

**THE ROLE OF INDIGENOUS KNOWLEDGE IN THE
MANAGEMENT OF SOIL FERTILITY AMONG
SMALLHOLDER FARMERS OF EMUHAYA DIVISION,
VIHIGA DISTRICT**

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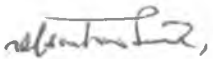
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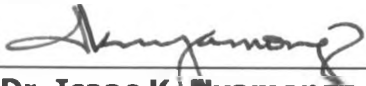
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DEDICATION

This thesis is dedicated to smallholder farmers of Ebusiloli location of Emuhaya division: including Emamnyonyi; wobaria; Mukhombe A; Mukhombe B; and Mwilonje. Their detailed knowledge of local soils and their struggle to enhance the fertility of these soils is recognized and appreciated.

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I must, however, state that I alone take responsibility for any criticisms that there could be of this study, and I owe my readers an explanation should any be required.

ABSTRACT

This study was undertaken to understand the role of indigenous knowledge in soil fertility management among smallholder farmers of Emuhaya division of Vihiga District, western Kenya. In effect, the study sought to demonstrate that being traditionally an agricultural community, the subjects of this study have gained and/or acquired an elaborate knowledge and skills that relate to farming in general and soil fertility in particular. The focus of this study, therefore, was on the indigenous knowledge perspective of soil fertility management. The assumption being that if smallholder farmers are to attain sustainable agriculture, future agricultural development programmes should not only incorporate indigenous agricultural knowledge, but should also see to it that both genders are included in the design and implementation of the soil fertility initiatives.

The inability of smallholder farmers to cope with the requirements of the modern soil amendment strategies was one of the reasons behind this study. The overriding factor here was that smallholders with limited landholdings and limited or no disposable cash income to purchase soil amendment inputs should be given the chance to explore the use of available local resources to support their farming.

This research was carried out in Emuhaya division of Vihiga District Western Kenya. A reconnaissance and the pre-testing of the research instrument preceded the data collection and also included the participation in wealth ranking exercise facilitated by the Tropical Soil Biology and Fertility Programme (TSBF). The actual fieldwork took two months and included the administration of a questionnaire to 100 farmers, conducting in-depth and key informant interviews with 30 farmers and 25 key informants, facilitating a total of 10 focus group discussions as well as direct observation in selected farmers' fields. The findings of the study have also been complemented by literature review on earlier studies but with similar focus. Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS) computer package whilst qualitative data were subjected to systematic content analysis before being analyzed further using the ATLAS.ti computer package.

The findings of the study suggest that farmers have detailed knowledge about their local soils. This knowledge is gathered from many sources, mainly experience, and is responsible for the naming and classification of local soils. Farmers also use their local knowledge to diagnose soil nutrient status.

Smallholder farmers are also increasingly becoming worried about the fertility status of their farms. Consequently, they continuously employ a number of strategies to manage the fertility of their croplands. While some of these strategies are derived from modern scientific thinking, others can be characterized as indigenous practices which have persisted with time. This study also found that smallholders continue to face constraints in their effort to manage the soil nutrient status. These include limited sizes of landholdings, none or a limited number of livestock, and lack of disposable cash income because of poverty.

The study recommends that indigenous knowledge and practices be mainstreamed in policies that touch on land and soil management. Indeed, it is time to start initiating processes and activities for the formulation of soil policy in Kenya. There is also need to institute studies focusing specifically on local crops and their nutrient requirements. At the same time, future studies should help us focus on specific inputs and how their efficiency can be enhanced. Integration of knowledge systems and practices will surely enhance soil fertility management among smallholders of Emuhaya.

CHAPTER ONE

INTRODUCTION

1.1 Background

The study of indigenous knowledge systems and their place in the quest for sustainable development is one of the more recent developments taking place worldwide. Today, according to Gerritsen (2000), the conservation of biodiversity is a major international goal and the involvement of farmers in conservation activities remains crucial. This is due in part to the complex relationships, which exist between farmers and their environment (Sharland, 1999; Gerritsen, 2000) - a relationship that is often not sufficiently understood by conservationists. Farmers have a broad knowledge of the environment. The United Nations Educational, Scientific and Cultural Organization (UNESCO) asserts that the symbiotic character of the relationship between biodiversity and cultural diversity has not been adequately analyzed as yet; although the fact remains that a critical and dynamic relationship did exist between the local community, its surrounding and its cultural identity (UNESCO, 1995). Indeed, through centuries of being close to nature, local people throughout the world have acquired detailed knowledge of these environments and their natural resources. Living in and from the rich variety of complex ecosystems, farmers understand the functioning of these systems, the properties of plants and animals and the techniques for using and managing the ecosystems (UNESCO, 1995; Brokensha *et al.*, 1999; Gerritsen, 2000).

However, there have been some changes that have made the situation of soil nutrient depletion even more problematic and, therefore, an issue of concern to both national governments and the international community. Perhaps even most serious is the effect of population growth on ecologically sensitive areas. The increasing density of population has forced farmers in poor areas to cut back on fallow periods, essential to restore soil fertility, without applying extra fertilizer to compensate for it (FAO, 1984). As a result, soil fertility gradually deteriorates and yields may fall, forcing farmers to cut fallow periods back even further.

In this study, local or indigenous knowledge was defined as skills and practices of the people living in a certain area generated by their own and their ancestors' experience as well as those originating from elsewhere which has been internalized by the local people. Soil fertility management refers to any strategy employed by farmers to maintain and possibly increase soil fertility for sustaining crop productivity through optimizing all possible sources of plant nutrients needed for crop growth and appropriate to each crop system and specific ecological and socioeconomic situation. Smallholder farmers in this study include farmers with family farms or landholdings measuring less than 10 hectares.

This study was undertaken in Emuhaya division of Vihiga district, Western Kenya. The study population was predominantly the Abanyore (a section of the Abaluyia). The other sub-ethnic groups found in this area include the Abatiriki and the Avalagoli. The main assumption in this study was that, because these people have practised agriculture for centuries, they have developed and adopted unique knowledge and skills used in managing farming activities, including soil fertility management. Indigenous knowledge is used at the local level by communities in developing countries as the basis for decision-making pertaining to food security, human and animal health, education, natural resource management and other vital activities (Brokensha *et al.*, 1999: xv)

It is in the light of the above perspective that the Tropical Soil Biology and Fertility (TSBF) in collaboration with partners has initiated a project which, among other things, aims to improve and sustain agricultural productivity by facilitating a common understanding between scientists, farmers and other stakeholders about how agro-ecosystems operate and how best to manage them. The specific focus of the project is to broaden farmers' soil fertility management strategies by incorporating scientific insights of soil biology and fertility in the repertoire of folk knowledge and practical skills. Conversely, and where this study comes in, is the parallel goal that seeks to strengthen the understanding of indigenous agro-ecological knowledge among scientists, extensionists and other stakeholders and to elucidate the local realities and complexities which inform soil fertility management practices used by farmers.

However, it should be noted that even though this study focused on the local or indigenous knowledge, integration (of indigenous and modern systems) was a key concern that attracted keen attention. This is because, as explained by various scholars (see for example, Brokensha *et al.*, 1999), this study also confirmed that there is no clear demarcation between the two knowledge systems. Some of the common local strategies of managing soil fertility in western Kenya include mulching, agroforestry, crop rotation, fallowing and the use of animal as well as compost manures. The study confirmed what Mukamuri and Murwira (2000) observed in Zimbabwe, which was that smallholder farmers do not just adopt the modern soil amendment packages as promoted by scientists but only adopt what has been modified and tested by them. The purpose of this modification is to suit local circumstances. The use of inorganic fertilizers among the Abanyore as observed in this study helped in confirming this assertion.

Significantly, this study has pointed out that the soil fertility situation in Emuhaya is worsening, especially among resource-constrained smallholders. Emerging information suggests that the trend will continue to be grave, especially when one looks at the fact that the population also continues to rise considerably. Moreover, as population rises, increasingly large areas will be taken up by non-agricultural uses, for example settlements. This also has the likelihood of pushing agriculture to the marginal areas. The reality in sub-Saharan agriculture is that there is no suitable land left for rainfed agriculture (World Bank, 1993). For example, in the case of Kenya, Hoorweg *et al.* (1995) observe that the pressure on land resources threatens the future balance between national food demand and national food production. The existing agro-ecological potential for rainfed farming is quite limited and the country is, in fact, already short of good agricultural land (Hoorweg *et al.*, 1995). Earlier, it could be argued that production increase would depend on the possibilities of increasing yields per hectare, and of bringing the remaining, often marginal areas, under cultivation (GOK, 1986, 1994b). It should also be noted that the potential for irrigation agriculture, especially among smallholders, is limited or nil.

Today, with growth in grain yields trailing growth in food demand and with little room for further expansion, land matters more than ever. Yet, cases of land abuse persist.

More than three-quarters of these abuses are caused by agriculture and livestock production or by converting forest in crop land (FAO, 1984; Rau, 1991; World Bank, 1993; Timberlake, 1994).

This is worrisome because, as Reintjes *et al.* (1992) observe, the transfer of technology (ToT) approach, which dominates the theme for agricultural improvement in the tropics, has resulted in exclusion of smallholders from most of the agricultural improvement initiatives. Limitations of using artificial external inputs and pursuing ToT in smallholder rainfed farming are clear indications that another type of technology and another approach to technology development are necessary. Indeed, the rise of participatory movement in agricultural research has also emphasized the importance of responding to farmers' perceptions and needs rather than assuming that formal science provides solution in its own right (TSBF, 2001: 15).

Rising populations and declining land parcels among smallholders of Emuhaya identify the areas as one in dire need of alternative strategies of managing their soils if their farming is to support their households

1.2 PROBLEM STATEMENT

Agriculture remains the backbone of the Kenyan economy and so deserves critical attention. This is demonstrated by the fact that some of the crucial national policies in Kenya are those related to food and self-sufficiency, food security, rural urban imbalance, rural development and overall growth (GOK, 1994a). Such policy statements include the *sessional paper no. 4 of 1994* on National Food Policy and are expected to drive the country towards sustainable food production. But upon review, it is overly clear that the agricultural development specialists and planners have neglected the use of local indigenous agricultural knowledge. This problem is deeply rooted in both colonial and post-colonial agricultural policies.

From the colonialists, Kenya – like other African countries – inherited a strong bias towards extension and international technology transfer as a means of accelerating agricultural development. This was based on the colonial premise that culture-bound

local farmers needed to be educated and motivated, and that this could be done with the aid of imported models of agriculture development (Ashley, 2000). Theories supporting this assumption have continued to dominate global scientific thinking. The main gist of the transfer of technology approach is that the smallholder sector is 'backward' and an increase of livestock or food production calls for a change in attitudes as well as traditional farming practices. This, according to (Suda, 2000), it is argued, could be achieved through greater exposure to new values, transfer of modern technology, capital and skills from the core to the periphery.

Consequently, in the agricultural sector, there is the constant hope that the new models, inputs and services will lead to significant increase in production. This study adopts the position that when these various forms of innovations are diffused, from outside and adopted by the indigenous target groups, this process succeeds only in relegating indigenous knowledge which is held by the local population. The value and efficacy of indigenous knowledge, therefore, becomes epiphenomenal. For instance, when it comes to soil nutrient depletion, the use of fertilizers has always been promoted. But reports indicate that fertilizer-use is also problematic. In the case of Kenya, for example, fertilizer consumption is still below the optimum level, especially for food crops and among small-scale farmers (Action Aid-Kenya, 1999). This is due to the high cost of fertilizers, the low returns from food crops, lack of credit and weak supply channels. Besides, as Gardner (1996) explains, fertilizers are no substitute for true soil health. They cannot supply soil with other essential elements – including organic matter, microorganisms, insects, water and secondary nutrients- whose interaction creates a supportive environment for plants (Gardner, 1996). These and other negative side effects warrant exploration of ways to supplement fertilizer use where possible.

An emerging area of hope is the recognition of indigenous skills and practices relating to soil fertility management. Indeed, since the advent of agriculture and livestock rearing as important modes of human adaptation, African farmers have relied on their local repertoire of knowledge and practical skills to manage these low input agricultural systems, and to continually adapt them to changing ecological and socio-economic conditions (Richards, 1985). Traditional farming involves the development of knowledge

and skills, and the various processes that take place within the farm are generally well understood. Globally, there is growing recognition of the importance and value of indigenous knowledge and practices in agricultural development (Khor, 2000; Eyzaguirre, 2001). While such recognition is almost totally lacking in Kenya, there is an appreciation that sustaining food production among smallholders will require more than just the adoption of modern scientific inputs.

At the same time, it must be emphasized that in Kenya, the shortage of potentially cultivable land in land-scarce areas means that increasing a better level of inputs to agriculture will be vital to achieving a better balance between populations and land resources. Among smallholders of Emuhaya, the most serious obstacles will be economic and human: the ability of poorer households and farmers to pay increased inputs and to organize the changes that will be needed to ensure efficient use of land and inputs. Nevertheless, given the twin challenges posed by anemic yields and rising food demand, a redoubled commitment to agricultural investment among these poor farmers is necessary. This has made the problem of soil fertility decline among small farmers an urgent issue requiring remedial measures so that soils on whose well-being households depend are not mined.

Another factor to consider is the gender perspective in agriculture. Women are perhaps the most important and most neglected rural people (Suda, 1986; World Bank, 1993). The issue of gender and its importance for an understanding of agricultural indigenous knowledge and farming systems seems to have been completely neglected by agricultural development planners. This gender issue in agricultural indigenous knowledge, according to Ashley (2000), calls for awareness that men and women have different ranges of knowledge and expertise, and that it is essential to identify and understand how gender differences influence the structure of social system. Indigenous agricultural knowledge provides men and women with a structure in which they can play their roles, allocate various resources and deal with various constraints in the farming system (Ashley, 2000).

The focus of this study, therefore, was on the indigenous knowledge perspective of soil fertility management. The argument is that if smallholder farmers are to attain sustainable agriculture, future agricultural development programmes should not only incorporate indigenous agricultural knowledge, but should also see to it that both genders are included in the design and implementation of the programme.

The study sought to provide answers to the following research questions.

1. What is the local soil classification system used by smallholder farmers and how has this affected land use in Emuhaya?
2. What are the local indicators of soil nutrient depletion or loss according to the smallholders of Emuhaya?
3. What remedial measures and coping mechanisms do smallholder farmers in Emuhaya use to manage soil fertility?

1.3 STUDY OBJECTIVES

The general objective of the study was to investigate the indigenous knowledge of soils and how this relates to the management of soil fertility in the study area. Specifically, the study sought:-

1. To identify the local diagnostic criteria for differentiating soil types among smallholder farmers within the study area.
2. To identify local indicators for discerning soil nutrient status among the study population.
3. To investigate the soil fertility management practices used by smallholder farmers in the study area.

1.4 JUSTIFICATION OF THE STUDY

High population, estimated to be rising at over 3.1% and declining land parcels, averaging 2.9 acres per household among smallholders of Vihiga district identified Emuhaya as one area in dire need of alternative strategies of managing soils if smallholder farming is to support their food needs.

This study has added to the search for information on soil fertility management being pursued by researchers and planners. It has also helped in shedding light on the role of indigenous skills and practices in soil fertility management. Besides, there is a growing appreciation and recognition of the importance of local or indigenous knowledge in the sustainable use of natural resources. But the lack of information stands in the way of good understanding of these methods. By taking time and effort to document the systems, they become accessible to change agents and client groups.

The study does not, however, portend that local knowledge and practices have the quick solution to the many problems facing farmers in the area of soil fertility management. Far from that, it recognizes the importance of integrated knowledge systems (modern and indigenous) and while focusing on the latter, the study paid attention to the former.

The Folk Ecology Project (that provided a background for this study) needed specific information that can facilitate the integration of two knowledge systems (modern and indigenous), which eventually will enable scientific information to become a component of the larger pool of local knowledge to be more efficiently applied by the local people themselves, particularly in the area of soil fertility management. Justification for documenting indigenous knowledge of soils is enormous. Working with indigenous soil classifications offer several important benefits. For one thing, when a detailed inventory of soil resources is required, indigenous classifications are often much faster and cheaper than conventional soil survey techniques. In addition, the use of local soil terms can considerably facilitate communication between farmers, extension workers and researchers (Tabor, 1990; Sikana, 1994). A third advantage is that local soil taxonomy can offer important insights into the land use considerations of farmers and the soil/plant interactions which they deal with.

The prevailing farming system in western Kenya involves an intensive use of labour and land resources to produce crop and livestock on a small-scale subsistence basis. Emuhaya division study site lies within a region which has poor subsistence economy due to unreliable rainfall and highly fragile soils. Smallholder farmers in this region face the double tragedy of environmental degradation and increasing demand for food. While

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the extension workers and other agencies could be willing to assist, their efforts could be hampered by the prevailing low socio-economic status, especially among the small farmers. This, therefore, called for the need to carry out a study which could inform the donor community or, more importantly, policy makers and the communities themselves to enable them formulate a broad strategy within which resources can be more effectively focused.

Findings from this study should, therefore, enable governments, policy-making bodies, non-governmental organizations and donors to formulate and design strategies that can alleviate suffering emanating from soil nutrient depletion among smallholder farmers. Agricultural research institutions could also base on the findings to institute the intervention programmes that could improve the conditions of smallholder farmers so that they are not left vulnerable to adverse socio-economic and environmental effects. Extension workers can also use the report to enable them understand indigenous knowledge perspective of soil fertility management.

1.5 SCOPE AND LIMITATIONS

The scope of the study was based on the study objectives and aimed at gathering information from smallholders on their perspective on soil fertility management. It was established that soil fertility management is not a new phenomenon among the Abanyore. Strategies used by the Abanyore to diagnose soil fertility and manage the same soils are many and varied pointing to the fact that soil fertility issues are dynamic and related to the other aspects of farming. This study recognizes the fact that capturing a dynamic phenomenon in a one time study is difficult.

A key aspect which could not be explored exhaustively but which was thought to be fundamental to this study was the indigenous classification of landscapes (ethnotaxonomy of land gradients) among the study populations. Similarly, issues related to soil profile as expressed by some farmers could not be explored exhaustively during this study. An attempt was made, however, to record how land gradients and different soil profiles impact on nutrient management.

This study was also conducted during the long rainy season and the findings here should be seen in that context. In Vihiga, there are two rainy seasons and the choice of soil fertility amendment strategy is also, to some extent, influenced by the season of the year. Since indigenous knowledge is holistic and ties the whole issue of soil fertility to other aspects of farming, rainfall patterns is a key aspect in soil fertility management.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter is divided into two sections. The first section presents the literature reviewed to inform the study while the second section presents the theoretical framework used to guide this study. Although the section on literature review mainly focuses on the role of indigenous knowledge and its limitations in the management of agricultural systems particularly in the area of soil fertility, a brief introduction is provided at the beginning to give some insights into the situation of soil fertility depletion in the tropics. The second part documents the situation of smallholder farming in Kenya, including the inherent gender dimension, while the last part throws some light on the relevant policy implications. Similarly, the section on theoretical framework is divided into two parts: cultural ecology as a theory in itself is presented; and then its relevance to the study of indigenous knowledge and soil fertility expounded.

2.1.1 Soil Nutrient Depletion

Not much literature exists on the topic of soil fertility in the tropics. The soil biota, TSBF (2000) observes, is a biological resource that contributes to plant production and the maintenance of a variety of ecosystem services but which has been significantly neglected in agricultural research. Nevertheless, there is growing recognition that soil nutrient depletion is one of the challenges facing agriculture globally. For example, the World Bank has recognized soil nutrient depletion as the single most important biophysical constraint to food security in Africa (TSBF, 2000).

Ironically, as Critchley (1991) observes, concern for soil conservation is not new in Africa. In the British ruled territories soil conservation became a major issue during the 1930s, when a number of schemes were started (Critchley, 1991). Part of the problem, as this study found, was the approach used by the colonial administration. In Kenya, resistance to colonial land management strategies led to the *Dini Ya Musambwa* by Elijah Masinde in western Kenya and also contributed to the *Mau Mau* revolt among

other protests. But as Turnham (1992) reports, in the past, natural resource management focused narrowly on a single use for a single target resource, forestry.

Today's accelerating resource depletion comes as production is sputtering and food demand is surging. There is a growing recognition that agriculture, especially in the tropics, faces the twin problems of decreasing food sufficiency and increasing natural resource degradation (FAO, 1984; World Bank 1993; Gardner, 1996; TSBF, 2000).

The situation, if not controlled, will be a great challenge to farmers and their households and to the whole society at large. This problem should be looked at against the background of the fact that population pressure and other factors have made expansion into new lands an impossibility. This is why Gardner (1996) argues that given the twin challenges posed by anemic yields and rising food demand, a redoubled commitment to agricultural investment is necessary. Rising demand for food and sluggish growth in yields would seem sufficient motivation to protect the remaining cropland, yet farmlands around the world continue to be lost to other uses (Gardner, 1996). The United Nations Food and Agriculture Organization (1984) estimates that cultivation of all potential cropland in developing countries would reduce permanent pasture, forests and woodlands by 47 per cent.

On the other hand, Ayres and McCalla (1996) contend that agricultural growth must now come primarily from rising biological yields other than from expanding cultivated areas or intensifying agriculture through irrigation, because fertile land and water are increasingly scarce. Most fertile lands are already under cultivation, and most areas suitable for irrigation have already been exploited (Ayres and McCalla, 1996). In Kenya at present, almost all the entire agriculture potential zones are under cultivation. Gardner (1996) is, therefore, not wrong to conclude that for the first time ever, the entire burden of increased grain production rests on yields alone!

According to Rau (1991), as populations have risen, mobility has become limited, and available land is now cultivated more intensively. Similar observations have been made by Grainger (1990), who postulates that overcultivation occurs when farmers try to crop the land more intensively than permitted by its natural fertility and fail to compensate

for the export of nutrients in the crops by using artificial fertilizers or fallowing the land so that its fertility can regenerate naturally. Overcultivation, therefore, reduces the fertility of the soil, damages its structure and exposes it to erosion (Grainger 1990; Rau 1991; Gardner 1996). The problem is particularly grave among smallholder farmers who cannot afford to 'buy' chemical fertilizers. It is against this background that the World Commission on Environment and Development (1987) called for the adoption of sustainable agriculture

The Technical Advisory Committee of the Consultative Group on International Agriculture Research (TAC) (quoted in Reijntjes *et al.*, 1992) states: "sustainable agriculture is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources". In other words, agriculture is only sustainable when it is ecologically sound: local resources are used in a way that minimizes losses of nutrients, biomass and energy and avoids pollution (WCED, 1987).

2.1.2 Smallholder Farming in Kenya

Smallholder farming continues to play an important role in the Kenyan economy since more than four-fifths of the population is located in rural areas and the bulk of it is dependent on agriculture (GOK, 1999). According to the Government of Kenya (1999) the small scale agriculture sector is the single largest source of employment in Kenya, absorbing over 51% of the labour force. Like everywhere in Africa, according to Reijntjes *et al.* (1992), smallholders farm under rainfed conditions in diverse and risk-prone environments.

A wide range of different farming systems have evolved among smallholders, each adapted to the local ecological conditions and inextricably entwined with the local culture. Reijntjes *et al.* (1992) insists that a closer look at these 'traditional' farming systems reveals that they are not static: they have changed over the past few decades – primarily as a result of the research and development activities of the local people. These activities have not only been in response to external pressures, they are also an expression of local creativity (Reijntjes *et al.*, 1992).

However, according to many scholars, increasingly rapid changes in economic, technological and demographic conditions demand increasingly rapid changes in smallholder farming systems. Yet, according to Chambers *et al.* (1989), conventional science-based research and extension activities in the tropics have focused on modern agriculture with high levels of external inputs such as agrochemicals, hybrid seed, and mechanization. Modernization of agriculture has been a constant theme in Africa. Technologies have been developed on research stations and experimental farms in better-endowed areas, and attempts have been made to transfer ready-made technology packages to farmers (Chambers *et al.* 1989). In Kenya, the primary aim of these efforts has been to increase production in certain commodities such as maize. While such efforts yield positive results in the short-term, they have always benefited smallholders less, and have sometimes worsened their situations by forcing them onto more marginal land while capital intensive cropping and ranching expands over the better land (FAO, 1984; Grainger, 1990; World Bank, 1993; Gardner, 1996).

Consequently, Gardner (1996) observes that many disadvantaged communities of smallholders are being forced to overexploit the resources available to them, and so environmental degradation is setting in. This is particularly true in Kenya. For example, the Government notes that, as a result of poverty, poor farmers engage in activities such as poor farming practices and burning of trees to make charcoal, which have negatively affected the environment and reduced the land potential, making the struggle for survival hard and leading to overexploitation of land and water resources. In essence, immediate survival needs of the population conflict with the long-term need for preserving and maintaining the viability and integrity of the environment (ROK, 1999). This problem facing smallholders is not uniquely Kenyan. The sheer necessity of survival forces smallholders everywhere to overexploit the land, farming more marginal, steeply sloping or arid areas, and reducing fallow periods below the levels needed to maintain soil fertility and soil structure (FAO 1984; World Bank, 1993).

Rapid population growth is another factor constraining smallholder farming in Kenya. Where individual private land ownership prevails, like in Western Kenya, smallholdings are being subdivided by inheritance and the more male children the owner has the more

his holding will be subdivided on his death. In many areas with such characteristics, large proportions of holdings are now too small to support a family, let alone to generate any surplus that could be invested in more inputs such as fertilizers, land improvements or small-scale machinery (World Bank, 1993). Such farmers will solely depend on local resources, including skills and practices to enhance the fertility of their fields.

There is also the gender dimension of smallholder farming. The World Bank argues that as farms shrink through inheritance and population pressure, and men turn to outside work and become part-time farmers, women increasingly manage the family farm. Women's agricultural workload grows while their traditional work burden in childcare, wood gathering, water fetching and stable food pounding remains the same – or grows too (Boserup, 1970; Suda, 1986). The burden on women means that land preparation, planting and weeding are often delayed, which depresses yields (World Bank, 1993:103). An additional gender constraint to smallholder farming in Kenya has mainly been caused by limited ownership of and access to land (Nasimiyu, 1985; Suda, 1986; GOK, 1999; ActionAid-Kenya, 1999).

According to ActionAid-Kenya (1999), although women can and do inherit land, African traditions support male inheritance, a practice which is usually reinforced by both parents. Moreover, registration and commercialization of land denies many women customary use rights (Action Aid-Kenya, 1999; Alcorn, 1999). Other constraining factors are lack of credit, collateral, and decision-making powers, and the fact that women in female-headed households are sole breadwinners. In Kenya, agricultural credit is definitely skewed against women (Action Aid-Kenya, 1999). The inability of smallholder farmers especially women, to easily access credit is cited as a major constraint to agricultural production in Kenya (ROK, 1996). Indeed, although they comprise 70 – 80% of the agricultural workforce, women's access to rural credit through the existing financial system is negligible as they lack collateral or non-farm income, both of which are necessary for one to qualify for loans. Without land titles or security of tenure, women's access to credit has been limited, thus making it harder for them to buy inputs (World Bank, 1993).

2.1.3 Indigenous Knowledge Systems and Agriculture

In recent years, the value of the traditional knowledge of indigenous peoples, and particularly their traditional environmental knowledge, has been recognized. This has heightened research focusing on knowledge systems. Today, a growing body of literature attests not only to the presence of a vast reservoir of information regarding plant and animal behaviour but also to the existence of effective indigenous strategies for ensuring the sustainable use of local natural resources. Farmers have a broad knowledge of the environment.

According to Johnson (1992), this knowledge is variously labeled as folk ecology, ethnoecology, traditional environmental or ecological knowledge, indigenous knowledge, customary law and knowledge of the land. Traditional environmental or ecological knowledge is probably the most common term; however there remains no universally accepted definition of the concept. This knowledge, which is usually found among indigenous people, is also found among non-indigenous groupings, especially pastoralists and farmers. These people have also acquired their knowledge and skills through hands-on experience living in close contact with their environment.

UNESCO (1995) asserts that although the symbiotic character of the relationship between biodiversity and cultural diversity has not been adequately analyzed as yet, the fact remains that a critical and dynamic relationship did exist between the local community, its surrounding and its cultural identity. Indeed, through centuries of being close to nature, local people throughout the world have acquired detailed knowledge of these environments and its natural resources. Living in and from the rich variety of complex ecosystems, farmers understand the functioning of these systems, the properties of plants and animals and the techniques for using and managing the ecosystems (UNESCO, 1995; Brokensha *et al.*, 1999; Gerritsen, 2000). Involving locals in the conservation of the biodiversity is, therefore, widely appreciated.

There is also the indigenous agricultural knowledge. Indigenous knowledge in the form of know-how and cultural practices is the set of tools that communities use to manage their natural resources, which include genetic resources, the building blocks of

biodiversity and agriculture (Eyzaguirre, 2001). Indigenous knowledge, according to Ashley (2000), is a science of adjustment and adaptation, which is produced by and reflects the interest of local farmers as a group within society.

Traditional farming involves the development of knowledge and skills and the various processes that take place within the farm are generally well understood (Ashley, 2000). Contributing to the subject, Reijntjes *et al.*, (1992) confirm that there are innumerable land use systems developed by traditional farming communities that exemplify careful management of soils, water and nutrients, precisely the type of methods needed to make farming sustainable. Traditional farmers have found ways of improving soil structure, water-holding capacity and nutrient and water availability without the use of artificial inputs (Reijntjes *et al.*, 1992). This implies that African farmers and herders have a deep and profound ecological knowledge, which they apply in getting a living from their land (Rau, 1991; Obasanjo and d'Orville, 1992; Timberlake, 1994). Both Sharland (1999) and Ayers (1999) are in agreement with Timberlake that the small farmers' expertise represents the single largest knowledge resources not yet mobilized in the development enterprise.

Above all, farmers' knowledge and skills in adapting new ideas to their local conditions and needs form the basis for change within the farming community (Reintjes *et al.*, 1992: 19). Besides, indigenous knowledge is important as it forms the information base for a society which facilitates communication and decision-making, so argues Brokensha *et al.* (1999). Therefore, those ignoring this resource are doing so at the risk of triggering an official rebellion.

2.1.3.1 Farmers' Indigenous Knowledge of Soils and Landscapes

A number of studies have documented farmers' knowledge of agro-ecosystem functioning and how such indigenous knowledge influences their management strategies. A well known example is that of soil and land classification. Farmers are experts in recognizing soil types in their farms and their regions (see, for example, Sikana, 1994; Msanya and Mwasebi, 2001). They also understand the advantages and limitations of the different soil types and have in many cases evolved different cropping and management regimes to deal with different soil niches. The apparently random

distribution of crops in time and space across the various fields, at closer inspection, carefully respond to the differential requirements of different crop species and varieties, and to how soil fertility in the various fields is evolving (Crowley and Carter, 2000).

Perhaps the lack of specific detailed study on the role of indigenous knowledge in the management of soil fertility is camouflaged in its holistic and dynamic nature. Nonetheless, Ayers (1999) insists that indigenous soil and water conservation practices and techniques are used, maintained and expanded in many regions of Sub-Saharan Africa. Furthermore, not only are indigenous agricultural techniques widespread but such systems are also characterized by considerable variety and complexity, ranging from extensive terracing, micro-catchments and mounds for control of erosion by runoff, mulching, mixed cropping and rotations. Such examples exemplify the widespread nature and degree of sophistication of indigenous soil conservation strategies and, thus, demonstrate not simply the potential for basing soil conservation improvement on such indigenous techniques but the absurdity of ignoring them and attempting to enforce alien and, at times, inappropriate techniques (Ayers, 1999; Sharland, 1999). Various works (Rau, 1991; Sikana, 1994; Kerven *et al.*, 1999) have demonstrated that peasant farmers had a breadth of knowledge and opinions about the local soils they used for farming. And the works of Msanya and Mwasebi (2000) illustrate how the indigenous knowledge of soils is best utilized for managing food crops.

In some cases, smallholders are able to detect nutrient deficiencies and imbalances and recognize the beneficial effects of certain species, particularly legumes, as fertility improvers (Ramakrishnan, 1994). There are cases where farmers deliberately encourage soil biological processes such as termite activity to improve soil fertility (Swift *et al.*, 1993). Smallholders are also experts at managing crops and animals in complex systems and recognize the advantages of the integration between agriculture and livestock (Swift, 1999). Ethno-ecological parameters for predicting changes in climate and other environmental conditions have also been reported in some societies. Indeed, at the conceptual level, evidence from diverse human cultures indicates that farmers view ecosystem functioning in a very holistic manner, often encompassing the natural domain, the production domain as well as the social and even spiritual spheres (Johnson, 1992; Richards, 1985).

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Studies of traditional land use systems reveal the principles upon which tropical farmers base their agriculture. An example provided by both Alcorn (1999) and Stigter (1999) is where traditional farming systems are designed to use the resources available to them. The natural processes and elements are manipulated so they can be used as inputs and energy harnessed to a farmers' advantage (Alcorn, 1999; Obua and Muhanguzi, 1998). Alcorn (1999) has appropriately described traditional agriculture as 'nature subsidized'. Therefore, what modern agriculturalists call 'weeds' are not always necessarily weeds in indigenous farming. He aptly argues:

...wild plants are used to regulate soil fertility. Farmers use 'weeds' to make water and nutrients available to crops at appropriate times and overtime. They use native vegetation to shade the soil between crop plants from the sun's heat and rays, thereby maintaining conditions necessary for positive microbial processes in the soil. They allow wild plants to continue to trap nutrients from air and subsoil and hold them for future crops so the nutrients are not leached and lost (Alcorn, 1999).

Alcorn's assertion is also shared by both Ayers (1999) and Stigter (1999) who, on their part, acknowledge that facts related to the ecological requirements of particular species or crop varieties, speed of growth of particular species, relative values of local plants for firewood, site renewal, or plant indicators of the soil's quality, are less commonly tapped by outsiders. This is also related to what most indigenous knowledge experts characterize as vegetations management techniques to achieve soil conservation. Such practices range from swidden agriculturalists' selective protection of native leguminous trees in natural secondary regrowth to renew a site, to mulching with leaves from particular plant species (Alcorn, 1999).

It must, however, be emphasized that farmers generally engage in the management of soil fertility without sometimes intending to do so. When we talk about ethnobotanical knowledge (Alcorn, 1999; Kerven *et al.*, 1999; Sharland, 1999), we have to recognize that such knowledge is not only held by individual farmers, it is also held in the customary 'scripts' or ways of farming that farmers learn from their parents and pass on to their children. These are methods of farming that have been fine-tuned to local conditions by farmers experimenting with basic plans over generations (Alcorn, 1999).

Nonetheless, knowledge of biologically mediated processes that improve and maintain soil resources can contribute to sustaining the resource base.

2.1.3.2 Limitations of Indigenous Knowledge Systems

Scholars (Brokensha *et al.*, 1999; Stigter, 1999; Sharland, 1999) and institutions (UNESCO, 1995) with interest in indigenous knowledge all acknowledge the fact that as a 'science', indigenous knowledge has limitations. Timberlake (1994) has warned agricultural experts that to insist on the indigenous 'science' of farmers is not to revive the fifteenth century European ideals of the "Noble Savage" who could solve all the problems that existed. It should be stressed that indigenous knowledge systems and practices do not constitute the solutions to all problems inflicting the agricultural sub-sector in Sub Saharan Africa. The shared opinion is that, indigenous farming practices provide an excellent base on which appropriate soil and water conservation systems can be based (Ayers, 1999; Stigter, 1999). Therefore, according to Sharland (1999), rather than introducing new techniques the emphasis, wherever possible, should be on increasing the efficiency of indigenous techniques. But improved, they must because, as Reijntjes *et al.* (1992) observe, some of the indigenous farming practices are now almost becoming extinct.

A related implication is the heterogeneity of local soil knowledge: even within a single village, similar soils may be referred to by different names (Tabor, 1990). This can be of considerable importance, since one of the main reasons to opt for indigenous classification is in order to facilitate communication between farmers, extension workers and researchers. If a local classification has a high spatial variability, then in effect everyone is still speaking a different language. In such cases, it might be more useful to adopt a common, more general classification capable of integrating aspects of the relevant local and scientific classifications.

In addition, some domains in folk knowledge, according to Guillet *et al.* (1999) inhere not in one or a few specialists, the usual case for application of expert systems until now, but rather in the individual. In farming, it is the individual who must manage his or her specific plots using his or her personal knowledge (Guillet *et al.* 1999). The methodological problems relating to the study and understanding of indigenous

knowledge systems have been exhaustively discussed (Johnson, 1992; Birmingham, 1998). This methodological constraint is not in any way solved when anthropological methodological approaches are adopted in the study of such knowledge systems. Alcorn (1999), for example, has lamented that during field work designed to capture indigenous knowledge and practices relating to farming, farmers often do not know the reason for following certain activities; it is simply 'just the way it is done'. Farmers do not describe the details of their traditional farming activities well (Alcorn, 1999). A similar problem is the fact that indigenous knowledge is part and parcel of the oral tradition and, therefore, lacks consistency and uniformity. According to Timberlake (1994) much of this knowledge is orally transmitted and is threatened as Africans leave the countryside for the cities and as 'bush culture' becomes less and less a part of daily survival techniques. Besides, the spiritual aspects of indigenous knowledge systems are yet to be understood (Johnson, 1992).

It should also be noted that although farmers have a lot of knowledge and practical skills to manage their soils, this knowledge is neither complete nor always accurate. The bottom line is that whereas indigenous knowledge should be recognized and celebrated, this should not obscure the fact that there is a great deal that farmers do not understand about agro-ecosystem functioning and about their wider economic and policy environments (Bebbington, 1994). An obvious example of existing gaps in farmers' knowledge is the whole 'black-box' of soil micro-organisms. Since most of these life forms cannot be observed through normal human senses, they largely remain outside local people's boundaries of knowledge and experience. For example, in Busia district of western Kenya, smallholder farmers in Emuyafwa village reported that earthworms are known to be the most destructive crop pests on their farms (see TSBF, 2002 unpublished information).

At the practical level, some of the established 'indigenous' management practices, such as the incorporation of farm-yard manure or crop residues, may not always be efficient and cost effective. For example, according to recent studies carried out by TSBF under the previous IDRC grant, the use of low quality farm yard manure does not increase maize yields, and might even reduce nitrogen availability in the short to medium term

due to immobilization process (Mutuo *et al.*, 2000). The same immobilization effects have also been shown for low quality crop residues.

Given that the application of manures and crop residues are widespread practices among smallholder farmers in sub-Saharan Africa, there is a clear need to equip farmers with knowledge about the quality and effect of different organic materials they use on their farms. There is also need to demonstrate the economic trade-offs of using different organic and inorganic resources of different qualities. The latter can be done by using participatory assessment techniques which incorporate farmers' own standards of measurement, values and assumptions (see, for example, Sikana, 1994).

2.1.3.3 Integrated Knowledge Systems

The discussion above shows that there is need to facilitate a common understanding between scientists, farmers and other knowledge brokers and stakeholders about how agro-ecosystems operate and how best to manage them. This would facilitate the formation of a strong foundation for the integration of soil fertility amendment strategies. It would also eventually help in ensuring that the limitations of local knowledge are addressed. Given that the majority of African smallholder farming systems still largely depend on organic inputs for soil fertility improvement, this provides a good entry point for scientific intervention. A substantial amount of TSBF research in the last five years has focused on improving the efficiency of the use of locally available organic inputs.

In addition to farm-yard manure and crop residues, organic inputs from many sources can be used, such as legume cover crops, multipurpose shrub and tree prunings, and green manure. Moreover, inorganic fertilizers can also be used in combination with either all or any of the above local resources. It is here that knowledge relating to the management of soil fertility matters most.

Whilst the nutrient release from inorganic fertilizers can be easily predicted, organic resources vary greatly in their nutrient content, biomass availability, decomposition rates and nutrient release patterns. In order for farmers to make informed management

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choices, there is need to equip them with knowledge of nutrient values and nutrient release patterns of various organic resources at their disposal. Once farmers have incorporated such knowledge, they will be better able to make informed management choices to improve their production.

Nowhere is the integration of knowledge systems more apt than in the understanding of soils and how this understanding influences agricultural production. According to Tabor (1990), land classifications that are developed by farmers separate soils by characteristics important to the farmer. Soil scientists tend to be biased toward classification systems they know and thus commonly separate soils to fit the division breaks of their own system. This practice can overly complicate the soil survey, or worse, disregard separations that are important to the farmer. Local systems can provide clues for identifying those soil characteristics that are most limiting to land management and can help the soil scientist identify agricultural interventions that will most economically improve soils productively (Tabor, 1990; Sikana, 1994).

At the same time, local tenure relationships are more easily understood by outsiders if they know the local systems of land classifications. Many of the soils described by farmers in developing countries fit within the concept of soils, including their relative productivity. In some cases, farmers make finer distinctions than would normally be made in a conventional soil series (Tabor, 1990).

2.1.4 Gender and Indigenous Agricultural Knowledge

The gender dimension of agricultural systems seems to be gaining prominence. However, according to Ashley (2000), the issue of gender and its importance for an understanding of agricultural indigenous knowledge and farming system seems to have been completely neglected by agricultural development planners. Most scholars agree that knowledge and expertise may be divided according to gender. According to Warren (1998 cited, in Ashley, 2000), knowledge is part of the social fabric of any society, and gender is one of the primary dimensions of that social fabric. Similar assertion has been made by Virginia (1999) who argues that one important but often neglected dimension in the search for cognitively and culturally acceptable strategies is that even within one

community; different categories of farmers operate under various decision-making environments due to systematic differences in access to knowledge, resources and rewards. This is true not only with respect to socio-economic standing but with respect to gender as well (Virginia, 1999: 155).

This gender issue in agricultural indigenous knowledge, according to Ashley (2000), calls for awareness that men and women have different ranges of knowledge and expertise, and that it is essential to identify and understand how gender differences influence the structure of the social system. Inevitably, indigenous agricultural knowledge provides men and women with a structure in which they can play their roles, allocate their various resources and deal with different constraints in the farming system (Ashley, 2000). Indeed, gender is a vital variable in agricultural organization. According to Birmingham (1998), the division of agricultural labour by gender means that men and women are available at different times of the agricultural calendar.

The notion of sustainability, according to UNESCO (1995), raises the question of how nature itself is conceived and consequently of the cultural values that condition a society's relationship to nature. Important variants in attitudes to ecological sustainability demonstrate the need for a culturally diversified approach to issues of culture, environment and development (UNESCO, 1995).

Socioeconomic variables like land tenure, availability of labour and capital, access to knowledge and inputs and social as well as sexual dimension of labour, apparently relate to gender and are all factors in agricultural decision-making. The decision-making frameworks, processes, and outcomes of individuals reflect a vantage point, which has been developed through a lifelong curriculum of socialization embedded in social interactions (Virginia, 1999). The indigenous decision-making framework is not as homogeneous as it may seem but is greatly influenced by the decision maker's position in the internal differentiation of society. Therefore, Virginia (1999) insists that although every individual has some leeway for working the system to his or her minimum advantage, we cannot deny the "boundedness" of the system in which day-to-day agricultural decision-making takes place, nor the fact that the ability to recognize the

existence of the alternatives and exercise choice is directly proportional to the individuals standing in the hierarchy of social and economic relations. This is so not only because access to resource is systematically skewed but even more so because the distribution of knowledge is socially patterned (Virginia, 1999: 173).

Quoting Dey (1985), Rau (1991) points to the range of skills and knowledge that women in Sierra Leone have about rice cultivation conditions and practices, which have essentially been passed on from mother to daughter. These women farmers command detailed knowledge about soil types and salinity conditions, about problems of water control and the changing responses of plants to water variations over the growing seasons, and about methods to minimize weed growth and erosion and to maintain soil fertility (Rau, 1991: 148). Our concern should be to see whether women face constraints in applying this knowledge in farming.

2.1.5 Policy Implications

It is clear that the situation of soil nutrient depletion is particularly becoming grave, especially among smallholder farmers. As a result, tough decisions need to be taken and policies developed to deal with the problem of how best to achieve sustainable agriculture among smallholders. Following on the UNESCO appeal in Mexico, as in most developing countries, a priority problem is to find inexpensive ways of increasing food output using systems that take advantage of the characteristics of the local environment and that can be sustained without the need for large-scale inputs in terms of fertilizer, capital and equipment (Hadley and Schereckenberg, 1999).

Specifically, there is need in Kenya for the formulation of a national strategy and framework of action for the sustainable application of indigenous knowledge for development. According to Nyiira (2000), such a strategy should aim at empowering local communities to utilize, exchange, develop and protect indigenous knowledge and to promote its application within the development process. It encompasses the establishment of a system of national and international coordination and co-operation, and the design of mechanisms to promote the use of indigenous knowledge in development (Nyiira, 2000).

The promotion of traditional and local knowledge has important policy implications. There is further recognition of the important role of local communities in contributing their indigenous knowledge systems to enhance the sustainability of development programmes (Eyzaguirre, 2001: 39). Reorientation of the agricultural sub-sector is urgently being called for.

Although, according to Ghai and Vivian (1992), the importance of people's participation in sustainable development has recently become increasingly acknowledged, there is as yet insufficient analysis of the multiple dimensions that such participation involves. This is why Redcliff (1992) stresses the importance of developing a frame-work for analyzing the issues involved in sustainable development which take into account the need for people's participation and the utility of local level environmental management. The question of participation, including empowerment and local knowledge systems, must be addressed by any programme concerned with environmental issues in the context of development (Ghai and Vivian, 1992:3).

2.1.6 Conclusion

In conclusion it can be stated that the problem of soil nutrient depletion has particularly become grave among stallholder farmers who, because of their poverty, cannot afford the agricultural inputs needed to increase agricultural production. This problem, if not adequately addressed, could lead to dire consequences for populations that mainly depend on agriculture for their well-being. An emerging area of hope is the increasing recognition of the important role indigenous knowledge systems and practices can play in making agricultural systems sustainable. However, a lot has to be done in terms of documenting and sharing of this indigenous agriculture knowledge. Clearly, hope for increased production will depend on how farmers can manage to integrate the knowledge systems. There is also an increasing acknowledgement and awareness about the limitations of indigenous knowledge systems and practices. It is also clear that the appreciation and utilization of indigenous knowledge and skills has a lot to do with gender appreciation and policy adjustments.

2.2 THEORETICAL FRAMEWORK

This study adopted the theory of cultural ecology, which was developed by Julian Steward (1955). The distinctive feature of Julian Steward's approach is strict confinement of the application of ecological principles and concepts of explicitly delimited aspects of human social and cultural life for which they are particularly appropriate (Geertz, 1968:6).

Cultural ecology looks at how cultural patterns affect the environment and how the environment in retrospect produces and reproduces cultural adaptations (Steward, 1955). The theory simply refers to the dynamic interrelations of people, the environment and their culture. Therefore, cultural ecology is to be understood as the analytical tool for explaining the interrelationship between culture and nature. The original strategy of Steward (1955) differs from both cultural determinism, which explains adaptation to the environment purely as a result of culture, and environment determinism which tries to explain culture in terms of its environment (Wolf, 1964). In essence, cultural ecology is concerned with analysis of the way human beings interact with their ecosystems through culture. The approach provided by cultural ecology sees human behaviour as adjustable and humans as always attempting to come to terms with or adjusting to the prevailing environmental conditions which they find themselves in.

As a mode of analysis, Geertz (1968) explains that cultural ecology pays attention to the pervasive properties of systems upon systems (systems structures, systems equilibrium, systems change) rather than on the point-to-point relationships between paired variables of the "culture" and nature. For instance, one conceives of the techniques of swidden agriculture as an integral part of a larger whole which includes alike the adaphic and climatological characteristics of tropical forests, landscape, the social organization of labour force which must be shifted continuously from field to field, and the empirical and non-empirical beliefs which influence the utilization of scattered and varied land resources (Geertz, 1968: 10). Since this study took cognizance on both indigenous and modern science knowledge, it was important to include both cultures (indigenous and modern) as "social fields of interaction" (Wolf, 1964: 55). The interest

of involving both indigenous and western methods of the conservation of biodiversity is being explored and its possibilities stretched.

The approach, as argued above, sees human behaviour as adjustable and humans as always attempting to come to terms with or adjusting to the prevailing environmental conditions which they find themselves in. As Steward (1955) originally argued, the extent and nature of the exploitation of the environment is the function of the behaviour patterns of the community found in that environment.

Indigenous knowledge in this theoretical framework, therefore, is an aspect of social structure, which is functionally adjusted to the technological exploitation of the environment. With its roots firmly in the past, traditional agricultural knowledge is both cumulative and dynamic, building upon the experiences of earlier generations to the new technological and socio-economic changes of the present. The broad framework offered by cultural ecology enabled us to capture traditional farming strategies while addressing the dynamic nature of indigenous knowledge, including the inevitable gender dimension.

2.2.1 Relevance of the Theory to the Study

Cultural ecology is particularly appropriate for exploring the relation between cognition and behaviour (Guillet *et al.*, 1999). The central argument of cultural ecology is that human beings transmit instruments for adaptation to and controlling the environments. The environment, on the other hand, also necessitates the development of cultural traits that enable people to adapt to the prevailing condition within their own environment.

The field of study is characterized by an ecologically fragile ecosystem where smallholder farmers engage in resource-poor farming of complex, diverse and risk-prone agriculture. Indeed, as Steward (1955) originally postulated it, the question to surmount is whether the adjustments of human societies to their environment require particular models of behaviour or they permit latitude for a certain range of possible behaviour. Cultural ecology, therefore, presents an interesting and useful inventory of

the manifold cultural representation of land use pattern, which attests to the creativity of human beings in their dealings with nature.

Cultural ecology, like cognitive anthropology, can be characterized as the study of people's perceptions of their surroundings as reflected in their use of language. This perspective in this study will also be beneficial for the analysis of findings. The taxonomies resulting from such analyses reveal categories based on locally relevant criteria. (Harold Conklin, 1954, cited in Brokensha *et. al.*, 1999) the founding father of ethnoscience, argued against the commonly held view that swidden agriculture was irrational, economically unproductive, and an example of 'backward' agriculture. Using ethnoscience to understand farmers' attitudes towards their environment, Conklin was able to explain the rationale behind swidden systems and demonstrate that they were in fact quite rational systems.

Specifically, cultural ecology enables researchers to interrelate how cultural aspects affect land use patterns, allocation of labour, and beliefs about certain farming practices. It also helps in exploring the coping strategies that the affected people engage in when faced by natural hazards, drought and other adverse ecological situations. Local knowledge knows the local environment and how to generate its production capacities. Therefore, we should welcome the participation of local people in the planning of what is ultimately everyone's environment (Shilabukha, 2000). Cultural ecology, like ecology generally, forms an explicitly delimited field of inquiry.

2.3 ASSUMPTIONS

1. Farmers have indigenous classification system based on their culture used in differentiating local soils.
2. The situational status of soil fertility can be diagnosed through the observation of certain specific local indicators.
3. Farmers' responsive behaviour to soil nutrient depletion depends on their cognitive view of the local soil fertility indicators.

2.4 Definition of Key Terms

- Indigenous knowledge (Ik):** Knowledge of the people living in a certain area generated by their own and their ancestors' experience and including knowledge originating from elsewhere which has been internalized by the local people. It is also referred to as folk or local knowledge.
- Soil fertility management:** Strategy to maintain and possibly increase soil fertility for sustaining crop productivity through optimizing all possible sources of plant nutrients needed for crop growth and appropriate to each crop system and specific ecological and socioeconomic situation.
- Smallholder farmers:** Farmers with family farms or landholdings measuring less than 10 hectares.
- Sustainable agriculture:** Management of resources for agriculture to satisfy changing human needs, while maintaining or enhancing the quality of the environment and conserving the natural resources.
- Traditional agriculture:** Farming systems, which are based on indigenous knowledge and practices, and have evolved over many generations.
- Subsistence agriculture:** Farming systems in which a large part of the final yield is consumed by the producer. Most subsistence systems involve production of some crop for sale, but the ratio of subsistence to cash production may vary greatly from year to year.

CHAPTER THREE

METHODOLOGY

3. Research Site

3.1.1 Administrative Boundaries

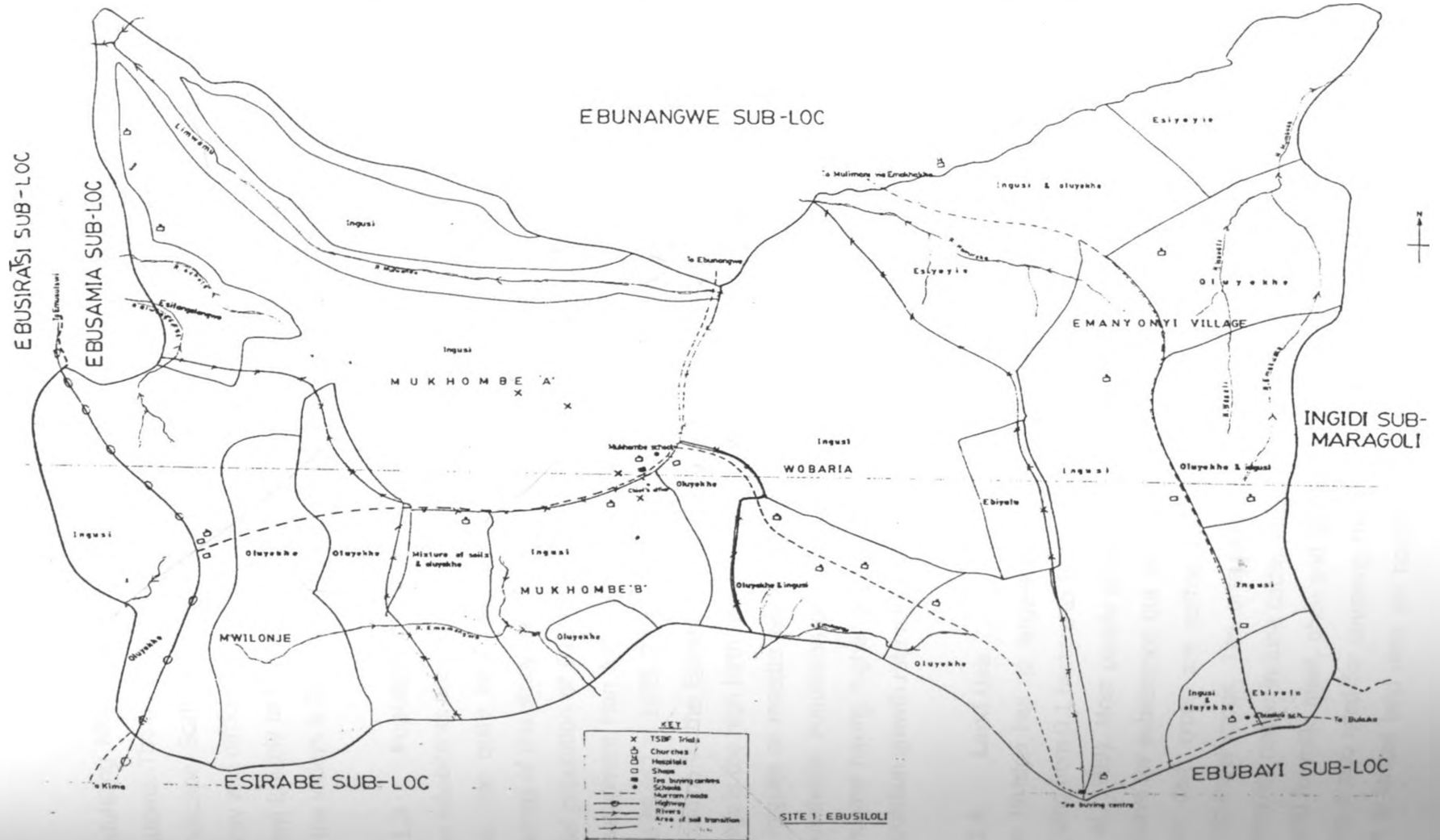
The study was carried out within Emuhaya division, Vihiga district, Western Kenya (Map 3.1). Vihiga district is bordered by Kakamega district to the north, Kisumu district to the south, Nandi district to the east and Siaya district to the south-west. The total area of the district is 613 sq.km. out of which Emuhaya division takes an area of 169.5 sq. km. (GOK, 1996).

3.1.2 Topography, Climate and Soils

Vihiga District lies on the eastern fringes of the Rift Valley's lake basin, and has an altitude that ranges between 1300m and 1500m above sea level and slopes gently from West to East. It is characterized by undulating hills and valleys with a vast network of streams and brooks which are tributaries of rivers Esalwa and Yala. The district experiences an annual rainfall, which ranges from 1500 to 2000 mm and which is bimodal in distribution. The peaks are gradually reached between April and June for the long rains and September and November for the short rains. The months of December to February are generally characterized by low rainfall. Emuhaya Division receives the lowest amount of rainfall compared to the other divisions of Vihiga because it is on the leeward side of the Maragoli hills (GoK, 1994b, 1996; Muruli *et al.*, 1999).

The soils in the district include the well drained, dark red friable soils partly covered with humid top soil derived from both volcanic and basement complex rocks and the yellow red loamy soils derived from both sediment and basement. And according to Muruli *et al.* (1999), the soils in Vihiga are losing their fertility through leaching and over-cultivation. The Tropical Soil, Biology and Fertility Programme under the Folk Ecology project have also characterized the soils using indigenous classification criterion. Map 3.1 shows local soil types of Ebusiloli (study area). The soils include the predominant loamy Ingusi which is well spread in the more plain land surfaces as well as in the

Map 3.1: Map of Ebusiloli Location, Emuhaya (study area) showing soil types in local names.



undulating hills. In fact, Ingusi is found in many places in Ebusiloli except in valley bottoms. The other soil type is the sandy Oluyekhe which is scattered over the Ebusiloli landscape. Scattered mainly on valley bottoms is the Limwamu which is black in colour, sticky and difficult to differentiate from the clayish Litoyi which is dark grey and smooth. Litoyi is likely to be waterlogged with low fertility and is found in swamps. Also common in the valleys is Sirongo which is also clayish but white grayish in colour.

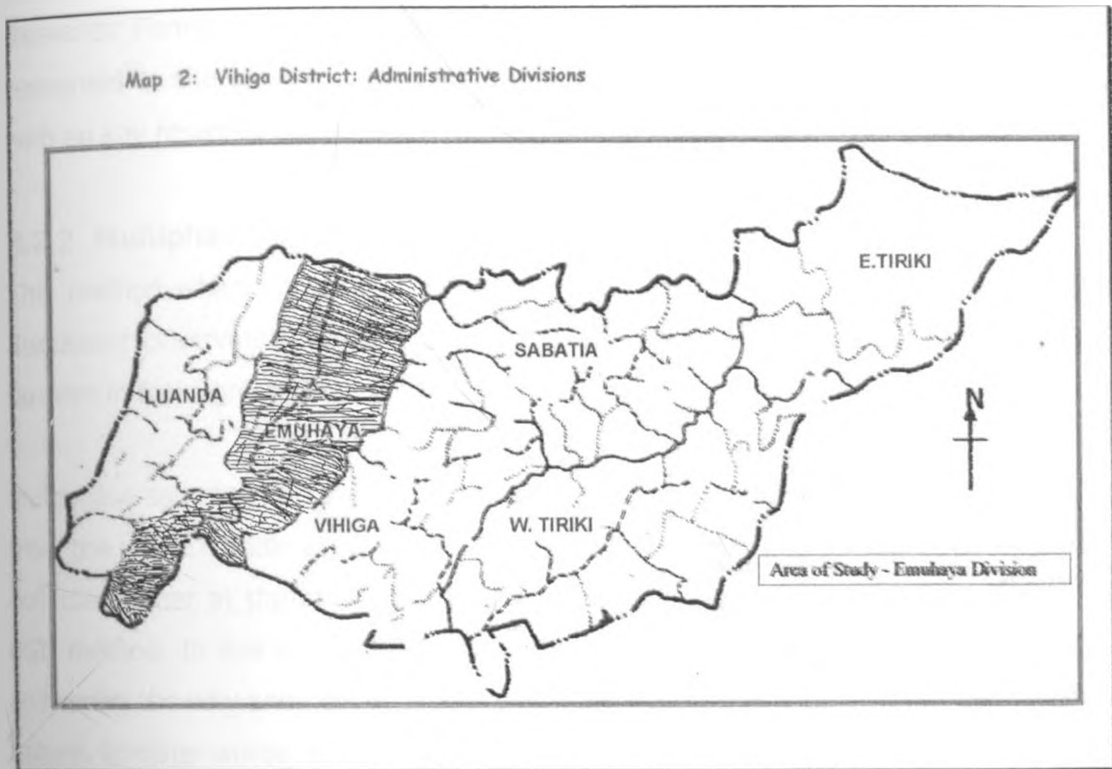
3.1.3 Population size and composition

The inhabitants are predominantly the Abanyore and provided a homogenous population that was quite beneficial for the analysis, interpretation and generalization of the findings of this study. According to the 1999 population census, Emuhaya division had a total population of 69,250 people (CBS, 2001). Earlier, according to the Vihiga District Development Plan for 1994-96, Emuhaya division had a population of 84,062 in 1997 and 89,952 in 1999. This represents an increase of 3.1% per annum. The main reason, according to the Government of Kenya (1994b), for this high density in population in Vihiga is the high birth rate coupled with attachment to ancestral land and unwillingness to migrate or resettle elsewhere even when available land space is dwindling for some households. Population density in the district varies across divisions, with Sabatia and Emuhaya having higher population densities than others. But Kenya is known for high population growth rate nationally.

3.1.4 Land Use

The Division has no large-scale farms. The agricultural land comprises smallholdings ranging from 0.1 hectare to 12 ha. The average land size in Vihiga district is 2.29 (Muruli *et al.*, 1999). Most people grow food crops such as maize, beans, millet, sorghum and cassava for subsistence but this is sometimes sold to small-scale business people. The main cash crops are coffee and tea though Emuhaya division has potential for horticultural crops. The area also has a potential for poultry production. Livestock commonly reared include cattle, sheep, goats and donkeys. Cattle, goats and sheep are reared for milk, meat, ghee and dung used as manure for increasing soil fertility. Cattle dung is also used for smearing the floor and walls of houses and granaries. However, due to limited land sizes per household the district does not have an extensive pasture

land and most of the napier grass fed to zero-grassed animals is grown along road reserves adjacent to the individual farms.



Map 3. 2: Map of Vihiga District showing Emuhaya Division

3.2 Sampling

While the sampling population for this study was the entire households in Emuhaya division, sample selection was made a little bit easier through the adoption of sampling strategy of the Tropical soil Biology and Fertility Programme. If anything, the statistical estimates for the existing households in Emuhaya were available from scientists working in the area. This made sampling more certain and easier.

3.2.1 Sampling Strategy and Sample Size

The initial sample of respondents enrolled in this study was drawn from the list of farmers working in partnership with the Tropical Soil Biology and Fertility Programme (TSBF). Therefore, the study adopted a sampling strategy designed earlier by the Tropical Soil Biology and Fertility Programme (See, for example, Muruli *et al.*, 1999;

Misiko, 2002; TSBF, 2002 unpublished data), which sampled a 1/5th of the households in the villages of the study area. Thus, every 5th household of each selected village was sampled for the study. Under this strategy, a total of 100 farmers (48 TSBFs' Adaptive Research Farmers and 52 non-adaptive research farmers) were reached. Further, responses to the survey questionnaire provided a criterion on who to make follow up with on key research themes.

3.2.2 Multiphase Focus Panel Method

This method which combines a statistical sampling method and socio-anthropological discussant observation of focus group discussion panel method, was used to sample farmers in focus group discussions.

Multiphase sampling is a type of sampling design in which some information is collected from the whole sample using the random sampling method and additional information is collected either at the same time or later from sub-samples of the full sample by the FGD method. In this study, this method was useful in recruiting farmers who helped in answering the why and how questions which are descriptive and, therefore qualitative in nature. In other words, since the socio-economic and demographic characteristics of the discussants had been gathered from the survey, FGD sessions concentrated mainly on the study discussion themes as derived from the study objectives.

3.2.3 Judgment and Snowball Sampling

Judgment and snowball sampling methods were used towards the last phase of the research to help identify key informants for follow-up study. In order to obtain the targeted sample size, the study adopted the purposive sampling strategy where the snowballing method was used to get the required number of farmers and indigenous knowledge experts. Here, it was useful in finding population sub-groups such as the elderly, the youthful, female and male farmers and people with knowledge and interest in ecology. Additional clusters of farmers were sampled with the assistance of local extension workers and agricultural officers.

Unlike during the survey where a standard questionnaire was used, a different type of instrument, an open-ended guide, was used to facilitate information gathering for this part of the study. This interview guide was prepared after the field activities had started and, therefore, aimed at feeling the gaps that were already emerging. In-depth and key informant interviews also served the other role of enriching and verifying the information gathered from respondents during the survey. Data gathered from these informants have been analyzed qualitatively.

Nevertheless, the sampled farmers have yielded information that is representative of the focus of the study, keeping in mind that the interest was indigenous knowledge and soil fertility decline. The unit of analysis was, however, the individual farmers. Also, indigenous knowledge experts within the study area were sampled. The importance of such a cluster of persons was to enable the research to gather information from a third party.

3.3 Methods of Data Collection

As mentioned above, the study mainly adopted qualitative methods of data collection. However, some quantitative methods were also employed to enrich and give orientation to the study.

3.3.1 Structured Interviews

Some 100 farmers were interviewed to obtain quantitative data which has enabled quantitative analysis to be done. Questions under the standard questionnaire were mainly used to gather information on the background characteristics of the study sample as well as provide insights about farm characteristics and crops grown (see Appendix 1). Interviewing wealthy, poor, men, women, elderly and young people separately allowed wealth, age and gender-based differences in knowledge and practices to emerge. Other data gathered with the use of the standard questionnaire were the type and frequency of input use, advantages of such inputs and constraints faced when such inputs are used on farmers fields.

3.3.1.0 Pre-testing

This involved a pre-administration of questionnaires to ensure that the questions that might be vague were changed or restructured before the full-fledged study. The aim of this was to improve questionnaire workability through correct wording, and appropriate ordering so that questions could be made clear. Although the questionnaire was still relatively long after the pre-testing, its understandability to the study population was considerably enhanced through appropriate rewording.

3.3.2 In-depth/Open-ended Interviews

The study targeted 30 farmers for open-ended interviews. The qualitative data generated here consisted of direct quotations from farmers about their opinions, views, feelings and knowledge about the situation of soil fertility depletion within the study area. They helped gather information on either the shortcomings or some issues the researcher wanted to revisit arising from the standard questionnaire and was based on in-depth interview guide attached in Appendix 2. Questions in this interviews focused on the delicate issues of local soil classifications and differentiation. The other specific area of focus was the local indicators of soil nutrient status within their farms and strategies used by them to manage soil fertility. These interviews were held as a follow-up to the standard questionnaire.

3.3.3 Key Informant Interviews

Key informants were people who are knowledgeable about farming systems within the study area. Such people were outside the study sample and included extension workers, agricultural officers, environmentalists, Environment Development Officers and staff members of agricultural research agencies within the study area. A total of 25 such key informants, including five elderly farmers, were purposively sampled for this study. The information gathered from key informants has yielded the information on traditional soil amendment strategies, some of which have been abandoned by the Abanyole. The other focus of the key informant interview schedules was to get a third party opinion on the soil amendment practices used by farmers both in the past and currently (see Appendix 3). Key informants were also resourceful in defining soil and its characteristics

as well as delineating the intricate relationship between soils and land as understood by the Abanyole.

3.3.4 Focus Group Discussions

As a qualitative method of data collection, focus group discussions brought together 6 to 12 people who were expected to give qualitative data to fill the gaps in knowledge on issues arising from the field. In setting these groups attention was paid to homogeneity of the participants to give ample room for free discussions. A total of 10 focus group discussions were held in this study. These involved farmers who were divided into groups on the basis of age and sex. Keen attention was paid to the gender concerns of indigenous agricultural knowledge that emerged during group discussions.

Focus group discussion (FGD) participants were treated to open-ended discussion questions categorized according to the thematic issues based on the research objectives of the study. During discussions facilitated by a local research assistant, notes were made which were later translated and analyzed. Similarly, information recorded on tape was transcribed and later translated before analysis. In this report, information emerging from focus group discussions has been used to give details about soil classification, soil nutrient diagnosis criterion and past and current soil nutrient amendment strategies.

3.3.5 Direct Observation

This aided in getting information on the farmers' behaviour, actions and the full range of farming methods that relate to soil fertility. Direct observation helped reveal what farmers do rather than what they said they do, thereby enriching the emic understanding of the study. In essence, observations made in farmer's fields revealed links between what they say (theory) and what they do (practice), and also illustrated practices and beliefs which either cannot be readily described or represented tacitly. Direct observation on farmers fields was enhanced during the field visit by TSBF staff as this helped camouflage the researcher intentions from the farmers point of view.

3.3.6 Secondary Data

Secondary data was obtained and involved written documents including those of agricultural research institutions within the study area. Studies done by the Tropical Soil Biology and Fertility (TSBF) as well as those undertaken by the Institute of African Studies (IAS), University of Nairobi proved valuable in providing orientation for this thesis.

3.4 DATA ANALYSIS

Data obtained from qualitative methods (open-ended, in-depth interviews and focus group discussions) were analyzed using qualitative methods of data analysis. Here, analysis centered on the search for the emic perspective and the documentation of folk analyses. Therefore, direct quotations and selected comments from key informants have been used. In this report, where necessary, Lunyore translations have been given followed by English equivalent translations. Also, the production of native folk taxonomies as a technique of qualitative analysis has been adopted. In line with cultural ecology, this has enabled the description of how people divide up the domains of culture, and how the pieces of domain are connected. Finer and further analysis of the emerging information has been done using the ATLAS.ti computer package of qualitative data analysis.

Data obtained from structured interviews or closed questions have been analyzed using quantitative methods of data analysis. Such information has been quantitatively presented in tables of frequencies and percentages based on the use of the SPSS software programme. Cross-tabulations have also been used to show relations between different variables.

3.5 PROBLEMS ENCOUNTERED DURING FIELD WORK

The study began when the long rains had not yet started and, therefore, the debilitating heat made not only the travels but also the fieldwork uncomfortable and tiring. It was also learnt that most farmers are not comfortable, especially with discussions touching on farming activities, when rains fail to arrive on time. The long awaited rains came two weeks after the study had begun but this too, had adverse effects on the field work

since it rained continuously, thus delaying the scheduled data collection activities. Moreover, many farmers were fully engaged in farming, and finding them at home became difficult the more it rained. Interviewing farmers on their fields when the rains failed or during morning hours and persistence in the number of home visits were part of the solutions to this natural problem.

Secondly, the main research instrument, the questionnaire, was fairly long and needed a lot of persuasion and patience to entreat the participation of farmers to the end of the interview process. This fairly long questionnaire was retained deliberately even after the pre-testing for purposes of comprehensiveness and thoroughness in the research issues at hand. Initially, the interviewing process was tedious and exhausting, but with time the work lessened and an average interview took about 30 minutes to accomplish. Additional problems were only encountered when follow-ups were made for clarification by farmers who had already been interviewed. This was particularly serious when the nature of the follow-up was such that the farmer was required to participate fully again as key informant.

Nonetheless, apart from inquiring about future assistance to them, most of the informants were happy to be interviewed and did not bother so much with the issue of time. If any thing, some farmers volunteered to be interviewed even if they were not within the sample frame. Such farmers were entreated to informal interviews to provide back-up information on the issues arising during the research process.

It was also learnt that in certain parts of Emuhaya, some researches had been done earlier by other organizations and individuals. Households which had participated in those researches were wary of this particular study claiming that the results of such exercise would be futile since they would not benefit them. Such households were assured that the partnership between the university and the research organization sponsoring this study is strong enough and is better placed to advise the government in designing suitable development agenda, which would benefit them. This won their trust and confidence.

Deaths and funerary rites that followed were also observed to be genuine problems that not only affected farmers but also the researcher in the study area. Among the Abanyore, people do not go to farms when one of them is dead and is not yet buried. When the dead person is an elder, people take leave from farming for as long as two weeks. During this research, deaths were very common especially in the villages of Wobaria and Emanyonyi. Additional research days were needed to exhaustively get through the research process.

The research was done among the Abanyore by a researcher whose native language is not Olunyore. The linguistic constraint encountered was, therefore, great. This was particularly made worse when the focus of research was on the local knowledge of soils which required that farmers provide details in their own language. A local research assistant was recruited to help overcome this constraint. In addition, the respondents were encouraged to speak in Kiswahili where possible.

3.6 ETHICAL ISSUES

As with all ethnographic studies, this study adhered to the code of ethics in conducting anthropological research. This called for openness and clarity about the purpose of the research by explaining the nature of research, being honest to proper demands of host visitor relations and emphasis on the need for and importance of free and open discussions. Getting the informed consent of the respondent/informants before recruitment in the study was also mandatory.

The research also sought to conceal the identity of the informants in order not to harm their safety, dignity or privacy. If names are recorded, such names have been pseudonymised during data presentation and analysis.

Also, to the community studied, the results have been conveyed during community meetings or workshops in which the common indicators of soil nutrient depletion have been pointed out and problems faced by farmers in soil fertility management highlighted. Farmers were also sensitized on the need to preserve and maintain soil nutrients if their farming is to become sustainable.

CHAPTER FOUR

CAPTURING THE KNOWLEDGE OF LOCAL SOILS

4.1 Background

This chapter presents the socio-demographic and economic characteristics of the population as well as the background information on land and local soils. As already indicated, in this study 100 households were covered in an extensive field survey spanning over two months (72 days). To gather detailed information so as to bridge the gaps in information emerging during the survey, some 30 farmers were purposively sampled for in-depth interviews. In addition, some 25 key informants were purposively sampled under this study. These informants were external to the study sample and helped in capturing the historical perspective on the soil amendment strategies among the Abanyore. The aim of this chapter is, therefore, to shed light on socioeconomic and other factors that characterize smallholder farming in Emuhaya division.

The initial activity in this study was the analysis of information on farmers' wealth category as obtained through a wealth ranking exercise facilitated by the Tropical Soil Biology and Fertility Programme (TSBF). A number of wealth ranking activities based on farmers' own criteria have been carried out within the study area. Two important indicators of wealth status identified by farmers themselves include the size of landholding and the number and type of livestock owned.

Poor farmers typically have either one or two indigenous or crossbred cows on their farms or no cattle at all, because they lack cash to purchase animals and enough land to grow pasture or fodder. This study sampled more poor farmers (69%) than wealthy ones (31%). Farmers keeping livestock, especially cattle, face fewer problems in managing soil fertility. In addition, as discussed below, farmers with limited landholdings face additional constraints in the adoption of certain agronomic practices such as the use of fallow. As will be seen in this study, farmers with limited landholdings face limited options in the choice of soil amendment strategies available to them.

Table 4.1 shows the information on land size of the respondents. As can be seen, most of the respondents have acreages that range between 2 and 3 acres. The limiting land size is a constraint in the utilization of different soil fertility management practices. Yet, land is not for farming alone. This study found that some 14 farmers had croplands that were less than 0.5 acres. Perhaps, other sections of these small parcels are being used as homesteads. With limited land holdings and none for cropland expansion, the success of food production in this area depends mainly on how well the soils are managed. Yield, which is the indicator of good agricultural practice, is now mainly dependent on soil fertility. The observed relationship between farm size and crop yield points to the danger that increasing population pressure on available land poses to food production in the study area.

Table 4.1: Number of farmers interviewed with landholdings in different size categories.

Size in Acres	Number of Farmers	Percentage
Less than 1 Acre	17	17
1-2 Acres	18	18
2-3 Acres	48	48
More than 3 acres	17	17
Total	100	100

The land size categories provided in Table 4.1 should not camouflage the fact that there is also a big difference in landholdings between different households within the study area. In fact, according to the wealth ranking exercise undertaken in the study area by the Tropical Soil Biology and Fertility Programme (TSBF), farmers themselves mentioned land size as an indicator of wealth status. However, as pointed out above, not all households that have land have the ability to put the whole of their land parcels to production.

As is expected among communities with limited landholdings, the main means of land acquisition among the Abanyore is through inheritance. This study revealed that 96% of

the farmers interviewed had acquired part or the whole of their plots through inheritance.

The study showed that livestock farms are generally larger than non-livestock ones. More livestock were found in households with more land and labour. Cattle ownership among smallholders has become one of the key criteria for distinguishing poor from wealthy households. Because cattle ownership is associated with status enhancement, households with livestock especially cattle were observed to be relatively well-off. As can be seen in Table 4.2 below, poor households have either indigenous or crossbred cows on their farm or no cattle at all. In this study, wealthy households exclusively owned grade cows. Other types of livestock owned by the respondents include sheep and goats. Poultry are owned by both poor and wealthy households, and play a significant role in household economies, and have great potential for soil fertility improvement.

The main livestock outputs are meat, milk, eggs and manure, which are consumed in the household or sold for cash. The use of livestock for beef production at the household level has declined considerably and the local population purchase beef and beef products from local butcheries. Sometimes, these animals are sold for revenue. Apart from the economic returns, these animals have social and cultural importance. Livestock are used as social security items during emergencies such as illness, funerals, and parties and paying for school fees and sometimes even fines.

This partly explains why indigenous breeds are preferred to crossbred or grade cows. Indigenous animals are more easily used in bride wealth payments, sold for quick cash or loaned to poor relatives in return for labour and other benefits. Cattle among the Abanyore are also generally perceived as a traditional form of wealth, a status symbol and a source of prestige and are, therefore, considered being higher status symbols than sheep and goats. While goats and sheep could be cheaper to acquire, farmers in Emuhaya indicated a strong preference for cattle, arguing that the latter are easier to raise. Farmers also reported that there is no entrenched tradition of consumption of goat and sheep products in this community.

The social functions of these indigenous cattle to smallholders cannot be substituted by the more extensive, higher yielding exotics despite the high returns from the latter. Informal interviews and observation during this study, however, point to the fact that not all households that have cattle use animal manure to manage their farms. Manure, like napier, can be exclusively for sale.

Table 4.2: Number of Respondents by Wealth Category owning different types of Livestock

Livestock Type	Farmers Wealth Class					
	Poor Farmers (n=69)		Wealthy Farmers (n=31)		Total (n=100)	
	Number	%	Number	%	Number	%
Indigenous cattle	48	69.57	6	19.35	54	54.0
Grade cattle	0	0	11	35.48	11	11.0
Cross cattle	4	5.8	23	74.19	27	27.0
Sheep	11	15.94	3	9.68	14	14.0
Goats	9	13.04	5	16.13	14	14.0
Poultry	68	98.55	28	90.32	96	96.0

Although men who also make important disposal decisions such as sales, slaughter and home consumption mainly own family animals, women are better placed to make decisions on their manure. For instance, direct observation confirmed that poultry litter in many households is handled as part of household refuse which is in the control of women.

Sixty percent of the respondents were women. That most of farmers in this study were women is mainly explained by the fact that males usually tend to migrate from rural to urban settings for formal gainful employment. Such men who migrate to towns may at times send cash remittances from time to time to help their rural relatives manage farms. In addition, some men could be engaged in off-farm wage employment but still

stay within rural areas. Women, therefore, manage a larger proportion of agricultural production within smallholder households.

Since many smallholder farmers are women, the failure among most of them to appropriately put into practice some of the recommended agricultural practices could be interpreted to mean that such information is not reaching women. Alternatively, most women lack disposable cash income and cannot afford the strategies proposed in the disseminated agricultural information.

Table 4.3 below illustrates the distribution of the respondents by age. As the table shows, three-quarters (75%) of them were below the age of 50 years. This shows in part that in this community, farming is an occupation that starts from an early age. Therefore, by the time a farmer acquires an age that is above 50, as is the case with 25% of the respondents, he or she has acquired and accumulated detailed knowledge relating to farming and the environment.

Table 4.3: Distribution of Farmers by Age

Age	Number of Farmers	Percentage
20-30	21	21
31-40	24	24
41-50	30	30
51+	25	25
Total	100	100

Further evidence confirming that farming as an occupation in the area starts early was generated when farmers were asked to state the duration in which they have been farming. Eighty-six percent of the respondents indicated that they had been engaged in farming for a period of more than 10 years. Only 13% had been farming for less than ten years. However, this last category also reported that they have been farming for a period of between 5 to 10 years. Knowledge and skills developed during long periods of farming is of vital importance to the practice of sustainable agriculture.

Most of the respondents who participated in this study were literate, as data in Table 4.4 shows. In fact, 46% had attained educational level of secondary school and above. That farming can still attract people with good formal education is testimony to the role agriculture plays in providing survival needs for rural households.

The benefit of having farmers who have undergone formal education is that they can understand and appreciate agricultural information provided to them from whatever source. On the other hand, such farmers often articulated without any difficulty their experience and knowledge acquired through farming. In Kenya, agriculture as a subject is taught in schools and people who have undergone some schooling must have come across literature or ideas relating to soil fertility management. Such farmers understand the reasoning behind the promotion of modern soil fertility amendment strategies better.

Table 4.4: Number of Respondents by Education

Level of Education	Number of Farmers	Percentage
None	15	15
Primary	39	39
Secondary	34	34
Post secondary	12	12
Total	100	100

Maize is the most widely shared crop and staple food in Vihiga and is always grown together with beans as an intercrop. Other crops grown in the area include sorghum, potatoes, cowpeas and yams while bananas are mainly grown in homegardens where indigenous vegetables also grow. Tea, coffee and French beans are important cash crops in Vihiga district although not so many smallholders have these crops. Vegetables such as kales (*sukuma wiki*), onions and tomatoes, as well as horticultural products such as avocado, citrus fruits and pineapples, are becoming important as small-scale cash-crop enterprises in Vihiga.

The choice of crop to be grown was said to be influenced, to some extent, by the reason as to why the crop is grown altogether. Maize is, therefore, favoured because of its many uses such as fodder for cattle, as fuel, as manure (stovers) and as food for humans. Besides, maize has a ready market as was pointed out by smallholders during the interview.

Contrary to the assumption that smallholder farmers usually engage in agriculture for purely subsistence needs, this study found that the need for cash is as important as for food among rural farming households. Out of the 100 respondents who participated in this study, 61% said that their reason for farming was both for food and for cash. Therefore, crops that can provide both food and cash like maize are preferred. Nevertheless, napier and trees (especially Eucalyptus) are significant in both land management and for household consumption.

Unique croplands, which deserve attention in Emuhaya, are the home-gardens. These gardens demonstrate richness in space use by farmers. Most crops in the home garden include indigenous vegetables that need special tendering to thrive such as pumpkin, *crotalaria* spp., *amasasa* and Amaranthus including pigweed. There are also bananas and trees providing the necessary shade for other plants. Because they are located next to the house, these gardens also serve as the most convenient place to dump household refuse (including wastewater). Moreover, because most of the compost pits are located under the shade provided by plants in these gardens, these plots seem to benefit more than the other plots from the manure prepared in these pits.

A major feature of the home gardens is that the emphasis is not on maximizing yields, but rather on ensuring that there are some products throughout the year. The management strategies employed in these home gardens are, therefore, different from those employed in other fields.

Home-gardens are also farmers' experimental and demonstration sites. As such, nurseries for beneficial crops and plants are found within these plots. A unique feature also in some of these gardens is the existence of seedlings or plants on sacks or

containers in the shade of trees or bananas and which are cared for in a very specific manner. Using the space above the ground is not only a strategy of maximizing soil use but also a way of protecting plants against free ranging poultry and other domestic animals.

Although, in terms of access and control, the home garden is the domain of women, this does not mean that other family members, and especially men, have little access to these gardens. In this study, direct observation revealed that there exist in these gardens different areas of male and female influence. Among the Abanyore, men tend to put claim to the ownership of bananas while women on their part own indigenous vegetables within the home-gardens. In addition, children have a role to play within these plots and usually begin their farming lessons in these gardens. It is, therefore, reasonable to state that the acquisition of indigenous farming knowledge starts at the home garden.

4.2 KNOWLEDGE OF LOCAL SOILS

Although, this section aims at presenting the knowledge of local soils, it starts by providing some insights on the informants' perception of land in general. This is because it was realized during discussions with key informants that the distinction between land and soil was not perfectly clear in the local context. The chapter then proceeds to provide presentation of the criteria employed by farmers in classifying and differentiating local soils as well as the findings on the indigenous diagnostic criteria for discerning soil nutrient status. Farmers' own account of their sources of knowledge of local soils is reported in the last section.

4.2.1 Perception of Land

Being traditionally a farming community, the Abanyore attach great importance to land. Land (*Omukunda*) according to key informants, is the greatest asset that people can possess. All struggles are waged to acquire or retain an already acquired land. It is the concept land that comes to mind among the Abanyore when one talks of farming.

Therefore, according to one informant, before talking about the soil (*liloba*), people should strive to understand the land, in which soil lies:

Land is bigger than soil. It is land that gives birth to soil. But we need land even if the soil in it is not good. If I can get land with good soil that is my luck. But I cannot leave my land even if the soils are bad.

The other interesting account given by one key informant is that while soil can change, land never changes. The physical properties of land change but the land boundary or demarcation remains. Therefore, according to farmers, whereas good soil is good for farming, good land is good too. Nevertheless, good soil is found in good land. An account by one elderly key informant revealed that farming land with good (fertile) soil is valued more than any other land. As a result, it can be argued that for the Abanyore, land is a valuable asset as pointed out above. Land among the Abanyore, is perceived more as tangible part of the earth which never goes away.

Traditionally, other than for farming, land is also valued for grazing and settlement. The Abanyore highly valued land that is found next to a water point. This is because "such land is good for cultivating vegetables even during the dry season". The two categories of land considered sacred by these people include the land that houses the spirits of the lineage ancestor, and/or former homestead land. But when soil is mentioned among the Abanyore, it is farming that comes to mind, as one key informant tried to explain:

... when you talk of soil we think of farming. For example, I can say that the soil in my land is good or bad ... but if you mention land, many things come to mind. It can mean anything ... again if I say that my land is bad many people will know that my land cannot produce food... bad land or bad soil does not support food production ...

The Abanyore, like most Africans, value land and as such, in the traditional context, land, according to elders, had no exchange value but had only use-value. Sale of land in the traditional context is unheard of. Land is valued most if the ancestors had fought and died for it. The elderly, when discussing issues pertaining to land, mention this account repeatedly. There seems to be no stronger claim to land than that it was acquired through conquest and blood. Land, therefore, draws its value through blood.

Land in the words of the Abanyore, must be protected at all cost. It should be noted that farming alone does not give land its value. Even hilly grounds that are uncultivated have social, cultural and spiritual values for their owners.

Traditional perception of land and landscapes, to some extent, influence the use to which a particular parcel is put. According to farmers, two of the most important factors that determined what was done on a land parcel included the position and the soil type in a particular land. According to informants, among the Abanyore, the best soil was reserved for farming while slopes or valleys were left for growing pasture and land on protruding (hilly) surfaces were reserved for homesteads. Homesteads were also situated close to water points. The informants, however, noted that there are changes to this perception about land and how it should be used.

However, an understanding of how the Abanyore perceive land is of vital importance for any person that needs to understand their knowledge of soils. This is because, according to elderly farmers, soil types depend largely on the land in which they lie.

In an attempt to draw a distinction between soil (*liloba*) and land (*Omukunda*), one informant used the metaphor of the pot or the container and the water in it. She argued that land is the pot or container and soil the water in it. According to her:

When you have water inside a calabash, you should look after it properly. You should not allow water to go to waste. You need that water. Every time, you guard against animals or things that might pour this water out... if through bad luck this water goes to waste you still have that calabash and next time you have water in it you become very careful.

This analogy of land being the container for soil was widely shared among key informants. However, the informants asserted that soil and land are inseparable. In this context, one elderly (male) informant linked land to a woman and soil as her 'placenta'. Consequently, he argued that land without soil is a woman without placenta or one whose placenta is bad or sick. Similar assertions were made during sessions discussing soil fertility. For instance, farmers used the term *obukumba* (Lunyore word for barrenness) to characterize soils or lands that could not support plant growth. Just like a

woman with good placenta would produce children, a good soil is expected to support crop production. Farmers characterized erosion to bleeding which can otherwise undermine the reproductive capability in a productive mother.

Nevertheless, informants agreed that soils are the most important parts of land. Soil is the 'nose' that land uses to breathe. Soil, another informant noted, is the oil of land (*amafura komukunda*). Or more importantly, soil is the 'soul' or 'heart'; '*omwoyd*' of land and without it, the land is as good as dead. Still on the analogy that attempted to compare land to human beings, one informant asserted that soil is like blood to land. Clearly from the assertions above, one can argue that soil is the living part of land. That soil has life was also shared during focus group discussions on the characteristics of soil. Presentation of human attributes to soils was common among smallholder accounts and was explained by the fact that smallholders believe that soils have some kind of life force inherent in them.

Moreover, whereas most statements attributed to land point to it as masculine, the opposite is true about soil. Soil is perceived to be feminine in many aspects. The impression given by the Abanyore is that soil is our mother that feeds us. Taken further, this perception to some farmers imply that soil is in inseparable union with the land as created by God and that it is the role of farmers to ensure that soils do not separate from the land. Knowing therefore that there are many forces that can separate land and soil, farmers should therefore be vigilant and deal appropriately with these forces. One such force that farmers should guard against is erosion!

4.2.2 Perception of the Soil

Farmers found the attempt to define soils difficult because, as they argued, some things do not have direct meanings or true equivalents. Soils, farmers argued, are not abstract entities and can only be defined in reference to other entities. Among the Abanyore, soil is viewed holistically. Soil (*eliloba*) in the understanding and perception of many farmers is a living natural body. And because soil has life, farmers, in describing it, used metaphors and analogies, similar to those used in reference to animals or humans. Yet, soil is larger than animals or humans. The supremacy of soil over all creatures was given by the assertion that all life came from soil. Whether within

the traditional belief system or the modern Christian teaching, farmers stressed that soil is the origin of people (*abandu neliloba*). Some of these testimonies can only be found in the bible as one key informant put it.

Soil is, therefore, sacred. But farmers also understand that soil was originally created by God (soil is god given). Soil is seen as God's gift to humankind. The sacred nature of soils means that soil is perceived with both fear and respect. Soil is the thread that links humans to the spiritual world. Key informants who contested the statement quoted above stated that soil is only our pathway to God. Soil is a means to an end (to God) and not an end in itself. Similar assertion was also given in relation to food. One participant in a focus group discussion had defined land as food, *udongo ni chakula* (Swahili term for soil is food). While the other participants accepted this definition, one of them sought to clarify that soil is only a means of acquiring food, that is, our pathway to food.

The holistic view of soil is widely shared among the Abanyole. Naturally, soil is the world: there is nothing in the world if not soil. All things exist in the soil or because of the soil. Like Mother Nature, soils feed the world and every life in the world. Soil is therefore life (*udongo ni maisha*, Swahili term for soil is life). Soil is also defined in relation to its economic importance. Economically, soil is wealth (*elilova ni emali*, Swahili term for soil is wealth). Those who have land are therefore considered wealthy. However, as stated above, soil only has use value but no exchange value in the traditional context. The exchange value of land can be derived from the production of food, the provision of pasture and the construction of settlement.

Soil also has social, cultural and historical implications. Farmers, as reported above assert that soil was fought for by their ancestors and handed over to them. According to these farmers, one of the reasons why their ancestors fought for land was that land had fertile soils. The fertility of soil is also a value of its own. Soil is, therefore, held in trust from past generations for the future generations. Therefore, when farmers talk of "*eliloba lia Anyole*" (Anyole's soil) in reference to soils in their farms, the implication is that the soil has to be held by Anyole's descendants (Abanyole).

The most striking analogy used by farmers in reference to soil was that soil is the placenta of the earth. This simply means it is the part of the earth that supports life. Other accounts provided by key informant farmers about the soil include that soil is 'blood' (*damu lia ligunda*, Swahili term for blood of the earth) or soul (*omwoyo lia omukunda*) of the earth. The implication is that soil has life. Soil, according to farmers, is not a mere solid surface or substance but an entity with life of its own. The uniqueness of soil is not in the possession of this life but in its ability to give this life to her entities. It is against this backdrop that one elderly farmer argued that the soil's life is a larger life. The term used in reference to soil's life is strength (*nguvu ya udongo* Swahili term for soil's strength). Soil, farmers argued, has strength. This strength can be renewed through appropriate care and nurturing (*obulindi*). Conversely, if this strength of the soil is not nurtured appropriately, it goes. The soil, therefore, becomes tired (*udongo unachoka* Swahili term implying that soils get tired). One way of nurturing the soil's strength is by allowing it to rest (under fallow). Like all living entities, soil also needs to rest.

4.2.3 Classifying Local Soils

Interviews and discussions with farmers revealed that farmers make use of many characteristics to classify soils under various categories. Names for some of the categories had been in use for centuries and were widely known by local farmers. The most widespread soil type, the red loamy, *ingusi* soil, for example, has historical connotations. Farmers recounted that in one decisive battle over land, one ancestor called Ingusi acquired a fertile field and the soils in that field were named *Ingusi*. The local term for such land is '*mambire*', meaning "seize for me". Among the Abanyole, there still exist the descendants of Ingusi who now constitute the Ingusi clan

The forefathers who were the first time farmers accomplished the naming of local soils. Soil names such as *Ingusi* mentioned above have been in existence for centuries. As shown in Table 4.5 below, the names of local soils are descriptive of their colour, texture and locality. Other important characteristics of soil identified by farmers include depth and fertility as well as soil constituents.

Table 4.5: Folk Soil Classifications in Bunyore

TYPE	COLOUR	TEXTURE	DEPTH	FERTILITY	LOCATION	USES SOIL TYPE
Ingusi , Loam	Red	Fine	Deep	High	Many places except valleys and hills.	All crops – Maize, beans, sorghum, potatoes, bananas, tea, coffee napier
Limwamu , Clay	Black	Sticky, soft	Deep	High	Scattered mainly on valley bottoms	Trees, napier, arrow roots, earthworms
Oluyekhe , Sand	Light Brown	Coarse	Shallow	Fertile in flat areas	Scattered over landscape	Groundnuts, millet, sorghum, grasses; crops mature quickly.
Litoyi , Clayish	Dark grey black	Smooth	Deep waterlogged	Low	Swamps, valleys	Reeds, arrowroots, yams, eucalyptus, trees, napier
Sirongo , Clayish	White, grey white	Very soft	Deep	Very low	Near rivers, slopes, alleys	Plastering walks and floors
Eliakhanyu ,* Loamy	Red	Fine	Deep	Low	Scattered	Brick making, trees, napier, fallows,
Esiyeyie , Waste land	Varies	Coarse	Shallow	Very low	Scattered	Trees, napier
Esilangalangwe , Eroded surface	Varies by parent rock, eroded surfaces	Hard Surface	Very shallow	None	scattered	Fallow, paths, pasture

* Eliakhanyu could be depleted version of ingusi.

Farmers' knowledge about soil composition is exhaustive and included both visible and invisible constituents of the soil. The visible constituents of the soil mentioned by farmers include gravel (*tsimbale*), stones (*machina*), sand, rotten plant remains as well as soil organisms such as insects (*evikukule*), earthworms (*emilambo*), nematodes (*amafunyo*) and ants (*amache*). There are also some organisms such as snakes (*tsinzokha*) and moles (*tsifukho*) that stay in the soil but are not part of the soil. According to farmers, however, such organisms play a great role in changing soil characteristics. During focus group discussion with farmers in one of the villages, there was consensus that these soil organisms work up the soil to the advantage of the crops and plants. Farmers narrated how ants eat up leaves and excrete them on soil as manure. Similarly, there was consensus that soil organisms also work the soil to allow water and moisture to go in and not to just run on the surface.

The invisible constituents mentioned by farmers include minerals (*amadini*), water or moisture (*amatsi*), micro-organisms (*ebikokho*) and seeds of various plants. In addition, as indicated above, farmers asserted that soils have health or life. Soil fertility is, therefore, part of soil health and exists in varying degrees in various soils. Although the fertility of the soil is inherent and original within the soils, farmers argued that it can also be enhanced with the use of both organic and inorganic manures. Soil fertility cannot be observed directly but can be 'read' from the performance of crops and plants. Other soil characteristics associated with fertility include colour, texture and location. The shared perception is that soils that are dark in colour, fine in texture and located at valley bottoms or near water points, are the most fertile.

The difference in soil characteristics is mainly attributed to the origin of such soils. And because the Abanyore believe that all soils originated from God, their differences are attributed to the work of creation. Soils are, therefore, different because God created them differently.

Soils cannot be the same. God created things differently... soils were also created differently. Even people cannot be the same. Look at plants or other things created by God.

However, farmers also agreed that soils can change. Such changes however take long and are not easily recognized. This is one reason, according to the farmers, why the original characteristics of some soils have changed and now names may not convey accurate descriptions as they did initially. Among the processes that can result in change in soil characteristics is erosion. Severe erosion can change the properties and, therefore, classification of a given soil. A fertile loamy, *ingusi*, ground is, therefore, reduced or changed into eroded hard surface, *esilangalangwe* after severe erosion, for example. Addition of ingredients such as animal manure and inorganic fertilizers may also lead to visible changes in the soil as they can improve fertility and change the original colour of the soils.

The repeated use of soil without fallow can also result in changes in the soil characteristics, especially after a very long time. Farmers described those types of soils as very thin, or simply shallow, explaining that if soil was overused or eroded, it became poor, lacking productivity. Soils such as *esiyeyie* fall in this category. Farmers, however, acknowledged that soils could change from one form to another. Health is another attribute associated with soils. Soil is called 'healthy' when it is fertile. Other characteristics of a good or healthy soil include a combination of ideal texture, depth and slope. But fertility is a distinctive criterion for differentiating local soils and which also influences what a farmer does on a particular land.

The soil characteristics are based on farming experience. Farming based on hoe cultivation has given the farmers a detailed knowledge of soil characteristics and behaviour depending on certain factors. Other soils are classified as light (*eliangu*) because they do not stick on digging implements. The loamy *ingusi* or the sandy *oluyekhe* are among the light soils. Although there was variation and overlap in terms of farmers' classification of local soils in terms of crop suitability, most key informants agreed that certain crops only perform well in certain soils. For instance, many farmers held the view that the sandy *oluyekhe* soil was specifically suited for sorghum, finger millet, groundnuts, cassava and potatoes.

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4.3 DIAGNOSING SOIL FERTILITY STATUS

The findings of this section were premised upon the assumption of the study which is that smallholder farmers have local means of discerning the situational status of soil fertility on their farms. Key areas used by farmers include: soil characteristics; crop performance; plant (vegetation) performance; and certain species indicator (animal or plant).

The soil characteristics associated with fertility include colour, texture, depth and location. Whether one looks at the survey data or the information from the key informants, farmers shared the perception that the colour black is associated with high fertility. On that basis, a local soil like the clayish *limali*, which is black, is considered more fertile than the red loamy *ingusi*. Also, among the *ingusi* family of soils, there are certain variations. Due to both repeated cultivation without fallowing and other natural factors such as erosion, the red version of loamy *ingusi* referred to as 'the red one' (*eliakhanyu*) is considered to be less fertile than the dark red *ingusi*. Where sufficient land is available, the observation made by a farmer, based on the colour of the soil, therefore, can determine what crop is grown on such a soil.

Another aspect is texture. Farmers asserted that finely textured soils are more fertile than coarse textured soils. It is upon this background that most farmers ranked the finely textured loamy *ingusi* as being more fertile than the rough textured sandy *oluyekhe*. Conversely, there was consensus among farmers that soil must at least have some roughness to suit crop production. According to farmers' experiences, soil that has very fine texture is prone to erosion and/or water-logging.

The third aspect of soil that is indicative of its fertility is depth. Because farming in this community is based on hoe cultivation (and hoe weeding), farmers have the knowledge of various depths of different soils. Therefore, as expected, they asserted that deep soils are more fertile than shallow soils. Some soils are naturally shallow like the sandy *oluyekhe* or sometimes the shallow depth is as a result of erosion like is the situation with depleted *esiyeyie* soil.

The location in which soil lies is another feature associated with fertility. Soils lying on slopes (*esikongomo*) or next to the road, are considered to be of low fertility. Consequently, such soils are reserved for growing pasture, napier, trees or simply left fallow. In the past, such landscapes used to be reserved for communal grazing fields. Conversely, soils that lie at the bottom of the valley or near water points, are considered to be of high fertility. The clay *limali* or *esilongo*, both found in varying proportions at the valley bottoms are considered to be of high fertility.

The soil characteristics mentioned above are not mutually exclusive but are related. It is possible to find a soil that is dark in colour, fine in texture, very deep and located near a water source. Farmers with such parcels consider themselves lucky.

Crop performance is the other most mentioned indicator of soil nutrient status. In fact, most farmers mentioned crop performance in terms of yield as the leading indicator of soil fertility. This is because, to many farmers, soils only remain functional when they can produce food. Farmers are, therefore, very keen when they cultivate land. From the testimonies made by farmers, the main method used in discerning crop performance is mainly based on observations. Farmers continuously and routinely observe their crops in the field. Such observations also help them identify cases of disease and/or pest infestations.

In describing crop performance in soils with poor fertility, farmers used expressions that are usually employed to describe humans when they show certain nutritional deficiencies. Focusing on specific crops, farmers gave descriptions that may help one classify their performance according to nutrient status of the soils on which, they are grown. Such farmers accounts relate to leaf colour, height, stem size, root depth and spread, and the general health of the crop in terms of stems and leaves. Yet, yield both in terms of quality and quantity, remains the leading indicator of soil fertility. For instance, in maize, which is the staple food and, therefore, the staple crop in Emuhaya, yield is used to diagnose the nutrient status of a soil. This is because every household feels obligated to have a maize plot even if the soil is not suitable for maize production. Sometimes, maize is grown as fodder and performance is observed in other aspects

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other than the seed quality. For example, one focus group recorded the following observation:

... The land can be big but every time you plant maize, you do not harvest anything. ... you end up with a few *gorogoros*. You cannot even use the maize plant to feed animals because they are not there. They do not even grow up to the height of your knee ... there, you know the soil is spoilt completely...

Perceptions about the performance of maize in fertile soils are that it should be dark-green in colour and taller than the tallest human being when mature. Other aspects of maize performance include thick or 'fat' stems and strong roots. Therefore, if maize is yellowish in colour, stunted in growth and thin in stem, then the soil is not good. Stunted growth in maize is uniquely associated with depleted soils unlike other aspects such as leaf colour, which can also be associated with too much rainfall. It should, however, be noted that farmers easily distinguish between deficiencies associated with poor soil fertility from deficiencies associated with other factors such as rainfall (too much or too little) and pests and/or diseases.

To point out that there is a difference between nutritional deficiencies and problems of pests and/or diseases, farmers brought in the term *esiyongo* to describe the soils with depleted fertility. The term *esiyongo* is derived from the term *eyongo*, a local stubborn weed in Emuhaya that is also used as fertility indicator (see Figure 4.1). As with all crops, the performance of maize as can be seen from the above statement is pegged more on yield. Yield, both in quality and quantity, is the main determinant of soil nutrient status.

Smallholders are therefore keen readers of the landscapes and at any given time, would confidently diagnose the fertility status of their fields. Plants such as Castor oil, *Ricinus communis* locally known as *Amavono* (Figure 4.2) and *Markamia* sp., called *Lusiola* (Figure 4.3) are associated with fertile soils while the thatching grass, *Pannisetum purpureum* known locally as *Amasinde* (Figure 4.3) and papyrus grass, *Cyperus papyrus* or *Likuku* (Figure 4.4) are associated with low nutrients. Eroded or bare surfaces known locally as *Eilangalangwe* (Figure 4.5) are considered to be of depleted fertility. Table 4.7 gives a summary of such plants.

Figures 4.1 - 4.5: Some of the Soil Fertility Indicators identified by Farmers in Emuhaya



Figure 4.1: witch weed, *Eyongo*



Figure 4.2: Castor oil, *Amavono*



Figure 4.3: Markamia, *Lusiola*



Figure 4.4: Thatching grass, *Amasinde*



Figure 4.4: Papyrus, *Likuku*

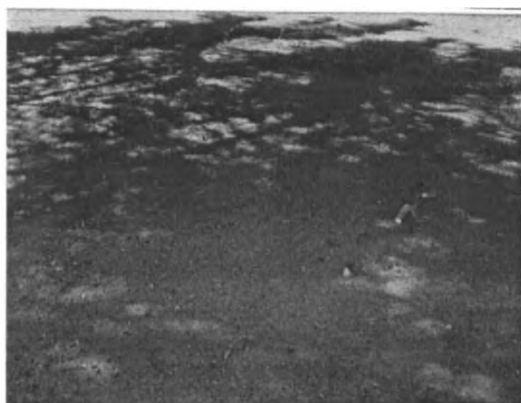


Figure 4.5: *Esilangalagwe*

Such aspects of crop performance are similar to those of plant performance associated with soil fertility. The general argument by farmers was that plants grown or growing in fertile soils flourish well and to their fullest limit. Here, like in the area of crop performance, one can argue that farmers assertions are based on the observations they have made overtime.

Apart from plant performance, there are some other aspects such as plant population in both density and diversity that farmers use as indicators of soil nutrient status. Where plant population is dense and diverse, the soils are perceived to be fertile. On the other hand, when vegetation is sparse, the soils are characterized as infertile. Based on such assertions, farmers characterize eroded surfaces (*esilangalangwe*) as infertile because they support no vegetation.

Table 4.7: Soil Fertility Indicator plant species

Fertility		Infertility	
Local name	English name/ <u>Botanical name</u>	Local name	English name/ <u>Botanical name</u>
<i>Amavono</i>	Castor oil/ <u>Ricinus communis</u>	<i>Eyongo</i>	Witch-weed/ <u>Striga hermontheca</u> .
<i>Linyolonyolo</i>	Wondering Jew/ <u>Cyanotis lanata</u>	<i>Amapera</i>	Guavas/ <u>Psidium quavaja</u>
<i>Tsimboka</i>	<u>Amaranthus</u> spp.	<i>Amasinde</i>	Thatching grass/ <u>Pannisetum purpreum</u>
<i>Lukoye</i>	Black jack/ <u>Bidens pilosa</u>	<i>Likuku</i>	Papyrus grass/ <u>Cypress papyrus</u>
<i>Olumbuku*</i>	Couch grass/ <u>Digitaria scalarum</u>	<i>Olumbuku*</i>	Couch grass/ <u>Digitaria</u>
<i>Lusiola</i>	<u>Markhamia platycalyx</u>	<i>Obwiyila batoro</i>	Poverty grass <u>scalarum</u>
<i>Olulusia</i>	<u>Vernonia</u> * <u>amagdalina</u>	<i>Omunyenya</i>	<u>Acacia</u> spp.
<i>Lusasabi</i>	<u>Sesban</u> <u>sesban</u>		

*Olumbukhu** or Couch grass was reported to grow in both depleted and fertile soils. The difference, farmers explained, can then be observed on its vigour and root depth.

In addition, soils that support single or few plant species, except when the plant species are those associated with fertility, are considered to be of low fertility. Therefore, the general trend is that the more the vegetation in terms of diversity and density, the more fertile the soil. Nevertheless, there are also certain specific plants species indicators used by farmers to differentiate between fertile and infertile soils. Some of the plant species are shown in the Table 4.7 above.

Table 4.7 shows that *olumbuku* (couch grass), which is a common weed in Emuhaya, is found in both depleted as well as fertile soils. The difference is that it flourishes well in good soils. Also, farmers argued that the roots of couch grass in poor soils go very deep and are difficult to uproot while in fertile soils, the roots are found near the surface and are easy to uproot. This is also the case with other plant species such as Castor oil (*amavono*). Since plant (weed) roots go very deep in soils with depleted fertility, weeding becomes delicate in such soils especially when crops grown are those that need tendering.

Naturally, all plants flourish well in fertile soils. As expected, plants associated with fertile soils are also believed to add to the fertility of soils. Other specific plants associated with high nutrient status include: the wondering jew, *linyolonyolo*; Castor oil, *amavono*; Amaranthus, *tsimboka*; *Vernonia*, *olulusia*; black jack, *lukoye*; and *markamia lutea*, *lusiola*, among others. On the other hand, plants that are found in infertile soils are also believed to cause infertility. Therefore, whether *eyongo* (*Striga hermontheca*) is as a result of or a cause of infertility in soils is a question that could not be exhaustively resolved with farmers. What clearly emerged from the discussions is that the appearance of plant species associated with soil infertility calls for certain specific actions like fallowing, crop rotation or the application of manures.

Apart from the plant species, there are certain soil organisms associated with high soil fertility. Although no specific insect was associated with soil nutrient status, the general perception was that insects are mainly found in fertile soils. Therefore, according to farmers, the more insects in a soil, the more fertile the soil. In addition, farmers also indicated that there are certain soil organisms that depict the soil fertility status.

Specifically, earthworms (*emilambo*) and nematodes (*amafunyu*) were mentioned by farmers as organisms that are found only in fertile soils. The existence of nematodes in compost manure is also a sign that the manure is ripe and, therefore, ready for use.

4.4 SOURCE OF KNOWLEDGE ON LOCAL SOILS

Results from both key informant interviews and focus group discussions show that farmers have a detailed knowledge of the local soils. In fact, almost all farmers showed no difficulty in naming and classifying local soils in the categories mentioned in Table 4.5 above. Moreover, neither generational nor gender differences were noted in the naming and classification of local soils.

The sources of detailed knowledge on local soils demonstrated by farmers seem to be varied. During the survey, almost an equal number of respondents mentioned scientists and their own experience as their source of this knowledge. Thirty six per cent of all the respondents mentioned scientists as their main source of knowledge on local soils. This was probably because of the fact that this study was preceded by the dissemination workshop organized by the Tropical Soil Biology and Fertility Programmes' Folk Ecology project team which, among other things, discussed with farmers information on local soils. An almost equal number (35%) gave experience as their main source of knowledge of local soils. Farmers themselves, even during informal interviews, often asserted that they had learned everything they needed to know about soils through their own experiences without being taught by anyone. But the same farmers were quick to refute that lack of knowledge is due to lack of experience, arguing that some of them had detailed knowledge of situations or things they had never experienced.

Farmers' own emphasis on personal experience as well as lack of wide variation in knowledge concerning local soils suggest that it is actually this experience, combined with observation, that forms the basis upon which new information is incorporated. This knowledge is also based on the fact that in farming communities, such as the one used in this study, farming is an activity that starts early. As could be observed during the study period, children among the Abanyore are typically involved in regular household chores including farming, which often include hoe cultivation and weeding. Children are,

therefore, likely to acquire information just from watching and listening to their parents who regularly engage in farming activities. Having parents who have interest and knowledge of local soils is, therefore, likely to be an important factor in the young farmer's learning. Indeed, in this study, some farmers (29%) cited elderly farmers and parents as their sources of knowledge of local soils.

The emphasis on personal experience and observation as the primary source of knowledge implies that learning in this community is an inherently local process, contingent upon which soils fill which parts of the local landscape and who has access to those parts of the landscape. It should also be pointed out that much experimental learning is shaped and facilitated by a multiple web of networks and contact with many of the information sources such as relatives, friends, group members, and extension personnel. Therefore, what farmers described as experience could be a result of many factors. The overriding issue is that this learning has really been informal and local.

CHAPTER FIVE

MANAGING SOIL FERTILITY

5.1 Introduction

The findings presented in this chapter are from both the interviews (survey, in-depth and key informant) as well as the focus group discussions. The first section starts by shedding some light on the farmers' perception of the nutrient status of their farms and the reasons advanced by them to account for the perceived farm nutrient status. As demonstrated below, smallholder farmers in Emuhaya have diverse strategies available for the management of soil fertility. As the third objective of this study sought to investigate, the results showing the use of soil amendment strategies by smallholders is presented in the second section starting with traditional soil amendment strategies. Constraints to Soil amendment strategies identified by farmers are also highlighted. The number, in terms of percentages, of farmers who used various inputs on their fields are recorded and highlighted. While some of the strategies are indigenous to the local community, others have been learned from modern scientists. The last section points to the need for integrated soil nutrient management among smallholder farmers if their farming is to become sustainable as well as the gender and wealth differentiated needs of farmers with different wealth status.

5.1.1 Farmers' Perception of the Soils' Nutrient Status

That soils in the farms within the study villages are of low fertility was widely acknowledged by the farmers themselves. Asked to give their own perception of the nutrient status of their farms, slightly over half of the farmers interviewed (52%) said that the fertility of their soils ranged from low to very low. In fact, 10% of them described the fertility status of the soils in their farms as being seriously depleted. Indeed, the nutrient status of the soils of most farms within the villages of the study area was classified as low. A related question which backed this position was when farmers were asked if they were satisfied with the food crop yields they always secure from their farming.

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Most of them, 76%, said that they are not always satisfied, attributing this dissatisfaction to poor nutrient status of soils. Moreover, only 16 (16%) farmers described their farm nutrient status as either high or very high. Nevertheless, more than double this number (38%) reported that the fertility of their farms was of medium status. The assertion by farmers that the fertility of the soils in their farms is medium implies that they were doing something to manage the nutrient status of such farms. It may also imply that what these farmers are doing is not adequate in their own perception, probably because of some constraints that face smallholder farming.

5.1.2 Accounting For Farm Nutrient Status

Repeated cultivation without the use of fallows or manure to enable the fertility of soils to regenerate was mentioned as the cause of low soil fertility on farms by over a half of the farmers (54%). These described their farm nutrient status as being of low or very low fertility.

Other reasons explaining the low nutrient status of soils were that such soils were naturally infertile, mentioned by 33%, and erosion, mentioned by 11% of the respondents. On the other hand, 66% of the farmers who described their farm nutrient status as very high mentioned the use of manures (organic and inorganic) as the reason behind their response. In addition, during in-depth interviews with farmers, they also mentioned that soil nutrients are always carried away with harvests. Smallholder farmers explained that nutrients are the food that plants and crops feed on and it is only natural that soil fertility should go down especially after crop production.

Use of inputs, therefore, is understood to result in the improvement of the fertility of local soils within Emuhaya. The knowledge that manures improve the nutrient status of soils was also widely shared during group discussions. Specifically, 24% who said they are always satisfied with the yield they get from food crops mentioned the use of inputs as the reason behind this satisfactory yield in food crops. The knowledge that certain practices and strategies improve the fertility of soils is, therefore, not lacking among the study population. In fact, 91% of the farmers asserted that they had deliberately, at one time or another, applied inputs of varied types to increase the nutrient status of

their farms. However, when all the soil fertility management strategies are observed and analyzed, it can safely be reported that all farmers have practices that are aimed at improving soil fertility.

5.2.1 Traditional Soil Amendment Strategies

Farmers in Emuhaya acknowledged that soil fertility depletion has been a problem that has continuously faced them for a very long time. The problem is believed to have been one of the conditions affecting local agriculture even in the past. Consequently, farmers (both in the past and in the present) have developed strategies aimed at replenishing nutrients lost to the soil. Some of the practices mentioned by farmers to have been used in the past to replenish soil fertility included shifting cultivation, rotational bush fallow, crop rotation, the incorporation of crop and plant remains into the soil, the selective matching of crops to soils and the integration of indigenous trees on croplands. Although some of these practices are no longer in use and none of the present farmers had used them, they are still widely understood among the smallholders sampled in this study. Some key informant farmers claimed that as children, they had witnessed some of these practices.

Key informant farmers mentioned shifting cultivation as the oldest soil fertility amendment strategy that they could remember. According to these elderly farmers, shifting cultivation involved the cultivation of a plot for as long as the fertility of such soils could support crop production. Once the soils became depleted, farmers would abandon such plots and move to other fertile plots which were under forest cover. The key feature of shifting cultivation, according to these key informants, was that when farmers moved from one field to another, settlements also moved to these new areas with good farming land. This practice, according to farmers, required large parcels of land and with the increase in population, the practice was abandoned altogether.

Rotational bush fallow which, according to elderly key informants, was also a strategy of managing soil fertility in the past was said to be similar to shifting cultivation in all manner except that in rotational bush fallow, settlements did not move. Under this strategy, residences were stationary. New plots were cleared, burned and then

cultivated for several years before being left to rest (fallow) for some years. The duration of the fallow used to be long in the past, sometimes for up to 10 years, or even more, but with time, the fallow period reduced to between 3 and 4 years.

Farmers also pointed out that even in the past, there were some strategies that were unique for the management of specific crops and which contributed significantly to the production of such crops. For instance, at this time, indigenous vegetables and bananas used to be grown on plots near settlements and benefited from amendments of cattle manure and household refuse, including the kitchen ash.

An attempt was also made to link landscapes with specific crops perceived to be suitable for such landscapes. Results from interviews with farmers (both survey and key informants) confirm that in the strict traditional sense, the choice of a crop to be grown largely depended on the type of landscape. And as this study found out, the choice of crop suited to a particular landscape is an old practice in Emuhaya which, despite many changes, can still be observed today.

Another practice of improving soil nutrient status in the past was the use of crop and plant remains. While the use of fire to manage bulk crop and plant remains was the surest way to reduce workload, especially during planting, elderly key informants including farmers maintained that crop remains constitute vital manure that was used in the past for soil amendment. Plant remains used in fertility improvement constituted the plant or crop residue parts that remain after burning. During cultivation, such leftovers were incorporated into the soil to improve fertility. The incorporation of weeds (shrubs and grasses) into the soil during cultivation was not only a strategy of controlling weeds but also one of enhancing soil nutrient status.

The potential of animal manure, especially cattle remains, seems to have been discovered by the Abanyole long time ago. Farmers explained that animal manure has been one of the strategies for soil fertility amendment in their community. To some farmers, animal manure is the only obvious input for nutrient improvement on farms. Traditionally, the use of animal manure on farms ranged from the use of cattle dung

droppings as they wander to graze on the fields, to their urine and dung droppings that accumulated in their shed. Specifically, elderly key informant farmers insisted that cattle dung is responsible for creation of fertile grounds or plots near the homestead. For example, they reported that in the past, the site where cattle shed had stood was particularly valued for its fertility and was managed differently when households moved.

5.2. 2. Intercropping

Intercropping, which is the practice of combining different crops in the same field during the same season, is an indigenous practice that has persisted to the present. Data from the survey under this study indicate that the practice of intercropping is widely shared among farmers regardless of their wealth status. Almost all (98%) of the farmers in the survey reported that they had in their farms either maize or sorghum with a legume intercrop such as beans or cowpeas during the interviewing period. Even the two percent who did not mix crops on their main fields during this season reported that they usually use this strategy sometimes.

In Emuhaya, the most frequently occurring crops are also the major users of land either in a single stand or jointly and also in combination. These are maize, beans, bananas and vegetables. It was, however, difficult to arrive at a clear pattern of crop combination on farmers' fields. What clearly emerged was that the occurrence of any given crop is in many situations not related to the occurrence of the rest. Exceptions to this are maize and beans, which are often intercropped. As illustrated in Table 5.1 below, four main crop combinations were observed in Emuhaya.

The four main crop combinations show that in the study area, crop patterning or arrangements do not just occur but depend on a number of factors. As is clear from the table, farmers would experiment with maize in almost all of the combinations either as an intercrop or in a single stand. The most typical crop combination in Emuhaya consists of maize, beans, groundnuts and potatoes. Farmers tend to describe this as the food crop combination. The poorest of the poor farmers tend to prefer the combination of vegetables, bananas, fruits and maize; which they grow mainly on the home gardens or on their limited land holdings near the homestead.

Table 5.1: Common Crop Combinations in Farmers' fields, Emuhaya (2002)

Category	Crops	Observation	Farmers accounts
Combination One	Maize, beans, potatoes, and groundnuts	This is the most typical of smallholder farms in Emuhaya.	This is food crop combination. Farmers' main argument supporting this combination is that they require food.
Combination Two	Vegetables, bananas, fruits and maize	This is mainly found in homegardens and among farmers with very small land parcels. Also common with very poor farmers in Emuhaya. These are also the farmers who work as labourers in other farmer's fields to supplement what their farm produces.	This combination is mainly for subsistence purposes. Farmers indicated that this combination is important as it helps in generating products for survival. Since the products are not adequate, other subsistence means are sought.
Combination Three	Potatoes, sorghum, finger-millet, cassava, napier and maize.	This combination is common in marginal fields where fertility is low, for instance, from continuous cultivation and/or erosion. Also common in parcels adjacent to road reserves.	Farmers argued that these soils were particularly suitable to such crops either naturally or because of the low/no nutrient status. These crops are perceived as suited to 'inferior' fertility conditions.
Combination Four	Tea, Sugarcane, napier, coffee, bananas and horticultural crops	Only observed in fields of wealthy farmers.	This is a cash-crop combination. Farmers argue that they need cash from farming these crops. Farmers also say that one needs a fertile ground and certain amount of input to enhance the production of these crops

Such a combination is geared mainly towards subsistence. Where soil fertility is perceived to be compromised either because of overcultivation or through erosion, farmers resort to a crop combination that on their perception requires conditions of limited nutrients. Potatoes, cassava, sorghum and finger-millet are the main crops grown on soils with limited fertility but maize is also included here just in a desperate attempt to get some harvest for household consumption.

Interestingly, the reasons for intercropping also varied considerably. Evidence from both key informant interviews and focus group discussions offered some insights as to why farmers choose intercropping rather than mono-cropping. Lack of sufficient land was consistently mentioned as the reason for the crop combination on fields. With the limited land sizes that they own, farmers seem to have little choice about crop patterning and sequencing. During focus group discussions with farmers in one of the villages, an attempt was made to provide an explanation as to why intercropping was preferred:

You cannot say you want to plant maize in one farm and beans in another farm. The land parcels you see when you walk are all we have. There are no other plots. People, therefore, must mix crops on their farms. If you fail to grow some crops, who will give you?

Sentiments such as the one above only point to how desperate farmers need to maximize crop production on their small fields. This can only be ensured if no space within the available small farmers' fields is left idle (fallow). The richness in space use among smallholder farmers of Vihiga can be understood if homegardens are studied in detail.

The other reason cited for the preference of an intercrop rather than a mono-crop on farmers' fields was that it serves as a strategy of controlling pests and diseases. The justification for this argument, according to the key informant farmers, was that different pests and diseases prefer different crops and the intercropping of different crops ensures that such pests or diseases are prevented or their effect minimized altogether. Related to this belief is the other farmers' assertion that the practise is also a strategy for weed control. While the latter assertion can be attributed to farmers' indigenous knowledge and practice, the former can be explained by the fact that

farmers who practise intercropping space these crops very near to one another so that there is hardly any space left for weed build-up. Besides, the nature of intercropping favoured by many farmers is such that weeds are inadvertently suppressed.

The practice of intercropping is also an insurance against many odds that face smallholder farming. Some of these odds include the variations in weather and rainfall as one focus group discussion seemed to suggest:

We plant two or many crops so that if one fails to do well we can still get food... for example, rain can fall and wipe out all the beans...

We do not die ... we know other crops will still provide food. Another thing, don't you see that maize takes time to be harvested? Can we wait for that? Therefore, the beans we grow help us while we are still waiting for other crops

While the main intercrops observed in many farmers' fields included that of a bean and maize or sorghum, other cropping patterns observed included situations in which different crops were restricted to different sections of the farmer's fields. One such pattern was observed where sugarcane and yams were planted close to the stream, groundnuts and maize intercrop on the next section of the same farm while the uppermost part of the farm was left for bananas and napier. Truly, it was observed during this study that different sections of such farms are managed differently.

Of particular concern to this study was the farmers' assertion that where an intercrop included a legume crop such as beans, such legumes help in the fertilization of crop fields through the fixation of nitrogen by the bacteria that exist in the root nodules of such legumes. Here it was difficult to determine whether this was farmers' own knowledge or knowledge coming from scientists. The role of intercropping, especially with legume crops, could be the subject of future research but it is worth noting that farmers in Emuhaya are well aware of the working of bacteria housed in the root nodules of legumes such as beans or cowpeas. The high prevalence of the practice of intercropping, however, should not camouflage the variation that there is in its practice. As a practice, intercropping is not uniform in nature and spread. Even the most common trend, which includes maize and a bean, shows variation in its timing and patterning.

In many farmers' fields which had an intercrop of maize and beans, the common practice is to plant maize first and then follow with a bean seed later, usually after one or two weeks depending on the bean variety to be planted. The exceptions to this rule are the category of farmers who plant considerably late and who on their part grow these crops simultaneously. Nevertheless, many farmers plant maize first and then follow with beans later when the maize have germinated and can be seen. The norm then is to plant beans in the available space or simply broadcast the beans randomly on the whole field and immediately follow with harrowing.

It was further observed that farmers who use manure in an intercrop field during planting exclusively use it on maize or sorghum by either putting small quantities on holes or by broadcasting it on fields and incorporating it on the soil through harrowing before planting. The bean or cowpea plant is not favoured with the manure either during planting or even during top dressing. While many farmers argued that beans do not need fertilizers to do well in their soils, one key informant farmer pointed out that the bean plant can benefit from the manure applied on the maize while others insisted that beans, being legumes, can fix their own fertilizer. Farmers also claimed that in an intercrop involving maize and beans, the yield in maize is much higher than when maize is in a single stand.

5.2.3 Animal Manure

Animal manure, or more appropriately farmyard manure (FYM), is the most commonly used organic manure among the study population. In fact, to most farmers what immediately comes to mind when the term manure is mentioned is animal manure which is essentially cattle dung. In the survey that formed the background to this study, 89% of the farmers had used some kind of animal manure on their fields during the study. Still, 91% of the farmers indicated that they had used animal manure in the past, with some 46% claiming that they use animal manure on their farms always. In addition, quite a good number (26%) of the respondents reported that they use manure on their farms occasionally.

The high numbers of farmers who claim to use farmyard manure among the study population appears difficult to accept, especially when one considers the other evidence emerging from the same survey. For example, as pointed out above, slightly more than half (52%) of the farmers described the soil nutrient status of their farms as either low (42%) or very low (10%). One has, therefore, to look beyond the survey data to understand this contradiction. Further clarification on this emerged during informal interviews with farmers who use animal manure on their farms as well as from the focus group discussions.

Although farmers generally did not dispute the importance of animal manure in improving soil fertility, they indicated that they have continued to face a number of constraints as far as the preparation, storage, transportation and use of this manure is concerned. Farmers regretted that the quantity of animal manure available on their farms was not adequate for their needs.

Since the animal manure available to smallholder farmers in Emuhaya is not adequate to fertilize the crop fields, farmers adopt a variety of ways to ensure that this small quantity available is used effectively and efficiently. There are, therefore, farmers who compost cattle dung, for example, alongside other compost materials as discussed below. Ironically, some farmers reported that they still use animal manure by broadcasting on whole or part of their fields. This is similar to how it was being used in the past.

Clearly, when farmers just throw animal remains, especially cow-dung, on the farms haphazardly, as was observed on some farms, the result could be predictably low. This study found that some farmers just throw raw cow dung on their farms that are in close proximity to the households or near the cattle shed. This practice has been given credence by the fact that most plots where cow dung is usually deposited show signs of high fertility by yielding satisfactory harvests. This was also the case with soil fertility status of home gardens. During focus group discussions with farmers in one of the villages, one female farmer took it upon herself to instruct her colleagues, on the need to use animal manure on farms that show signs of nutrient depletion. She argued thus:

If your farm is spoilt and crops cannot do well, you should not just watch. You should do something... ...what you can do if you have some animals is to be throwing their remains on your farm. Even if you have one cow, you can be throwing its dung on your farm each morning ...after some time you will see changes...

The above assertion not only shows the extent to which farmers believe in the importance of animal manure in replenishing soil fertility but also the inappropriate way of its application on farms. Whether one looks at the evidence from the key informant interviews or listens to the assertions from the focus group discussions in this study, what emerges is that farmers are doing very little to improve the quality of animal manure before it is applied on the fields. This is true even with farmers who compost animal remains alongside other compost materials. Farmers mainly compost animal manure to increase its quantity and also to check on the routine requirement of walking to the farms to throw animal remains everyday. In fact, to many key informant farmers, composting is a strategy of reducing the labour requirement of transporting animal dung to the fields everyday. To some, composting is a strategy of storing animal manure as they wait for planting time. To those groups, the most efficient way of applying manure is to store it up to the time of planting, when small quantities are placed in planting holes for planting, especially in maize fields.

Composting of animal manure takes a variety of forms. While some farmers compost it on pits alongside other compost materials, mainly plant remains, others heap it either on its own or in the same combination. There are also some farmers who heap animal manure alone particularly near the animal shed. Such farmers explained that they also collect cattle dung from the grazing and tethering fields, especially within the home compound and fallowed lands and gather them together with those collected from the cattle shed. However, it was also observed that other farmers do not make any attempt at collecting or gathering animal remains to prepare manure; they simply wait for it to accumulate in the cattle shed where it is collected and taken to the farm where it is used.

It was observed that the manure that results after the composting process could be classified as being between compost manure and farmyard manure. When prepared in

the same way as compost, the distinction, according to key informant farmers, between compost and farmyard manure depends on the proportion of constituents. Informal interviews with farmers also revealed that manure is called compost when the major constituents of the materials used in its preparation are of plant origin. When, on the other hand, animal dung forms the greater part of the manure, it is referred to as farmyard or animal manure. It is, however, difficult to draw a clear distinction between compost and animal manure, especially when the process of their preparation is the same.

For the purposes of classification, this study took the farmers' distinction that differentiated the two organic manures based on the constituents rather than on the method of preparation. It should, however, be pointed out that smallholder farmers in Emuhaya also believe that the inclusion of animal manure, especially cattle dung in the compost pit, is advantageous as it facilitates the rot of compost materials. The use of cattle dung as a compost material is widely shared and can only be compared to the other farmers' belief that both soil and water also facilitate the natural decomposition of plant materials used in compost preparation. Therefore, as discussed in this study under compost preparation, soil, water and cattle dung are some of the materials combined with crop residues in compost preparation.

While the role of animal manure in soil fertility management is still widely appreciated, the nature and amount of animal manure used by the Abanyore has drastically changed partly due to the decline in the number of livestock owned per household. One vital lesson learnt in this study as far as the storage of organic manure is concerned was that farmers do not follow their knowledge with practice. While farmers explained adequately the requirements for proper manure preparation, storage and application, it was observed that not many followed this with practice. The labour required for proper manure preparation was mentioned as the reason for this.

Labour was also a constant drawback mentioned by farmers in relation to preparation, storage and use of animal manure. Specifically, most of the farmers (58%) of the 89 farmers who had used some form of animal manure on their fields during this study

pointed out labour shortage as a constraint associated with the use of animal manure. Some of the constraints mentioned by farmers included transportation and labour in preparation, both of which were reported by 19% of these farmers. The other drawback associated with the use of animal manure among smallholders of Emuhaya is lack of proper storage technology.

As discussed above, the preparation of animal manure takes a number of methods. While manure storage is not a concern to many farmers, particularly those who do not engage in any attempt to prepare animal manure, a number of farmers said that they had faced the problem of where to store organic manures. Ordinarily, the storage of manure should not result in major problems among smallholders because, as this study found, the manure preparation is timed such that whether it is of compost or animal origin, it becomes 'ready' for use around the time it is needed in the fields. While the attempt to time the preparation of manure to suit the planting time is a strategy employed by smallholder farmers to solve the problem of manure storage, it is also a way that compromises the quality of manure. This is because in many situations, manure may not be ready for use when it is needed in the fields. The reason as discussed above, is that many farmers use manure only during planting which, unfortunately, is not a predictable activity but depends also on other prevailing factors such as the ever-fluctuating rainfall.

Perhaps one even needs to understand the manner and nature of application of manure before making conclusion on the constraints that face farmers who use animal manure. Like with compost, there are numerous ways in which animal manure is applied on fields. As explained above, some farmers throw small quantities of animal manure, especially cattle dung, on their farms, putting it on areas that show signs of nutrient depletion.

Animal manure is used mainly during planting. The procedure when using animal manure during planting, according to farmers, is to either broadcast the manure on the whole or part of the field before planting or place small quantities in planting holes before planting. Because the quantity of manure available to farmers is limited, most

farmers tend to use manure on their fields by placing small quantities in planting holes. Another rare practice is one in which after planting with animal manure, what remains is thrown on the parts of the farm with observable serious signs of depletion. Crops that require animal manure during planting include maize, sorghum, kale (*sukuma wiki*) and tomatoes. Bananas, napier and trees are also treated to what remains after the other crops have been planted.

If animal manure is to be of the required quality, proper storage facilities and preparation, skills must be used. However, in this study, both direct observation and interviews with farmers who claim to use farmyard manure revealed that there is neither the space nor the facility for storing animal manure. In fact, to many farmers, heap or pits are not methods of manure preparation but strategies for storing manure before use. Nevertheless, some farmers argued that to get manure of good quality the manure must be stored in the shade away from the hot sun and direct raindrops. The direct sun, farmers argued during focus group discussions, leads to the evaporation of nutrients while the rain results in the leaching of nutrients. Here again, as with many occasions, it was difficult to determine whether these assertions were based on farmers' own experimentation and knowledge or on the knowledge gained by farmers from the partner scientists. As mentioned earlier, Emuhaya has played host to many scientists since the early 1990s.

It should also be noted that because animal manure is gathered at or around the household, plants growing on the homestead benefit from them most. Observations made on the home-gardens during this study almost gave the impression that soils of the study area are of high fertility. Because of their proximity to the source of animal manure and because of constraints faced by farmers in the transportation of this manure to distant fields, home-gardens benefit first and most from the animal manure. Clearly, farms that are located very far from homesteads showed signs of poor fertility.

Nevertheless, despite these drawbacks, farmers acknowledged that animal manure is the best organic input available to them. The advantages of animal manure are many and varied, according to accounts by key informant farmers. Animal manure can be used

in all seasons and in all soil types and in fertilizing all crops. Furthermore, farmers held a strong belief that repeated application of animal manure on farms controls the spread of *eyongo* (*Striga hermontheca*) which was mentioned as one of the leading indicators of farm nutrient depletion. While it should be obvious that the continuous application of any manure type should check on the population of *Striga*, farmers did not report this in the case of other manures. Contrary to the expectation, some farmers alleged that the use of inorganics had led to the introduction of *Striga* in their fields.

5.2.3. The Use of Compost Manures

Out of the 100 farmers enrolled in this survey, 46% had used compost manure on their farms during the interview period. To this group, compost manure originated from plant or crop materials within or outside their farms. Two main methods of preparing compost manure include the use of pits and the use of heaps. Sixty six percent of the farmers who claimed to have used compost on their farms during the interviewing period mentioned pits as the method they used to prepare this manure.

What varied a great deal, whether compost is prepared in pit or in heap, is the time in which it is left under preparation. In the survey, 38% of the respondents reported that they considered their compost ready after 3-6 months under preparation while 29% reported that compost could only be ready after 6-12 months. Still, some 31% insisted that for compost to be ready, it had to be left under preparation for a period of more than 12 months. There were also those who argued that the preparation of compost manure should be left open-ended and should only be harvested piecemeal. To this group which comprised 20% of the farmers, when harvesting compost manure, there must be residues which, they referred to as bad compost. These residues are recycled into the pit or heap for future manure preparation. In fact, according to these farmers, recycled materials facilitate the rotting of new materials. In essence, compost manure preparation is a continuous venture. Information emerging from key informant interviews confirmed this practice by many farmers.

The variation in explanations about time for compost manure preparation as indicated in this study only helps to illustrate the lack of uniformity in knowledge and skills

associated with compost manure preparation and use. Over a half of farmers with compost (54%) use it during planting where it is either broadcast on the whole or part of the farm or placed in the planting holes during planting, depending on the size of the farm and the quantity of manure available. Constraints to composting mentioned by farmers included the availability and quality of raw materials, transport and appropriate technical knowledge. Where materials are available, like in farms that are near homesteads, the major constraint is labour. In this survey, 81% of the farmers who had compost mentioned labour shortage as their major constraint as far as the preparation and use of this manure is concerned.

The application of compost manure, like that of animal manure, depends on the amount of manure available and the size of the farm that needs it. As stated above, this survey found that slightly more than half of the farmers who had ever used compost manure (54%) apply it at planting. Farmers mentioned two main methods of compost manure application. The first method involves the broadcasting of compost manure on a plot before planting. This method is mainly employed when the farm size is small and the compost manure is estimated to be enough for the field in question. This means that the compost manure is incorporated into the soil before planting during cultivation, and in a few instances during planting. The broadcast is done when the farm is already cultivated and the incorporation of compost manure means that the farm is cultivated for a second time.

The labour required in the latter arrangement is prohibitive and not many farmers opt for this method, especially when the farm is considerably large. Farmers who broadcast compost manure before planting and follow by harrowing are those who have small plots to plant. This is similarly the practice with seedling nurseries. It should be noted that some farmers only prepare compost for specific crops during specific seasons. Such specific crops that need compost manure according to farmers include vegetables such as kales (*sukuma wiki*), onions and tomatoes. Such specific arrangements are not common and cannot be adopted by farmers who use compost manure on their farms regularly. In this study, only 25% of those who had compost manure use it regularly while the majority who had it (59%) reported that they use it only occasionally.

The second method of compost manure application on farms involves the putting of small quantities in planting holes. Farmers prefer this method because the manures they always have cannot be enough to be broadcast on their farms. Many of the times, a small quantity of compost manure is left after the whole farm is planted and farmers broadcast what is left on the farm, particularly in the areas that are perceived to exhibit low fertility. Sometimes what is left after planting is used to fertilize other fields or applied specifically to already existing crops such as napier, bananas and trees. However, not many farmers have sufficient quantity of compost manure to be left with some after placing small quantities in planting holes. In fact, direct observation made on fields during planting reveal that at times the compost manure available is not even enough for planting the whole field.

The quantity and quality of compost manure prepared by farmers is influenced mainly by the method of preparation and the time and materials available for this exercise. No wonder farmers talked of both 'bad' and 'good' compost during interviews and focus group discussions. In the farmers' perception, compost manure should be dark grey in colour and soft in texture and if the preparation of compost is through heaping of materials, it is this portion of the heap that is used for planting. The remaining bit, usually comprising crop residues (leaves and sometimes stems), is referred to as bad compost and is either recycled to rot or used in a number of ways. Two main areas in which 'bad' compost is used include the incorporation into farms alongside other plant remains during cultivation or throwing on crops such as napier, trees or bananas.

For farmers who use pits to prepare compost, the amount of manure they harvest may be good but not enough for planting the field even if deposited only in holes to enable them remain with some to broadcast on farms. Nonetheless, compost manure is the farmers' favourite manure in seedbed preparation or even in intensifying banana or napier fields. Farmers also claimed that compost manure is appropriate for all soil types.

Because of the scarcity of quality raw materials for preparing compost, farmers are faced with the difficulty in choice of raw materials to use in preparing compost manure. Farmers, therefore, resort to materials that are readily available such as crop residues,

plant remains and kitchen refuse. Crop remains mainly favoured in compost preparation include, banana stems and leaves, maize cobs, stovers and bean husks. And since the crop remains will not be adequate, according to most farmers, they add to the compost plant remains such as grass, napier or cattle feed remains, shrubs from weeded fields and branches and leaves from specific plants.

As compost material, farmers prefer plants with thick but soft leaves such as *maua malulu*, (*Tithonia diversifolia*), *lusiola* (*Markhamia lutea*), *amasatsi* and *olulusia*, among others. In fact, one farmer shared during focus group discussions that she uses tithonia to form a thick mat at the bottom of the compost pit before depositing other materials for compost manure preparation. Whether this was her innovation or a lesson learnt from other sources could not be discerned immediately but the farmer reasoned that this practice checks on the leaching of nutrients from the compost materials. This study also took cognizance of the fact that agricultural research institutes such as the Kenya Agricultural Research Institute (KARI) have had successful experiments about soil fertility with some of these farmers.

The combination of crop residues and plant remains increases the quantity of compost material but not to the level that farmers would consider adequate for their use. Many households, therefore, still add to this combination the compound wastes and kitchen refuse. In this way, litter (leaves dropping from trees) and leftovers from cattle feed find their way into the compost heap or pit. This is particularly true when the heap or the pit is within the home compound or in the homegarden. Kitchen refuse comprising banana peelings, bean pods, ash, and dust from everyday sweeping, are conveniently added to the compost pit or heap.

Compost pits that are near houses also benefit from water from either the roof run-off after rains or wastewater from kitchens after washing. Farmers also deliberately pour water on pits or heaps claiming it will facilitate the rotting of compost materials. As expected, where the heap or the compost is located near the cattle shed, the cattle dung automatically becomes part of the material for compost preparation. The use of cattle, sheep and goat remains as compost material in Emuhaya is so widespread that at

times what results after compost preparation is a mixture of compost and animal manure. And as discussed above, farmers insisted that farm yard manure is different from compost manure.

A unique material for compost encountered with many farmers is soil. Soils are also considered good when incorporated into compost material as they facilitate rot and improve manure quality. While some farmers get such soils from special sites like termite mounds or anthills, some argued that any soil can do, since all soils are inherently endowed with a life force. The shared perception is that soil is a good compost material.

5.2.4. Inorganic Fertilizers

The importance of inorganic fertilizers in the amendment of soil fertility among the Abanyole has increased considerably. For example, 64% of the respondents stated that they had experimented with the use of inorganic fertilizer of one kind or another to enhance the fertility status of their farms at one time or the other. From the testimonies of the elderly key informants, inorganic fertilizer became available to smallholder farmers of Vihiga from the 1960s. Inorganic fertilizer has, therefore, since become one of the major soil amendments to maize fields, although its use has always varied by region and wealth category. Eighty percent of the wealthy but only 52% of the poor households sampled in this survey said that they had used some form of inorganic fertilizer on their fields. The use of inorganic fertilizer among smallholder farmers in Emuhaya is, however, irregular.

From the survey data, the most widely used type of inorganic fertilizer is diamonium phosphate (DAP). As expected, only 44% of the farmers reported that they use DAP always. Ten percent reported that they only use DAP sometimes while 8% claimed that they had used DAP only once. A clear 38% of the farmers have never used DAP. The other popularly used inorganic fertilizer is CAN, which was reported by 50% of the farmers with some 38% of its users claiming that they use it regularly. The wealth category of the farmers determines the use of these inorganic fertilizer types. The same trend was also reported for the use of CAN in topdressing. Of the farmers who had top

dressed their crops with CAN, 52% were of the wealthier category. The other inorganic fertilizers always used in top dressing is Urea.

Data from the interviews revealed that one of the greatest advantages of inorganic fertilizer ease in application, which does not require a lot of labour. Farmers also reported that when used appropriately, inorganics have high returns per unit area. As farm sizes decline and animal population per household also reduces, the use of inorganic fertilizer to amend soil nutrient status in Emuhaya will increase considerably.

It should also be noted that although Abanyore farmers recognize that inorganic fertilizers improve yields, they are also believed to have two main side effects. First, many farmers associate inorganic fertilizer uses with weed infestation, often claiming that the fertilizer is mixed with weed seeds. While this belief is widely shared even among farmers who have never used inorganic fertilizers, it is also a concern for farmers who use this input regularly. Thirty one percent of the 64 farmers who reported use of inorganics on their farms mentioned weed infestation as the main limitation of this fertilizer.

While it is natural that the application of inorganic fertilizer on farms should lead to weed infestation, the claim that weeds that are not indigenous to the study area were brought by fertilizers should be a major concern to those interested in smallholder farming. Farmers also tend to claim that exotic weeds might have been brought by machinery such as tractors and rollers used in road construction. The latter assertion is given credence by the fact that most of these foreign weeds are mainly found along the road or on farms that border the road reserve. But generally, exotic weeds in Emuhaya are associated with the use of inorganics. Separately, there were isolated cases of farmers who asserted that the use of inorganics spoil the tastes in bananas, potatoes and groundnuts, explaining only that inorganic fertilizers spoils the tastes of such crops making them not very good as meals.

The second worrisome side effect of inorganic fertilizers mentioned by not only 51% of the farmers who regularly use this manure but also by many who have never used it is

that inorganic fertilizers spoil the soil. Farmers strongly believe that inorganic fertilizers "spoil the soil" and that the "soil becomes addicted" to them, forcing farmers to ensure their use every season after using it once. The other related belief is that once inorganic fertilizer is used during planting, this must be followed with topdressing. Here it is not the labour that goes into the application of inorganic fertilizers but the cost of acquiring them that is considered a constraint.

Cost is the main constraint to organic fertilizer use among poor farmers. During focus group discussion it was observed thus:

Sometimes, the planting can begin when you do not have money and you do not want to delay planting. Even if you do not plant in time thinking that you can get money, sometimes the money does not come. We, therefore, just plant like that without any fertilizer. When you do not have money you cannot do anything.

The time for application of inorganic fertilizer on farms, also seems to be a constraint. For those who plant with DAP, there is not much problem on timing since only small quantity is placed in planting holes during planting. The problem comes during topdressing as one key informant tried to point out:

The officer says that you topdress your maize when it is knee-high. What if you are busy or sick during that time? What if you delay? You see, we are told this would be a waste. Even if you have the money and buy fertilizer, you may end up not using it at the right time.

Farmers also raised concern with the requirement that inorganic fertilizers should be applied on farms when there is no rain to avoid nutrient leaching. The constraint faced by farmers in relation to this emanates from the fact that rainfall in Emuhaya may be continuous during the planting season. Importantly also, there seem to be the assertion that inorganic fertilizer has scorching effect on seeds, especially if it fails to rain for some days after its application. Farmers expressed fear that there seem to be some kind of contradiction about messages regarding the use of inorganic manures.

Technical knowledge relating to inorganic manure use is either low or lacking among most smallholder farmers of Emuhaya, as revealed by both survey data and evidence emerging from interviews with key informants. Nineteen percent of farmers who regularly use DAP cited lack of appropriate technical knowledge as the constraint they faced in its use. Technical knowledge involves not only the timing as explained above but also the nature of application. As with other manures, farmers who regularly use inorganic manures do so during planting by placing small quantities on planting holes before placing the seed or the seedling. It was, therefore, not surprising when 15% of the farmers mentioned poor germination as the other side effect of its use. While poor germination could be as a result of either pests or diseases, it can easily be argued that the inorganic manures had a direct effect probably because the seeds were directly placed on the manure. The chemical effect of manure on grain seeds is still not properly understood by many smallholders. Nevertheless, evidence emerging from interviews, seems to suggest that the use of inorganic fertilizers is set to increase among smallholders.

The only surprising finding in this study about the use of inorganic fertilizer is that some 10% of the smallholders mentioned poor results as the constraint they had faced, particularly with the use of DAP. Many factors observed and gathered from the interviews can help explain this scenario. First, crop performance depends on many factors and not soil nutrients alone. Seed quality is one such factor. Secondly, the quantity of fertilizer available for planting to resource poor smallholders is usually not sufficient for their fields. During in-depth interviews with farmers in one of the study villages, two female farmers revealed that since they cannot always afford to purchase inorganics for planting in time, they have on certain occasions resorted to borrowing some fertilizers from friends and neighbours.

Among the Abanyole, the culture of sharing is still very strong and farmers sometimes 'underdose' their fields with manure in order to share what is left with friends, neighbours or relatives. Sometimes the decision to share is made out of choice. One farmer argued that she has on several occasions been forced to share her fertilizer she was provided with by the Kenya Tea Development Authority officials for her smallholder

tea farm. As could be deduced from her statement, the sharing is socially conditioned and one can really invite a lot of scorn if she or he refuses to share. For households with interest in inorganic fertilizer, there seem to be strong blind faith attached to this input to the extent that they sometimes do not care which type of fertilizer to use on their farms. The case explained above is clear indication that farmers could be experimenting with tea fertilizer, mainly the super phosphates, in maize production. Overall, unlike animal manure, which farmers said is suitable for all seasons and all crops, the use of inorganic fertilizer was believed to be appropriate when there are rains and the crops planted are either maize or *sukuma wiki*. Whether this is followed in practice is an issue for future research.

5.2.5. Crop Rotation

Crop rotation, that is, the practice of planting crops in a sequence to take advantage of the varying degrees of soil fertility is an indigenous soil management strategy which has become modern but in declining and totally changed environment. The rotation of crops although still understood to be important, has continued to decline in practice because of a number of constraints. Out of the 54% of the farmers who reported that they had rotated their crops in the season preceding the interview, only 13% said that they used this practice always. But quite a high number of farmers (60%) indicated that they rotate crops in their fields sometimes.

The importance of crop rotation, according to the farmers, is that crops differ in their nutrient requirements and, therefore, by rotating crops in a field, the soil nutrients are utilized more efficiently. Crop rotation was, therefore, understood first of all as a strategy of maximizing crop yields. The second importance of this practice mentioned by farmers is to control pests and diseases. This was mainly mentioned by farmers who grow horticultural crops and vegetables. The shared opinion was that vegetables, such as onions, kales and tomatoes, suffer from the same pests and diseases and to control these pests and diseases, these crops must be rotated in the fields, especially with grains. When crops are rotated to control pests and disease, the soil condition is not put into consideration, according to some farmers, while others strongly believe that crops grown on seriously depleted soils are susceptible to diseases. Farmers also adopt the

practice of crop rotation to control stubborn weeds such as the witch weed (*eyongo*), *Striga hermontheca*. Since this weed is associated with grains such as maize and sorghum, farmers believe that to control it, crops such as napier or vegetables should be rotated with these cereals.

There is, therefore, no doubt among smallholders that the practice of rotating crops is beneficial to the soil and crops growing on such soils. Where practised, crop rotation is based on the principle that soils after some time become 'tired' with certain crops but can still support the production of other crops. Crop rotation, therefore, largely depends on the individual households' needs and available labour. The labour requirement for particular crops, according to farmers, is also put into consideration before the crop is included in a rotational sequence.

Although this strategy of managing soils and landscapes has been into existence for a very long time, this study did not find a clear script or formula of rotating crops. However, the general trend shared by many farmers was that lands that have just been cleared under fallow are suited for sorghum or millet. Therefore, as reported elsewhere in this study, sorghum and millet becomes the first crop in a rotational sequence. However, this study also found that since smallholders seriously need maize, the growing of sorghum and millet has declined considerably in Emuhaya. Maize has continued to take the position of the other grains in a rotation.

There is also a belief among farmers that crops need to be planted on a field until the soils become 'tired'. This leaves the end of crop rotation open. It should also be noted that the practice of rotation is exclusive to the main crops in the grain field. Therefore, a farm that is perceived to be "tired" from maize and beans intercrop can be considered suitable for sorghum and bean intercrop. Here, it is the maize that is rotated with sorghum while the bean is not affected. Anyhow, if in the first season of land cultivation a farmer grows maize or sorghum with bean intercrop, the replacement comes only after signs of soil infertility are observed on the farm. As mentioned above, the only crops that must not be repeated on the farm, according to farmers' beliefs, are vegetables and this is to control pests and diseases.

5.2.6 Mulching

The use of mulch, the protective covering of the soil surface by various materials for a number of reasons, was one of the indigenous soil management strategies noted among smallholder farms, both through direct observation and interviews. Mulch cover soils while at the same time enriching them with organic matter and nutrients. In fact, mulching and installing vegetative strips on farming fields are indigenous practices of controlling erosion. From the survey data, 22% of the farmers reported that they had mulch on their farms during the interview season. The use of mulch is, however, specific to certain crops.

Bananas, tomatoes and kales (*sukuma wiki*) are the crops on which mulch is applied regularly. Varying thicknesses of mulch were also observed in tree fields. Farmers' understanding is that mulching is an important technique for improving soil fertility and maintaining moisture, reducing weed growth, controlling erosion and reducing the need for hoe weeding. Widely used mulches in Emuhaya include layers of dry grass, crop remains, plant materials, weeds, household refuse and soils. Cattle dung combined with animal feed leftovers, also form part of the mulch materials. Farmers apply mulches to kales when they are tall enough for the leaves to be well above the ground so as to avoid contact with mulch materials. Banana fields can be mulched any time. The amount of mulch seems to be dependent on the farmers' access to the materials mentioned above and the size of the plot to be mulched.

Constraints to mulching mentioned by farmers included insufficient availability of mulch materials, poor results and pests and diseases. Thirty-nine percent of the 22 farmers who had mulch during the interviewing season mentioned pests and disease build-up as the constraints they face in the fields with mulches. In addition, some twenty-three per cent of the farmers who had applied mulch on their fields mentioned difficult weeding as the constraint they face in working mulched plots. This position was strengthened by farmers sampled as key informants who, on their part, asserted that bananas on mulched fields are weak and easily break during the windy season. The explanation given by farmers was that during weeding, one should be careful with mulched bananas because they have their roots above the ground. Nevertheless, some of these

complaints were farmer specific and were not widely shared. This pointed to the lack of uniformity in knowledge of mulches among smallholders.

5.2.7 Incorporation of Greens

As farm nutrients decline, smallholder farmers in Emuhaya have also recognized the importance of green manure. Both survey data and key informant interviews, show that trees, shrubs, cover crops, grains legumes, grasses, weeds and even crop parts provide an additional source of organic fertilizer for soil amendment. In comparison to inorganic fertilizers, farmers said that green manures have longer-term residual effect on the fields. While the understanding that greens can be beneficial to soil fertility is part of the local farming knowledge, plants providing this manure currently are said to have come with scientists working in the studied villages. Some of these plants are indigenous to the area but their potential in soil fertility improvement came with the scientists. Among the organizations associated with the introduction of green manure use in Vihiga include the Kenya Agricultural Research Institute (KARI), the International Centre for Agroforestry Research (ICRAF) and, more recently, the Kenya Forestry Research Institute (KEFRI), and the Tropical Soil Biology and Fertility (TSBF).

The most frequently mentioned sources of green manure include *maua malulu* (*Tithonia diversifolia*), *Mucuna*, *Caliandra*, *Crotolara*, *Tephrosia* and *Sesbania sesban*. Farmers also incorporate weeds into the soil during weeding. Green manuring is used in a variety of forms. Besides, farmers claimed that during planting or cultivation they deliberately incorporate shrubs from their farm hedges into the soil.

The list of greens provided by farmers include both exotic and indigenous plants and seem to be endless if one considers the fact that even crops are sometimes incorporated in the soil. It is, therefore, surprising that only 27% of the farmers indicated that they had used some form of green manure during the interview period. Worse still, out of these, 33% proceeded to mention poor results as the constraint they had faced in the use of greens. Perhaps, the leading constraint faced by farmers in their need to use green manures according to 37% of the respondents, was labour shortage. Some of these constraints, as discussed below, are specific to the type of green manure and the

form in which it is used. Where available, a farmer cuts stems and leaves of these plants, and chop them into pieces before incorporating the mixture into the soil. And because the quantity of manure available to farmers is not always enough to be incorporated into the whole field, farmers resort to placing small quantities of greens on planting holes during planting. Green manure is also mostly used in fertilizing seedbeds and nurseries by farmers who grow vegetables and trees.

Tithonia diversifolia (*maua malulu*) and *Calliandria calothyrsus* were some of the plants mentioned under this category. A specific constraint faced by farmers as far as the use of tithonia is concerned is availability. This is because the plant population of tithonia in Vihiga has declined considerably after it has been replaced on the farm hedges by more permanent plant species like euphorbia, cypress and eucalyptus. Moreover, the declining land sizes means that they cannot be planted on farmers' fields. Tithonia, therefore, exists mainly along pathways where it also faces competition as goat feed. Besides, tithonia growing along pathways is always vandalized through road works which farmers said are unpredictable.

In their partnership with scientists and researchers, farmers in Emuhaya have also been introduced to other forms of green manuring. Farmers as one of the sources of information on greens mentioned the Kenya Agricultural Research Institute scientists. Other organizations mentioned included the International Centre for Research in Agroforestry (now called the World Agroforestry Centre) and the Tropical Soil Biology and Fertility.

5.2.8. Fallowing

The practice of fallowing land, that is, leaving land uncultivated for one or more growing seasons to allow the soil fertility to regenerate naturally, is one of the indigenous strategies that is now threatened as the smallholder population increases and rural poverty heightens. This study found that only 9% of the farmers in the survey had fallowed their land during the survey session. The 9% were exclusively from the wealthy category. The reasons for lack of widespread use of the practice among poor households are obvious.

Farmers, however, understand that natural fallows take considerably long time before the soils are able to regenerate their fertility. They have, therefore, sought ways of improving on this strategy. Partly because of the concern by farmers and also because of the interest of agricultural scientists and researchers on the importance of fallowing, some strategies have been devised to increase the effect of this practice in the shortest time possible. Some of these strategies also benefit smallholders in a number of ways, for example, in the provision of green manures, compost materials and even in the provision of livestock fodder for farmers with animals. Such strategies included the use of "improved fallow" and the concept of "biomass transfer" which, according to key informant farmers' accounts, were introduced by scientists from the Kenya Agricultural Research Institute (KARI) in 1997.

Coming only 5 years after these strategies were introduced, this study found that farmers still have accurate knowledge on how these practices should be managed. Nevertheless, the constraints mentioned below have resulted in these practices being used by only a few farmers.

Under improved fallow, the natural fallow vegetation is replaced with specific crops to speed up regeneration of soil fertility and to shorten the duration of the fallow. These crops may be left to grow for one or several years. *Tephrosia*, *Crotalaria*, *Leuceana leucocephala* and even the indigenous *Tithonia diversifolia*, were the most mentioned crops perceived to be suitable for improved fallow. Then, there is also the strategy of "biomass transfer" in which, plants, mainly legumes, are sown alongside the food crops after these have been established using the gathered biomass for improving the fertility of soils in a number of ways. The integration of shrubs or trees on croplands, whether as improved fallow or for biomass transfer, is beneficial to farmers in a number of ways. While the aim is to improve soil nutrient status, farmers clearly understand that some of these plants serve as human and animal feed.

Besides, it is a strategy that improves the soil fertility in a number of ways. Plants integrated into croplands (usually legumes), increase the amount of nitrogen in the soil.

They can also be used as green manure or mulch, as well as being materials for composting.

The benefits of either improved fallows or the biomass transfer are numerous and their low adoption among smallholder farmers of Emuhaya should be of concern to the organizations and individuals interested in rural agriculture. Ironically, knowledge of such benefits is high among smallholders. But as indicated above, the main constraint faced by farmers in the adoption of these practices is land. According to smallholder farmers, the land available to them is too small and too crowded to allow for the integration of other plants. Farmers also fear fallowing their land (improved or otherwise) because they might starve. For smallholder farmers whose harvests are below the household needs in terms of food, the strategy of improved fallow cannot be attractive. Farmers, therefore, cannot reserve land for trees whatever the benefit. Where integrated into the croplands, these trees are replaced with crops before their benefit can be realized.

Direct observation revealed that farmers have resorted to cultivating these trees or shrubs close to the hedges marking their farm boundaries or establishing farm paddocks. Many farmers have also been forced to cultivate trees on private compounds and home gardens. It was also observed that seedlings planted next to the fence were suppressed and, where they were established, they were vandalized by the unconcerned neighbours and passersby. Farmers also stated that where such trees are used as boundary marks, they generated conflict with neighbours who do not understand their value.

The other constraint associated with biomass transfer and improved fallow was the shortage of labour. All forms of sown fallow, farmers retorted, demand a great deal of labour. This study also found that more important among smallholders is the point in time when this labour is needed. Even if the requirement for this labour does not coincide with other farm activities, improved fallow is not acceptable because, according to one key informant farmer, it interferes with their social activities.

The introduction of improved fallow among smallholder farmers of Emuhaya did not take cognizance of how agriculture fits in with the broader social and cultural characteristics, and how labour is socially organized and performed. It was also gathered from informal interviews with farmers that the reason why fallows are not popular among the farmers is because farming as an activity is considered part of the social norm.

Among the Abanyore, farmers who do not cultivate their land in time and completely are said to be lazy if not deviants. Such farmers, especially if they are women, have no respect in society. While this points to the importance of farming among the Abanyore, it also provides the social constraint that farmers face, especially in their quest to adopt new farming strategies. Among these people, ownership and cultivation of land have a great cultural significance which also has historical and social implications. According to an elderly key informant, land must be cultivated at all costs.

5.2.9 Agroforestry

Farmers in Emuhaya deliberately use trees or shrubs on the same land as crops, either in mixed spatial arrangement in the same place at the same time, or in sequence over time. This practice as, discussed above, is indigenous to the area. The local population did plant trees in their gardens in order to control soil erosion on the steep slopes and provide firewood, building poles and bean stakes. Another reason for integrating trees into croplands, according to key informants, is that these trees help in the management of croplands. However, depending on the agroforestry design, better soil cover is achieved by including perennial species and sowing cover crops as observed in the home gardens. Cover crops reduce direct rain impact, trap sediments and may reduce evaporation, so that soil moisture is regulated. Trees on farms also provide cover for other plant species as well as the shade where heaps or pits for composting could be located. Farmers also argued that trees provide a larger part of compost materials.

Agroforestry is, therefore, an appropriate strategy in smallholder farming. Nevertheless, because of the constraints reported by farmers under this study, this practice is not bringing a lot of benefit to smallholders due to lack of appropriate technical knowledge relating to tree management. Although it was difficult to isolate the farmers' indigenous

knowledge of the tree management, it was observed that some tree species had been pruned, but in some cases very crudely. Some practices like tethering animals on these trees are destructive, but were also observed to be common. Smallholder farmers also need to learn other tree management techniques as well as the cultivation of species that is supportive of their farming as opposed to Eucalyptus species which seem to be quickly replacing indigenous tree species, with dire environmental consequences. There was a general feeling, even among farmers themselves, that deliberate efforts need to be initiated to reduce the Eucalyptus stands so as to give room for other tree species in Emuhaya.

5.2.10 Matching Crops to Landscapes and Soils

Abanyore farmers also attempt to match crops to landscapes or, sometimes, even soils. Indeed, this is an indigenous practice which is still common albeit with a different approach.

It is, therefore, not surprising that farmers with land parcels next to pathways or near the road, reserve such parcels for trees and napier. Since parcels next to pathways or roads are prone to erosion from surface run-off, farmers argued that they grow napier and trees on such parcels to control erosion. Napier and trees in that case are, therefore, for both consumption and cash as well as for soil management. Apart from trees and napier, farmers also argued that potatoes are suitable for less fertile soils. Decidedly, many farmers grow potatoes on sloping landscapes where, apart from the food it provides, it is an agent of soil management. Importantly, there was also a perception widely shared among smallholder farmers that potatoes improve soil fertility.

This study also found that the Abanyole traditionally believed that certain soils are suitable for certain crops. Specifically, both interviews (survey and in-depth) as well as focus group discussions, confirmed that the people have detailed knowledge regarding soil suitability to specific crops. From time immemorial, the sandy *oluyekhe* soils have been mainly selected for sorghum, millet, groundnuts and, sometimes, potatoes. On the other hand, the fertile loamy *ingusi* soils are believed to support all the crops. The management of *ingusi* to suit different crops, therefore, means that crops are planted on

it to take advantage of the varying fertility stati. As pointed out above, *amabuoni* (sweet potatoes) are grown sometimes on *oluyekhe* soils but mainly on the loamy *ingusi* soils, especially after the fertility has declined altogether.

And as shown in the Table 4.5, the fertility of the soils is one of the criteria used by farmers in classifying local soils. The clayish *limwamu* and *litoyi* soils, where drainage channels have been dug, are also valuable for growing most crops. Farmers also believe that the production of root crops such as yams are suited mainly to waterlogged soils such as *litoyi* that did not have proper drainage channels. Trees and napier are also mainly grown on such soils. The least fertile *esiyeyie* soils tend to be reserved for trees or, sometimes, napier. Where there are no top soils such as an eroded hard surface, *esilangalangwe*, no cultivation is practised.

The other perception widely shared among smallholders of Emuhaya is that horticultural crops should only be grown on fertile soils and/or with large amounts of manure. This suggests that these crops compete with food crops mainly for the inputs required for the enhancement of yields rather than land. Therefore, lees land is devoted to horticultural crops as soil fertility declines, especially among households that cannot afford inputs. This unfortunate perception could be a justification of situations whereby crops such as maize, beans, sorghum and millet take precedence over vegetables on increasingly marginal land. This is unfortunate because farmers believe that these crops can tolerate 'inferior' environmental conditions. Similarly, such farmers are less likely to put in use the soil amendment strategies because of their belief that the crops they grow may just do well even under nutrient depleted conditions.

A unique practice is in which farmers harvest soils from other areas (river banks, road banks and termite mounds) for use in growing certain crops was also reported by some farmers. In addition, soils are also manipulated deliberately to alter depth and texture to suit particular crops. Direct observation made on farmers fields showed a few examples in which soil is heaped on mounds for the growing of napier or sweet potatoes. Conversely, where terraces or trenches are dug for soil and water conservation, the mounds that result are used to grow sweet potatoes, bananas or napier. Farmers on

their part immediately explained that trenches dug on their farms are important in holding water for the crops as well as in checking the surface runoff that may lead to erosion. Soils are also used in topdressing, as mulch and in compost preparation.

5.3 CONSTRAINTS TO THE USE OF TRADITIONAL SOIL MANAGEMENT STRATEGIES

The traditional soil amendment strategies discussed above are not widely practised among smallholder farmers today. During key informant interviews, focus group discussions as well as informal discussions with farmers, a number of constraints were identified to be the reasons for their limitations.

As expected, farmers mentioned population pressure as the leading factor and constraint that has made some of the traditional soil fertility management practices inapplicable. In relation to shifting cultivation and rotational bush fallow, farmers clearly pointed out that when people become many, movement becomes restricted. One female farmer explained:

... In the past, people could move from place to place because the world was not full. But now where do you move to? The whole world is covered (full)... Again, farmers used to farm as long as the land was good. But when they realized that the soil was now bad, they would leave it to rest and plant on new plots. Today, there are no new plots.

The immediate effect of increased population, according to the farmers, was the decline in the size of landholdings. Indeed, as explained above, farmers with small land parcels cannot even leave such parcels to rest (fallow) these lands. The constraint resulting from the size of the landholdings, especially in relation to its management, also has implication on other soil fertility management practices. Declining land size per household, according to farmers, means a limitation on the choices of crops to be grown. The constraint faced by households because of limited land size can be found in the following statement from one farmer:

If the land you have is just one and it is small and you are not employed anywhere, you cannot sit home and starve. You still farm.

You cannot even allow it to rest. What will you be eating? You see, our work is to dig and plant crops. That is what we eat.

The above statement should be understood from the perspective of farming being the main occupation among rural households in Vihiga. It is, therefore, understandable to argue, like some farmers did that they must use modern soil fertility amendment strategies to enhance the productivity of their fields. Yet, other soil amendment strategies are also not appropriate due to the above and other factors.

As will be seen below, even the strategy of crop rotation is in jeopardy. This is because, as one female farmer argued, certain types of crops must be grown in all seasons.

Those of us who have children must grow maize. If we grow other crops but fail to plant maize, it will be a problem because our children will suffer. They will go begging from other children in school ... or some can even steal. Also, these days if you do not grow maize then you are the thief that wants to steal other people's maize. A home or a house cannot be without a maize plot ...

The above argument points to the many reasons as to why farmers grow certain crops. No wonder, direct observation made on the farmers' fields during this study confirmed that maize is the most preferred crop among the smallholders of Emuhaya. While maize is the main food according to these farmers, it has also acquired social importance. Every household, therefore, strives to have a maize field. This happens even where the soil conditions are not suitable for the production of maize.

Therefore, contrary to the assertion made above to the effect that the sandy *oluyekhe* soils suit only sorghum, millet, potatoes and groundnuts, farmers argued that they are sometimes forced to grow maize in these soils continuously even if the harvest they get is not satisfactory. The declining land size among households in Vihiga has not only restricted the expansion of cropland but has also resulted in the decline in the number of livestock owned by households because of lack of pasture.

Coupled with the decline in land sizes, farmers also mentioned the restriction caused by the changed nature of land tenure systems. When land was under communal ownership,

like in the past, elderly informants reported that the community leaders or the elders were responsible for land allocation and protection of communal lands such as pastures. But with the changed land tenure to individual ownership, one needs permission or cash to tether his or her animals in the neighbour's fields. Farmers lamented that grass and napier, which used to be gathered free in the past, must now be bought.

Individual land ownership also means that the wider clan cannot suggest to an individual what to do with his or her parcel of land. There are nonetheless individuals in Vihiga with land parcels that are not in use but which cannot be put to use by others to produce food for fear of prosecution. While the main constraint here emanates from the policy relating to land ownership, it cannot be changed even locally because according to farmers' own accounts, most of the people with land that is not on use are absent from the community. Such people have migrated to distant areas in search of alternative survival needs.

Despite the constraints identified above, farmers acknowledged that some of the traditional soil fertility management strategies could be used today. Some of these strategies can be used with a little bit of modification to suit current circumstances. Evidence from direct observation and informal interviews with farmers on farmers' own fields revealed that numerous traditional soil amendment strategies are still being used. Some of these practices are discussed above and include intercropping, crop rotation, agroforestry, mulching, planting in mounds and the selection of crops or farming practices to suit landscapes.

For the purposes of this study, the traditional soil amendment strategies that are still being used formed the interest of the research and, therefore, deserved a detailed investigation. Inevitably, these traditional soil amendment strategies have survived the test of time and now rightly constitute what this study referred to as folk, local or indigenous skills.

5.4 MAIN CONSTRAINTS TO CURRENT SOIL AMENDMENT STRATEGIES

This study also sought to know the types of information or soil amendment strategies which, people found difficult to utilize. This was done by asking farmers to mention the main constraints they face with the soil amendment strategies that were thought to be available to farmers in Emuhaya. Table 5.2 below shows reasons given by farmers for not utilizing various types of agricultural information.

From this table, it is clear that access to disposable cash income, limited landholdings, and lack of one's own cattle are the main reasons which limit utilization of modern agricultural information. For instance, with disposable cash income, farmers cannot only afford to procure inorganic fertilizers but also hire labour required for application of the other strategies that otherwise they cannot carry out on their own. At the same time farmers mentioned limited land parcels as the reasons behind their inability to rotate crops in a field. This is because in their effort to provide the subsistence needs of their households, some crops like maize and beans must be cultivated. This means that among farmers with limited land holdings, maize and beans are more or less permanent crops in their fields.

Table 5.2 Main Constraints to Soil Amendment Strategies

Practice not used	Frequency	Reason(s) for not using	Frequency
Fertilizer	36	Capital Shortage	26
Fallowing	68	Land Shortage	37
Compost	32	Labour Shortage	23
Mulching	47	Labour Shortage	13
Crop Rotation	38	Land Shortage	11
Agroforestry	28	Land Shortage	6

5.5 POOR RESULTS DESPITE MANURE USE

One of the main constraints mentioned by farmers in as far as the use of soil amendment strategies is concerned is poor results. During the survey, a clear 22% claimed that they have been continuously getting low yields despite manure application on their farms. Key informant farmers as well as discussants in focus groups were in agreement that farmers in their villages continue to face frustrations in yields obtained from their fields despite manure use.

Numerous reasons were given by respondents to explain the reasons why farmers continue to end up with low or poor harvests even after manure application on their farms. The quantity of manure available for the farmers' fields usually tend to be inadequate according to some accounts. Because of this, some farmers have devised strategies of manure application which, according to them, helps in ensuring that the nutrient status of their farmers continues to support crop production. Some of these strategies include the selective applications of inputs in areas perceived by the farmer to be seriously depleted in nutrients. Farmers reported, and this was also observed, that manure, whether organic, such as compost and farm yard, or inorganic, such as DAP or CAN, could at times be applied to specific parts of the farmers' field. The selective application of soil amendment inputs on the farm is based on the observation made by the farmer about either crop/plant performance or the soil condition as interpreted by them.

Some farmers also said that when faced with the constraint of manure quantity, they only apply what they have to specific crops. Even among wealthy farmers, maize, sorghum, and horticultural crops such as *sukuma wiki*, cabbages, tomatoes and onions, are believed to perform well when the soil is fertile. Farmers expressed their opinion which is that exotic cash crops such as coffee and tea must only be cultivated by those who can afford chemical fertilizers. In fact, according to the poor farmers, one reason why they do not venture into horticultural crops is that they cannot afford the inputs in terms of fertilizer and pesticides needed to sustain their growth. Among the factors considered in the selective application of manures on farmers' fields is also the type of crop in the field.

The other concern voiced by farmers themselves was the quantity and manner of manure application. Because farmers admitted that the fertility of the soils in their fields had deteriorated, they argued that they cannot know and they also lack the means of establishing the exact amount of manures required for crop production on these fields. Clearly, much of the farmer's efforts to restore yields is experimental and tends to be based on trial and error. More often than not, the key informants reported that farmers 'under-dose' their fields with manures. This position was strengthened by views expressed by key informant farmers.

Besides, it was also observed that the method of planting among smallholders also leaves a lot to be desired. Although the traditional planting method of broadcasting seeds on the ground has been abandoned and is almost disappearing among smallholder farmers of Emuhaya, the adoption of row planting has not been strictly adopted. Direct observations made on farmers, fields showed that where a crop for example, maize is planted in a row, farmers tend to prefer planting many seeds or seedlings. Plant and or spacing in many farmers fields were also observed to be chaotic and not adhering to any requirement but only depending on the farmers needs. Many of the farms observed showed that farmers during planting put, on average, more than two seeds per hole and, therefore, end up with many germinating seedlings per hole. In fact, on some farms, once the plant cover has established, it is difficult to know just through observation alone whether planting was by broadcasting or through row planting.

Farmers, however, have their own reason for preferring to crowd crops on their fields. One reason for this was that placing one seed per hole would be a risk as pests or diseases can easily destroy the seed or "it can just fail to germinate because of soil and/or weather conditions". The planting of many crops in a single hole as an insurance against the many odds that face smallholder farming in Emuhaya, is a perception shared by many farmers. Surprisingly, where all the seeds germinate, thinning is not done in time to allow the remaining seedlings to develop without unnecessary competition. The crops are allowed to mature without thinning and which, definitely, suppresses yield.

The second reason given by the farmers as to why maize in particular is planted in a crowded fashion is to provide fodder for animals. Regrettably, it was observed that even those households that do not own animals also plant maize in this manner so as to sell the extra maize plants as fodder to obtain quick cash for household needs. In such cases, farmers said that they harvest piecemeal what they consider mature fodder and sell to wealthy farmers. Nonetheless, whether maize is spaced to allow for greater crop population to check on the odds mentioned above or to provide fodder for animals, the result is that this practice does not correspond to the maize-manure requirement. Obviously, the result has to be poor and farmers acknowledged this during focus group discussions.

In addition, from the informal discussions, farmers reported that for planting, especially maize, they preferred local seeds to hybrid seeds. Key informant farmers also made similar observations during in-depth interviews. The preference for local seeds to high yielding varieties, especially for maize, requires that proper seed storage technology be developed. However, this, according to information gathered during the research, has been lacking among the Abanyole. The level of food insecurity, according to some farmers, also means that poorer households may be forced to feed on grains stored as seeds. During planting, farmers said that they usually secure locally available cheap seeds from the local markets. Poor crop performance may have some relation to such doubted quality seeds rather than on the use of manures.

Ironically, even those farmers who plant hybrid seed report dissatisfaction with yields. Although hybrid seed has higher yield potential than local seed varieties, this is only true when adequate management practices are carried out. Even farmers themselves acknowledged that under circumstances of improper care, local seed can give higher yields than hybrid seed. Farmers' indigenous knowledge also testifies that local seeds are well adapted to the local environment in terms of climate and soils.

Besides, farmers themselves appreciated that, indeed, there are many forces that affect crop performance on their fields and that the use of manures cannot be the sole remedy to poor harvests. For instance, late weeding, although mentioned by only one farmer

during the survey, kept on occurring during in-depth interviews with farmers as well as in focus group discussions. In the case of maize, which many farmers use to interpret soil nutrient status, there was also an agreement among farmers that it has a high responsiveness to care. As with other crops, early weeding prevents the competition of soil nutrients associated with weed growth in maize production. Late weeding is, also, a reflection of difficulties faced by farmers in raising the required labour for that task. Keen attention to farmers in focus groups also revealed that late weeding may also be the cumulative effect of both delayed land preparation and late planting. Significantly, as key informant farmers maintained, manure use in crop cultivation could only be beneficial if accompanied by good husbandry.

Since the position taken by farmers was based on the observation made on the yields they got from their fields, the reasons leading to poor harvests were perhaps only partly related to the soil conditions. Nevertheless, as Table 5.3 below shows, soil nutrient depletion is still the leading cause of poor harvests among smallholder farmers sampled in this study.

Table 5.3: Reason and Number of Farmers who expressed Dissatisfaction with yields, Emuhaya, 2002.

Reason	Frequency	% of farmers
Depleted Soils	25	54.35
Late planting	8	17.39
Theft	4	8.70
Too much rainfall	6	13.04
Less rainfall	2	4.35
Late weeding	1	2.17
Total	46	100.00

5.6. INTEGRATED NUTRIENT MANAGEMENT AMONG SMALLHOLDERS OF EMUHAYA

Farming systems and soil fertility management practices among the smallholders of Emuhaya are becoming increasingly diverse, which makes the task of research and extension more difficult. As discussed above, smallholders on their farms are employing both indigenous and modern soil amendment strategies of varied proportions. This study found that there are a number of constraints that hinder the efficient use of some of the strategies. These constraints partly explain why farmers still believe that the soil nutrient status of their fields is still below their required level.

Integration of farming systems is not new in Emuhaya, according to farmers' accounts. The role of indigenous knowledge in the integration of soil amendment strategies cannot be underestimated, going by the information gathered from key informant farmers. Equally, to meet the requirements of the diverse and risk prone nature of smallholder farming, key informant farmers stressed that modern soil fertility management strategies must also be encouraged and their use strengthened.

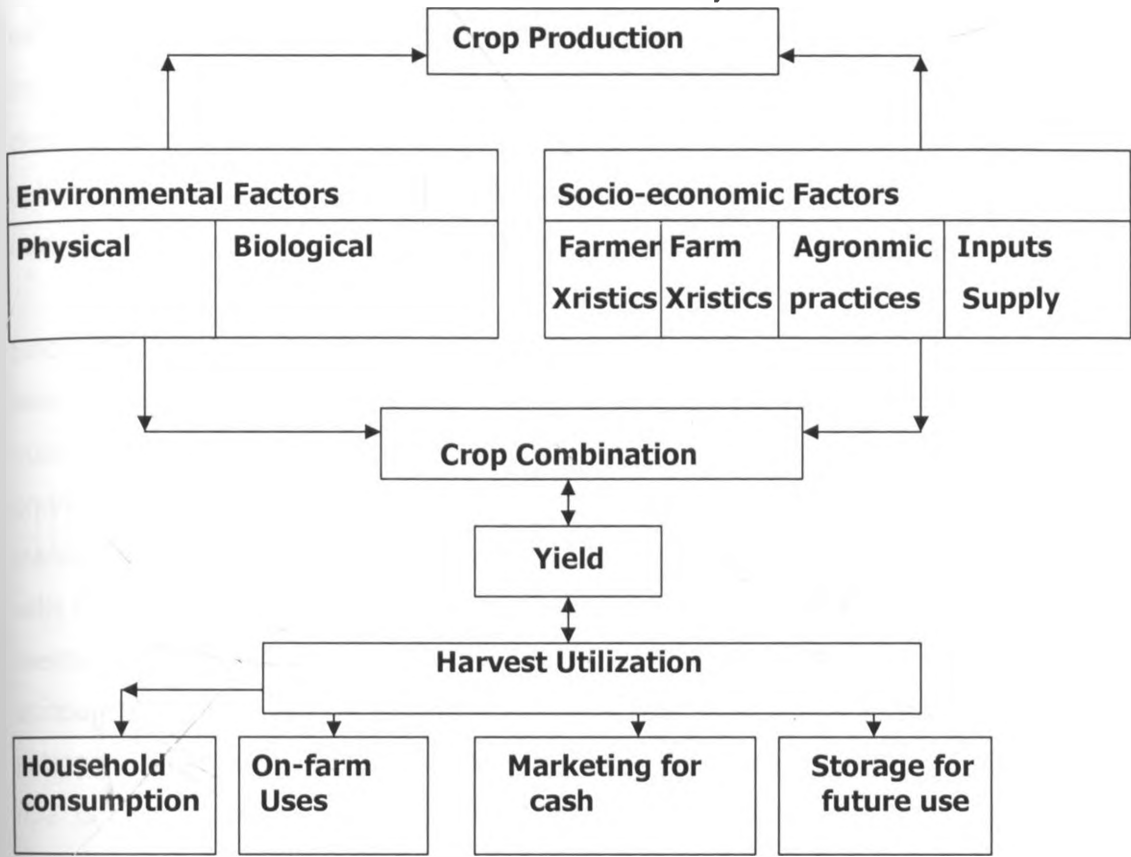
Whether on their own or jointly in farmers' groupings, smallholders have always experimented with the combination of soil amendment strategies on their fields. Further and detailed observations about integrated nutrient management of farms of smallholders in selected villages of Emuhaya was made possible during this study through visits and participation in farmers field school sessions. Integration also seems to be a strategy preferred by farmers to help them overcome the constraints faced when using particular inputs. Farmers explained that, they are at times forced to combine strategies on their farms to increase crop performance because the quantity they have of each input is inadequate. Moreover, mainly because of this reason but also because of other reasons, farmers said that they occasionally use animal manures as compost material. Therefore, integration as a strategy often starts before manure application on farms.

It is the concern for food production that pushes farmers to use the available soil amendment strategies (See Figure 5.1 below). In general, soil fertility amendment

among smallholders of Emuhaya is dependent on the interaction between environmental and socio-economic factors. Environmental factors here are both physical such as the location in which a field is located and biological such as the observable soil fertility indicators. On the other hand, socio-economic factors include the gender, age, and the wealth status of a farmer as well as the size of landholding available for the farmer's use. Socio-economic aspects may also be deduced from the type and number of livestock owned by a farmer.

The main soil fertility amendment strategies available in Emuhaya include animal manure, compost manure, fallow, crop rotation, use of greens, inorganics or shop fertilizer, fallow, crop rotation and mulching. Other soil amendments strategies include matching crops to soils or landscapes, use of farm residues and crop remains and manipulating soil depths during cultivation to avail nutrients to crops. Where possible, smallholders use these strategies either alone or in combination with others.

Figure 5.1: Factors at Interplay in Integrated Nutrient management among smallholders of Emuhaya.



Source: Fieldwork; Emuhaya, 2002.

Whether a farmer uses the available soil amendment strategy alone or in combination with others depends on the environmental and socio-economic factors mentioned above. For example, farmers do not use inorganic fertilizers in the homegardens since such plots are perceived to be fertile. Homegardens are perceived to be fertile because they are located near households and they occasionally benefit from household refuse, including animal remains. Homegardens also harbour indigenous vegetables considered by some farmers as indicators of soil fertility.

It was also observed that the number and type of crops grown in a farmer's field also influence the manner and type of soil amendment strategy or strategies used by a farmer. Since crop mix is a common practice among smallholders, they strive to respond to this by combining nutrients on their plots hoping to satisfy the needs of different

crops. Inevitably, some soil amendment strategies are associated with particular crops. It is important to note that the practice of mixing crops on farmers' fields is to some extent dependent on the environmental and ecological factors as observed and interpreted by smallholders. In addition and on the other hand, the crop mix is dependent on the diverse needs of a particular farmer. As the study found, maize cultivation among smallholder poor farmers, for example, is inevitable because it is considered a convenient crop both in terms of its management and consumption.

Since the smallholders' concern is to enhance crop productivity, they are bound to be keen with farm harvests. Farmers observe and measure yield to keep a breast with both quantity and quality of farm produce. They also compare their yield with the yield of previous harvests and with yields from neighbours' fields. Based on locally validated standards of yield estimation, which was observed to attempt to match crop quantity with farm size, farmers obviously understand whether their produce is satisfactory. The measurement and observation on the quality of farm produce is also based on local standards that are now part of the local script. For some crops such as bananas and potatoes, quality attributes extend to how quickly or how well they cook and taste when ripe or when cooked. Further, smallholders will not apply inorganic fertilizers in homegardens where bananas, potatoes and indigenous vegetables grow arguing that inorganics may compromise the tastes of such food crops.

Interestingly, farmers also report that food crop yield, whether in terms of quantity or quality is also influenced by both environmental and socio-economic factors, including farmer's ability to afford the input and labour costs that match the various strategies available for farm needs.

Clearly, farmers observed that maize yields and maize acreages, for example, are related: but at the same time, they also appreciated that use of inputs has a significant role in production of maize, and/or other food crops.

5.7 GENDER AND SMALLHOLDER FARMING IN EMUHAYA

Gender is a principal dimension of smallholder food production and consumption in Vihiga. Over the last few decades, migration to other areas has increasingly played a role in the livelihood strategies available to rural households. Those who remain within their villages are mainly women, as this study found, who have been forced to compensate for the absence of migrants by assuming responsibilities in addition to their usual productive and reproductive work. Both survey data and informal interviews provided evidence that women involved in smallholder farming are often mothers who migrate less than other household members because their reproductive and productive activities are critical to household survival.

For women facing the uncertainty of cash remittance or declining income, subsistence production becomes an important safety net. No wonder, more women than men claimed that they farmed for both food and cash. For poor women, even crops to grow must be chosen depending on many factors, as one focus group discussion observed:

... We must plant maize, we cannot stop planting maize. It is the oil we cook with, it is the salt, it is the soap and it is everything... Even when the child is sick, it is the maize you sell to get money for medicine...

Maize provides food, it is a safety net and, among the poorest households, limited but extremely significant income for meeting daily expenses, over which women have control. To such category of women, the question of crop rotation on their fields is, therefore, out especially if their landholdings are also limited.

One of the critical concerns to this study was the fact that women whose husbands migrate have taken on an increased share of the entire set of agriculture tasks. But, as observed during the study, these women have taken on an increased share of the responsibilities involved in agricultural⁸ production from a disadvantaged position. Patriarchal orientation compounded by male bias among the Abanyore has limited women's access to land and other resources indispensable to smallholder agriculture production. In fact, during informal discussions with farmers, it was established that rural women are often still considered housewives rather than agricultural producers at

par with men. Gender differences have, therefore, meant that the changes that have impacted on smallholder farming have affected men differently from how they have affected women. As illustrated on Table 5.4 above, even the use of various strategies to manage soil fertility has been segregated by gender.

Table 5.4: Soil Management Practices of Men and Women Farmers in Emuhaya

PRACTICE	GENDER			
	MALE (n=40)		FEMALE (n=60)	
	Frequency	Percent	Frequency	Percent
fallow some land	3	7.5	6	10.0
practise crop rotation	28	70.0	26	43.33
Regularly apply farm yard manure.	37	92.5	52	86.67
made compost	23	57.5	23	38.33
used inorganic fertilizer	32	80.0	32	53.33
incorporate green	15	37.5	12	20.0
had mulch	9	22.5	13	21.67

Clearly, from Table 5.4, men are ahead in the numbers that use various strategies to manage the fertility of their soils. For example, 80 per cent of the males but only 53.3 per cent of the females applied inorganic fertilizers on their fields during the research season. Similarly, whereas more than half (57.5%) of the male farmers made compost during the research season, only 53.3% of the female farmers had that manure. The explanation for this situation is that women face more constraints than men in their everyday farming activities and in particular labour constraint in as far as composting is concerned.

Women also tend to own fields that are nearer the homestead. And as revealed in this study, homegardens were also managed more intensively than the other distant fields and, therefore, they did not need to be fallowed. Constrained by both limited

landholdings and other social factors mentioned above, women said that they have increasingly found following unsuitable.

Attitudes towards food production among smallholders are highly gendered. Men, who are widely perceived as the primary breadwinners in many rural households, value agriculture mainly for its ability to produce income. This has been heightened by changing social roles that link women's status, dignity and identity on their ability to feed and provide for their households. Women must, therefore, engage in farming activities all year round as this also means that they are defending their identity which is linked to their ability to provide and feed. Besides, among the Abanyore, women who do not actively engage in farming are perceived to be lazy and morally questionable. This study found that in the past when land sizes were large, women exclusively owned homegardens, as these gardens needed constant attention.

Poverty, which is prevalent in rural western Kenya, is also manifested differentially along gender lines. In Vihiga district, poverty affects female-headed households most chronically. Such women, therefore, cannot afford the required levels of inputs (fertilizer and labour) for the farm activities. Labour status (use of family or hired labour) for farm activities, number of livestock owned and the amount of fertilizer used at planting were observed to be less among female farmers. Women also are more likely to work as casual labourers on other farms before tending their own, thereby planting and weeding late.

The traditional role of women further puts them at a disadvantage as far as the management of soil fertility is concerned. In many traditional societies in Africa, women have been responsible for providing fuel which in many rural cultures, comes from firewood. Even among our study population, key informants confirmed that women are disproportionately responsible for finding and gathering bundles of firewood though quite often it was men who chopped down the big trees initially. Without forests, like is the current situation in Vihiga, firewood becomes very difficult to come by. While women with disposable cash income can obtain firewood from the market, women from poor households have no choice but to use crop residues as fuel.

Direct observation confirmed that women from poor households use dried maize stalks as fuel. The incorporation of crop remains into the soil which could be one of the ways of managing soil fertility is, therefore, low or totally unattainable among poor female households. One would, therefore, expect that women would be in the forefront in adopting strategies that incorporate trees to crop fields, but there is a cultural constraint that stipulates which crops or trees women are allowed to cultivate. In our area of study, there was a feeling that women of childbearing age are not supposed to plant trees. Agroforestry as a strategy of managing croplands is also not fully embraced by women because of the obvious labour constraints. With most of the farmers being women, the situation of soil fertility among the study population seems to be giving way.

5.8 FARMERS' WEALTH STATUS AND SOIL MANAGEMENT STRATEGIES AMONG SMALLHOLDERS OF EMUHAYA

As pointed out in the background section of this study, farmers cited land size per household as well as the number of livestock owned as the two most important factors of farmers' class differentiation. As this study confirms, the wealth status of a farmer clearly determines the farmer's choice of land management strategies (Table 5.3). Whether from the survey data or the data emerging from key informant interviews, it can be argued that the size of landholding is a prerequisite to soil management practices. As farm sizes diminish, poorer households that have been differentially affected more by subdivision have had less opportunity to practise crop rotation and fallow and so their land tends to be placed under continuous cultivation. This study specifically found that no farmers from the low wealth category fallow any part of their lands while only 37% of the poor farmers rotate crops on their farms as compared to 96% of farmers from the wealthy households.

Similarly, variation in the use of soil management practices was also evident in the use of inorganic fertilizers. Seventy-four percent and thirty percent of the wealthy and the poor farmers, respectively, reported that they used DAP during planting in their fields always. A similar trend was also found in the use of CAN for topdressing where 41.9% and 8.2% of farmers from wealthy households and poor households, respectively,

claimed that they use it on their fields always. Inorganic fertilizers seem to be used mainly by the wealthier households, with some disposable cash income.

When it comes to the incorporation of green manure into croplands, it was again the wealthy farmers who reported regular use of this practice. Ten percent of the wealthy, but only 6.7% of the poor farmers surveyed reported that they incorporate greens into their croplands always. The constraints faced by poorer households in the use of green manure include both labour and limited finance. Poor households do not have additional labour and disposable cash income to hire labour for the search and incorporation of greens. The same constraints also hinder their wider use of compost manure. During the survey, it was found that 51.6% of farmers from wealthy households compared to only 37.7% of the farmers from the poorer households who indicated that they use compost manure on their farms do so only sometimes. Table 5.5 provides a summary of different farm management strategies by farmers under different wealth categories.

Table 5.5: Soil Management Practices of Wealthy and Poor Households

Practice	Farmers' Wealth Class			
	Wealthiest (n=31)		Poorest (n=69)	
	Frequency	Percent	Frequency	Percent
practice crop rotation		96		
apply animal manure		90.3		86.9
make compost		51.6		37.7
have ever used inorganic fertilizer		83.9		55
incorporate green manure on their fields		67.7		8.7
use mulch regularly		45.2		11.8

From Table 5.5 above, it can be seen that the occasional application of manure in planting holes, crop rotation and the use of mulching, are the principal means of maintaining soil fertility in smallholder fields in Emuhaya. These, regrettably, as can be seen in the table, are not widely used by farmers of low wealth category. Farmers

reported that as farm sizes decline, crop rotation too is increasingly becoming unpopular especially among poor households. Farmers from poor households maintained that their land was insufficient for the practice of crop rotation. Other management strategies of maintaining soil fertility among smallholders of Emuhaya include the incorporation of crop residues into the soil at ploughing, which also varied by farmer's wealth category. The widely used crop residues are maize stovers, dried stalks and discarded cobs. But among the poorest households, these are used as fuel since the hearth still figures prominently as the principal means of cooking. Worse still, some respondents said they sold their crop residues as fodder to wealthy farmers to obtain quick cash for their household needs.

CHAPTER SIX

DISCUSSION, CONCLUSION AND RECCOMENDATIONS

6. 1 Introduction

In this chapter, the findings are interpreted to show how they relate to some other studies done elsewhere and which have some relationship to the problem of soil fertility depletion among smallholder farmers. The first part starts by providing insights into farmers' knowledge of local soils as well as indigenous diagnostic criteria for discerning soil nutrient depletion, while the second part presents findings on soil fertility management strategies among smallholders and how these vary by gender and wealth status. It is also pointed out here that farmers themselves reported that the integration of soil amendment strategies is the only sure way overcoming the constraints faced in managing soil fertility. Finally, conclusion and recommendations for future research and policy implications are spelt out.

6.2 DISCUSSION

In this study, it was found that farmers have detailed knowledge of their local soils. This knowledge of local soils is part of the repertoire of knowledge and practical skills that farmers have acquired over a long time. The knowledge of local soils encompasses not only the visible constituents but also the invisible constituents. As has been observed among various communities, this study found that the Abanyore perceive soil as 'a living thing'. Significantly also, this study found that soil in the area is not only regarded as a living entity but also has fertility or strength which can be nurtured and transformed into a state of strength by human intervention in the same manner that human beings or animals are cared for and transformed into reproductive and productive adults. In many parts of the world, soil, or land in general, is perceived as a 'living thing', which shows that smallholders have an appreciation of below ground processes and vitality (Sikana, 1994; Birmingham, 1998).

The naming and classification of local soils is based mainly on the surface characteristics such as colour, texture and location. Occasionally, sub-soil characteristics are used. Nevertheless, the knowledge of local soils has also historical as well as social

attachments. Soil is holistically perceived and has political, social, economic and spiritual importance. This study also found that land is an important entity and has an inseparable connection with the soil. The knowledge about different types of landscapes is widely connected with the wider knowledge of land and soils.

This study also found that farmers' knowledge of soils is exhaustive. Similar findings have been made in the same area by the Tropical Soil Biology and Fertility programme (TSBF, 2002 unpublished data). Farmers, therefore, know in detail all the constituents of local soils. Of particular interest to the study was the assertion made by key informants to the effect that soils have health or strength, which should be cared for appropriately or nurtured. Similar assertion was that soils can get 'tired' and might occasionally need some 'rest'. Farmers also clearly pointed out that without appropriate care or nurturing, soils can be barren. Regrettably, it was also learnt that some soils were perceived to be naturally barren. Terms such as 'health', 'strength' or 'barren' when mentioned in relationship to local soils simply imply fertility. Inevitably, fertility was one of the criteria for differentiating these soils.

Because of this detailed knowledge which is widely shared among the smallholder farmers, there is also an elaborate way of classifying and differentiating local soils. Similarly, the same knowledge is used in diagnosing the nutrient status of these soils. The study has revealed that farmers are familiar with the various soil types in their localities. This confirms findings among farmers in other countries (see, for example, Msanya and Mwasebi, 2000). As Msanya and Mwasebi found among the Iraqw and Mbulu of Karatu in Tanzania, this study found that based on their knowledge of soil types, the Abanyore of western Kenya decide the use to which a particular piece of land can best be put. Similar findings have been reported among the Abakabras by Tabu (see TSBF, 2000) and Avalogoli (Crowley and Carter, 2000), both of western Kenya.

Interviews and discussions conducted with farmers revealed that the sources of this knowledge of local soils are varied. Significantly, however, the data collected did not yield a very neat pattern with a clear positive linear relationship between either age or gender and knowledge of local soils. For instance, informal interviews with farm workers

showed that their knowledge of local soils is as elaborate as that of elderly and wealthy farmers. Farmers themselves asserted that they had learnt everything they needed to know about local soils through their own experience, without being taught by anyone. That experience is an important source of all categories of agricultural information in Vihiga has also been reported by Muruli *et al.* (1999).

It should also be noted that much experiential learning is shaped and facilitated by a multiple web of networks and contacts with many of the information sources such as relatives, friends, group members and extension personnel. The emphasis on experiential learning points to the significance of observation in learning among smallholders. Among agricultural communities such as the one under this study, children and young adults are typically involved in regular household chores, which often include farming activities such as hoe cultivation, planting and/or weeding. They are likely to acquire knowledge just from watching or listening to their elders carrying out such activities as hoe cultivation or hoe weeding. Indeed, many young farmers explicitly cited parents (and this could include grandparents) as their most significant sources of information relating to soils, after personal experience. The emphasis on personal experience and observation implies that among smallholders, learning is an inherently local process. Therefore, in the area of soil characteristics, even knowledge that is acquired from formal sources is ultimately integrated in the minds of local people in very local contexts. This probably was the case with information on local soils acquired by smallholders through extension agents and other scientists. Just how formal scientific knowledge gets integrated into local context is a concern that could be addressed in future studies.

That knowledge can be based on experience is not unique or original with this study. Scholars of renowned repute such as Bertrand Russell had established that link in their earlier studies. What a person knows, Russell asserts, is dependent on that person's own individual experience: "He knows what he has seen and heard, read and what he has been told, and also what, he has been able to infer" (1948:9). Of particular interest to this study is the assertion that knowledge can be inferred.

As stated above, farmers also rely on their knowledge to diagnose the soil nutrient status of their fields. In this study, farmers reported that they use a combination of indicators to learn about the nutrient status of local soils. Although yield of cultivated crops was the most frequently mentioned indicator of soil nutrient status, farmers also reported that there are some ways of discerning soil fertility depletion in particular. Certain animal and plant species are indicative of soil nutrient status in Emuhaya. Specifically, nematodes and earthworms were associated with soil fertility and farmers generally argued that such organisms are mainly found in very fertile soils. Similarly, farmers reported that the existence of soil organisms such as insects can be associated with the soils' fertility. Without specifications, farmers generally accepted that the more diverse the insect population there is in a field, the more the fertility of the soil.

Certain plant species are associated with soil nutrient status. *Lusiola*, *olulusia*, Wandering Jew (*linyolonyolo*) and *Tithonia divesifolia* (*mauwa malulu*), are some of the local plants associated with fertile soils. Conversely, *Striga hamonthea* (*eyongo*), *nyangweso*, guavas (*amapera*), thatching grass (*amasinde*) and *batoro* are some of the plants associated with soil infertility. Some plant species such as Castor oil (*amavono*) and couch grass (*olumbuku*) are found in both fertile and infertile soils. Farmers, however, are well aware of the differences in plant growth and vigour depending on soil conditions. General plant or crop 'health' as seen and interpreted in leaf vigour, root spread and strength, leaf colour, stem diameter and general plant height, are used to discern soil conditions.

Information emerging both during focus group discussions as well as in-depth interviews with key informant farmers revealed that in the case of couch grass, the roots go very deep in soils with depleted fertility and are quite difficult to uproot but remain near the surface in fertile soils. Farmers also said that plants growing in infertile soils are vulnerable to pests and diseases much in the same way as animals or humans who are not well fed. Farmers understand fertility to imply 'certain type of food or medicine' in the soil for plants and crops.

Soil fertility is also inherent in the soil characteristics. Soil characteristics associated with fertility include depth, colour and location in which the soil is found. Whether one looks at information emerging from the survey or the key informant interviews, the general impression is that farmers tend to associate the colour black with high nutrients. The more predominant loamy soil, *ingusi*, in the villages selected for this study is used to illustrate this perception. According to farmers' assertion, the darker the *ingusi* soil, the more the fertility. In fact, key informant farmers unanimously agreed that the red version of *ingusi* that they refer to as *eliakhanyu* (or simply the red one) performs dismally in terms of supporting crop production. Farmers participating in focus group discussions made similar observations.

Farmers also believe that deep soils are rich in nutrient status. Farmers asserted that the deeper the soil, the higher the fertility. On that basis, farmers have a number of strategies that they use to manipulate the depth of the soils in their fields. Soil is harvested from various points and deposited on farmer's fields, mainly to support the production of certain crops but also to improve the fertility of severely depleted soils. Often, farmers also reported that they heap soils in mounds when they want to plant certain crops which, in their perception, need deep soils to enhance their performance.

Direct observation on farmer's fields also helped in demonstrating that farmers prefer to plant potatoes in mounds. To make mounds, farmers simply pile soil and plant potato cuttings on the heaped mounds. Soils for making mounds may also harvested from termite mounds, road reserves and, sometimes, from trenches dug on the farm to control erosion. Farmers also believe that good tillage practices such as 'digging deeply', enhances yield because the plants will now reach the nutrients. Although farmers could not agree on the location of soil nutrients, their general perception was that certain types of nutrients are found deep down the soil and can only be availed to crops if the soils are cultivated properly. Proper tillage constitutes digging to certain depth, depending on the soil type.

The ecological gradient in which fields are located is also associated with the soils' nutrient status. Because of this, farmers said that the clayish *limwamu* is more fertile

than the soils that are located some distance from water points. But farmers were also quick to add that water or moisture, which is very distinct, is also an aspect of crop production. Interestingly, poor drainage or waterlogging was also associated with poor crop performance. Farmers associated the papyrus-like grass, *likuku*, with poor nutrient status. Therefore, in improving the soil drainage, the grass naturally disappears and nutrients return to the soil. Although it did not come out clearly, farmers seemed to suggest that too much water inhibits the use of nutrients by plants. Consequently, the improvement of soil drainage system is not only a strategy to control erosion but also to improve soil nutrient status.

Smallholder farmers are also increasingly becoming worried about the status of their farms in terms of fertility. Consequently, they continuously employ a number of strategies to manage the fertility of their croplands. Figure 6.1 below illustrates some of the soil amendment strategies used by farmers during the study period. While some of those strategies are derived from modern scientific thinking, others can be characterized as indigenous practices which have persisted through time. Probably, the concern for managing soil fertility provides an area of knowledge integration. Farmers spoke of a variety of practices as well as concepts used to deal with soil fertility and plant growth. At the level of practices, most farmers in the study area, except the poorest, make some use of commercial inorganic fertilizer, which they call *mbolea ya duka* (literally meaning shop fertilizer), especially DAP and CAN, on their crop fields.

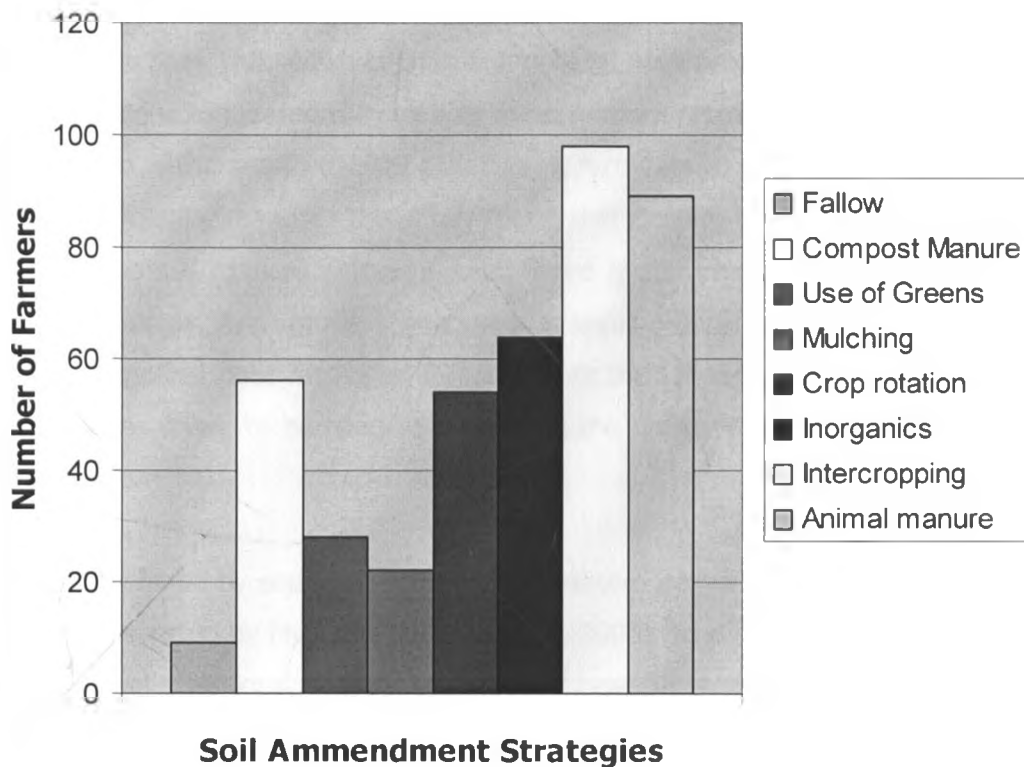
Most farmers, however, continue to use the more traditional cow dung as manure, often in combination with crop residues or plant materials as compost or by itself. Some farmers use green manure as their soil amendment strategy. Farmers' belief behind the use of these strategies is the idea that plants or crops require certain types of "food" or fertilizer. At the same time, because farmers believe in the life force inherent in all soils, they claim that it is this life force that works to regenerate the fertility of soils when such soils are left fallow. Farmers also believe that crops might at one point or the other be sick and require treatment. As with humans or animals, plants that become sick need treatment and more so when the sickness emanates from nutritional deficiency. While this belief may have arisen separately in folk knowledge, it is certainly also part of the

global scientific agricultural thinking and guides the production of commercially manufactured fertilizers such as DAP. This probably explains why some of the management practices preferred by smallholders are crop specific. Similar belief has been reported by Brodt (2002) among villagers of Madhya Pradesh, India.

Strangely, diverse practices and concepts, some stemming perhaps from different knowledge systems, are mixed and matched by smallholders to enhance the productivity of their fields. The wider use of inorganic fertilizers in combination with compost or animal manures during planting was explained in two ways. First, both manures are needed by crops; second, compost or animal manures are used to limit the burning effect of inorganic fertilizer. Here, compost or animal manure has both a cooling or moderating effect as well as being food for crops. Therefore, even farmers who do not have compost or animal manure try to incorporate inorganic fertilizer in the soil before planting. It was also observed among some farmers that they mix inorganic fertilizer with soil before placing small quantities in planting holes during planting.

Farmers, surely have been told by scientists and extensionists but they also have observed that when an inorganic fertilizer is put directly on a seed or the roots of a seedling, the result can be disastrous or, as observed in this study, poor germination. Consequently, the effect of inorganic fertilizers on seeds must, therefore, be minimized. The above explanations provide an appropriate example of how pieces of knowledge that seem to be coming from different knowledge systems are gathered together and woven into a workable local model of soil fertility management. Interestingly, while water was generally represented as a removing agent that washes away vital soil nutrients and must not be allowed to spoil the effects of inorganic fertilizers, farmers also appreciated its power as a secret growth force which is necessary for crop production.

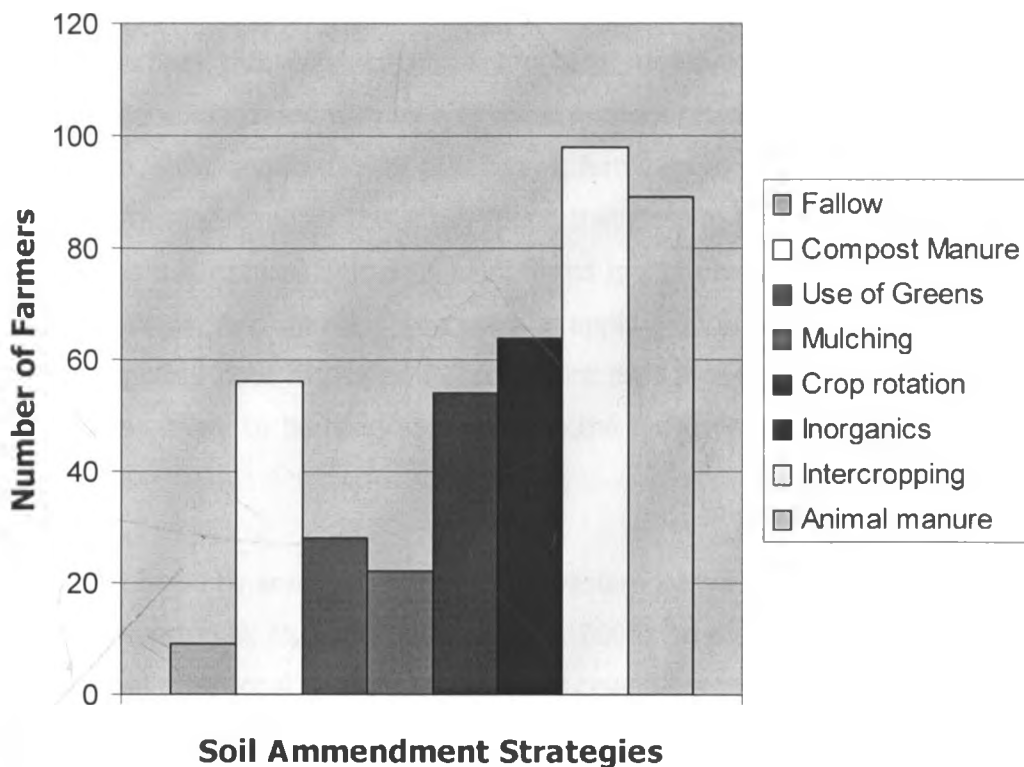
Figure 6.1: Soil Ammendment Strategies Used by Smallholders



Source: Survey data; Emuhaya, 2002

This study also found that smallholder farmers are involved through a number of strategies in the management of the soils of their fields but are hardly making any meaningful impact. This is mainly because of the many constraints faced by smallholders, especially the poor. These constraints are sociocultural, political and economic and have been brought about by the current world economic order which has, in turn, emanated from distorted policy and social disruptions. This new world economic order is an aspect of the whole process of social, cultural and economic disintegration and marginalization which, as the findings of this study indicate, seem to conspire against the indigenous soil management strategies that could be used by smallholders in their fields among the Abanyore of western Kenya. Ideally, these traditional soil

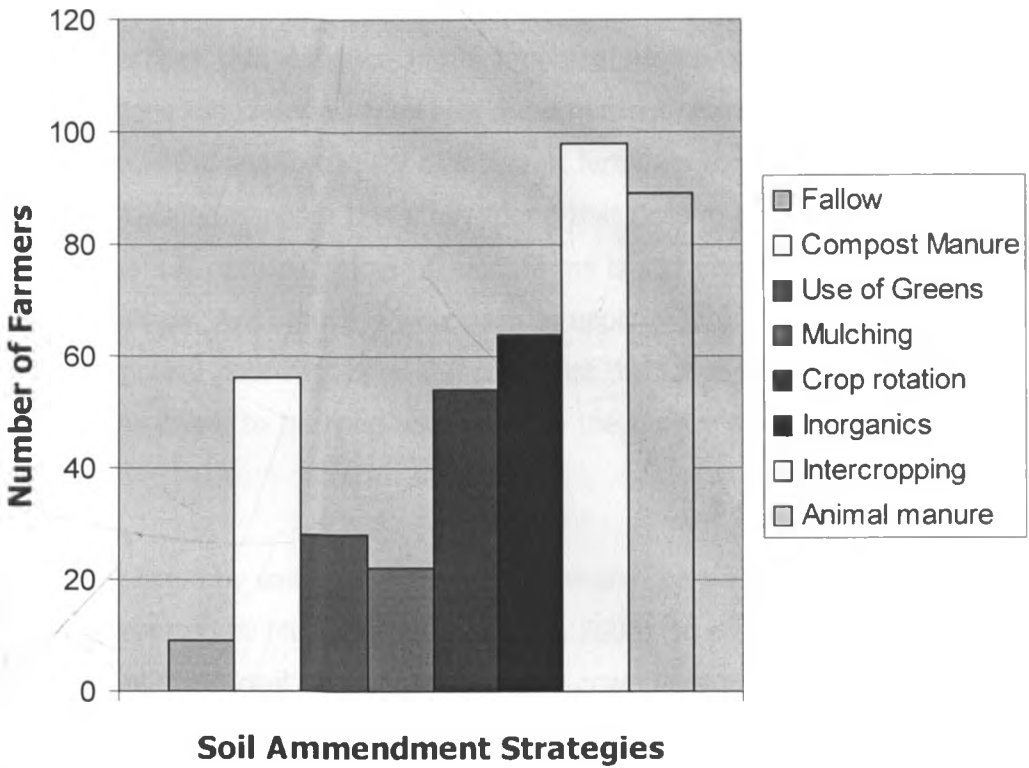
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amendment strategies operate under great pressure in the contemporary world in which farming systems seem to be in transition.

Practices to improve the fertility of depleted soils include the application of inorganic fertilizers, manures and composts, crop residues and plant prunings, crop rotations and agroforestry practices that enhance nutrient cycling. However, as mentioned above, there are limitations associated with each of these nutrient restoration technologies. The obvious example is the unaffordability of inorganic fertilizers to smallholder farmers and inadequate low quality manure. This study found that despite occasional application of these inputs, the soil nutrient status of most farms is still unacceptably low or simply very low. Surprisingly, even farmers who claim to apply organic manures on their fields regularly still reported poor results as the constraint they face in using these manures. The problem was found to be lying squarely with the quality of these locally prepared organic manures.

That manure prepared by smallholder farmers in western Kenya is of low nutrient quality had also been reported by Mutuo *et al.* (see TSBF, 2000). In an experiment designed to evaluate the quality of local manure, Mutuo and coworkers reported that yields from 'farmer controls' treatment (farmyard manure as normally applied by farmers) were not any different from those of the control with no inputs. The low yield following an application of manure is an indication that manures from this area are of poor quality. The low nutrient status of manure limits its effectiveness as a nutrient source. A number of reasons are responsible for the poor nutrient status of locally available manures. An experiment by Nzuma and Murwira (see TSBF, 2000) cited nitrogen losses during storage and handling. Indeed, organic manure decomposing under the conventional heap storage is subject to a high potential of losses due to exposure of storage systems. While some farmers ensure that organic manure preparation and storage is done under pits, this study found that the labour constraint involved in this discourages poor farmers without disposable cash income to hire labour for this exercise.

Nevertheless, manure use has been restricted mainly due to the unavailability of this resource to farmers in large enough quantities. The same problem faces farmers who

want to use green manures on their fields. Moreover, the sustainability of green manure use by farmers to recycle nutrients in farming systems can be limited by the intensive labour involved in biomass collection, processing and application. Such is the constraint faced by farmers who could otherwise use green manure sources like *Tithonia diversifolia*. To overcome the problem of limited availability, farmers within the study area have experimented by planting *Tithonia* hedges, for example, since most of them know how to propagate it through cuttings. This is because farmers believe that having enough quantities of *Tithonia* within a short distance from the farm will also reduce the labour required for carrying *Tithonia*.

Similarly, some farmers plant greens such as *luceana* and *calliandra* along the farm's hedges. The problem is that boundaries are considered 'no persons land' and *Tithonia* or any other green grown on boundaries are threatened by both neighbours and animals. Where available, *Tithonia* was said to be a good source of green manuring. Farmers, however, are still needy of the strategies that will help them overcome the constraints associated with *Tithonia* use. On their part, Mutuo and colleagues also recognized the important role *Tithonia* plays in increasing soil nutrients. They, therefore, suggest that surface application of *Tithonia* can be adapted to reduce the labour requirements in incorporating *Tithonia* into the soil. In places where availability of *Tithonia* is a big constraint like in some villages of Emuhaya, Mutuo *et al.* (TSBF, 2000) recommend that other promising organic materials in the area can be used as green manures. But still, in Emuhaya, green manure alone will not do for smallholder farmers.

The complicated issue of the need for a sustainable farming system to balance between residue type, quality and quantity, tillage system and soil type must also be considered. Given the relatively low productivity in the villages where this research was undertaken, the use of on-farm residues from maize stovers and bean husks, together with on-farm leguminous trees, was seen as a distinct possibility to enhance productivity. Often, the use of plant residues obtained off-farm was found to be opportunistic, depending on availability. The use of hedge cuttings, for example, was observed to be important in villages where this resource is available but, generally, increases in agricultural production will require more than this resource. This study points to the general feeling

that there is a greater need for research on integrated nutrient management rather than on inorganic fertilizers or extension. Nevertheless, the study also acknowledges that there is now good data throughout the western Kenya region on integrated nutrient management which must be extended to farmers. There is a great deal of information available to allow a better assessment of the value and management of organic materials in the farming systems of the region (TSBF, 2000).

In Emuhaya (or more appropriately Ebusiloli), there was a growing concern that agricultural information and knowledge (whether modern or indigenous) are not appropriately being used in soil fertility management among smallholders (TSBF, 2002). It was further observed that this feeling is a result of varied factors, among them policy distortions mentioned above and lack of resources, which is occasioned by the current poor economic conditions. This is an indication that the process of social and economic change is transforming the indigenous strategies and practices that could otherwise adequately support the management of soils among smallholders. Yet, the same sociocultural and economic constraints have continuously proved to be constraints in the adoption of modern soil fertility management practices.

Gender is a principal dimension of smallholder food production in Emuhaya as this study found out. A growing body of literature now refers to the process whereby women intensify their participation in farm-related activities as other household members become full/or part-time workers elsewhere as the "feminization of subsistence agriculture" (Preisbisch *et al.*, 2002). In the villages covered in this study, and throughout much of Emuhaya and other rural parts of western Kenya, women play a pivotal role in the production of food. While the feminization of agriculture in western Kenya is not new (Suda, 1986; Muruli *et al.*, 1999), this research demonstrates how this process is deepening and taking on new dimensions. But, as Preisbisch and coworkers observe, women have taken on 'an increased share of the responsibilities involved in agricultural production from a disadvantaged position. Patriarchal ideology, compounded by male bias in colonial and post colonial agricultural development programmes, has limited women's access to land and other resources (credit, extension, inputs) which are inevitable to soil fertility management. As pointed out above, it is important to note the

changing dimensions of the feminization of subsistence agriculture, as lack of cash income to purchase inputs may as well mean that women intensify their labour on their fields.

Indeed, many (60%) of the smallholder farmers in this study were women with limited sizes of landholdings and none or a limited number of livestock. Therefore, the households in this study were associated with poverty that affected female-headed households and this increases additional constraints in the management of soil fertility. Among the Ahalogoli of western Kenya, Crowley and Carter (2000) found that farmers from poor households do not earn enough income to hire the labour needed for the efficient management of their fields. Farm management in these households tend to be poor, often planting and weeding late or using minimal soil amendments, focusing on subsistence production but rarely meeting subsistence needs (Crowley and Carter,2000). Key informants in this study strengthened this position by asserting that even among the Abanyore, the cost of fertilizers is the leading constraint to its use among poor households.

Like Tabu (quoted in TSBF, 2000) findings for Kabras show that farmers are varied significantly in their resource level status. Most smallholder farmers can be characterized as average or poor resource persons. This confirms that these types of farmers cannot afford the required levels of input (labour and fertilizer) for use in their own field. Labour status (use of family or hired labour for farm activities, working as a casual on other farms before tendering their own), number and type of livestock owned, and the amount of fertilizer used at planting, are some of the factors that affect smallholder farming (Crowley and Carter, 2000; Tabu, 2000).

The fact that female-headed households face comparatively more constraints as observed in this study, could be traced to the traditional household division of labour among the Abanyore where men were expected to go out and fend for the family, while the women were expected to organize at the household level what the husband brought home. However, because of the changes mentioned above which are forcing the mode of production to shift from locally available resources to outside ones, women, especially

within rural households, find it difficult to adjust immediately to the role of the husband upon his migration. This is particularly the case now when farming and livelihood dependent on it are being shaped more by modern scientific thinking. Apart from lack of resources, female farmers were also found to be overburdened by household chores. Regrettably, women's agricultural workload grows while their traditional work burden in childcare, fuel gathering, water fetching, and meal preparation, remains the same or grows too. This burden on women means that land preparation, planting, and weeding are often delayed, which depresses yields (World Bank, 1993:103). These and other factors warrant that women be given special attention in as far as the management of soil fertility is concerned.

6.3 CONCLUSION

The knowledge of local soils possessed by smallholder farmers was found to be elaborate. Knowledge of local soil was responsible for the naming, differentiation and classification of soils. The study also shows that farmers understand different processes that occur on their farms. They were, therefore, not only able to identify different landscapes but also recognize different niches.

Farmers also acknowledge that some of these niches, such as the home gardens, are as a result of human action while some, like valley bottoms and eroded surfaces, *esilangalangwe*, were a result of natural process. What is more, farmers understand that these natural processes can be facilitated by the action of farmers. The study has shown that farmers are familiar with the various soil types in their locations. This confirms the first assumption of the study that farmers have local diagnostic criteria for classifying soils. As discussed above, this study also confirms findings among farmers in other countries.

According to information obtained in this study, the local knowledge of soils is learnt through a number of sources, mainly experience and observation. The other sources mentioned include elderly farmers as well as parents. The role of scientist and researchers in the gathering and dissemination of this local knowledge of soils was also

acknowledged. The implication here is that in addition to the farmers' indigenous knowledge, scientific knowledge is also needed for sustainable smallholder farming.

Because of the broad nature of their knowledge of local soils, farmers also have an indigenous criterion for diagnosing the soil nutrient status. It was observed that smallholders have a variety of ways which they employ to interpret the fertility status of the soils in their farms. Soil fertility, which is an invisible constituent of soil, is interpreted through soil characteristics such as colour, texture, depth and location. Farmers also diagnose soil nutrient status through plant and crop performances. This study also found that there are certain specific plant and animal species associated with different soil conditions. This seems to confirm the second assumption of the study that the situational status of soil fertility can be diagnosed through the observation of certain specific indicators. It was further learnt that an action taken by a farmer when the signs for soil nutrient depletion is witnessed depends largely on the type of the indicator. Diagnosing the situational status of the farm nutrient is, therefore, part of the wider repertoire of local agricultural knowledge.

Households within the study area were found to be engulfed in the crisis of poverty and this, coupled with the process of socio-cultural and economic change, was found to be a constraint to smallholders' efforts to manage the fertility of their croplands. The sizes of the family landholdings are gradually declining as the number of livestock owned by households also decline as a result of the social, demographic, cultural and economic transformations that are taking place in contemporary Kenya. These changes, to a greater extent, have profoundly altered the farming system and introduced landscapes that were unknown to the Abanyore. In general terms, smallholders' households were found to be undertaking certain strategies to support the management of their landscapes and croplands. However, it was also observed that smallholder farmers face a number of constraints in their effort to efficiently manage the fertility of soils. As reported here, indigenous soil management strategies that still survive have been overstretched and will require external support in terms of repacking if they are to be of any help to smallholders' needs. Largely because of these constraints and partly because

of the nature of poor resource farmers, the responsive behaviour to soil nutrient depletion sometimes is not determined by the type of infertility indicator observed.

This study has revealed that farmers varied input use, crop choices and cultivation, depending on the niche type. For instance, no farmer reported the use of inorganic fertilizers in the home gardens. On the other hand, food production, income and labour, guided the farmers' management decision. The above argument partly confirms and partly disapproves the third assumption of the study that farmers' responsive behaviour to soil nutrient depletion depends on their cognitive view of soil fertility indicators. Data collected throughout the study reveal an existence of both indigenous and modern strategies of soil nutrient management within the study population that can be effectively manipulated to address the problems faced by smallholder farmers in the study area in managing the fertility of their soils. However, these strategies are not effectively dealing with the problem of soil nutrient depletion mainly due to the many changes identified above. Part of this inefficiency can be attributed to the varied number of constraints that farmers face in their effort to apply these strategies to their fields.

The soil fertility management practices adopted by farmers are mainly perceived as efforts meant to increase yield. Farmers prefer inputs that are relatively cheap, need considerably less labour to apply and benefit particular crops in the shortest time possible. Therefore, while farmers acknowledge that different soil types require different management strategies, some practices are crop specific or appear to be associated with a particular set of crops. However, farmers and the general community did not have an alternative strategy that could help smallholders improve crop productivity. In fact, key informants seemed to support the coping mechanisms widely used by farmers despite the fact that they were widely aware of the constraints faced by them in using these strategies. One can, therefore, not avoid concluding that crop productivity among smallholder farmers of Emuhaya, seems to have no option but the enhanced management of the soils. Integration of farm nutrient management is the only sure way to enhance productivity on farmers' fields. This, inevitable calls for the integration of knowledge systems (modern and indigenous).

6.4 RECOMMENDATIONS

Food availability to smallholders in the face of declining soil nutrients and rising populations such as the situation observed in Emuhaya require deliberate efforts aimed giving prominence to local resources, including indigenous skills and practices which more often becomes a casualty of social distortions and policy misrepresentations. In light with the findings generated from this study, the following recommendations for an integrated approach to soil fertility management among smallholder farmers of Emuhaya have been proposed as a matter of policy reference and future studies:

- Policies designed to address the soil fertility management problems smallholders face should not look at farming in isolation. For such policies to be affective, and to be closely linked to the needs of smallholder farmers, they need to take into consideration the farmers' folk knowledge that incorporates both environmental and ecological aspects. Specific areas of focus should be on the classification and differentiation of local soils. Further areas that require attention include the diagnosis of soil nutrient status.
- This study also recommends that the integration of knowledge systems should be encouraged if smallholders in Emuhaya are to make their farming sustainable. This is because even as this study reports that farmers have detailed knowledge of their soils and practical skills to manage their soils, there is a clear gap that exists in far as soil fertility management is concerned. Policies that guide the integration of knowledge systems without annihilating either are welcome.
- The statement above sows that there is need to facilitate a common understanding between farmers and those working to enhance the productive capacity of smallholder farms. Policies that guide and enhance interactive learning between farmers and scientists are urgently called for. In all initiatives designed to assist farmers, they should be made to take an active role, and their folk perspective in farming respected. This would facilitate acceptability and, may be, the long-term sustainability of such initiatives.
- Policymakers and implementers should, formulate a formal soil policy detailing how both knowledge systems (indigenous and modern) can be harnessed to help smallholders. Such a policy should aim at empowering local communities to utilize, exchange, develop and protect indigenous knowledge and to promote its

application within the soil fertility management process. It encompasses the establishment of a system of national and international coordination and co-operation, and the design of mechanisms to promote the use of indigenous knowledge in soil fertility management

- There is also need to look at strategies of overcoming the cash, labour, land and information constraints faced particularly by the poor households in their effort to use various soil fertility management practices on their fields. This will for example call for the initiation and support for farmers groupings to enable them start their own income generation activities or mobilize savings to enable them access credit. This unfortunately cannot happen in a vacuum. Clear microfinance policies that recognize farming as an economic activity are called for. As for now, this study recognizes that the situation in Emuhaya calls for the urgent implementation of the already formulated poverty reduction strategy paper.
- There is need to carry out a study to help reveal the factors that have led to the relegation of this valuable knowledge, especially among poor smallholders who cannot afford the modern strategies of soil management.
- Future research should focus on specific manures (inorganic or organics) with the aim of coming up with specific strategies of enhancing their use.
- Similarly, there is need for studies focusing on indigenous knowledge of soils among smallholders in different parts of Kenya. This will help evaluate and compare different knowledge systems.

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APPENDIX 1: SURVEY QUESTIONNAIRE

My name is _____. I come from the University of Nairobi and I am conducting a survey on the situation of soil fertility and its management. Although I would be interested on your knowledge of local soils, my concern is on the local indicators of soil nutrient status and the management strategies used by farmers in this area to enhance soil fertility. I would be grateful if you could spare some time to answer a few questions, which I shall be putting to you.

BACKGROUND:

(1) Date of interview _____

(2) Name (optional) _____

(3) Location and sub-location _____

(4) Religion _____

(5) Village _____

(6) Indicate your Age Bracket

25-30 Yrs 30 – 40 Yrs 40-50 Yrs Over 50 Yrs

(7) What is your Marital Status?

Single Widow Married Others (Specify)

(8) Level of Education

None Primary Secondary post secondary

(9) For how long have you been farming?

Less than 5 years between 5-10 years More than 10 years

(10) Apart from Farming, what else do you do?

(11) What is the total area of your cropland including rented and/or borrowed land)?

Up to 0.5 ha. 0.5 – 10 ha. More than 10 ha.

(12) What is the total area of your land (plus home compound, pastures, rocks etc?)

0.5 – 10 ha. More than 10 ha.

(13) Do you own or farm any other land either jointly or singly?

Yes No

If yes, how big is the farm? _____
 If yes, what is grown on it? _____

(14) How did you acquire your land?
 Inheritance Bought Other (specify)

(15) Do you lease any other land?

Yes No

If yes, please explain _____

(16) For how long have you lived in this area?

Less than 5 Years 5-10 Years More than 10 Years

(17) Why do you engage in farming, respond in order of priority

Subsistence Cash
 Cash
 Prestige Other (specify)

(18). If reason for farming above is both for subsistence and cash, respond in terms of proportion

Food ___% Cash ___%

(19). Which of the following crops do you grow on your farm? Please estimate acreage.

Maize	
Millet	
Sorghum	
Beans	
Potatoes	
Cassava	
Groundnuts	
Vegetables	
Fruits	
Sugarcane	
Other (Specify)	

(c) Please, give reasons for your answer. _____

(20) Are you engaged in Livestock Production?

[] yes [] No

If yes which animals? [**Record number**]

(1) _____

(2) _____

(3) _____

(4) _____

(b) Explain the value of your animal

(21) Are you satisfied with the yields of food crops obtained on your farm? [] Yes [] No

(b) Give reasons for your answer

(22) What types of cereal seeds did you plant in your farm last session?

[] Hybrid

[] Local seed varieties

(b) Give reasons for your answers

(C) How do you rate the local seed yield.

(23) Are you satisfied with the yields of cash crops obtained on your farm? [] Yes [] No

(b) Give reasons for your answer

B. KNOWLEDGE OF LOCAL SOILS

(24) Give the names of soils found on your farm and briefly comment on their characteristics.

Soil name	Characteristics/location (position)
(1)	
(2)	
(3)	
(4)	
(5)	
(6)	
(7)	
(8)	
(9)	

(25) Give the crops which according to you are best suited for the soils above

(26) For the soils above which are not suited for crop cultivation (farming) please give their local uses.

(27) What characteristics do you use to differentiate the soils above?

Texture [] Colour [] Other []

(28) How and where did you learn the things in 24, 25, 26 and 27 above?

(29) Is soil type related to its fertility?

Yes No

Explain your answer

(30) What soil characteristics are indicative of its nutrients status?

Texture Colour Strength Other

(31) What other nutrient status are associated with its nutrient status?

(32) Does soil type influence what is done on a particular parcel of land?

Yes No Cannot tell

If yes, explain giving local examples

(33) Which soil types would you say to be naturally fertile?

(34) Which soil types would you say to be naturally infertile?

C. DIAGNOSIS OF SOIL NUTRIENT STATUS

(35) How would you characterize the soil nutrient status of your farm?

Very low Low Medium High

(36) Would you provide the trend to the above in the last 5 to 10 years?

Decrease Static Increase cannot tell

(b). What accounts for this trend?

(37) What do you think about the soil nutrient situation in this village in general?

Decreasing Static Increase cannot tell

(38) Is soil nutrient status uniform (the same) all over your farm?

Yes No

If no, which areas differ and why?

(39) Would you identify a farm with low or no nutrients?

Yes No

(b) Explain your answer

(40) Is crop performance related to soil fertility?

Yes No Cannot tell

(41) What aspects of crop performance is indicative of soil nutrient status?
[] Growth rate [] Leaf colour [] Flowering time [] Root depth [] Other

(42) What aspects of vegetation is indicative of soil nutrient depletion?

(43) Which three local plants would you associate with soil nutrient depletion?

1. -----
2. -----
3. -----

(b) What would you do to improve the nutrient status of such soils?

(c) How would you know that what you have done is working?

(44) Which three plant species would you associate with fertile soils?

1. -----
2. -----
3. -----

(45) Which crops would you grow on such soils and why?

(46) Are soil organisms (insects, worms etc.) indicative of its fertility?

[] Yes [] No [] Cannot tell

(b) Explain your answer above

(47) Which three soil organisms would you associate with high fertility?

1. -----
2. -----
3. -----

(48) Which crops would you grow on such soils and why?

(49) Which three soil organisms would you associate with low/no fertility?

1. -----
2. -----
3. -----

(b) What would you do to improve the nutrient status of such soils?

(c) How would you know that what you have done is working?

D. MANAGING SOIL FERTILITY

(50) Please indicate your experience with the following farming systems. Score your experience as indicated.

	Never	Used Once	Uses sometimes	Always use
Rotation				
Fallowing				
Mulching				
Intercropping				
Improved fallow				
Biomass transfer				
Animal manure				
Inorganics				
DAP				
CAN				
TSP				
Countour bounds				
Mixed farming				
Graded furrows				
Green manure				

(b) Give four of the above that you regularly use on your farms

(1). _____ (2). _____ (3). _____ (4) _____

(c) Mention constraints faced by you in using the above

(51) Have you ever trying comibining two soil amendment inputs on your farm?

Yes No

If yes, explain your experience

(52) Which two combinations give the best results when used together?

(53) How do you manage crop resiudes after harvest?

Burn Leave on farm Carry to kraal Compost Sell

(b) Mention where burning is necessary-----

(c) For residues left on the farm, which of the following applies

Grazed to animals Spread all over the farm Placed in particular areas
 Deposited in pit Used as mulch Other

(d) What is the importance of depositing crop residues in animal kraal-----

(54) Which is the best way of preparing compost manure?

Pit Heap

(55) How long do you leave your compost before use

Less than 3 months 3-6 months 6-12 months More than 12 months

(56) How do you decide when your compost is ready for use?

(57) Do you collect certain plants for use as compost?

Explain_____

(58) Which plant types or species give the best results as compost?

(59) How often do you turn your compost manure during preparation and why?

(60) What are the signs of good compost-----

(b) What are the signs of bad compost-----

(61) When do you apply compost manure in your farm?

During cultivation During planting During weeding Others (specify)

APPENDIX 2: IN-DEPTH INTERVIEWS GUIDE

This guide was used to conduct in-depth interviews with selected farmers in the study. A total of 30 farmers were sampled for in-depth interviewing.

A. KNOWLEDGE OF LOCAL SOILS

1. Give the characteristics of the following soil types found on some farms of this village. Comment on their location, colour, texture, depth and fertility.

Soil name	Characteristics/location (position), colour, texture, depth and fertility
1) <i>Oluyekhe</i>	
2) <i>Ingusi</i>	
3) <i>Limali</i>	
4) <i>Litoyi</i>	
5) <i>Esilongo</i>	
6) <i>Esiyeyie</i>	
7) <i>Eliakhanyu</i>	
8) <i>Esilangalangwe</i>	

b) Any other soil in this village not included above?-----

2. Which of the above soils is found on your farms?

1. _____ 2. _____ 3. _____

b) If more than one type, give the dominant soil type-----

3. Give the crops that you think are best suited for the above soils.

Soil name	Crops suited ...
1) <i>Oluyekhe</i>	
2) <i>Ingusi</i>	
3) <i>Limali</i>	
4) <i>Litoyi</i>	
5) <i>Esilongo</i>	
6) <i>Esiyeyie</i>	
7) <i>Eliakhanyu</i>	
8) <i>Esilangalangwe</i>	

4. For the soils above which are not suitable for cultivation (farming) give their local uses.

5. What characteristics do you use to differentiate the soils above?

Texture [] Colour [] Other []

6. How and where did you learn the things in 1, 2, 3, 4 and 5 above?

7. Is soil type related to its fertility?

Yes [] No []

Explain your answer

8. What soil characteristics are indicative of its nutrients status?

Texture Colour Strength Other

9. What other aspects of soil are associated with its nutrient status?

10. Does soil type influence what is done on a particular parcel of land?

Yes No Cannot tell

(b) If yes, explain giving local examples [Probe if they do the same on their farms]

11. Which soil types would you say to be naturally fertile?

12. Which soil types would you say to be naturally infertile? _____

C. DIAGNOSIS OF SOIL NUTRIENT STATUS

13. How would you characterize the soil nutrient status of most farms in this village?

Very low Low Medium High

14. Would you provide the trend to the above in the last 5 to 10 years?

Decrease Static Increase cannot tell

(b). what accounts for this trend?

15. What do you think about the soil nutrient situation in this village in general?

Decreasing Static Increase cannot tell

16. Is soil nutrient status uniform (the same) all over the farms in this village?

Yes No

If no, which areas differ and what accounts for the difference?

17. Would you identify easily a farm with low or no nutrients?

Yes No

(b) Explain your answer

18. Is crop performance related to soil fertility?

Yes No Cannot tell

19. Of the following aspects of crop performance which are used by farmers to know the soil nutrient status, please explain how they differ in plants growing in different soils

Growth rate _____ Leaf colour _____ Flowering time _____
 Root depth _____ Pest resistance _____ Other _____

20. What aspects of vegetation are indicative of soil nutrient depletion?

21. Which three local plants would you associate with soil nutrient depletion?

1. _____
2. _____
3. _____

(b) What would you do to improve the nutrient status of such soils?

(c) How would you know that what you have done is working? _____

22. Which three plant species would you associate with fertile soils?

1. _____
2. _____
3. _____

23. Which three soil organisms would you associate with high fertility?

1. _____
2. _____
3. _____

24. Which three soil organisms would you associate with low/no fertility?

1. _____
2. _____
3. _____

D. MANAGING SOIL FERTILITY

25. For each of the soil fertility management below, mention crops applied to, constraints and results

Practice	On which crops	Constraints	Results
Chemical fertilizer			
Farm yard manure			
Mulching			
Compost manure			
Green manure			

26. How do you prepare compost manure? Explain and give reasons.

27. How do you prepare animal manure before use? Explain and give reasons.

28. When do you apply manure on your farm? Explain how and give reasons

29. How do you transport (compost/animal) manure to your farms?

(30). How do you apply compost manure on your farms?

APPENDIX 3: KEY INFORMANT INTERVIEW GUIDE

This guide was used to extract information from selected farmers in the villages, extension workers and indigenous knowledge 'experts' among others.

A. BACKGROUND

1. What is soil? (probe for local definitions and terms; verify if soil differs from land; ask for relationship between land and soil; what expressions are used locally to refer to soil/land; probe for cultural, historical, economic and social aspects of land).
2. What is the origin of soil? How are soils formed? Does soil change? What causes the changes/and after how long? What makes soils different?
3. What are the constituents of soil? Where do the soil constituents come from? Are soil constituents the same?
4. Which is the predominant soil type in this village? (Give local names and terms). Which are the other soil types in this village?
5. Who gave or gives the names of local soils (probe for meanings)

B. INDIGENOUS SOIL NUTRIENT MANAGEMENT PRACTICES

5. Please indicate your experience with the following farming systems. Rank your experience as indicated.

	Never	Low	High	Very high
Rotation				
Shifting Cultivation				
Fallowing				
Mulching				
Intercropping				
Agroforestry				
Fertilizer (organic)				
Contour tillage				
Mounds				
Counter bunds				
Zays				
Tied riding				
Mixed farming				
Graded Furrows				
Minimum tillage				

6. Mention any three from the above that are commonly used in this village. Rank in order of prevalence.

1

2

3

7. What would you say are the advantages/disadvantages of the THREE above?

	Advantages	Disadvantages
1.		
2.		
3.		

8. Mention Constraints faced by farmers in USING the above

9. Is there any other local strategy of managing soil fertility in this village?

Describe the strategy _____

C. KNOWLEDGE OF SOIL FERTILITY

- I. In your opinion has soil fertility been declining, static or increasing in this area in the recent past? Consider the last five to ten years
 - II. Is this fertility decline associated with local farming methods?
 - III. In your opinion are farmers doing anything to redress soil fertility decline. Is what the farmers doing rational? Kindly explain yourself.
 - IV. Is there what can aptly be described as indigenous agricultural/environmental knowledge? Explain its characteristics and how it is acquired and shared.
 - V. In your opinion are there local diagnostic criteria for detecting soil nutrient depletion?
 - VI. Kindly describe the common constrains faced by farmers as they try to manage soil fertility in this area.
 - VII. What are outsiders (NGOs, Government officials, agricultural institutions e.t.c. doing in regard to soil fertility decline?
 - What are their constraints?
 - What are they doing in the situation of women farmers?
- V111. In your opinion do you think that women farmers face different problems from male farmers?
- 4 Has anybody or extension officer contributed anything to enhance the status of women farmers.
 - 4 What in opinion can be done to reduce the situation of soil nutrient depletion?

Appendix 5: Focus Group Discussion Guide

This focus group discussion guide was based on the themes derived from the study objectives and was used to facilitate discussions with selected discussants in the villages.

- A. Knowledge of local soils
 1. What is soil?(probe for local definitions and terms; verify if soil differs from land; ask for relationship between land and soil; what expressions are used locally to refer to soil? And to land? Probe for cultural, historical, economic and social aspects of land)
 2. What is the origin of soils? How are soils formed? Does soil change after formation? What causes these changes/and after how long? What makes soils different?
 3. What are the constituents of soil? Where do the soil constituents come from? Are soil constituents the same?
 4. Which is the predominant soil type in this village? Which are the other soil types available in this village? (Arrive at consensus with discussants on the local soil types).
 5. Who gave (gives) these names to the local soils? (Probe for meaning to local soil names).

FGD Table 1: Abanyore Soil Names and their meanings

<i>Oluyekhe</i>	
<i>Ingusi</i>	
<i>Litoyi</i>	
<i>Esilongo</i>	
<i>Limali</i>	
<i>Esiyeyie</i>	
<i>Eliakhanyu</i>	
<i>Esilangalangwe</i>	

6. What are the characteristics of the local soils above? (Lead discussants to consensus)

FGD Table 11: Abanyore Soil Names and their characteristics

Soil Name						
	Colour	Depth	Texture	Fertility	Location	Crops suited
<i>Oluyekhe</i>						
<i>Ingusi</i>						
<i>Litoyi</i>						
<i>Esilongo</i>						
<i>Limali</i>						
<i>Esiyeyie</i>						
<i>Eliakhanyu</i>						
<i>Esilangalangwe</i>						

B: Soil Fertility

1. According to your understanding, what is soil fertility?
2. Are the soil fertility on farmers fields the same or different? What causes this differentiation?
3. What creates soil fertility? Is it natural to the soil or it can be added? Are some soils naturally fertile (probe and if yes give names). Are some soils naturally infertile (probe and record names).
4. Which soil organisms seen on a soil indicate that soil is very fertile?
5. Which soil organisms seen on a soil indicate that soil is very infertile?
6. Which plant species seen on a soil indicates that soil is very fertile?
7. Which plant species seen on a soil indicates that soil is very infertile?
8. In which other way do farmers learn the soil fertility status of their farms?

C: Management of Soil Fertility

1. For soil fertility management practices below, mention crops applied to, constraints and results

Practices	On which crops	Constraints	Results
Chemical fertilizer			
Farm yard manure			
Green manure			
Mulching			
Compost manure			

2. For constraints to soil fertility management practices above, mention possible solutions and how you get to know if these solutions work well or not

Practices	Constraints	Indicator
Chemical fertilizer		
Farm yard manure		
Green manure		
Mulching		
Compost manure		

Appendix 4: Direct Observation Checklist

Background

- Land size [] Small [] Medium [] Large
- Crops grown [] Food [] Cash [] Other
- Ecological gradient [] Plain [] Lowland [] Undulating [] Highland
- Soil types [] Clay [] Sand [] Mixture
- Erosion (gullies) [] Deep [] Shallow
- Soil Depth [] Deep [] Shallow
- Animal kraal position _____ Size _____
- Livestock type [] Cattle [] Goats [] Sheep [] Poultry [] Other
- Cow type [] Grade [] Cross [] Grade
- Home garden [] Present [] Absent

Nutrient Depletion

- Plant health [] Good [] Poor
- Plant species (nutrient indicators) _____
- Erosion (gullies) _____
- Soil characteristics: Colour _____ Texture _____
Other _____
- Crop Health _____
- Yield: Quantity _____ Quality _____
- Vegetation _____

Managing Soil Fertility

- Fallow (improved or otherwise) _____
- Mulches (spread and type) _____
- Agroforestry (trees or shrubs) _____
- Compost: Pits _____ Heaps _____ Size _____ Materials _____
- Contour _____
- Furrows _____
- Intercropping _____
- Green manure _____
- Plant remains _____
- Crop remains _____
- Cultivation (tillage) _____
- Farm yard manure _____
- Fire (signs of burning) _____