FACTORS INFLUENCING SOIL ANALYSIS ADOPTION AMONG SMALL SCALE HOLDER FARMERS IN LUANDA SUBCOUNTY, VIHIGA COUNTY KENYA.

BY

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DECLARATION

This Research project is my original work and has not been presented for any Award in any other university.

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This Research project is submitted for examination with my approval as the University Supervisor

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DEDICATION

This Report is dedicated to My Family and to the Entire Nairobi University Lecturers for the support and guidance that you have given me throughout the entire course.

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ABBREVIATIONS AND ACRONYMS

BSA	Basic Soil Analysis
SNA	Soil Nutrient Analysis
CSA	Complete Soil Analysis
ILRI	International Livestock Research Institute
LA	Leave Analysis
SES	Social Economic Status
ST	Soil Testing
UON	University of Nairobi
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behaviour
T&V	‘‘training and visit’’
SPSS	Statistical Package for Social Sciences

ABSTRACT

Most rural farms in Western Kenya comprise subsistence farming with excess production being sold to nearby markets to raise income for other need. The lifestyle and personal considerations of farmers strongly influence farm management decisions and technology adoption rates. Smallholder farmers in western Kenya are increasingly using soil analysis techniques as a means of increasing production. This research project was carried out to examine the extent of adoption of soil analysis techniques in Luanda Sub-County, Vihiga County and factors that contribute to smallholder's behavior with respect to soil nutrient analysis. The purpose of this study was to establish the adoption rate and factors that contribute to soil nutrients analysis. The research design used in this study is descriptive survey design. A questionnaire was used to collect information from smallholder farmers. The survey instrument provided a guide to the interviewer, and covered identification of social economic status of small scale farmers, awareness level and perception on soil nutrient analysis, direct cost and benefits of soil nutrient analysis and identification of cultural beliefs and government policies associated with soil nutrient analysis.

The Sample Size for this Study is (359).Three hundred and fifty nine households were sampled, the target population in Luanda County is 23,347(Twenty three thousand, three Hundred and forty seven Thousand)the data was collected using semi-structured questionnaires and analysis conducted using SPSS for windows (Version 16). From the results, the smallholder farmers can be clustered based on income levels, number of dependents, household income, gender, age and education levels of household head. Most of the smallholder farmers perceived soil nutrient analysis not beneficial. Most of those who cited that nutrient analysis was beneficial had limited information on access of the technologies. Based on the theory of planned behavior, most farmers cited awareness and interest in soil nutrient analysis even though uptake of soil nutrient analysis techniques was low. The study recommends awareness creation among smallholder farmers on access and benefits of soil nutrient analysis techniques. This will address limited information on the topic which was highlighted by respondents as the major impendent to adoption of soil nutrient analysis technologies. Based on the findings, the study also recommends capacity building of smallholder farmers to increase awareness of soil nutrient techniques, evaluation, trials and adoption. This will decrease soil analysis techniques discontinuance rates. This will also inform farmers on the benefits of analysis to improve the attitude.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

In the recent decades, land degradation globally has resulted from soil erosion and nutrient depletion creating serious environmental concerns and socio-economic problem (Amsalu and De Graaff, 2007). Strong gradients of decreasing soil fertility are found with increasing distance from the homestead within smallholder African farms, due to differential resource allocation (Tittonell et al., 2005). Food security in the East African Highlands has declined due to dependence on the productivity of lands managed by smallholders who face difficult challenges in maintaining the fertility of their soils (Murage et al., 2000). Arable land in western Kenya is under considerable pressure from increasing human population. Rural households depend on farming for at least part of their livelihood, and poverty rates are among the highest in Kenya. Land is often depleted of nutrients, and for most farmers, access to inputs and markets is poor (Waithaka et al., 2006).

Agriculture has been the most important source of livelihoods for many people in rural areas, especially the poor. Research indicates that growth in agricultural production is a pre-requisite for improving the livelihoods of farmers. Agricultural growth has been used as an engine for poverty reduction; hence the importance of understanding the factors that face agricultural growth in poor rural areas.

The farmers' decision to carry out soil nutrients analysis depends on his financial and environmental position (Franzel, 1999). Most of the farmers in Vihiga County are resource constrained and farming is subsistence. Occasionally, extra output is sold to get money to buy the basic commodities. Since most small scale farmers have not been commercialized their operations in the region, most do not find the need to conduct soil nutrient analysis. This has reduced their outputs, both qualitatively and quantitatively.

Traditionally, researchers based the extent of nutrient analysis on economic basis. Over the past decades, social networks have been reported to influence the farm management, especially for smallholder farmers. In fact, social networks have been considered part of farmers' resources during production. This is evident as numerous researches conclude that farm management options are dependent of several interrelated social and economic factors. Among the farm management options that have gained popularity among smallholder farms is nutrient management. This have generated the need for soil nutrient analysis as a means to address the diminishing soil fertility, which has been on an incline due to poor management practices. Interest has increased among farmers on conducting assessments of the outcomes of their choices in terms of farm management (Rossing et al., 1997; Zander and Kachele, 1999; Leeuwis, 1999; EC, 2005). This interest mainly concerns the assessment of socio-economic and crop performance of farms as a result of innovations.

The highlands of western Kenya are densely populated as a result of the good soils and high initial fertility. The high populations have caused reduction in the farms sizes among smallholder; the average range is from 0.6 ha in Vihiga Counties to 2.2 ha in Teso district. This have caused diversification in land usage; subsistence farming in Siaya, Kakamega and Vihiga Counties and more cash-crop oriented farms in the sugar belt (Rotich et al., 1999).`

1.2 Statement of the Problem

Research has brought out the importance of improving agricultural production for rural economic growth and poverty reduction. Most of the research has been concentrated on improving agriculture in rural areas. Poor soil fertility is a major factor limiting productivity of smallholder farms in Africa (Sanchez et al., 1997). Most smallholder farmers are subsistence producers and their management systems lacks business oriented approach. Inappropriate farm management techniques have been reported to be the main cause to the decline in soil fertility. Most smallholder farmers lack the ability to analyze the soil nutrients status, mainly due to the small scale nature of their operations. The farmers also lack adequate resources to cover the costs of soil nutrient analysis.

Most small scale farmers in Vihiga County have limited information on soil nutrients analysis (Waithaka, 2006). Despite research showing that the benefits of soil nutrients analysis outweigh the cost, small scale farmers are yet to take up this technology (Binswanger and Pingali, 1988). This has in turn led to lack of knowledge of the soil status in smallholder farms by owners and therefore lack of proper nutrient management strategies have being used. This has led to depletion of the nutrients required by plants; hence farmers are not able to get optimal yield and quality of their harvest (Godfray et al., 2010).

The decision to conduct soil nutrient analysis has been reported to be influenced by the social and economic characteristics of the farmers (Smit and Smithers, 1992). Despite the fact that research on the diversity of farmers' livelihoods based on their agricultural diversity has been conducted, there lacks limited empirical information on the extent of adoption of soil analysis techniques by smallholder farmers in Vihiga County.

Poor Soil Fertility leads to decreased yields. Government intervention is required to improve extension services, train farmers on proper use of agro chemicals, proper soil management and good methods of pest control techniques through monitoring. Companies that analyze soil should also train farmers on the benefits. This may avert immediate occurrence of famine now and in the future. Agriculture is advocated for as it is sustainable and environment friendly (Ibeawuchi et al., 2009)

1.3 Purpose of the study

The purpose of this study is to establish the factors influencing soil analysis adoption among small scale holder farmers in Luanda sub county, Vihiga County, Kenya.

1.4 Research Objectives

This study is guided by the following four objectives

1. To assess attitude on basic soil analysis among smallholder farmers influence in Luanda Sub-County to soil analysis adoption.
2. To establish how social economic status of smallholder farmers in Luanda Sub-County influence their soil analysis adoption.
3. To determine how awareness about analyzing soil among smallholder farmers in Luanda County influence their soil analysis adoption.
4. To establish how social environment among smallholder farmers in Luanda Sub-County influence soil nutrient adoption.

1.5 Research Questions

1. How do smallholder farmers attitude on basic soil analysis affect soil analysis adoption?
2. How does the social economic status of smallholder farmers influence their soil analysis adoption?
3. In which ways does awareness on soil analysis techniques among smallholder farmers influence soil analysis adoption?
4. To what magnitude does the social environment among smallholder farmers in Luanda Sub-County influence soil nutrient adoption?

1.6 Significance of the study

The main reason for this study was to provide a detailed understanding of the uptake of soil and leaf testing and use of the recommendations given to change the economic status of farmers. The factors that motivate farmers to conduct soil nutrients analysis for design of policy initiatives in such a manner as to promote uptake and to foster desirable social developments in rural areas. The setting of most rural farms in Western Kenya comprises subsistence farming with excess production being sold to nearby markets to raise income for other need. The lifestyle and personal considerations of farmers strongly influence management decisions.

Research on extent of soil nutrient analysis among smallholder farmers have brought out the importance of integrating social and economic characteristics in assessment of farmers' behaviors. In social sciences, economic models have traditionally been applied to bring out the behavior among smallholder farmers. However, these have been reported to lack the ability to capture the full complexity of farmers' social structure, motivators and behavior. Accordingly, this research was designed to bring out an integrated approach to establish farmer social-economic characteristics. The inclusion of social assessments is unique for this research.

The importance of understanding how the social-economic characteristics of farmers influence management decision with regards to soil nutrient analysis among smallholder farmers is poor understood. This information is expected to provide guide to policy initiatives that will make farmers more knowledgeable on the importance of soil nutrient analysis, by incorporating social characteristics into economic models. With these, this research deviced systems that can be used to improve soil nutrient status among smallholder farmers which have been on a decline, thereby improving farmers' livelihood.

Conducting the research in Western Kenya provided representative information of the situation and this will enable the farmers to understand the importance of soil testing. This study also assisted the County Government with ideas on how to assist in various donour projects in soil testing and improving crop yields and Market for the various Produce. It will also assist in other African highlands with comparable soil types, climate, technology and demography, that is, in Uganda, Ethiopia and Madagascar. These highlands have been reported to have similar social and environmental characteristics. In addition, the climatic conditions are almost similar (Braun et al., 1997).

1.7 Delimitation of the study

The study was conducted in Luanda Sub-County in the Western region. This sub-county is among the most populated in Western Kenya, with the average land size of 0.6 ha. There exists diversified land usage with majority of the farmers being subsistence producers. Only smallholder farmers with diversified production systems were interviewed in the survey. The study was conducted at a specific time, that is, data was collected in July and early August, 2015.

1.8 Limitations of the study

The study was conducted in only one sub-county in Western region due to limitation of time and resources. The numbers of farms are many and cover a wide area and this required a lot of walking. The project time took one year thus only a limited area can be covered. Some of the farms were also not easily accessible due to poor access.

1.9 Assumptions

The study assumed that respondents are willing to give information. The study also assumed that the farmers selected for sampling will be representative of the whole region.

1.10 Definitions of significant Terms used in the Study

Soil Analysis Testing

A soil test is the analysis of a soil sample to determine Nutrient content, composition, and other characteristics such as the acidity or PH Level. A soil test can determine Fertility, or the expected growth potential of the soil which indicates nutrient deficiencies, potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace Minerals.

Small Scale Holder Farmer

Smallholders are the primary producers of commodities such as cocoa, coffee and cotton. The pursuit of export-led growth strategies in developing countries has brought them into global value chains.

The term “smallholders” is widely understood to include small farmers who do not own or control the land they farm. Often, the term “outgrowers” is used to refer to smallholders who are in a dependent, managed relationship with an exporter.

Attitude on basic Soil Analysis

Attitude is an expression of favor or disfavor toward soil testing. Existing practice on Soils Nutrient Analysis, access, cost and benefits.

Social Economic Status

Socioeconomic status (SES) is an economic and sociological combined total measure of a person's work experience and of an individual's or family's economic and social position in relation to others, based on income, education and occupation.

Social Environment

The social environment consists of the sum total of a society's beliefs, customs, practices and behaviors

Farming attitudes:

Range from risk aversion, innovation, diversification, off-farm work, environment, production, management, legislation, stress, pessimism, and satisfaction toward farming.

Modeling:

Using existing theory and knowledge to extrapolate farmers' behavior and long-term predictions.This are long term methods that have been used over time.

Soil test:

The analysis of a soil sample to determine nutrient and contaminated content, composition, and other characteristics such as the acidity or pH level.

Technology adoption:

Uptake of a specific technology by farmers to enhance their produce and soil fertility.

1.11 Organization of the research project report

This study is in 5 chapters outlined as follows:

CHAPTER1: A general introduction of the research project outlining the different research areas covered in this study based on the activities carried out under different sub-objectives.CHAPTER TWO: Literature review on the study area. Topics covered in the literature review include concepts to soil analysis, effects of soil nutrient analysis, assessment of social economic factors, models used to assess technology adoption rate. The conceptual framework used to design the study is also highlighted. CHAPTER 3:The methodology section which brings out the study design, description of study area, sampling, data collection procedures and data organization.CHAPTER 4:The section brings out data analysis, presentation and analysis based on the objectives of the study.CHAPTER 5:This chapter gives a summary of the major findings, discussion and conclusions. This section also gives the way forward on the study through recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction.

This literature review covers four areas of the research questions: trends in categorizing smallholder farmers based on their social economic characteristics, secondly to assess attitude of smallholder farmers to technology adoption, thirdly how to evaluate technology adoption rates and fourthly bringing out the factors that influence extent of soil analysis. Soil analysis is the process of determining nutrient and contaminated content, composition, and other characteristics such as the acidity or pH level of a soil sample. Majority of the literature reviewed are meant to bring out empirical information of soil analysis in African Highlands.

2.2 Attitude on basic soil analysis among smallholder farmers

Soil scientists have been aware of the reality of spatial variation of field soils since the early 1900's (Pendleton, 1919; Smith, 1938; Beckett and Webster, 1971; Webster, 1994). However, it was not until the late 1960's and 1970's that field scientists began to study soil variability in a systematic way. The first studies were independent tests of soil maps in which soil variation was seen as a nuisance that reduced map reliability. Gradually the general nature of soil variation, and its unpredictability, have led researchers to see variability as a key soil attribute rather than a nuisance. In recent years, soil variability has been the subject of a huge research effort (Burrough, 1993). In a 1992 international workshop of the International Soil Science Society in Wageningen, the Netherlands, a new name "Pedometrics" was coined to describe the quantitative study of the variation of field soil (Webster, 1994). Extensive reviews of soil variability, including a description of the sources of variability, can be found in Beckett and Webster (1971) and Burrough (1993).

In agriculture, a soil test is the analysis of a soil sample to determine nutrient and contaminated content, composition, and other characteristics such as the acidity or pH level. The reason why you are sampling the soil is to estimate the capacity of the soil to provide adequate amounts of the necessary nutrients to meet the needs of the crop (or crops) to be grown. It should be clearly understood that soil testing does not measure the amount of nutrients in the soil

2.2.1 Awareness on soil analysis techniques

Continuous cultivation of the land is resulting in soil fertility decline in most agricultural systems in sub-Saharan Africa. Since most small-scale farmers cannot afford inorganic fertilizers, net negative balances of nutrients result when nutrients are removed from the farm by the harvested product (Lupwayi et al., 2000). Soil nutritional variability at regional level depends on climate and dominant soil types, historical and ethnic aspects and sociocultural practices. On the other hand, variability at farm level depends on the soil structure and differences within soil fertility management (Deckers, 2002; Crowley and Carter, 2000). Soil management practices depends on the resources owed by farmers, large scale farmers have better management that small scale farmers, therefore, it's expected that small scale farmers have more nutritionally depleted and degraded farms.

Concerns about soil degradation and agricultural sustainability have kindled renewed interest in the effects of crop rotations and crop management on soil organic matter quallty. Because crop residues are the primary substrate for organic matter replenishment in soils, changes in crops and their management can exert a significant influence on soil quality (Campbell et al. 1990).

Research by the Canadian Prairies concluded that the degradative effects of frequent fallow on soil quality, evidenced by increased organic matter loss, depreciated organic matter quality, reduced microbial activity, and enhanced susceptibility to erosion. Research also show that soil productivity can be effectively sustained over the long-term by adoption of stubble mulch tillage techniques combined with proper fertilization and reduced fallow frequency. Application of fertilizer, particularly N, consistently benefited the various parameters of soil quality, presumably by increasing the amounts of organic residues returned to the soil. The inclusion of legume green manure or legume-containing hay crops generally benefited soil productivity although soil quality maintained by these rotations usually did not exceed that under adequately fertilized continuous wheat, perhaps due to the inclusion of fallow in the forage rotations. Organic matter was more likely to be enhanced in lower organic matter soils (Brown and Dark Brown) than soils with inherently high organic matter (Black soils). Generally, deailed analyses done on the systems located in the drier regions were used to draw up conclusions (Campbell et al., 1991).

In recent years, nutrient budget and balance approaches have become widely applied in the African context. Studies have been undertaken at a variety of scales: from plot and catchment to regional analyses and, sometimes, even continent-wide assessments. The conclusions emerging from many such studies point to widespread processes of `nutrient mining' and soil fertility decline. Considering the urgent need to increase agricultural production in Africa, these are alarming conclusions. These, in turn, have prompted a variety of responses at a policy level, where conclusions from nutrient budget and balance assessments are increasingly used to justify policies and interventions, both at national and international levels (Scoones and Toulmin, 1998).

Soil nutrient balance studies in Africa show evidence of widespread nutrient mining leading to severe nutrient deficiencies across ecological zones. Soil nutrient stocks are not static entities and studies in different parts of Africa at different spatial scales show that nutrients are being depleted at alarming rates. Nutrients are annually taken away in crops or lost in processes such as leaching and erosion which far exceed the nutrient inputs through fertilisers, deposition and biological fixation. Nutrient mining has been estimated to average 660 kg of nitrogen (N), 75 kg of phosphorus (P) and 450 kg of potassium (K) per hectare per year during the last 30 years from about 200 million hectares of cultivated land in 37 countries in Africa. Losses of 130 kg N, 5 kg P and 25 kg K ha1 per year have been reported in the East African highlands (Scoones and Toulmin, 1999). The estimated nutrient balances for small-scale farming systems in Western Kenya is negative for all crops except for nitrogen (N) and phosphorus (P) in the sugar cane based land use type.

The concern for soil nutrient depletion and low soil fertility has led to the development of several integrated soil fertility management technologies that offer potential for improving soil fertility management in Africa. These include improved soil erosion control using living barriers or micro-catchments, inoculation of grain legumes for improved N-fixation, efficient use of manure and other locally available organic materials, use of green manure and cover crops and use of low levels of N and P fertilisers on maize (*Zea mays*) and beans (*Phaseolus vulgaris*) in Western Kenya. However, there has been limited uptake of these ‘‘improved’’ INM practices (Esilaba et al., 2005).

There are a limited number of long-term studies monitoring the nutrient status of soils, nutrient balances, and crop productivity in Western Kenya. It is important to calculate and monitor nutrient flows to quantify the impact of integrated nutrient management (INM) systems on soil fertility and sustainable agricultural productivity. Monitoring of nutrient stocks and flows is a tool for assessing the degree of nutrient mining in an agroecosystem. When applied to systems where INM practices are being introduced, nutrient monitoring can be used to assess the effects of INM strategies on soil nutrient stocks and flows. Improved soil nutrient management is important for maintaining and improving soil productivity in Western Kenya and strategies are required that more closely address farmer requirements and priorities (Esilaba et al., 2005).

Rainfall in western Kenya ranges between 1400 and 2000 mm annually, and distributed in two cropping seasons, that is, long rains from March to July and short rains from August to November. Nitisols, Ferralsols and Acrisols are the predominant soil types in this region (Jaetzold and Schmidt, 1982; Andriesse and Van der Pouw, 1985). Nitrogen and phosphorus are the main deficient nutrients for food crop production (Shepherd et al., 1997). Nutrient depletion and soil degradation are spatially heterogeneous, and depends on the underlying parent material, geomorphology and management practices (Smaling et al., 1997). Variability in soil fertility management depends on both biophysical and socio-economic.

Soil nutritional variability at regional level depends on climate and dominant soil types, historical and ethnic aspects and sociocultural practices. On the other hand, variability at farm level depends on the soil structure and differences within soil fertility management (Deckers, 2002; Crowley and Carter, 2000). Soil management practices depends on the resources owed by farmers, large scale farmers have better management that small scale farmers, therefore, it's expected that small scale farmers have more nutritionally depleted and degraded farms.

2.2.2 Social economic characteristics of farmers on soil analysis adoption.

The high population has caused gradual depletion of nutrients through crop harvest removal, leaching, and soil erosion. Farmers have been unable to replace the nutrients lost using crop residues, manure and mineral fertilizers (Shepherd and Soule, 1998). Reduction in soil fertility has negatively affected production of crops by reduction of both the production levels and the quality of output. This in turn has increased material and economic losses to farmers which have increased income for the farmers. This has created need for soil nutrient analysis.

Secondary literatures on farm management options have brought out the importance of integrating social and economic characteristics in assessment of farmers' behaviors. Purely economic models have been reported to lack the ability to capture the full complexity of farmers' motivation and behavior. Accordingly, this research will be designed to provide an integrated approach to studying farmer characteristics by collecting data on farm structural variables (crop produced, farm size, farm type, land type, location, labor usage, family income, etc.), social demographics, farmers' attitudes and objectives and on personality traits and intelligence. The inclusion of social assessments in addition to the more conventional farming-oriented questionnaire is unique to this research (Antle and Capalbo, 2001).

Soil quality is increasingly proposed as an integrative indicator of environmental quality and food security. Therefore, it would appear to be an ideal indicator of social economic characteristics. In view of the scarcity of land in Western Kenya, emphasis has been given to increasing food production by intensifying the use of land, chemical fertilizers, pesticides and water. Subsidies are provided for chemical fertilizers, pesticides and irrigation equipment to enable smallholder farmers to adopt these technologies for increasing crop yields. This has caused major changes in cropping patterns, uses of agricultural inputs, and management of soil fertility. Likewise, cropping intensity has increased considerably. Use of chemical fertilizers increased six-fold between 1990 and 2005, and the use of pesticides increased about three-fold in the past decade, from 1995 to 2005. On the other hand, the areas under pulses, oilseeds, fodder and sugarcane have decreased. Likewise traditional cropping practices, such as mixed cropping, crop rotation, and intercropping, are gradually disappearing. This has led to mono-cropping and higher dependency on external inputs such as irrigation, chemical fertilizers and pesticides (Waithaka et al., 2006).

Mono-cropping, along with imbalanced use of chemical fertilizers, pesticides, and intensive use of land without application of organic fertilizers, has led to the deterioration of both soil quality and fertility. More than 65% of the total agricultural area is suffering from declining soil fertility, and about 85% of the net cultivable area has less organic matter than the minimum requirement for maintaining soil productivity. As a result, crop yields are decreasing steadily, despite increased use of agricultural inputs. Realizing the adverse impact of mono-cropping, the government had advised farmers to implement crop diversification during the late 1980s involving concerned agencies. This failed to achieve its objective due to inadequate coordination among stakeholders (Rasul and Thapa, 2004).

Increasing population and farm management techniques have however led to gradual depletion of nutrients through crop harvest removal, leaching, and soil erosion. Farmers have been unable to replace the nutrients lost using crop residues, manure and mineral fertilizers. Reduction in soil fertility has negatively affected production of crops by reduction of both the production levels and the quality of output. This in turn has increased material and economic losses to farmers which have increased income for the farmers. This has created need for soil nutrient analysis (Rasul and Thapa, 2004).

2.3 Technology awareness among smallholder farmers

Constructing and testing models of the possible causal relationships between personality, attitudes and behavior has gained popularity among researchers. The main assumption of modeling is that one or more variables $\{y_i\}$ can be predicted from the set of variables $\{x_i\}$. Usually, the y variable is an observable outcome such as a particular farm management technique such as soil nutrient analysis. Statistical methods are used since the survey data unavoidably contain errors deriving from various sources of uncertainty. Some of these sources of uncertainty include error associated with inadequacy of the model, inadequacy of data collected and measurement error associated with the information provided by the subjects. Data collected may be inadequate probably due to either unavailability or is failure to measure data source.

Models are regarded to be useful in two ways; first, they explain certain phenomenon and secondly, the assist in prediction of future occurrences. The explanatory role allows relationships in the data to be understood more fully while the predictive role allows the results to be generalized to other datasets. Adoption, diffusion and domestication models have been used to bring out technology adoption among smallholder farmers.

The adoption approach describes adoption decisions of different individual and social decision making theories. Commonly used models include Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), and the extension of TRA into a Theory of Planned Behaviour (TPB) (Pedersen, 2003). TAM suggests that when a user is presented with a new technology, a number of factors influence their decision regarding how and when they will use it (van Akkeren and Cavaye, 1999). This includes its perceived usefulness and its perceived ease of use. However, TAM does not account for the influence and personal control factors on behaviour. Other factors such as economic factors, outside influences from suppliers, customers and competitors are also not considered by the TAM (van Akkeren and Cavaye, 1999). The Technology Acceptance Model is shown in Figure 1.

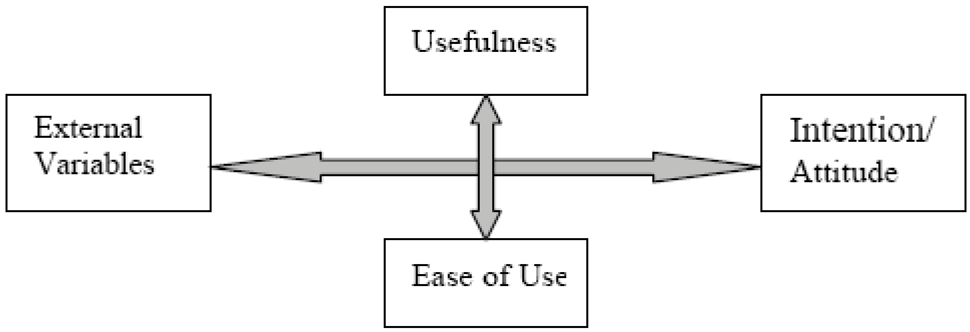

Figure 1: Technology Acceptance Model (Source: Cloete, E. and Courtney, S., 2002)

A key theoretical concept used to be applied in the study is Transactional Theory of Human Behavior which states that aspects of the person and their environment are important antecedents of behavior; there may also be mediating factors between antecedents and outcomes (Lazarus and Folkman, 1984; Deary et al., 1996).

Another theory that may be used to establish the extent of soil nutrient analysis based on social and economic characteristics is “The Theory of Planned Behavior” (TPB). TPB attempts to predict and understand behavior by measuring the underlying determinants of that behavior: attitudes, subjective norm and perceived behavioral control. The main assumption of this theory is the tendency of people to behave rationally, in accordance with the beliefs that they hold. In addition, a person’s behavior is depends on information or beliefs that he/ she has which may be based on experience, fact, hearsay or may be fallacious (Ajzen, 1985).

Roger's Diffusion of Innovation theory states that the media and interpersonal contacts provide information that influences a person's opinion and judgment. The theory comprises four elements: invention, diffusion through the social networks, time and consequences (Van Akkeren and Harker, 2003). Information filters through the networks and depending on the nature of the networks and the roles of its opinion leaders, new innovations are either adopted or rejected. Opinion leaders influence an audience through personal contact while intermediaries such as change agents and gatekeepers also contribute to the process of diffusion. There are five adopter categories that include: innovators, early adopters, early majority, late majority, and laggards. The five categories follow a standard deviation curve where very little innovators adopt at the beginning (2.5%), early adopters constituting 13.5%, the early majority constituting 34%, the late majority another 34%, finally the laggards at 16% (Rogers, 1995). Roger's model is shown in Figure 2. This is relevant to this Study in that if it is adopted Luanda county farmers can access information and change their mindset on soil analysis.

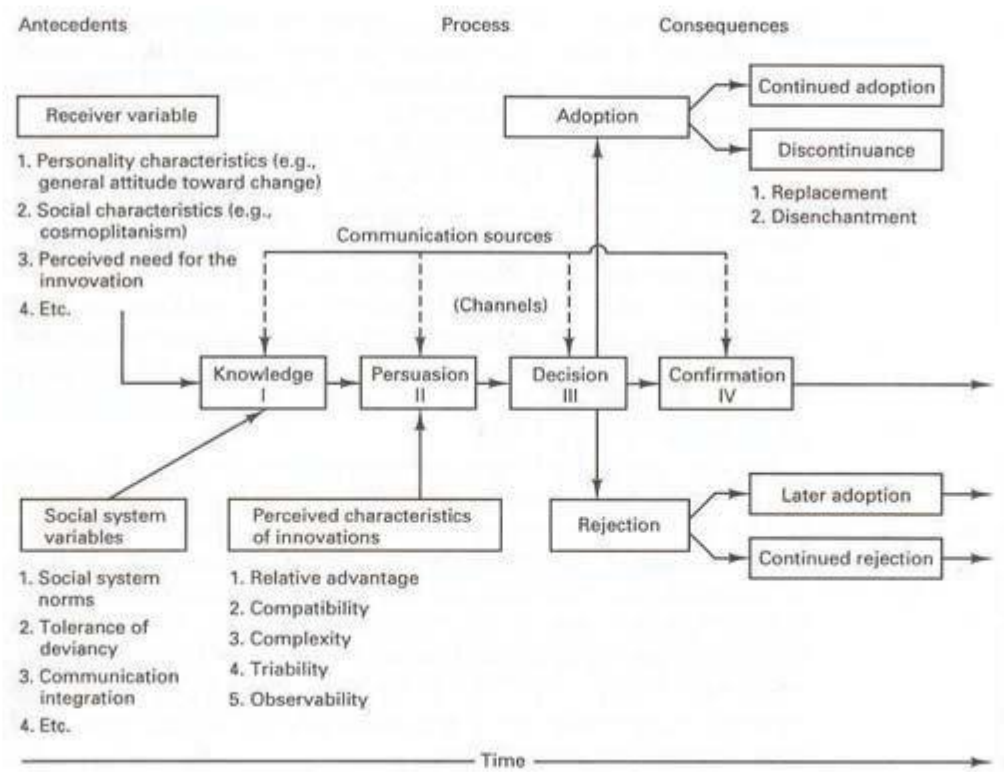

Figure 2: Rogers' Diffusion of Innovation model (source; Rogers, E.M. 1995)

The domestication approach deals on processes where technology is an integral part of daily habits. Conceptual context distinctions are used on new phenomena. Crucial distinctions include work and leisure context; end-users that belong or do not belong to a demographic group; and the private and the public. Domestication process is dominated by sociologist researchers and is often characterized by demographic variables such as age and gender (Pedersen, 2003).

2.4 Attitude to basic soil analysis

There is a large, diverse literature on the attitudes and objectives of farmers and the impact of these on farming vocational behavior. At present, no definitive measurement tools exist for the assessment of farmers' attitudes or behaviors. Prior to constructing a set of such tools, the relevant literature on attitudes, objectives, and behaviors was reviewed in order to identify important domains. The literature review represents the span of variables studied within the last decade.

Farming attitudes identified as important range from risk aversion, innovation, diversification, off-farm work, environment, production, management, legislation, stress, pessimism, and satisfaction toward farming. One complication of existing literature work is that generally the outcome variable for all of the attitudes studied is profit or production maximization. Attitudes toward risk are of major importance in the study of technology adoption decision making, and many economic analyses suggest that, despite functioning in an inherently uncertain environment, farmers are risk averse and slow to accept unproved ideas. Risk aversion includes an abhorrence of debt, and this may limit innovation and adoption of new technology. It is also believed to result in the taking out of insurance, enterprise diversification, hedging, contract selling, and taking off-farm. Descriptive studies of farmers' attitudes to risk have identified attitudes towards sustainability, farming succession, and having off-farm employment as important facets of risk aversion.

Attitudes to take up new innovation are probably closely related to those towards risk. Economists generally believe that innovations are adopted because they are thought to increase the economic viability of the farm. In contrast to agricultural economists, business managers associate innovation with entrepreneurial spirit rather than the early adoption of technology. They argue that unless farmers operate their business using both strategic (long-term) and tactical (everyday) plans based on fundamental management ideas, they will be unable to innovate (Chatterton, 2011).

Adoption of technologies which are considered environmental policies does not seem to be affected by the same variables as production/financial decisions. An attitude for profit maximization or sustainability may determine which type of innovations will be adopted. Income alone is not a significant predictor of conservation behavior; a positive attitude to the environment is also required. However, this issue is not without debate, and several studies suggest that profit motives are stronger than environmental motives, even when an awareness of the environmental problems exists.

Farmers are usually highly satisfied with farming as a way of life and enjoy greater job satisfaction than do other professions. Traditionally, farmers enjoy a quality of life defined by unconstrained decision making, and having interesting and challenging work in pleasant surroundings with no separation of work and home. Farming as a profession is seen as status enhancing. However, more recently, some of this satisfaction toward farming has given way to stress and pessimism regarding the future of farming, which in some ways is related to increased legislative and bureaucratic requirements.

Increases in arable land, intensive capital investment, and decreased labor requirement of modern farming have left farmers vulnerable to stress. Previous literature has ranked farming in the top ten of 130 stressful occupations. Although financial stress has been widely studied in farmers, it is not the only factor contributing to farming stress. Unpredictable weather, time pressure, government policies, farm hazards, and geographic isolation and unexpected events also account for stress and illness. The outcome of prolonged periods of stress, regardless of cause, can lead to depression, which in turn can contribute to a number of other factors, such as increased suicide and alcohol problems. Thus, identifying the variables associated with stress is important in any psychological study of farming behavior.

New policies and legislation are perceived to increase farmers' workload and reduce their income. Farmers find coping with new legislation as stressful as coping with the weather. Farmers complain that they are not equipped to deal with the administrative aspects of new legislative requirements of farming. Legislation-related stress has contributed to factor in the increasing suicide and depression rates observed among farmers.

Many farmers and non-farmers complain that the government and recently legislatures are increasingly interfering with farming. Regardless of farmers' stated perceptions of legislation, some work has suggested that, when goals are assigned by legitimate authority, they typically influence people's personal goals and attitudes Darnton, 2008).

2.5 Modeling to assess farmers attitude, behavior and uptake of technology

Mechanistic models which are built on existing theory and knowledge have been used to extrapolate farmers' behavior and long-term predictions (Antle and Capalbo, 2001). Empirical models are constructed using existing data to bring out the relationships in the observed data and to predict likely events in the future (Austin et al., 1998). Mechanistic models may have two approaches; positive approaches which model the actual behavior of the farmer by describing farm responses and making inferences on them and the normative approaches which provides the optimal solutions and alternatives to the problem of resource management and allocation (Flichman and Jacquet, 2003).

Normative approach requires one to set a 'norm', for example, to describe what farmers ought to do in order to achieve a certain objective, in this case, to improve soil nutrients status (Berntsen et al., 2003). The information obtained using this model is affected by imperfect information, risk aversion, management quality and skills (Falconer and Hodge, 2000; Calker et al., 2004).

Even if new and more productive technologies are available, farmers might lack information about their existence and knowledge about proper implementation techniques. Extension services have been used as a means to diffuse new technology in developing countries. Extension services also include related services, such as health and nutrition services. When they began, extension services mostly included education about new technologies, as well as input and credit provision. However, most field staff lacked the necessary technical training and field experience to effectively deliver the services to farmers. Previously, the ‘‘training and visit’’ (T&V) approach have been used. In addition to teaching farmers about new technologies, it included obtaining their feedback about the problems they encountered.

2.8 Conceptual framework

Perception to adopt a technology is the main determinant to adoption of a technology. In addition, soil analysis is capital intensive process that greatly depends on the social economic status of farmers. The social economic status and perception will influence intent to analyze soil. This three will all affect the adoption rate. Other macroeconomic factors which affect adoption rate include cultural factors and government policies. Figure 1 brings out the conceptual framework of the study.

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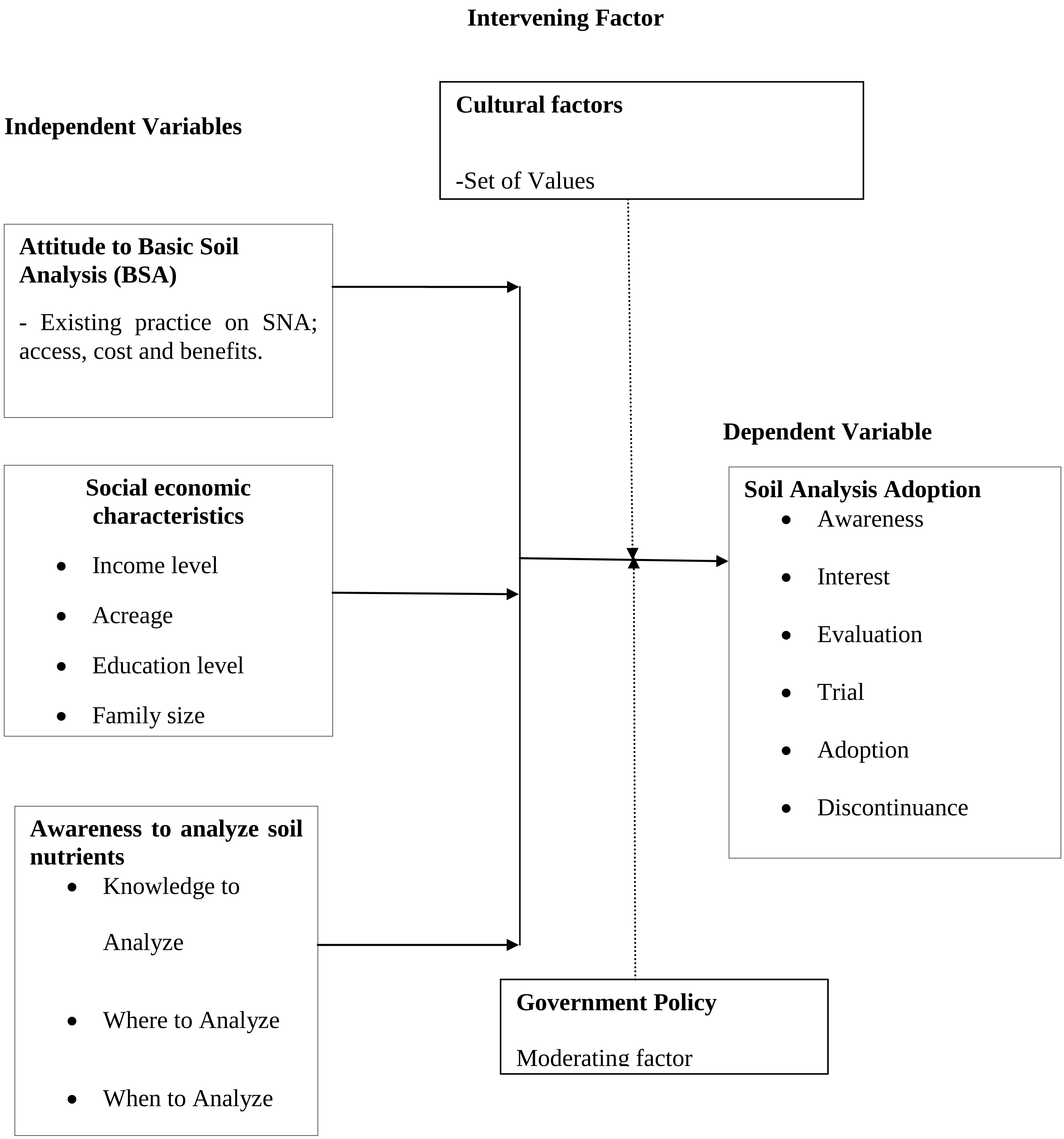

Figure 1: Conceptual framework

2.9 Research Knowledge

Kenya being an Agricultural Country, farmers do not Plan to submit soil samples for analysis. Most Farmers are not aware of this. It may take several weeks before the laboratory results become available. If liming is recommended for your soil, the effects of the amendment will not be realized for a month or more after incorporating the lime. Soil analysis results from the Laboratory will be sent to the by Email.

The test values will be given, as well as an interpretation of them. For example, available nutrient levels will be rated as very low, low, sufficient, high, very high, or extremely high. Based on these interpretations and on the nutritional requirements of the crop you wish to grow, the form will also provide specific recommendations for soil amendments and fertilizer formulations, as well as the amounts of these to apply. The analysis results form also asks for feedback on how your crop grew after you followed the fertilizer recommendations. This information helps the lab to fine-tune future recommendations. The bottom line Applying too much or the wrong kinds of fertilizer can harm your crop and be a costly waste of money.. Failing to correct soil problems or apply enough of the right types of fertilizer to your crops can result in poor yields and wasted effort.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the overall research procedures that will be employed in the study under the following subsections: the research design, description of the study site, target population, sample and sampling procedures, data collection procedures, pre-testing of data collection instruments, data organization and analysis.

3.2 Research Design

The research design used in this study is descriptive survey design. A questionnaire was used to collect information from smallholder farmers. The survey instrument provided a guide to the interviewer, and covered identification of social economic status of small scale farmers, awareness level and perception on soil nutrient analysis, direct cost and benefits of soil nutrient analysis and identification of cultural beliefs and government policies associated with soil nutrient analysis.

The researcher also held focus group discussions with the sub-County agricultural officers as well as the County agricultural officers to explain the purpose of the study and seek their assistance on the research. After the discussion, schedules for field visits were agreed upon. The researcher and enumerators then administered the instruments to selected smallholder farmers in face to face interviews and their responses recorded accordingly.

3.3 Target Population

The study was conducted using situational analysis using the survey approach to generate both qualitative and quantitative data. The study was carried out on small scale farmers in Luanda Sub-County in Vihiga County of Western region in Kenya.

The population of the study (sampling frame) was purposively selected, clustered and categorized from a population of 23,347 small scale farmers in Luanda Sub-County (2009 census).

3.4 Sample Size and Sampling Procedures

The sampling procedure used to identify the respondents to participate in the survey was random sampling technique. The population was divided to select sample size. This ensured that different groups of population were represented. The population was divided based on land acreage from which the researcher drew a sample of target population into a number of categories and production system. Ogula (1991) stipulates the number of people selected from each grade should be proportional to the number of people in that population class. Mugenda and Mugenda (2003) say that 10-20% of the accessible population is enough for descriptive studies.

3.4.1 Sample Size

The most popular is an equation from late 60s. Yamane (1967) provides a simplified formula to calculate sample sizes.

If the population is small then the sample size can be reduced slightly. This is because a given sample size provides proportionately more information for a small population than for a large population. The sample size (n_0) can be adjusted using

To get the sample size, the equation: $n=Z^2pq/\partial^2$, as used in social studies will be used, where: *n* = the desired sample size; *Z* = the standard normal deviation at the required confidence interval set at 1.96; *p* = the proportion in the target population estimated to have characteristics being measured; *q*= 1-p; ∂= level of significance Therefore, the sample size $n_i= (z^2.p(1-p))/\partial^2$, where z= 1.96, p=0.5, q=0.5, ∂=0.05

$$n_i= (1.96)^2(0.5)(0.5)/0.05^2$$

$$n_i=384$$

Since the sample size (n<23,347), then n needs to be modified to get n_f

$$n_f = n_i/ (1+ni/n)$$

Where n =23,347 estimated number of smallholder households in Luanda Sub-County.

The final Sample size n_f was therefore; $n_f=n_{i/}1+ (n_{i/}n)$; n_f=384/1+ (384/4000) =359 respondents

Where;

n_i = the sample size if n> 23,347

n = estimated population size with characteristic of interest.

n_f = the sample size when n<.23,347

3.4.2 Sampling Procedure

Random sampling using random Farmers names was conducted to identify the farmers to interview in the county. The enumerators started from a central point, with the list of the farmers and every 5th farmer from the list was interviewed. Each enumerator was expected to move in one direction, turning only to the left as he/ she interviewed the identified households. Physical features were used as starting point and every fifth homestead on the left side of the road identified randomly selected.

3.5 Research Instruments

Primary and secondary data were collected. The study used semi- structured questionnaires to get primary data while documents review was used to get secondary data. Semi- structured interview schedule was used to collect data from the smallholder farmers. Questionnaires are effective research tools for surveys since the respondents usually give honest answers since they remain anonymous and have adequate time to consult and think out (Ogula, 1999). Both closed and open ended questions were used to draw quantitative and qualitative data. The respondents were interviewed at the same time to help bring down biases resulting from personal characteristics.

3.5.1 Piloting the Instruments

The questionnaires and the interview schedules were pre-tested using a small, but representative sample of respondents to whom the questionnaire was administered. The pre-testing was done in Vihiga Sub-County since it has similar social-economic orientation to Luanda Sub-County.

3.5.2 Validity of the Instruments

According to Mugenda (1999), validity is the accuracy and meaningfulness of inferences, which are based on the research results. Validity per se is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study. To ensure validity of data collection instruments, the questionnaire and the interview schedule were pre-tested using a small, but representative sample of respondents to whom the questionnaire was administered. The pre-testing was done in Vihiga Sub-County, which has similar social economic characteristics and cultural practices similar to Luanda Sub-County. Ten farmers were selected for this based on different types of crops. In addition, Vihiga Sub-county has farmers who have also analyzed their soil nutrients status. In the location the population with similar characteristics as the target population was used, i.e. small scale farmers with diversified production systems. The groups and the farmers therein were randomly selected and the interviews conducted. This exercise helped to improve the instruments to gather relevant data. The pre-testing results improved the data collection procedures, the choice of statistical and analytical procedures used in data analyses.

3.5.3 Reliability of the Instruments

According to Mugenda and Mugenda (1999) reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability in research is influenced by random error, as random errors increase, reliability decreases. Errors may arise from inaccurate coding, ambiguous instructions to the subjects, interview fatigue and interviewers bias.

The researcher used Cronbach's alpha, which is an internal consistency techniques, because Alpha equals zero when the true score is not measured but Alpha equals 1.0 when all items measure only the true score and there is no error component. The internal consistency of data was determined from scores obtained from a single test administered by the researcher to a sample of respondents. In this approach, a score obtained in one item was correlated with scores obtained from other items in the instrument. Cronbach's coefficient (Alpha) was computed to determine how items correlate among themselves. Cronbach's Alpha is a general form of the Richardson 9K-R) 20 formula. The use of the K-R 20 formula to assess constituency of an instrument was based on the split – half reliabilities of data from possible halves of the instrument.

The K-R 20 formula is as follows:-

Where KR = Reliability coefficient of internal consistency

= Number of items used to measure the concept

= Variance of all scores

= Variance of individual items

Using the formula, the KR value was 0.91. The high coefficient implied that items correlate highly among themselves, that is consistency among the items in measuring the concept of interest. This implied that the data had fulfilled all requirements for it to be analyzed.

3.6 Data Collection Procedure

Before carrying out the study, the researcher searched for a permit from the National Commission of Science, Technology and Innovation with an approved introductory letter from the University. The researcher held focus group discussions with the district agricultural extension teams as well as the sub-County teams to explain the purpose of the study and seek the local administration's assistance in locating the small scale farmers and the farmer groups with diversified production systems. The County Agricultural Officer availed a list of all small holder farmers in the areas of study. Meetings were organized by the research team and held with the small holder farmer groups. After the discussion, schedules for field visits were agreed upon. The researcher and enumerators then administered the instrument to the randomly sampled smallholder farmers to collect the required data in a face to face interview and their responses recorded accordingly.

3.7 Data Analysis Technique

Before analyzing the data, the instruments were edited to check completeness, clarity, consistency of the responses**,** errors in responses, omissions and other inconsistencies. The data was coded numerically in order to put them in limited number of categories. The researcher first edited the data to inspect the data pieces and identify responses that were not applicable. Qualitative data was logically arranged into themes and presented in prose. Quantitative data was rearranged in logical order of percentages and frequency distribution tables for each item in the questionnaire. Descriptive statistics was used to seek answers for the study questions. This provided simple summaries about the sample and the measures

Descriptive statistics such as percentages and frequency distribution were used to present the data. The data was analyzed using the Statistical Package for Social Sciences (SPSS) Version 17.

3.8 Ethical Consideration

Before carrying out the study, the researcher searched for permit from the Vihiga County Agricultural Officer with an approved introductory letter from the faculty. The letter specified the objectives and expected benefits from the project. The letter brought out ethical consideration fulfilled during the research.

3.9 Operationalization of Variables

Qualitative data was logically arranged into themes and presented in tables. Quantitative data was rearranged in logical order of percentages and frequency distribution as per the questionnaire. Descriptive data was presented using percentages and frequency. The analysis was run using the Statistical Package for Social Sciences (SPSS) version 20 (Miller and Acton, 2009; Nie *et al.*, 1975).

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter covers the data analysis, presentation and interpretation based on the study findings. Demographic information of the respondents comes first, followed by the presentations and interpretations of the findings according to the research questions. Correlation has been used to bring out social-economic factors that contribute to adoption of soil nutrient analysis technology among smallholder farmers.

4.2 Questionnaire Return rate

In Luanda Sub-County, 359 respondents participated during the study. Table 4.1shows the distribution of the respondents in the four wards. The target respondents was 359, hence return rate was 100%. This was Achieved by Enticing the Respondents by advising them for free on the favorable crops to grow and also advising them on the Agro dealers in their area who agreed to offer them subsidized rates for fertilizers.

Table 4.1: Distribution of respondents in the four wards in Luanda Sub-County

	Frequency	Percent	Valid Percent
Luanda township	75	20.9	20.9
Wemilabi	87	24.2	24.2
Mwibona	101	28.1	28.1
Luanda South	96	26.7	26.7
Total	359	100.0	100.0

Mwibona town had the largest respondent.Wemilabi had the lowest.

4.3 Demographic characteristics of the respondents

There were various respondents during data collection. There was almost a balanced gender representation in the population response. However, the male respondents were higher with 4% at 52% compared to their female counterparts whose percent was 48 (Table 4.2)

Table 4.2: Gender of respondents

	Frequency	Percent	Valid Percent
Male	187	52.1	52.1
Female	172	47.9	47.9
Total	359	100.0	100.0

Sampled population age was spread from below 30 to over 50 years. The highest population was aged 41-50 years which was 35% and lowest population was less than 30 years at 12%. The percent population with 31-40 years and over 50 years was almost balanced with 25% and 28% respectively (Table 4.3).

Table 4.3: Age of respondents

	Frequency	Percent	Valid Percent
Less than 30 years	43	12	12
31-40 years	101	28	28
41-50 years	126	35	35
Above 51 years	90	25	25
Total	359	100.0	100.0

Highest population had more than 5 dependents and the number dropped linearly to one dependent. There was a direct proportionality between the number of respondents and the number of dependents (Table 4.4).

Table 4.4: Number of dependents in the households

No of Children in Household	Frequency	Percent	Valid Percent
1	5	1.4	1.4
2	17	4.7	4.7
3	53	14.8	14.8
4	69	19.2	19.2
5	81	22.6	22.6
6	134	37.3	37.3
Total	359	100.0	100.0

Respondents' level of education assumed a curve. The data was however skewed as most respondents reported not having attained tertiary level. Additionally, secondary level had the highest population with 178 people primary 129 tertiary 31 and no formal education had the least population at 21 (Table 4.5)

Table 4.5: Educational level of respondents

Education Level	Frequency	Percent	Valid Percent
No formal	21	5.8	5.8
Primary	129	35.9	35.9
Secondary	178	49.6	49.6
Tertiary	31	8.6	8.6
Total	359	100.0	100.0

The highest no of famers were primary and secondary. This explains that those with higher level of education embraced soil analysis adoption rate more.

The farmers were smallholders with some owning even less than half of an acre of land. 10% ownes less than half an acre of land,29% owned half to one acre of land Majority of the population in Luanda Sub county had between 1 to 2 acres forming 33% of the total respondents. 22% had 2-5 acres whereas relatively larger farms for (more than 5 acres) could only be afforded by 5.8 % of the population (Table 4.6).

Table 4.6: Land acreage of respondents

	Frequency	Percent	Valid Percent
Less than 0.5 acres	36	10.0	10.0
0.51 to 1.00 acres	104	29.0	29.0
1.00 acres to 2 acres	119	33.0	33.0
2 acres to 5 acres	79	22.0	22.0
More than 5 acres	21	5.8	5.8
Total	359	100.0	100.0

Some of the respondents had more than one income generation but others mainly relied on agriculture as their source of livelihood. Only 6% did livestock farming, 7% practiced crop farming only, 22% were both employed and did farming, 32% tried to diversify the risk involved in agricultural product by practicing mixed farming and finally a third of the population had farming and some business going on. Table 4.7 brings out the occupations of the respondents.

Table 4.7: Occupation of respondents

	Frequency	Percent	Valid Percent
Mixed farming only	114	31.8	31.8
Livestock farming only	22	6.1	6.1
Crop farming only	26	7.2	7.2
Farming and business	120	33.4	33.4
Farming and employed	77	21.4	21.4
	359	100.0	100.0

There were three major divisions on the types of crops grown in the region. Almost half of the population grew sugarcane maybe it could have been as result of many sugar companies in the region. The cane growers composed 43%, the second most popular group was legumes and pulses and only 27% grew cereal crops. The main cropping activities are highlighted in Table 4.8.

Table 4.8: Main cropping activity

	Frequency	Percent	Valid Percent
Cereals crops	98	27.3	27.3
Legumes and pulses	106	29.5	29.5
Sugarcane	155	43.2	43.2
	359	100.0	100.0

The income levels of the farmers ranged between less than 5000 to more than 50000 but majority earned 10000 to 20000. The income is evenly spread forming a perfect curve where the majority of the population is middle income earners with very few people on low and high income levels. the respondents' income levels are highlighted in Table 4.9.

Table 4.9: Respondents income level

	Frequency	Percent	Valid Percent
less than 5,000	46	12.8	12.8
5,001 to 10,000	95	26.5	26.5
10,001 to 20,000	102	28.4	28.4
20,000 to 50,000	79	22.0	22.0
More than 50,000	37	10.3	10.3
	359	100.0	100.0

The marital status was an important aspect as majority of the population was formed by married people. The percent number of married farmers was 69%, 21% was single and only 10% was divorced. Table 4.10 brings out the marital status of respondents.

Table 4.10: Marital status of respondents

	Frequency	Percent	Valid Percent
Single	75	20.9	20.9
Married	249	69.4	69.4
Divorced/ widowed	35	9.7	9.7
	359	100.0	100.0

To raise the level of income and market purpose some farmers had groped and joined to form memberships groups. Majority of the farmers had joined the groups and this mounted to 57% of the population while the rest of the 43% opted to operate individually. Table 4.11 brings out respondents' membership in farmer groups.

Table 4.11: Membership of farmer groups

	Frequency	Percent	Valid Percent
Yes	154	42.9	42.9
No	205	57.1	57.1
	359	100.0	100.0

In order to know the benefits of soil nutrients analysis farmers had to gather information from various sources. The sources of information included relatives, neighbours, extension agents, agricultural officers, radio, television, newspapers and others like workshops and seminars. More than half of the population received the information from the neighbours and relatives, followed by the extension agents and very few people relied on television for source of information (Table 4.12)

Table 4.12: Source of information to respondents

	Frequency	Percent	Valid Percent
Relatives/ Neighbours	154	42.9	42.9
Extension Agents	103	28.7	28.7
Radio	31	8.6	8.6
Television	14	3.9	3.9
Newspaper	23	6.4	6.4
Others	34	9.5	9.5

4.4 Attitude to basic soil analysis and adoption of soil analysis

It was noted that many farmers did not bother to do soil testing and analysis. On further probing a number of reasons as to why the farmers did not do soil nutrients analysis brought out perception of farmers toward the same. Some of the common reasons included: techniques for analysis are not readily available for utilization by locals outlines as number one question by 76% of the respondents. Some farmers were not aware of nutrients variability in soils, some were just contented with the amounts of harvest therefore saw no need for soil nutrient analysis. Farming was also a way of showing the social worth and since nutrient analysis had no social implications some farmers ignored the analysis this was comprised of 65%. The other perceptions and their percentages are as shown in Table 4.13.

Table 4.13: Attitude to soil nutrient analysis among smallholder farmers and existing practices.

	Factors that contribute to attitude	**Respondents (%)**
1	Techniques for analysis not available	76
2	Knowledge of nutrient analysis and nutrient variability	73
3	Subjective methods easy to conduct	71
4	Not bothered with analysis since harvest is always adequate	68
5	Soil nutrient status does not improve social status	65
6	Knowledge of nutrient content reduces risk of crop failure	58
7	Nutrient analysis is inexpensive to conduct	54
8	Knowledge of nutrient content reduces input costs	47
9	Soil nutrient analysis is compatible with farming systems	41
10	Knowledge of nutrient content increases social value	39

4.5 Awareness and adoption of soil analysis among smallholder farmers

Farmers used various technologies in order to assess the nutrients content and overall soil condition in the soil. The technologies were both from soil and plant behavior. The technologies included soil colour to show moisture content which 51% of the farmers were interested in, soil tendency to stick which 48% were interested and only 37% were aware about, soil colour was also used to show organic matter but only 36% were interested in using it and 24% were aware. The most commonly used technology was areas colonized by weeds as a way of showing areas of high fertility in the land adopted by 39% of the farmers. The farmers were however not very aware of the soil colour to estimate soil moisture content and leaf size to indicate nutrient adequacy which were 3%. 10% discontinued the use of leaf size to show nutrient content being the technology with the highest number of discontinuation (Table 4.14)

Table 4.14: Level of adoption of subjective soil fertility assessment techniques (visual obsrevation)

Soil nutrient analysis technology	**Level of adoption**						
	NA	**A**	**I**	**E**	**T**	**A**	**D**
Soil color to estimate moisture content	3	23	51	9	6	5	3
Stickiness of soil to imply moisture content	6	37	48	6	1	1	1
Soil color to imply organic matter	5	24	36	15	16	3	1
Soil color to imply mineral content	9	31	27	13	9	5	6
Particle size to imply texture	4	21	28	19	14	9	5
Rills and gullies to imply eroded soils	7	36	29	16	5	3	4
Plants growth rate to imply nutrient content	13	18	29	24	14	2	0
Plants color to show nutrient deficiency	6	15	26	34	9	7	3
Leaf size to show nutrient fertility	3	23	21	18	14	11	10
Areas colonized by weeds to imply show fertility rate	9	13	19	39	11	5	4

Results of 7-point likert scale: 1- NA; Not Aware, 2- A; Awareness, 3- I; interest, 4- E; Evaluation, 5- T; Trial, 6- A; adoption, 7- D; discontinuance

Similarly, respondents were asked to cite their level of adoption based on 7-point likert scale.

Table 4.15 brings out the level of adoption of objective soil fertility assessment techniques.

Table 4.15: Level of adoption of objective soil fertility assessment techniques (laboratory tests)

Soil nutrient analysis technology	**Level of adoption**						
	NA	**A**	**I**	**E**	**T**	**A**	**D**
Takes to the laboratory for mineral content analysis	29	19	14	11	7	5	15
Regularly samples soils	37	29	18	9	6	1	0
Calculates leaf size	12	27	36	23	1	1	0
Plant biomass analysis	43	17	14	10	9	5	2
Estimating fertility based on produce yield at harvest	11	25	37	19	7	0	1
Estimating fertility based on quality grades of harvest	16	29	29	16	6	3	1
Totals	**148**	**146**	**148**	**88**	**36**	**15**	**19**

Results of 7-point likert scale: 1- NA; Not Aware, 2- A; Awareness, 3- I; interest, 4- E; Evaluation, 5- T; Trial, 6- A; adoption, 7- D; discontinuance

4.6 Influence of social environment on the adoption rate

There was relationship between the socio-economics factors and nutrients analysis adoption. The r-values showed that age, marital status and occupation were negatively correlated with nutrient analysis adoption as they were -0.015, -0.221 and -0.227 respectively. Perception of farmers towards nutrient analysis had the highest correlation at r-value of 0.59 while sources of information had the least correlation at r-value of 0.020. However, only age, marital status and occupation had significant effect on the nutrient analysis adoption (Table 4.16).

Table 4.16: r-values to bring out factors that influence extent of soil nutrient analysis

VARIABLES	r-values
Sex (gender)	0.028
Age	- 0.015
Educational level	0.053
Number of dependents	0.065
Acreage	0.059
Marital status	- 0.221*
Membership of farmer groups	0.084
Occupation	-0.277**
Main cropping activity	0.078
Sources of information	0.060
Perception to soil nutrient analysis	0.591

* = Significant at 0.05% level; ** = Significant at the 0.01 level

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the key issues that have been addressed. It forms a short narrative of the whole project, incorporating ideas which have been proposed over the course of the research. At the end of this chapter are the limitations of the research and proposals for future research.

5.2 Summary of findings

The study found that most farms were held by smallholders who owed less than 2 acres, more farmers were males (52 %). In addition, most of the farmers were young aged between 30 and 50 years. Most of the farmers were also married. Most of the farmers relied on observation of crop growth rate and health of products in addition to observation of soil particulate matter. With regards to objective measurements, most of the farmers were not aware of the existence of such techniques and for those who were aware of such techniques, considered the techniques too expensive. The farmers were not aware that lack of knowledge on soil nutrient status can have negative effects on plants and products. In general, the farmers had negative attitude to soil nutrients analysis.

5.3 Discussion of the findings

There was almost a balanced gender representation in the population response this showed that gender as a social economic factor did not influence on nutrient analysis adoption. However, the male respondents being higher with 4% at 52% compared to their female counterparts whose percent was 48 (figure 1) shows that women despite being higher demographically they are no yet fully in control when it comes to farming and consequently soil nutrients assessments. Sampled population age was spread from below 30 to over 50 years this could be attributed to the fact that most of the farmers did farming as subsistent. The highest population was aged 41-50 years which was 35% due to the economic empowerment of the people at this age unlike less than 30 years who have fewer resources (figure 2). Nutrients analysis adoption was negatively correlated to age and significant at level 0.01 as shown in table 4. This implies that farmers as they age and gain farming experience they are less willing to take up technology. This is in consonance with the findings by Edeoghon’s (2008), who reported that farmers usually are more involved in practices that they are more familiar with than other practices. The findings also agree with the literature that organic producers are newer entrants to farming (Padel, 2001). This can be attributed to the fact that farmers who have been long in the business are usually older, less educated and more resistant to change than new entrants.

Marital status of farmers was found to be negatively correlated with adoption of organic farming practices which means there is an inverse relationship, but is significant at 0.05 level which means if both variables are cordial there would be increase in adoption. Marital status of respondents was an important factor in adoption of organic farming practices. This is in line with Ekong (2000), Nwachukwu and Jibowo (2000), Bamneke (2003), who reported that majority of respondents involved in agricultural activities are married.

Adoption of soil nutrient analysis was influenced by various perceptions they had. For instance 73% had knowledge of nutrient analysis and nutrient variability while the rest had a perception that soil nutrient do no varies. Respondents also stated that there was common believe that subjective methods such as direct observations easy to conduct as indicated by 71%. Additionally, some of the farmers were not bothered by nutrient analysis as they got the usual harvest they had year in year out forming 68% of the respondent. Adequate harvest made these farmers see no need for analysis explains one of the reasons of low adoption of the nutrient analysis in Luanda sub-county. Some of the other perceptions that influenced farmers' decisions on nutrients analysis included, soil nutrient status does not improve social status 65%, nutrient analysis is inexpensive to conduct 54% and soil nutrient analysis is compatible with only large scale farming systems 41%. These factors show that the farmers will behave, adopt a technology depending on the mindset attitude, perceptions or past experiences that they have towards the technology (Beedell and Rehman 1999).

I found out that awareness was also a key factor towards the adoption of soil nutrient analysis. Some of the nutrient techniques included; taking soil and plant samples to the laboratory for mineral content analysis, calculating leaf size, plant biomass analysis, estimating fertility based on produce yield at harvest and estimating fertility based on quality grades of harvest. The farmers were aware of the technologies due to media extension officers and through other farmers. However, the level of awareness was low this could be due to inadequate number of extension officers and poor dissemination of the technology and benefits associated with the nutrients analysis adoption.

5.4 Conclusion

The research has outlined social-economic factors of smallholder farmers that contribute to soil nutrient analysis. From the results, gender contributes to technology adoption. Most of the households are headed by men; that means that they have better access to resources, including land, and therefore the men are the decision makers in soil nutrient analysis. Age is also an important factor; the older the farmers, the less likely they will conduct soil nutrients analysis. Most of the farmers in Luanda Sub-County are less than 50 years old hence may be willing to adopt soil nutrients analysis. The number of dependents was another factor reported to contribute to soil nutrients analysis. Most of the respondents reported to have more than five dependents indicating higher soil analysis adoption rate. Despite the fact that acreage contributes to soil nutrients analysis, most of the farmers owe less than two acres bringing out reason for low adoption rate.

Main cropping activity also contributes to soil nutrient analysis. The main reason for the high correlation is that nutrient depletion from the soil depends on the cropping activity. Most of the respondents cited sugarcane as their main crops. Since this plant is not nutrient depleting, slight changes on plant quality. In addition, most of the farmers earned less than KShs. 20,000 per month. However, there was no correlation between household income level and soil nutrients analysis and this could be attributed to the small-scale nature of most farmers and high numbers of dependents.

The research also demonstrates that lack of information on access to soil nutrient analysis techniques had the greatest impact on smallholder farmers' attitudes. Existing empirical information on awareness of technology causes negative attitude to technology uptake. Similarly, lack of information on techniques and access of soil nutrient analysis could be the main reason for the limited uptake of technology. In addition to limited information, the perceived high cost for analysis may contribute to higher negative attitude. Despite the numerous benefits of soil nutrients analysis, this had limited contribution to positive attitude of soil nutrient analysis.

There exist numerous subjective techniques to assess soil nutrient analysis. Some of the commonly used techniques include estimating organic carbon, moisture content and mineral content based on color of soil, estimating soil texture based on particulate characteristics of soil and estimating soil nutrient status based on plant health, yield and quality. In addition, there exist numerous objective techniques to assess soil nutrient status. Objective techniques commonly used include chemical and physical analysis to measure soil nutrient status and quality of plants and produce.

Despite awareness of techniques to assess nutrient status, the research brings out that most farmers are just interested in the techniques with limited evaluation, trial and adoption to the techniques.

5.5 Recommendations

Since adoption was negatively correlated to land size, the study recommends advocacy for adoption of analysis techniques that will cover groups. Group formation will improve economies of scale and hence the adoption rate. Most farmers had negative perception to soil nutrients analysis. Therefore, the farmers need to be trained on the benefits of nutrients analysis. Based on the findings, the study also recommends capacity building of smallholder farmers to increase awareness of soil nutrient techniques, evaluation, trials and adoption. This will decrease soil analysis techniques discontinuance rates. This will also inform farmers on the benefits of analysis to improve the attitude.

5.6 Suggested area of further research

The study suggests further research in development of capacity development tools such as manuals and guidelines based on the social-economic characteristics of farmers.

CONCLUSION The study indicated that the soil testing process was well known to the farmers and they also knew its importance. But the attitude of farmers towards soil testing practices was unfavourable. The efforts should be made by KVK and Department of Agriculture to encourage the farmers in adoption of soil testing practices by organising training programmes and campaigns especially on soil testing process. If possible, mobile soil testing laboratories should visit the villages sometime to test the soil samples at their doorsteps in the villages itself. By doing this, the reliability of results of soil samples could be increased among the farmers widely in future for better farming. By adopting the soil testing 2 ISSN :0972-2181 Indian Research Journal of Extension Education Volume 6, No. 3, September 2006 practices the farmers also reduced the large unnecessary chemical fertilizer consumption and the judicious use of chemical fertilizers could be popularised.

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APPENDICES

Appendix 1. Introduction Letter

Mwihaki Ndung'u

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EMAIL:Hakskirugo@gmail.com

TO THE CHIEF OFFICER, AGRICULTURE,

RE: REQUEST FOR ASSISTANCE TO CONDUCT RESEARCH

I am a Post graduate Student at the University of Nairobi undertaking a Masters Degree in

Project Planning and Management. I am carrying out research on Influence of soil testing on the social economic status of Luanda Sub-County Small scale Farmers.

The Findings of this research will be helpful to the agricultural sector which has been ailing for years. The purpose of this letter is to seek your assistance as we conduct the research in your county.

The respondents response gathered from them will be treated as confidential as possible,

Thank you in advance for your assistance.

Yours Faithfully,

MWIHAKI NDUNG'U.

APPENDIX 2: QUESTIONAIR FOR FARMERS

INTRODUCTION

The Objective is to establish the adoption rate soil analysis techniques by small scale farmers to their social –Economic Status

The purpose of this Study is to explore Soil testing practices as practiced by farmers in Luanda Sub-County. You are kindly requested to answer all questions as honestly as possible. The information you provide will be confidential and will be used only for the purpose of the research.

You May have to tick more than one. Where requested to provide the additional information. Do not write your name on the questionnaire.

Section A: Household Information

1. Name of respondent ______________________________
2. County ____
3. Sub-County ____________________________________
4. Ward ____
5. Date of interview ________________________________
6. Time of interview ______________________________
7. Name of Enumerator ____________________________
8.

Section B: Social economic

9. Please Indicate your Gender
   Male ☐ Female ☐
10. How old are you?
   Below 20 ☐ Between 20 and 30 ☐ Above 30 Years ☐

11. What is your Marital Status

Single ☐ Married ☐

12. What is your Highest Level of Education

No formal ☐

Primary ☐

Secondary ☐

Tertiary ☐

13. How Long Have you Been Farming

0-5 yrs ☐

5-10 yrs ☐

10-15 yrs ☐

15-20yrs ☐

14. How many dependents rely on this household? ____________

15. How many acres of land does this household possess? _________

16. What is you occupation? _____________

17. If for sale, have you noticed an improvement on yields after soil testing?

Yes ☐

No ☐

18. Which are the main crops produced in this farm? ______________
19. What is the total income that this household gets? _______________
20. Are you a member of any farmer group? ____________
21. What is source of information do you use to access extension? _____________

SECTION B. Soil Analysis

1. Do you analyze your Soil?

Yes ☐

No ☐

2. If No, why?

I have no Information on how to Sample ☐

I have no Information on what to analyze ☐

I don't know where to Analyze ☐

I don't know the cost of analysis ☐

3. If yes, Tick the Analysis Done

Basic Soil Analysis ☐

Complete Soil Analysis ☐

Leaf Analysis ☐

4. How frequently do you analyze the soil nutrient status of your farm?

Yearly ☐

After Two years ☐

5. In your opinion, do you think soil nutrients analysis is important?

Yes ☐

No ☐

6. How has the Soil Analysis Helped improve your Crops Yield

No Change ☐

Decreased Yields ☐

Increased Yields ☐

7. Do you think the soil nutrient status of the farm affects your social economic status?

Yes ☐

No ☐

8. If yes, how?

Increased Income after Sales ☐

Increased Health ☐

Better Living Conditions ☐

9. If for sale, have you noticed an improvement on yields after soil testing?

Yes ☐

No ☐

10. By what Percentages was the Yields Increase after Soil Testing?

Below 10% ☐

Between 10%-40% ☐

Between 40%-70% ☐

Between 70%-100% ☐

Above 100% ☐

11. Which is you preferred source of information

a) Relatives/ Neighbours [ ]

b) Extension Agents [ ]

c) Radio [ ]

d) Television [ ]

e) Newspaper [ ]

f) Others [ ]

12. On a scale of 1-5 where 1 is least important while 5 is most important reason, please rate your perception of soil nutrient analysis

a) Techniques for analysis not available [ ]

b) Knowledge of nutrient analysis and nutrient variability [ ]

c) Subjective methods easy to conduct [ ]

d) Not bothered with analysis since harvest is always adequate [ ]

e) Soil nutrient status does not improve social status [ ]

f) Knowledge of nutrient content reduces risk of crop failure [ ]

g) Nutrient analysis is inexpensive to conduct [ ]

h) Knowledge of nutrient content reduces input costs [ ]

i) Soil nutrient analysis is compatible with farming systems [ ]

j) Knowledge of nutrient content increases social value [ ]

13. On a scale of 1 – 7 where 1- Not Aware, 2- Awareness, 3- interest, 4- Evaluation, 5- Trial, 6- adoption, and 7- discontinuance please rate the following technologies that are used in soil nutrient analysis

a) Soil color to estimate moisture content [ ]

b) Stickiness of soil to imply moisture content [ ]

c) Soil color to imply organic matter [ ]

d) Soil color to imply mineral content [ ]

e) Particle size to imply texture [ ]

f) Rills and gullies to imply eroded soils [ ]

g) Plants growth rate to imply nutrient content [ ]

h) Plants color to show nutrient deficiency [ ]

i) Leaf size to show nutrient fertility [ ]

j) Areas colonized by weeds to imply show fertility rate [ ]

14. On a scale of 1 – 7 where 1- Not Aware, 2- Awareness, 3- interest, 4- Evaluation, 5- Trial, 6- adoption, and 7- discontinuance please rate the following technologies that are used in soil nutrient analysis

a) Takes to the laboratory for mineral content analysis [ ]

b) Regularly samples soils [ ]

c) Calculates leaf size [ ]

d) Plant biomass analysis [ ]

e) Estimating fertility based on produce yield at harvest [ ]

f) Estimating fertility based on quality grades of harvest [ ]