COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

ASSESSMENT OF INDIGENOUS KNOWLEDGE CONTRIBUATION TO SOIL FERTILITY MANAGEMENT TO ENSURE HOUSEHOLD FOOD SECURITY IN HETOSA WOREDA, OROMIYA REGION, ETHIOPIA

By: Gemeda Alemu

Advisor: Amare Bantidar (PhD)

A thesis submitted to Addis Ababa University, College of Development Studies, Center for Food Security Studies in partial fulfillment of the requirements for the Degree of Master in Food Security and Development

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Name: **Amare Bantidar (PhD)** Signature: ______________

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Approved by the Board of Examiners;

College Dean Signature

_________________________ _________________

External Examiner

_________________________ _________________

Internal Examiner

___________________________ ___________________

DECLARATION

I, the undersigned, declare that this thesis is my original work and that all sources of materials used for the thesis work have been fully acknowledged.

Name: Gemeda Alemu

Signature: __________ **Date:** __________________

This thesis has been submitted with my approval as a university advisor.

Name: **Amare Bantidar (PhD)**

Signature: _______________ Date: __________________

Dedication

To my mother Hirphe Jiru with your sickness there is no tragedy in life that is too big for me to overcome. You scarify your health to have blessed my life. I wish God keep you in rest.

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This thesis would not have come to reality without the kind support and assistance of many individuals. I would like to express my genuine thanks to all those who have given me the strength to complete this journey that was filled with its own ups and downs.

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ACRONOMY

CAS	Central Statistical Agency
DA	Development Agents
FAO	Food and Agricultural Organization of United Nation
FDS	Focused Group Discussion
GTP	Growth and Transformation Program
IP	Indigenous Practice
ISFM	Integrated Soil Fertility Management
Kg	Kilogram
MoA	Ministry of Agriculture
N	Nitrogen
NGO	Non-Governmental Organization
P	Phosphorus
SFM	Soil Fertility Management
SSA	Sub Saharan Africa
UNEP	United Environment Program
WCED	World Commission on Environment and Development

Abstract

The study entitled by "Assessment of Indigenous knowledge contribution to soil fertility management to ensure household food security" was conducted in Hetosa Woreda. Rural communities in Ethiopian developed several Indigenous soil fertility management strategies that have enabled them to maintain soil fertility for sustainable food production. In fact Indigenous knowledge was a common practice of farmer's household heads in soil fertility management in the study area. The main assumption of this study was that farmers in the study area engaged in agriculture for a long period of time and they have developed and adopt unique knowledge and skills in soil fertility management. These studies were therefore aimed at identifying of Indigenous knowledge contribution to soil fertility management to ensure household food security ensuring agricultural productivity and food security. Four Kebeles in Hetosa Woreda were selected purposively on their bases of population and productivity capacity. Depending upon the application of Indigenous knowledge of four Kebeles one village in which modern means of soil fertility management were predominated to compare with those village apply commonly Indigenous knowledge of soil fertility management. Household respondents were selected by using random sampling techniques from proportional sample size represent each village. In order to know the relationships between the outcome variable Yield and independent variables, a multiple linear regression model was implemented. In addition to this, a logistic regression model also conducted to demonstrate the effect of using Indigenous knowledge on food self-sufficient. The finding of this research explain that, farmer's applying Indigenous knowledge have better food security. This is because they are with better soil fertility management. Therefore, Indigenous knowledge ensure food security. This is through sustained soil productivity. A researcher suggest that, Woreda administrators and Rural agriculture office should, equip farmers on soil management practices how they use both Indigenous and modern knowledge system in their farm. Such activities should aim at empowering Indigenous communities to utilize exchange, develop and protect Indigenous knowledge and to promote it.

Key words: Food Security, Indigenous Knowledge, Soil Fertility Management

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CHAPTER ONE

1. Introduction

1.1. Background and Justification

The struggle for food security is one of the main global concerns in many developing countries. It is much debating to tackle negative correlation between food demand and supply in developing countries and how much should farmers have to react on their subsistence farming on fragmented land with increasing population growth.

Agriculture is the backbone of the Ethiopian economy and is given special attention by the Government to ensure food self-sufficiency. Hence, the growth of the agricultural sector is particularly important, as it constitutes the bulk of the national economy in terms of human and material resources. However, this sector is characterized` by low productivity of land and labour that it failed to make a substantial contribution to the country's economic growth and to ensure food self-sufficiency. In addition, declining soil fertility is the major constraining factor on crop production in Ethiopia, improved soil fertility management cannot be overemphasized (Eyasu, 2002)

Low agricultural productivity can be attributed to limited access of small scale farmers to agricultural inputs, technologies, irrigation and more significantly to poor land management activities that have led to continuous nutrient depletion from farm land.

Land degradation in general and soil fertility decline in particular still remains major challenges that are adversely affecting the agricultural performance of the country (Woldeamlak,B., 2003)

There are many factors responsible for soil nutrient depletion. It might be attributed partly to the failure to take substantial care to the soil resources while remaining unaware of the tragic consequences.

Rural communities in Ethiopian developed several Indigenous soil fertility management strategies that have enabled them to maintain soil fertility for sustainable food production. Indigenous knowledge, defined as "knowledge that an Indigenous or Indigenous community accumulates over generations of living in a Particular environment" (United Nation Environment Program). According to (Nakashima, D. and Roué, M., 2012), Indigenous knowledge refers to the knowledge and know-how accumulated across generations and renewed by each new generation, which guides human societies in their innumerable interactions with their surrounding environment. Communities'

Indigenous knowledge has been defined as institutionalized Indigenous knowledge that has been built upon and passed on from one generation to the other by word of mouth (Ajani, E., Mgbenka, R. & Okeke, M., 2013). Indigenous peoples' knowledge focuses on elements of significance for Indigenous livelihoods, food security, and well-being, and as a result, it is essential for soil fertility management strategy. Soil fertility management refers to any strategy employed by farmers to maintain and possibly increase soil fertility for sustaining crop production through optimizing all possibly sources of plant nutrients needed for crop growth. The livelihood of the rural poor depends almost entirely on specific skills and Indigenous knowledge essential for their survival.

Indigenous knowledge is unique to a particular culture and society and is the basis for local decision making in agriculture and other activities (Indigenous Knowledge Systems. Department of Science and Technology, South Africa, 2005). Indigenous knowledge provides the basis for problem-solving strategies for local communities, especially the poor. Indigenous knowledge is an immensely valuable resource that provides insights on how to manage soils for sustainable crop production, and can contribute significantly to increased food availability household food security (Mascarenhas, A. Knowledge, indigenous knowledge, peace and development. , 2004).

In the literature, Indigenous knowledge has also been conceived in terms of Rural People's Knowledge. It is a valuable and underutilized resource that needs to be intensively and exhaustively studied, and 'incorporated' into formal research and extension practice in order to make agriculture and rural development strategies more sustain, food security depends on farmer's ability to practice Indigenous knowledge for sustainable crop production to acquire the food they need.

Indigenous knowledge is often seen to exist in a local context, anchored to a particular social group in a particular setting at a particular time. Significant contributions to global knowledge have originated from Indigenous people. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with people's cultural values.

One of the strategies for developing the agricultural sector is to harness the potentials of Indigenous agricultural knowledge which has continued to gain recognition and whose potential contribution towards ensuring food security and livelihood of smallholder farmers (Warren, D.M., 1991).

Despite the fact that Indigenous knowledge is an emerging area of interest for land management, the exchange of knowledge between scientists and Indigenous peoples dates back to the very origins of science (Nakashima, D. and Roué, M., 2012). The importance of Indigenous knowledge has been known in the design and implementation of sustainable development projects. Improving farmers' knowledge and their capacity to observe and experiment is an essential element in the development of integrated soil fertility management technologies

This study was conducted in Hetosa Woreda, Oromiya Regional State. This Woreda represents the high land and mid altitude agro climate that characterized by mixed farming system and dominated by smallholder farmers which practice Indigenous soil fertility management to increase land productivity and ensure food security. The main assumption of this study was that farmers in the study area engaged in agriculture for a long period of time and they have developed and adopt unique knowledge and skills in soil fertility management. These studies were therefore aimed at assessing the contribution of Indigenous knowledge to soil fertility management to ensure household food security.

1.2. Statement of the Problem

Declining soil fertility is the major constraining factor on crop production in Ethiopia, improved soil fertility management cannot be overemphasized (Eyasu, E, 2009). In Ethiopia normally, Indigenous and Indigenous communities traditional practice have long used towards soil fertility management in order to increase land productivity and to meet their livelihood needs. To cope up with the impact of soil fertility depletion, farmers have various Indigenous ways of soil fertility management practices. And the importance of Indigenous knowledge has been realized in the design and implementation of sustainable development projects, however little has been done to incorporate this into formal soil fertility management strategies. Researchers and developmental practitioner try to address the soil fertility problem through technology interventions that quite often do not take into consideration the Indigenous knowledge and existing practices. As result success in addressing the real problem and local needs and priorities has been limited and soil fertility depletion continues unabated (Eyasu, 2002). In other words, failure to understand and document Indigenous knowledge of soils and farmers management practices is one of the major causes for low agricultural productivity in Ethiopia.

Rural people to whom development efforts are directed have their own cumulative body of knowledge that enables them arrive at decisions, which could help better manage their life. Today, Indigenous knowledge is seen as pivot above all in discussions on sustainable resource use and balanced development (Brokensha, D.. Warren, D. & Werner, O. (eds) (1980) , 1980).

The current agricultural extension approach is focused on intensified package approach, which mainly concerned on increasing production, using fertilizer and improved seed, without giving emphasis for Indigenous knowledge of soil fertility managements. Reports indicate that use of chemical fertilizer is challenging or problematic, without using of Indigenous knowledge of soil fertility managements. This is because in Ethiopia fertilizer consumption is still below the optimum level for food crops among small scale farmers. These were mainly due to the high price of fertilizer, limited credit services. In addition to this, fertilizers are not enrich soil fertility and cannot supply soil with essential nutrients and elements. Based on their long year experiences on farming, smallholder farmer’s of Hetosa Woreda practice different types of soil fertility management strategies using Indigenous knowledge to ensure food security.

The value and efficacy of Indigenous knowledge is very important for sustainable agricultural production to improve soil fertility, protect soil nutrient depletion and ensure household food security. Arsi zone specifically Hetosa Woreda, take the lion share of this problem. Besides the vast literatures on Indigenous knowledge and Indigenous community practices in soil fertility management, most of the scholar's analysis findings are based on secondary source of data and average data collected at national level and the research work by using primary survey data on the study area in particular and country level in general is not conducted. Therefore, this study was designed to analyze the role of Indigenous knowledge of smallholder farmers and Indigenous community participation for soil fertility management in Hetosa Woreda towards ensuring food production in particular and country level in general.

1.3. Research Questions:

This research intended to answer the following basic questions which are derivatives of the above mentioned research objectives

1. What are the role of Indigenous knowledge of smallholder farmers on soil conservation and fertility changes?
2. What are the Indigenous knowledge used by the smallholder farmers to improve soil fertility in order to enhance agricultural productivity and food security?
3. What is the impact of Indigenous knowledge on soil conservation and fertility towards increasing agricultural productivity and self food sufficiency in the study area?
4. How can farmers tell whether a soil is fertile or suitable for crops, what are the characteristics that tell you that a soil is infertile or unsuitable for crops, and what are the signs that tell you the soil fertility is declining?

1.4. Objectives of the Study

1.4.1. General objective

The overall objective of this study was to assess the Indigenous knowledge contribution to soil fertility managements to ensure household food security in Hetosa Woreda.

1.4.2. Specific objectives

- To describe the local diagnostic criteria for categorizing soil type among smallholder farmers and which soil type is good for crop production

- Describe Indigenous soil fertility management practices in the study area
- To assess the impacts of Indigenous knowledge contribution to household food security in the study area
- To assess soil fertility management practices used by smallholder farmers in improving agricultural productivity and contribution to ensure self-food sufficiency in the study area

1.5. Significance of the Study

The recognition of the importance and value of Indigenous knowledge and practices in agricultural development is almost lacking in the Ethiopian context and more especially with regard to the Indigenous soil fertility management to wards in enhancing food security.

In Ethiopia agriculture is the most important sector which is given special attention by the government, as it constitutes the bulk of the national economy in terms of human and material resources and the driving force through which poverty can be alleviated and food security assured, this study will hopefully give confidence for farmers of Hetosa Woreda to appreciate their own Indigenous soil fertility management methods and the role of the methods in enhancing crop production in combination with the modern farming methods.

Indigenous knowledge need to be recorded to achieve for sustainable food security and can be of good use to create innovative research for agricultural researchers, extension workers, development practitioners, and environmentalists for sustainable agriculture development and management of soil fertility. These studies appreciate that improving crop production and achieving the sustainable agriculture through the use of Indigenous soil fertility management is the most crucial.

The finding of the study could necessarily contribute to formulate inclusive soil fertility management policy in Ethiopia and will also serve as a baseline for further research in Indigenous soil fertility management. Finally, the study will have a long-term benefit for those who are interested to know about the role of Indigenous soil fertility practices towards ensuring smallholder farmer’s food security.

Hetosa Woreda was selected purposively due to no previous study has been conducted on soil fertility management practices, high potential for productivity with mixed farming system, dominated by smallholder farmers and familiarity of the researchers with study area.

1.6. Scope of the study

Understanding the contribution of Indigenous knowledge to soil fertility management to ensure food security is crucial. However, due to the large data requirement, budget and time constraints this study limits its investigation to Hetosa Woreda. As a result, the study could not allow for the assessment of Indigenous knowledge contribution to soil fertility management to ensure food security outside Hetosa Woreda in the data analysis of result discussion. The study was limited to cross sectional survey data collected in 2020.

This paper was bounded to analysis Indigenous knowledge to soil fertility management so as to ensure food security in Hetosa Woreda. In line with this, a researcher was limited to four Kebeles from the total 20 Kebeles existed in the Woreda. Therefore, survey data was collected only from smallholders of those four Kebeles with the sample respondents of 173 farmer's household heads.

1.7. Limitation of the study

The study lacks to apply the standard food security measurement index consists affordability, availability, and quality of food. It is due to lack of budget and time constraints, a researcher do not collect enough data on indicators for food security at household level. The major important data required to compute indexes are household income/livelihoods level, asset (wealth), expenditure -30 day recall for food and 6 months non-food, food consumption and coping, water sources, sanitation and access and health.

CHAPTER TWO

2. LITERATURE REVIEW

According to (FAO, 2009), 'Indigenous knowledge (traditional and Indigenous) is the knowledge that people in a given community has developed over time, and continues to develop. It is based on experience often tested over centuries of use, adapted to the Indigenous culture and environment, embedded in community practices, institutions, relationships and rituals, held by individuals or communities, dynamic and changing'.

In developed and developing countries all over the world, farmers and Indigenous and Indigenous communities have traditional knowledge, expertise, skills and practices related to food security and to food and agricultural production and diversity. Since its creation in 1945, FAO has recognized the significant contributions these make to food and agriculture, and the relevance of on-farm/in situ and ex situ conservation of genetic resources for food and agriculture. Over the decades, FAO has included traditional and Indigenous knowledge and activities in polices programmers and projects related to a wide range of issues, including farmers' right, poverty alleviation, nutrition and health, and gender equity, among many others. More recently, it has used traditional knowledge to tackle the emerging problems of soaring food price and climate change.

(FAO, 2009), indicates the linkages between traditional knowledge and food security, millions of traditional farmers and Indigenous and Indigenous communities use their traditional knowledge to ensure food and livelihood security in a wide range of ecosystems, including fragile and harsh ones. Traditional practices are related to cultural traditions and biocultural dynamics and can regenerate Indigenous food systems while increasing socio-environmental sustainability and resilience.

Such practices can also be applied in innovative ways to help tackle today's problems.

Through their on-farm/in situ conservation and management of resources, farmers, pastoralists/ herders, fishers, foresters, foragers, mountain people and other communities following traditional lifestyles maintain high levels of genetic resources for food and agriculture. This creates an important basis for the food security of present and future generations worldwide. The application of traditional knowledge in such areas as ecosystem and landscape management, water management, soil conservation, biological control of pests and diseases, ecological agriculture and livestock practices, and plant and animal breeding often enhances food security and prevents or alleviates poverty.

2.1. An Overview of Soil Fertility Depletion

Soil fertility depletion is the fundamental cause of declining per capital food biomass, especially in developing countries (Joshi M, Kiran B, Bargali SS, 1995), (Omotayo OE, Chukwuka KS, 2009). In intensive agricultural systems, soil fertility can be maintained through applications of manure and other organic materials, inorganic fertilizers, lime, and the inclusion of legumes in the cropping system, and combination of some of these (Pandey CB, Sharma DK, Bargali SS, 2006). Although, the reliance on biological nutrient sources for soil fertility regeneration is adequate with low cropping intensity, it becomes unsustainable with more intensive cropping unless artificial fertilizers are applied (Mulongoy K, Merckx R, 1993).

However, in many parts of the developing countries, the availability, use and profitability of inorganic fertilizers have been low whereas, there has been intensification of land-use and expansion of crop cultivation to marginal soil. As a result, soil fertility has been declined and it is perceived to be widespread, particularly in sub-Saharan Africa including Ethiopia (Belachew T, Abera Y, 2010). So, soil fertility maintenance is a major concern in the region to improve agricultural production in order to feed the growing population. The fertility continued to decline due to continuous cropping (abandoning of fallowing), reduced manure application, removal of crop residues and animal dung for fuel wood and erosion coupled with low inherent fertility of the soils (Yohannes U, 1994).

Soil fertility decline is the major environmental challenge that threatens agricultural productivity and the livelihoods of millions of rural households in Ethiopia (Mitiku, H., Herweg, K., & Stillhardt, B., 2007). According to (Abebe M, 1998), challenges of soil fertility decline in Ethiopia are related to cultural cropping practices like traditional cultivation, removal of vegetative cover (such as straw or stubble), burning plant residues as practiced under the traditional system of crop production or the annual burning of vegetation on grazing lands. These are the major contributors to the loss of nutrients.

According to (Barry B, Ejigu J, 2005), the main causes of fertility decline in Ethiopia are deforestation, land fragmentation, overgrazing, low fertilizer inputs, inadequate soil and water conservation practices and cropping of marginal lands. All of these have resulted in lowering of agricultural production which is leading to **food insecurity** and increased poverty. Inappropriate land use, overgrazing, deforestation and continuous cultivation of the same land without appropriate and sufficient management lead to soil degradation and its consequences like depletion of nutrients and reduction of output (Conant RTJ. six, Paustian K, 2003), (Kebede W, Awdenegest M, Fantaw Y, 2013), (Bernoux M, Cerri CC, Neill C, de Moraes JF, 1998).
Likewise, the study area is characterized with densely population and intensive, agriculture that contributes for soil fertility decline, deforestation is also causing soil erosion. On the other hand, shortage of grasslands (grazing areas) in the study area forced the farmers to remove crop residues from cultivated land for animal feed. Until recently, farmers' knowledge of soil fertility has been largely ignored by soil researchers, but with increasing use of participatory research approaches, it is becoming clear that farmers have a well-developed ability to perceive differences in the level of fertility between and within fields on their farms.

Farmers Use different criteria to evaluate and identify their soils. Usually, they characterize their field as fertile(good /high) or infertile (bad/low) by using soil color, soil texture, soil depth, soil drainage, topography and distance from home as criteria to classify into different groups as fertile and no fertile (Gebeyew, 2015). Farmers' decisions to conserve natural resources in general, and soil and water in particular are largely determined by their knowledge of the problems and perceived benefits of conservation (Amsalu A, De Graaff J , 2007). However, farmer perceptions of soil erosion and soil fertility management problems in Ethiopia have received little emphasis either in status analysis or use in conservation planning. In order to give a sustainable solution to all above mentioned challenges, researcher and farmers response is very crucial.

2.2. Soil Fertility Management

Soil fertility management simply refer to those techniques adopted by farmers to maintain soil fertility status and hence improving the physical, chemical and biological soil properties to enhancing the organic matter content, increasing the efficiency of nutrient by using closed nutrient cycles and by minimizing nutrient loss from the agro-ecological system (Conway, C., 1997). Though many of the continent-wide studies indicate that soil fertility is declining, scholars are starting to question the underlying assumptions, evidence, methodologies and scale upon which studies and beliefs of soil fertility decline are based (Scoones, I. , 1997) (Scoones, I, Toulmin, C. , 1999). This problem has often been attributed to the improper utilization and under management of natural resources by the traditional farmers. Due to increased population pressure, farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or unable to leave land fallow for long enough for it to be effective. The use of mineral fertilizers is declining as they are beyond the means of most small-scale farmers (Larson, B. A. and Frisvold, G. B., 1996).

According to (Sanginga, N. and Woomer, P.L, (eds.)., 2009), need to move away from blanket fertilizer recommendations to basing guidelines upon the principles of ISFM, thus offering farmers the opportunity to make more judicious and synergistic use of available organic resources and purchased inputs. Most blanket fertilizer recommendations were formulated many years ago and disregard the potential benefits from organic resources, variation in soil properties and climate, and the changing relationships between production costs and commodity prices. As a result, several existing recommendations may be considered obsolete. In many cases, fertilizer labels only report the contents of macronutrients, ignoring the secondary and macronutrients. Past fertilizer recommendations focus on the maximum yield attainable for broad agro-ecological regions, whereas individual farms may be extremely heterogeneous. To account for this shortcoming, it is important that recommendations be considered an informed starting point for further refinement by land empowered managers.

2.3. Indigenous Knowledge in Soil Management and Scientific Knowledge

Indigenous Knowledge initially defined as the knowledge held by Indigenous communities (people) has been expanded to include: The sum total of the knowledge and skills which people in a particular geographic area possess, and which enable them to get the most out of their environment. Most of this knowledge and these skills have been passed from earlier generations but individual men and women in each new generation adapt and add to this body of knowledge in a constant adjustment to changing circumstances and environmental conditions. They in turn pass on the body of knowledge intact to the next generation, in an effort to provide them with survival strategies.

There has been an attempt to romanticize and idealize Indigenous knowledge in a new reverence, and imply thereby a functional separation between two sorts of knowledge validated by different sets of criteria. When we conceptualize IK systems, we often think of ‘other culture’. However, the danger of this has been noted in that we perceive cultures as discrete bounded systems that are undynamic and unchanging, which is not always the case. Indigenous knowledge is also seen as pivotal in discussions on sustainable resource use and balanced development (Brokensha, D., Warren, D. & Werner, O. (eds.), 1980), (Chambers, R., 1983), affirms the complimentary role of the two knowledge systems when he assets that rural people’s knowledge and scientific knowledge are complimentary in their strengths and weaknesses and that combined, they may achieve what neither would alone (Chambers, R., 1983). Indigenous knowledge is often seen to exist in a Indigenous context, anchored to a particular social group in a particular setting at a particular time. Significant contributions to global knowledge have originated from Indigenous people. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with people’s cultural values.

Integrated use of chemical fertilizers and organic manure such as compost, green and farmyard is in many ways advantageous as soil organic matter is replenished and builds the nutrient reserve in the soil. Organic manure releases nutrients slowly, reducing the risk of leaching and improves soil water retention. The application of organic manure such as compost to soil is the quickest and most effective way of raising the organic matter levels for the soil fertility improvement. Whereas chemical fertilizers may increase the yield and cannot supply soil with essential nutrients and elements to maintain soil fertility.

2.4. Indigenous Knowledge Soil fertility Management and Food Security

Culture and the respective systems of Indigenous peoples have been widely misunderstood or even dismissed by development planning experts in the past. This issue was raised recently in a final statement by the Brundtland Commission (WCED): “Some traditional lifestyles are threatened with virtual extinction by insensitive development over which the Indigenous people have no participation. Their traditional rights should be recognized, and they should be given a more decisive voice in formulating policies about resource development in their areas.

Many scientific and social researchers associated with the formulation of development assistance policies are now beginning to recognize the decisive role that Indigenous peoples and their knowledge of the ecosystem, contribute to the success of development projects and strategies (Lalonde A, 1991). It is reasonable to assume, that essential global development assistance activities including; Indigenous participation, capacity building, and sustainable resource management can be enhanced in cost-effective programs and strategies which understand and work with Indigenous knowledge and Indigenous decision-making systems. Africa may be an ideal continent to learn about and begin seriously integrating Indigenous expertise with development planning techniques.

Despite the rich diversity and number of Indigenous cultural groups throughout Africa, much of the remaining areas of Africa today are threatened by growing environmental and social pressures. In this unexploited, remote or sparsely populated area, the Indigenous societies tend to live traditional lifestyles (Lalonde A, 1991). Indigenous knowledge (IK) has attracted the interest of researchers nowadays. Accordingly, various investigators tried to recognize how conservation of natural resources such as water and soil can be done through Indigenous knowledge of communities compared to modern ways. (Ajibade LT., 2003), conceptualizes IK as it has been built upon and pass from one generation to generation and improves within a particular culture or ethnic group and tries to meet continuation of objectives in a specific environmental background. The densely residential areas of Northern Ethiopia are among those with the highest rate of soil loss because the environment is highly degraded as compared to the Southern part of the country. The forest reserves of the country are predicted to be 2.5-3% of the total land where approximately 100,000 hectares of forest are lost annually. About 1 billion tons of topsoil also believed to be eroded annually (Berisso T, 1995). In line with this, (Tsighe Z. , 1995) asserts that the average soil erosion is 42 tones/hectare/year in the croplands.

It is well-known that soils with low fertility are unable to allow sufficient crop cover to sustain life. Low humus content and erosion of such soil decrease infiltration and moisture holding capacity of the soil. Thus, it is increasingly recognized that adequate conservation of soil resources is a precondition for sustainable rural development strategies mainly in the highlands of Ethiopia. Most of the projects for soil conservation, however, planned at the center and implemented at the Indigenous level shows little attention to the question of whether the Indigenous population could apply techniques on their farm fields. Similar to the above experience at the end of project farmers did not have the interest to expand new methods to the rest of farm fields. This is partially attributed to the costly nature and problem of adaptability of the new technology otherwise not contextualize.

Furthermore, planners in the area assume that the Indigenous population is responsible for the overall maintenance of the structures built by a project (Tsighe Z. , 1995). Most highland areas of Ethiopia are characterized by high population, high rainfall, and sloppy lands. How to maintain the fertility of the productive soil and rehabilitate degraded arable lands are the primary concern of many stakeholders in highland areas (Amede T, Belachew T, Geta E., 2001). Extensive literature review and Indigenous experiences show that proper food security is threatened by deteriorating soil quality and declining crop yields in Ethiopia and throughout Africa where a majority of the population relies on small-scale farming for its livelihood. Depletion of soil fertility constitutes one of the most important constraints to sustainable agricultural production, causing low per capita food production in Africa.

Indigenous knowledge has come to occupy a privileged position in discussions about how development can best be brought about so that finally, it really is in the interests of the poor and the marginalized (Agrawal, Arun., 2002). To ignore people's knowledge is almost to ensure failure in development (Brokensha, D., Warren, D. & Werner, O. (eds.), 1980). Since Indigenous knowledge is essential to development, it is often suggested that it must be gathered and documented in a coherent and systematic fashion (Brokensha, D., Warren, D. & Werner, O. (eds.), 1980). As more studies of Indigenous knowledge become available, its relevance to development will become self-evident.

(Shepherd, Andrew., 1998), postulates that food security does not depend on crop production alone whether at household region or country level. It depends to a greater extent on people’s ability to command the resources to acquire the food they need – whether this is through production, farm production of cash crops, other income-earning activities, employment or remittances. The major problem, however for crop production lie in the farmers’ use of high level chemicals, reduced diversity of the cropping systems, taking livestock out of the system and controlling nature to a high degree. It appears that (Shepherd, Andrew., 1998), is faulting the over-reliance on the modern scientific knowledge only to the exclusion of the Indigenous knowledge.

2.5. Farmer’s Indigenous Knowledge, Characterization and Classification of Soils

Regarding soils, Indigenous knowledge can be defined as “the knowledge about soil properties and management possessed by people living in a particular environment for some period of time” (Winklerprins, A. M. , 1999). Such knowledge includes complex practices and decisions made by Indigenous people based on experience built over time; it is dynamic, continually changing and rarely systematized (Boven, K., & Morohashi, J., 2002).

It adapts and integrates novel notions over time, may be location specific or vary among individuals from different social groups differentiated by factors such as wealth, gender, ethnicity and occupation. Such knowledge is transmitted and shared within specific social and agro ecological contexts (Séhouéto, L., 2006), providing a framework for decision-making in a plethora of social, economic and environmental activities and livelihoods among rural households. Therefore, the term Indigenous knowledge emphasizes the fact that farmers constantly produce and adopt new forms of knowledge subject to certain patterns of their own cultural, agro ecological and socioeconomic conditions as an adaptation mechanism.

Farmers have developed traditional approaches to enhancing soil fertility and conservation such as: the use of organic manure (mainly from livestock and compost); fallowing; mulching; and intercropping (Kolawole, O., 2002), making their knowledge in soil fertility management a subject of interest. Although practices such as fallowing can no longer be extensively used in many areas due to the competing land use demands as caused by increased industrial growth and population pressures, a combination of manure application, mulching and intercropping with scientist-based approaches to soil fertility management remains plausible.

The farmers have their own perception to characterize and classify soil based on their Indigenous knowledge. Indigenous level soil characterization and classification are based on visible soil properties. These soil properties comprise soil color, texture and water content. Soil Color, texture, consistency and utility appear to be common categories in soil classification while fertility and workability are also recognized in some Indigenous stems. The color of the topsoil is found to be important parameter for farmers to distinguish soil types. Commonly, darker soils regarded as more fertile ones than light colored soils. (Taylor-Powell, E., A. Manu, S. C. Geiger, M. Ouattara, and A. S. R. Juo, 1991). Topsoil color in combination with the indicator plants are used by farmers to make a choice for crops types and their rotation pattern (Mikkelsen JH, Langohr R, 2004). In addition, farmers used soil color and texture to describe the soil quality and as a criterion to differentiate soils.

2.6. Integrated Soil Fertility Management

Integrated soil fertility management is the application of soil fertility management practices and knowledge to adopt these to Indigenous condition, which maximize fertilizer and organic resource use efficiency and crop productivity. These practices necessarily include appropriate fertilizer and organic input management in combination with the utilization of improved germ plasm (Sanginga, N. and Woomer, P.L, (eds.)., 2009).

The concept of ISFM involves simultaneous integration of individual soil management practices with an overall aim of exploiting complementarily effects that exist among these multiple technologies (Marenya, P. P., & Barrett, C. B., 2007). A core assumption in this approach is that each soil fertility management practice (technology) has a significant contribution to make in enhancing soil fertility and productivity; none of them is sustainably sufficient in meeting all soil fertility requirements (Place, F., Barrett, C. B., Freeman, H. A. Ramisch, J. J. & Vanlauwe, B., 2003), thus, they should be used in complementary ways.

(Sanginga, N. and Woomer, P.L, (eds.)., 2009), state that the overall goal of integrated soil fertility management (ISFM) is to maximize the interactions that result from the potent combination of fertilizers, organic inputs, improved germplasm, and farmer's knowledge. The ultimate outcome is improved productivity through wiser farm investment and field practices. Efficient farming must maximize profitability of soil addition and the productivity per unit applied in a manner that enhances soil fertility through improved nutrient availability and recycling. Maximizing water use efficiency and minimizing soil loss by erosion are important parallel condition toward this end. ISFM also offers environmental services through fostering soil biological diversity and sequestering additional carbon within the soil.

Several indicator of ISFM are available to both land managers and agricultural policymakers (Table 1. Farmers can apply simple criteria to their incomes, crop and land to assess the benefits from adopting ISFM practices while the outcome of broader and more complex evaluation may redirect future action toward rural development and drive needed policy reform. Large differences exist between reliance upon mineral fertilizer use as standalone soil fertility management practice compared to ISFM in terms of their respective approaches

Table 1. Strategic goals and selected ISFM indicators for farmers and evaluators

Land managers' objective	**Indicators for Land managers**	**Indicators for policymakers**
Maximize profitability of fertilizer and organic inputs	Net increase in farm revenue	Increase in net benefits and product demands
Maximize productivity per unit fertilizer applied	Increased in yields	Change in yields per unit fertilizer
Enhance the soil fertility status	Change in soil color, feel and Water retention	Overall increases in diagnostic soil fertility indicators
Maximize cycling of nutrients	Less fertilizer needed to obtain Same yields change in surface soil	Nutrient cycling efficiency and reduce soil nutrient depletion
Maximize water use efficiency	Delayed wilting, less run -off	Increase water use efficiency and Improvement in water quality
Minimize soil loss by erosion	Reduction in soil erosion	Reduction in sediment loads with in water catchment
Maintain soil biological diversity	Changes in key species, particularly Weeds beneficial soil fauna	Increases in biodiversity indices

Source: (Sanginga, N. and Woomer, P.L, (eds.)., 2009).

2.7. Importance of Indigenous Knowledge as Part of the Lives of the Rural Poor

In the emerging global knowledge economy a country's ability to build and mobilize knowledge capital, is equally essential for sustainable land management as the availability of physical and financial capital (World Bank., 1997). The basic component of any country's knowledge system is its Indigenous knowledge. It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood.

The livelihood of the rural poor depends almost entirely on specific skills and knowledge essential for their survival. Accordingly for the development process, Indigenous knowledge is of particular relevance for the most sectors and strategies, like agriculture, animal husbandry and ethno-veterinary medicine, use and management of natural resources, primary health care, preventive medicine and psychosocial care community development, Poverty alleviation through self-help and societal care.

2.8. Indigenous Knowledge as an Entry Point to Participatory Technology Development

The increasing attention Indigenous knowledge is receiving by academia and the development institution has not yet led to a unanimous perception of the concept of Indigenous knowledge. The definitions are essentially not contradictory; they overlap in many aspects. As quoted by the (Warren, D.M., 1991) and (Flavier, J.M., 1995), present typical definitions by suggesting: Indigenous knowledge (IK) is the Indigenous knowledge– knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for Indigenous-level decision making in agriculture, health care, food preparation, education, natural resources management, and a host of other activities in rural communities. It is the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems. According to (Ellen, R., Harris, H., 1996), there are distinct characteristics to understand and comprehend Indigenous knowledge.

2.9. Indigenous Knowledge is not Fully utilized in the Development Process

Conventional approaches imply that development processes always require technology transfers from locations that are perceived as more advanced. This has often led to overlooking the potential of Indigenous experiences and practices. The following experience on sorghum improvement for alleviating food insecurity in the sorghum growing regions of Ethiopia is a typical example where the Indigenous knowledge existing within the society is not captured in the development of the new varieties. For example: According to (Oduol, W. , 1992), higher yielding sorghum varieties were introduced in Ethiopia to increase food security and income for farmers and rural communities. When weather and other conditions were favorable the modern varieties proved success. However, in some areas complete crop failures were observed, whereas Indigenous varieties, with a higher variance of traits, were less susceptible to the frequent droughts. The loss of an entire crop was considered by the farming community as more than offset by the lower, average yields of the Indigenous varieties that performed better also under extreme conditions. An approach that had included the Indigenous experience of farmers might have resulted in a balanced mix of Indigenous and introduced varieties, to reduce the risk for the producers. Introduced varieties and commercially marketed seeds are replacing Indigenous varieties; along with them the concomitant Indigenous knowledge disappears. Efforts are being made to preserve genes and clones, however the seeds do not carry the instructions how to grow them. The knowledge needs to be captured, preserved and transferred as well. This is not realized in the collection schemes carried by several breeders and crop improvement experts thereby losing the knowledge system that had been preserved by the communities in their efforts to sustain these varieties of crops.

2.10. The Role of Indigenous Practices in Development Process and their Interaction

Indigenous practices have a considerable degree of sustainability with the Indigenous environment. It is because they have been developed in line with the laws of natural ecological systems. They are within the scope of the farmers acquired or inherited culture, traditions and knowledge (Belay Tegene, , 1998).

Indigenous practice is important on three levels for the development process. Firstly, it is obviously important for the Indigenous community in which the bearers of such practices live and produce. Secondly, development partners such as NGOs, private sector initiatives, government, donors and Indigenous leaders need to recognize it in the interaction with the Indigenous communities before incorporating IP in their approaches. They need to understand it and critically validate it against the usefulness for their intended objectives and lastly, IP forms parts of the global practices. In this context, it has value and relevance in itself. IP can be preserved, transferred or adopted to ecological, social cultural and economic conditions of a particular community (Grenier L.,, 1998).

Regarding the interaction between development process and Indigenous knowledge, three scenarios can be observed when designing or implementing development programs or projects. A development strategy either: relies entirely or substantially on Indigenous knowledge, overrides Indigenous knowledge, or incorporates Indigenous knowledge. Planners and implementers need to decide which path to follow. Rational conclusions are based on determining whether Indigenous knowledge would contribute to solving existing problems and achieving the intended objectives. In most cases, a careful amalgamation of Indigenous and external knowledge would be most promising, leaving the choice, the rate and degree of adoption and adaptation to the clients. External knowledge does not necessarily mean modern technology, it includes also Indigenous practices developed and applied under similar conditions elsewhere. These techniques are then likely to be adapted faster and applied more successfully. To foster such a transfer, a sound understanding of Indigenous knowledge is needed. This requires means for the capture and validation, as well as for the eventual exchange, transfer and dissemination of Indigenous knowledge.

2.11. Indigenous Knowledge Systems are at a Risk of Becoming Extinct

Because of rapidly changing natural environments and fast pacing economic, political and cultural changes on a global scale, Indigenous knowledge is at risk. Practices vanish, as they become inappropriate for new challenges or because they adapt too slowly. However, many practices disappear only because of the intrusion of foreign technologies or development concepts that promise short-term gains or solutions to problems without being capable of sustaining them. The tragedy of the impending disappearances of Indigenous knowledge is most obvious to those who have developed it and make a living through it. But implications for others can be detrimental as well, when skills, technologies, artifacts, problem solving strategies and expertise are lost (Kibwana, O.T., Mitiku Haile, Valdhuizen, L., Waters-Bayer, A. 2001b.).

2.12. Conceptual Framework

Improved soil fertility by applying Indigenous knowledge of soil fertility practice is important for sustainable food production, hence, the way to improve food security.

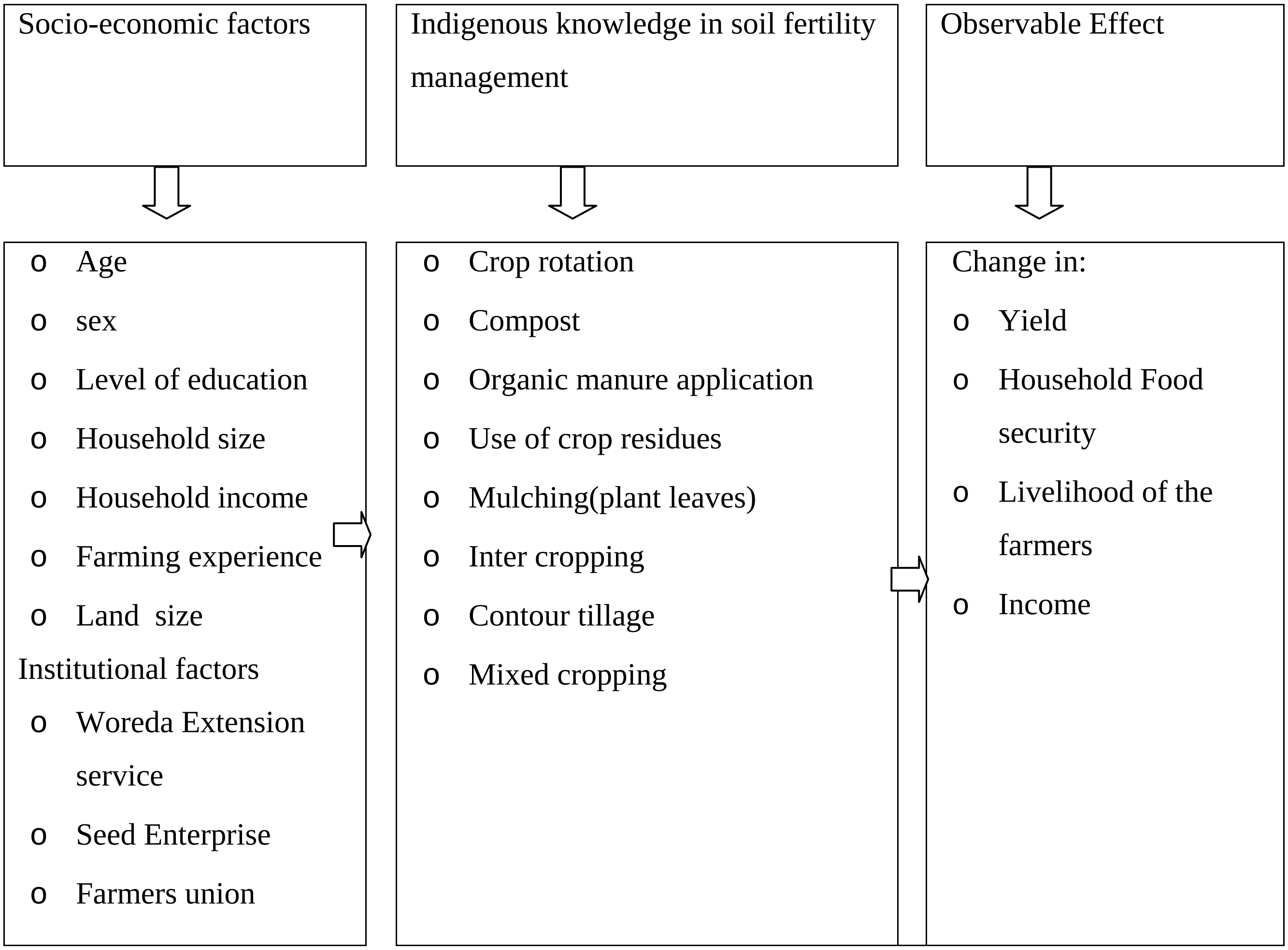
Figure 1 is diagram of the conceptual model which identifies the factors influencing the use of Indigenous knowledge systems in soil fertility management by smallholder farmers in the study area. In the context of the study the independent variable in the model includes:

- Socio-economic variables which comprise; age, level of education, household size, household income, farming experience, farm size;
- And institutional variables which comprise; contact with extension agents and membership in cooperative societies, seed enterprise.

The dependent variable is the Indigenous knowledge technique in soil fertility management. Soil fertility management system considered is Organic manure application, Use of crop residues, Compost Mulching (plant leaves), Crop rotation, Mixed cropping and Contour tillage.

The model in figure 1 shows that independent variable (X) would influence the dependent variable (Y) which is the indigenous knowledge technique in soil fertility management. The observable effects of indigenous knowledge technique in soil fertility management are change in: output (yield) income, household food security and livelihood of the farmers.

Figure 1: A conceptual model showing a priori expectation on the analysis of the application of Indigenous Knowledge System for soil fertility management among smallholder farmers of Hetosa Woreda.



CHAPTER THREE

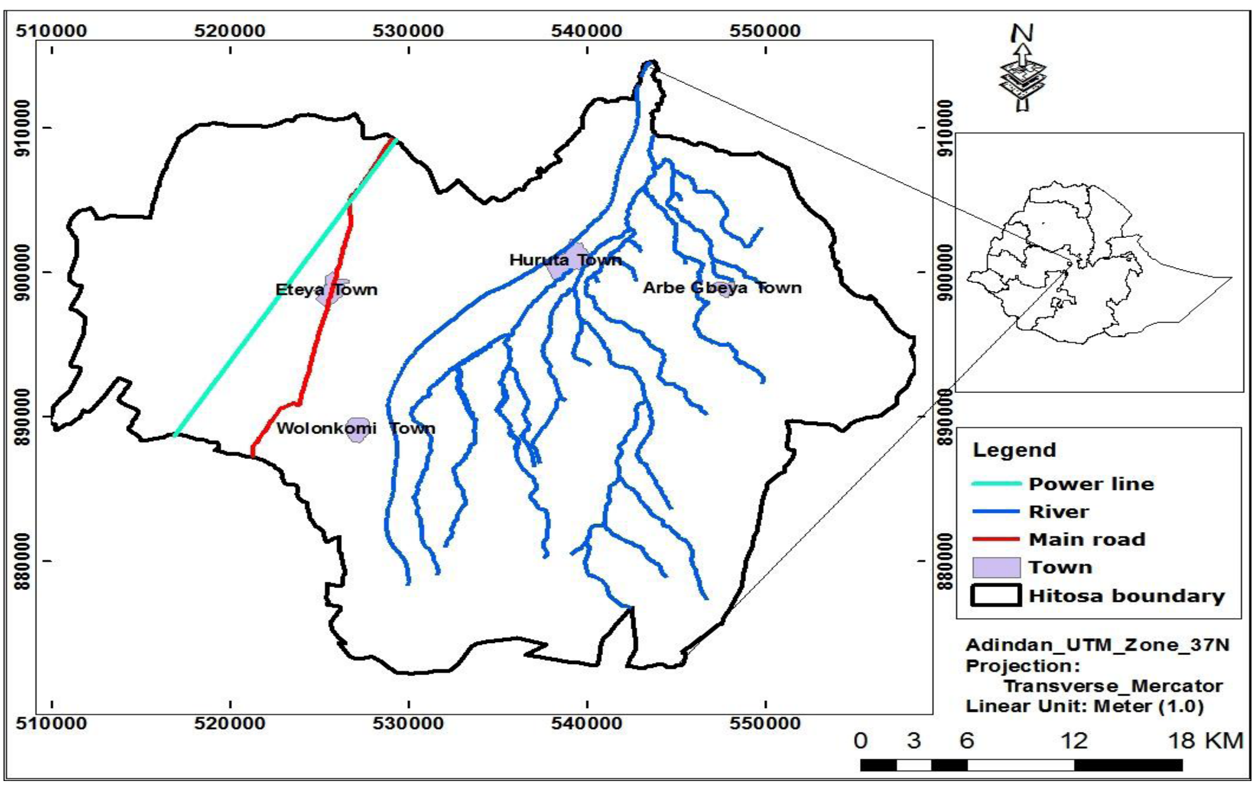
3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Location

Hetosa Woreda (currently Lude Hetosa and Hetosa) is one of the Woredas in Arsi zone of the Oromia Regional State of Ethiopia. The administrative center of the Woreda is Iteya town, which is located south east of Addis Ababa at about 160 km and 25 km from northeast of Asella, the capital of Arsi Zone. This Woreda has a total area of 1260 km2 and located geographically between $7^{o}54'45''$–$8^{o}17'56''$ N latitude and $39^{o}07'09''$– $39^{o}33'08''$E longitude. It shares boundaries with Dodota in the North, Digeluna Tijo in the South, Ziway Dugda in the West, Misrak Shewa Zone in the northwest and Tena Woredas in the East. It is located completely within the Ethiopian Rift Valley.

Figure 2: Location map of the study area



Source: (Ebisa T, 2016)

Climate and Topography

Hetosa Woreda has three climatic zones. The topography of the area comprises 27 % highland (dega), 31% midland (weyena dega) and the rest (41percent) is lowland (kola). The altitude of the Woreda ranges from 1590m a.m.s.l. to 4185m a.m.s.l.. The average temperature of the Woreda varies between 20.5^{0}C and 27^{0}C with minimum annual rainfall of 800mm.

Population and Economic Activity

Total population of Hetosa Woreda is about 124,179. Out of this, 62,335 are men and 61,734 are women, most of them (about 85 %) live in rural areas (Central Statistical Agency (CSA). Federal Democratic Republic of Ethiopia Statistical, 2008). Agriculture is the dominant livelihood strategy of the majority of the population and it is one of the most agriculturally productive Woredas in the Oromia Region.

Land Use Land Cover

The total land size of the Woreda is 126,000 hectare. The land use types in the study area are classified into five classes (Fig. 3). These are agriculture, bare-land, forest, grass land and settlements. Of this, agricultural sector takes the lion's share (69,438 hectare), bare-land (19,188 ha), forest (4,676 ha), grass land (29,003 ha) and settlements (3,695 ha) as shown in figure 2

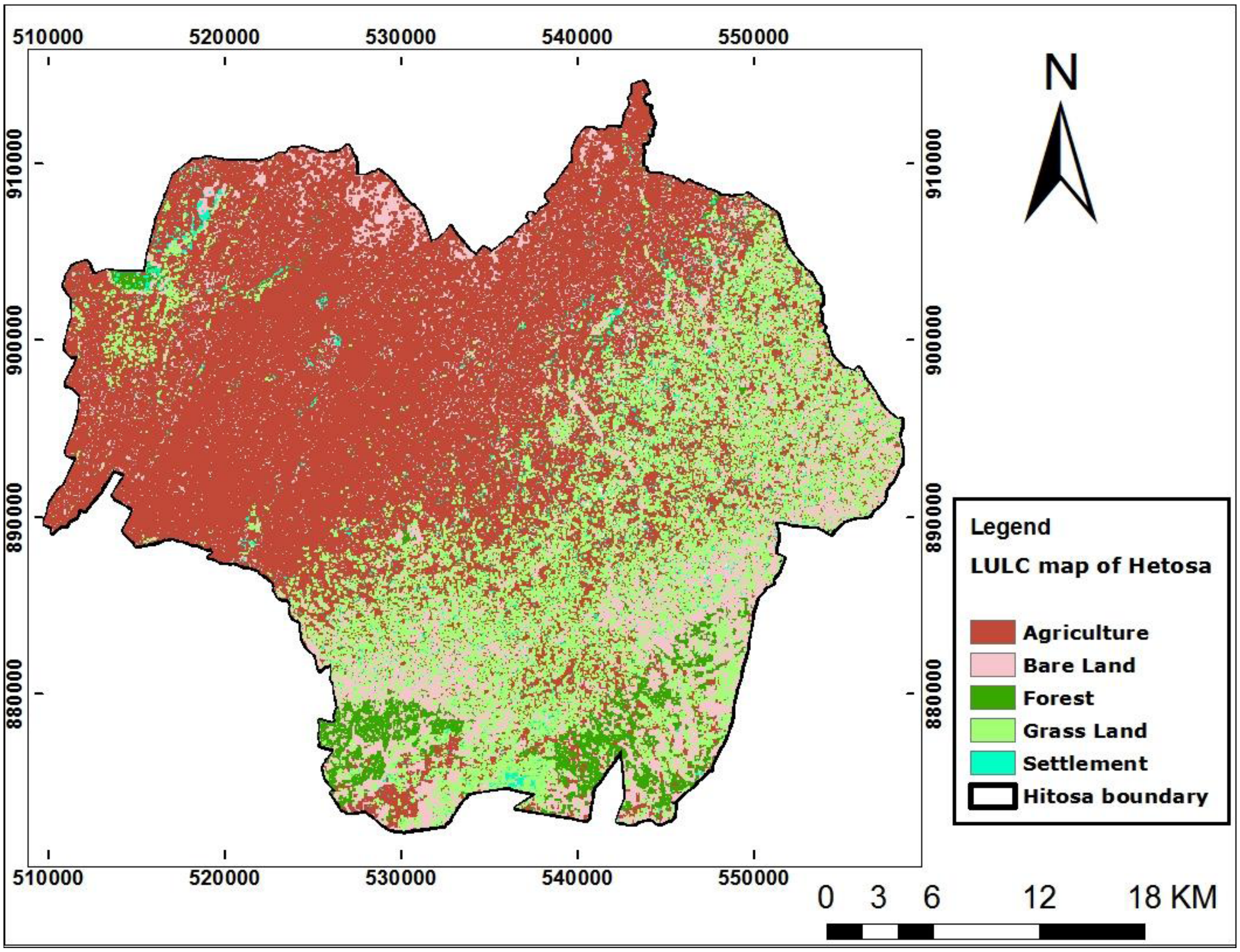


Figure 3. Land use Land cover map of Hetosa

Source: (Ebisa T, 2016)

3.2. Research Design

The study on the assessment of Indigenous knowledge contribution to soil fertility management to ensure food security was conducted in Hetosa Woreda, Oromiya Regional National State. Hetosa Woreda was selected purposively because of convenient to the researcher in which a researcher has knowledge about the area. The study used both quantitative and qualitative approaches of data analysis. This design was selected because it is helpful to show situations as they currently exist (Cohen, 2000:169). It is also assumed that this method is economical since it enables to describe the prevailing situations both quantitatively as well as qualitatively which eventually help draw valid general conclusion

3.3. Research Methods

3.3.1. Sample Techniques and Sampling size

Researcher selected four Kebeles purposively based up on the potential crop production and population size from the total 20 Kebeles (kebeles) of Hetosa woreda. In order to determine the representative sample population size from those selected Kebeles consists farmer's household heads, key informal interviewers and focal group discussions, a researcher use Cochran's, 1991 sample size design formula.

$$n = \frac{Z^2 P(1-P)}{e^2} \quad , P - population\ ratio\ and$$

$$P = \frac{target\ population}{total\ population},$$

Where $n =$ sample size

$Z =$ The significance level

$P =$ Population proportion (ratio)

e^2 = level of accuracy (residual or error term)

According to Woredas Rural Agriculture and land Management Office, there were 44,731 farmers' household heads that has his/her own land either cultivated or grazing land.

Due to time and budget constraints a researcher forced to minimize sample size and investigated only 25% of the total smallholder households selected randomly in which estimated to represent total landholder cultivate various types of food crops in the study area.

Therefore the sample size were determined as

$$n = \frac{(1.96)^2 0.25(1 - 0.25)}{(0.05)^2}$$

$$n = 288$$

Of the total 288 distributed questioners for the respondents 60% of the data's are returned from the respondents and the rest were failed to collect because of unwillingness of the respondents and lack of enough time to collect in effective manner. Therefore, in these studies there was 173 number of respondents are under the investigation

Table 3.1. The proportional sample survey data obtained from Hetosa woreda selected Kebeles

Sample	Village				Total
	Jengo-Kilisa	Boru	Daya'a	Xado	
Random sample population	35	50	62	26	173
% of random sample population	20.	29	36	15	100

3.3.2. Data Sources and Data collection instruments

In these studies a researcher uses both primary and secondary sources. With respect to primary sources, a researcher collected data from farmers' household heads, development agents and Woreda Agriculture and Rural development office officials. On the other hand, the secondary sources are reports and documents from Hetosa Woreda Agriculture and Rural development office, MoA, Research centers and FAO.

In order to have a better understanding and achieve the desire goals of the research, the data was collected through questionnaire, interview, and focus group discussion. Questionnaire containing close and open- ended questions was developed. The questioners are developed based on the research questioners and research objectives. Close-ended questioners are developed via provision of some alternatives for the respondents as they choose the best of them. While open-ended questioners are the question for the respondents left the answer up to the respondents. In here the respondents are free from the alternatives provided by the researcher and they simply give their opinion to the question they asked. In this paper open-ended interview are administer to agriculture and rural development office, sample of agriculture expert, development agent and focus group discussion.

The significance level of the data is checked by running pre-test 5 percent residual values and 95 percent confident intervals. A researcher used Pearson chi2 to tests either there is statistically significant or not among the tested variables and P values tends to zero (i.e P<0.05) the variables are statistically significant variation among tested categorical variables.

3.3.4. Data Analysis Method

The collected data from the respondents of farmer's household heads, key informants and focal group discussions are analyzed in both qualitative and quantitative approach. The qualitative methods explain a data in the form of sentence, pie chart and graph box to validate the relationships as well as comparison among the predictor variable. Whereas quantitative approaches present a data's in both descriptive and inferential statistics. The descriptive statistics present a data in the form of tables, frequency distribution and percentage, while inferential statistical employees t-test, z-test, ANOVA, P-value and Pearson chi-squared.

Furthermore in order to examine the estimated relationships between the outcome variable and predictors I develop multiple linear regression models as fellow.

$$yield = f(age, \text{religion}, \text{mrstatus}, \text{hhsize}, \text{tsu}, \text{tfu}, \text{Afert}, , \text{sseed}, \text{lknow}, \text{Tlknow},)$$

Where, age is age of respondent, religion is believes of household, mrstatus = marital status, hhsize = household size, tsu= type of seed used, tfu = type of fertilizer used, Afert = amount of fertilizer, $\text{cocropdn} =$ constraints in crop production, lknow = Indigenous knowledge, Tlknow= type of Indigenous knowledge and $\text{dexlkno} =$ development of experience on Indigenous knowledge.

Assuming classical assumption for multiple linear regressions model, the estimation was as follow:

$$yield = \alpha + \beta_1 age + \beta_2 \text{religion} + \beta_3 \text{ mrstatus} + \beta_4 \text{hhsize} + \beta_5 \text{tsu} + \beta_6 \text{tfu} + \beta_7 \text{ Afert} + \beta_8 \text{ sseed} + \beta_9 \text{lknow} + \beta_{10} \text{Tlknow} + \epsilon_i$$

The cross checks of residual normality distributions were tested by conducting individual residual test t-test and conclude that $\epsilon_i \sim (0, 1)$. Therefore there are no hetrocedasticity problems in the model. Whereas VIF test was conducted to check the problem of multicolinerity and the value VIF = 4.63 which is less than 10 implies there is no multicolinerity problem in estimation.

In order to examine the relationships between the two categorical variable i'e food self-sufficient and use of Indigenous knowledge logistic regression model was estimated as follow.

A single binary predictor where

$$fss = \begin{cases} 1, & if\ individual\ farmer\ have\ food\ self-sufficiency \\ 0, & if\ not \end{cases}$$

$$logit\big(p(fss)\big) = \log\left(\frac{p(fss)}{1-p(fss)}\right) = \alpha + \beta x$$

Then for $fss = 0$ (food self-insufficient), logit (p (fss) = logit (p$(0) = \alpha + \beta(0) = \alpha$
$fss = 1$ (Food self-sufficient), $logit(p(fss) = logit\big(p(1)\big) = \alpha + \beta(1) = \alpha + \beta$

3.4. Ethical Consideration

Necessary ethical clearance is obtained from Addis Ababa University and also from Hetosa Woreda Agriculture and Rural Development Office prior to data collection and when the data will be collected from selected respondents who have a willingness to participate. Those who have the willingness have made to sign formal "Consent Form" designed for same purpose. Great care and precautions is taken not to state items of the instrument in such ways that they are free from gender-, age-, ethnic- & religion-based biases. Collected data and information is kept confidential until the end of the study; and then after they are destroyed.

CHAPTER FOUR

4. RESULT AND DISCUSION

This chapter deals with the data obtained through household survey, FGDs, and key informant interviews are presented. To make the finding more meaningful information gathered through FGDs and key-informant interviews. Accordingly, the analysis is presented in four major sub- sections. In the first sub-section, demographic characteristics of respondents are presented. In the second sub-section some back ground information on households' livelihood activities and strategies are discussed. Thirdly, findings related to food security status of households are presented.

4.1. Socio-demographic characteristics of the respondents

Education level of household head respondents

The impact of education on gender in farm activity participation was known and possible to measure as well as quantifiable. The survey data provides that female household heads participants in agricultural food crop production were more educated than male participants. The data can be illustrated in below table 4.5

Table 4.5 Gender and education level relationships

	Education level of respondents				
gender	college	junior	primary	schooling	Total
female	50.00	37.50	41.67	32.65	39.88
male	50.00	62.50	58.33	67.35	60.12
Total	100.00	100.00	100.00	100.00	100.00

Source: Stata output from survey data, 2020

According to the above table 4.5 above both genders has the same percentage share of college graduate, however the percentage of male household heads graduate at junior were greater than that of female household heads, whereas male headed household at primary graduate level was greater than female headed. The survey data proved that, a high rate of illiteracy among male household heads were greater than female headed house hold in rural agricultural food crop production in

Hetosa Woreda. From the interview conducted data, FGDs and key informants, about 28.3 percent of illiterate farmers apply Indigenous soil fertility practice, whereas primary, Junior and college graduates are 20.8%, 27.7% and 23.1 % respectively. This shows that schooling graduate smallholder's household heads in applying Indigenous knowledge are relatively more than others educational graduate household heads participants. This finding illustrate that, Ethiopian agriculture is mainly focus on technological transfer which put less attention to Indigenous soil fertility management practices and current agricultural extension services is focused on intensified package. So that, those households that have better education level smallholder household heads are less apply Indigenous knowledge and they mainly concerned on increasing production, without taking into account sustainable food production and depletion of soil fertility.

Beside this, old age household heads learn to adopt the applications of Indigenous knowledge from long year's age practice and exercise in absence of education. The interview data with key model farmers tells us how they have to adopt the usage of Indigenous knowledge in soil fertility management. Long year ago, generation has no knowledge how to manage their home wastes like ash (**dara ibida),** animal manure (**dikke looni**) and other wastes. So that, they accumulate those wastes either in one place or drop on farm fields and they observed that in the area growing different weed species and not water logged, so they learn these home waste and animal manure is very important for soil fertility in enhancing crop production. Finally they start applying it to their farm fields, and develop this Indigenous knowledge by transferring from generation to generation.

On the other hand household that have better education level, thinks that applying Indigenous knowledge can take much of their time and labour intensive to prepare as well as it resulted to bring various crop disease and pests.

Gender is another vital socio-demographic variable in applying high yielding inputs to improve soil fertility practices. The probability of being male or female could be significantly determine the usage of high yielding inputs to improve soil fertility management. Below table 4.6 proves this statement.

Table 4.6. Gender application of high yielding inputs to improve soil fertility

gender	do you use high yielding inputs to improve soil fertility 0	1	Total
female	6.94	32.95	39.88
male	29.48	30.64	60.12
Total	36.42	63.58	100.00

Pearson chi2(1) = 17.9417 Pr = 0.000

Source: Stata output from survey data, 2020

From the above table 4.6. About 36 percent of both genders do not use high yielding inputs whereas; more than 63 percents are applying it. The comparison among gender in using high yielding inputs relatively the probability of being female household heads participants in agricultural crop production is greater than male household heads. Quantitatively female household heads apply high yielding inputs accounted to about 33 percent while male household heads was about 31 percent. Pearson chi2 value 17.94 and P value 0.00 implies gender is statistically significant in practicing high yielding inputs in order to improve soil fertility level towards enhancing the intensity of food security.

However, the application of Indigenous knowledge to soil fertility management relatively the probability of being male farmer's household heads participants in agricultural crop production is greater than female household heads. From the interview conducted data, FGDs and key informants, male household heads apply Indigenous soil fertility practice than that of female household heads engaged in food crop production

4.2.Farmers perception towards soil fertility management

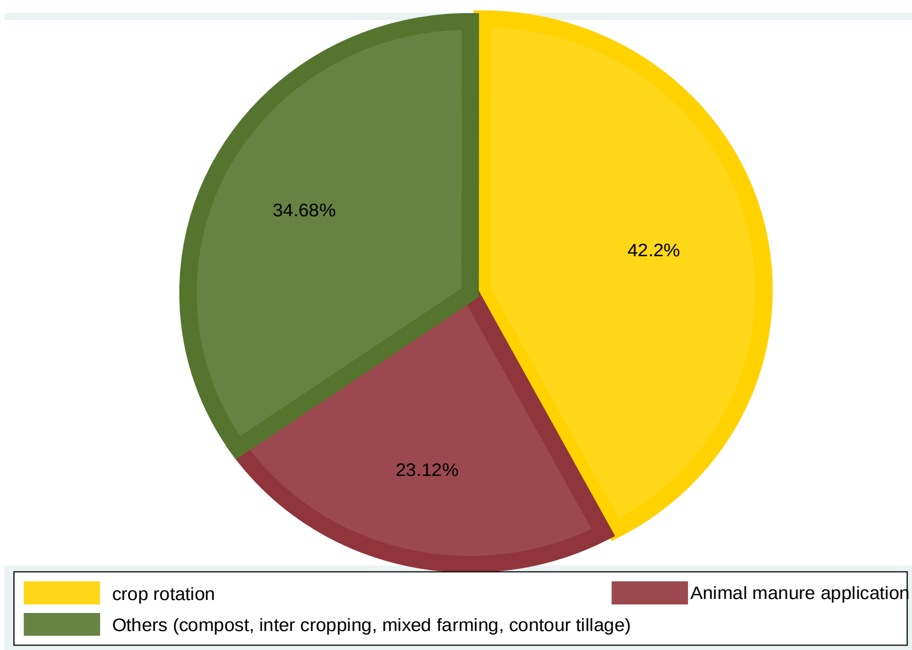
Farmers perception towards soil under studied area described as fertile soil is considered as in Indigenous language " biyyoon bula'e akka dabboo yookin buddeena nyaataf qoopha'etti" meaning "fertile soil is like bread or injera ready for eat". They define soil as the base for their life, source of income, base of for food and (biyyee malee jiruun hin jirtu) meaning "there is no life without soil". Therefore, Indigenous farmers are identify a soil type as well as isolate good soil for food crop production from bad which gives low yield per a given hectare of land.

4.3. Indigenous knowledge Farmers practices in soil fertility management

One of the specific objectives of this paper is to assess soil fertility management practices used among smallholder farmers in order to raising agricultural productivity and ensure self-food sufficiency.

Therefore, a researcher collects survey data from farmer's household heads to describe how they try to improve soil fertility in order to increase production and productivity by using Indigenous knowledge. The most common practices and constraints on their implementation are outlined in below pie chart

Figure .4.1. Indigenous knowledge practice in soil fertility management



Source: Stata output from farmers household heads survey data, 2020

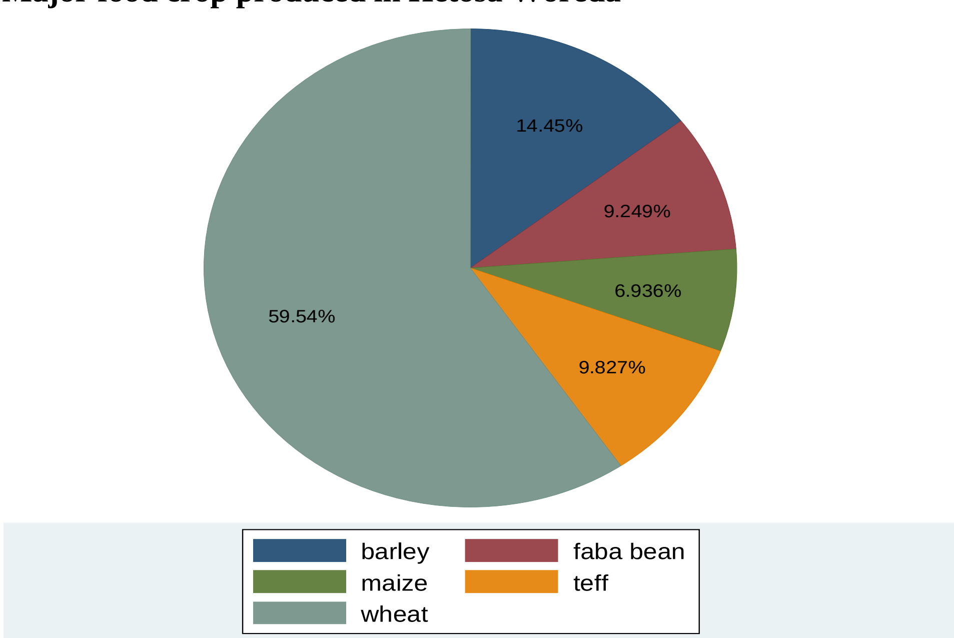
From the above pie chart, crop rotation is one of the most perceptible Indigenous knowledge practiced in the Hetosa Woreda. Out of the total 173 farmers household heads sample collected data 42.2 percent of them commonly used crop rotation followed by others which accounted to 35 percent

Indigenous knowledge consists compost, inter cropping, mixed farming and contour tillage. Crop rotation was predominant Indigenous knowledge because of it is very easy to apply, less cost than the others, and common practiced in the study area. Beside this, animal manure is commonly known and practiced but the application of this Indigenous knowledge requires more accumulation of animal manure which depends on smallholders having number of animals (oxen, cow, donkey, sheep, goats and horse). Farmer who is the owner of few numbers of animals could not prepare enough amount of animal manure for soil fertility in his/her farm. In another hand, average land holding can also determining the application of the Indigenous knowledge.

Crop Rotation

In the area understudied farmers are well aware about rotating crops to improve soil fertility in their farm. In case of animal manure and other Indigenous knowledge is no longer they now rotate crops on the fields away from their homestead, which receive very little manure. In the study area farmers identify primarily soil type which gives high yield for food crop productivity. Black soil Indigenous terminologies (***biyyee Aradda yookan Gurracha fi maka diima***) are predominant in those selected Kebeles in the Woreda. Major food crops produced in the Woreda are illustrated in below fig 4.2.

Figure 4.2. Major food crop produced in Hetosa Woreda



Source: Stata output from survey household conducted data, 2020

During the survey data farmers respond that they mostly cultivate food crops which grow in rotation according to how they adapt to the soil and rainfall patter. Accordingly from the above pie chart wheat is a predominant food crop produced in the study area followed by barley production. Therefore, personal preference and economic considerations such as the price of crop also influence the farmer's choices.

Interview conducted during survey major crop rotations practiced in the selected Woreda's Kebeles are:

- Wheat – barely/maize- wheat
- Faba bean –wheat-barely
- Teff-maize-wheat
- Pea-wheat-barely /maize

Majority of farmers in the study area practices the crop rotation with wheat or other cereals and then planting faba bean or peas to improve soil fertility and ensure food security. However, crop rotations in the region are dominated by cereals than more other food crop type produced.

A research by (Yusheng, Jiping, and Jikun Huan, 2019) using farm level panel data from 2003 to 2013, the relationships between maize yield and farm size, after controlling for farm specific characteristics restore a mild U- shape relationship. Again study by (Mark Paul, 2017)shows that there are inverse relationships between farm size and yield. Below table 4.8. Shows these discussion

Table 4.8. Average relationships between hhsize, clhohect and yield

stats	hhsize	clhohect	yield
mean	5.375723	1.859827	39.80925

Source: Stata output from farmers household heads survey data, 2020

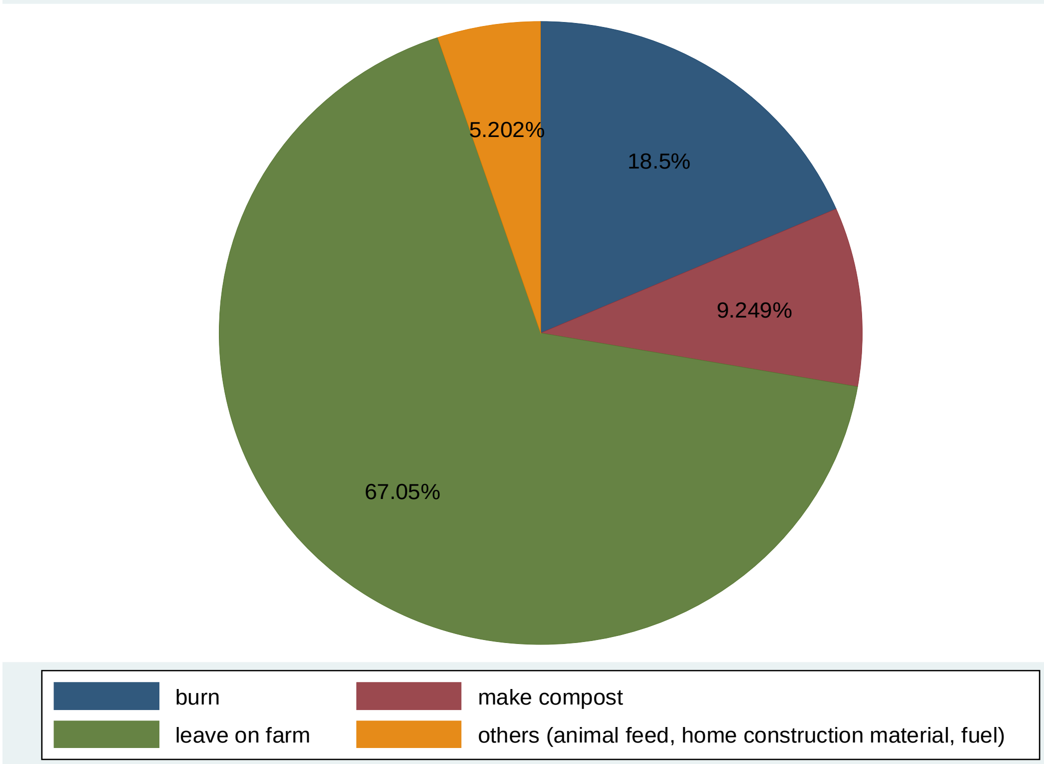
From the above table 4.8. The average rural smallholders family size was estimated to six including husband and his spouse. The average cultivated land allocated for those family are about 1.86

hectare of land and average annual yield they produce are estimated to 39.8 quintals per 1.86 hectars of land. This study finding confirms that there were the inverse size-productivity relation is found to be reversed in areas undergoing to adopt Indigenous knowledge from those not adopt.

Crop residues

Crop residue in the study area is also commonly known and practiced among farmers to maintain soil fertility so as to ensure food security. However, some of them mainly used crop residues for animal feed, home construction material, or fuel.

Figure . 4.3. Management of crop residues after harvest using Indigenous knowledge



Source: stata output from survey farmers household heads data, 2020

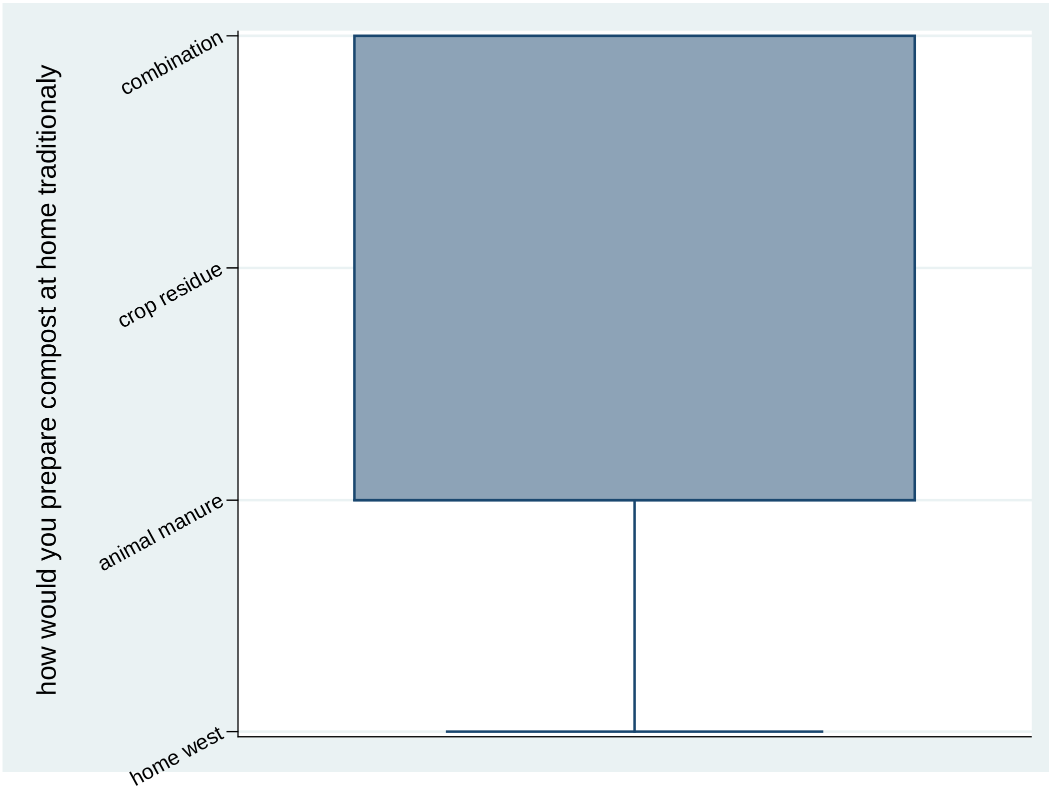
The above pie chart shows that, about 67 percent of households manage crop residues after harvest by leave on farm than remove away by different Indigenous knowledge followed by burn residue accounted about 18.5 percent.

Compost

Compost is a recycled or decomposed organic waste from different crop residues, animal and human manure and wastes and sludge being stabilized by the work of macro- and micro-organisms through aerobic, semi-aerobic and anaerobic biological processes inside a pit and/or on a surface" (Katovich, J., Becker, R. and Doll, J., 2005), (Elias, E., 2002), (Abawi, G.S. and Widmer, T.L., 2000), (Roulac, J. , 1996), (Taddesse, Y. and Abdissa, G., 1996). Compost does several thinks to benefit the soil that chemical fertilizer cannot do. It enriches the soil with organic matter, which improves soil aeration and the way water interact with the soil. Compost also inoculate the soil with vast number of beneficial microbes like bacteria, fungi, etc. that promote biological activity of the soil (Muse, jr., J.K. , 1993), (Zibilske, L.M., 1987). These microbes are able to extract nutrients from the mineral part of the soil and eventually pass the nutrient on to plant (Johnson, 1996). The use of composted organic waste as fertilizer and soil amendment not only results in an economic benefit to the small-scale farmer but it also reduces pollution due to reduced nutrient run-off, and N leaching (Nyamangara, J., L.F. Bergstrom, M.I. Piha, and K.E. Giller., 2003).

Compost is the most important Indigenous knowledge practiced in Hetosa woreda. Among purposively selected Kebeles farmers household head more than 60 percent of them use compost during the interview period. They prepare compost manure from home waste, animal manure, crop residue and the combination of all. Consider below fig 4.4

Figure 4.4. Compost preparation at home



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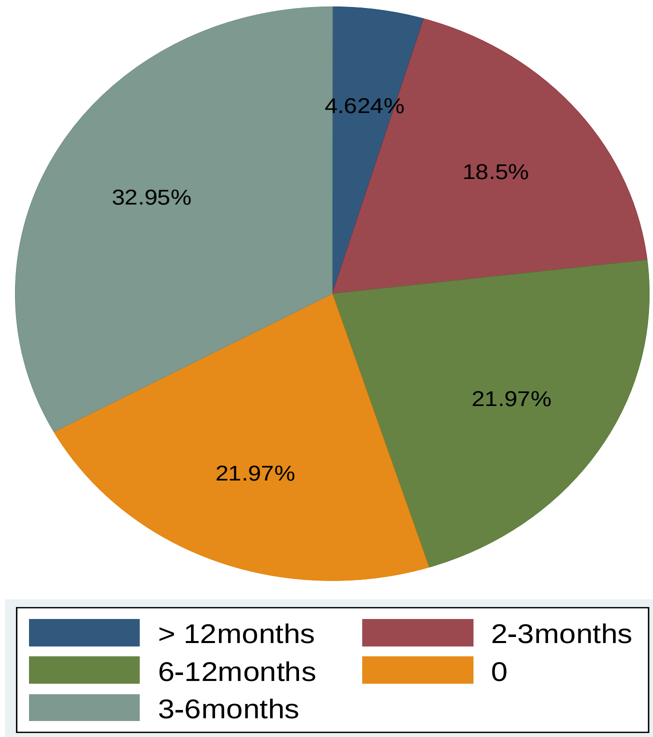
Source: stata output from farmers household heads survey data, 2020

From the above figure 4.4. graph box about 46.8 percent of households are prepare compost from animal manure followed by the combinations of both home waste including fire ash (daraa ibida) and animal manure accounted to 46.24 percent. Compost preparation from home west accounted about 7 percent. This shows that, in the area under studied compost is predominantly prepared from either animal manure or the combinations of all home west, animal manure and crop residue.

What varied a great deal, whether compost is prepared in pit or in heap, is the time in which it is left under preparation. Accordingly, a finding from survey data farmers' household heads 32.95% of them reported that they considered their compost ready after 3-6 months under preparation. While 21.97% report that compost could only be ready after 6-12 months followed by 18.5% and 4.6% percent of 2-3months and greater than 12 months respectively. In contrary to this result about 21.97% of farmers reported that they do not need to allocate any time frame for compost preparation and those farmers apply only modern soil fertility management than the application of Indigenous knowledge . Below pie chart under figure 4.5. Explain the store of compost.

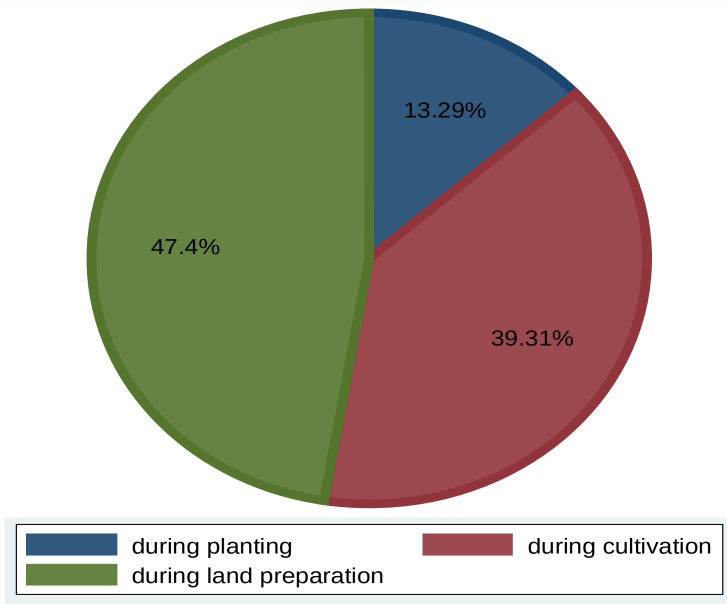
Figure 4.5. Compost storage time before use



Source: stata output from survey farmers household heads survey data, 2020

The variation in time for compost manure preparation as indicated in this study helps to isolate farmers who adopt compost manure or elsewhere. These indicated to examine either the application of compost manure increase soil fertility and increase food crop production or not. In another hand these variation illustrate the lack of uniformity in knowledge and skills associated with compost manure preparation and use. Depending on the size of the farm and the quantity of manure available, about 47.3% farmers' respondent on compost use it during land preparation where it is either broadcast on the whole or part of the farm or placed in the in the planting holes during land preparation.

Figure 4.6. Time apply compost manure to farm.



Source: stata output from farmers respondents survey data, 2020

Major challenges that the farmers mentioned during compost preparation is the availability and quality of raw materials such as crop residue, animal manure, transport and appropriate technical knowledge. Where materials are available, like in farms that are near homesteads, the major problems are labour. In this survey, 75% of the farmers who apply compost mentioned labour shortage as their major problems as far as the preparation and use of this manure is concerned. The application of compost manure, like that of animal manure, depends on the amount of manure available and the size of the farm that needs it. In this survey found that 47.4 %, 39.31% and 13.29 % apply compost during land preparation, cultivation and planting respectively. Two main methods of compost manure application. The first method was the broadcasting of compost manure on a plot during land preparation. This method is mainly in use when the farm size is small and the compost manure is predictable to be adequate for the field. This means that the compost manure is integrated into the soil before planting during cultivation and in a few instances during planting.

Contour tillage

Contour tillage is a practice of plowing land along a contour line to reduce soil erosion from slope land. Farmers applied different soil conservation methods cultivating crops on the contour where the slope was steep. During interview conducted about 25% of smallholder farmers report that apply contour tillage in the study area where the slope of the land is Steep hillside in order to minimize runoff and erosion.

Fallowing

From interview conducted during survey majority of the farmers not apply fallowing due to shortage of farm land as population pressure is increasing from time to time. But, farmers understood the benefit of fallowing to improve or maintain soil fertility. Therefore fallowing contribution to Indigenous knowledge in the study was statistically insignificant.

4.4. Indigenous farmers diagnostic indicators of soil types and fertility

How Do Farmers View and classify Soil

Farmers through their long life on farm experiences have developed their own indicators for classifying the fertility status of soil on their farms. These indicators help farmers to improve soil fertility using different techniques they choice. In the study area the major indicators identified are yield, color, soil type, weed/plant species cover and topography. Accordingly, yield response 85 % was found as the main indicator followed by soil color 80 %, weed species cove 40%, soil type 35 % and topography 25 % respectively.

Table 2 Farmers' specific indicators for assessing soils as fertile or infertile

Indicator	Fertile soils	Infertile soils
	• High growth rate (20%) • High yields in all seasons (78%) • Vigor and green leaves (30%)	• Stunted and under sized plant growth (22%) • Low yields (75%) • Long/short, yellowish leaves (15%)
Soil characteristics • Soil colour (95%) • Moisture retention capacity (75%) • Soil workability (85%) • Soil particle (40%)	• Black colour (95%) • Medium (78%) • Easiness of plowing (75%) • Small and sand present (45%)	• Ashen /white (78%) • Low (62.4%) • Difficult to plow (70%) • Large and stones present (25%)
Biological characteristics • Presence of microorganisms (75%) • Presence of soil micro-flora (70%) • Growth of different weed species (40%)	• Small mammals, earth warm (70%) • Blue green, mushrooms and yeasts present (50%) • Broad leave weed (15%)	• Few mammals (60%) • Absence/few (41%) • Grassy weeds
Topographical factors • The slope of the land (35%)	• Middle slope (40%)	• Steep hillside (35%)

Source: own computation from farmer household heads survey data, 2020

4.5. Challenges in using Indigenous knowledge in soil fertility management practice

Nowadays some of small holders are not widely practiced Indigenous soil fertility management. During key informant interviews, focus group discussion with farmers and development agents, a number of challenges were identified to be the reasons for their limitations. As it is obvious lack of enough training how to develop less cost Indigenous knowledge into modern well equipped way, shortage of animal manure, concerning shifting cultivation farmers clearly pointed out that due to the increase in number of population, movement becomes restricted. In the selected Kebeles of Xado, Jengo-kilisa and Boru model farmers explained that:

… *Before two decades ago, during summer time, people migrate from highland area to lowland Indigenously known by "**Godansa**" and back to their original home after summer left. But now where do you move to? The whole village is covered (full) …..Again, farmers used to farm as long as the land was good. However, when they realized that the soil productivity is decline, they would leave it to rest and plant on new plots. Today, there are no new plots.*

The increments in population size immediate effect as explained by those farmers were decline in the size of landholdings. The implication is clear that, declining land size per household, according to farmers, means a limitation on the choices of crops to be grown. From survey data of farmers household heads survey mention major constraints in applying Indigenous knowledge in their farm production illustrated in table 4.10 below.

Table 4.10. Farmers respond to constraints of food crop production

Constraints	Freq.	Percent	Cum.
decline in soil fertility	38	17.34	17.34
lack fertilizer and improved seeds	33	19.08	36.42
pests and diseases	49	28.32	64.74
rainfall shortage	28	16.18	80.92
shortage of labour	27	15.61	96.53
shortage of land	6	3.47	100.00
Total	173	100.00	

Source: stata output from survey farmers household heads survey, 2020

The above table 4.10 illustrates that, 28.32% of farmers mention pests (earth worm, desert locusts) and diseases are the predominant constraints in using Indigenous knowledge to produce food crops so as to maintain self-food sufficiency and security. About 17.34% of farmers report that, decline in soil fertility is due to repetitively cultivating the same crops every year and impact of chemical fertilizers used on soil nutrients is another constraint in food crop in Hetosa Woreda. Lack of fertilizer and improved seeds, shortage of rainfall and labour shortages are reported by stockholders about 19.08%, 16.18% and 15.61 % respectively.

4.6. Impact of Indigenous knowledge on food security

The application of Indigenous knowledge was different among selected Kebeles in Hetosa Woreda. The differences among those Kebeles in using Indigenous knowledge also affect the level of soil fertility as well as food security. Below table 4.11. Illustrates farmers report on the use of Indigenous knowledge and its' contribution.

Table 4.11. Farmers report in using Indigenous knowledge, seed type and fertilizer used.

	Selected village				
	Jengo-kilisa	**Xado**	**Boru**	**Daya'a**	Pearson chi2(3) test
Use Indigenous Indigenous knowledge					
Yes	35	18	34	19	Pearson chi2(3) = 48.3215
No	0	9	15	43	Pr = 0.000
Seed type used					
improved	15	15	26	23	
Indigenous	20	12	23	39	Pearson chi2(3) = 34.0905 Pr = 0.002
Type of fertilizer used					
DAP	6	4	9	12	
UREA	10	4	14	19	
Dap + UREA	19	17	24	29	Pearson chi2(3) = 41.0905
Organic	0	2	2	2	Pr = 0.000

Source: Stata output from farmers household head survey data, 2020

From the above table 4.11. Farmers mention that, about 61.27 percent of farmers use Indigenous knowledge, while 38.73 percent of respondents are not used it. Mostly Village like Jengo-kilisa and Boru are apply Indigenous knowledge than chemical fertilizer for soil fertility management accounted about 33.02% and 32.08% respectively. Daya’a village is commonly used chemical fertilizer than Indigenous knowledge. Only 17.92 percent of farmers use Indigenous knowledge in Daya’a village and the rest of them about 82.08 % of them apply chemical fertilizer with improved seed than others Kebeles accounted to 30%. However, in the village such as Jengo-kilisa and Xado chemical fertilizer towards soil fertility management is the least used accounted only 19%. A Pearson chi2 statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets arose by chance. Therefore, a use of Indigenous knowledge, seed type used, and types of fertilizer used among purposively selected Kebeles are different and it is statistically significant implied by $P = 0.000$

In general the role of Indigenous knowledge for farmers household heads are unreserved opportunities. The survey data obtained during interview and focal group discussion from farmers household heads and development agents 80% of them mention that safe from hunger, 63% of the reduce expenditure from chemical fertilizer, 76% of them respond increase in soil fertility, Indigenously (**gabbinni biyyee dabalee**), 66% of them mention supply surplus crop to the market (increase annual income) and 48% of them rise independence from government aid. Below table 4.12 summarize the above discussion

Table 4.12. Comparison between benefits from Indigenous and modern soil fertility management

Benefit from Indigenous soil fertility management	Benefits from modern soil fertility management					
	increase crop yield	increase income	Increase soil fertility	safe from hunger	stable food	Total
increase crop yield	31	0	0	0	0	31
increase income	0	44	0	0	0	44
Increase soil fertility.	11	1	18	10	0	40
safe from hunger	0	0	0	25	0	25
stable food	0	0	0	0	32	32
Total	42	45	18	35	32	172
Pearson chi2(16) = 520.1567 Pr = 0.000						
likelihood-ratio chi2(16) = 447.1878 Pr = 0.000						

Source: stata output from survey of farmers household heads, 2020

During survey interview with farmers, they indicate that, Indigenous soil fertility such as crop rotation, animal manure, compost, and contour tillage’s are likely to not only provide crop productivity which gives high yield per a given lot hectare of land but also increase soil organic matter, which results in increasing land productivity and ensure household food security. In this paper a comparison between modern and Indigenous soil fertility management demonstrate that, in both application the raise in crop yield is relatively the same account 73.8% but in case of increasing in soil fertility management almost 100% Indigenous soil fertility management is better than the modern one. This finding were supported by the study conducted by (Chadha, , 2020)advanced the hypothesis that the productivity differences are due to differences in the fertility of soil. In order to prove his point he went a bit further. He pointed out that when land was “standardized” on the basis of land revenue ratings, decline in productivity per acre on large farms, was reduced significantly.

From farmers point of views again about 100% application of Indigenous knowledge insures stable food than modern soil fertility management. The use of modern soil fertility management is for temporal raise in crop productivity and agricultural earning (income) but do not sustain soil fertility content rather it decline. The result is tested by Pearson chi2 involves the squared difference between the observed and the expected frequencies of Indigenous knowledge and modern in soil fertility management approved by$P\ value = 0.000$. Therefore, application of Indigenous knowledge in soil fertility management is statistically significant different from modern soil fertility management so as to maintain food security.

A multiple linear regression explain dependent variable (yield) on independent variables such as; age, religion, marital status (mrstatus), household size (hhsize), type of seed used (tsu),type of fertilizer used (tfu), amount of fertilizer used (Afert), Constraints in crop production (cocropdn), source of seed smallholders plant (sseed), Indigenous knowledge towards high yielding inputs (lknow), type of Indigenous knowledge (Tlknow), and experience in using Indigenous knowledge (dexlkno). Therefore, a researcher gives attention to those above mentioned predictors, whether they are statistically significant and, if so, the direction of the relationships.

Table 4.13 estimation of multiple linear regressions

Yield	exp(Coef.)	Std. Err.	T	P>t	[95% Conf. Interval]	
age	.743***	.188	3.95	0.000	.372	1.114
Religion	1.715	1.535	1.12	0.265	-1.316	4.746
mrstatus	0.276	1.304	-0.21	0.833	-2.852	2.301
hhsize	-2.008**	0.762	-2.64	0.009	-3.512	-.504
tsu	-13.295***	3.456	-3.85	0.000	-20.121	-6.470
tfu	-.060*	1.810	-0.03	0.004	-3.635	3.515
Afert	.144***	.0118	12.23	0.000	.1211	.168
cocropdn	- 0.707***	30.313	3.616	0.000	-4.799	0.974
sseed	12.669***	1.781	7.11	0.000	9.152	16.187
dexlkno	0.245*	0.510	-0.676	0.001	0.004	14.910
_cons	0.000	0.000	-0.671	0.003	0.000	6.209

legend:	*	p<.05;	**	p<.01;	***	p<.001

Number of obs = 173
F(13, 159) = 34.95
Prob > F = 0.0000
R-squared = 0.7408
Adj R-squared = 0.7196
Root MSE = 16.358

From the above estimation of OLS regression the F-test is statistically significant where Prob > F = 0.0000 this means that this estimation is statistically significant and the R-squared is 0.7408 meaning that approximately 74.08% of the variability of yield is accounted by the variables in the model. The adjusted R-squared indicate that about 72% of the variability of yield is accounted by the model, even after taking into account the number of predictor variables in the model. Although with a P-value =0.000 for predictor such as **age, tsu, cocropdn, sseed**, are statistically significant at $\alpha = 0.1\%$ level of accuracy The coefficient of **tsu** is negative which would indicate that, given that all other variable in the estimation are held constant, a decrease of 13.295 quintal's of **yield** per hectare of land per year is due to the increase in the low quality type of seed used by farmers household heads. Therefore, **tsu** variable is highly related to yield level and functions more as a proxy for self-food sufficiency in the study area. Thus, low-level of self-food sufficiency are associated with low **yield** per year resulted from inadequate improved type of seed used during farm periods. The estimated coefficient of **hhsize** and **cocropdn** are - 2.008 and - 0.707 are significant at $\alpha =$0.1% and $\alpha =$1% level of precision respectively. This indicates that, household with large family size and numerous constraints in food crop production are related to lower yield per year. The negative coefficient of household size gives sense associated with (W. ARTHUR LEWIS, 1954) two- sector model the underdeveloped economy consists of two sectors: a traditional, overpopulated rural subsistence sector characterized by zero marginal labor productivity and classified as surplus labor that can be withdrawn from the traditional agricultural sector without any loss of output. The implication is in fact land size bounded and limited but as farmers house hold size increase the share of land per family size decrease and the next sibling born or added in the family does not add significant yield from agricultural land productivity. Whereas a **cocropdn** coefficient - 0.707 illustrate that, about 70.7% of yield decline per annual is due to plentiful constraints in crop production per year. Those constraints are: shortage of rainfall, pests and diseases, soil fertility decline, lack of oxen, shortage of land, lack of fertilizers and inadequate farmers training and information's. However, the coefficient of variable **age** and **sseed** are 0.743 and 12.669 demonstrates that a one year increase in age of farmers household will increase annual yield by 74.3% in his/her agricultural productivity. Because farmers engaged in agriculture through the year can adopt and learn from the experience. While **sseed** coefficient 12.669 exhibits, a source of seed household's plants such as; from farmers union, Woreda Agricultural office, model farmer's and seed enterprise significantly determining yield per a lot of hectar of land productivity per year rather than continuously using Indigenous seeds

However, the **lknow** and **tlknow** are statistically insignificant. Meaning farmer's household heads using Indigenous knowledge is not as such different from those households not using Indigenous knowledge on yield. Please note, that it doesn't mean that there is no difference on soil fertility management. Farmers who adopt and implement Indigenous knowledge could be keep sustain of their soil fertility as to give better production than those who do not apply in the near future.

Furthermore, a variable **tfu** with coefficient -.060 and **dexlkno** coefficient 0.245 are statistically significant at $\alpha =$5%. About 6% percent decline in yield per a given hectare of land per a given year was due to a unit change in type of fertilizer that farmers apply in their farm. Citreous paribus, the more organic fertilizer a farmers apply in his/her farm better would be yield per a given hectare of land. In contrary, development of experience from social engagement, neighbor farmers and development agents on Indigenous knowledge of soil fertility management have a direct relationships with yield per a given hectare of land at a given production time. Holding other predictors constant, a better farmer has **dexlkon**, the more yield per a lot of crop cultivated land.

In order to know the effect of Indigenous knowledge on food self-sufficiency, the logistics regression model is estimated. From the logistics regression the estimated part of marginal effect was interpreted that shows the effect of using Indigenous knowledge on food self-sufficiency as follow:

Logistic estimation

fss	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
lknow	1.271745	.3704811	3.43	0.001	.5456157	1.997875
_cons	.4554755	.2514303	1.81	0.070	-.0373188	.9482699

Number of obs =	173
Wald chi2(1) =	11.78
Prob > chi2 =	0.0006
Pseudo R2 =	0.0642

Log pseudolikelihood = -89.727695

In the above logistic estimation the Wald chi2(1) =11.78 with Prob > chi2 =0.0006 was significant at 5% level of precession and Pseudo R2 =0.0642 illustrates, else constant Indigenous knowledge explain food self-sufficiency about 6.42 %. The effect of Indigenous knowledge on food self-sufficiency could be explained by the marginal effect after logit shown as below.

Marginal effects after logit

y = Pr(fss) (predict)

= .7746393

Variable	dy/dx	Std. Err.	Z	P>z	[95%	C.I.]	X
lknow*	.2371163	.06894	3.44	0.001	.101987	.372245	.612717

(*) dy/dx is for discrete change of dummy variable from 0 to 1

The above marginal effect analyzes the effect of farmers who applying Indigenous knowledge on being food self-sufficient or not. The above output shows that, as a farmer using Indigenous knowledge on soil fertility management rises in a year, the probability to be being food self-sufficient better by 23.7% than those households not using it. Therefore, the conclusion derive from here is that , the probability of farmer house hold heads used Indigenous knowledge on soil fertility management towards food security was better than those not adopt it. Farmers applying Indigenous knowledge have better food security. This is because they are with better soil fertility management. Therefore, Indigenous knowledge ensures food security. This is through sustained soil productivity.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1.Conclusion

A study conducted on Assessment of Indigenous Knowledge Contribution to Soil Fertility Management to Ensure Household Food Security comes across with plentiful finding. A Indigenous knowledge on soil fertility households have had in agriculture reliefs them for naming, differentiation, classification and characterizing soils in their farm. The study validates that, socio-demographic factors, farmer's perception and practices on soil fertility management determine food self-sufficiency and food security. They were, therefore, realizing attitudes, awareness, perception and knowledge on soil was considered as the opportunity cost of the next year in their life's.

- Gender participation in agriculture was exclusive and biased which is associated with owning land certification. So that, female household heads participation in farm is less than male participant.
- The lower participation rate of female in farm than male creates differentiation in usage of high yielding inputs and Indigenous knowledge. Male farmers could be using more Indigenous knowledge than female and vice-versa in high yielding inputs.
- Schooling graduate smallholder's household heads in applying Indigenous knowledge are relatively more than others educational graduate household heads participants.
- Farmer's practices a plentiful Indigenous knowledge in soil fertility management which is predominated by crop rotation followed by animal manure and others such as compost inter cropping, mixed farming and contour tillage.
- Soil fertility, which is an invisible constituent of soil, is interpreted through soil characteristics such as colour, texture, depth and easy ploughing (work). They also diagnose soil nutrient status through biological characteristics of plant and crop performances. It was further learnt that on action taken by farmer when the signs for soil nutrient depletion is witnessed depends largely on the type of the indicator. Diagnosing the situational status of the farm nutrient is, therefore, part of the wider repertoire of Indigenous agricultural knowledge.
- The explanatory variables age, hhsize, tsu, afert,cocropdn, sseed are statistically significant at P-value <0.01.

- As a farmer using Indigenous knowledge on soil fertility management rises in a year, the probability to be being food self-sufficient is better by 23.7% than those households not using it. Farmers applying Indigenous knowledge have better food security (ensure food security). This is because they are with better soil fertility management. This is through sustained soil productivity.

5.2. Recommendation

Food insecurity to smallholders were the consequence of various constraints in application and practice of Indigenous knowledge's in soil fertility management such as the situation observed in Hetosa Worada require deliberate efforts aimed giving prominence to Indigenous resources, including Indigenous skills and practices which more often becomes causality of social distortions and policy misrepresentations. In light with the findings generated from this study, the following suggestions for an integrated approach to soil fertility management among smallholder farmers of Hetosa Woreda as follow:

- These papers suggest that, it makes better if Woreda administration integrate modern soil fertility management with Indigenous knowledge by providing extension for smallholders.
- It makes better if policies designed to address the soil fertility management problems smallholders face should not look at farming in segregation. For the effectiveness of the policies, taking into consideration the farmers' folk knowledge that incorporates both environmental and ecological aspects.
- The study suggests that there is need for integration of knowledge of smallholders in the Woreda to make their farming sustainable. This is because even as this study reports that farmers have detailed knowledge of their soils and practical skills to manage their soils, there is clear gap that exists in far as soil fertility management is concerned. Policies that guide the integration of knowledge systems without annihilating either are welcome.
- A researcher suggest that, Woreda administrators and Rural agriculture office should, equip farmers on soil management practices how they use Indigenous knowledge system in their farm. Such activities should aim at empowering Indigenous communities to utilize exchange, develop and protect Indigenous knowledge and to promote it.
- There is also need to look at strategies of overcoming decline in soil fertility, lack of organic fertilizer and improved seeds, pests and diseases like desert locust, shortage rainfall, labour and land constraints faced particularly by the poor households in their effort to use various soil fertility management practices on their fields. It might be come by adopting various activities like call for the initiation and support for farmers grouping to enable them start their own income, mobilize savings to enable them access to credit.

- There is need to carry out a study to help reveal the factors that have led to the relegation of this valuable knowledge, especially among poor smallholders who cannot afford the modern strategies of soil management.
- Future research focus on specific Indigenous knowledge with the aim of coming up with specific strategies of enhancing their use
- Similarly, there is need for studies focusing on Indigenous knowledge of soil fertility management among farmers in different part of Ethiopia. This will help evaluate and compare different knowledge systems.

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