UNIVERSITY FOR DEVELOPMENT STUDIES

ASSESSING THE EFFECTS OF SOIL FERTILITY AND CONSERVATION TECHNOLOGIES OF FARM LANDS IN YENDI MUNICIPALITY, GHANA

BY

NYAABA JOSHUA ANONDE

(UDS /MNG/0017/09)

DISSERTATION SUBMITTED TO THE DEPARTMENT OF COMMUNITY DEVELOPMENT, FACULTY OF PLANNING AND LAND MANAGEMENT, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN NON-GOVERNMENTAL MANAGEMENT AND RURAL DEVELOPMENT

OCTOBEER, 2012

CANDIDATE'S DECLARATION

I hereby declare that this result is of my own research and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature:............................ Date:..06-11-12.........

Joshua Nyaaba Anonde

Supervisor's Declaration

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines of supervision of dissertations laid down by the University for Development Studies.

Supervisor's Signature---------------------------- Date:..06/11/2012.........

Mr. Shaibu Abdul-Ganiyu

ABSTRACT

Soil and water degradation is a source of problem confronting sub-Saharan Africa with regard to improving agricultural productivity, reducing poverty and securing food insecurity. Unfortunately, many Soil and Water Conservation (SWC) programmes design to address soil and water degradation in the traditional agricultural sector have fallen far short of expectation. This study therefore assessed the effects of soil fertility and conservation technologies on farmlands in Yendi Municipality. Simple random sampling was used to select fifty (50) respondents each from Kulkpanga, Kpatia and Gundogu for face-to-face interview. Other data collection tools included observation of farms and focus groups discussions. Descriptive statistics and frequency distributions were used to present the results in the form of tables or graphs. The SWC practices adopted by farmers in the study communities included: contour ploughing, earth bunding, non-burning of farmlands, cover cropping, mixed cropping and crop rotation. The benefits of these include improvement of soil fertility and soil erosion control. However, capital and labour availability were a constraint. It is therefore recommended that farmers' capacities are enhanced to improve and sustain existing technologies being used. Further research should be carried out in those study communities to determine the physical, chemical and microbiological properties of the soils for enhanced crop productivity.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my principal supervisor Mr. Shaibu Abdul-Ganiyu for his invaluable comments, suggestions and guidance throughout all stages of this work. I am also indebted to the other supervisors, Dr. Edward Salifu Mahama, Dr. Kunfaa, Dr. Boye Bandie and Dr. Francis Bacho for their useful suggestions and guidance and continuous follow up in the entire process of the dissertation work without which this dissertation could not have been possible. Also, Kennedy Kobina Donyong has been of tremendous help to me

I am grateful to EPDRA-Yendi for providing financial support for my studies and to E P Church for granting me study leave to pursue the course.

The researcher benefited from useful suggestions from staff of EPDRA-Yendi and Ministry of Food and Agriculture-Yendi and wishes to thank them very much.

Finally, my thanks go to Rev. Prof. Saa Dittoh for the guidance and advice during my studies in the University. May the Almighty God bless all of us.

DEDICATION

This dissertation is dedicated to my beloved wife, Emilia Nyaaba, daughter, Dora Alepasse Nyaaba and two sons, Moses Nyaaba and Barnabas Nyaaba for their patience, love and understanding while l was studying at University for development Studies.

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CHAPTER ONE

1.0 Introduction

1.1 Background

Soil and water degradation is one of the fundamental problems confronting sub-Saharan Africa in its efforts to increase agricultural productivity, reduce poverty and alleviate food insecurity (Hailu *et al.,* 1993). Unfortunately, many conservation programs designed to address soil and water degradation in the traditional agricultural sector have fallen far short of expectation. (Hailu *et al.,* 1993). Research findings have shown that despite a number of soils and water conservation management technologies in place, adoption by farmers is still very low (Hailu *et al.,* 1993). This has been due to complex socio-economic and demographic factors that have affected the choice of land and water technology investment toward improved food security. Gaps have been identified in the way researchers and extension workers have packaged research results to make them more user-friendly for the farmers (Hailu *et al.,* 1993). Knowledge sharing mechanisms have not been incorporated in the broader agricultural extension systems to help disseminate success stories emanating from research (Hailu *et al.,* 1993).

To increase agricultural productivity, soil conservation practices are of paramount importance to farmers involved in crop production. Replenishment of soil fertility by artificial fertilizer would be very expensive. Even then, the use of inorganic fertilizers does not compensate for the loss of soil organic matter.

The traditional low-input agriculture practiced by many of the farmers in the absence of replenishment of mineral nutrients, is slowly reducing many of the soils to almost inert systems (Stoorvogel and Smaling, 1990). As many of the soils also have low resilience, future corrective measures may be exorbitantly expensive.

Every country wants many things from their soil and water resource base. The basic elements include food and fiber of high quality and at low price, a healthy environment, a high standard of living, and an improved quality of life. To achieve these goals, decisions must be made about how best to match future demands of food, fiber, water, fuel, and other agricultural products with the needs for a healthier environment. These decisions must consider the social, economic, and political structure of the country as well as the conditions of the natural resources. They must be based on accurate and adequate information, appropriate technology, and a cost-effective delivery system.

According to FAO (2008), limited availability of additional land for crop production, along with declining yield for major food crops, have heightened concerns about agriculture's ability to feed a world population expected to exceed 7.5 billion by the year 2020. Decreasing soil fertility has also raised concerns about the sustainability of agricultural production at this current level. Future strategies for increasing agricultural productivity will have to focus on using available nutrient resources more efficiently, effectively, and sustainably than in the past. Integrated management of the nutrients needed for proper plant growth, together with effective crop, water, soil, and land management, will be critical for sustaining agriculture over the long term.

Substantial improvement in the productivity of agricultural systems is required to support growing rural and urban populations in the developing world. Because of strong pressure on land resources, agricultural intensification of existing production systems involving increasing cropping intensity and/or increased use of external inputs is often the only way to increase agricultural production. There is, however, a broad concern about the sustainability of agricultural production systems in many developing countries. Sustainable agriculture, as defined by Food and Agriculture Organisation (FAO, 2008) means agriculture that conserves land, water, plant and animal genetic resources, does not degrade the environment, and is economically viable and socially acceptable. Thus sustainable agriculture manages and uses natural resources to meet people's needs both now and in the future.

People endeavor to make a living by clearing the forest; by cultivating lands on steep slopes; by adopting faulty methods of cultivation that neither conserves water nor soil; by felling trees for fuel power and shelter and letting their animals loose for grazing until all vegetative cover has been so reduced that it no longer offers protection to the soil (Ahaneku, 1996).

The challenge for agriculture over the coming decades will be to meet the world's increasing demand for food in a sustainable way. Declining soil fertility and mismanagement of plant nutrients have made this task more difficult. Improving soil fertility contributes to global and national food security, improving rural livelihoods, and significantly reducing rural poverty and improving crop production. Little attention is given to soil fertility improvement practices because it is considered to be in conflict with the main farming activities. It is certain that time is spent on soil fertility management to increase crop yields, but it is admitted that when dung is brought into the field, it is to return to the soil something that has been taken away.

More than 70% of Africa's poor live in rural areas, a pattern that is expected to continue for many years. Since the rural poor derive most of their livelihood from agriculture, increasing agricultural productivity is essential for significant poverty reduction. Food insecurity, a fundamental measure of poverty, is one of the most pressing problems facing the continent. While per capita food availability in the rest of the world has increased significantly over the past 45 years, the situation in sub-Saharan Africa (SSA) has improved only slightly (Ahaneku, 1996). For instance, the average cereal yield is still below 1 ton per hectare per year in SSA, and the continent-wide average yield has increased by a meager 5.2 kg ha^{-1} y^{-1} over the past 33 years (Food and Agriculture Organisation of the United Nations Statistical Databases-FAOSTAT, 2005). In contrast, crop yields on well-managed farms are several times larger and yields obtained on research stations are commonly ten times higher than farm average yields.

About 55% of Africa's land area is unsuitable for agriculture. Only 11% of the continent, spread over many countries, has high-quality soil that can be effectively managed to sustain more than double its current population (Eswaran *et al.,* 1997). Approximately 65% of agricultural land, 31% of permanent pastures and 19% of forest and wood land in Africa were estimated to be affected by some form of degradation in 1990 (Oldeman, 1994). The current situation is undoubtedly worse. Soil moisture stress inherently constrains land productivity on 86% of soils in Africa (Eswaran *et al.,* 1997), but soil fertility degradation now places an additional serious human-induced limitation on productivity.

Though land provides a means of livelihoods for the majority of the population, land resources are facing increasing degradation mainly due to water erosion in the form of sheet and rill erosion. Generally, low productivity characterises Ghanaian agriculture which has made it difficult to attain food self-sufficiency at a national level. Soil degradation is one of the major environmental problems in Ghana. This manifests itself mainly in the form of land on which the soil layer has been eroded away and nutrients have been continuously extracted with little or no any replenishment. The problem is particularly severe on cultivated marginal and sloping land because such areas are generally susceptible to soil erosion (Tadesse and Belay, 2004; Greenland *et al.,* 1994).

Agricultural systems with insufficient nutrient input on land with poor to moderate potential are the root cause of human-induced soil degradation in Africa. Although many farmers have developed soil fertility management strategies to cope with the poor quality of the limited resources they possess, low inputs of nutrient and organic matter contribute to poor crop growth and the mining of soil nutrients.

Fertilizer use throughout Africa is by far the lowest in the world – less than 9 kg nitrogen ha^{-1} and 6 kg phosphorus ha^{-1} compared with typical crop requirements of 60 kg nitrogen a ha^{-1} and 30 kg phosphorus ha^{-1}. Mid-1990s estimates show that every country in Africa had a negative nutrient balance in its soils, in that the amount of nitrogen, phosphorus and potassium added as inputs was significantly less than the amount removed at harvest, or lost by erosion and leaching. This is in sharp contrast to the nutrient overload of soils in the northern hemisphere, but poses as great an environmental threat (Eswaran *et al.,* 1997).

Soil fertility decline is associated with several simultaneous degradation processes feeding on each other to produce a downward spiral in productivity and environmental quality. Combined effects of tillage and insufficient applications of nutrient and organic matter inevitably lead to a decline in soil organic matter. This reduces the retention of essential plant nutrients, breaking down soil physical structure and in turn diminishing water infiltration and the water management, Storage capacity of the soil. Beyond this, African farmers face other degradation processes such as erosion, salinisation and acidification. Droughts and/or prolonged dry spells often worsen the situation resulting in severe crop damage or complete crop failures. In a region where the majority of livelihoods are anchored on agriculture, it is clear that urgent measures must be taken to boost productivity and mitigate the negative impacts of climate change and variability. Batjes (2003) reported that degraded soils amount to about 494 million ha in Africa.

It was also estimated that 65 per cent of SSA's agricultural land is degraded because of water and soil erosion, chemical and physical degradation (Oldeman *et al.,* Scherr., 1999).

Forms of degradation vary with the causative factor: loss of topsoil, terrain deformation, mass movement or over blowing (water and wind erosion), loss of nutrient and organic matter, salinisation/alkalisation, acidification, pollution (chemical deterioration), compacting/crusting, water logging. Of the total degraded area, overgrazing, soil mismanagement, deforestation and overexploitation of natural resources are said to account respectively for 49, 24, 14 and 13 percent respectively, (Oldeman *et al.*, Batjes., 1999).

In Ghana, there has been no significant growth in the yields of most crops in the last 10 years, and the yields of certain crops (e.g., sorghum, millet, cassava, yam, cocoyam, and beans) have shown modest declines, in the range of 1–2 percent between 1995 and 2004 (Wegayehu, 2003). In Wegayehu's view, agriculture in Ghana is not only an economic activity but also a way of life for which agricultural land is an indispensable resource upon which the welfare of the society is built. The livelihood of the vast majority of the population depends directly or indirectly on this sector. Needless to mention, such dependence obviously leads to increased vulnerability of the economy to problems related to land degradation (*ibid*).

In fact, the declines observed for some crops may be related to expansion into less fertile land. A decline in the production of a crop has a direct negative effect on the income of farmers who grow that crop, which reduces their demand for all agricultural and nonagricultural commodities differently (as income elasticities vary across commodities). Soil degradation in Ghana accounts for an approximately one percent reduction in real Gross Domestic Product (G D P) growth per year, (Alfsen *et al.,* 1997). While Ghana's economy has grown steadily over the last two decades, agriculture is still a major income source for the rural population, which accounts for more than 50 percent of the total population, (Alfsen *et al.,* 1997).

1.2 Problem Statement

There are diverse views about reasons for the low agricultural productivity in Kpatia, Kulkpanga and Gundogu context. Among other things, it is attributed to declining soil fertility, unpredictable and erratic rainfall. Farmers are further hampered in their activities by inefficient input supply systems and markets for produce, and have limited opportunities to earn off-farm income. Discussions with the farmers revealed that other factors which affect agriculture are insufficient credit facilities and cash for investment, inadequate extension services, insecure land tenure and poor infrastructure. However, while it may be easy to list the problems that need to be overcome, there are no simple formulae for addressing these constraints and improving food security and rural livelihoods (Jager, 1999; Kinyanjui *et al.,* 2000).

According to the Ministry of Food Agriculture (MoFA) report of 1996, the main problems in the district include declining soil fertility, a reduction in the amount of arable land available per capita, unpredictable and unreliable rainfall, unproductive livestock and limited use of agricultural inputs. Agricultural production and productivity, estimated at about 1.19 tons /ha for cereals and legumes and 1.065 tons/ ha for roots and tubers.

Low agricultural production in the study area may be partly due to the declining soil fertility caused by the use of inappropriate farming practices such as shifting cultivation, continuous cropping, bad ploughing, ridging and planting along the slopes, over grazing, indiscriminate agrochemical use and felling of trees and bushfires, which are causing environmental degradation.

In the district, farmers have tried to increase agricultural production by increasing farm sizes, which is destroying the vegetation cover and causing land degradation. The farmers are producing only food crops and not cash crops, which is not profitable. Food crops production has the tendency to destroy land due to continuous cropping. Farmers are also in the habit of cultivating yam, which destroys the land faster, because yam and cassava are heavy feeders and easily exhaust the soil of its nutrients, rendering the land unproductive. Yam cultivation requires virgin land, which leads to the destruction of many trees and the vegetation, which is causing deforestation and also encourages shifting cultivation, which together is causing land degradation. The adoption rate of soil conservation technology is very low among farmers in the study area, because farmers prefer to remove the soil conservation structures (contour bunds) from their farmland instead of maintaining and replicating them after they have been constructed.

According to Beshah, (2003), there are diverse views about reasons for the low agricultural productivity in Yendi municipality. This is attributed to drought, unreliable rainfall, war and conflicts, pests and diseases, insecurity of land tenure, population pressure, soil erosion, overgrazing, deforestation, lack of efficient rural organizations and weak institutional support.

Although drought and poor rainfall are considered as the major causes for low agricultural production and food shortage, the contribution of soil degradation (excessive nutrient exhaustion and removal of top soil by water erosion) is by far greater (Sahlemedhin, 2000). Degradation resulting from soil erosion and nutrient depletion is one of the most challenging environmental problems in Yendi Municipality. Yendi lands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on fragile land. (Delgado *et al.,* 1994). The soil fertility condition of cultivated lands is an important factor of farmers' decisions on the continued use of soil and water conservation practices. Previous trainings on soil and water conservation technologies by MoFA have simply highlighted the proportion of farmers participating in conservation practices in the villages. For now, no known study has attempted to measure the factors that influence the impact of soil fertility and conservation practices on crops production. The purpose of this research is, therefore, to contribute to the understanding of the factors that influence the practice of soil and water conservation in the study area.

1.3 The main research question

What are farmers' adoption levels of soil fertility and conservation techniques in Kulkpanga, Kpatia and Gundogu communities in the Yendi District?

1.3.1 Specific research questions

1. What are the current soil fertility and conservation practices (indigenous and/or improved) farmers are using in Kulkpanga, Kpatia and Gundogu communities in the Yendi District?
2. What are farmers' perceptions of soil fertility and conservation technologies on agricultural production in the study areas?

3. What are the levels of adoption of the existing soil fertility and conservation practices by the farmers in the study areas?

1.4 The Main research objective

To ascertain farmers' adoption levels of soil fertility, and conservation techniques in Kulkpanga, Kpatia and Gundogu communities in the Yendi District.

1.4.1 Specific objectives

1. To identify the current soil fertility and conservation practices (indigenous and/or improved) farmers are using in Kulkpanga, Kpatia and Gundogu communities in the Yendi District.
2. To assess farmers' perceptions of soil fertility and conservation technologies on agricultural production in the study areas.
3. To determine the levels of adoption of the existing soil fertility,and conservation practices by the farmers in the study areas.

1.5 Justification

Appropriate improvement and corrective measures in promoting soil and water conservation can only be made when there is a way of determining critical factors for any given practice. Anything less than this may lead to unnecessary financial expenditures that could otherwise be avoidable. A better understanding of the factors that will condition adoption and possibly restrict the adoption of soil and water conservation practices would allow the formulation of well-tailored interventions that could result in rationalizing the scarce physical, financial and human resources that the nation most requires for use in other sectors of the economy. A better understanding could further facilitate close monitoring of conservation activities. Moreover, future related efforts in other areas with similar characteristics may be targeted with less difficulty and it would allow for prediction of the speed at which adoption of the practice would likely take place.

Declining soil fertility jeopardizes the sustainability of farming systems in the country especially in arid and semi-arid areas that are ecologically fragile. Highly variable and declining rainfall patterns observed since the 1970s compound the ecological fragility of these regions which account for half of the cultivable land in SSA (Marter and Gordon., 1996).

1.6 Scope of the Study

This study covers Kulkpanga, Kpatia and Gundogu in the Yendi district of the Northern Region. It concentrated on assessing the impact of soil fertility and conservation technologies on agriculture production. Due to the numerous soil fertility management practices and the practical difficulty of considering all of them, the study is limited to analyzing only those that are believed to be popular and effective.

1.7 Organisation of the Study

The study is organised in the following way: chapter one is introductory chapter, giving the background, problem statement, research questions, objectives, justification and organization of the study. Chapter two dealt with the literature review. It covers the conceptual and theoretical issues in soil fertility and conservation practices, farming systems as well as the advantages and constraints associated with the various soil fertility and conservation practices. Chapter three covers the study area and the method of research. It gives a description of the study area, the data needs, methods and procedures used in the data collection, analytical framework and the analytical techniques. Chapter four discusses the findings of the research as presented and analysed and the chapter five presents the conclusions and recommendations.

CHAPTER TWO

2.0 Literature Review

2.1 Soil and Water Conservation, as Livelihood Strategy

According to Kurukulasuriya and Rosenthal (2003), promotion of soil and water conservation (SWC) technologies has been identified as adaptation strategy in this era of climate change with its negative consequence on livelihood activities for countries in the developing world, particularly in sub-Saharan Africa to mitigate growing water shortages, worsening soil conditions, and drought and desertification. In fact, land provides a means of livelihood for the majority of the world human population and as such, land as a resource is facing increasing degradation mainly due to erosion (FAO, 1986). Therefore, SWC measures with regard to the application of organic manure in order to restore its productivity should be given a priority.

The adoption of SWC technologies lead to more income to farmers as a result of increase in water availability, and this allows production of cash crops. SWC measures reduce vulnerability because it reduces risks associated with low and erratic rainfall, also the measures improve food security in the sense that improved soil and water management leads to higher crops yields, and also increases well-being of farmers because group approaches to SWC allow development of social and human capital (Boyd, *et al*. 2000)

According to Boyd *et al.* (2000) households intensify their agricultural production- improve output per unit area through capital investment or an increase in labour inputs-by adopting SWC practices. Also, Hailu & Runge-Metzger (1993) points out that SWC measures impose opportunity costs through their demands on labour, often at times of peak labour demand. Boyd *et al*. (2000.p.7) "investments in SWC tend to generate returns in the long term, but do not necessarily result in higher yields or income in the short term."

Also, Boyd *et al.* assert that the adoption of SWC practices can be regarded as a risk reduction strategy, because it enhances farming system and reduces the impact of any stress (such as erratic and untimely rainfall). Although investment in SWC may be more risky than other options open to households such as migration, as returns to any investment in land cannot be relied upon in semi-arid environments (ibid). The SWC technologies are generally low-cost interventions, but they can still be too risky for very low-income, risk-averse households (Yesuf and Bluffstone, 2007). Similarly, Yesuf (2004) points out that farmers adopt technologies not merely on impacts on crop yields but also risk effects.

Kerr & Sanghi (1991) report that indigenous SWC designs suggest that conservation measures are most likely to be adopted if they increase productivity, and that soil conservation measures that produce the most rapid return on investment are the most favoured, and they included bunds that require relatively small initial investment, provide fodder or fuel, and conserve moisture on-site. SWC techniques are used in many areas to adapt to the drier, degraded conditions brought on in part by changes in climate (Kato Ringler, Yesuf and Bryan, 2009)

2.2 Environment Degradation and SWC Practices

Agriculture, most especially farming is believed to be associated with environmental destruction. However, population growth and agricultural intensification have been accompanied by improved rather than deteriorating environmental quality (Mortimore,1993; Tiffen, Mortimore, and Gichuki, 1994). Although, Tiffen *et al*.(1994) point out that it is clear that increasing population pressure created the demand for more productive and sustainable resource management, as well as providing the workforce to implement what in many cases were highly labour-intensive technologies. Other reports have suggested that local approaches to natural resource management are well suited to complex and dynamic environments (Reij, Scoones and Toulmin,1996).

In the opinion of Kerr & Sanghi (1993) indigenous and recommended SWC measures have evolved on the basis of different objectives, they point out soil conservation programmes in India traditionally have had a single objective: to design and introduce technologies that conserve the maximum amount of soil and water. Farmers, have multiple objectives, of which soil conservation is only one: bunds demarcate property lines and protect against encroachment by a neighbour. They are often lined with thorny barriers to keep trespassers out. Or they may be lined with vegetation to produce valuable commodities such as fuel, fodder or fruit (ibid). Crop residues are also allowed to decompose on farmlands for the reason of increasing the organic matter content of a given soil.

According to Azene (1997), farmers have been virtually considered ignorant of SWC practices and were largely excluded from the planning, implementation, and evaluation of these conservation measures. Also, in the view of Amsalu (2006) only rare attempts were made to include indigenous experience and knowledge in SWC technologies.

The adoption of improved SWC technologies in developing countries has attracted much attention from scientists and policy makers mainly because land degradation which leads to low organic matter content of soil is a key problem for better agricultural production (De Graaff, Amsalu, Bodnar, Kessler, Posthumus and Tenge, 2008). De Graaff *et al.*(2008) point out that there are three phases in the adoption of process of SWC such as the use of organic manure by farmers: the acceptance phase, the actual adoption phase and the final adoption phase.

According to De Graaff *et al.*, the acceptance phase generally includes the awareness, evaluation and the trial stages and eventually leads to starting investment in certain measures. With the actual adoption phase, efforts or investments are made to implement SWC measures on more than a trial basis. The third phase, final adoption, the existing SWC technologies are sustained over many years, while new ones are added on other fields by the same farmer.

Kessler (2006) opines that the most important reason for limited use of SWC technologies is farmers' low adoption behaviour- the degree to which farmers are intrinsically motivated to maintain and replicate SWC measures. According Kessler, when farmers are convinced by the efficiency of a SWC technology, and not by incentives or by statements from others that a measure actually works, it leads to the highest degree of adoption, but it should be known that the adoption of SWC measures does not automatically guarantee long-term use.

2.3 Soil Formation and Conservation

Soils are complex systems. They usually consist of weathered and partly decomposed rock, water, air, organic material formed from animal and plant decay, and thousands of different life forms, mainly microscopic (Bennet,1993). According to Bennet (1993), soils are normally in a form of dynamic equilibrium with the balance of their various components changing with variations in rainfall, temperatures and the surface cover, and of course, the way they are managed by humans. Soils vary enormously both chemically and physically and they vary greatly from place to place. Nature takes between 300 - 1000 years to build 2.5 cm of soil (Onwualu *et al.,* 2006), while a very intensive rainfall event can result in the loss of tones of soil.

This makes soil resources a subject of importance in the drive towards enhancing soil and water conservation practices in Ghana.

Efficient and profitable crop production hinges upon achieving a conducive soil environment (Onwualu *et al.,* 2006), capable of retaining adequate soil nutrient and moisture for sustained seed development and growth. It is therefore not an over statement to say that because of the role soil plays in sustaining plant and animal life, our very existence depends on the conservation practices of soil fertility De Graaff *et al*. (2008), of this all important natural resource base.

Conservation farming, also referred to as permanent agriculture, involves the proper use of every parcel of land (especially soil) for good sound agriculture with a view to enhancing the future soil potential (Akinbile and Odebode, 2007). This is through wise use of the natural environment, which includes protection of nature, controlled production of useful materials as well as control or elimination of environmental pollution. (Akinbile and Odebode, 2007). Several methods have been recommended to farmers for the conservation of their soils. These include the planting of vetiver grass to check and reduce erosion, zero tillage and minimum tillage. (Mc Donald and Brown. 2000). Farmers in their effort to make their farmlands continue to sustain their activities have adopted conservation methods that are not labour-intensive, highly cost effective, compatible with the existing farming system, cheap and easy to install and maintain. These practices which include mulching, cover cropping and contour tillage are considered as sustainable soil conservation practices. Many indigenous conservation methods such as ridging, terracing, multiple cropping and fallowing were used in the pre-colonial era (Igbokwe, 1996). In the colonial times, the British Government conducted large scale projects on soil conservation but many failed as imported technologies were inadequate. Soil fertility issues have gained more emphasis after independence (Slaymaker and Blench, 2002). Improving soil fertility contributes to global and national food security, improving rural livelihoods, and significantly reducing rural poverty and improving crop production. Little attention is given to soil fertility improvement practices because it is considered to be in conflict with other farming activities. (Igbokwe, 1996).

The issue of land degradation has been a major concern and subject of many research activities for more than four decades now. For a variety of reasons however, the problem and its causes and impacts are far from being fully understood. Conservation tillage using chisel plough which does not invert soil, significantly increased soil moisture storage by maximizing water entry into the soil, thus reducing surface runoff and soil loss. Amsalu and de Graaff (2006). Also, under no-tillage condition, there is higher soil cover resulting in consequent increased infiltration rates (Ahaneku and Sangodoyin, 2003). The problem of declining soil fertility is much more complex than often presumed and cannot be thoroughly explained through investigating only the physical aspects. (Ahaneku and Sangodoyin, 2003).

2.4 Governance Issues on SWC Measures

Most African governments have used agriculture as a main source of revenue by restricting producer prices and taxing exports (Cleaver, 1993). Relatively little attention has been paid to rural areas by national governments, lowering the relative returns to farming. Therefore, few improved soil-fertility management technologies have been widely accepted by African smallholder farmers (Conway & Barbier, 1990).

The low national priority given to the rural sector in Africa also results in poor road and market infrastructure, lack of timely access to credit and inputs at reasonable cost, lack of timely information, and ineffective extension systems (Badiane & Delgado, 1995; Tomich *et al.*, 1995). Soil-fertility depletion therefore is largely a consequence of socioeconomic constraints and policy distortions. Because the soil resource has not kept its productive capability over time, farmers have witnessed low and declining yields. (Tomich *et al.*, 1995).Current crop yields are low due to poor agronomic practices, droughts, weed and pest attacks, lack of cash for investment, and soil fertility depletion. Tenge *et al.* (2004). Several decades of nutrient depletion have transformed originally fertile lands that yielded 2 to 4Mtons of cereal ha^{-1} 1 grain, into infertile ones where cereal crops yields less than 1Mton t ha are ha^{-1} common. For instance, a long-term trial in Kabete, Kenya, indicates that a fertile, red soil (Oxic Rhodudalf) lost about 1t ha^{-1} of soil organic N and 100 kg P ha^{-1} of soil organic P during 18 yr of continuous maize *(Zea mays* L.), common bean *(Phaseolus vulgaris* L.) rotation in the absence of nutrient inputs. Maize yields without N and P fertilizer inputs decreased from 3 to one ha^{-1} during that period (Qureshi, 1991; Swift *et al.,* 1994; Kapkiyai, 1996; Bekunda *et al.*, 1997).

2.5 Perceptions and Attitudes of Farmers

Perceptions of soil erosion and soil fertility management as a hazard to agricultural production and sustainable agriculture are the most important determinant of effort at adoption of conservation measures (Semgalawe and Folmer, 2000; Gebremedhin and Swinton, 2003). According to Semgalawe and Folmer (2000), and Gebremedhin and Swinton (2003) those farmers who perceive soil erosion as a problem having negative impacts on productivity and who expect positive returns from conservation are likely to decide in favour of adopting available conservation technologies. On the other hand, when farmers do not acknowledge soil erosion as a problem, they will not expect benefits from controlling erosion and it is highly likely that they will decide against adopting any conservation technologies (*ibid*).

Additional evidence to this assumption is the explanation given by the farmers during informal discussions about decline in fertility levels of their lands. They generally agreed that there had been a decreasing trend in fertility levels of their plots of land, but that was attributed to immature of the land due to overuse, and erosion was rarely mentioned. In general terms, it can be concluded that the farmers were well aware of the problem of soil erosion.

2.6 Soil Erosion and Mitigation Measures

Soil erosion, and the other related forms of land degradation, now constitutes an extensive and serious problem in many parts of the world, (Semgalawe and Folmer, 2000; Gebremedhin and Swinton, 2003), particularly in the developing countries. It is believed that soil erosion is one of the most widespread environmental problems globally. In spite of the importance that the subject has been given by national and international organizations, the problem has been increasing in recent years. For example, despite the US government having spent an estimated US$18 billion on soil conservation between the mid 1930s and early 1990s, and presently spending over US$2 billion per year on soil conservation, that country is losing an estimated 6000 million tons of topsoil annually, according to Ahaneku I. E., (1996). The picture is similar in other parts of the world.

There have been successful soil-conservation programs but, overall, not enough has been achieved and generally farmers and other land users have been slow or reluctant to take up practices that would protect and rehabilitate their land. Guerin (1999). There are a number of reasons for this but they stem from lack of understanding of the real causes of the problem by those who have been responsible for the programs and projects, (Reich *et al.,* 2001). Often, soil erosion has been seen as a problem in itself, rather than the symptom of bad land use and management. Soil-conservation programs have therefore tended to proceed very slowly unless farmers have been either forced or paid to participate, and the maintenance of conservation works has always presented a problem. Susceptible dry lands (arid, semi-arid, and sub-humid aridity zones), covering 43% of Africa, are the worst-affected areas, impacting 485 million people (Reich *et al.,* 2001). The current situation is undoubtedly worse. Soil moisture stress inherently constrains land productivity on 86% of soils in Africa (Eswaran *et al.,* 1997), but soil fertility degradation now places an additional serious human-induced limitation on productivity, (Eswaran *et al.,* 1997).

2.7 Constraints to Improvement of Soil fertility and Productivity

The future livelihoods of the world's poorest people will depend on the development and widespread adoption of practices aimed at restoring and sustaining the productivity and ecosystem service functions of Africa's soils, (Reich *et al.,* 2001). However, resource-poor land users cannot bring about this transformation by themselves. Support from the international community and governments of affected nations should be directed at building a science and technology platform that accelerates progress and learning towards achieving sustainable soil management in Africa, ((Reich *et al.,* 2001). Soil fertility is closely linked to soil organic matter (SOM), whose status depends on input, i.e., mainly biomass and output, i.e., mineralization, erosion and leaching. Preliminary results from runoff plots and on hill slopes in West Africa indicated that carbon losses by erosion and leaching ranged between 10 and 100 kg C ha^{-1} y^{-1} depending on annual rainfall and vegetal cover. Under natural conditions, losses may be low enough to be compensated by aerial deposits, (Reich *et al.,* 2001).

Together with mineralization, erosion can locally be an important cause of soil organic matter (SOM) decrease in cropping systems where there is poor soil cover, steep slopes and erosive rain conditions (FAO, 1984). "Without conservation measures on rain fed lands, soil erosion or loss by wind or water, salinisation or alkalinisation, depletion of plant nutrients and organic matter, deterioration of soil structure and pollution will lead to the loss of 544 million of cropland: losses of 10% in South America, 16.5% in Africa, 20% in Southwest Asia, 30% in Central America and 36% in Southeast Asia (FAO, 1984). Much of the remaining land will also lose fertility due to loss of top soil. The total loss in productivity on rain fed crop land will amount to a daunting 29%" (FAO, 1984).

2.8 Land degradation in sub-Saharan Africa

A major environmental hazard associated with agricultural production is soil degradation. Rapid population growth and economic needs push farmers to cultivate steeper and more fragile lands, resulting in an annual loss of 50 to 200 tons of topsoil (Garrity, 1995). As a consequence, farm productivity is reduced to 200 from 500 kilograms per hectare per year (Fujisaka *et al.,* 1995), and income levels of farm households fall to less than 50% of the poverty threshold level (Mercado *et al.,* 2000).

According to Hoekstra & Corbett (1995) SSA is among those sub-regions where land degradation is currently a severe problem affecting the productive performance of most land- use systems in the various ecological zones. Unfortunately this has tend to contradict each other and lack any systematic bases for more general conclusions.

Everywhere in the world people settle first in high-potential areas with fertile soils, adequate rainfall, and mild temperatures (Sanchez & Buol, 1975), such as parts of the highlands of eastern and Central Africa, the plateau of southern Africa, and some river basins in West Africa. The Lake Victoria Basin in East Africa is one example, and now supports one of the densest rural populations in the world, 500 to 1200 inhabitants per square km (Hoekstra & Corbett, 1995). Such settlements were first supported by the originally high soil fertility. As populations grew, this fertility was gradually depleted by crop-harvested, leaching, and soil erosion, when farmers were unable to sufficiently compensate these losses by returning nutrients to the soil via crop residues, manures, and mineral fertilizers (Shepherd & Soule, 1998).

Smallholder farmers also cultivate low-potential areas primarily in sub-humid and semiarid areas, where many of the sandy soils are naturally infertile. Still, the smaller soil nutrient stock is also being depleted in these areas (Pieri, 1989; Smaling, 1993; Sanders *et al.,* 1996).

Most researchers agree that soil fertility management has a serious impact on agricultural production. However, it is difficult to quantify the effect of the loss of a unit of soil on crop yield (Lal, 1987), because of lack of direct, clear-cut relationship between soil fertility loss and productivity. Moreover, soil is only one of the factors affecting productivity, as crop yield is a function of many variables (Perrens and Trustum, 1984).

The development and dissemination of sustainable soil conservation technologies for smallholder farming systems is a formidable task. Farmers who might use them generally have little investment capital and essentially have short investment horizons. Markets are often times inaccessible; transportation service is difficult and extension efforts are usually insufficient (Garrity, 1999). Successful natural resource management in these fragile lands rests on three fundamental pillars: technologies appropriate to resource-poor farmers; ii) strong community institutions and; iii) proactive government support. (Garrity, 1999).

Appropriate technologies enable farmers to sustain food production on their lands, and help them in their gradual evolution towards crop and/or livestock-based systems that provide better income and maintain environmental services. (Garrity, 1999).

Proactive and dynamic community institutions support effective participation of the rural population in taking decisions that impinge upon their livelihoods.

Local government institutions can provide financial, technical, facilitation and policy support required for effective natural resource management.

2.9 Conservation Agriculture as a Measure to Soil Fertility Improvement

Conservation Agriculture has been and continues to be tested and promoted as a promising solution to the problem of low agricultural productivity in Africa, (Dommen, 1988). In the opinion of Dommen (1988) conservation agriculture concept centers on three basic principles:

i) Minimizing soil disturbance;

ii) Maintaining a permanent soil cover, and

iii) Practicing crop rotations.

When combined with other good agronomic practices such as timely planting and effective weed, pest and disease management, Conservation Agriculture has shown to sustainably increase crop yields and to help mitigate the impacts of droughts. However, uptake of the technology by farmers in Africa remains low due to policy, technical, social and environmental constraints, for which solutions are urgently needed (Dommen, 1988).

Despite the key roles conservation practices plays in food security and income generation in Ghana, its yield potential has not been fully achieved. Subsequently this has led to stagnation/decline in food production. Despite the trend, the human population continues to increase causing frequent food shortages among different wealth classes. This has been partly attributed to soil degradation due to poor conservation measures.

According to Hassan, (1998) many farmers in African countries face declining crop yields, which has constrained economic growth. The underlying constraints are low and unreliable rainfall, pests and diseases, and inherently infertile soils. The soil infertility is related mainly to the low nutrient status of the soils. The qualities of some soils have declined as a result of continuous cultivation without returning enough nutrients to the soil. In the tropics, the maintenance and management of SOM are central to sustaining soil fertility on smallholder farms (Swift and Woomer, 1993; Woomer *et al.*, 1994). In low-input agricultural systems in the tropics, soil fertility management helps retain mineral nutrients (Nitrogen, Sulphur, micronutrients) (Swift and Woomer, 1993; Woomer *et al.*, 1994), in the soil and make them available to plants in small amounts over many years as soil organic matter is mineralized.

Soil organic matter increases soil flora and fauna (associated with soil aggregation, improved infiltration of water and reduced soil erosion), increases the buffering capacity on low-activity clay soils, and increases water-holding capacity (Woomer *et al.*, 1994). Current soil organic matter inputs are insufficient to maintain organic matter levels in tropical agricultural soils. Continuous cropping, with its associated tillage practices, provokes an initial rapid decline in SOM, which then stabilizes at a low level (Woomer *et al.*, 1994).

The conventional mechanisms for addressing losses of SOM in tropical, rainfed, low-input systems are fallowing, rotations (especially involving legumes), the addition of animal manures, forms of intercropping (including intercropping with hedgerow legumes), and reduced tillage. For instance, it is estimated that in Burkina Faso, stone bunds alone increase sorghum yields on very degraded soil from 350 kg/ha to 515 kg/ha and that yields could be further increased to 630 kg/ha by adding 1.7 ton/ha of organic manure, to 700 kg/ha by adding 150 kg/ha of inorganic fertilizers and to 850 kg/ha by adding both (Mando, 2000). In the case of Ghana, Convey and Tutu (1992) estimated that bad practices and nutrient depletion cause annual production losses of about 5 percent of AgGDP, and Drechsel and Gyiele (1999) provided a similar assessment.

2.10 Approaches for Managing Soil Fertility

Essentially two approaches can be used in managing soil fertility (Sanchez, 1995). The best known approach, used in producing most of the world's food, involves overcoming soil constraints to meeting plant requirements through the application of purchased inputs. In fact, much of the increase in crop yields in developing countries since the Green Revolution, especially in Latin America and Asia, can be attributed to the purchased inputs used by greater numbers of farmers (Pinstrup-Andersen, 1994). The second approach relies more on biological processes to optimise nutrient cycling, minimise the use of external inputs, and maximise the efficiency of input use. The understanding of the principles underlying this second, more complex approach is not well developed, and knowledge gained in temperate areas may be inappropriate for smallholder agriculture in the tropics. The solution may lie in developing combinations of various techniques: manuring and composting a part of the residues, agroforestry, mulching, weeds and leguminous cover-crop management (with herbicides). A supplementation of mineral fertilizers directly available for crops improves soil organic matter management and increases available biomass (Ouma, *et al.,* 2002; Yesuf and Köhlin, 2008).

Where animals are few, farmers turn to other sources of SOM. Leaf litter from trees can make significant contributions in areas close to woodlands, but as population grows, the deforestation associated with the demand for a rabble land, building material, and fuel works against this option. Although composted crop residues are used in wetter areas and where crop biomass production is relatively high, composts are rarely sufficient for more than a modest part of the cultivated area, and, like manures, their quality is often poor. These technologies require substantial labor from farmers (Huchu and Sithole, 1994; Carter 1993). The reality is that organic matter is rarely sufficient to maintain soil organic matter, and in marginal areas where rainfall is low it is impossible to grow enough biomass to maintain SOM. Furthermore, the productivity boost that smallholders need cannot be supplied by organic manures alone. The use of manures will need to be combined with the judicious use of chemical fertilizers, improved pest and weed management techniques, and the use of high-yielding crop varieties.

More recently, researchers discovered that burning is probably a part of the natural functioning of Mediterranean ecosystems, and that, in Africa and Asia, burning is a complex strategy to transform the natural conditions into more useful agro-pastoral systems (Levang, 1984). Without burning, large parts of African savannas would be presently under dry forest. Burning is often the only way for poor farmers to clear the land, decrease the pressure of pests, increase available phosphorus, cations and pH, and reduces aluminum toxicity in acid soils (Jurion and 2-Henry, 1967; Moreau, 1993; Moreau *et al.,* 1998). However, 40–60% of the carbon and 30–50% of the nutrients from the grazed biomass do not return to the soil (Roose, 1996). In addition, available biomass for grazing in Africa allows the manuring of 10–30% only of the cropped fields; soil organic matter cannot significantly be increased by such a limited application.

The traditional long fallow is very efficient in restoring biological, chemical and physical properties of the topsoil (Greenland and Nye, 1959; Floret and Serpantié, 2000), but it is frequently no longer possible to wait 10–50 years between two cropping cycles, due to population pressure. Expanding cropped areas is difficult in many parts of Africa, where often less than 30% of the land surface is suitable for cropping.

Three solutions seem technically possible to improve fallows: *tree fallows* (leguminous bushes) with intercropping (Harmand, 1998); *short fallows* of natural weeds between crops managed with herbicides, to produce a litter mulch for no-till cropping; *short legume fallows*, which are presently under extension in Latin America and in an experimental phase in Africa (Azontonde, 2000; Sanchez, 1999). In sub-equatorial areas, short legume fallows are effective for maintaining both SOM levels and grain yields (Azontonde, 2000).

2.11 Effects of Low Soil Fertility on Humans

According to Bekunda, Bationo and Ssali (1997), soil fertility decline is not just a problem of nutrient deficiency, but also a problem of physical and biological degradation of soils, of inappropriate crop varieties and cropping systems, and of pests and diseases. Low soil fertility as a result of land degradation leads to poverty, but the problem of land degradation is the failure of often perverse national and global policies, and institutional failures (Bekunda *et al.,* 1997).

Also, Bekunda *et al.* asserts that nutrient depletion produces negative on-farm side effects and exacerbates several off-farm effects or externalities. The on-farm effects are identified as: less fodder for cattle, less fuel wood for cooking, less crop residues and animal manure. It is pointed out that these effects often increase runoff and erosion losses because there is less plant cover to protect the soils.

Sandy soils with characteristics low organic matter and its low fertility, topsoil structure may collapse and this results in soil compaction or surface sealing which reduces crop yields, and eventual creates problem of food insecurity- more famine relief- and reduced farmers revenue; as a result of higher food prices, and increased farmers expenditures on health (Bekunda *et al.,1997*). Also, Delgado *et al.* (1994) intimate that soil nutrient depletion lowers the returns to agricultural investment, which reduces nonfarm incomes at the community level through multiplier effects. According to Delgado *et al.* as long as returns to agriculture are limited by nutrient depletion, farm employment and spillover nonfarm employment opportunities will remain low. They assert that the consequence is severe poverty. They also said the negative effects of low soil productivity are not confined to rural communities, because poverty often pushes individuals and households into urban areas.

Low soil fertility relates to food inadequacy at the household levels, and the phenomenon leads to malnutrition. According to Pelletier *et al.* (1995) malnutrition is a major factor in over 54% of deaths of children under 5 worldwide, and that the percentage is even higher in SSA than the global average. In the opinion of Caulfield *et al.* (2004) and Villamor *et al.*(2005) most of the deaths are not due to famine but to malnutrition, which is linked to infectious diseases that are widely recognised as the underlying cause of mortality. They point out that low soil fertility lies at the heart of malnutrition, because of the little incentive for farmers to invest in new germ plasm once soils are degraded.

Apart from low food production, inadequate soil management has serious consequences for other natural resources essential to African livelihoods and development. Water for example, increased sediment loads; degrade the quality of surface water, which may harm fisheries as well as water supplies for people and animals, in turn leading to health problems (Bekunda *et al.,1997*). According to Oldeman, (1994), the Global Land Assessment of Degradation based on expert opinion indicates that human-induced degradation of soils in Africa was already extensive by 1990, involving several processes. The areas affected were estimated at 46% by water erosion, 38% by wind erosion, 12% by chemical degradation, and 4% by physical degradation. Oldeman asserts that these effects are critical because people depend on soil to provide a wide range of essential 'ecosystem services', and that they include support to food production, water cycle, biological regulation of pests and diseases, regulation of major greenhouse gases such as carbon dioxide and methane, serving as a rich source of medicines, and other biochemical present in soil organisms.

2.12 Organic/Biosolid Wastes and the Environment

Waste from human activities especially from agriculture may be nuisance. For instance, The US Environmental Protection Agency (USEPA) estimated that animal waste production in 1992 was 13 times greater on a dry weight basis than human production. It then creates problem of waste disposal and its attendance insanitation. According to USEPA (1998) large-scale confined animal feeding operations are a source of agricultural pollution and pose risks to water quality and public health due to the large amount of manure generated.

Fortunately, these waste animals waste are biodegraded and therefore are sources of nutrients to soil if applied on farmlands. Although, pollution of surface flow and ground water from animal waste applied to soils has been documented (Gagliardi and Karns, 2002), and they invariably contaminate drinking water or water used for recreational activities, thereby become conduit of disease transmission (Entry, Bjorneberg and Verwey,2010).

The harmful effects of these agricultural wastes can be mitigated by using them as organic manure to restore degraded lands that have low levels of organic matter and soil fertility. According to McGeehan (2012), waste materials, and materials derived from wastes, possess many characteristics that can improve soil fertility and enhance crop performance. Also, McGeehan opines that the waste materials can be particularly useful as amendments to severely degraded soils associated with mining activities, and as soil amendments, waste materials have received increased attention in recent years. In the view of McGeehan, adding waste materials to soils can be viewed as serving a dual purpose:

- for disposal of solid waste from municipalities and agricultural operations, and
- as a means to improve chemical and physical soil properties which in turn promotes improved crop performance.

For example, applications of composted municipal solid waste and composted crop residues were shown to increase soil fertility and improve structural stability in agricultural soils (Tejada, Hernandez and Garcia, 2009). Similarly, municipal biosolids have been used to improve soil chemical and physical properties in numerous studies (Li, Chaney, Siebielec, and Kerschner, 2000). These positive effects of waste materials especially agricultural operations waste such as crop residues, and farm animal manure create the platform to turn bad material into useful purpose; increasing crop productivity, and securing food security.

2.13 Conclusion

Despite the huge amounts of money being spent by governments on organic matter management due to its negative effects on the environment, waste materials, most especially from agricultural operations become a valuable material if it is managed in such a way that it decomposes on farmlands. This action would avoid the high financial investments associated with policies formulation, and enforcement of laws in waste management. The proper use of farm waste materials such as animal droppings and crop residues as farm manure becomes conduit for poverty alleviation and enhancement of food security, and prevention of diseases that result from malnutrition.

CHAPTER THREE

3.0 Methodology

3.1 Introduction

This chapter gives the rationale for the choice of the study area and a brief description of the area. It covers the sampling schemes and procedures, Also, this section points out the methods or procedures that were used for the data collection, and in analysing the data.

3.2 Brief Description of the Study Area

3.2.1 Location and size

The Municipality is located in the eastern corridor of the Northern Region of the Republic of Ghana between Latitude 90 – 350 North and 00 – 300 West and 00 – 150 East. The Greenwich Meridian thus passes through a number of settlements – Yendi, Bago, Laatam, Lumpua, Gbetobu, Gbungbaliga and Nakpachei.

The municipal ranks sixth (6th) in the Region in terms of surface area with a landmass of 5350sqkm. The Municipal shares boundaries with 8 districts:to the East – Saboba/Chereponi and Zabzugu/Tatale, to the South – Nanumba North and East Gonja, to the West – Tamale Municipality and Savelugu/Nanton, and to the North – Gushegu and Karaga.

Farming is the main source of livelihood for majority of the people in the district. Figure 3.1 shows the location of the district. About 85% of the population of the district are into agriculture; engaged in the cultivation and production of food crops. However, yam is the dominant crop which is sometimes rotated with cowpea, maize and sorghum. Around and near the homesteads, maize is grown which serves as a source of the staple food for most farmers. The main farming system is rainfed mixed cropping on permanent farm lands and livestock production. It is estimated that 50% of the cultivated area is prepared by tractors, 40% by hand and 10% by bullocks. In view of the nature of the lands, the usage of tractors is seen on most farms and distant farming is dominant in the district. It is estimated that 70% of farm holdings are owned by men and 30% by women. Farm holdings range between 0.8-3.5 ha with about 48% of farming population owning 0.8 ha.

Principal crops grown are maize, yam, sorghum, groundnuts, cowpea, and soybean. Dry season farming is not predominant due to inadequate water bodies in the study area. Livestock ownership in the district is important as farmers keep them as source of investment to meet cash needs of the family and also against food insecurity. Animals kept include cattle, goats, sheep, pigs and poultry; they are useful for traditional religious sacrifices and to promote family prestige. The droppings are sometimes used as manure. The sector's development potential is constrained by factors such as inadequate feeding and water resources in the dry season, low patronage of available animal health practices, amongst others.

3 .2.2 Relief and drainage of the area

The municipality is endowed with a number of rivers and streams, the most important of which is the Oti Rivers. The streams and rivers exhibit a dendritic pattern, which forms the Oti basin. The relief and drainage systems favour the development of fish farming, cultivation of valley bottom rice and dry season vegetables.

The traditional method of farming, which involves the slash and burn, coupled with indiscriminate burning of bush by unscrupulous people during the long dry season (harmattan) exist in the district. These actions lead to the depletion of soil nutrients and low agricultural yields in the district. Furthermore, the destructive nature of bushfires results in loss of farms and forest, thereby leading to loss of income and properties to individual farmers and the district as a whole.

The topography of the municipality is basically undulating with few hills, which provide a good flow for run-off water. The District is underlain by Voltain rocks normally suitable for rural water supply – boreholes. The soils are quite good along valleys.

During the raining season, water normally drains to the Oti River, as well as dams and streams present in the district. There are although many incidences of large quantities of water that collects on road sides, washing roads out or pooling to prevent proper transportation.

3.2.3 Geology of the area

The geology of the study area is essentially Voltaian sandstones, giving easily worked light soils but prone to concretions and hardpan (Junner & Hirst 1946; Runge-Metzger 1993). The granites have both a greater concentration of nutrients and better retention of precipitation. The ochrosols which form on top it are less prone to erosion than the sandy soils forming on the sandstones. Valley bottoms concentrate hydromorphic soils and cultivation of both rice and other horticultural crops is possible. Actual soil fertility is determined as much by the exceptional concentrations of population allied with a low-input farming system. There are virtually no elements of the system that encourage the return of nutrients to the soil. Livestock roam freely in the dry season, but in the wet season they are taken away from the farms to avoid damage to crops and the manure is effectively lost.

3.2.4 Soils and Soils Typology

Basically, sedimentary rocks of predominantly voltarian sandstone, shales and mudstones. The soils derived from the above parent materials range from laterite, ochrosols, sandy soils, alluvial soils and clay. The organic content is low and is increasingly worsened by the extensive bush burning and bad agricultural practices. This to a large extent accounts for the low yield per acre and its consequent food shortage during the dry or lean season in the Municipal.

Firewood is so short that the stems of cereals are removed from the farms and used to cook food, thus not returning their organic matter. The elimination of almost all types of ground cover leaves the area prone to wind erosion.

3.2.5 Climate/Climatic Conditions

Mean annual rainfall for the Municipal is (January- December) – 1,125mm. Mean wet season rainfall for the Municipal is (April-October) 1,150 mm. Mean dry season rainfall (November – March) 75mm. Mean annual deficit is between 500 mm and 600 mm. Rainfall is seasonal and unreliable.

Temperature ranges between 21°C- 36°C giving rise to high temperature range. The vegetation is of the tree savannah type in areas not affected by settlements and farming activities. The degraded savannah type of vegetation is found around settlements and heavily cultivated areas.

The rampant and extensive bush burning is having a marked effect on the Vegetation and consequently the climate.

High temperatures make the environment uncomfortable for both biotic and a biotic organisms to function effectively. Economic trees in the Municipal include ubiquitous Shea trees, Dawadawa, Mango and Cashew.

3.2.6 Vegetation type

The usual description of the vegetation is Guinea savannah in the Northern Region, grading into Sudan savanna in the semi-arid region of the Yendi municipality. The dominant tree species are locust ('dawadawa') (*Parkia biglobosa*), shea (*Vitellaria paradoxa*) and kapok (*Ceiba pentandra*) with a ground cover of perennial grasses such as *Andropogon gayanus.* Further north, the baobab (*Adansonia digitata*) and whitethorn (*Faidherbia albida*) become predominate.

However, much of the area is an example of an extreme anthropogenic landscape. The natural tree fauna has been severely depleted. The bush fires that are set every year reduce all the large trees so that even in remote areas, the vegetation may consist of young trees. The only exceptions to this are the sacred groves attached to most villages in the municipality; these retain a variety of species (Aubréville 1939; Adam 1948 ;). These groves still maintain considerable diversity of both wildlife and vegetation, but they are under threat, with farmers encroaching on their boundaries every year as well as annual bush fires.

3.3 Land based livelihood activities

Households in the study villages engage in farm or/and non-farm activities or eventually out migrate. The farm sector comprises field cultivation, animal rearing, and gardens during the dry season and irrigation plots. The non-farm sector is composed of all non-agricultural activities such as employment sources in public and private spheres, self-employment in trading and manufacturing, and the extraction of natural resources.

Livelihoods in the study villages are regulated by the dry and the wet seasons, with the wet season being the domain for farm activities, while the dry season abounds with non-farm activities. Qualitative interviews showed that in the 1970s most households only engaged in natural resource gathering activities for noncommercial purposes during the dry season. This trend has changed, as most households are now busy during the dry season gathering fuel wood, burning charcoal and gathering wild fruits for sale in the urban and village markets. Pushed to the margins of excruciating poverty household members out-migrate to the south of the country in search of farm work or menial work in urban areas.

Livelihood activities are used in different intensities and combinations according to the wealth status of the household and its environmental resources. A livelihood in the Kpatia community is built on prioritizing a balance between income and expenditure of the household and the individual. There has been a concentration on farming and natural resource related income-earning activities to meet the rising expenditure patterns imposed by current economic policies. A historical overview of Ghana's economic path from the early 1980s is appropriate in understanding the livelihoods portfolios and orientations of peasants.

Population pressure has led to land fragmentation that causes continuous cropping with variable or no use of fertilizers. Land ownership in the area is highly unequal showing the destitute with no lands while small percentage of households own over six acres. Almost 90% of lands around the villages are cultivated continuously (focus group discussions), reflecting shortage of lands due to the high population density of 126 people per square kilometer.

With the decline of both crop yields and real prices of crops, the need to increase income from other activities to enable them buy imported food and pay for public services has led to concomitant surges in investments in livestock rearing, commercial harvesting of fuel wood, fishing, hunting, and arts and crafts that rely on natural resource harvesting. Other income-generating activities that did not directly result from natural resources include retail services, beer (pito) brewing, weaving, selling cooked food and white-collar jobs.

Declining soil fertility is reflected in the falling yields of major staples such as millet (reported during focus group discussions in both villages). Farmers switch to crops such as cowpeas and groundnuts that require less fertilizer and which also have high commercial values and yields to compensate for cost of fertilizing. The result of the pressure on land is the reduction in soil fertility. This is identified as the most devastating form of land degradation and blamed directly for the growing poverty among peasants.

3.4 Demographic Characteristics

The population of the municipality is 155,000 and is varied in terms of ethnicity with the Dagombas constituting the majority. The other ethnic groups include Kukombas, Akan, Ewe, Basare, Moshie, Chokosi and Hausa. The population is largely rural. About 62% live in the rural areas while 37.4% are in towns. The population growth rate is approximately 2.9% per annum. Out of the total, 75,950 and 79,050 constitute the population of males and females respectively. Additionally, 96,100 live in rural communities while 58,900 live in urban centres. There are fourteen (14) Villages and Three hundred and thirty six (336) communities. The main religious groupings are Moslems, Christians and Traditionalist. Migration pattern is more pronounced among the youth and especially female girls who basically travel down south to engage in 'Kayaye'. Out migration by young girls exposes them to all forms of sexual abuse and low female school enrolment.

Figure 3:1 Map of Yendi Municipality; Source: Yendi Municipal Assembly (2011)

The study was carried out in Kulkpanga, Kpatia and Gundogu communities. However, the climatic condition is generally semi-arid. The mean annual rainfall ranges between 801-1,600 mm. The rainy season extends from April to October followed by a long dry season from November to March. The heaviest thunder storm occurs in August, whilst dry episodes are common in June causing crop stress.

The topography of the district is fairly undulated with occasional hillocks in some places with a variety of soil types, e.g. gravelly soils, located in very thin upper stratum in the uplands. Sandy loams the intermediate stratum between the lowlands and uplands, characterised by the presence of vigorous natural regrowth dominated by shea trees.

Under customary tenure, land is passed from parents to children, although in some cases village authorities may allocate land to other people who seek a place to farm. In the formal legislative terms, all land belong to the state and thus there is some certainty regarding the rights and responsibilities of local people, their ability both to control access to their land and to solve conflicts between different land users. Yendi district has a population of 160,263 people with 383 villages (Yendi Municipality Assembly, 2011) .The population density is 24 persons/sq km, with relatively high unemployment rate of 40%. The annual temperature varies within the range of 23°C-35°C. The elevation ranges between 1500-3000 meters above sea level and the slopes ranges from nearly flat to a gradual steep. (Yendi Municipal Assembly, 2011)

3.5 Sampling

The study district was purposively sampled due to its long history of SMC programmes. Although, twenty-five (25) major farming communities were identified, only three of them- Kulkpanga, Kpatia and Gundogu- were also purposively selected for the survey. Farmers in these communities have been exposed to many farming technologies transfer through interventions by EPDRA-Yendi which aims at improving farmers' productivity.

Simple random sampling of identified farmers was done by the use of Statistical Package for Social Sciences (SPSS) to select fifty respondents from the farmers in the communities.

3.6 Pre-testing of Measuring Instrument

The questionnaires for the survey were pre-tested in the three study communities with ten randomly selected farmers. This was done after the research assistants were accordingly trained on what to conduct face-to-face interview.

After the pre-testing the gaps that were identified with regard to how to appropriately achieve the needed data for a given variable were according fixed.

3.7 Methods of Data Collection

The farmers who were research participants were informed about the purpose of this study so as to build up trust, and for them to give out the needed information during the survey. The survey was conducted by the use of face-to-face interview of the respondents with structured questionnaires. The research assistants also critically observed peculiar features of farms such crops types and their yield characteristics, and agronomic practices and noted them down during the questionnaires administration.

Also, focus groups discussions were held with farmers' groups, and development agents. These groups' discussions helped to acquire useful and additional detailed information which would have been difficult to collect through the questionnaires administration only. The discussions with the farmers and with the change agents provided a forum where they openly expressed their opinions and views regarding the issues under study. The field work took nine days to complete.

3.8 Analysing and Presenting the Data

The data were analysed by the use of SPSS and Microsoft Excel pieces of software.

The results from the data were mainly descriptive statistics and frequencies distributions. They were presented in the form of either tables or figures. The mainly qualitative data that were obtained from the groups discussions were used to verify and supplement the data from the structured questionnaires.

CHAPTER FOUR

4.0 Results and Discussions

4.1 Socio-Economic Characteristics of Respondents

4.1.1 Age Distribution

Age groups of respondents were youth (20-40 years), (50 %); middle age (41-60 years), (37.5%) and old age (> 60 years) (12.5%) (Figure 4:1).

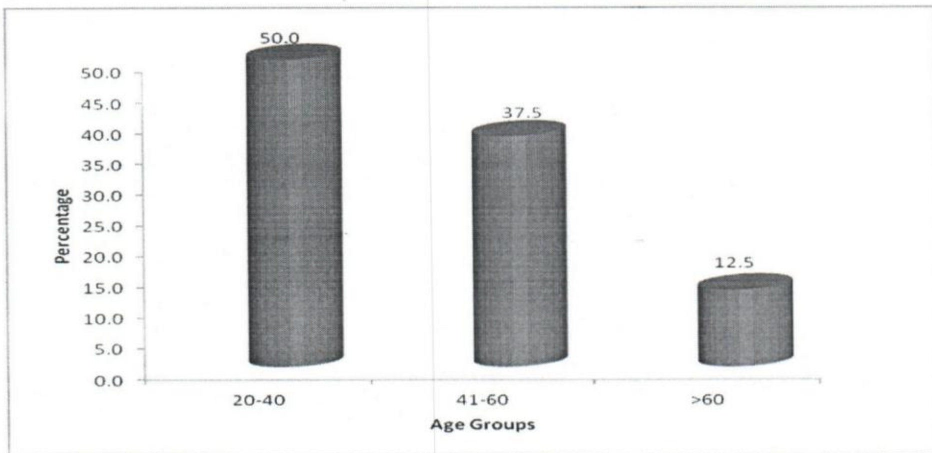

Figure 4:1 Age Distribution of Respondents: Source: Field survey (2011)

The age distribution was characterized by a high number of young people (20-40 years) and a low number of old-age people (> 60years). Generally, there were more young people than older people probably due to poor health care that would have led to the earlier death of the aged.

In most Ghanaian rural areas, the main sources of labour are the family members, including wife and children. Most of the respondents in the study area (87.5%) belong to the young and the middle-aged groups suggesting a large labour force for agricultural activities, a potential for increased food production. According to the study, these farmers have better understanding of soil erosion due to more access to information in the area, and as a result, they are more interested in applying the knowledge they acquired from soil and water conservation in their farms. They have the potential with this labour force to increase food production within the district and can easily accept new technologies. As indicated in Figure 4.1 a proportion of 12.5% of old farmers may be a cause of labour shortage which would hinder soil and water conservation measures. Moreover these farmers were observed to be conservative and stick to their traditional ways of farming which does not support soil fertility improvement even though there is abundance labour force. This therefore means that increase in food production will decline due to old age, and being conservative does not give them the opportunity to adopt new technologies that can support increased production.

4.1.2 Education level of respondents

As shown in Figure 4.2 three education level groups were identified to include basic (7 %), secondary (6 %) and tertiary (0%). The respondents without formal education formed 87 %.

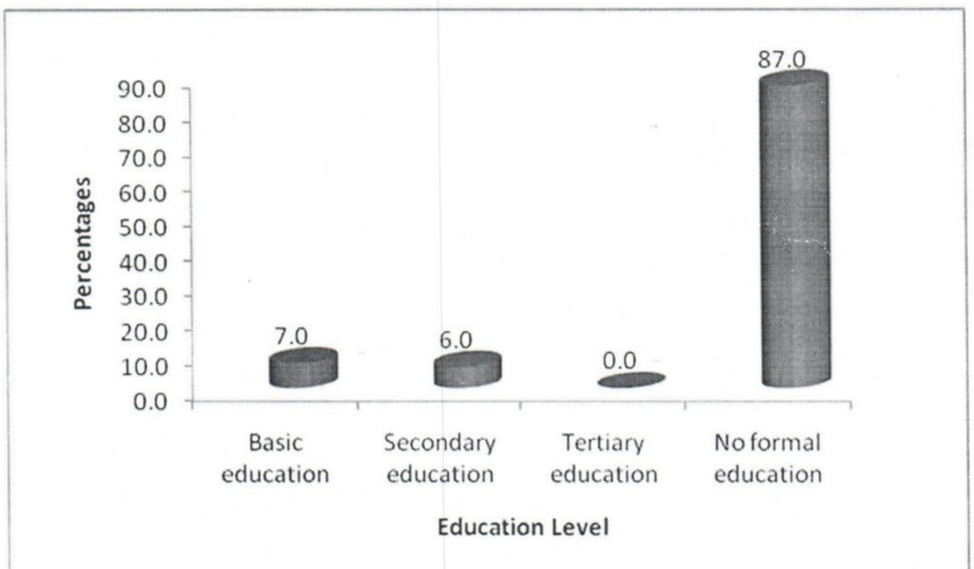

Figure 4:2 Educational Levels of Respondents; Source: Field survey (2011)

The majority of respondents being without formal education may affect negatively their access to information and usage of technologies about soil and water conservation. From the survey results, respondents with formal education status have a more realistic perception about soil erosion and conservation problems, more knowledge related to SWC and thus can more easily be involved in conservation activities. Higher numbers of respondents in Kpatia were more formally educated. This could be attributed to Kpatia being near to Yendi (12 kilometers), the district capital, which has relatively many schools.

4.1.3 Source of farm labour and Occupations

The main source of labour for farm work is family labour. The average size of families for Kulkpanga, Gundogu and Kpatia were 6, 6 and 7 respectively.

Some respondents (42%) were involved in various forms of off-farm activities, such as carpentry and collecting and selling of fire wood as mentioned by community members. Off-farm activities by some respondents may imply, no sufficient time and labour for soil and water conservation technologies.

In general, the relationship between off-farm employment and adoption performance of soil and water conservation is poorly understood (Kessler, 2006). Off-farm activities may have a negative effect on the adoption behaviour of SWC due to reduced labour availability. When the farmer and family members are more involved in off-farm activities, the time spent on their farms will be limited thus discouraging them from being involved in construction and maintenance of SWC structures. On the other hand, off-farm activities can be a source of income and might encourage investment in farming and SWC.

4.2 Indigenous Soil Fertility and Conservation Practices

4.2.1 Cropping Systems Practised by Farmers

Farmers in the study area use a number of traditional and improved soil and water conservation technologies. That includes application of manure, traditional and newly introduced cut-off drains, plantations of both traditional and newly introduced trees, stone bunds, leaving crop residues in the field and practicing land fallowing on the farm.

Various major soil and water conservation practices (traditional and improved) have been identified by the local development agent in the study area within the previous two years.

Cropping system may be used as a SWC measure by a crop farmer. When the respondents were higher proportion (about 43%) of the respondents indicated that they practised mixed cropping about 33% of them did mixed and sole-cropping while about 25% engaged in sole-cropping (Figure 4:3).

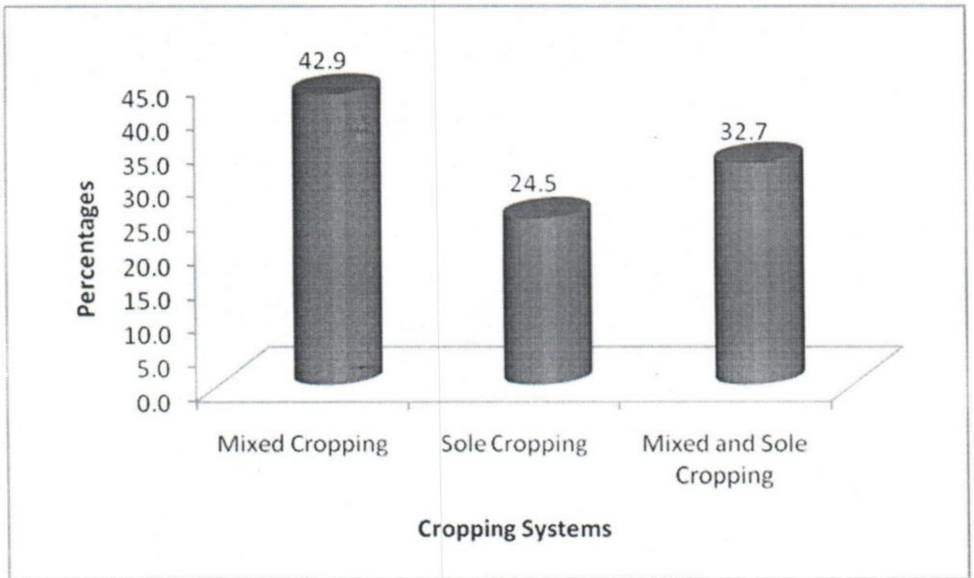

Figure 4:3 Methods of Cropping; Source: Field survey (2011)

The respondents intimated that mixed-cropping was done so as to guard against limited rainfall which could have adverse effect on any one type of crop in terms of growth and yield. According to Boli *et al*.(1993) and Lal (1975) reported that due to financial difficulties, crop farmers could not buy chemical fertilizers to help improve upon the soil fertility, so they inter cropped with that could fix atmospheric nitrogen for the benefit of non-leguminous. This is in line with the findings of (Gebremedhin, B., Swinton, S. M., 2003).

The respondents indicated that they sowed sorghum with groundnuts, and groundnuts with maize when practicing mixed cropping. The respondents who practised sole-cropping said that certain lands have low fertility and so they had to grow a sole crop usually leguminous crop such as cowpea or and soybeans to help improve the fertility and for better crop yield; but lands that they had applied organic manure, the fertility level improves, so they grow more than one crop on such lands.

Some of the respondents indicated that, to achieve food security, it was wise for a farmer to do mixed cropping due to draughts or other reasons that could bring about poor crop performance while others said, it was better to grow sole crop instead of mixed cropping so that the yield could be increased about 25% of the farmers indicated that they practice sole cropping and their reasons were that when they followed the recommended practices and the use of manure or chemical fertilizers, the yield that would be obtained from the farm is as good as a farmer practicing mixed cropping. Farmers practicing sole cropping also said they normally grow most of the cash crops as a sole crop.

4.2.2 Non-Burning of Crop Residues

Burning is a widespread traditional strategy for clearing large areas of biomass, for grazing and cropping purposes (Levang, 1984). The difficulty in cropping in areas of high organic residues and the lack of knowledge about the negative impacts of burning of organic matter makes it a common practice among crop farmers. Burning of debris on farmlands militates against SWC measures.

As indicated in Table 4:1 a higher percentage (about 47) of the respondents indicated that they would not burn crop residues because the practice damaged farmland mainly by reducing soil fertility. Their opinion is supported by FAO (1974) and Roose (1978) who asserted that burning of farmlands resulted in decreased biodiversity especially in the number of tree species; rapid mineralisation of biomass, most especially in the topsoil; emission of gases, ashes and dust, and subsequent soil erosion.

The second majority of the respondents (about 15%) intimated that crop residues were feed for ruminants and for that matter they would desist from burning them. Also the third popular opinion among the respondents was that the crop residues were source of fuel for domestic use.

Table 4:1 Reasons for non-burning of Crop Residues

Reasons	Frequency	Percentage
Lowers soil fertility	70	46.7
Serve as fuel for domestic cooking	17	11.3
Serve as feed for ruminants	22	14.7
Total	**150**	**100**

Source: Field Survey (2011)

However, the respondents also mentioned that burning decreases the pressure of pests on their farms, but they were also quick to add that for better crop yields, it was better not to burn. During group discussions, some respondents who practiced growing of a leguminous crop that is meant for soil fertility improvement e. g mucuna mentioned that decomposed crops residues on farmlands led to high moisture retention of soils and accordingly improved soil fertility for higher crop yields, unlike farmlands which had their crop organic matter burnt. According to the respondents, burnt farmlands encouraged run-off which resulted in soil erosion. Also, the respondents mentioned that pasture was lacking for their ruminants so they left the crop residues as animal feed. Some respondents expressed the opinion that since their wives used the crops residues as fuel they need not burn them, and that the organic matter attracted termites which were in turn used in feeding their local poultry.

4.2.3 Crop Residues Management

As shown in Figure 4:4 the majority of respondents (83%) indicated that they leave their crop residues on the farmland to decompose while probably as a matter of necessity the remaining (about 17%) fed the crop residues to their farm animals. According to the respondents who leave crop residues on farmland to decompose; decomposing makes the soil loose, resulting in better soil aeration and soil nutrients availability to crops/plants.

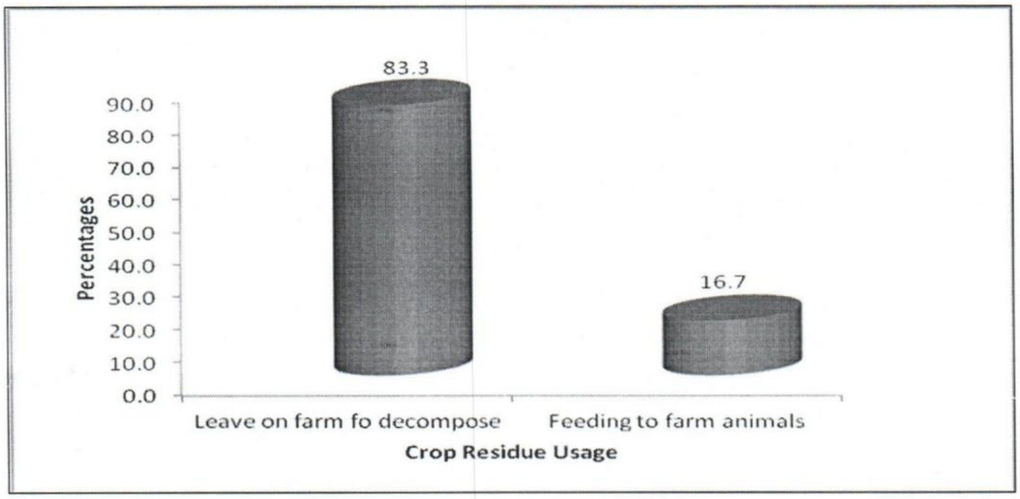

Figure 4:4 Ways of Crop Residue Usage; Source: Field survey (2011)

Some of the respondents as shown in Figure 4:5 indicated that they leave the crop residue on the farm for the purpose of using it to feed their animals in order to generate more animal manure. Nutrient content in animal manure is low as compared to that of crop residues. The commonly used dry animal manure is of poor quality as it has lost most of its N and K, contains pests, diseases and weed seeds in the dung (Swinton, 2003), as faeces are not heated up sufficiently to kill these contaminants. Good quality manure is rare in Africa, but its positive influence on yields, its slow release of nutrients and positive effects on pH and other soil properties are well documented as indicated by (FAO, 1975; Shaxson, 1999). However, 40–60% of the carbon and 30–50% of the nutrients from the grazed biomass do not return to the soil as indicated by (Roose, 1996). In addition, available biomass for grazing on farm lands allows the manuring of 10–30% only of the cropped fields. Farmers indicated that they also use the crop residues as bedding for their cattle, sheep and goats during the wet season of the year due to moist ground. This is also done to increase the volume of the material to be decomposed as animals lie on the crop residue and urinate on the bedding. They added that, the residue absorbs the water and the urine of the animals which is later collected and spread on their farms to improve the soil fertility after decomposition. Similar results were found by Amsalu (2006).

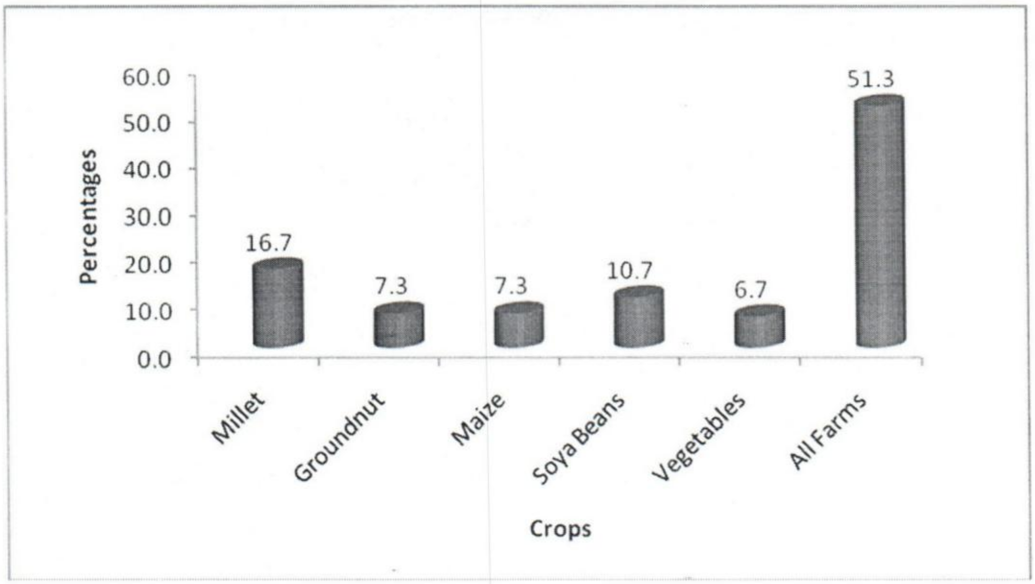

Figure 4:5 Manure Usage on Crops

4.2.4 Use of Manure for Soil Fertility Improvement and Conservation

Farmers in the study area testified that there is deterioration of soil fertility and attributed this problem to continuous cultivation, fragmentation and consequently erosion. The respondents also reiterated that sometimes they supplemented organic manure with mineral fertilizers in order to improve the soil fertility, the need for organic matter application to farmlands stems from the fact that every country in Africa has a negative nutrient balance in its soils and it causes poor crop yields/growth (Eswaran *et al*., 1997). This is in line with the findings of (FAO, 1975; Shaxson, 1999).

4.2.5 Soil Fertility and Conservation Improvement Technology Adapted by Farmers

Crop rotation, non-burning of crop residues on their farms, land fallowing, growing of leguminous crops such as mucuna, groundnuts, soybeans and cowpea as well as planting of crotalaria and vertiva along land boundaries to check runoff where soil fertility and conservation improvement technologies adopted by farmers. Use of fallow and manure is very low in the study area. This is an indication that farmers probably heavily depended on the use of commercial fertilizers. Those farmers who applied fallowing for soil fertility restoration reported a time span of 1-6 years before the land is used for crop production.

Farmers interviewed did not burn their crop residues but used them as in-situ mulch. Some of the farmers planted legumes such as soybeans, groundnuts, crotalaria, cowpea and *Cajanus Cajan* as a way of improving soil fertility, others practiced land fallowing and composting using crop residue and animal manure which were spread over the field before ploughing and planting is done. Some farmers also indicated that they normally ploughed across slopping lands during the farming season to retain water after it had rained. The farmers mentioned that by doing this, the top soils are not washed away during heavy rains and this does not allow manure that has been applied to be washed away. This also gives opportunity for the gradual percolation of water into the soil without any harm being caused to the soils.

Fifteen percent of the respondents said they practiced non- burning because they have been educated by the agricultural extension staff that burning of their crop residues reduces the soil fertility.

Another conservation practice common in the area of study is the broadcast of crotalaria seed before the maize crop tassels or three weeks after planting of the maize. By this practice, after the harvest of the maize, the crotalaria plant is allowed to grow to maturity so that at the beginning of another farming season, the crop is ploughed back into the soil as green manure.

During a transect walk with respondents, it was realized that almost all farmers in the communities were practicing crop rotation because through their own observation, yields of crops starts to decline after three to five years of continuous use of the same piece of land. During discussions with the farmers, it was observed that the farmers had problems with land acquisition due to population growth, forcing farmers to abandon the practice of crop rotation.

At Gundogu and Kulkpanga, majority of farmers practiced shifting cultivation and the use of rice straw which is not practiced at Kpatia as adopted methods for improving soil fertility. In the above mentioned two communities, farmers have enough land to practice shifting cultivation, which is not the case in Kpatia. The use of rice straw is part of the process of making compost, but in Kpatia, farmers use only animal manure and household refuse in making compost, but land fallowing cuts across the three communities because fallowing is a traditional practice of leaving the land out of production for 1-6 years for the purpose of restoring soil fertility and minimizing soil loss. During discussions with the farmers it was learnt that with time, fallow periods became very short and rare in the area as a result of the high population pressure on residential land usage. Beshah, T. (2003) found similar results if Ethiopia where yields of farmers are declining due to population pressure.

4.3 Effects of Soil Fertility and Conservation

4.3.1 Reduction of Soil Loss

Methods of reducing soil loss vary in Ghana. Many respondents said that extension agents from MoFA thought them ways of reducing soil loss. As indicated in Figure 4:6 about 54% of the respondents indicated that they grow cover crops such as (mucuna) which provide protection against the impact of raindrops on the soil which lead to soil erosion, other farmers also observed that cover cropping restricts the growth of weeds and the competition for soil nutrients because leguminous crops used as cover crops fix atmospheric nitrogen into soil, some farmers also mentioned that the cover crops improve water holding capacity of the soil.

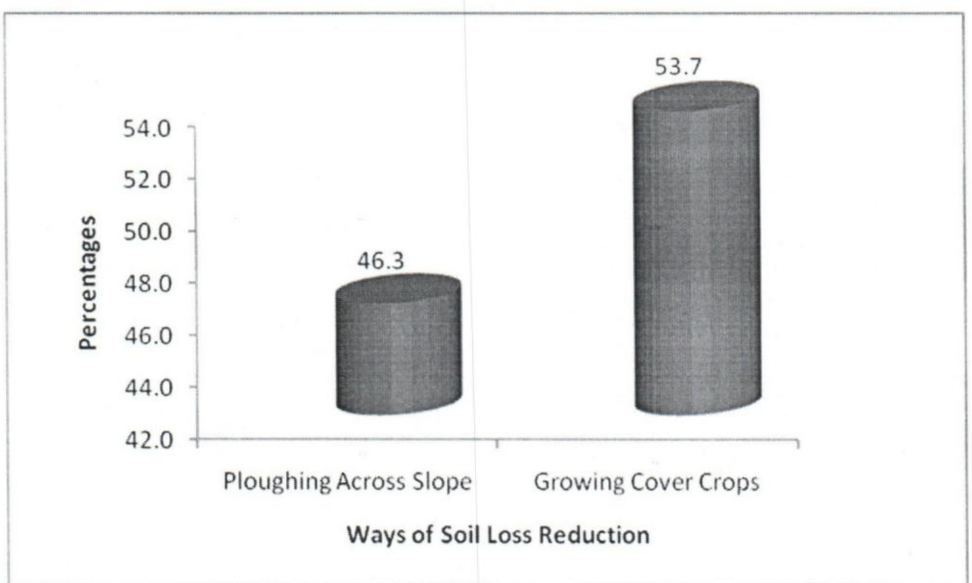

Figure 4:6 Methods of Reducing Soil Loss; Source: Field survey (2011)

Also, 46% of respondents indicated that they normally plough across the slopes of their farmlands to protect the soil from runoff that carry top soil away. Contour farming is also practiced to reduce the runoff on lands with a slope of over 6%. It is practiced alone or in combination with other conservation practices such as cut-off drains and plantation of different trees to reduce soil loss. Similar results were found by (Eswaran, *et al.,* 1997).

4.3.2 Level of Usefulness of Soil Fertility Management and Conservation

Soil fertility management and conservation improves soils and cause increase of crops yields. As shown in Table 4:2 the majority of the respondents (36%) intimated that SWC practices provided better soil fertility, also 28% of the respondents acknowledged improved crop yields while about 19% intimated that SWC measures lead to increased land productivity. The remaining 5% of the respondents indicated that SWC helps in the differentiation between fertile and infertile soils.

28% of responding farmers also said that fertility management and conservation was an obligatory activity because, if they do not improve upon the fertility of the soils they will soon have no food for themselves and their families.

Table 4:2 Level of usefulness of soil fertility management and conservation

Usefulness	**Frequency**	**Percentage**
Improve land productivity	28	18.7
Improves Soil Fertility	54	36.0
Helps differentiate between fertile and infertile soils	8	5.3
Improve Yield	42	28.0
Gives knowledge on how to Protect the Land	18	12.0
Total	**150**	**100**

Source: Field Survey (2011)

4.3.3 Methods of Soil Fertility Improvement

During discussions with the farmers it was learnt that through time, traditional farmers have worked with different methods of maintaining soil health and have come to adopt different ways of keeping their soils healthy. When the respondents were asked to indicate ways of soil fertility improvement, the majority constituting 43% pointed out crop rotation, also 36% of the respondents said that they could apply organic manure while 9% of the respondents mentioned the planting of leguminous crops. However, 11% of the respondents could not indicate any way of soil fertility improvement (Figure 4:7).

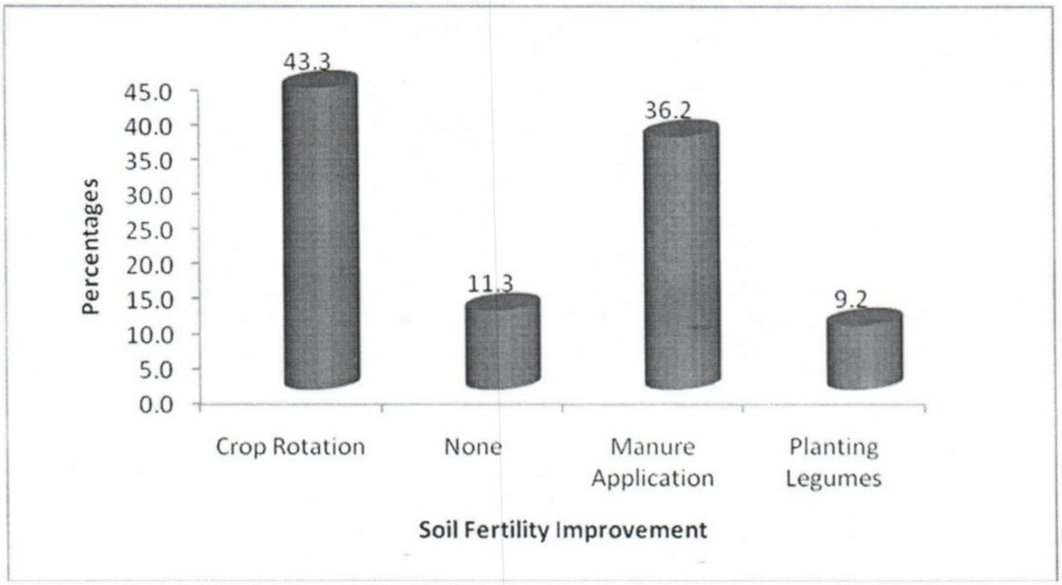

Figure 4:7 Ways of Improving Soil Fertility; Source: Field survey (2011)

4.4 Constraints to adoption of Soil Fertility and Conservation Practice

4.4.1 Constraints with Manure Usage

Due to high poverty levels of farmers in the study area, majority of the farmers are not able to own cattle or small ruminants that could yield them enough manure to be used for soil fertility improvement. Also, 58% of respondents interviewed indicated that they have no housing for their animals, to enhance gathering of manure. The few animals are therefore exposed to thieves or arm rubbers and also exposed to weather hazards. Thus, enabling only little animal manure for their farms

Due to high poverty levels in the district, 42% of respondents said they have no access to manure, meaning they have no animals that could give them manure because they could not afford to buy them due to the cost in the open market. Those that have the animals, they are a source of financial security to the farmers, at any point in time if the farmer(s) have a problem, they sell the animal (s) to earn them income which does not give them the opportunity to have many of the animals that can give them sufficient manure.

The main advantages of this practice according to the farmers were that, effects of animal manure were immediate when applied. However, the major drawback was that, quantities of farmyard manure were generally low and variable. This is due to livestock ownership, particularly cattle, being very small among the farmers (about 15% of the sampled households had livestock). In most parts of the municipality, farmers composted household refuse near the homestead which is used to fertilize vegetable gardens and farm lands. Here again the constraint is the availability of the manure in required quantities as well as labour and transportation of such manure from points of production to the farms

Distances from the point of manure production to the farmer's farm discourage farmers in terms of carting manure from the house to a distant farm. The farmer eventually ends up by not using manure on some of the farms that would have enhanced good yield. Manure is bulky and labour demanding in the processing and conveyance to the farms. As such if the farmers have no adequate family labour or animal drawn implements, it becomes difficult to cart significant amounts of the manure to the farm that will make meaningful impact on soil fertility improvement. Farmers can adopt on farm organic manure production for the distant farms. The studies of Gebremedhin and Swinton (2003) also reported that farmers are more likely to continue conservation measures on farms that are distant and highly prone to inorganic manures.

4.4.2 Land Tenure and Ownership of Land

Figure 4:8 shows the proportions of respondents with respect to ownership of land. The majority (66%) of respondents cropped on their own land. They said that they were motivated to allow crops residues to decompose on their own land as a soil fertility improvement measure.

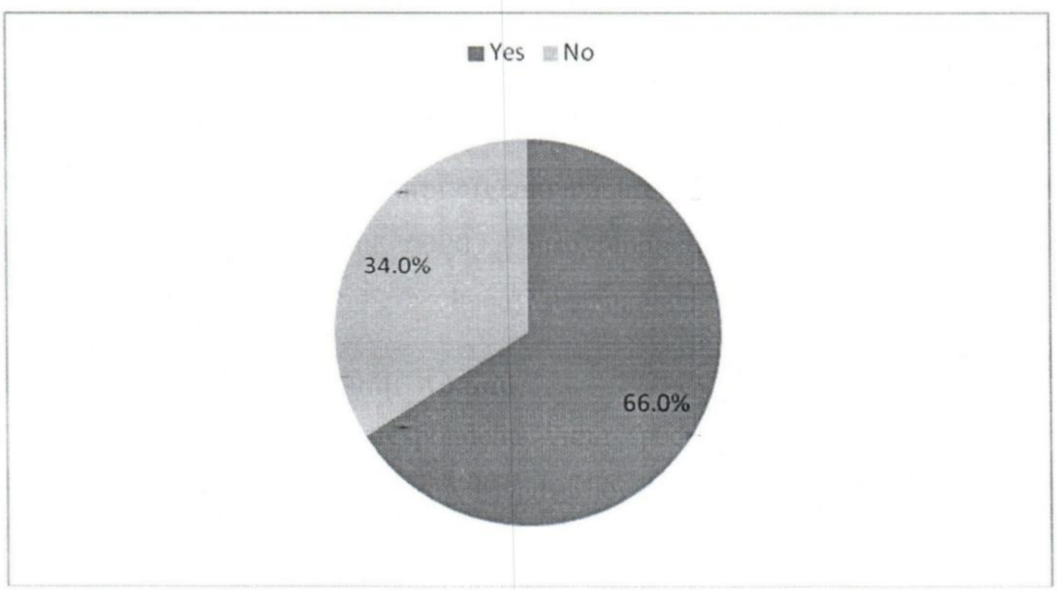

Figure 4:8 Ownership of Land; Source: Field survey (2011)

The challenge respondents with land mentioned was that, sometimes either bush fires burn the crop residue on their farms or residues are grazed by cattle which is a hindrance to their efforts in improving soil fertility levels of their farms. They concluded that ownership of land was a key factor in the practice of soil and water conservation for soil fertility improvement because one cannot rent land and use it the way you want because when its fertility level is improved, the land owner comes for it. The respondents also said that once you have your own land, the practice of composting and crop rotation does not become a problem for the same reason mentioned earlier.

Thirty four percent of the respondents also indicated that they have no land of their own. To them, they depend on friends and other people for land for farming and this makes it very difficult or challenging for the practice of soil fertility improvement techniques due to the fact that one cannot improve fertility status the way you want because the owner can caution you if you don't use the land according to his taste. Respondents started that since they did not have their own lands but depended on others, it was not safe to make any investment on the land because they have the fear that when fertility status of the soils are improved, the owner will come for it. A farmer said: "if l had my own land, how to handle it to give me good yields lies in my hands, but here l stand without my own land, l have to manage the situation as it is", he concluded.

4.5 Summary

Agricultural development in Ghana is hampered by land degradation; (Hudson, 1992). Degradation in turn is threatening the overall sustainability of agricultural production. Soil erosion is a major cause of land degradation in Ghana.

Farmers' age and education level have a positive impact on adoption of some soil and water conservation practices. Older farmers have advantages of more experience and access to more farmlands, and younger farmers possess some level of education. The cost of soil and water conservation also includes the cost of travel to the plot from home.

CHAPTER FIVE

5.0 Conclusions and Recommendation

5.1 Conclusions

The study revealed that respondents use some level of organic manure for cropping. This became clear since most of the farmers keep livestock of one type or the other. However, the main constraint to the use of organic manure was found to be the limited availability of manure and in cases where they have, carting to distant farms.

From the survey it was observed that 35% of the respondents practice crop rotation as a way of maintaining soil fertility levels. Only 27% of the respondents use chemical fertilizers. Even though farmers realized the benefits of chemical fertilizers to increasing crop yields, the main constraint identified was the high cost. The lack of loans was also realized to be a constraint to the use of chemical fertilizers.

Though 59.3% of the respondents indicated that they practice cover cropping as a measure of increasing soil fertility, it was observed to be a widespread practice among farmers in the study area. However, it was also observed that the mode of cover cropping did not conform to any recommended practices; planting distances were very wide as against the standard. From the study, one ton of manure may result in high returns to soil fertility improvement.

5.3 Recommendations

- Every effort should be made to promote the use of manure. From some of the constraints mentioned in the discussions, labour was found to be a major constraint in all the soil fertility management practices.

- Hence every effort should be made to increase the amount of manure available and means of carting to distant farms.

- Farmers should be supported with credit facilities and subsidies to enable them increase productivity due to the economic situation facing farmers in the study area.
- More education should be given to farmers on crop species to be used for cover cropping since the legume crop (mucuna) that is being used is phasing out because farmers do not know how to process the seed for home consumption. So mucuna should be phased out.

- In order to do a more thorough study, there is the need to use a medium to long term data set. This will give a more elaborate indication of the nutrient dynamics in the soil. There is the need to involve more farmers and to get more data on the management techniques that were left out in this analysis.

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APPENDIX

Questionnaire

UNIVERSITY FOR DEVELOPMENT STUDIES

MA IN NGO MANAGEMENT AND RURAL DEVELOPMENT

TITLE: ASSESSING THE EFFECTS OF SOIL FERTILITY AND CONSERVATION TECHNOLOGIES OF FARM LANDS IN THE YENDI MUNICIPALITY, GHANA

This document is an academic one and whatever information you will provide will be used for just that and will be kept very confidential. No portion will be disclosed or released to anyone without your express permission.

(Tick or write where applicable)

(A) Demographic data

1. What is your name? ---

2. How old are you? ---

3. Are you married or single? ---

4. If yes, how many children do you have? ---------------------------- -------------------------

5. How many boys and girls? --

6. Have you attended school before? Yes ( ) No ( )

7. If yes, what stage? ---

(B) Farming System

8. How long have you been in farming? ---

9. Do you do mix cropping or sole cropping? ---

10, a. If mix, why do you prefer to mix the crops? ---

10, b. What type of crops do you cultivate under mix cropping? ---------------------------------------
----

11, What type of crops do you grow?--

(c) Land preparation

12. How do you prepare your land before planting? ---

Tractor ( ) Animal traction ( ) Hoe ( ) others, ( ) specify--
----

13, a. Do you rear animals? Yes ( ) No ( )

13, b. If yes, what type of animals? --

14. Do you house the animals? --

15. Give reasons for housing the animals---

16, a. Do you apply organic manure on your farms? ---

16, b. If, yes, where do you get the organic manure? ---
----

17. What quantity do you apply per acre? --

18. Do you get enough organic manure for your farm? ---

19. If no, do you supplement with inorganic fertilizers? --

20. To what crops do you apply the inorganic manure? --

21. On what farms do you apply the manure? ---

22. What are the benefits of applying organic matter on your farms? --------------------------------
----

23. If you do not apply manure to your farms, why don't you? ---------------------------------------
----

24. Do you practice crop rotation? Yes ( ) No ( )

25. If yes, in what sequence?---
----

26. What do you use your crop residues for? --

27, a. Do you treat the residues before using? Yes ( ) No ( ) --

27, b. If yes, which of the residues do you treat? ---

28. How do you treat it?--
----

29. How do you reduce soil loss?---
----

30. How do you control weeds on your farm? ---

31. How do you retain water in your farm? --

32. Do you practice any cover cropping? Yes ( ) No ( )

If yes, what type of cover crops? --

33. Do you burn after harvest of crops? --

33, a. If yes, why do you burn? ---

33, b. If no, why don't you burn? ---

34. What are the reasons for burning? ------------------------

(D) Land tenure system

35. Do you own the land you are farming on? Yes ( ) No ( )

36. If yes, how did you acquire it? ---

37. If no, who owns the land? ---

38. How is family land treated? --

39. What are the requirements to acquire land? ---

40. Who has the right to give out land for farming? ---

(E) Indigenous soil conservation practices

41. What is the fertility status of your farm? ---

42. What is the difference between a fertile soil and a soil which has lost its fertility? -------------
----

43. What are the indigenous ways of conserving water? --
----

44. What are the indigenous ways of conserving fertile soils? --
----

45. What are the indigenous ways of controlling soil loss? ---

46. Do you control soil loss? Yes ( ) No ( )

46, a. If yes, how do you do it? ---

46, b. If not, why don't you control soil loss? --

47. What is the indigenous technology of improving soil fertility? --------------------------------------
----

48. How many improved soil fertility and conservation technologies do farmers practices in Yendi communities? ---

49. Can you describe the procedure involved in any of these improved soil fertility and conservation technologies? --

50. How does these improved soil fertility technologies help maintain the fertility of the soil? ----
----

(F) Economic feasibility of soil fertility and conservation technologies

51. How many soil fertility and conservation technologies do you know? ---------------------------
----

52. Which of them do you use? ---

53. How much does it cost you to practice this technology? --

54. Is it the cheapest among the soil fertility technologies? Yes ( ) No ( )

55. If yes, which is? --

56. If no, then why don't you apply the cheapest soil fertility technology? ---------------------------
----

57. Which is the most expensive of the soil fertility technology? --
----

58. Does this technology have a higher impact on conserving soil fertility than the other soil fertility technologies? --

59. How effective is the cheapest soil fertility technology? --

60. Is it effective enough to your satisfaction? --

61. How much will each of the various soil fertility and conservation technologies cost you? -----
----

62. Is the cheapest as effective as the most expensive soil fertility and conservation technology? -
----

63. Do you think cost incurred in relation to a technology determines the effectiveness of that technology? Yes ( ) No ( )

64. If yes, how? ---

65. If no, why not? ---

66. Do you find soil fertility management and conservation useful? Yes ( ) No ( )

67. If yes, how useful is it to you? ---

68. If no, why do you think it is not useful? --

69. Do you improve fertile soils of yours? Yes ( ) No ( )

70. If yes, how do you do that on your farm? ---

....

71. What were the results? ---

72. Do you know of any other ways of improving soil fertility? Yes ( ) No ( )

73. If yes, what are they? --

74. Which one do you prefer to use?..

75. Why do you prefer this method of conserving soil fertility?..

....

76. Will you adopt this method ahead of other methods? Yes ( ) No ( )

77. Are you able to tell between good/bad technologies for soil fertility improvement? Yes ( ) No ( )

78. If yes, how do you do that?...

79. Do you know of any bad technology being practiced by farmers? Yes ( ) No ( )

80. If yes, which one is it?..

81. Do you rear animals? Yes ( ) No ( )

82. How much does it cost you to apply manure?..

83. Is it difficult using animal manure? Yes ( ) No ( )

84. If yes, what are the difficulties?...

....

85. What type of organic matter do you apply?...

....

86. How long does it take you to apply manure?..

87. How many bags of organic manure do you apply on your farm?...................................

....

88. How many people need to apply manure at a time?..

89. Which is cheaper to apply, manure or fertilizer?...

90. Which of the two help improving soil fertility better?..

....