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Traditional farming in Horro Guduru Wollega Region in Ethiopia and its effect on environmental and economic sustainability

BSc. Thesis

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Declaration

I declare that I have elaborated my B.Sc. thesis aimed at "Traditional farming in Horro Guduru Wollega Region in Ethiopia and its effect on environmental and economic sustainability" independently under the leadership of my supervisor (Ing. Josef Holec, PhD). I have used only the literature and other information sources that are cited in the work and listed in the bibliography at the end of the work. As the author of the thesis, further I declare that I am related to its creation and did not infringe the copyright of third parties.

April 12th, 2013 In Prague

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Tarike Terefe

Summary

There has been growing interest in finding alternatives to the modern farming methods that have emerged during the 20th century. The venomous effects of pesticides, inefficient fossil fuel usage, chemical fertilizer inputs genetic monocultures etc. have become increasingly apparent. One approach to circumvent the deleterious effect of this farming system is to build upon traditional methods, which are based on traditional knowledge systems. Since food production systems are complex, peoples' knowledge base for managing them can be very sophisticated. The experiences of farmers in traditional systems over centuries of food production without external inputs, capital , has guided the development of sustainable agro-ecosystems managed with locally available resources and human and animal energy in many parts of the world.

Ethiopia has welcomed three approaches of modern farming system in the name of agricultural extension during the Imperial, Military, and EPRDF regimes for the last eight decades. Although the agricultural productivity has been improved during these regimes, there is a deleterious effect on environment and crop diversity of the farming community as a whole. The farming communities of Horro district have their own traditional way of crop production. They use a unique farming calendar with different farming operations within a given calendar. Their traditional in-situ manuring practices using temporary cattle sheds and a subsequent prioritization of planting crops as part of general crop rotation have been their traditional way of maintaining soil fertility, crop diversity and clearer environment. Diversifying the crop types and crop verities also helped the people of the area for storing and providing highly demanded crops to the local market. This strategy of producing diversified crops was one of reason of economic stability of the farming communities for centuries.

The introduction of modern way of farming has brought serious environmental and economic problems to the farmers of the study area. Intensive application of nitrogen fertilizers has resulted in soil acidity and eutrophication of rivers, springs, lakes and ponds. The use of industrial made agricultural inputs have initiated the cultivation of few crop types on extensive farmland as it simplifies the farming operations such as weeding. This has resulted in shrinking of crop variety and its subsequent effect on unstable economic situation of the farmers.

Key words: Traditional farming, modern farming, environment, crop diversity, sustainability .

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1. Introduction

Around the world, there is growing interest in finding alternatives to the industrial or modern farming methods that have emerged during the 20th century. The noxious effects of pesticides, chemical fertilizer inputs and genetic monocultures has become paramount. Due to its effectiveness on maximizing productivity per a given area of land, the modern way of farming has contributed a lot in feeding the ever increasing our global population. This has come in to play on the expense of the quality of water, soil and climate of our precious plant. One approach to circumvent the deleterious effect of this farming system is to build upon traditional methods of farming. These oldest way of agriculture produced a tremendous variety of domesticated crops and livestock, and systems of farming. In such a way, these methods were able to sustain diverse cultures of knowledge for centuries. Unfortunately, within the last generation, much of the knowhow of traditional systems has been lost, especially in the more industrialized countries.

One definition of traditional farming is where the farmer has a mixed farm of livestock and crops. They use manure from the livestock to fertilize the crops and some of the crops to feed the livestock. Farmers of this type operate with the minimum of supplies purchased from outside the farm. This type of farming involves intensive human and animal labor for farming operations, and it is still common in most developing countries such as Ethiopia.

Horro district is one of the most agricultural productive area in western Ethiopia. The farmers of the area used to produce enough crop and livestock products for their households by using their own knowhow that accumulated and transferred from generation to generation. Since recent years, the introduction of modern agriculture (so called Agricultural Extension) with intenssive use of agricultural inputs have been shifting the agricultural practices towards the production of limitted types and varieties of crops and animals that yield maximum production. There has been visible soil, water and forest degradation and unstable economic situation of the farmerming comunities. This paper is to asses the historical background of traditional and quasi modern modern farming systems of the area and to analyse the traditional way of farming with respect to the economic stability of the farming communities and environemental sustainability issues.

2. Objectives of the study

2.1.Main objective

- The main objective of the study is to assess the mechanisims of traditional farming practices and its contribution to environmental and economic stabilities of the livelihood of the farming communities of the study area.

2.2.Specific objectives

- To study how farmers of the study area have adopted the traditional farming practices, and the constraints of Agricultural Extension.
- To study how the farmers of the study area define and use seasons in relation to crop production.
- To highlight the chanllenges within traditional farming practices due to global climate changes and other uncertainties.
- To assess the traditional way of maintaning soil fertility and the susequent sytems of crop ratation and prioritization used by the farmers of the study area and its contribution to maintan crop diversity.

2.3.Problem statement

Horro Distric is the most greenest, and surplus producing pockets of areas in ethiopia. Farmers of the study area have developed their own way of farming operations with a unique farming calendar. They used to practice the farming with properly maintaning the fertility of the soil by applying traditional manuring system. Since the introduction of ‘Agricultural Extension’, the farmers are complaining of the environmental pollution and degradation of their land quality. The disturbance in rainy seasons due to global climate change has become a puzzle for the farmers. Crop diversity is also decreasing due to the favor of monocultures with agricultural inputs which resulted in disappearance of some crops from the market relating the problem with the issue of economic instability.

3. Literature Overview

3.1. Traditional farming

Traditional and indigenous knowledge for crop production, sustainable land use and agro-ecosystem management has received increasing attention in recent years, especially in third world countries where resource-poor, low-input and smallholder farming systems are practiced (He et al., 2006). A tradition is the art or knowledge handed down from generation to generation by custodians of culture in any human community. Such knowledge is born out of decades or centuries of interaction with and experimentation within the environment. Thus, traditional knowledge systems are built and modified with information derived from the interaction of people with their environment from where the most adaptive information for a particular function is selected for use. Such successful adaptations are preserved and passed from one generation to another through verbal and experimental means (Alteiri, 1990).

Traditional knowledge is specific and interactive, especially at the microscale (Osbahr and Allan, 2003; Malley et al., 2004). Since food production systems are complex, peoples' knowledge base for managing them can be very sophisticated. Thus, in the study of any traditional or modern agricultural system, production should not be analyzed separately from the human culture that nurtures the system. According to Alteiri (1990), however, until recently agricultural development programs to modernize traditional food production systems have generally prescribed purely technological solutions to problems which are also environmental, cultural, social and economic in nature. The tragic consequence has too often been a mismatch of development objectives to the needs and potentials of local people. To obviate this tragedy, development planners must study and understand some basic features of traditional agriculture, such as risk bearing capacity, biological folk taxonomies, symbiotic crop mixtures and sustainability criteria.

The study of traditional farming system also helps us to apply ecological principle to the design of improved food production in industrial nations. Practical application of traditional agriculture knowledge could help to correct deficiencies that affect modern agriculture. Many such deficiencies are related to the substitution of high energy inputs for local biological and cultural resources. The experiences of farmers in traditional systems over centuries of food production without external inputs, capital or scientific knowledge, has guided the development of sustainable agro-ecosystems managed with locally available resources and human and animal energy in many parts of the world. Thus, many agro-ecologists view traditional farming systems as unique opportunities to evaluate the properties of stability and sustainability, and to obtain ideas about alternative design and management of agroecosystems (Alteiri, 2004).

3.1.1. Traditional Farming Systems and the Sustainability Perspectives

As it pertains to agriculture, the word “Sustainable” describes framing systems that are capable of maintaining their productivity and usefulness indefinitely. Such systems must be resource conserving, socially supportive, commercially competitive, and environmentally sound. In traditional way of farming, farmers have been overcoming or minimizing enormous production constraints associated with low soil productivity, steep landscapes, floods, erosion, droughts, pests and diseases, and etc. by applying unique management principles using traditional techniques. Today such are known as principles of Agroecology and Sustainability. A full list of the Principles of Agroecology and Sustainability has been compiled by Reijntjes *et al.* (1992*).* Sustainable Farming Systems must possess characteristics that utilize majority of the principles:

- Use of Renewable Resources of energy and materials that occur naturally and can be recycled on farm.
- Minimization of toxicity and environmental pollution.
- Conservation of soil chemical and physical properties
- Conservation of water and energy.
- Conservation of genetic resources by saving seeds and maintaining local landraces.
- Managing ecological relationships by integrating fauna and biota to minimize the effects of pests, diseases and weeds while encouraging beneficial effects.
- Recycling nutrients through residues and manures.
- Adjusting to local environments by matching cropping patterns to the productive potential and physical limitations of the farm landscape and adapting plants and animals to the farm ecology instead of modifying the farm to meet the needs of the crops and animals.
- Diversifying by utilizing various landscapes and top sequences and integrating the Biota.

- Using sound economics by avoiding single commodity farming, using alternative markets, processing to add value to products, avoiding dependence on external subsidies, finding alternative incomes via off-farm activities.
- Empowering the people to control their development process by encouraging local partnerships, linking farmers with consumers and ensuring intergenerational fairness.
- Maximizing long term benefits socio-culturally, economically and in building up of soil organic matter and general fertility.
- Placing great value on health by considering the effects of all practices on man, animals and plants.

3.2. Historical background of modern farming system in Ethiopia in general

The introduction of modern farming system in Ethiopia started during the imperial regime (The regime by king Haile Silassie who ruled Ethiopia between the years 1930-1974) in the form of 'Agricultural Extension' (Kebede, 2008). The base for the start of real agricultural extension at that time was the agreement between the US and Ethiopian government signed in 1952 with broad mandate such as; high level man power training, agricultural extension promotion, and dissemination of research output and scientific information using agricultural extension as a network (Abesha et al., 2000). During that time the country was without any trained manpower and to fulfill the above objective, the now Haromaya University was established in the same year as the agreement. The collage played a significant role in establishing agricultural extension in the country shouldering national mandate to develop and deliver agricultural extension programmes (Belay, 2003).

The so called comprehensive package approach was implemented at that time by the imperial government due to the fact that the country's trained manpower, financial and material resources were inadequate to modernize agrarian societies in all corners of the country at a time. Chillalo Agricultural Development Unit (CADU) was the first comprehensive package program, established in 1967 in Arsi (nowadays, called Arsi Zone, in Oromia Regional State) with financial aid from the Swedish International Development Authority (SIDA) (Abesha et al., 2000). CADU focused at general socioeconomic development such as integrated planning, market and credit services, mechanization, stabilization of market price, training to local project employees, research related to intermediate agricultural technologies and farm inputs (Belay, 2003). Wolayta Agricultural Development Unit (WADU), that was supported by World Bank, and Arsi Rural Development Unit (ARDU) were some of the comprehensive package approaches followed by the imperial regime (Wale and Yalew, 2007). According to Belay (2003), the approach implemented by the comprehensive package to reach the farmer, especially CADU, was demonstration whereby extension agents and model farmers were demonstrating new agricultural technologies and farmers field days were arranged so that farmers in a nearby area could learn from the demonstration sites. Some farmers in the vicinity were also supplied with improved seeds and fertilizers.

Since the mid 1960s, there were also extensive efforts in research focused on testing fertilizers and key crops in different areas of the country by FAO and the then Imperial Institute of Agricultural Research. This resulted in another approach called Minimum Package Program (MPP) in 1971 (Keeley and Scoones, 2000). According to these authors, the MPP was applied at different stages (as MPP I and MPP II, of which only MPP I is applied in the imperial period) and tried to link external inputs (fertilizer and seed) to credit facilities with the narrative in favor of Green Revolution elsewhere.

By September 1974, the country entered into a new era as a result of revolution undertaken in the country. The imperial regime was overthrown and the military force called ‘Derg’ took the power. The Derg (meaning "committee" or "council" in Amharic) is the short name of the Coordinating Committee of the Armed Forces, Police, and Territorial Army that ruled Ethiopia between 1974 to 1991. Some drastic changes happened in the country, of which the March 4, 1975 land reform proclamation is the major one concerning the agricultural policy of the country. The proclamation banned private ownership of land, prohibited transfer of land through sale or mortgage, declared land distribution to tillers without any compensation to the private owners, and limited the maximum land size that a single family can have to 10 hectares (Belay, 2003, EEA, 2006). Under its third chapter, the proclamation contained the establishment of peasant association as the basic instrument for the implementation of the land reform. A peasant association has to cover an area greater or equal to 800 hectares and 250-270 households as members (Belay, 2003).

Under the military regime, two major extension programs were applied, the Minimum Package II (MPP II) and the Peasant Agricultural Development Extension Project (PADEP). MPP II was planned to be implemented between the periods 1975-1979, however the political instability in the country did not allow the timely implementation of the program. After the establishment of producers' and service co-operative in 1978, the MPP II was reinitiated in the year 1981 to be implemented between the years 1981-1985 by support from the International Fund for Agricultural Development (IFAD), World Bank, and by SIDA (EEA, 2006). However, PADEP came in as a result of the shortcomings of MPP II in 1985 that emanate from the limited resource capacity of the country towards developing technology that fit into highly diversified ecological and social setup.

The formulation of PADEP divided the country into different, more or less homogeneous zones, and set different objectives to these different zones. Bases on climate, geographic position, resource endowments, and cropping patterns, the country was divided into eight different agricultural development zones whereby 235 districts (181 cereal producing and 54 coffee producing districts) were selected as surplus producing districts (Belay, 2003). Some of the objectives of PADEP were to boost national food production, to promote cash crop production, to expand cooperatives in rural areas, to create employment opportunities for the rural communities, and also to avert soil loss through erosion. The program's approach to reach the farmer was a modified version of the Training and Visit (T&V) system whereby one DA is assigned to 1300 farmers in contrary to the conventional T&V, which assigns 800 farmers per single DA (EEA, 2006).

The current government (Ethiopian People Revolutionary Democratic Front-EPRDF in short) , after overthrowing the military regime in 1991, opts for Agricultural Development-Led Industrialization (ADLI) as a general strategy of food security and poverty reduction in the country. To realize the strategy, Participatory Demonstration and Training Extension System (PADETES), was adopted as a national extension system as of 1994/95 (Abesha et al, 2000). However, the approach followed by PADETES, was first introduced in the country by an NGO called Sasakawa Global 2000 (SG 2000), on 160 farmers in two regional states (Oromia and Southern Nations, Nationalities and People-SNNP) in 1993 with farmers' wheat and maize Extension Management Training Plots (EMTPs) (EEA, 2006). According to the same source, SG

2000 came to the farmers with inputs (improved seeds, fertilizers with recommended rate), credit for the purchase of the inputs, training for Development Agents (DAs) and farmers, and serious follow-ups of EMTPs by a nearby DA. As a result, SG 2000 got acceptance and in very short time, other regions (Tigray and Amhara National Regional States) were included and technologies for other crops (Teff - *Eragrostis teff*, and sorghum- *Sorghum bicolor*) together with maize (*Zea mays)* and wheat (*Triticum spp)*, were demonstrated on 1600 farmers by the year 1994. The yields from EMTPs were two to three fold of what has been harvested from the traditional plots. Therefore, PADETES is the result of the success story of EMTPs introduced by SG 2000.

Under the current regime (EPRDF), regional states have got a full responsibility of executing agricultural extension systems. The Ministry of Agriculture has the mandate of policy formulation, coordination of inter-regional projects and development programs, provision of training and technical advice to raise the competence of staff at regional level (Abesha et al 2000). The basic approach is the package approach and there are different packages. Some of the major packages are: extension package that bases on cereal crops, package for high value crops, package for livestock sector, package for soil and water conservation, package for agroforestry, and package for post- harvest technology.

According to Wale and Yalew (2007), the different approaches were in place to avoid the problem of their predecessor. For example, MPPs replaced the comprehensive package programs because the comprehensive package programs were found expensive and not applicable for poor farmers. The MPPs were also found to be in favor of wealthy farmers and replaced by PADEP. These are more or less the same as contemporary extension program attempted in the 1960s. However, the newly implemented package program was designed based on a thorough evaluation of efforts applied in the field of agricultural extension in the country for the past three to four decades. Agricultural extension in Ethiopia faced many problems in the past and it still has many shortcomings. Some of the major problems are indicated in the next section.

3.3. Major constraints related with modernization of agricultural system in Ethiopia

It is true that modernization of the farming system of a given society needs accepting and incorporating the indigenous farmers' traditional knowledge in research processes and sees farmers as partners during decision making. However, in most cases the problem with science in agriculture and extension is that it has a poor understanding of the knowledge from very poor, indigenous rural people. For many scientists, in order to develop those rural people, formal research and extension has to transform their knowledge into another knowledge system, because their knowledge is considered as unscientific and primitive (Röling and Pretty, 1997). In most cases, the approach is top-down, whereby technologies are developed somewhere and the farmers are told what to do by the development agents (EEA, 2006; Belay, 2002; Belay, 2003; Abesha et al., 2000; Wale and Yalew, 2007). This is very true when it comes to the case of modernization of agricultural system in Ethiopia, and some of the drawbacks can be put in the following way:

3.3.1. Lack of equally benefitting all farmers

In the aforementioned both regimes of the country (Imperial and Military regimes), who played a great role in introducing science and technology in to the farming system of the country; extension service coverage was not properly emphasized and certain groups were more favored than others. In spite of their large number, smallholder farmers were not given attention until recent days. Development of big commercial farms and industries have got attention during the imperial regime while the focus was towards cooperatives and big commercial state farms, which consumed about 95 percent of agricultural inputs (fertilizers, pesticides, improved seeds and farm implements), during the military regime (EEA, 2006).

3.3.2. Lack of linkage

Another shortcoming is from the linkage of extension with research in the country. Under normal conditions, agricultural extension serve acts as a farmer organization that expresses the concern and feeling of farmers to the public and conveys information from research institute to farmers and from the farmers back to research institutes (Birkhaeuser et al 1991). Contrary to this fact, agricultural research in Ethiopia is poorly linked to extension (Belay, 2003; EEA, 2006; Wale and Yalew, 2007). This is because of the fact that extension and research activities have been carried out under different institutions with zero or minimal coordination between them (Belay, 2002). In addition, agricultural extension agents in Ethiopia (named as Development Agents), are involved in different activities which are not necessarily related to their normal work such as collection of fertilizer credit, being government spokesmen, or agents for other government bureaus and this will highly affect their relation with the farmers (Belay, 2003). According to the same source extension coverage in the past followed main roads and only farmers on both sides of all-weather main roads benefited from extension.

3.3.3. Lack of learning from the past

Agricultural extension approaches in the past were renewed with no or weak evaluation and monitoring of the systems. Moreover, the extensions that were put in place used one size-fits for all types of extension methods and there is no extension that suits for all categories of adopters (EEA, 2006).

To summarize, research process and agricultural extension services in Ethiopia lack preferences, criteria and conditions of the farmers, and a well articulated national research and extension policy is not yet developed in the. In general, all of the above mentioned programs came up with some inputs which are totally or partly external to the traditional farming system. This has an impact on the farming system in general and the diversity of the farmers' crop variety in particular.

3.4. Ethiopia as a center of genetic diversity

Considering the 1920 N.I.Vavilov's concept of gene centers as a point of departure, Ethiopia is considered as one of the eight world's centers where crop plants are highly diverse and also where some of the crops are primarily or secondarily domesticated (Engels and Hawkes, 1991). Because of the fact that today's modern crops are domesticated from their wild relatives, the relative abundance of crop wild relatives in Ethiopia is also an indication for the center of diversity. Many wild plants are used as source of food in Ethiopia, especially during drought and normally when there is food shortage between sowing and harvest (Edwards, 1991).

The natural environment, the farming system, and the active involvement of the farming communities resulted also in endemic crops and high number of farmers' local varieties (landraces) that evolved with very peculiar adaptation characters (Geleta et al 2002). Highlands of Ethiopia, such as Horro Guduru Wollega zone, are highly dissected by natural barriers where primitive farming systems conditioned by the purposive farmers' selection of crops from multi cultural and multi ethnic societies for millennia, resulted in the endemism of the crops with special traits (Engels and Hawkes, 1991). When it comes to endemism, Ethiopia has many fully domesticated endemic crops of which ‘Teff’ (*Eragrostis teff*) and *Ensete ventricosum* are the best known ones (Edwards, 1991). Earliness, pest and disease resistance, drought and stress condition resistance, nutritional quality and in general, characteristics useful for low input agriculture are some of the special traits, which are believed to exist in most of the crops grown in the country (Worede, 1991; Worede et al., 2000).

Transformation of the country’s traditional farming system necessitated changing in order to feed the highly growing population. On the other hand, there is a need to conserve the crop genetic diversity. These objectives are most of the time challenging for the government and for the concerned organizations. Worede (1991) emphasized this idea indicating there is no part of the country that is free of special crops and/or their wild relatives, and it is a challenge for conservationists who are involved in conserving local varieties and their wild relatives to be used in modern cropping systems. Nowadays many of these crops are lost or threatened because of many reasons. Some of the reasons are indicated in the following section.

3.5. Potential threats of modern agriculture to local crop diversity and the environment

Traditional farming, with farmers long lasting accumulated knowledge and experience to sustain yield in diversified farming conditions basically based on locally available resources, is the unique character of Ethiopian farming systems. Traditional crops and landraces, which are adapted over centuries of farmers’ selection to satisfy their changing and dynamic needs, is the foundation for Ethiopian farming (Worede et al 2000). Nevertheless, there is a trend to adopt modern agriculture and unless properly handled, this has a paramount impact on the traditional crops in particular and the environment in general.

3.5.1. Local crop variety loss

Traditional varieties (landraces) are used by subsistence farming, which accounts for 60 percent of agricultural land and supply about 15 to 20 percent of the global food demand. On top of that, local varieties are the primary input for plant breeders to come up with modern varieties, which supply the remaining world consumption (Wood and Lennea, 1997). However, the global trend is to opt for few high yielding varieties that can suit for high input agriculture, neglecting the farmers’ varieties (landraces) on which human beings depended for millennia (Asfaw, 2000).

When it comes to local crop variety of Ethiopia, most of the existing diversities are under constant threat of being irreversibly lost as a result of replacement of low yielding local landraces by introduced exotic or improved varieties at an alarming rate (Worede, 1991). Moreover, the rate at which the exotic or improved materials are replacing the indigenous local varieties in Ethiopia has not been fully documented, and the rates of displacement vary from crop to crop and from region to region (Worede et al., 2000). A study by Asfaw (2000), on Ethiopian barley indicates that local barley landraces are replaced by improved cultivars and also by other crops like oats and wheat. Some Ethiopian barley landraces are no longer under cultivation and some of them are kept somewhere (e.g. Gaterslben gene bank in Germany), and no more found at the farmers hand or in the country (Kebede, 2008).

Ethiopian farmers play significant role in conserving crop varieties as they control the bulk of genetic resources of the country. Unless circumstances force them, the peasant farmers retain at their hands some seed stock for security reason. Even under serious situations when they are forced to leave their home because of drought or war, they store small amounts of seed to use when they come back. Rock hewn mortars or clay pots that can be sealed and buried in secured places inverted in underground pits, are the basic instruments to conserve these seeds (Worede et al., 2000). Nevertheless, the experience from the recent severe drought revealed that seeds imported as food grain by relief agencies, even pose more serious threat on the diversity of local crops, as farmers have already been forced to eat or sell their own seeds during drought periods (Worede, 1991).

One of the effective strategies to help resource poor farmers who practice low input agriculture under marginal environment is to maintain field level species diversity. In spite of its importance, on-farm conservation of resources has got very little institutional research attention and it was a topic of past neglect and recent interest (Wood and Lennea, 1997). To this regard Ethiopia has experienced a continuous flow of germplasm out of the country since the European journey of discovery whereby Portuguese were the first beneficiaries followed by Italians, Germans, Russians, and others (Engels and Hawkes, 1991). This has also a contribution to the loss of genetic diversity to the poor farming communities in particular and the country in general. On the other hand, in most cases modern agriculture is followed by use of external farm inputs like fertilizers and pesticides, which also have environmental implication both locally and globally.

3.5.2. Impact of fertilizer and pesticide on the environment and bees

Since the beginning of Green revolution, up to 1996 the use of chemical fertilizer increased at about 20-fold and the annual consumption of pesticides reached 2.5 million tons at a cost of 20 billion US Dollar globally (Pimentel, 1996). If we consider only herbicides alone, their half-life in the surrounding environment can vary, and some stay less than a month while the others can stay even more than a year (Freemark and Boutin, 1995). That means, there is a residual effect from both fertilizer and pesticide use.

According to Pimentel (1996), the use of pesticide has an intricate impact on the environment and its inhabitants. In the first place it is fatal to human beings; domestic animals in several millions are poisoned each year; and animal products like milk, meat, egg etc. are contaminated with these chemicals. Secondly, as the pesticides that are applied to crops finally enter into water bodies, they result in contamination of both surface and ground water. The problem is more severe when it comes to ground water because almost half of the world's population depends on wells for their domestic water demand, and once ground water is contaminated by pesticides, the chemicals stay for a long period of time. Third, even though pesticides are applied for the purpose of crop protection and to reduce loss from insects and pest attacks, under certain conditions crops can be affected by the use of pesticides that are applied for protection purpose. This is because; at recommended dose, growth, development and yield of some crops can be reduced; crops adjacent to the target crop can be affected form pesticide drift; crop rotations that are sensitive to chemicals can be inhibited or their growth can be hampered because of the residual effect of pesticide after the target crop growth is over. Finally, the application of some volatile chemicals results in the contamination of the atmosphere.

On the other hand Isherwood (1999), tried to reveal problems related to use of chemical fertilizer on human beings, biodiversity, soils, water, air, and non-renewable resources in general. To look into it very roughly, application of nitrogen containing fertilizers can cause soil acidification and some fertilizers result in the disruption of soil structure. Soil physical properties are also adversely affected when fertilizer use is incorrect or beyond the required. Concentration of nitrates in drinking water has got greater attention because of its impact on human health, and both nitrates and phosphates are the cause of eutrophication of water bodies that hampers fishing, reduces recreational value of water bodies, and affects aquatic ecosystems in general.

Volatilization of nitrogen in the form of Ammonia can pollute the atmosphere and later cause destruction of marine waters and natural habitats and acidify soils and lakes.

The other threat from the use of agrochemicals is its impacts on insects, especially honey and wild bees. Honey bees and wild bees play a significant role in pollinating vegetables, fruits and other crops globally, and their contribution to global agriculture amounts to several billion dollars every year (Pimentel, 1996). Agricultural intensification and loss of habitat are the major causes to impoverished pollinators and finally reduced crop yield. The problem is even more dangerous when it comes to application of pesticides to treat forest trees (Richards, 2001). Because of heavy application of insecticides on crops, bee keeping by small farmers becomes impossible in some cotton growing areas of Kenya and Tanzania (Pimentel, 1996).Even though the application of agro-chemicals in developing countries is small as compared to the developed ones, the negative effect is high in developing countries as a result of high level of illiteracy, inadequate enforcement of standards and laws, inadequate safety precautions and safety devices, improper pesticide labeling, and insufficient knowledge base in general.

3.6. Agricultural calendar of the study area

As Horro district is located in the wettest part of the country, rain-fed agriculture is popularly practiced and season for crop cultivation is highly dependent on seasonal precipitation conditions. Commonly, farmers of the district produce different crop types once a year during the long production season. Thus, agricultural calendar of the district slightly changes according to the yearly weather condition. Most of the time land clearing starts during the months of March to April, which is the beginning of the rainy season for the area. In normal condition, the rainy season starts at the middle of March and it ends at the month of October. Therefore, the general agricultural practice of the district starts from the months of March or April, and extends until the harvesting and storing time of crops. The gross agricultural calendar of the district can be summarized in the form of the following table 5.

Table 1. Gross farming calendar of Horro District of Horro Guduru Wollega Zone

No.	Activities	Month (Operational months)
1	Land clearing	March, April
2	Sowing (planting)	May, June, July & August
3	Weeding	June, July, August
4	Harvesting	December, January
5	Storing	January & February

Accordingly, different types of crops are grown during the gross farming calendar outlined in the above table. This depends on the time required for the crop maturity and the time required for land preparation. Some crops e.g. Teff (*Eragrostis teff*) need intensive and longer time of land preparation, while other crops such as Field Peas (*Pisum sativum*) need simple land preparation that normally takes shorter time. Field peas can be sown in one day (in the beginning of July) long land preparation, and almost one month long (June to early July) land preparation is necessary for sowing Teff. There are other crops such as Barley (*Hordeum vulgare*) that can be produced twice in a single production season. The first round is sown in May and harvested in September, where as the second round is sown during mid September and harvested during late December and early January. The same variety of Barley is used but they have different local names ('Samareta' for the first round, and 'Mosno' for the second round).

To summarize for all crops, the time from mid April to the whole month of May is the operational season for sowing Maize (*Zea mays*) and Millet (*Panicum milieaceum*), though not commonly produced in this district. Niger seed (*Nyjer*)and Barely are commonly grown during the time of late May and early June depending on the arrival time of the spring rain. Sowing of Teff starts from early July and extends to mid August. The time for maturity of the crops depends on the variety within a given crop type; for example, there are some variety of Maize and Teff that mature at different length of time. The early maturing variety of Maize and Teff are called 'Dafte geessu' and 'Saffii' (both in Afan Oromo language) respectively, whereas the late maturing maize and Teff varieties are 'Shombolol' and 'Manya' (both in Afan Oromo language) respectively.

Indigenously, the farmers of the study area break down the busiest section of gross operational months (July to mid September) in to a more refined and locally well-recognized manner. Starting from 5th of July to 17th of September of Ethiopian Calendar (E.C.) they divide the period in to 10 equal parts, each interval having 7 days. Each interval has its own specific name, which has technical meaning related to sowing and weeding of Teff. This is a typical calendar, which has been used by the local farmers; preserved by orally passing from generation to generation can be summarized in the following table 2.

Table 2. Typical calendar of Horro District for farming of Teff and other grains

Name of farming calendar	Equivalent English name	Range of the calendar in Ethiopian Calendar (E.C.)	Activities related to Teff	Other activities
Aruwato	-	5^{th} July – 12^{th} July	Sowing white Teff	No weeding activity** Sowing of Wheat
Kurnan	tenth	12^{th} July – 19^{th} July	Sowing white Teff	Weeding of maize
Salgan	ninth	19^{th} July – 26^{th} July	Sowing white & red Teff	
Saddettan	eighth	26^{th} July – 3^{rd} August	Sowing red Teff	Sowing of Saffii wheat
Torban	seventh	3^{rd} Aug. – 10^{th} Aug.		
Jahan	sixth	10^{th} Aug. – 17^{th} Aug.	Sowing saffii	Harvesting of early maturing barley (Samareta)
Shanan	fifth	17^{th} Aug. – 24^{th} Aug.		
Afran	forth	24^{th}Aug. -1^{st} Leap Year*		
Sadan	third	1^{st} leap Year – 3^{rd} Sept.	Weeding of teff	Weeding
Lamen	second	3^{rd} Sep. – 10^{th} Sept.	Weeding of teff	Weeding
Tokke	Single	10^{th} sep. – 17^{th} Sept.	Weeding of teff	Sowing Barely (Mosno)

** This is a typical Ethiopian 13^{th} month between August and September. Ethiopia follows the Julian Calendar system where all the 12 months have equal number of days (30 days each), except the 13^{th} month, which has 4 to 5 days depending on the type of year (Mathew, Mark, Luke and John).*

*** This indicates that during the farming calendar of Aruwato, there is a traditional belief among the farmers of the study area that if they practice weeding, the crops will be destroyed*

4. Materials and Methods

4.1. The study area

4.2. Overview of profile of Oromia Regional State

The Oromia National Regional State is one of the Regional States in the Federal Democratic Republic of Ethiopia. Geographically, the Region extends from 3°24'20" - 10°23'26"N latitudes and 34°07'37"-42°58'51"E longitudes. It shares borderlines with all the Regional States in the Federal Democratic Republic of Ethiopia, except Tigray (see Fig.1). It also shares international borderlines with the Republic of South Sudan (with 66 km borderline) in the west and with the Republic of Kenya (with 521km) in the south (BoFED, 2008).

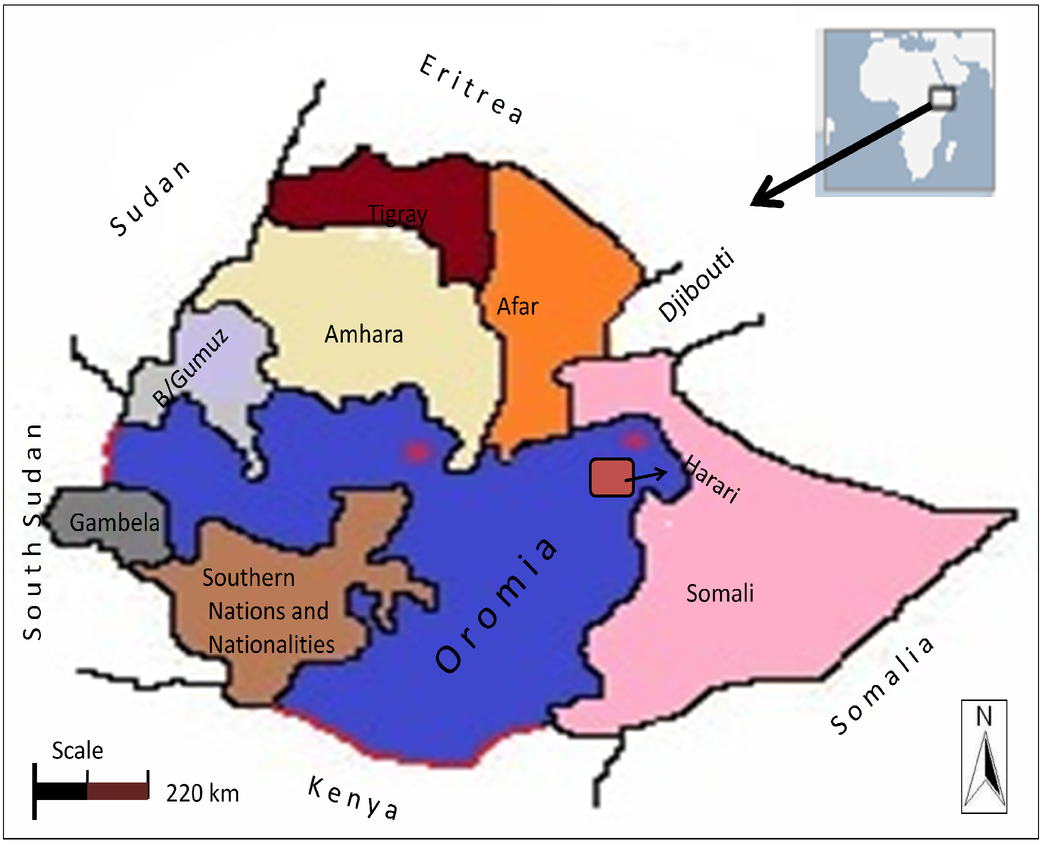

Figure 1. Location Map of Oromia National Regional State

4.2.1. The Size and Shape of the Region

The Oromia National Regional State is the largest regional state in terms of area. The total area of the Region is 363,136 km^2, accounting for about 34.3 percent of the total area of the country. The Regional State has an elongated shape which extends from the Kenyan border in the south to the southeast across the central Ethiopia and to the Sudanese border in the west. Administratively, the Region is divided into 18 administrative zones, 304 districts (woredas) (out of which 39 are towns structured with the level of woredas, and 265 rural woredas), more than 6,342 peasants and 482 Urban Dwellers Kebeles. For detail, see figure 2 and the table 1 below. Generally, the region can be categorized into three distinct geographical areas. These include: the western highlands and associated low lands, the eastern highlands and associated lowlands and the rift valley.

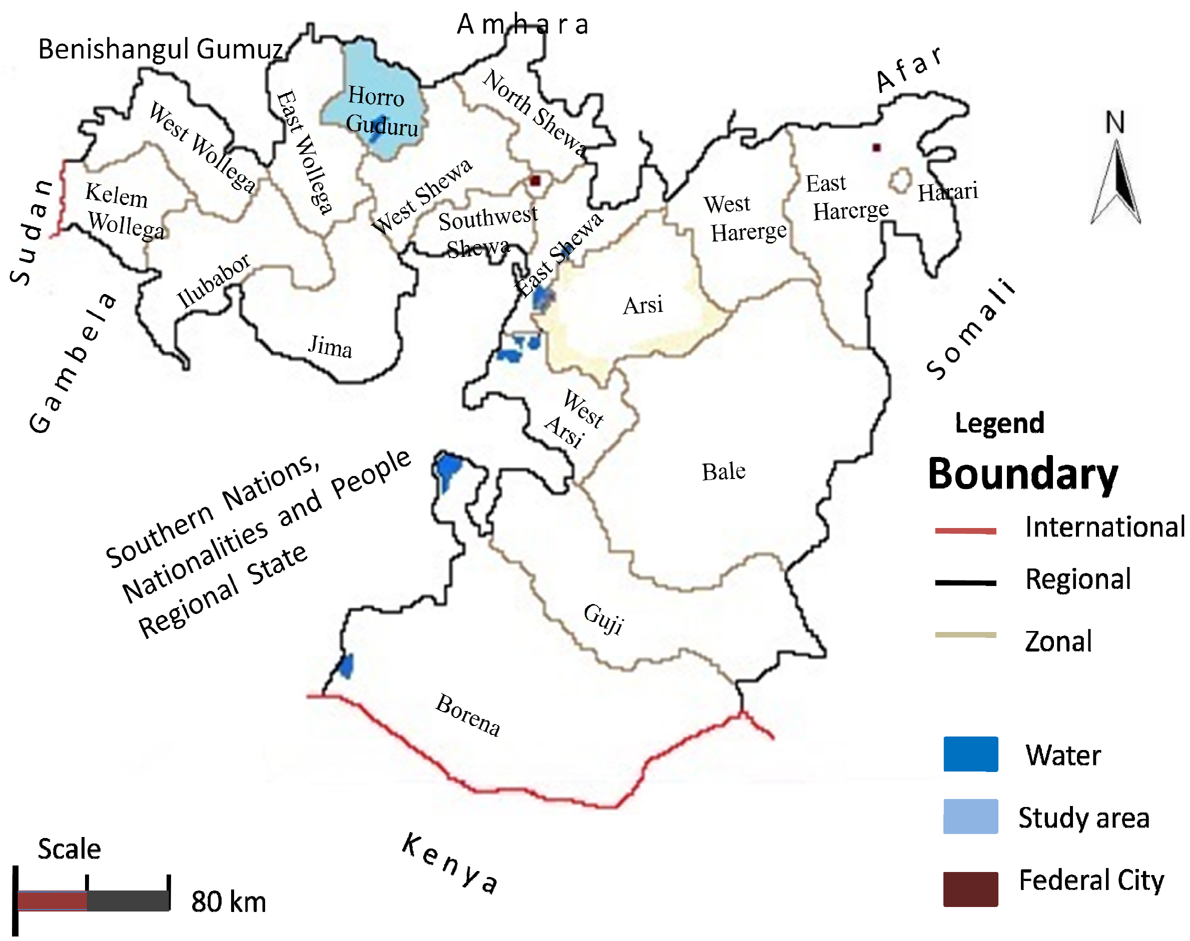

Figure 2. Administrative Zones of Oromia Regional State

Table 3: Administrative divisions and subdivisions of Oromia Regional State

NO	Zone	Capital town	Area km^2	No. of Peasant Associations (Pas)	No. of Rural Districts (Woredas)	No. of Town woredas
1	Arsi	Asella	21009	567	24	2
2	West Arsi	Shashemene	12556	325	12	2
3	Bale	Robe	63555	360	10	2
4	Guji	Negelle	33290	301	13	2
5	Borena	Yabello	63939	190	13	1
6	East Harerge	Harar	26308	534	19	3
7	West Harerge	Chiro	17779	379	14	2
8	Illu Abba bor	Metu	16884	500	22	2
9	Jimma	Jimm	18696	538	17	2
10	East Shewa	Adama	9547	313	10	5
11	North shewa	Fiche	8989	267	13	1
12	West Shewa	Ambo	14371	531	18	1
13	Southwest Shewa	Weliso	5813	265	11	1
14	East Wellega	Neqemte	14103	281	17	1
15	Horro Guduru Wollega.	Shambu	8076	172	9	1
16	West Wellega	Gimbi	13131	481	19	2
17	Kelem Wellega	Dambi dollo	10448	249	10	1
18	Finfinne Surrounding	Finfinne	4809	150	6	8
	Total		**363136**	**6.342**	**265**	**39**

Source: Socio-economic profile of Oromia Regional State (BoFED, 2008)

4.2.2. Relief Features

The Oromia Regional State is a region of great physiographic diversity. Its landscape includes high and rugged mountain ranges, undulating plateaus, panoramic gorges and deep incised river valleys, and rolling plains. It is also common to get massifs that rise from less than 500 meters above sea level to high ranges that culminate into Mt. Tulu Dimtu (4377 m a.s.l., meters above sea level) which is the highest peak of the region. About 49% of the regions land surface is above

1500 m a.s.l. and it is considered as highlands. The low lands and the rift valley system account for the remaining 51% of the regions' land surface. Oromia is endowed with varied relief features which in turn accentuate varied and amiable climatic condition and other rich natural resource bases.

4.2.3. Climate

The climate of Oromia is affected significantly by variations in its altitude, its latitudinal position, air pressure and circulation, and its proximity to the sea (The Red Sea) and ocean (The Indian Ocean). The climatic types prevailing in the region may be grouped into 3 major categories: arid climate in eastern and southern lowlands, tropical rainy climate in south-western highlands, and temperate rainy climate in central highland parts of the region. In general, about 30 percent of the lowlands of eastern sub-region have arid climate. Over 35 percent of the intermediate highlands of central and western Oromia have hot tropical rainy climate, while the highlands have warm temperate rainy, tropical and arid climates. The mean annual temperature of Oromia is about 19.3^0c with a range of mean maximum over 30^0c in lowlands areas.

The rainfall pattern of the region is bimodal, receiving the greatest share of rainfall in summer and the smallest portion in spring. The distribution of mean annual rainfall varies from place to place and from year to year, decreasing in all directions from the western highlands (1600-2400 mm) towards the eastern and south eastern arid lowlands (which accounted to be less than 400 mm) in a year.

4.2.4. Population

Oromia is the most populous region in the country. It runs first both in terms of size and population. Based on the 2007 (1999 E.C) population and housing census the population of the region is 27,158,471 accounting for over (36.7%) of the population in the country .The female to male ration of the region is nearly 1:1 though the figure of the later is slightly greater. Out of the total population in the region, about 12.2% is estimated to dwell in towns, whereas the remaining 87.8 % resides in rural areas. The region is characterized by high population growth, increasing at a rate of 2.9 percent annually. The age structure of the region shows that over 47.61 percent of the population is less than 15 years of age, while the economically active age group (15-64) is about 49.23 percent. Due to low life expectancy, those in the age category of 65 and above account only for 3.16% of the total population.

4.2.5. Diversity

The Oromo are very humble and hospitable people; live harmoniously with the other nations and nationalities in the region and in the surrounding. Oromia can be taken as a microcosm of Ethiopia when it comes to population diversity. All nations and nationalities, and people following all types of religion in Ethiopia are somehow represented in the region due to the fact that Oromia neighbors almost all of the regional states in the country, and because of the welcoming and friendly attitude of the people.

4.2.6. Religion

The hospitality of the Oromo people is further denoted by the religious practices. Followers of different religions coexist harmoniously in the region. Various forms of Christianity (orthodox, protestant, and catholic), Islam, traditional believes like 'Waqefana' and other beliefs are commonly practiced in the region. There is no any kind of religion radicalism in the region.

4.2.7. Language

The official working language in the region is Afan Oromo, which belongs to the Eastern Cushitic group of Languages. Latin alphabets are used in Afan Oromo Scripts. Since Oromia neighbors all regional states in the country except Tigray and as there are many nations and nationalities residing in the region, other local languages are also widely spoken. Though not extensively used, in addition to the local languages, international language such as English is used as medium of instruction at Universities and High Schools, and by the elites.

4.3. Overview of Horro Guduru Wollega Zone

Horro Guduruu Wollega zone is one of the eighteen zones in Oromia Regional State (for further inormation see fig. 2 and table 1). Its zonal adminstrative twon is called Shambu. The zone is devided in to 6 admistrative woredas (Districts) namely Amuru Jarte, Horro, Abe Dongoro, Jima Rare, Abay Choman and Guduru. The overall physical settings and socio economic profiles of each district is summarized and presented in the following form (table 2).

Table 4 Socioeconomic and physical setting profiles of Districts of Horro Guduru Wollega zone

Indices		**Horro**	**Amuru Jarte**	**Abe Dongoro**	**Abay Choman**	**Jima Rare**	**Guduru**
Total area in km^2		779.98	2,380	1,092	791	340.78	2,474
Climatic condition		temperate	Sub-tropical, Temperate	Sub-tropical, Temperate	Sub-tropical, Temperate		sub-tropical
Population as of 2007 (in thousands)		125	79	57	54	60	116
Land Use (%)	Cultivated land	61.6	49.1	54.07	45.27	47.9	53.8
	Forest and bush land	11.1	10.5	15	30.41	3.5	14.3
	Degraded land	-	-	17.53	0.68	1.4	-
	Pasture land	8	16	7	6.11	9.5	15.3
	swamp		-	-	15.08	4.2	-
	Other	19.3	24.4	6.4	2.45	33.5	16.6
	Total	100	100	100	100	100	100
Main types of crops grown in the district		Cereals, Pulses, Oil seeds, Others	Cereals, Pulses, Oil seeds, Others	Cereals, Pulses, Oil seeds, Others	Cereals, Pulses, Oil seeds, Others	Cereals, Pulses, Oil seeds, Others	Cereals, Pulses, Oil seeds, Others
Livestock		Cattle, Sheep, Goats, Equines Poultry	Cattle, Sheep, Goats, Equines Poultry	Cattle, Sheep, Goats, Equines Poultry	Cattle, Sheep, Goats, Equines Poultry	Cattle, Sheep, Goats, Equines Poultry	Cattle, Sheep, Goats, Equines Poultry
Main cash crops		Niger seed, Rape seed Linseed	Niger seed, Rape seed Linseed	Niger seed, Linseed, Rapeseed, Sesame, Groundnut, Fenugreek	Niger seed, Linseed Rapeseed, Sesame, Groundnut Fenugreek	Niger seed, Linseed Rapeseed, Sesame, Groundnut Fenugreek	Niger seed Rape seed
Farming calendar		Mar.- Jan.	Mar.- Jan.	Mar.- Jan.	Mar.- Jan.	Mar.- Jan.	Mar.- Jan.
Main domestic energy supply		Firewood	Firewood	Firewood	Firewood	Firewood	Firewood
Soil type		Rendzinas, Haplic, Luvic - Phaeozems	Rendizinas, Haplic, Phaeozems	Loam	Loam	Clay, Loam	Nitosols, Eutric Cambisols, Arenosols
Mean annual precip.(mm)		1800	1200	2250	1450	1300	1300
Mean annual temp. (^{0}C)		22	25	21	26	21.5	23
Altitude range (m) a.s.l.		1800 -3178	860 -2657	1350 - 2500	1350 -2444	1700 -3047	1200-2430
Potential problems		Soil erosion, Deforestation	Soil erosion, Erratic rainfall	Soil erosion, Erratic rainfall	Land-Inundation, Soil erosion, Erratic rainfall	Soil erosion, Erratic - rainfall	Land-inundation, Soil erosion, Erratic rainfall

Source: Summarized (by Tarike Terefe) from Oromia Regional State Zone's profile – Horro Guduru Wollega.

This study was focused on Horro District, which is one of the districts in Horro Guduru Wollega zone of Oromia Regional State, and located in western part of Ethiopia (figure 3). Its distance from the capital city of Ethiopia, Addis Ababa, is about 315 km. It is located between 9º -10º´N latitude and 35º 50΄0΄΄ – 37º20΄0΄΄´E longitude. Horro District borders Abay Chomen and Guduru in the east, Abe Dongoro in the west, Amuru Jarte in the north and Jima Rare within the Horro Guduru Wellega zone (see Fig.3). Shambu town is the administrative center of the district. Total land area of the district is accounted to 77,998 ha (779.98 km ^{2}) (obtained from the District's Agricultural Office).

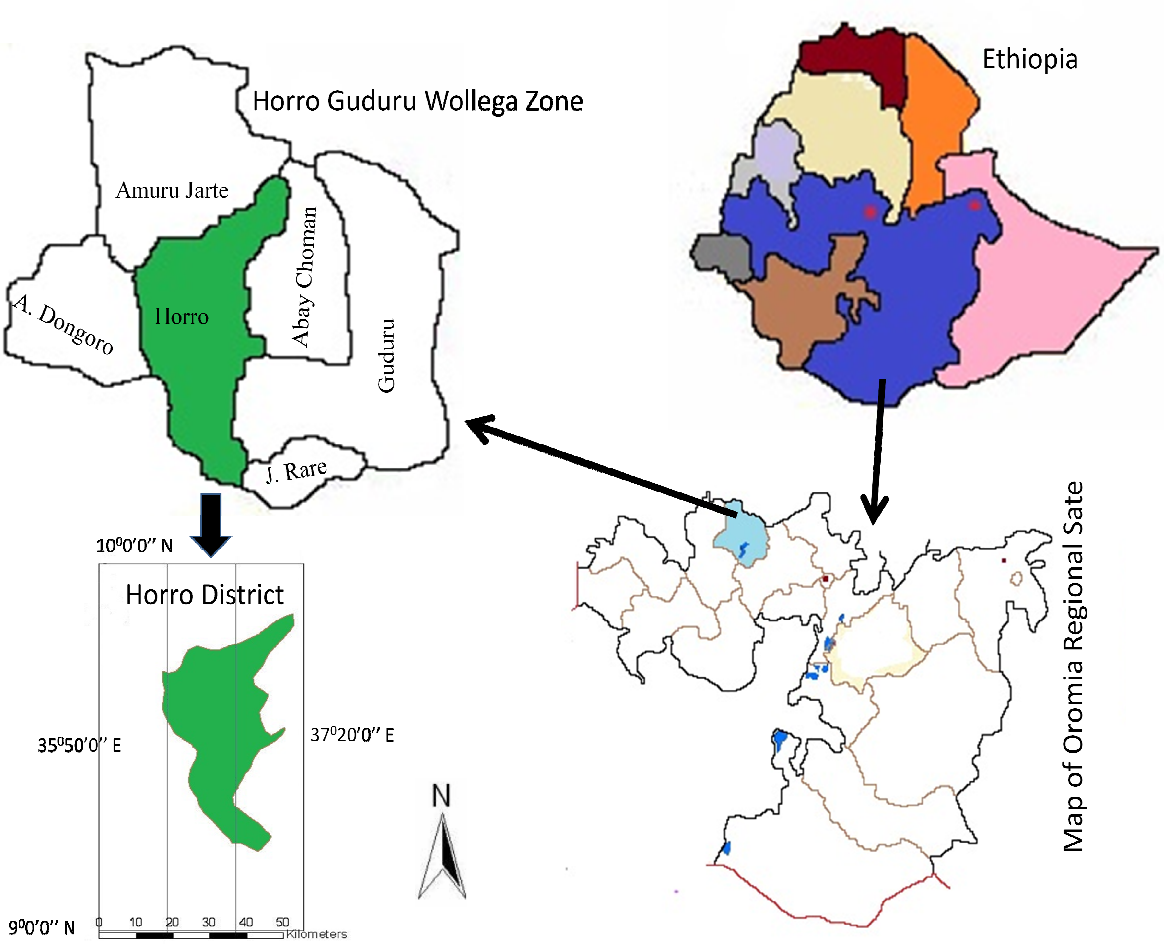

Figure 3 Location of the study area (Horro District).

Horro District is a little bit unique from other districts of Horro Guduru Wollega Zone which is highly diversified part of the region, and its physical characteristics and socio-economic profiles are separately highlighted in what follows:

4.3.1. Physical Characteristics

Most part of the district is characterized by undulating surface dominated by mountain ridges and hilly landforms. The altitude of the district ranges from 1800 to 3178 m.a.s.l. The proportion of highland, midland and lowland areas in the district is about 49.8%, 48.96% and 1.24 % respectively. There are many mountains (with their heights- a.s.l.) such as Belbela (3178 m), Debisho (2980 m) Jeldessa (2950 m), Gudena (2740 m) and Korma (2820 m). Most of these mountains are the sources of many rivers and streams in the district. Some of the rivers are Geber, Gembo, Deneba and Abjar. The dominant soil types are Rendzinas, Haplic and Luvic Phaeozems. There are natural and man-made forest areas delineated in the district. There are also small patches of forests in different parts of the district.

4.3.2. Climatic condition

The district has one long rainy season that extends from March to mid-October with mean annual precipitation of about 1800 mm. The mean, average maximum and average minimum temperatures of the district were reported to be about 22^0C, 27^0C and 11.7^0C, respectively (Olana, 2006). The district experiences a temperate (Baddaa,Afan Oromo) type of climate.

4.3.3. Population

Horro district is the most populous district in Horro Guduru Wollega zone. The total population of the district was 125,346 as of 2007 national census. The urban population was 14% of the total. Females accounted for 52.2% of the urban, 50.6% of the rural and 50.8% of the total population in the district. The crude population density of the district was about 109 persons per km^2.

4.3.4. Agriculture

Cultivable land and grazing land covers about 61.6% and 8.0% of the district respectively. About 11.1% was covered by forests and shrubs, while others covered 19.3% of the district. The important crops grown in the district are listed in table with their scientific names in Appendix 2. According to the information obtained from the agricultural office of the district, about 6563 quintals (one quintal = 100 kg) of fertilizers, 304 quintals of improved seeds, 179 kgs of powder pesticides and 300 liters of herbicides were distributed to farmers every year. Crop pests such as termites, weevils, rodents, apes, monkeys and birds and crop diseases such as rust, smuts, leaf blights and powdery mildew were reported. Niger seed, Rape seed and Linseed are produced as local cash crop. Large quantities of these crops are supplied to the central market for export.

4.3.5. Services

Access to the transport system of the district is very limited. It has only 89kms of all weather and 15kms of dry weather roads. There are one telephone station and two post offices. There are services such as mobile telephones and very limited internet usages. About 11.7% of the district's populations have access to potable water supply. The farmers get their drinking water from nearby springs and homemade wells. The district has two banks (Commercial Bank and Development Bank) but no insurance organizations. The district gets hydro electricity supply from Fincha'a (east of Shambu). Only Shambu town has electricity service, a fuel station in the district. There are 20 elementary, 6 junior and 2 senior secondary schools in the district. The district has one hospital and 8 clinics. Regarding veterinary service, the district has one veterinary clinic and 3 animal health posts.

4.3.6. Domestic Energy Supply

Both urban and rural residents use different sources for domestic energy supply. Firewood holds the highest rank and charcoal in the second place for urban dwellers. Firewood & crop residue serve as energy supply in first & second place in rural area. The people of the area use these sources of energy mostly for cooking in both urban and rural areas, and for very simple machines like grain mills and beauty salons in the urban area. The general situation of domestic energy sources of the study area for urban and rural areas can be summarized as in the following table 3.

Table 5. The energy sources of the study area for urban and rural areas.

No	Sources	Urban	Rural
1	Firewood	1^{st}	1^{st}
2	Charcoal	2^{nd}	4^{th}
3	Crop residue	5^{th}	2^{nd}
4	Animal dung	3^{rd}	5^{th}
5	Kerosene	4^{th}	3^{rd}

Source: Horro Agricultural Office of food security and disaster risk prevention

4.3.7. Potential problems of the study area

Shortage of farmland and grazing land due to increasing population of the farming communities, deforestation, high prices of agricultural inputs and insufficient veterinary services can be mentioned as problems in the district. Soil erosion due to the erosive nature of the wind and precipitation, and erodibility of the land, erratic rainfall and very recently the pollution of water and soil acidity from agricultural effluents are some of the problems of the study area.

4.4. Methodology

For this study, secondary data was obtained from Horro Agricultural Office, the department of 'Food Security and Disaster Risk Prevention and Control directorate'. The yield of some of the main crop types that are commonly produced by almost all the farmers was the target for this analysis. The Agricultural office had made regorous data collection from representative farmers and representative topographical area of the district. The yields of the selected crops per hectar of the cultivated field for both modern way of farming (with agricultural inputs) and traditional (indigenous) way of farming were compared.

Traditional way of producing crops for domestic uses such as food for households and feed for animals, and market oriented cash crops of the study area was discussed. The knowhow of the farming community of the Horro district, and, yet, the gap of understanding towards the issue of global climate change was addressed. Historical understanding of generation long knowledge and skill of crop production system, that infact, practically and orally passed from generation to generation, specifically the typical agricultural calendar of the district, traditional manuring system for soil fertility protection and the way of maintaining crop diversity that helped as a gene bank for the modern generation was critically analysed.

4.5. Materials used

The difference between the yields that are obtained by modern and traditional way of farming was analyzed using excel spreadsheet and SPSS (Statistical Pakage for Social Sciences) programs. For these purpose, cocerning the works using excel, Microsoft Office 2007 programm was used. For the statistical analisis in order to compare means, the SPSS programm (SPSS 13.0 for windows) was used.

5. Results

5.1. Yield and crop diversity

Traditional and quasi modern farming systems are going side by side in the study area. Modern way of farming has been practiced with the name of ‘Agricultural Extension’. The tools for farming operations are the same for both farming systems. Oxen and horses are used as a source of power for tilling the land. Only very few farmers can rent tractors to till their land. The main difference is the manuring system, the type of seeds used and the diversity of crops on the field. In the quasi modern way of farming, farmers use synthetic fertilizers and improved seeds to boost their crop productivityn, and chemical herbicides and pesticides to avoid the influences of weeds and pests. Traditional manuring methods and proper crop rotations are practiced to maintain the soil fertilit, and human powerer extenssively used for removing of weeds in the old way of farming.

Some farmers prefere their indigenous way of farming while others accpeted the advice from the Extension workers and stared to use agricutural inputs such as fertilizers, improved seeds, pesticides & herbicides on their farms. For the comparision of the yield from both faming systems as it was outlined in the methodology, the yield of some commonly produced crops obtained during the farming year 2011/12 (2004/05 E.C.) was used. Figure 4 shows the bar graphs of the land area cultivated on the vertical axis for the corresponding crop types such as maize (*Zea mays*), Teff (*Eragrostis teff*), Wheat (*Triticum spp*), Barely (*Hordeum vulgare*), Horse beans (*Vicia Faba*) and Field peas (*Pisum sativum*) on the horizontal axis. From the graph (blue bars) one can easily understand that there is a tendency of using larger area of land for some crops (e.g. for maize, 1758.24 ha and for wheat, 1715 ha) that initiates monculture, which is less diverse. With regard to the traditional farming system, on the other hand, the farmers of the study area tend to use their land area to produce more of crops such as horse beans and field peas compared to other types of grains such as maize and wheat, which are favored in the quasi modern way of farming (see dark red bars).

The most common reason why the local farmers are prefering to allocate their land for more of crops such as horse beans and field peas is connected with the labor required to produce each crop type. Since maize and wheat need thorough preparation of land and continous follow up such as weeding and pest prevention, farmes are obliged to reduce the allocation of land for these crops. In comparision, less power and time is used to prepare land for beans and peas and these plants can copete other weeds (parasites) more effectively than the other types of crops (maize and wheat0. The ability of these crops (field peas and horse beans) to grow well on soils of low fertility value (which is scientifically true that leguminous plants can convert atmospheric nitrogen in to nitrate and use it for growing) is the other reason why the farmers prefere them. These inherent narute of the crop types on one side and the corresponding power, time and resources required to grow crops make the traditional way of farming more diverse and sustainable. (The sustainability issue will be discussed later).

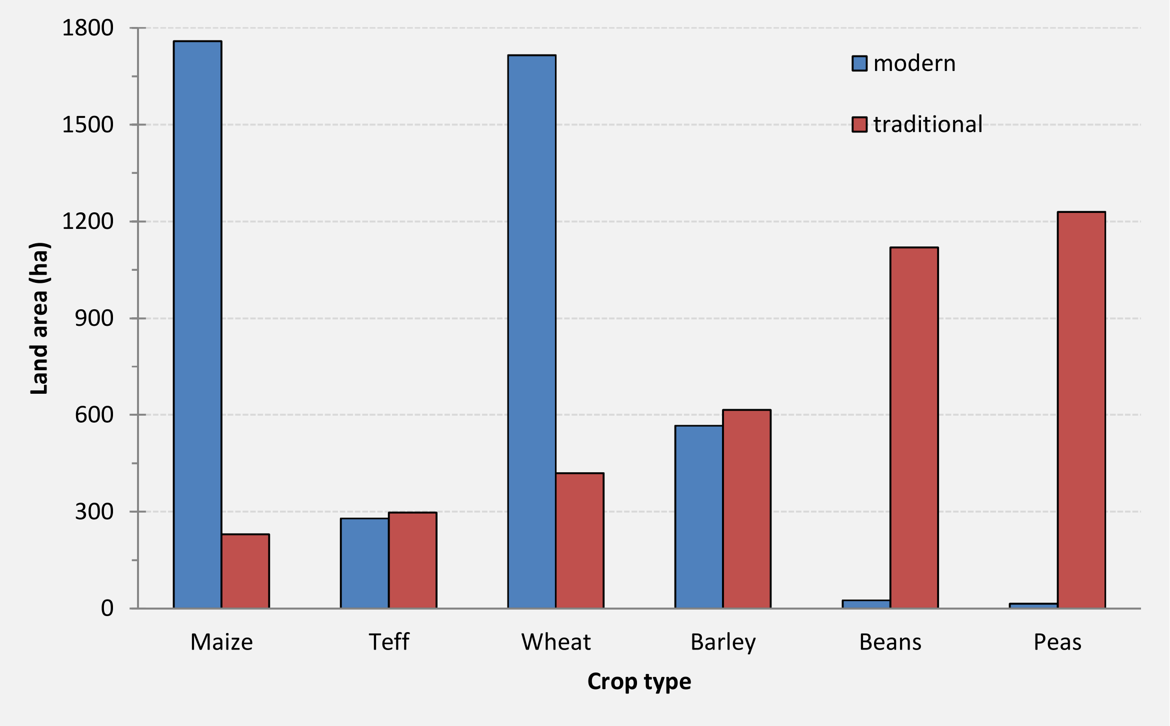

Fig. 4 Comparision of the area of land used in quasi modern and traditional way of farming for main types of crops grown in the study area (Horro District) as of 2004 E.C. (2012 G.C.).

The yields (expressed in quitals, which is equivalent to 100 kg) of the crops from one hectar of land for both types of farming systems are dipicted in fig (5). The values assigned on the vertical axis indicate the yield from a hectar of land area, while the values dipicted on the horizantal axis indicate the type of crops selected for this study. The bargraphs of the yield for both farming systems indicat that farmers produced more quintity of crops from a unit area of farm by using the modern way of farming as compared to the traditional one. By using proper agricultural inputs such as synthetic fertilizers, improved crop varities, appropriate herbicides and pesticides, they produced on average three folds of the amount they usually get by using their indeginous way of producing crops. As it was highlighed in the fig (4), this increased productivity of the yield has come at the expense of reduction in crop diversity as farmers would like to allocate their farm land to produce few crop types in an extensive way than their traditional way of farming.

There is a strong confilict, however, from economical viability and environmental sustainability point of views concerning the two types of farming systems. The farmers are obiliged to buy all the agricultural inputs from their limitted income. They could get logistics and field expertise from the local extension workers, but they are asked to pay more for fertilizers, improved seeds and chemicals for weed often times with out access to loans. In additions, this quasi modern farming system involves the application of those chemicals as an input to improve productivity, and its consequence on the soil and water of the study area has been a serious concern since few years. Farmers are complaining of their soil conditions after using nitrogen and potasium fertilizers such as Urea and DAP (Diammonium Phosphate). Once these fertilizers are introduced to the land, there is excellent yield at the first year, but the problem comes the following year. The farmers say that the crpos are burned (dry up) due to soil acidification related to the use of nitrogen fertilizers if they don’t apply the fertilizers again. The buying of these fertilizers need their cash.Even if they can buy the fertilizers during the following crop production term, the yield is not as good as it was in the first production season.

This trend is completley different from the indegenous expperiences of the farmers. They used to produce crops at least for five consecutive harvesting seasons once their land is manuterd in their own traditional way. The farmers used to grow different varities of crops and crop rotation in oreder to maintaing their crop productivity and soil fertility. The higher yield of crops by using madern way of farming than their traditional way of farming (as shown in fig. 5) is, threfore, comes in to play on the expence of loss of local crop varieties, degradation of farmlands and unstable economic situation of the farming community.

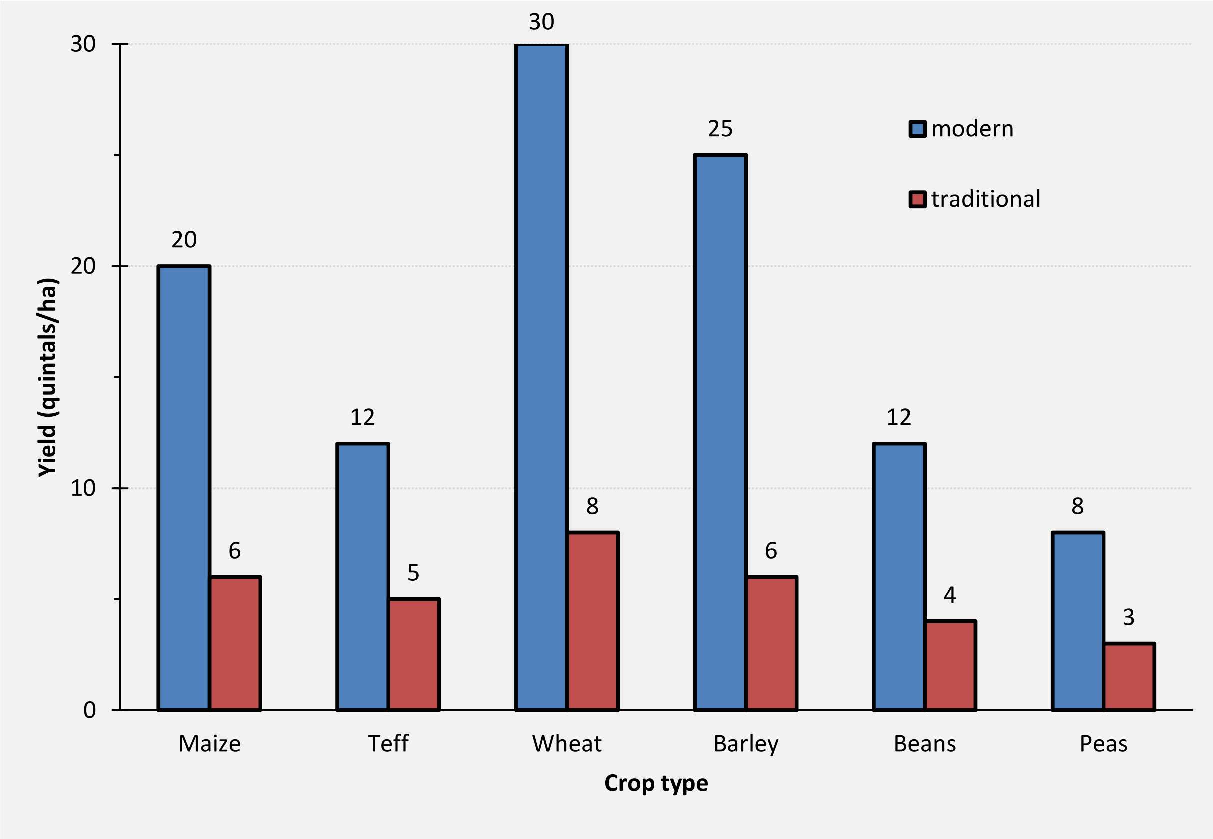

Fig. 5 comparision of the crop yield obtained from one hectar (ha) of land in modern and traditional way of farming of the study area (Horro District) as of 2004 E.C. (2012 G.C.).

5.2. Statistical test

Although it is very clear from bar graphs of the yields corresponding each crop type that there is considerable difference in yield per unit area of the land cultivated, it is necessary to know whether the difference is statistically acceptable or not. Therefore, a statistical test was required in order to decide if the difference in means of the yield of the two groups (traditional = trd, and modern = mod as described in table 3) were statistically significant. The independent-samples t-test (or independent t-test, for short) was chosen, for this purpose, to compare the means of yields obtained from traditional and modern way of framings (assuming they are two unrelated groups, on the same continuous, dependent variable, which is the yield). This Statistical test was performed by using SPSS (Statistical Package for Social Sciences) program.

A confidence interval is an interval within which a hypothesis is considered tenable at a given significance level $\alpha = 0.05$. The null hypothesis (H_0) is that any given residual is equal to the mean residual i.e. there is no significant difference between the two means. Therefore, with the confidence interval, a lower and upper limit (range) for the corresponding mean are generated which gives us an indication of how much uncertainty is involved in our estimate of the true mean. The narrower the interval, the more precise is our estimate. After analyzing the data for t-test, the decision rule is as follows: if the decision criterion (which is usually labeled *p* in research reports) is less than significance level α, reject H_0;if it is greater than alpha, do not reject H_0.

Table 6. The SPSS result for the independent t-test of the yield.

T-Test

Group Statistics

	trd_mod	N	Mean	Std. Deviation	Std. Error Mean
Yield_per_ha	1	6	17.83	8.589	3.506
	2	6	5.33	1.751	.715

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield_per_ha	Equal variances assumed	15.625	.003	3.493	10	.006	12.500	3.578	4.527	20.473
	Equal variances not assumed			3.493	5.415	.015	12.500	3.578	3.509	21.491

Paired samples t-test in the above table 3 indicates that the significance value (p-value) of 0.006 and 0.015 for equal variances assumed and equal variances not assumed respectively is less than α = 0.05. During this time, we can reject the null hypothesis that dictates the equality of the two means. Therefore, statistically there is significant difference between the groups, i.e. the yields obtained by both types of farming systems.

5.3. In- situ manuring: a traditional way to maintain soil fertility in the study area

The farmers of the study area have their own knowhow for maintaining soil fertility of their farmland. The in-situ method of manuring farmland has been practiced for many generations (Osbahr and Allan, 2003; He et al., 2006). Since the farmers of the study area practice mixed farming, i.e. rearing of animals and crop production side by side, the role of livestock is very important for soil fertility. Certain pieces of land are intensively manured by keeping animals (cattle) for some period where land is available. This is done by constructing temporary sheds

(Dallaa, in Oromo language) in the fallow lands and the animals (commonly cattle) are kept during the night in these sheds on average for 5 nights. Such temporary sheds are moved every five days to the adjacent fallow land to manure the entire fallow area. Traditionally the farmers know that five nights of keeping animals in the shed and accumulation of their urine and dung makes the soil fertile enough to use it for the following five (5) consecutive seasons of effective crop production. In the study area, land is commonly used to produce crops once in a year. After harvesting crops, the land is kept fallow and serve for grazing animals until the following season of cultivation. If the sheds are moved every six days, the manured land can be used for six consecutive years of crop production, i.e. one night of manuring the land with the animals with in the sheds corresponds to one cycle of crop production. The size of the shed is proportional to the number of cattle owned by the farmers (fig.6). Therefore, the more number of animals a farmer owns, the more his/her land is kept manured with a regular cycling of the fallow land.

Fig. 6 Temporary sheds (Dallaa, in Afan Oromo) for keeping animals (cattle) in the fallow land: in-situ traditional manuring method to maintain soil fertility in Horro District of Horro Guduru Wollega Zone, Ethiopia (*Photo: by Tarike Terefe, 2012*).

5.4. Prioritization of planting crops on newly in-situ manured land

In such intensively manured lands, farmers have ample experiences to prioritize the type of crops that should subsequently be planted. Most of the farmers prefer maize to be planted on the first year of the manured land. They think (know) that the fertility is too much for other types of crops to be planted on newly manured land. There might be very high nitrogen content in the land from the urine and droppings of the animals. Different varieties of maize are used on the highly fertile land as maize is commonly planted more sparsely than other types of crops and, therefore, less prone to lodging problems and easy to keep the space between the plants free of weeds by removing the weeds manually. In addition, maize plants do have stronger root system (compared to other cereals) that can penetrate the un decomposed cow dung after freshly manuring the land. In the case of other cereals such as wheat, barley, Teff and other oil seeds such as Niger seed, there is high probability of lodging problems in the case of adverse wind conditions if they are planted on newly manured land. These plants, at the same time, have lower capacity to compete weeds by themselves and it is very difficult to remove the weeds manually as the plants are planted very close to each other. The most common trend of crop rotation (better to say prioritization in this context) after the in-situ manuring of the farmland that has been practiced for centuries in Horro district is shown in the following flow chart diagram (fig.7).

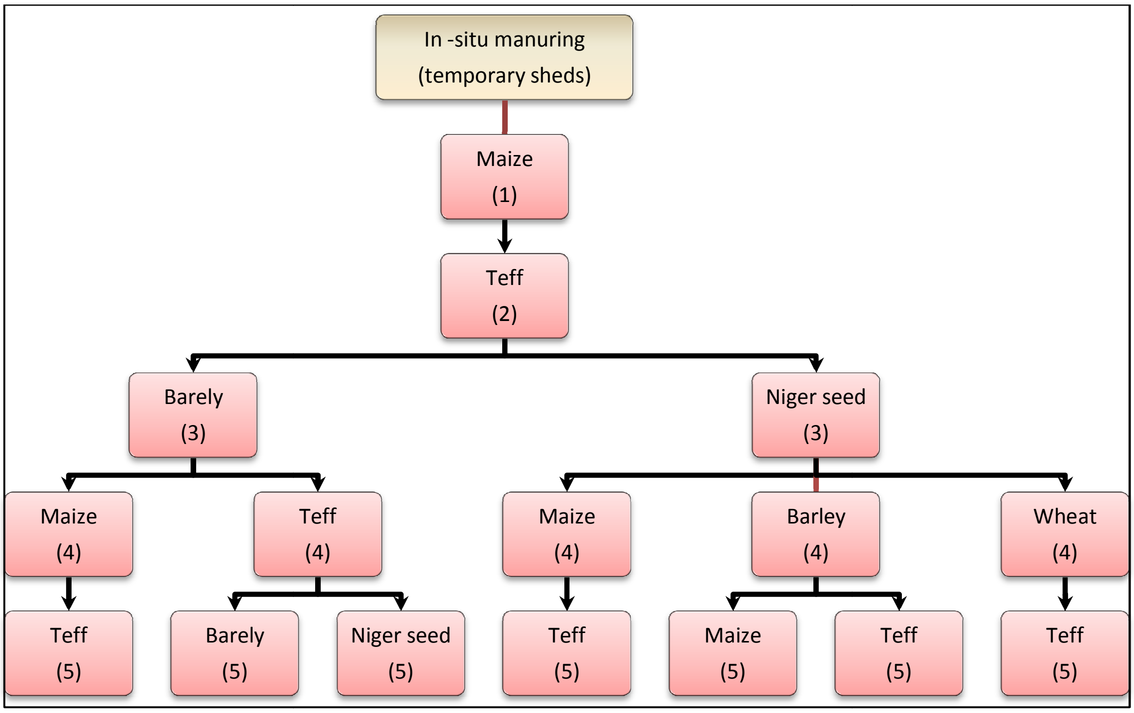

Fig. 7. Flow chart showing the possible prioritization of crops after intensive in-situ manuring of the barren land using temporary animal sheds. The numbers (1to 5) at the bottom of crop's name indicate the order of years for a given consecutive production season.

The prioritizations of the different types of crops depicted in fig.7 are carried out according to the farming calendar of the district that has been outlined in the section 3.6. under the review of literatures. Since Teff is the most staple crop in the country, greater land area and greater resource is often allocated for the production of this crop. As mentioned earlier (3.6.), Teff requires thorough land preparation; on average, the land has to be plowed up to four times in an interval of roughly seven days. The number of tilling practices depend on the nature of the land and the nature of precipitation that wets the soil. Up to 20 cm soil depth of plowing is required using traditional oxen or/and horse driven plow system. The tilling process starts little by little and finally the soil has to be well pulverized. Any weed needs to be removed and the uppermost soil layer has to be fined very well. During the sowing process, the well-prepared soil needs to be compacted using cattle and horses in order to prevent the loss of water from the soil by evaporation and to minimize the emergence of weeds. This is necessary because Teff has a very shallow root system, which is too short to hunt water from the deeper soil profile and it so delicate crop that can easily be competed by weeds. Thereafter, a well-experienced person (very often 'elders') directly spreads the Teff seeds on the compacted field.

5.5. Effect on environmental and economic situation of the farmers

The traditional farming system of the district looks like the modern Organic farming which is more appropriate for its considering the important aspects like sustainability of natural resources and environment. Organic farming is a production system, which favors maximum use of organic materials (crop residue, animal residue, legumes, on and off farm wastages, growth regulators, and bio-pesticides). It discourages the use of synthetically produced agro-inputs for maintaining soil productivity and fertility and pest management under conditions of sustainable natural resources and healthy environment. Traditional farming system of the study area fulfills all the mentioned conditions of organic farming except the farmers practice it with a little understanding of the issues of sustainability both in environment and economic.

6. Discussion

6.1. Traditional farming and economic stability issues in the study area

In their traditional way of farming system, the farmers allocate the land among different crop types and varieties for two main reasons: first for proper management of the farming operations and second for economic sustainability. The later addresses the food security for household consumption and their cash income for their livelihood. Farming operation is the main challenge and the overall day-to-day activity of the people of the area. Throughout the gross farming calendar, farmers know that some crops need intensive land preparation, weeding and harvesting operation and yet very crucial for domestic use as staple food or as a cash crop. A good example for this is the crop Teff, which requires huge amount of labor and resources and, yet, very demanded grain at the national level. Therefore, farmers allocate manageable amount of land to such type of crops and use the rest of the land for other crop types that do not need intensive labor and time for cultivation. In such a way, in a given farmer's land one can see a number of crop types, and different varieties of the same crop just for the sake of managing the farming operation. From economic point of views, the overall income of the farming communities is based on the selling of whatever they produce on their farmland. As we speak the traditional way of farming which the true expression of traditional way of life of the farming communities in developing countries in general, there is no central marketing system and as a result, the farmers are not sure which type of crop would be demanded on the market during the following year. Therefore, they (farmers) have to diversify their agricultural productivity as much as they can in order to provide the local market the most demanded crop and use the ones with little demand for their household consumption.

Farmers of the study area also know that there are some types of crops, such as Barley, Maize and Wheat that have so many enemies such as pests that limit their time of storage. The reason is no widespread use of pesticides or other modern preservation methods, the farmers are often obliged to limit the production of these types of grains and use their land for other types of crops such as Teff and Peas that do have longer life span after harvesting that makes them possible to store for a longer period. Therefore, the farmers have to compromise among the issues of management related to farming operation, market demand and management related to storability of the grains after being harvested.

6.2. Traditional farming and environmental sustainability issues in the study area

The use of traditional in-situ manuring system and the subsequent effective use of crop rotation as a means to maintain the soil fertility have enabled the framers to preserve their environment in a cleaner manner. Except the erratic nature of precipitation, which has been a challenge since few years, the natural resources of the study area were unpolluted before two decades ago. Of course, there is loss of forest resources of the area due to the expansion of urbanization and the lack of alternative energy source for the urban. The local farmers have an indigenous respectful attitude towards the water and forest resources of their area. Local springs and rivers are the main source of drinking water for their household and livestock. The local fragmented forests are the main source of tools for agricultural activities, construction of houses for the farming communities and sheds for their livestock. Even, the farmers have a tradition that each of them should have trees planted in their territories to use them for their household needs. The barren land, land covered with bushes and long grasses are used as a common grazing area for livestock. This indicates that, the farmers of the study area used to have a social and moral obligation to care for the natural resources such as water, soil and forest as their whole life is very dependent on them.

Since the last two decades, intensified farming system has started. The farmers were advised and sometimes forced to use synthetic fertilizers and improved seeds that are provided by developmental agents (DA) which is run by the local government. The farmers get only technical supports from the government and there is no either insurance for some uncertainties or subsidizing in terms of prices of these inputs. Fertilizers, improved seeds and other herbicides and pesticides have to be distributed to the farmers, and the farmers has to pay in cash for these inputs started using improved seeds replacing the local ones, synthetic fertilizers instead of traditional practices of in-situ manuring of their land, and synthetic herbicides and pesticides. By using these agricultural inputs, even though the harvests of crops of the first year were be encouraging, the negative effects on their farmland and crop diversities were very immense. Barren fields started to be cultivated; on the majority of the land, a few crop types were grown. Lately, the farmers realized that they could not grow this improved seeds without the use of synthetic fertilizers. The soils became completely degraded. Crop diversity was reduced significantly and the farmers were losing their locally adopted crops. Typically, the two important problems associated with fertilizer pollution are the following:

6.2.1. Nitrate Pollution

The adverse use of nitrogen fertilizers by the local farmers has resulted in various adverse effects on soil and water. Application of N_2 fertilizers such as urea and ammonium sulphate to soils has resulted in soil acidity of the study area (Matson et al., 1997). Farmers realized the situation when the productivity of their land significantly reduced when fertilizer had been applied on the field in the previous year. The land has to be manured by using temporary cattle sheds in order to get better yield. The process of soil acidification by the fertilizers is mainly two. Firstly, the natural process of oxidation of ammonia ions to nitrate ions releases acid. Part of acid produced is neutralized by alkaline ions released by plants during the subsequent uptake of the nitrate ions. Secondly, since nitrate ions are not strongly absorbed by the soil they are liable to leach or move down through the soil. The negatively charged nitrate ions carry positively charged basic cations such as Ca, K, Mg and Na in order to maintain the electric charge on the soil particles.

6.2.2. Eutrophication of Water

Intensive application of fertilizers has come up with serious problem of water bodies of the study area. This effect was facilitated by the nature of precipitation of the area. Intensive rainfall and subsequent soil erosion by overland flow is a common phenomena of the area. This water erosion takes fertilizers from agricultural fields to the nearby water bodies, and disturbs the nutrient balance within the water that causes eutrophication, which is the process of enrichment of surface water bodies with nutrients. The normal N:P (Nitrogen: Phosphorus) ratio in water is around 20:1. Algal growth increase when this ratio drops to around 7:1 (Asmed, 1993). A severe symptomatic of eutrophication is where there is excessive accumulation of dissolved nutrients such as phosphorus, nitrogen and other element in water that leads to an excess production of algal biomass. This requires a corresponding increased supply of oxygen for decomposition of organic materials when the algae and their remnants sink to bottom, reduced O_2 content and eventually anaerobic condition may prevail. This may leads to a serious loss of marine life, blockage and aquatic passages and a major reduction in real estate value of the affected areas.

6.3. Advantages and disadvantages of the method

The in-situ manuring system is an efficient method of recycling organic residues, since animal wastes and crop residues are properly utilized directly into the soils with no nutrient loss (Osbahr, Allan, 2003). It involves a minimum of human labor, a central issue in soil fertility management in Horro district. Limitations in the more widespread use of other forms of manuring methods such as compost and Farm Yard Manure (FYM) are caused by labor constraints (Wakene et al., 2005). Neither does the system involve any external inputs. Further, as a traditional practices it does not suffer any communication barrier, as many new technologies do. On the contrary, farmyard manure consists of a decomposed mixture of Cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle. The waste material of cattle shed consisting of dung and urine soaked in the refuse of the shed is collected daily and placed in trenches about 6-7 m long, 1.5-2 m wide and 1 m deep, and each trench is filled up to a height of about 0.5 m above the ground level. Commonly, it becomes ready to apply after 3-4 months (Wakene et al., 2005). However, in the in-situ manuring method, the decomposition goes on slowly year after year and the farmers manage the system by using different crop types that have different ability of decomposing the raw crop residues and animal wastes. The prioritizing of crop types on the in-situ manured farm will be discussed in the next section. In the mean time, however, it is worth to say that the in-situ manuring practice is more attractive in terms of labor requirements and the urine is also completely utilized. The farmers are so convinced that this practice is more useful than the application of FYM.

One of the main constraints of the in-situ manuring by temporary animal sheds is the lack of land for grazing. This lack of land is very pronounced during intensified cultivation of different crops especially between the months of March to January. The next constraint of the method is related to the economic issue of the farmers. Only farmers who have animal like cattle, which is the most important measure of wealth in the district, can keep their land fertile. The other drawback, but manageable, of the method is that the land is not ready for any types of crops after manuring. The crops cultivated have to carefully be prioritized based on the experiences of the farmers.

7. Conclusions

Unlike the modern farming system, traditional way of farming or early farming is focused more on subsistence than actually growing anything to sell. It is totally dependent on climatic conditions, and involves much more manual labor for working in the field for longer hours than the modern methods where synthetic chemicals such as herbicides are intensively used to save the time and labor required for weeding operations. Crop production and animal rearing is the main activities and almost all members of the farming communities are agrarian workers. Cropland was smaller, more diverse and horses and oxen are used primarily for tilling, seeding and transporting fields and crops. The work is so demanding, however, most of the time it not aggressive to the environment. Soil manuring is done in-situ using temporary animal sheds, and there were no such things as fertilizer or pesticide chemicals to use in the fields. Farmers were highly dependent on climate and the weather to be able to bring in some profit margin or to produce crops for their domestic consumption. Therefore, knowledge of agricultural calendar and cropping sequences is very important in order to get better harvest. Livestock are always grazed out of doors and used for in- situ soil manuring , and managed just enough so that the offspring could be sold for some sort of profit in addition to other cash crops. Selective breeding is mostly done by traditional way.

Modern way of farming (Agricultural extension) of the area is still also dependent on climate and weather conditions like that of traditional farming. The vast majority of farms that grow crops grow them out doors as it is impossible to grow cereal, oilseed or pulse crops under a climate-controlled area with the economic and technology level of the farmers of the study area. The main difference between the two farming systems, in the study area, is the use of synthetic fertilizers instead of in-situ manuring and producing few crops that are productive and that can be sold on local and national markets instead of producing different types of crops within farmers' farming calendars. To recapitulate, it involves less labor requirements to cover a certain area of a field than what could be done with the traditional way of farming. For this case, fertilizers and pesticides are commonly used to maximize crop productivity with bigger returns per acre.

The traditional way of farming was economically stable and environmentally sustainable among the farming communities. However, with alarmingly increasing population of the district and the erratic nature of the rainfall due to global climate changes, only the traditional way of farming might not be technically feasible to produce enough crops within such climatic uncertainties, and to feed the growing population. On the other hand, in using the modern way of farming that is characterized by intensive use of synthetic agricultural inputs in order to boost the productivity of the land, there are obvious problems on environmental qualities and disturbances in economic situation of the farmers. One of the environmental problems is the issue of soil acidification, which has attained an irreversible stage on some of the farms with the existing economical and technological capability of the farmers. Loss of crop diversity and eutrophication of water bodies are other environmental problems.

Therefore, the farming system that combines the issues of environment cleanness and increase of land productivity must be found out. This could be done in a number of ways. First, the traditional knowhow of the farmers should not be ignored. The application of fertilizers and other inputs must be done in a compensating way by filling the gaps that the farmers cannot attain by using only their traditional methods. For example, they can use fertilizers on their exhausted lands that they cannot cover by traditional in-situ manuring method, and they might use herbicides if and only if they cannot manage removing the weeds in their own methods. Similarly, improved seeds can be used side by side with the local seeds. Second, the qualities of fertilizers that have been used so far should be given attention. Only fertilizers that have minimal negative effect on the soil should be used. Third, farmers need to get trainings and other technical supports so that they can build more knowledge up on their previous experiences.

Finally, the author would like to stress the importance of research in finding out the real problems of the study area. Very often, the farmers just express their feelings why their soil is degrading and their water becomes rubbish, but they do not know the reason that caused it happened. At this point, the role of scholars is very crucial in conducting basic researches in a participatory and an integrated approach so as address the real problem of the area.

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Abbreviations

CADU: Chillalo Agricultural Development Unit

SIDA: Swedish International Development Authority

WADU: Wolayta Agricultural Development Unit

FAO: Food and Agricultural Organizations

MPP: Minimum Package Program

PADEP: Peasant Agricultural Development Extension Project

IFAD: International Fund for Agricultural Development

EEA: Evaluation of the Ethiopian Agricultural Extension

DA: Development Agents

ADLI: Agricultural Development-Led Industrialization

PADETES: Participatory Demonstration and Training Extension System

SNNP: South Nations, Nationalities and People

EMTPs: Extension Management Training Plots

NGO: Non-Governmental Organization

SG: Sasakawa Global

EMTPs: Extension Management Training Plots

Appendixes

1. Land area and yield per hectare for the crops mentioned in the table during 2011/12 production year for Horro District, in Local language (Afan Oromo) (a), and translated in to English (b).

a)

Dosa midhanii	Maqaa midhaanii	Sanyii filatamaa+xaa'oo			Sanyii naannoo qofa		
		Lafa (ha)	Callo/ha	Callaa	Lafa (ha)	Callo/ ha	callaa
Midhaan Agadaa	Boqolloo	1758.24	20	35164.80	230.00	6	1388.00
	Xaafii	279.18	12	3350.16	297.00	5	1485.00
	Qamadii	1715.00	30	514550.00	418.95	8	3351.60
	Garbuu	567.00	25	14175.00	615.44	6	3692.60
	Ida'ama	**4319.42**	**87**	**567239.96**	**1561.39**	**25**	**9917.24**
Midhaan dheedhii	Baqelaa	25	12	300	1120	4	4480
	Atara	14	8	112	1230	3	3690
	Ida'ama	**39**	**20**	**412**	**2350**	**7**	**8170**
Wali gala		**4358.42**	**107**	**104551.96**	**3911.39**	**32**	**18087.24**

b)

Crop category	Crop Name	Modern farming system			Traditional farming system		
		Area (ha)	Yield (quintal/ha)	Total yield	Area(ha)	Yield (quintal/ha)	Total yield
Grains	Maize	1758.24	20	35164.8	230	6	1380
	Teff	279.18	12	3350.16	297	5	1485
	Wheat	1715	30	51450	418.95	8	3351.6
	Barley	567	25	14175	615.44	6	3692.64
	Total	**4319.42**	**87**	**104139.96**	**1561.39**	**25**	**9917.24**
Pulses	Beans	25	12	300	1120	4	4480
	Peas	14	8	112	1230	3	3690
	Total	**39**	**20**	**412**	**2350**	**7**	**8170**
Total		**4358.42**	**107**	**104551.96**	**3911.39**	**32**	**18087.24**

2. Different types of crops grown in Horro District with their English, Scientific and local names.

Crop Category	**Name of crops (English)**	**Scientific Name of crops**	**Local name of crops (Oromo)**
Grain*s*	Teff	*Eragrostis teff*	Xaafii
	Maize	*Zea mays*	Boqqoolloo
	Wheat	*Triticum spp*	Qamadi
	Barely	*Hordeum vulgare*	Garbuu
	Sorghum	*Sorghum bicolor*	Boobee
	Millet	*Panicum milieaceum*	Daagujjaa
	Oats	*Avena sativa*	Mata -jaboo
Pulses	Haricot beans	*Phaseolus vulgaris*	Qalawee/Lojee
	Horse beans	*Vicia Faba*	Baaqelaa
	Chick peas	*Cicer arietinum*	Shumbura
	Field peas	*Pisum sativum*	Atara
Oil seeds	Niger seed,	*Nyjer*	Nuugii
	Ground nut	*Arachis hypogaea*	Lawuzii
	Fenugreek	*Trigonella foenum-graecum*	Sunqoo
	Sesame	*Sesamum indicum*	Saalixoo
	Linseed	*Linum*	Talbaa
	Rapeseed	(*Brassica napus*)	Gommana
Others crops	Cotton	*Mahyco*	Jirbii
	Sugar cane	*Saccharum spp.*	Shonkoraa
	Coffee	*Coffea spp.*	Buna
	Potato	*Solanum tuberosum*	Mussee
	Spices		Mi'eessituu