98.3
	Weeding			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
Hand weeding one times	2	3.3	58	96.7
Hand weeding two times	56	93.3	4	6.7
Herbicide post emergence	3	5.0	57	95.0
Others specify	0	0	**60**	**100**
	Irrigation			
	Yes		**No**	
	Frequency	**%**	**Frequency**	**%**
In situ water harvesting	39	65.0	21	35.0
Other specify	2	3.3	58	96.7
	Harvesting			
	Yes		**No**	
	Frequency	**%**	**frequency**	**%**
Manual harvesting	58	96.7	2	3.3

4.4. Diversification of Sofi Agricultural Land

Crop diversification is the key to good organic farming. it is a major substitute and clearly more environmentally sound option for the use of chemicals to maintain soil fertility and control pests. To determines farm level diversity of crops, area of the farm land was measured using meter tapes and all crop plants in the farm were enumerated by species. To determine the area share of the crops on the farm land, the different plots constituting the farmland were identified and measured. Then the total area occupied by each crop is summed up to determine its area share within the farm. The abundance of each crop species in the plot were determined by using sample quadrats having sizes of 20mX20m for annual and perennial crops. The data obtained from these measurements were then used to calculate farm level diversity indices. From the study site, a total of 17 crops species was recorded. These are sorghum (*Sorguhm bicolor*), maize (*Zea mays*), sweet potato (*Ipomaea batatas*), groundnut (*Arachis hybogaea*), Coffee (*Coffea arabica*), Chat (*Catha edulis*), Tobacco (*Nicotiana tabacum*), Tomato(*Solanum lycobersicum*), Peanut (*Arachis hybogaea*), Lemon (*Citrus limon*), Cordial (*Cordia africana*), Mango (*Mangifera indica*), Cabbage (*Brassica olracea*), Caster Bean (*Ricinus communis*), Sour Soup (*Annona muricata*), Guava (*Psidium*) and Wild casterard apple (*Annona chrysophylla*).

From the total land coverage of the study area, sorghum, maize, sweet potato and groundnut accounted for about 46%, 14.6%, 13.5% and 7.72%, respectively, in the year 2015. Coffee, Chat, Tobacco and Tomato take the share of 6.4%, 4.23%, 2.16% and 0.86%%, respectively. Furthermore, Peanut, Lemon, Cordial, Mango, Cabbage, Caster Bean, Sour Soup, Guava and Wild casterard apple cover 0.67%, 0.61, 0.43%, 0.37%, 0.37%, 0.24%, 0.24%, 0.18%, and 0.12% of the agricultural land area of the study site, respectively and the rest 1.3% cover other activities.

Table 8. Species diversity index calculation

No	Species Name	Found%	P_i	$\ln P_i$	$P_i \ln[P_i]$	Value
1	Tobacco	2.16	0.021	-3.86	0.08	0.38
2	Caster bean	0.24	0.002	-6.21	0.01	0.35
3	Cordial	0.43	0.004	-5.52	0.02	0.36
4	Sweet botatos	13.5	0.135	-2.00	0.27	0.46
5	Sorghum	46	0.460	-0.78	0.35	0.50
6	Chat	4.23	0.042	-3.17	0.13	0.40
7	Mango	0.37	0.003	-5.81	0.01	0.35
8	Wild casterard apple	0.12	0.001	-6.91	0.0006	0.35
9	Peanut	0.67	0.006	-5.12	0.03	0.36
10	Groundnut	7.72	0.07	-2.6	0.182	0.42
11	Guava	0.18	0.001	-6.91	0.0006	0.35
12	Cabbage	0.37	0.003	-5.81	0.01	0.035
13	Maize	14.6	0.146	-1.92	0.28	0.046
14	Coffee	6.4	0.064	-2.7	0.17	0.41
15	Tomato	0.86	0.008	-4.82	0.03	0.36
16	Lemon	0.61	0.006	-5.12	0.03	0.36
17	Sour sop	o.24	0.002	-6.21	0.01	0.35

We can see from the results that the diversity and evenness of the crops in the study area five species are higher than other species, This implies high values of H would be representative of five species start from the higher one (Sorghum, Sweet potatoes, Groundnut, Coffee and Chat) in the study area. A community with five species would have an H value of 0 because P_i would equal 1 and be multiplied by ln P_i which would equal zero. If the species are evenly distributed then the H value would be high. So the H value allows us to know not only the number of species but how the abundance of the species is distributed among all the species in the community. The result of species diversity showed the crops (Sorghum, Sweet potatoes, Groundnut, Coffee and Chat) are abundance which the farmers are growing it in the study area .

4.5. Soil physical, chemical and biological properties

The result of soil physical, chemical and biological properties for the two cropping system considered is presented in table 9. The mean values of soil physic-chemical properties are highest in mixed cropping system than mono cropping system.

Table 9. Paired samples t-test for Soil physical properties

	Mean	Std. Error	P-value	t-value
Soil texture				
Clay(%)				
Mono-cropping	11.0000	1.50000	0.735	0.352
Mixed cropping	10.3571	.87092		
Sand(%)				
Mono-cropping	81.0000	3.00000	0.724	0.368
Mixed cropping	79.7143	1.65421		
Silt(%)				
Mono-cropping	8.0000	1.50000	0.399	-0.898
Mixed cropping	9.9286	1.04328		
Bulk density (gm/cm^3)				
Mono-cropping	1.300	0.01780	0.010	-3.381
Mixed cropping	1.4440	0.02926		

Soil texture

The result on Table 8 shows that, there is no significant difference between mixed cropping and mono cropping farming system on the silt, sand and clay under the study. The mean of silt, sand and clay for mono cropping was 8%, 81%, 11% and for mixed cropping 9.6%, 3%, 10.3% respectively.

The higher sand particles observed in mono cropping farm use type may be presumably due to erosion caused by the long period of intensive cultivation while the lower proportion of silt particles under mixed cropping suggested that cultivation of crops especially under continuous mono cropping reduces silt particles in soil. This may also be attributed to erosion, which removes finer particles of soil due less vegetative cover that could reduce the impact of raindrops on soil in the cultivated plots. It is necessary to increase the ground cover to reduce soil loss and to incorporate organic manure to aid aggregation and stability of the soil.

Bulk density

The result of bulk density contents of the soil sample showed that, there was a significant difference between mixed cropping and mono cropping farming system. The mixed cropping system showed significantly higher amount of soil bulk density than mono cropping.

The possible reason for the increase of bulk density in soil of mixed cropping is due to increase in the period of cultivation. This was in agreement with works of Sintayehu M .(2006) and Lemenih M *et al*. (2005), who postulated that the significant difference is due to differences in the land management and land use history but contradict.

Bulk density was higher in the mixed cropping however the result corresponds with the observation of (Dalal 1982) that bulk density increases with increase in the period of cultivation. This otherwise shows that as cultivation causes decline in the organic matter, the bulk density increase.

Table 10. Paired samples t-test for Soil chemical properties

	Mean	Std. Error	P-value	t-value
Nitrogen %				
Mono-cropping	9.000	1.22066	0.049	2.335
Mixed cropping	11.700	1.15635		
Phosphorous (ppm)				
Mono-cropping	17.8257	1.06097	0.005	4.054
Mixed cropping	18.2050	1.06766		
Potassium(mg/kg soil)				
Mono-cropping	371.18	32.43499	0.778	0.24
Mixed cropping	337.76	152.84195		
OC%				
Mono-cropping	0.3347	0.25156	0.024	2.876
Mixed cropping	1.5900	0.35668		
PH				
Mono-cropping	7.8040	0.14001	0.123	-1.752
Mixed cropping	8.1029	0.22258		
Exchangeable Ca and Mg(mg/kg soil				
Mono-cropping	0.0008	0.00007	0.519	-0.679
Mixed cropping	0.0031	0.00459		

Total Nitrogen

Total Nitrogen in mixed cropping farmlands was found to be higher than in mono cropping fields .The mean of the two farming system were 11.70% and 9.00% for mixed cropping farmlands and mono cropping farm land ,respectively.

The higher value in mixed cropping farmlands can be explained in terms of the types of crop they grow that fixed nitrogen and rapid humification. The lower mean values in mono may be attributed to inadequate application of nitrogen based chemical fertilizers, increasing immobilization by plants as well as leaching and volatization which is common to most mineral soils (Jones and Weld 1975; Brady and Weil, 2002).

The lower concentration of total nitrogen in mono cropping reflected the organic matter dimunition as organic matter has a direct influence on it (Aweto, 1981). This could be attributed to the leaching of nitrogen in its soluble form as it (leaching) is accelerated by clearing of vegetation and higher percentage of sand content. (Kowal and Kassam 1978) stressed that the nitrogen status of the soil is closely associated with the soil organic matter as it (organic matter) is the major source of soil nutrients. This nutrient decline is also due to nutrient removal while harvesting crops because the crops stores large quantities of nitrogen (Cooke, 1982).

Available Phosphorous

Available Phosphorous (P) which increases plant resistance to disease higher in mixed cropping than mono cropping farming system. The mean was 17.825mg/kg soil and 18.205mg/kg soil for mono cropping and mixed cropping farmlands respectively. The phosphorous content on mixed cropping is basically high. This also goes with high organic matter content obtained on mixed cropping (Adamu and Dawaki .2008).

This finding was in agreement with Moges and Holden (2008) as well as Wolde and Veldkamp (2005) who found higher mean value of available Phosphorous from mixed cropping compared to mono cropping . The higher phosphorous content in mixed cropping could be associated with higher soil organic matter. The application of good organic manure is important for the maintenance of available phosphate to the crops.

Available Potassium

Table 9 shows that, there is no significant difference between the two cropping system on the available potassium. Potassium equally decreases from a mean of 371.18cmol/kg to 337.76 cmol/kg in mono cropping and mixed cropping farmlands respectively. This reduction delays plants growth and hence variation in crop yields is bound to occur between the cropping systems. (Chapman . 1965).

The low amount of K in the mixed cropped soils may have also contributed to the high Ca and Mg values because of its better competitive ability for exchange sites, although their values are not however extremely bad (Foloronsho,1998).

Organic carbon

Organic carbon content of the mixed cropping farmlands was higher than the mono cropping farmlands. The mean of the two cropping system were 0.33% and 0.59% in mono cropping and mixed cropping farmlands respectively. The fairly high level of Organic carbon observed in the mixed cropping site can be due to the humus formed by fallen leafs and dead plant decaying on the surface. Differences between the two cropping systems may reflect the differences in vegetation cover, turnover of organic carbon and the degree and frequency of soil disturbance. The relatively low organic carbon in mono cropping system may be attributed to their lost through extensive cultivation and mixed cropping. (Shah *et al.*, 2003) reported that soil organic C was increased by N inputs from both fertilizer and by retention of residues and by N fixation in case of the legume planted. These results concurred with those reported by (Surekha *et al.,* 2003) and (Shah *et al.,* 2007).

Organic matter content of the mixed cropping farmlands was higher than the mono cropping farmlands. The mean of the two cropping system were 0.57% and 2.60% in mono cropping and mixed cropping farmlands respectively. The fairly high level of Organic matter observed in the mixed cropping site can be due to the humus formed by fallen leafs and dead plant decaying on the surface. Differences between the two cropping systems may reflect the differences in vegetation cover, turnover of organic matter and the degree and frequency of soil disturbance. The relatively low organic matter in mono cropping system may be attributed to their lost through extensive cultivation and mixed cropping.

The analysis of organic carbon is related to Woodruff (1949) view that says whenever virgin soils are brought under cultivation and cropping, organic carbon content generally declines because the amount of organic materials returned to the soil decreases sharply. The lower organic matter content of mono cropping compared to mixed cropping was therefore due to site clearance before cultivation which would have disrupted the rate of organic matter decomposition (Nye and Greenland et al., 1985), and this would have given chance for erosion and leaching to degrade the soil. Meanwhile the soil pH analysis is similar to the findings of (Aweto *et al*., 1992) in south western Nigeria.

Soil pH

The soil PH revealed that there is no significant difference between the pH value of the two farming system and the soils of the two farming system were slightly basic with mean values of 7.8 in mono cropping and 8.1 in mixed cropping. This implies that most nutrients needed by plants will not dissolve easily for proper uptake by roots.

There was no significant variation between mono cropping and mixed cropping as soil erosion is prevalent from these areas .The highest pH value from mixed cropping and mono cropping could be due to high CEC and exchangeable bases. This finding was in line with the findings of Moges and Holden (2008) who found no significant difference in pH.

This result was in agreement with the finding of (Asadi *et al*,. 2010) who found a non-significant difference in soil pH between soils on mono cropping farm land and mixed cropping farm land of semiarid region of Iran. The soil analysis results showed that the soil pH for accumulation and loss zones were moderately acidic based on USDA (1998) ratings, which is similar to the report of Alemayehu (2007) for Anjeni watershed. Due to the excessive rainfall that causes leaching for basic nutrients (calcium and magnesium), which is the major soil nutrient management problem for the soils of humid tropics. Soil pH could also be associated with the type of parent material and extent of soil erosion. For every half-unit drop in soil pH, percent base saturation declines by about 15% (Baruah and Barthakur, 1998).

Therefore, the relatively lower pH mean value could be attributed to the relatively lower base saturation percentage and lower soil organic matter content while the highest pH value in the accumulation zone could be attributed to the presence of higher exchangeable cations due to reduced erosion. The slightly acid nature of the soil will enhance the availability of nutrients and may further facilitate the solubilisation of sodium ions which are the primary agents of salinization and alkalinisation especially in irrigated soils (Alhasan,1996).

Exchangeable Calcium and Magnesium

Table 9 shows that, there is no significant difference between the two cropping system on the content of exchangeable calcium and magnesium. The mean of exchangeable calcium and magnesium content for mono cropping was 0.0008 cmol/kg and 0.0031 cmol/kg for mixed cropping respectively.

The relatively lower mean values in mono and mixed cropping may be attributed to inadequate application of nitrogen based chemical fertilizers, increasing by plants as well as leaching and volatization which is common to most mineral soils (Jones and Weld 1975; Brady and Weil, 2002). These base elements are generally low for mono-cropping and mixed cropping but mixed-cropping has a slight higher value than that of mono cropping. The variation in the base elements will be reflected in the growth rate as well as the translocation and storage of carbohydrates and proteins into seed and tubers. The comparatively low values for the two cropping systems may be a reflection of losses through leaching, cultivation or harvesting (Wilson and Kang, 1983; Jaiyeoba, 1995).

Table 11. Paired samples t-test for Soil biological properties

	Mean (%)	Std. Error	P-value	t-value
Microbial biomass				
Mono-cropping	17.8333	3.9405	0.064	-2.200
Mixed cropping	25.6667	1.6766		

Microbial biomass

The microbial biomass consists mostly of bacteria and fungi, which decompose crop residues and organic matter in soil. This process releases nutrients, such as nitrogen (N), into the soil that are available for plant uptake. About half the microbial biomass is located in the surface 10 cm of a soil profile. When microorganisms die, these nutrients are released in forms that can be taken up by plants.

Microbial biomass of the mixed cropping farmlands was higher than the mono cropping farmlands. The mean of the two cropping system were 17.83 and 25.66 in mono cropping and mixed cropping farmlands respectively. The fairly high level of Microbial biomass observed in the mixed cropping site can be due to soil was wet or have enough organic carbon .

Differences between the two cropping systems may reflect the differences in vegetation cover, turnover of organic carbon and the degree and frequency of soil disturbance. The relatively low microbial biomass in mono cropping system may be attributed to their lost through extensive cultivation and rainfall. (Shah *et al,*. 2003) reported that soil organic C was increased by N inputs, from both fertilizer and by retention of residues and by N fixation in case of the legume planted.

The different agricultural practices can cause positive or negative effects on soil microbial and organic matter content. Management of crop residues influences microbial biomass as they are one of the primary forms of organic carbon and nutrients used by the microbial biomass. In the case of organic agriculture, several studies has showed that the agricultural practices in mono cropping and mixed cropping system, such as addition of compost, straw and natural amendments, promotes positive changes in the soil microbiological and biochemical process, resulting in the increase of soil microbial biomass. In this way, the organic systems are extremely important for the increase of soil fertility and the maintenance of the environmental sustainability (Kaiser *et al*., 1992).

4.6. Economic Analysis Result

Table 12. Annual Production Profiles of the mixed and mono cropping farms in Sofi kebele.

No.	No. of farms	No. of crops	Costs of input (Birr/ha)	Output value (Birr/ha)	Net annual profit (Birr/ha) Mean	Std	T	P value
Mixed cropping system							2.156	0.083*
1	2	5	7850.0	101500.0	93650.0	20718.23		
2	2	7	9200.0	39250.0	30050.0	12657.21		
3	2	9	4850.0	12700.0	7850.0	2616.30		
Mono cropping system								
4	3	2	4550.0	11934.0	7384.0	2240.09		

The economics of organic agriculture a subfield of agricultural economics, encompasses the entire process and effects of organic agriculture in terms of human society, including social costs, opportunity costs, unintended consequences, information asymmetries and economies of scale. Although the scope of economics is broad agricultural economics tends to focus on maximizing yields and efficiency at the farm level. Different crop combinations have different economic potentials. It requires generations of experience to decide on the optimal crop combinations and rotations for sustainable yield and profitability.

The study of (Smolik *et al.,*1995) indicated that depending on crop combinations, alternative agricultural systems with zero chemical inputs were more or less profitable than conventional chemical farming system in South Dacota. This study shows that mixed cropping farming system in the same soil and climate proves economically more efficient than mono cropping farming systems. A summary of the data from the farms that grow identical numbers of crop species is presented in Table 12 above . The data clearly show that the net value of the annual production of an average mixed cropping farm is uniformly more than that of an average mono cropping farm. Crop diversity also helps the farmer reduce risk - if one crop fails or market prices drop, other crops can compensate for the loss.

4.6. SWOT Analysis Results

Table 13. shows analysis of strengths, weaknesses, opportunities and threats of Sofi kebele farmers, which originate from the result of the sample survey and enquiries, evaluating the present climatic conditions and agricultural status of the Sofi district. SWOT analysis is a method on the basis of whose knowledge is to establish a balance between internal capabilities and external possibilities. It is a set of analytical method used to compare their strengths and weaknesses with opportunities and threats that are perceived in the environment.

Table 13. SWOT analysis

Strength	**Weakness**
• Agricultural knowledge • Hard worker • Introduction of promising household water harvesting and micro- irrigation technologies. • Mixed farming system • Better benefit from their products • Crop rotation practices • Strong society rules and regulation • Rapidly increasing population number	• Illiterate (Farmers are not educated) • Poor linkage between research and extension systems • Not suitable for shrub and tree production
Opportunities	**Threats**
• Reforestation • Irrigation farm • Expansion of cash crop (khate and coffee) • Education • Extension • Good marketing opportunity for agricultural products.	• Unexpected heavy rain and flood • Size of farm land • Expansion of desert • Shortage of water • Livestock create problem for crop production • Lack of fund for support green agriculture in the area • Environmental impact (climate fluctuation).

From the interview find that farmers in the study area have agriculture knowledge about organic agriculture practices as adaptation to climate change which is strength factor that can provides agriculture information and advice to farmers and ranchers who don't have agriculture knowledge and the agriculture industry on topics ranging from crop and livestock production to new research and technology, government programs and services and farm business management to create unprecedented opportunities for growth and poverty reduction .

The result showed that most of the farmers were practiced mixed cropping system have better benefit from their products than mono cropping system and that also maintains the life of the soil which farmer conducts different agricultural practice together to increase soil fertility and income through different sources and to complement land and labour demands across the year.

Opportunities for organic agriculture (Table 13) have been forecasted in various ways. organic agriculture could apply particularly in the future its innovative ideas and excellent marketing for instance in the area of organic wellness and health but also in the further development of organic agriculture regions.

To be able to distinguish itself clearly in the future from conventional organic agriculture should be understood as an alternative social concept. Particularly in the future organic agriculture has to withstand an increased liberation, market concentration and an decreasing demand for organic products. Education and consulting as well as the absence of organic agriculture as a general agricultural mission statement has been rated low. With regard to opportunities the connection of organic products with wellness and health aspects followed by the development of a unified organic label and organic regions.

There is poor linkage between research and extension systems in the study area and organic agriculture to be relevant to local needs researchers, extension workers and farmers must play important roles in identifying research problems, adapting the recommendations to local conditions and providing feedback to researchers about the innovations that have been developed.

Lack of fund threat organic agriculture practices because funds as a vehicle for financing agricultural projects and agricultural investment growth has not only been spurred by increased agricultural prices and food security concerns, but also importantly because of innovation and experience in risk mitigation of investment.

The environmental impact depends on the production practices of the system used by farmers threat organic agriculture through climate change, climate change is a critical environmental issue and has broad implications for sustainable development and the future of our economy, health, and food system.

5. SUMMARY AND CONCLUSION

Based on the descriptive statistical analysis, it was found that most of the farmers adopt organic agricultural practices in the study area as adaptation measure for climate changes. Farmers in the study area are well aware of climate change and perform organic agriculture as an adaptation option for climate change. The study revealed that all (100%) the sample respondent participated in land preparation and 98.3% of them participated in manure application and also 98.3% of the sample respondents in participated weeding practices. 98.3% of the sample respondents were participated in harvesting activities. 93.3% of the sample respondents were participated in the fertilizer application activities. 68.3% of the sample respondents were participated in irrigation activities. Therefore this study shows that the Sofi kebele farmers practices organic agricultural activities that benefit them but as a result of institutional factors 93% of the sample respondents utilize artificial fertilizer that is one of the limitation for the 100% practices of organic agriculture.

Results of the soil analysis and household survey revealed that the contents of the soil chemical, physical and biological elements vary between the two cropping system. The finding of the study showed that the land management practices using mixed cropping system have significant role in improving the soil chemical ,physical and biological properties like; soil organic matter, total nitrogen, available phosphorous, pH and bulk density. These made the soil chemical, physical and biological properties in mixed cropping practice are higher than that of mono cropping practices. These imply that different cropping systems effect changes in the content of the soil physical, chemical and biological properties.

Therefore, It is recommended that organic residue be added to the soil, sustainability of the management systems should be enhanced through mixed cropping. This has the advantage of ensuring better efficiency of the added fertilizer and mixed cropping improves the physical attributes of the soil such as moisture holding capacity and resistant to erosion.

Also, recommended support is required from donors, non-governmental organization, private investors and develop appropriate policy and farming communities in joining efforts to support organic agriculture. Support is need in terms of training and experience sharing program given to the local farmers on use of mixed cropping practices for up scaling and Creation of incentives for organic agriculture and promoting organic farming techniques through agricultural research and extension systems.

Furthermore, there is a critical need for improved farmer access to information about climate change , scientific findings and other data that have been assembled and used as the basis for public and private sector decision making on organic agriculture performance opportunities and environmental impacts.

To be successful, wider recognition of the potential of organic agriculture is needed among bodies that currently mainly promote conventional agriculture. An important step could be that agricultural policy begins to prominently support organic agriculture as aadaptation to climate change .

To adopt organic agriculture practices whereby financial institutions and other agricultural funders should extend credit or support to agricultural activities with farming practices and technologies that promote organic agriculture.

As climate change occurs, farmers may need means of sharing and learning very local practices to further adaptation, locally and globally. When natural principals are used as a guide, farmers can reduce their risks and increase their ability to cope with climate change.

6. REFERENCE

Adams R.A.1999. Economic effects of climate change on US agriculture. In: Mendelsohn R. J.E. Neumann eds. 1999 The impact of climate change on the United States economy. Cambridge University Press, Cambridge UK, New York, Melbourne.

Adamu, G. K., and Dawaki, M. U. 2008. NPK level in Multiple Crop Land in a Smallholder Farm Land in Kano Closed Settled Zone. Biological and Environmental Sciences Journal for the Tropics, Bayero University Kano, 5, 88- 97.

Agro Eco BV and Grolink AB. 2008. Organic Exports – A Way to a Better Life. Sida, Uppsala Available athttp://www.grolink.se/epopa/Publications/Epopa-end book.pdf.

Agroeco and Grolink. 2008. Organic Exports – a way to a better life. G. Rundgren ed. Grolink Arbenz, M. 2010. Personal message.

Alemayehu Mengistu, 1985. Feed resource in Ethiopia. pp 35. Proceedings of the second PANESA Workshop on Animal Feed Resources for Small Scale Livestock Producers. Nairobi, Kenya, 11-15 November 1985.

Alemayehu, A. 2007. Impact of Terrace Development and Management on Soil Properties in Anjeni Area, West Gojam. Master's thesis, Addis Ababa University, Ethiopia.

Alhasan, J.1996. Determination of cation exchange capacity and exchangeable bases of soils from Sokoto-Rima River Basin at Kwalkwalawa: A B Sc. project submitted to the department of soil science and Agriculture.

Anonymous.1994. Sustainable Agriculture through Integrated Pest Management . Twenty-Second Regional Conference for Asia and the Pacific, APRC, Manila.

Arce, A. and Marsden, T. 1993. The Social Construction of International Food: exploring its principles for a new research agenda, Economic Geography, 69: 293-311.

Asadi, Raeisvandi, Rabiei, B.and Ghadiri, H. 2010. Effect of land use and topography on soil properties and agronomic productivity on calcareous soils of a semi-arid region, Iran. Land degradation and Development.

Aweto. 1981b. Total nitrogen status of soils under bush fallow in the forest zone of South Western Nigeria. J. Soil Science , 32: 639-642.

Aweto, Obe and Ayanniyi, 1992. Effects of Shifting Cultivation and Continuous Cultivation of Cassava .manihot esculenta. intercropped with maize on a Forest Alfisol in South Western Nigeria. *Journal of Agricultural science Cambridge*, 118: 195-198.

Ayalneh, D. 2003. Integrated national resources management to enhance food security. The case of community based approaches in Ethiopia, FAO, Rome, Italy 1-44.

Aydinalp, C, and Cresser, M. S. 2008. The Effect of Global Climate Change on Agriculture. American- Eurasian Journal of Agriculture and Environmental Science.

Azeez, G. 2009. Soil Carbon and Organic Farming. Soil Association, November 2009. http://www.soilassociation. org/climate.asp. Accessed on Feb. 23/2015.

Barber, R. 1984. An assessment of the dominant soil degradation processes in the highlands their impacts and hazards. Ethiopian highlands reclamation Study. Land use Planning and Regulator Department, Ministry of Agriculture, Addis Ababa, Ethiopia.

Baruah and Barthakur. 1998. A Textbook of Soil Analysis. Vikas publishing House Pvt. Ltd., New Delhi, India.

Bationo, Lompo and Koala. 1998. Research on nutrient flows and balances in west Africa: state-of-the-art. Agriculture, Ecosystems and Environment 71: 19 – 35.

Beddington J. 2010. Food security: contributions from science to a new and greener revolution. Philos Trans R Soc B 365:61-71.

Beder, S. 1997. Global Spin: The Corporate Assault on Environmentalism, Scribe, Melbourne.

Belasco, W.J. 1989. Appetite for Change, Cornell University Press: Ithaca.

Biswas, Bryce and M. Diesendorf. 2001. Model for empowering rural poor through renewable energy Technologies. Bangladesh. Environmental Science and Policy.

Bizikova , Robinson, and Cohen. 2007. Linking climate change and sustainable.

BOFED. 2010. Demographic and socio economic profile of Harari Region.

Bogota, Colombia. 1985. More people, less erosion: Environmental recovery in Kenya. John Wiley and Sons, New York.

Borch, Christensen, Jørgensen, Kristensen, Mathiasen, Nielsen and Pedersen. 2004. Green Technological Foresight on Environmental Friendly Agriculture: Executive Summary. Riso National Library, Denmark. Available at www.risoe.dk

Borron, S. 2006. "Building Resilience for an Unpredictable Future: How Organic Agriculture Can Help Farmers Adapt to Climate Change." Rome: FAO, Sustainable Development Program.

Boyle, G. and Harper, P. 1976. Radical Technology, Penguin Books, Melbourne.

Brandy. N. C. and Weil, R. R. 2002. *The Nature and Properties of Soils* 13th edition. New Jersey: Prentice Hall.

Brawn. Byers and Cheong. 1994. High-altitude railway designed to survive climate change.

Brook and Bhagat, Gaurav. 2004. Hope in Jatropha: India Gives Biofuels a Chance to Grow.

Bruin. K. 2011. An Economic Analysis of Adaptation to climate Change under Uncertainty. Unpublished Doctoral Dissertation, University of Wageningen, the Netherlands.

Burch. D. and Goss, J. 1999. Global Sourcing and Retail Chains: Shifting Relationships of Production in Australian Agri-foods, in Rural Sociology, May 1999.

Burton, I., B. Lim. 2005. Achieving Adequate Adaptation in Agriculture, Climatic Change.

Byerlee, D. and Janvry, 2007. World Development Report 2008: Agriculture for Development. World Bank. Washington D.C.

Campbell, H. 1996. Organic Agriculture in New Zealand: Corporate Greening, Transnational Corporations and Sustainable Agriculture, in Burch, D., Rickson, R. and Lawrence, G.eds Globalization and Agri-food Restructuring: Perspectives from the Australasia Region, Avebury, Aldershot: 153-169.

Cattanach, Pandy and Navy.1995.Agriculture Biotechnology-based Green Enterprise Development for Sustainable Rural Livelihoods and Economic Growth: Opportunities with biofuel in selected Asian Economies .APCAEM, Beijing.

CEA 2006.Climate Change and Natural Events–Insurers contribute to face the challenges.Comité Européendes Assurances,Paris,27pp.

Cervantes-Godoy, D. and J. Dewbre. 2010. "Economic Importance of Agriculture for Poverty Reduction" OECD Food, Agriculture and Fisheries Working Papers, No. 23.

Chapman, H. D. 1965. "Cation Exchange." In Black, C.A. eds. *Methods of Soil Analysis American Society of Agronomy Monograph, 9*(2), 891-90.

Chaturvedi, S.2007. Agriculture Biotechnology-based Green Enterprise Development.

Chen, Y., Pan, J. 2002. Rural Energy Patterns in China. Chinese Academy of Social Science China.

Clive A. Edwards, Rattan Lal, Patrick Madden, Robert H. Miller, and Gar House. 1989. editors, Sustainable Agricultural Systems ,Soil and Water Conservation Society.

CMS(Content Management System). 1996. Biogas Technology: A Training Manual for Extension . FAO, support for Development of National Biogas Programme cited in Karki, A.B., Shrestha, J.N., and Bajgain, lable at http://www.ecoworld.com/.

Cooke, G.W., 1982. Fertilizing for Maximum Yield. 3rd Edn., Granada Publishing Ltd., London.

Cookson WR, Murphy DV and Roper M 2008. Characterising the relationships between soil organic matter components and microbial function and composition along a tillage disturbance gradient. Soil Biology and Biochemistry, 40: 763-777.

CSA(Central Statistical Agency). 2013. Ethiopia household income, consumption, and expenditure surveys, Available www.csa.gov.et. Accessed on march 3/2014.

Dalal, R.C. and R.S. Mayer, 1986a. Long-term trends in fertility of soils under continuous cultivation and cereal cropping in South Western Queensland, I overall changes in soil properties and trends in wintercereal yields. Aust. J. Soil Res., 24: 265-279.

Dalal, R.C., 1982b. Organic matter content in relation to the period of cultivation and crop yields in some subtropical soils. 12th International Congress. Soil Science., 6: 59.

Daniel, NMA ,Wondwossen .2008. The relationship between land use change and climate change. *journal of Ecological Applications*. p. 7, 753–769.

Deressa, T. T. 2007. Measuring the Economic Impact of Climate Change on Ethiopian Agriculture: Ricardian approach. World Bank Policy Research Paper No. 4342.World Bank, Washington, DC. development at the local level," Climate Policy 7(4): 271–77.

El-Hage Scialabba, N., and C. Hattam, eds. 2002. Online document. Organic Agriculture, Environment, and Food Security. Environment and Natural Resources Service.

FAO and ILO. 2009. Food and Agriculture Organization of the United Nations, Statistical Databases, Online at http://faostat.fao.org. Accessed on dec.23/2015.

FAO. 2001. The Role of Agriculture in the Development of LDCs and their Integration into the World Economy. Paper Prepared for the Third United Nations Conference on the Least Developed Countries. Rome, Food and Agriculture Organization of the United Nations.

FAO. 2004. Drought impact mitigation and prevention in the Limpopo River Basin ,A situation analysis. Land and Water Discussion Paper4,FAO,Rome, 160pp.

FAO. 2005. Impact of Climate Change, Pests and Diseases on Food Security and Poverty Reduction. Special event background document for the 31st Session of the Committee on World Food Security. Rome. 23-26 May 2005.

Fein, J. 2003. Learning to Care: Education and Compassion. *Australian Journal of Environmental Education* P19: 1–13.

Foloronsho, E. 1998.Evaluation of soil fertility status Under Irrigation in Jakara River Valley: A case study of Air-Port Road-Katsina Road, Kano Metropolis; Post Graduate Diploma in Land Resources Thesis; Geography department, Bayero University, Kano.

Gardiner and Miller. 2004. Understanding Farmers: Explaining soil and water conservation in Kons Walaita and Wello, Ethiopia. PhD. Dissertation Wegeningen University. The Netherlands.

Gbetibouo G. A. 2009. Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa. IFPRI Discussion Paper 00849.

Gereffi, G., J. Humphrey and T. Sturgeon,T. 2005. The Governance of Global Value Chains. Review of International Political Economy. P.12: 78-104.

Greening Agricultural Transformation in Ethiopia .GATE. 2013. Ministry of Foreign Affairs, Denmark Embassy in Addis Ababa .

Greenpeace .2010. Ecological farming: Drought-resistant agriculture, University of Exeter, UK, GRL-TN 02/2010 Grolink 2009. Organic Agriculture Development. ed. G. Rundgren, Grolink.

Hallegatte, S. Heal, G. Fay, M. Treguer, D. 2011. From Growth to green Growth, A Framework The World Bank wps 5872.

Hoyle FC and Murphy DV 2006b Seasonal changes in microbial function and diversity associated with stubble retention versus burning. *Australian Journal of Soil Research*, 44: 407-423.

Hoyle FC, Murphy DV and Fillery IRP 2006a Temperature and stubble management influence microbial CO_2-C evolution and gross transformation rates. Biochemistry. 38: 71-80.

HPRS 2011. Harari People Regional State, Programme of Plan on Adaption to Climate Change Technical and Financial Support: Environmental Protection Authority of the Federal Democratic Republic of Ethiopia.

IFOAM .International Federation for Organic Agriculture Movements .2006. Mitigation and Adaptation to Climate Change: The Role of Organic Agriculture. IFOAM side event to the 24th Session of the Subsidiary Bodies, Bonn, Germany, May 24, 2006.

IPCC. 2001. IPCC third assessment report climate change. 2001. impacts, adaptation and vulnerability. Published for the Intergovernmental Panel on Climate Change by UNEP/GRID Arendal, 1032pp. Retrieved from http://www.ipcc.ch/.

Jaiyeoba, I. A. 1995. Changes in Soil Properties Related to Different Land uses in part of Nigerian Northern Savanna. *Soil Use and Management, 11*, 84-89.

Jarvis, A. Varma, A. Ram, J. 2011. "Assessing green jobs potential in developing countries, A practitioner's guide" ILO Geneva.

Jones, M. J. and Wild, A. 1975. *Soils of the West African Savanna: The Maintenance and Improvement of their Fertility.* Haependen Commonwealth Agricultural Bureau.Kwara State of Nigeria. *Kwara State Diary*, Government Press Ilorin .1993.

Jürgens, I .2002 . Study of the effects of climate change on agriculture: Policy implications Presented at the sixth session of the OECD Joint Working Party on Agriculture and Environment, Paris.

Kaiser, Elzakker and Alonso. 1992. Evaluation of methods to estimates the soil microbial biomass and the relationship with soil texture and organic matter. Soil Biology and Biochemistry**,** v.24, p.675-683.

Kebede , Kunjal and Coffin. 1990. Adoption of new technologies in Ethiopian agriculture: The case of Tegulet-Bulga District, Shewa Province. Agricultural Economics.4: 27- 43. Koch 2007.

Kowal, J.M. and A.H. Kassam, 1978. Agricultural Ecology of Savanna. A Study of West Africa, Clarendon Press, Oxford, UK.

Krebs, C,J .1999. Ecological methodology . Benjamia /seris in the life science. Cummings ,California. Kwara State of Nigeria. *Kwara State Diary*, Government Press Ilorin 1993.

Lemenih M, Karltun E and Olsson M. 2005. Assessing soil chemical and physical property responses to deforestation and subsequent cultivation in small holders farming system in Ethiopia. *Agriculture, Ecosystems and Environment*. P. 105:1-2.

Lundqvist, Fraiture and Molden. 2008. Saving Water: From Field to Fork Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief.IWI.

Maddison D., 2006. The perception of and adaptation to climate change in Africa CEEPA. Discussion paper No. 10. Centre for Environmental Economics and Policy in Africa. Pretoria, South Africa: University of Pretoria.

Magurran , A , E .2004. Measuring Biological Diversity . Black - well , oxford / Victoria .

Matous ,P,Y, Todo. 2013. Agricultural Intensification and Ecosystem Properties.Journal of Science. p. 277: 504–509.

Mia Mac Donald and Justine Simon .2010. Climate, Food Security and Growth: Ethiopia's Complex Relationship with Livestock. Brighter Green

Moges, A., and Holden, N. M. 2008. Soil fertility in relation to slope position and agricultural land use: A case study of Umbulo catchment in southern Ethiopia. Environmental Management, 42, 753-763.

Msangi, Tokgoz, Batka and Rosegrant. 2009. Investment Requirements Under New Demands on World Agriculture, paper presented at the FAO Expert Meeting, 24-26 June, Rome on How to Feed the World in 2050.www.fao.org/wsfs/forum2050/wsfs-backgroun documents/wsfs-expert-papers/en/. *Accessed on mar.3/2015*.

Murphy , Sparling GP and Fillery IRP. 1998. Stratification of microbial biomass C and N and gross N mineralization with soil depth in two contrasting Western Australian Agricultural soils. *Australian Journal of Soil Research* 36: 45-55.

Nelson, and Thompson .2009. Barriers perceived by administrators and faculty regarding the use of distance education technologies in pre- service programs for secondary agricultural education teachers. *Journal of Agriculture and Education* 46: 3.

Nhemachena and Hassan .2007. Micro-level analysis of farmers adaptation to climate change in Southern Africa. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute, Washington, D.C.

NRE.2008. Ministry of Natural Resources and Environment, Malaysia http://www.nre.gov.my/opencms/opencms/NRE/EN/Services/Water/geothermal.htmlnt for Sustainable Rural Livelihoods and Economic Growth: Opportunities with biofuel in selected Asian Economies .APCAEM, Beijing.

Nye, P.H. and D.J. Greenland, 1998. The soil under shifting cultivation. Plant Soil, 21: 101-112.

OECD .2008. Environmental Performance of Agriculture in OECD Countries since 1990, OECD, Paris .

OECD .2010a. Climate Change and Agriculture: Impacts, Adaptation and Mitigation.

OECD .2010b. Interim Report of the Green Growth Strategy: Implementing our Commitment for a Sustainable Future, Meeting of the OECD Council at Ministerial Level 27-28 May 2010, www.oecd.org/dataoecd/42/46/45312720.pdf.

OECD forthcoming 2010, Climate Change and Agriculture: Impacts, Adaptation and Mitigation, Paris.

OECD(Organization for Economic Cooperation and Development) .2001. Adoption of Technologies for Sustainable Farming Systems: Wageningen Workshop Proceedings.

OECD, Paris. OECD .2004. Agriculture and the Environment: Lessons Learned from a Decade of OECD Work, OECD, Paris. Production of Fruits and Vegetables in Ethiopia, Addis Ababa

Purohit .2004.Water and soil conservation for sustainable agriculture. United Nations Environment Programme. International Federation of Agricultural Movements.

Rounsevell. Syndikus and Kroschel 1999. The Corporate Assault on Environmentalism, Scribe, Melbourne. Belasco, W.J. 1989. Appetite for Change, Cornell University Press: Ithaca.

Sachs. Babcock and Castle. 1998.The relationship between land use change and climate change. Ecological Applications, 7, 753–769 .

Science Council of the Consultative Group on International Agricultural Research .CGIAR .2005, System Priorities for CGIAR Research 2005-2015, Rome.

Shah . Lyons and Hughes.2003. Determinants of farmers' willingness to participate in soil conservation practices in the highlands of Bale: The case of Dinsho farming system area.

Shah.Brawn and cooke J. 2007. Regulating Meaning, Appropriating Nature: The Codification of Califorinia Organic Agriculture, Antipode, 30, 2: 135-154.

Sintayehu M.2006, Land Use Dynamics and its Impact on Selected Physicochemical Properties of Soils in YabelloWoreda of Borana Lowlands, Southern Ethiopia [M.S. thesis], Haromaya University, Haromaya, Ethiopia.

Smolik, J.D., T.L. Dobbs, and D.H. Rickerl. 1995. The relative sustainability of alternative, conventional, and reduced-till farming systems. Amer. J. Alternative Agric. 10:25-35.

Strietska - Ilina, Hofmann, Duran Haro, M. and Shinzoung. 2011 Skills for Green Jobs, A Global View. ILO, Geneva study.pdf Sustainable Development Department, Food and Agriculture Organization of the Unite.

Surekha Lawrence and Sach .2003. Estimation of available phosphorous in soils by extraction with Sodium bicarbonate, U.S. Department Agriculture . p. 939.

Tan, H.K.1996. Soil sampling, preparation and analysis Marcel Dekker., New York.

The World Bank 2010 World Development Report .Development and Climate Change.

Trochin, William M.K.2006. Descriptive statistics Research Method Knowledge Base. Retrieved 14 March 2011.

UNEP and IFOAM. 2011. Organic Agriculture: A Step Towards the Green Economy in the Eastern Europe, Caucasus, and the Central Asia Region. Case studies from Armenia, Moldova and Ukraine. United Nations Environment Programme. International Federation of Agricultural Movements.

UNEP. 2011. Towards a Green Economy Agriculture . advance copy online release. The World 2010 World Development Report .Development and Climate Change . UNEP : http://www.unep.org/greeneconomy/SuccessStories/Organicagric agriculture in Uganda/tabid/29866/.

USDA. 1998. Conservation Service, Soil Information Sheet, Soil quality Indicators: pH. Natural Resources. Retrieved from http://soils.usda.gov/sqi/publications/files/indicate.pdf.

Wilson and Kang .1983. Forging New Cultures of Food: Retailer-Manufacturer Relations, in N. Wrigley and M. Lowe (eds), Retailing, Consumption and Capital: Towards A New Retail Geography, Longman, London.

Wittenberg and brawn.2004. Is Organic Farming more Profitable? Organic Agriculture Centre of Canada (OACC). Available at:http://www.org.asp Accessed on Mar. 23/2011.

Wolde, M., and Veldkamp, E. 2005. Impacts of landuse changes on soil nutrients and erosion in Tigray, Ethiopia, Conference on International Agricultural Research for Development, Deutscher Tropentag 2005, Stuttgart-Hohenheim, October 11-13, 2005.

Wondwossen Sintayehu .2008. Climate change: global and national response. In: Green Forum Climate change a burning issue for Ethiopia: proceedings of the Green Forum Conference held in Addis Ababa, 31 October–2 November 2007. Addis Ababa: Green Forum. p37–69.

Woodruff, C.M., 1949. Estimating the nitrogen delivery of soil from the organic matter determination as reflected by sanborn field. Soil Sci., 14: 208.

Yesuf, M., Falco, D. S., Deressa, T., Ringler, C., and Kohlin, G .2008. The Impact of Climate Change and Adaptation on Food Production in Low-Income Countries. Ethiopia

Development Research Institute. International Food Policy Research Institute. Discussion Paper No: 828, Washington D.C. IFPRI.

You, and Ringler. 2010. Hydro-Economic Modeling of Climate Change Impacts in Ethiopia. IFPRI Discussion Paper No. 960.Washington, DC: International Food Policy Research Institute, 2010.

Young . 1976. Critical examination of rapid method for determining organic carbon in soils, effect of variation in digestion conditions and an inorganic soil constituent. Soil Science, 632.251.

7. APPENDIX

Appendix 1.Conversion factors used to calculate TLU

Livestock category	TLU
Calf	0.2
Heifer	0.75
Cow and Ox	1
Donkey	0.7
Sheep and Goat	0.13
Chicken	0.013

Appendix 2 List of Crop Species Grown on Sofi kebele

Common Name	**Scientific Name**
Cereals and Millets	
Sorghum	*Sorguhm bicolor*
Maize	*Zea mays*
Coffee	*Coffea arabica*
Chat	*Catha edulis*
Tobacco	*Nicotiana tabacum*
Legumes	
Groundnut	*Arachis hybogaea*
Peanut	*Arachis hybogaea*
Vegetables and fruit	
Sweet potato	*Ipomaea batatas*
Tomato	*Solanum lycobersicum*
Wild casterard apple	*Annona chrysophylla*
Cordial	*Cordia africana*
Cabbage	*Brassica olracea*
Caster Bean	*Ricinus communis*
Sour Soup	*Annona muricata*
Guava	*Psidium*
Lemon	*Citrus limon*
Mango	*Mangifera indica*

Evaluation of green agriculture practices as adaptation to climate change in Sofi district, Harare regional state , Ethiopia

Date of interview: Day:……………Month…………………….Year:..................................

Interviewed by:...

Starting time: …………………… Ending time: …………………………......

Date checked: Day: …………...Month:……… ……………………Year:....................

Checked by: ....

Date entered: Day: ....Month:………… ……………Year: ....

Region……………….. District ………………………

1. Household composition

Name of HH member (start with respondent)	Relation to HH Code A	Gender (0=male;1=female)	Marital status (Code B)	Age (years)	Education level Code C	Religion (Code D)
1						
2						
3						
4						
5						
6						

Codes A
1 Household head
2 Spouse
3 Son/daughter
4 Parent
5 Son/daughter in-law
6 Grand child
7 Other relative
8 Hired worker
9 Other, specify…

Codes B
1 Married living with spouse
2Married but spouse away
3 Divorced/separated
4 Widow/widower
5 Never married
6 Other, specify…

Code C
0 None (illiterate)
1 Basic (can write and read)
2 Lower primary (1-4)
3 Upper primary (5-7)
4 Secondary (9-12)
5 High education (13 -14)
6 College

Codes D
0 Moslem
1 Christian
2 Other, specify

2. Household items

Asset name	Number	Purpose Code A	Current per unit value (Birr)	Total value (B	Year of acquisition of this item	Walling material for the building Code B	Roofing material for the building Code C	Type of house is timber (0=no; 1=yes)
1. Homestead								
2. Other building								
3. Satellite dish								
4. Gas oven								
5. Sofa								
6. Chairs								
7. Tables								
8. Shelf/wardrobe								
9. Bed								
10. Carpet/matt								
11. Other furniture								
Other								
12.								
13.								

Codes A
1 Residential/sleeping
2 Livestock pen
3 Store
4 Farm building
5 Other, specify………….

Codes B
1 Bricks (stone/mud)
2 Stone
3 Mud
4 Unburned bricks
5 Other, specify………..…

Codes C
1 Grass thatch
2 Iron sheet
3 Tiles
4 Other, specify……………

3. Food expenditure fill the following table for the consumption of the whole household for the last 12 month

Expense Item	How many month in the last 12 month did you buy this item?	Frequency of purchase per month (e.g. 2 times/month)	What is the average quantity you bought each time?		If previous cannot be answered: What is the average quantity bought per month?		What is the average price for this item per unit?	If previous cannot be answered: How much did you spend for this item per month?	Total value of item received as gift in the last 12 month
			Quant	Unit	Quant	Unit	**Birr**	**Birr**	**Birr**
Coffee									
Khat									
Sorghum									
Maize									
Peanut									
Ground nut									
Tomato									
Cabbage									

Sweet potato									
Tobacco									
Caster bean									
Cordia									
Wild custard apple									
Mango									
Guva									
Lemon									
Soursop									
Animal origin foods									
Beef meat									
Sheep meat									
Goat meat									
Chicken									
Fish									
Other meat, specify									
Milk									
Butter									
Cheese									
Eggs									
Other, specify									

4. Agricultural production (land holdings during the planting season (in acre)

	Total	Cultivated land	Fallow land
Own			
Rented in			
Total			
Rented out			

5. Variety Adoption and Sources of Information and Seed

Crop (Codes A)	Varieties known	Main source of variety information (Codes B)	Ever planted? (Codes C)	If NO, Why? (Codes D)	If YES, year first planted	Main source of first seed (Codes E)	Quantity of first seed kg	Means of acquiring first seed (Codes F)	Planted variety in 2010/11 season? (Codes C)	If NO in 2010/11 why? (Codes D)	Will you plant the variety in future? (Codes C)	If No, why? (Codes D)

Codes A	Codes B	Codes C	Codes D	Codes E	Codes F
1. sorghum, 2. khat 3. coffee 4. Maize	1. Government extension 2. Farmer club 3. Research centre: on-farm trials/demos/ field days 4. Seed/grain stockist 5. Another farmer/ neighbour 6. Radio/newspaper/TV 7. Other, specify…...……	0. No 1. Yes	1. Cannot get seed at all 2. Lack of cash to buy seed 3. Diseases & pests 4. Poor taste 5. Requires more rainfall 6. Low yielding variety 7. Poor prices 8. No market 9. Requires high skills 10. Seeds are expensive 11. Other, specify…………	1. Research PVS 2. Extension demo plots 3. Farmer club 4. Local seed producers 5. Local trader or agro-dealers 6. Farmer to farmer seed exchange (relative, friend,) 7. NGOs 8. Govt agency 9. Inherited from family 10. Other (specify)……	1. Gift/free 2. Borrowed seed 3. Bought with cash 4. Payment in kind 5. Exchange with other seed 6. Other, specify…..

6. Crop production

Operations	**Recommended technologies for sorghum**	**Tick if used**
1. Land preparation (Ploughing primary and secondary tillage)	Animal traction	
	Tractor plough	
	Hand hoe	
	Other, specify………..	
2. Compost/Manure application	Farmyard manure	
	Compost manure	
	Other, specify………..	
3. Seed treatment	Fungicide	
	Other, specify………..	
4. Fertilizer application	40-60Kgs N /ha	
	90Kgs N/ha split application and p	
	Other, specify………..	
5. Weeding/Herbicide application	Hand weeding 1 times	
	Hand weeding 2 times	
	Herbicide –pre emergence	
	Herbicide post emergence	
	Other, specify………..	
6. Irrigation	In situ water harvesting	
	Other, specify………..	
7. Harvesting	Manual harvesting (Cutting the heads)	
	Other, specify………..	

- **For the last five years**

Name of crop (Code A)	**Annual cost (Birr)**	**The benefit from crop residues (Code B)**	**The return for each crop (Birr)**	**Name of crop**	**Limitations (Code c)**

Codes A
1 Coffee
2 Sorghum
3 Khat
4 Maize
5 Other

Codes B
1 Burning of crop residue
2Composting organic
3 Feed farm animals
4 Others

Code C
1 Lack of information about buyer
2.Lack of information about places
3 Low price
4 Need to travel long distances
5 Lack of information about prices
6 Broker fix the price
7 Others (specify)…

7.Livestock (Livestock production activities)

Animal type	No. of animals 12 month ago	Value in Birr/ animal 12 month ago	Animal type	No. of animals 12 month ago	Value in Birr/ animal 12 month ago
Cattle			**Goats**		
Milking cows			Mature milking goats		
Crossbred/improved milking cows			Other mature female goats		
Exotic milking cows			Mature male goats		
Other non milking cows (mature)			Young goats		
Trained oxen for ploughing			**Sheep**		
Oxen			Mature female sheep		
Heifers			Mature male sheep		
Calves			Young sheep (ram and lamb)		
Other livestock			**Other livestock**		
Mature trained donkeys			Bee Hives		
Young donkeys			Cock and hen		
Mature chicken			Poultry		

What are the main sources of feed for your livestock? and How is dung from livestock utilized? (Use codes below).

Livestock Type	FEED SOURCE(Code A)	Dung Utilization (Code B)	Annual cost (Birr)	The return for each Livestock (Birr)

Code A
1 Grazing grass 2 Grazing stubbles 3 Dry folder (hay) 4 Dry folder (forage) 5 Green folder
6 Green folder 7 Concentrate
Code B
1.Fuel (dung cake) . 2.Fuel (biogas). 3. Manure/organic fertilizer. 4.Sold. 5.Not used. 6.Other specify

9. Livestock maintenance costs

Description	Total quantity per year	Unit	Total quantity from own source	Unit	Total quantity bought	Unit	Per unit price (Birr)	Total cost (Birr)
1.Crop residue								
2.Green fodder								
3.Dry fodder (hay)								
4.Concentrates								
5.Veterinary services								
6.AI services								
7.Herds boy (animal tending)								
Other costs, specify								