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Full Length Research Paper

Sustaining the agriculture: Practices, challenges and opportunities of integrating indigenous and modern methods of soil fertility management in rural Ethiopia. The case study of Bore district, southern Ethiopia

Mekuria Guye (M.Ed)

Bulehora University
E-mail: mekuriaguye@gmail.com

Abstract

Steady declining of soil productivity aggravated by diminishing per capita holdings of arable land poses a severe threat to sustainability of agricultural production and livelihoods for the majority of the farming population in rural Ethiopia. Farming mechanism and strategies in Ethiopian agriculture is mainly focus on technological transfer which put loose attention to local soil fertility management practices. Thus, aggregately, less production is being achieved. Hence, the only use of modern science in diverse agro-ecological zone of farming area and complex socio-economic conditions of the people has failed to ensure sustainable agriculture. Nowadays, across the world however, there is significant recognition of the role of Indigenous Knowledge (IK) in many development dimensions which is not exceptional to soil fertility management. However, in Ethiopia the absence of effective linkage between IK and modern science in land management in general and soil in particular is the most probable problems that hinder the effectiveness of the development of agriculture. Therefore, the attempt of this paper work was to assess the integration of indigenous and modern methods of soil fertility management measures and prominent challenges in sustaining agriculture at rural Ethiopia. Three kebeles from the study district that found at different agro-ecological zone were purposively selected. It was due to visible intense practices of indigenous soil fertility management measures. Out of 1422 household residents under the three agro-ecological zones, 142 household farmers were randomly selected using simple random sampling procedure. Questionnaire surveys, key informant interview and observation checklist were data gathering tools used. As the finding, the use of chemical fertilizer was not only lesser but also far below what is normally recommended per hectare. This was due to a number of inconveniences (i.e., wealth difference, high price of farm inputs, in sufficient credit, and untimely supply of the fertilizer), and therefore, retarded the practices for ensuring food security. There is integration of the two bodies of knowledge. Lack of adequate and organized trainings for farmers, limited input, fragmented land holdings, technical failure, and deficiency of the farmer-extension services are the major constraints in linking the two bodies of knowledge.

Keywords: Indigenous knowledge, soil fertility, sustainable agriculture, nutrient depletion, food security.

1. Background of study

1.1. INTRODUCTION

World food crisis over the past two centuries have triggered a standard debate each time. 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. In many developing countries, nutrient depletion already threatened food production, so that food shortage in Africa is a serious problem (NEPAD, 2007). Most of Sub Saharan African (SSA) countries including Ethiopia are remained highly food in secured. Accordingly, about one third of rural household cultivate farms less than 0.5 ha which are more of rain fed and thus at current yield levels, cannot produce enough food that meet the imbalance between food demand of rapidly growing population. 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. Ethiopia is one of the county, with highest rates of nutrient depletion in SSA that the annual Phosphorus and Nitrogen loss nationwide from the use of dung for fuel is equivalent to the total amount of commercial fertilizer applied (MoA, 2009). Thus, it faces serious land degradation with 1-2 million tons of soil and 200000ha of forest land lost annually while 80 billion liters leave the country with soil and nutrients. Therefore, it has leaded the highest estimated rates of soil nutrient depletion which reduces productivity and increases vulnerability to food insecurity. 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. According to Yohannes (2004), Failures in agricultural productivity has been attributed to a wide range and combination of factors, such as population pressure, backward traditional farming, ignorance and reluctance of farmers to adopt modern technology, in appropriate agricultural policy, absence of land insecurity, inadequate marketing systems and transfer of in appropriate technologies. Moreover, neither of the policy frameworks in agriculture and rural development strategies promotes the full utilization of indigenous practices as means of Soil Fertility Management (SFM) nor endorses the integration of the indigenous knowledge with modern methods of soil fertility management in rural development policy and strategies.

1.2. Statement of the problem

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 et al, 1980). To ensure positive agricultural development, proper utilization of soil resource and environmentally friendly inputs are mandatory. Sustainable agriculture is not the way to ensure food security in behalf of deteriorating the natural fertility of the soil, but is an agriculture that conserves land, water, and plant resources that does not degrade the environment, and is economically viable and socially acceptable; thereby meeting needs of both now and the future generation. However, the contribution of Indigenous Knowledge (IK) in development paradigm is not necessarily acted up on in policies and programs of most countries (Ashish, 2007). Similarly, significance of indigenous practices in maintaining soil fertility paid little attention in Ethiopian agriculture, where development of joint experimentation between indigenous and modern methods of maintaining soil fertility is still in low progress. Agricultural extension services in Ethiopia have tended to be top-down and focused on technology transfer approaches (Teklu and Gezahegn, 2000). And also, the technology transfer approach tended to be top-down and rely almost exclusively on research station based standard recommendations often neglecting taking part in decision making of rural livelihoods and socio-economic diversities at local level. More worst, the participation of local communities in decision making is not well developed, rather decision made at higher level should implemented at grass root level or plan made at local by development agents (DAs) approved or rejected at local even not reaching regional level where participation of farmers is still remains minimal. In addition, professionals from top policy makers down to development workers, recommend more of modern soil conservation measures used to work at program, so they were not convinced at all and did not fully recognized indigenous practices of local farmers.

Eventually, the main objective of this paper is to identify different indigenous practices of maintaining soil fertility in subsistence agriculture, application challenges and opportunities on the behalf of farming system on the fragmented agricultural land that aggravated by high population pressure. And to assess the integration of indigenous practices with modern methods of maintaining soil fertility at the area under study.

1.3. Objective of the Study

1.3.1 General Objective of the Study

The general objective of the study is to assess challenges and opportunities of integrating local knowledge experience and practices of farmers in soil fertility management strategy with modern technology of conserving soil fertility as potential to ensure agricultural sustainability.

1.3.2. Specific Objectives

- To identify the types of possible indigenous and modern methods of soil fertility management?
- To analyze farmers' attitudes and perceptions in using the two bodies of knowledge concomitantly?

- To examine the pattern and extent of integration of IK and scientific method of maintaining soil fertility.
- To discuss farmers understanding and perceptions about soil fertility and soilfertility decline.
- To assess the challenges and opportunities of integrating indigenous and modern methods of soil fertility management.

1.3. Research questions

- What types of indigenous and modern methods of soil fertility management mechanisms are used?
- What are attitudes and perceptions of farmers in using integrated methods of soil fertility management concurrently?
- To what extent and pattern indigenous and modern methods of soil fertility management is integrated?
- What are the challenges and opportunities of integrating indigenous and modern methods of soil fertility
- What do farmers understand and perceive about soil fertility and soil fertility decline?
- What are the leading challenges and opportunities of integrated application and use of indigenous and modern methods of soil fertility management?

2. RESEARCH METHODOLOGY

2.1. Description of the study site

Bore is one of the Woreda found in Guji zone of Oromia Regional State. And the zone is named after a tribe of the Oromo people 'Guji'. It had been a part of Borena zone until it along with four other Woreda were split off in September 2003 to form the Guji zone. It is bordered on the south by Borena Zone, on the west by SNNPR Regional state, on the north by the Ghenale River which separate it from Bale and on the east by the Somali region. Astronomically, the district situated at $6^{0}15'$N to 7^{0}N and $38^{0}45'$E to $39^{0}15'$E north of the equator.

The diverse topographic features of the area made it to experience a complex and divers climatic condition. The altitude of this district ranges from 1800-3000 meter and above, above sea level. Mount Dara Tibiro is the highest point; and other notable peaks include Haro Milki, Suta Dhiba, Lucho moltiti and Higatte. The district encompasses Kola, Dega and Woina dega agro-ecological zones. It receives an estimated amount of 420-1430mm of rainfall annually and with annual average temperature of 11.2-21^{0}c, Bore district agricultural office (BWAO). The district has two main rainy seasons, spring and autumn that are locally known as *Ganna* and *Hagayya* rains respectively. Most of the area receives its maximum rainfall in spring and small rainfall in autumn. About 60% of the of the total annual rain fall is received during spring season which comes at the end of February to the May and autumn is the minor rainy season of the area where rains begins in September and ends in November.

Bore woreda has one water shade and five main rivers in which Bidirsa, Ghenale and Lekole are the notable one and where Bukisa and Shela are the minor rivers that drains west ward. However, due to fluctuation of the rivers and location constraints, no functions they provides to the people except for small scale fishing Ghenale river in the east.

Although detailed soil study was not conducted in the study area, the agricultural development of the district indicated the soil type of the area is derived from crystalline rocks and volcanic rocks. As can be seen from the soil map of the National Atlas of Ethiopia, the soil units of the area are Dystric Nitosols and Acrisols. In addition, according to BWAO the soil of the study area are classified as black, red and brown soil accounting 10.19%, 37.31% and 52.50% respectively (BWAO). Barley, Wheat, Corn (maize), Horse been and Pea are important crops cultivated. And *Enset* remain staple food, where coffee is grown in some parts of the district.

2.2. Sources and Method of Data Collection

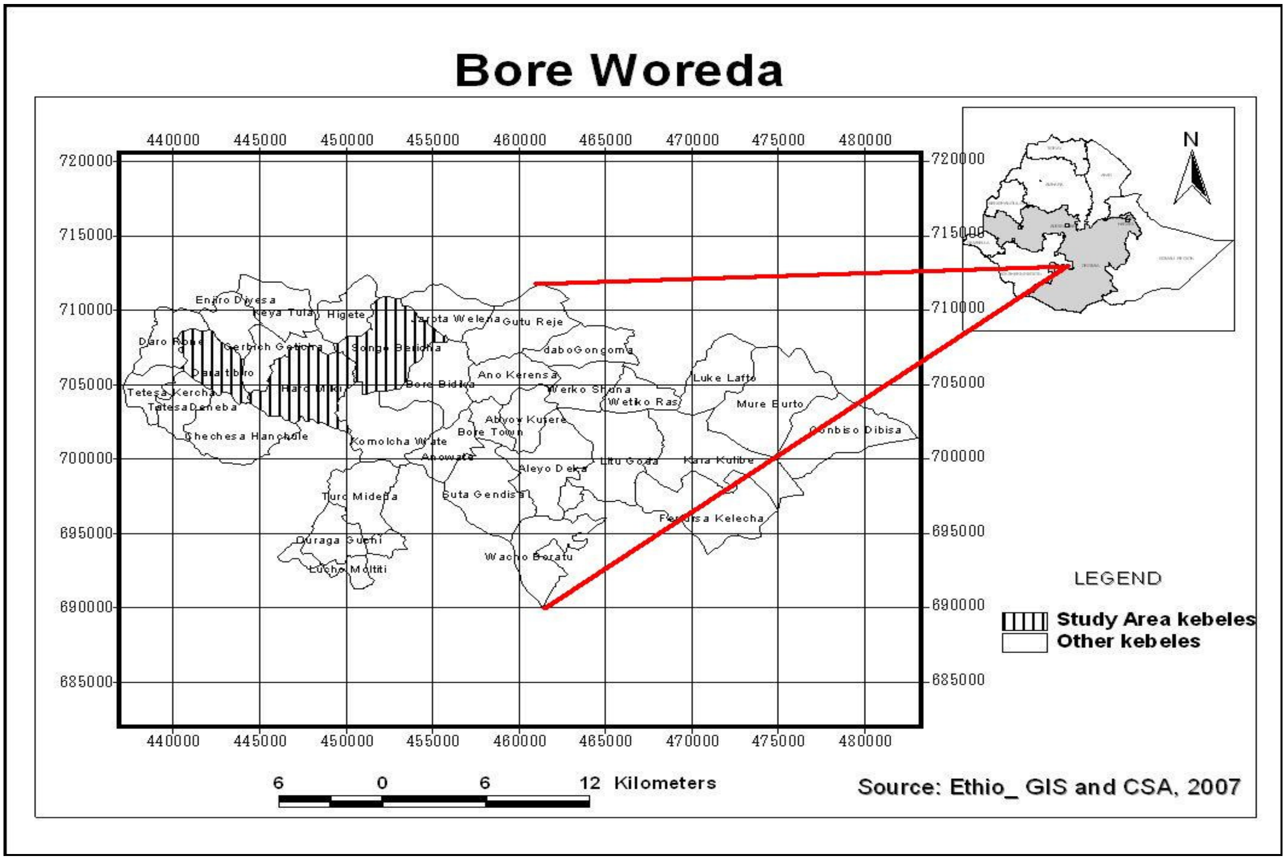
The researcher used both primary and secondary data sources to carry out the study. Primary data were collected through:

Questionnaire: Structured questionnaire was developed and necessary information was gathered from key informants. Firstly, it was developed in English and later translated into vernacular language that the reliable information gathered. And the questionnaire was made mainly to capture data on ideas concerning overall types of IK farmers use in their agriculture and nature of the inclusion of modern methods in their farming activities, demographic characteristics of the household and sources of their livelihood income and like variables.

Observation: Direct observation was done to and farmer's practices on farm land, how and when they apply the measures. It was mainly emphasized to have clear information and real practices of the nature of indigenous practices, approaches used and their reasons, the source of practices and time of application on farm land.

Interview: The interview consisted of a combination of structured and open-ended questions. Information concerning progress, productivity of agriculture and integration of IK to farmers agricultural activity, challenges, benefits and limitations of using IK along with modern methods of maintaining soil fertility was collected through un-structured interview from development agents and Agricultural sector of district administration.

Secondary data was obtained from published and un-published materials that have direct or related relevance to the study. These are journals, articles, books, works of others and Websites.



Bore Woreda Map (2012

2.3. Study Design and Target population.

A case study design was applied to accomplish the research work. The target population of the study is house hold (farmers) of the three kebeles namely, Dara Tibiro, Songo Baricha and Haro Milki of Bore district in Guji zone, Southern Ethiopia.

2.4. Sampling Procedures

The study was collected during the early 2010 to late 2011 farming seasons of the area. Three kebeles involved in the study districts was obtained from the district by purposive sampling procedure. This is due to the fact that the farmers at the area have pool of indigenous practices of soil fertility management along with modern methods i.e., chemical fertilizer. A kind of split-plot design experiment was conducted on few farmers, during the first cropping season with the main factor being use of IK (continuous rotation of kraal on farm land, application of manure), and modern methods (chemical fertilizer) and productivity a sub factor. IK of soil fertility management in the study area is undertaken through the application of transported farmyard manure, kraal rotation on farm land along with use of chemical fertilizer of revealed positive feedback as compared relatively to what they gain from the same acre. As food insecurity is the most challenging problem knocking the door of each house hold study area, assessing the problems behind this complexity remained number one focus of this paper work. As a result, the innermost interest of the researcher is to find out what was been the challenges and obstacles behind their subsistence farming that let them not to ensure food security. Thereafter, out of total 1422 households of the three kebeles purposively identified, 142 household headed farmers were selected through simple random sampling procedure by the help of Kothari proportional sample allocation formula. Accordingly, 48, 50, 44 farmers house hold were randomly selected from Dara Tibiro, Songo Baricha and Haro milki respectively. Therefore, the head of households was incorporated in the study as the target population.

2.4.1. Sample size determination.

Researcher used proportional sampling procedures of Kothari (2004). Thus, representative sample of this study were computed by the formula
nh=(Nh/N)n, *where: nh=* sampling *size of the study, Nh= Total population of the kebele, N=Total population (total hhs) and n= Total sample size*

Table 2.1, Study sample allocation.

Kebeles	Number of house hold in each Kebele	Sample size
Data Tibiro	480	48
Songo Baricha	500	50
Haro milki	440	44
Total 3	1422	142

Source: Field survey 2011

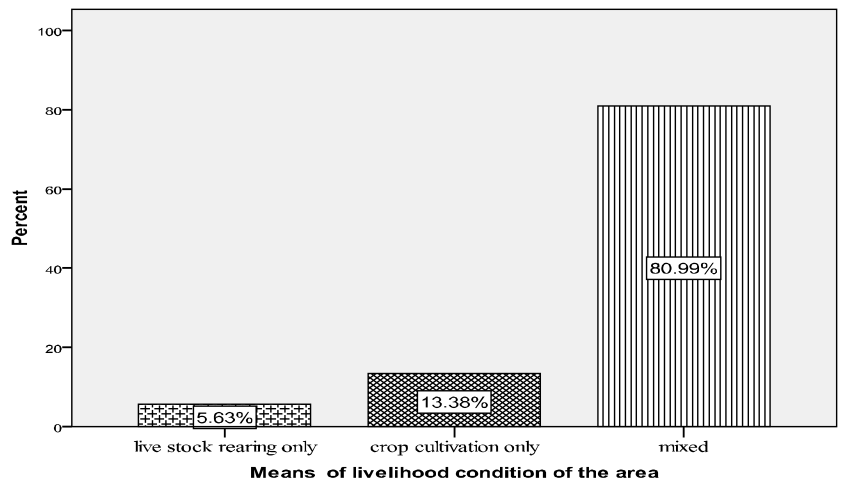


Figure 3.1. Means of livelihood condition of the study area.

2.4. Method of Data Analysis

Both qualitative and quantitative data analysis measures were used. Thus, responses to the questionnaire that was gathered from respondents was quantitatively analyzed which was assisted by Statistical Package for Social Science version 17.0 (SPSS), and presented in table, graph, and charts. Whereas, data gathered through observation and interview was qualitatively analyzed and presented descriptively. And descriptive statistics for the socio-economic variables collected by questionnaires were analyzed using frequency counts, percentages, and simple cross tabulation.

3. RESULTS AND DISCUSSION

The livelihoods of the farmers in the study area are mostly dependent on agriculture, where rearing of animal and crop cultivation. About 80.99% of the farmers are engaged in mixed agriculture (crop production and rearing of animals), unlike 13.38% and 5.63% practice only crop cultivation and livestock rearing respectively. Therefore, the large scale of farmers of the area dominantly engaged in mixed agricultural activities. Animal rearing is source of income and practiced mainly to sustain families livelihoods in the case of crop fail.

The value of rearing animals is beyond a single factor. A number of respondents claim that dung collected from the cattle grazing area, serve as fertilizer to grow crops, and the newly dropped dung serve as house decorating material and other cultural rituals. Moreover, in addition to use of them for dairy product, they sell their cows to pay money for marriage as to compensate the families of the girl what they locally call (*qarshii araaraa*). After marriage, the families of boy have to pay money as compensation to the families of the girl. Accordingly, about 4000-10,000 of the money is given to the father and 1000-4000 sometimes more given to mother of the girl. The amount of money might differ from one area to another or depending on the educational level of the girl or livelihood status of the girl's family. Thus, the high the educational level of the girl tend to raise the amount of money to be paid. Therefore, animals are sold to fulfill both home necessities and serve as an asset for such a social affairs.

3. 1. Ways of access to land and soil fertility management practices.

Farmers at the study area acquired their land through different means of access to land. This can be inheritance, rent and share. Inheritance is the most common land holding system of the study area. Out of

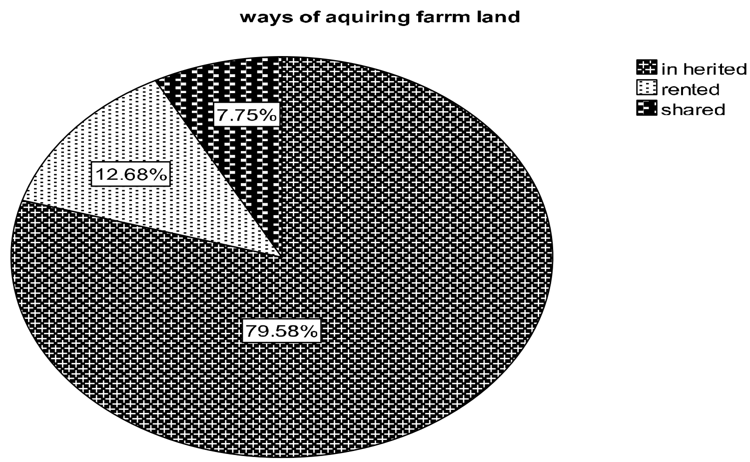


Figure 3.2 Ways of acquiring farm land at the study area

142 households, about 129 households that account for 90.8% have their own farm land. Among this, about 79.58% of them inherited their farm land from their parents either for one or other reason, followed by rent and share that comprise 12.68% and 7.75% respectively. In inheritance holding system, land given to the son either when the son form their own household after marriage or up on the death of parents given as share by the power of the elders of close relatives. Consequently, those who have more sons have chance to possess small plots of land hence the process continue until all the sons will have the land of their own. Unlikely, daughter has no chance to inherit land unless there is no son or father is volunteer to give his land and have more land. This is because they believe females gain their own land from the side of her husband after marriage. This is true that a woman had their share (land, cows, sheep and all other resources) just next day after marriage.

The share and rental form of access to land is not as commonly seen as access to land in the form of in heritance. Farmers rented land either when they don't have land of their own or want to cultivate crops to increase their yearly production. In the case of rented land holding system, the one who rented the land, have full right of cultivating the land personally. Therefore, in such system there is probability to maintain the soil fertility at least the years of cultivation as compared to land under share cropping.

In share form of access to land, all the situation of production depends on the agreement of the two or rarely dominated by land owner if he put pre conditions like (type of crop to be cultivated, use of fertilizer, cost of labor and weeding) thus share cropper must abide. For more case however, the land owner gives farm land and thereby all other inputs like seeds, fertilizer and labor covered by share cropper. Although there is no secure land holding right for the share cropper, they equally share the product they gained after harvest. As a result, the probability of maintaining soil fertility for long term is less. Thus, maintaining soil fertility for long term is seem to be more high in land under inheritance than the other two forms of access to land. This is because, farmers are willing continuously maintaining the land they consider as their own and at least share cropper claim bit of fear for they think there would be the agreement between share cropper and land owner may terminate for the coming cultivation year depending on the product gained or other factors. Consequently, they remain reluctant to invest much of their money and human power in maintaining soil for long term. Thus have negative impact on soil fertility management.

About 55% of the farmers use oxen drawn form of farming system. Hence, relatively good in time managing and timely land preparation and proper cultivation of crop land as compared to manually (hoe 25%) type of land farming. There are also about 20% farmers being in group that they locally called *Garee misoomaa* (literary development group). These are a group of farmers working together for common land preparation, and overall improvement of agricultural production. Those farmers who plow by oxen and members in group at village are supposed to cultivate their farm land early, dispersing seed on time and good weeding potential (labor sufficient). Thus, the agriculture of the area is not only influenced by soil fertility management inputs, but also availability of the labor force. Similarly, the larger the number of labor (human and oxen) utilized at farm land level the better land preparation time and good in weeding that inevitably the way to gain good product.

3.2. Farmer's perception about trends of soil fertility on their farm land

Farmers are not passive observers of what happening to

Table 3.1 Farmers response to the trends of soil fertility on their farm land.

	Responses	Frequency	Percent
Farers response of trends of soil fertility on their farm land	Increasing	10	7.05%
	Decreasing	79	55.63%
	No change	37	26.05%
	I don't know	16	11.27%
	Total	142	100.0%

Source: field survey 2011

their farm land. At local level, it has become increasingly evident that farmers who are living under high risk and uncertainty have without any external intervention developed pools of indigenous practices which are gradually adapted to the environmental changes (Yohannes 2004). Majority of the farmers 55.63% recognized that the fertility of the soil on their farm land is continuously declining especially on the farm land where monocropped cereals intensively practiced. One of the farmer from Songo Baricha said that, "I *am cultivating only Barley from one season of cultivation to other, Had it not the matter of poverty I could have changed the crops to be cultivated yearly, However, now, I have neither money to buy other seeds to cultivate nor stored crop that sustain lives of my families for the coming four months of non-cropping season.*"

From the table 3.1, above from the response made, although about 26.05% claimed no change in fertility status on their farm land at least for the current cultivation season, and followed by those who don't know, and respond increasing fertility status trends of fertility of soil on their farm land that is 11.27% and 7.05% respectively, majority (55.63) of the respondents understand and claim the presence of soil fertility decline. Moreover, farmers are owners of pool of IK parameters that enable assess the fertility loss of the farm land. They use different indigenous techniques and parameters of identifying quality of fertility of their soil on farm land. Hence, they perceive soil color change, productivity decline, appearance of sand in the field, poor seedling germination immediately after sawing, yellowing and other coloration of crop leaves during crop growth was something to be related to poor soil fertility. Although they don't understand amount of loss of nutrient content in the soil type as soil scientists do, they also do have their own means of identifying fertility of local soil on their farm land. For instance, there is about four soil type that farmers identify at least based on tangible parameters colour and texture of the soil. Accordingly, the most common local soil are what they say *Biiyyee gurraattii* (black soil), *Biiyyee diimtuu* (red soil), *Biiyyee cirrachaa* (sandy soil) *Biyyee qorcaa* (haplic luvisols) and the suffix 'gurraattii', 'Cirrachaa', Qorchaa' and 'diimtuu' represent colour black, sandy, brown and red respectively and 'Biiyyee' to mean soil. Though their classification parameter is only based on colour and soil texture, they do have good knowledge in understanding which soil is more fertile, infertile and which one need more fertiliser or manure to add. Accordingly, they claim Biiyyee gurraattii is the most fertile soil of all the others that found in the areas where land was left uncultivated for a long periods of cultivation seasons or not continuously cultivated fallowed land), at place where pens or kraal are formerly constructed, at home garden for continuous dumping of home wastes and manure and farm land under previously covered by vegetation. Thus one of the farmer said a proverb that tied with their farming system *"Qonna biiyyeen gurraachaa buliin Burraassa"* that is literary to mean if the cultivation is on black soil, the crop gain is optimum that brings the family happiness. Again they have long year experience of working with Biiyyee diimtuu. It is not as fertile as that of Biiyyee gurraattii it represents soil with low organic matter and low fertility and has potential to be productive if fertiliser is added and conserved well. They believe nothing can be cultivated on Biiyyee Cirrachaa because it was nutrient depleted soil for one or other reasons.

3.3 Farmers perception of indicators of soil fertility decline.

There are a number of factors perceived by the farmers in the study area as indicators of soil fertility decline. Majority of farmers 43.66% claim as major indicators of soil fertility decline are reveal itself in productivity decrease from year to year followed by those who claim soil unable to produce varieties of crops 31.69% for long term. Almost these two parameters for sure indicate the prominent challenges in agriculture, hence accounting for $3/4^{th}$ of reason of agricultural failure.

Therefore, the continuous fertility fall of soil on farm land, increasing challenge in preparing farm land that is becoming severe from time to time and decreases in productivity per farm plot that made the farmers to gain far less than the product they used to gain a number of years before. Thus, their long year experience on the same farm land is the most fundamental parameter of realization of soil fertility loss.

Table 3.2. Farmers perception of soil fertility decline

Indicators of fertility decline	Alternatives	Responses	
		N	Percent
	Crops bearing yellow leaf	23	16.19%
	Productivity decrease	62	43.66%
	soil un able to grow variety of crops	45	31.69%
	land preparation become difficult	12	8.46%
Total		142	100.0%

Source: field survey 2011

Table 3.3 Livestock ownership among wealth group and rate of fertilizer usage

Wealth group	**Total livestock (TLU)**	**Fertilizer usage**	
		DAP kg/ha	**Urea kg/ha**
Rich	17.2	66.3	31.4
Medium	9.6	31.4	20.5
Poor	4.1	21.6	15
Over all mean	10.3	39.8	22.3

Source: Field survey 2011

3.4. Soil fertility management practices.

4.4.1. Modern method of maintaining soil fertility in the study area

3.4.1.1 Chemical fertilizer

Modern method of SFM has helped increase food security and agricultural production globally through the propagation of high yielding varieties (World Bank, 2004). In the developing countries like Ethiopia where food demand and supply is negative synergies, effective use of chemical fertilizer is the main way to ensure food security in short run. In current Ethiopia where the application of fertilizer use is not only below actual recommendation to improve production but also in insufficient supply, untimely availability at cropping season, it is very difficult to sustain agriculture and ensuring food security is impossible.

About 93% of farmers use fertilizer that are mainly DAP (Di-Ammonium Phosphate) and Urea at least somehow. They use it either mixing them together or individually by dispersing on the farm land during sawing the seed simultaneously.

However, the application of chemical fertilizer is either not properly used (insufficient for farmers use what is only for a single hectare among many for more than 3 or 4 hectares) which is misleading.

Thus, although this much of the farmers are using chemical fertilizer, the rate of application of DAP 100kg/ha and Urea 50kg/ha is far below what is MoA recommended 100kg /ha. Fertilizer use in Ethiopia is low even compared to many other African countries due to cost, lack of credit, poor availability and the risk of crop failure.

Moreover, the rate of application of both soil fertility management measures differs between rich farmers having a large number of livestock, bee hives, and large farm land and other non-farm income (local wealth identification parameter) medium, and poor possessing moderate and less of these parameters respectively. For instance, rich farmers have a number of cattle and therefore they sell them to afford the price for fertilizer as three or more times what poor farmers use.

(Wealth categorization not represent wealth classification of Ethiopia or any distinct country, rather, was calculated on the basis of the standard values for Africa) that was given by Jahanke in 1982). Accordingly, one cattle is equivalent to 0.7 Tropical Livestock Unit (TLU), one goat/sheep = 0.1 TLU, and one calf =0.4 TLU.

Therefore, farmers at the study area apply an average mean of about 62.1kg of chemical fertilizer DAP and Urea) per hectare than what MoA recommend 100kg/ha.

Aggravated by wealth difference however, the rate of chemical fertilizer application for medium and poor farmers is far below than that of rich groups. This in turn remain the foremost problem in maintaining soil fertility and ensuring food security and kept it unattainable for so long. The degree of chemical fertilizer use is significantly related to contact with Development Agents (DAs). And also the result of the study by itself indicates that, the more closer the farmers to information, the better they are in use of fertilizer.

Fig 3.3. Compost (pit) prepared (buried) at Haro milki

And also level of fertilizer usage differs in educational level access to information and training. Farmers who contact DAs regularly, and follow training seem to be more effective in maintaining soil fertility.

However, the truth over here is that, farmers use chemical fertilizer neither below recommended amount on a farm land for they share one sack being in four or more in which it is not sufficient to neither maintain soil fertility nor have full know-how of application pattern for the contact between DAs and access to extension is very infrequent. Most of the farmers claim that they contact with (development agents) in a frequency less than 2-3 a month. And again, among those farmers using chemical fertilizer, most of them are complain about the price of the 100 kg Urea per plot of land with 480 birr and 100kg DAP/ha with 960-1050 birr and improved seed of maize 50kg with 230 birr/plot of land and 460/ha that require a total amount of 1440-2530 birr/ha for a single farming season and in which this is similar to other crop seeds that most of the farmers can't afford. Moreover, inorganic fertilizer is not effectively used due to the infrastructure problems at the study areas. Sometimes the delivery remains much let and farmers remain without applying the fertilizer. As a result, the degree of nutrient input is far less than nutrient loss that is significantly treat to agricultural production. Similarly, Hilhorst and Muchena (2000) explained that the main problem of African soil nutrient decline is insufficient inputs applied to compensate for soil nutrient loss during crop harvesting and residues taken elsewhere. Thus, the uses of chemical fertilizer at the study area are not promising in maintaining soil fertility at study area.

The compost preparation of the study area evolves the use of crop straws, ashes, leaves, grasses cow dung, leaf litter.

There are two ways of preparing compost, one is on the surface of the land and the other one is that buried inside the ground. Thus the one prepared on the surface of the earth is known as *heap* while the one prepared inside the ground by digging 1m deep and 2m wide is called *pit* (Yilikal 2002). Pit is prepared inside the ground even at the place where rain fall intensity is high like Haro milki, thus can't affect the decomposition of the ingredients.

Heap is prepared practiced in dega agro-ecological zone where annual rainfall is relatively low, thus the rain drop can't disintegrate soil particles and erode the soil. The grasses, crop straws and dung collected and dumped on the ground where it decompose and later spread over the farm land where farmers suspect soil fertility is declined.

Nevertheless, though majority of the farmers believed using chemical fertilizer is much promising in sustaining agriculture, it is not to mean they are all effectively using it, rather, there is a negative synergies between supply and demand of the peasant on one hand and farmers actual potential to afford the price for it from the other corner. As a result, farmers perception, need and desire to use chemical fertilizer at the study area is significantly positive.

However, actual potential to afford price for the amount of recommended fertilizer to be applied per hectare is mismatching. In addition, low accesses to extension and technical failures are the foremost problems of using chemical fertilizer and have been responding negatively to agricultural productivity at the area under study.

Fig.3.4. Heap practice at Songo Baricha

Table 3.5 Composition of Indigenous method used to maintain soil fertility.

	Types of ISFM	Responses	Valid percent	Cumulative percent
Indigenous methods used for SFM	adding manure	111	25.3%	81.6%
	kraal or cattle pen	124	28.2%	91.2%
	Crop rotation	45	10.3%	33.1%
	Fallowing	39	8.9%	28.7%
	Intercropping	69	15.7%	50.7%
	multi cropping	51	11.6%	37.5%
Total		439	100.0%	322.8%

Source: field survey 2011
*The count is not to 100%, it is because of multiple responses

3.5. Indigenous methods used in maintaining soil fertility.

Soil fertility problems remain a high priority for agricultural development and sustainability. However, in most cases, a scientific point of view in maintaining soil fertility can only partially reflect the farmers' point of view in terms of agricultural sustainability. Thus, this complexity creates a gap between the scientist and the farmer where there is no use of optimal soil fertility management practices. However, to fill this gap, it should be bridged in order to facilitate mutual understanding on the problems to be tackled. Farmers of the study area practice indigenous technologies manuring, traditional kraal (pen), crop rotation, and fallowing, intercropping, multi cropping for more case and leaf litter to some extent.

These farmers who can neither afford nor rely on an irregular supply of inorganic fertilizers, use their IK as alternative means of improving nutrients on their farm land. Farmers claim most of local technologies are often cheaper, more efficient than inorganic fertilizer.

3.5.1. Traditional kraal (pen)

This is one of the traditional forms of maintaining soil fertility. Farmers practice this by shifting pen locally known as '*Moonaa'* every few weeks or month on the farm land before farming season. Animals are penned in the field at night and the dung they deposit is later spread over the farm land that is considered to be infertile. As the bases of their long year experience, many farmers indicated that optimum crop yields were obtained from the farm on previous kraal was made on than that of farm land cultivated without kraal. This is most intensively used (91.2%) form of indigenous practice to maintain fertility of the farm land. However, the rate of use of traditional kraal is highly limited to by way of access to land and livestock ownership of the household. For instance, those farmers who have large number of cattle have more potential and access to make kraal over the farm land. Similarly, those who lack their own farm land (mainly rent) have very little or no possibility prepare kraal on the respective farm land.

Figure 3.5. Traditional kraal

Fig 3.6. Manure prepared to be added at garden

3.5.2. Manuring

Manure is used mainly as a source of N and P, which are nutrients that increase crop production in the majority of agricultural soils (Albert 2006) that serve as good ingredient in increasing productivity. Animal manure locally known as *Dhoqqee (dikee)* is used by many (81.6%) of the farmers at study area. Almost all farmers have Enset *(Ensete Ventricosum)* which is perennial root crop for its security to withstand drought season. Therefore, more of the collected *Dhoqqee* is added to farm land at homestead to maintain fertility of soil for growing *Enset* and root crops like potatoes, cabbage and onion. About 50%the farmers add manure they collected to the farm land at home garden followed by those farmers who apply manure on the farm at distance which is as less as three times (16.9) what is added to home garden.

There are challenges in applying manure on farm lands. For instance, Shiferaw (2002) claimed the expected amount of manure added to the farm land is about 8996kg/ha, 5769kg/ha, and 3862kg/ha for rich, medium and poor farmers respectively. Thus, rich farmers always lead application of manure to their land. Moreover, this method of maintaining soil fertility is more difficult for those who lack livestock 21.8% and don't use manure at all. And also transportation of that much dozen of manure to a farmyard at a distance is both cost-ineffective and require large amount of labor.

3.5.3. Crop rotation

It is one of the indigenous practices to improve soil fertility as well as conserve the soils fertility. It is a system by which nitrogen restoration is attained by alternating different types of crops on the same cultivated land (Michael 2002). Farmers has been using crop rotation that rooted as long as many years. The degree and pattern of rotation highly influenced by choice of the farmer depending on which crops to be grown in rotation are also largely based on their personal preference as well as suitability of the soil. Michael (2002) indicated, about similarly of a study conducted in Tigray that farmers choose which crops to grow in rotation according to how they adapt to the soil and the rainfall pattern as well as economic consideration such as the price of the crops to be chosen. Crop rotations practices are mostly of cereals types where land cultivated barely two to three years before, changed to wheat or maize for the following two or three cropping years. Here what have to be noticed is that, overall endeavors of the farmers is not only targeting to maintain soil fertility but also mostly emphasized on increasing productivity and feed their ever increasing number of family. The rotation pattern and system farmers practice is what they experienced in their day to day activity, however, it can be more convincing if assisted by experts for certain technical cases for they may have limited awareness about nutrient cycle and what type of crop should be planted after a crop cultivated from one year to another that was not seen actually in the area.

3.5.4. Fallowing

Fallow is a cropland that is left uncultivated and without crops for a number of periods ranging from one season to several years.

According to Albert (2006), the fallow period would increase the organic matter content of the soil; improve the soil structure including water holding capacity; recycle and trap nutrients from sub-soil; protect the soil from erosion and eliminate weeds, pests and diseases specific to the cropping system.

However, it is only few farmers practice fallowing due to shortage of farm land per house hold, lack of other off-farm gains and fear of land under fallow for long season would grow bushes and weeds that potentially reduce productivity when cultivated. Despite this shortcomings however, few farmers at study area are still leave the land (at least one-third) of what they totally have uncultivated for two or more years to let the soil recuperate its fertility believing are good in improving level of soil quality and crop productivity. In general, this kind of soil fertility will not provide persuasive role hence, many of the house hold have large number of family size that depend on farm land they have in common.

3.5.5. Intercropping

It is form of growing more than one crop of different type by mixing them on the same farm land at the same time. It is indigenous practice as long as agricultural history. Its value in productivity increase as farm land size decrease (Woldeyesus 1997); thus, advisable to be practiced in all study kebeles where average house hold land size is less than 1ha and in high population pressure. About 50.7% of the farmers of the study area practice intercropping. However, the degree of planting mixing crops on the farm land is highly influenced by wealth difference among the farmers. Those farmers considered as rich have potential to buy a variety of crops and plant on the same farm land at the same time in a single season, while it remain challenging for the said to be poor, and are rushing just to enhance their families with food. Those who use intercropping claim as it provide them stability of production and if one crop damaged, they have one or more to harvest. Accordingly, they grow wheat (*Triticum Vulgare*) and Field pea (*Pisum Vativum)* on the same farm land on one season and Barely (*Hordeum Vulgare*) with Field pea, *Enset (Ensete Ventricosum)* with root crops like potatoe and sweet potato (*selenium tuberosum),* Maize and cabbage. However, development agents claim this kind of farming have drawback. Pea cultivation mixing with barley or wheat in rarely recommended, hence Pea nearly let crops grow straight and sometime cause them to fall.

Similarly Woldeyesus (1997) came up with similar finding at Adit area where farmers grow Gomenzer (*Brassica Carinata*) as intercrop in maize or finger millet in small acreage. And the value of intercropping in compacting soil and reduce risk of soil loss by rain drop is high and therefore good in maintaining soil fertility and increasing productivity.

3.5.6 Multi cropping

It is the practice of growing two or more crops in the same space during a single growing season. Multiple cropping in agriculture is more important especially in the tropics and the world at large (Francis, 1986). It creates favorable condition for the soil, water, nutrients and provides excellent environmental conservation and sustainability. Therefore, the role of it in conserving the soil and maintaining its fertility is relevant. It is good in maintaining soil fertility and controlling of pests and disease (Tofinga, 2001). Farmers believe that they are using multi cropping for it is easy to harvest and increase productivity. About 37.5% of the farmers at the study area use the system in their local agriculture.

3.6. Other ISFM practices of the study area

3.6.1. Weed heaping

Weed heaping is another indigenous soil fertility management practices. Farmers at the study area use weeds and plant litter to enrich fertility of their soils. They usually chop the straws of the barley and wheat and disperse over the farm land where it later decomposed and enriched in fertility.

3.6.2. Kosii

Kosii is the name for house hold waste in local language. It is a practice of spreading household's wastes to the field for soil fertility maintenance Teklu and Gezahegn (2000). All household waste and animal leftovers was collected near the living home. This wastes expected to have a number of ingredient that support plant growth, thus after long period of accumulation farmers reuse the wastes as fertilizer on farm land.

3.6.3. Leaf litter

From their day to day life experience, farmers identified different plant leaves that serve them in enriching the fertility of their soil. For example after harvest, a farmer burns the stem or leafs of maize on their farm land. In addition, they use leaf litter as a mulch to enhance soil. The leftover of straws of wheat and barley after harvest left on the farm land where it decomposed to and later dispersed over the farm land.

3.7. Integrate use of Indigenous and Modern methods of soil fertility management

The integrated approach of indigenous practices and modern method of soil fertility management measures will enable farming practice that will not only improve soil fertility but also insure sustainability to preserve resource base degradation (Buthelezi et al, 2010). Many farmers at different parts of Africa responded as well. Modern practices such as the use of chemical fertilizers, pesticides and new farming technologies can combined with farmer developed indigenous technologies such as manuring, traditional kraal, crop rotation. Indigenous practices are cost effective and environmentally friendly, socially acceptable and easy for use.

At the area under study, the integration of the two bodies of knowledge was remained low for so long period of time that retarded the productivity level of agriculture of local farmers. It seem there is improvement in pattern of use and short term productivity increment, fertilizer use is still high, however, the promotion of improved seeds which are considered to bring about agricultural sustainability is something in low progress. Moreover, farmer's actual use and different alternative soil fertility management inputs to the agriculture is low. As indicated earlier, the 100kg of DAP/ha or 8ton of manure expected to be added on the single hectare that the experts are recommending is misleading and something that farmers can't actually afford and also practiced as due to price and less manure supply respectively. Similarly, farmers respond, they share 100kg of DAP being in 3 or more (20-25 kg) and or more on their respective farm land. Hence, neither it improves fertility of their cultivation land nor it increase production. The study thus shows that the level of improvement that emerged from the integration of the two bodies of knowledge is neither sufficient to induce a sustainable agriculture nor to bring any notable changes to food security and the lives of peasants of the study area.

3.8. Challenges in integrating indigenous and modern method

Integrated soil fertility management is the key in raising productivity levels while maintaining soil fertility in particular and land resource in general. For instance, the manure use in local agriculture and different household refuse and trashes can changed into compost by the help of agricultural experts, hence good in improving fertility of the soil. Had it not been as a result of poverty, no wrong in complimenting and use of chemical fertilizer with animal dung on farm land. Similarly, manuring and chemical fertilizer can best fit and complement each other with in a given plot of land. Farmers easily handle and accept new adopted technologies if integrated to what they already know. Integrated systems in agriculture are not only aims to replenish soil nutrient pools but also maximize on-farm recycling of nutrients, reduce nutrient losses from the farm land (*http://www.ifpri.org/2020/briefs/number67.htm*). And also this in turn enhances improvement of the efficiency of external inputs.

The challenges of integrating the technologies at the study area are diverse and complex, which are more technical and socio-economic related problems. Lack of adequate and organized trainings for farmers and extension-workers-farmer in which for most of the framers is not in a frequency of not more than 2-3 a month, limited input from farmers as a result of (limited access for manure and cost for transport to farm land) and money to by chemical fertilizer, fragmented land holdings, technical failure and deficiency of the extension services are the major constraints in linking the two bodies of knowledge. Those farmers who have more livestock and capital have potential to apply both manure and chemical fertilizer on the same farm land. But, those relatively considered as poor farmers are not able to afford price to use the integrated SFM at the same time. And thus, even using the single measures of maintaining soil fertility remains very difficult for many of the farmers. Similarly, the extension–farmer linkage uncertainly remain very low for there is no close examination and control over the work efficiency of the DAs due to the fact they are tied with other bulky duties at administration level (fertilizer delivery process, workshops, and meetings) during the farming season. Therefore, there is negative and insignificant relationship between access of farmers to training and application of DAs demonstration on the farm land in the study area

3.9. Opportunities and need to integrate Indigenous and modern method of maintaining soil fertility

Many experts and policy makers now appreciate and acknowledge that the conventional approaches to land management have failed with small-scale farmers in the developing Tropical world (Michael 2002). This may something that related to ineffectiveness of conventional science failure to address multi faceted problems that community face. Most of the agricultural failure in small scale farmers is not something to be related to single factor, hence require a number of struggles to overcome challenges. Although indigenous measures of SFM have their own deficiencies, they are not only something to be recognized as a basis for sustainable land management but also the way to raise agricultural productivity, suitable to the biophysical properties of the soil and fit the socio-economic conditions. In fact, without the participation of farmers, it is more likely soil management effort to conserve and manage the land resources in a sustainable way that would conclude in failure. It is because the single techno-fix approach is not the whole answer to the complex societal needs, small scale subsistence farming system and highly rain-fed agriculture. Thus different inputs of modern methods of SFM measures have proved to be ill adapted to the existing systems of poor rural farmers. Technological options must be based on indigenous knowledge and on local resources with sound ecological principles integrating social, cultural and economic dimensions to avoid dependence on external inputs (Eyasu 2002).

But a healthy and sustainable agriculture has to be depending on an integrated SFM system. The animal dung, manure, crop rotation and traditional kraal being used at the study area is both economically affordable, locally acceptable and easy to use. Consequently, farmers feel secure using what they own (skills, knowledge, know-how, materials etc) because they able to use effectively for they have long term experience of use. In such cases, they are likely to grow more crops in sustainable manner and develop interest in its long term utilization. Like all other parts of Ethiopia, agricultural extension the study area has promoted use of in organic fertilizer and improved seeds and has provided credit to obtain inputs that must be repaid immediately after harvest. Moreover, farmers are not confident enough to have fertilizer in credit.

In the case of crop failure farmers are forced to pay back the credit selling their cows in which things remain for those who lack off-farm gains or expropriation of other property may follow. Consequently many of the farmer's respond fear of the risk in case of crop failure and ceased fertilizer credit. Furthermore, the continuous increase of the price of fertilizer is another determinant factor that diminished the attention of farmers to use chemical fertilizer at the study area. It is thus very important to give due attention of integrating Indigenous and modern SFM practices to sustain the agriculture of the small-scale farmers and livelihoods of the rural poor.

4. CONCLUSION

Similar to the other parts of Ethiopia, the livelihood of the farmers in study area is totally dependent on subsistent agriculture that includes rearing of livestock and cultivation of crops. The overall farming system is strongly food crop production oriented and that operated manually by use of oxen or hoe for land preparation. However, the development of the agricultural sector of the area is highly affected by continuous soil fertility decline that attributed to different factors and hence put lives of many in problem and left thousands of rural farmer's food insecure. A number of factors contributing to soil fertility decline, which are diverse and complex (bio-physical and human) related. Though most of the causes of soil fertility losses at the study area are significantly from the socio-economic condition of the rural population, continuous cultivation, lack of effective soil conservation, un-controlled grazing and in effective use of chemical fertilizer are the fore most are notable problems. Even though farmers are now become more familiar in using chemical fertilizer, the extent and amount of fertilizer used in a farm plot is significantly far less than what MoA recommend. Moreover, due to the lesser extension-farmer linkage the technical failure (when to apply, on what type of soil to apply, how to use and amount to be added) is the main constraints to the farmers in using fertilizer. Generally, the integrated use of the two bodies of knowledge is absent. This is mainly due to lack of adequate and organized trainings for farmers and extension workers, limited input, fragmented land holdings, technical failures, deficiency of the farmer-extension close linkages, lack of incentives and subsidies and economic problem (lack of potential to buy fertilizer) are the major constraints in linking the two bodies of knowledge. In addition, integration of the system is highly influenced by wealth difference.

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