

**FACTORS INFLUENCING THE ADOPTION OF LOCAL ORGANIC RESOURCES FOR SOIL  
FERTILITY IMPROVEMENT IN CROP PRODUCTION: A CASE STUDY OF ADA WEST  
DISTRICT OF GHANA**

**BY**

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN  
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## DECLARATION

I, RICH KOFI KOFITUO, the author of this thesis, titled; **“FACTORS INFLUENCING THE ADOPTION OF LOCAL ORGANIC RESOURCES FOR SOIL FERTILITY IMPROVEMENT IN CROP PRODUCTION: A CASE STUDY OF ADA WEST DISTRICT OF GHANA”**, do hereby declare that with the exception of the relevant references duly cited, the entire research was carried out by me in the Department of Agricultural Economics and Agribusiness, School of Agriculture, University of Ghana, Legon from August 2016 to July 2017. This thesis has never been presented either in whole or in part for any degree in this University or elsewhere.

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This thesis has been submitted for examination with our approval as supervisors

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(Co-Supervisor)

.....  
DATE

.....  
DATE



## **DEDICATION**

I dedicate this work to Miss Rosebud Mawuse Abidiwa my dear mum and Mrs Jennifer Esenam Kofituo my lovely wife. The two precious women who stood by me throughout the course of my post graduate studies.



## **ACKNOWLEDGEMENT**

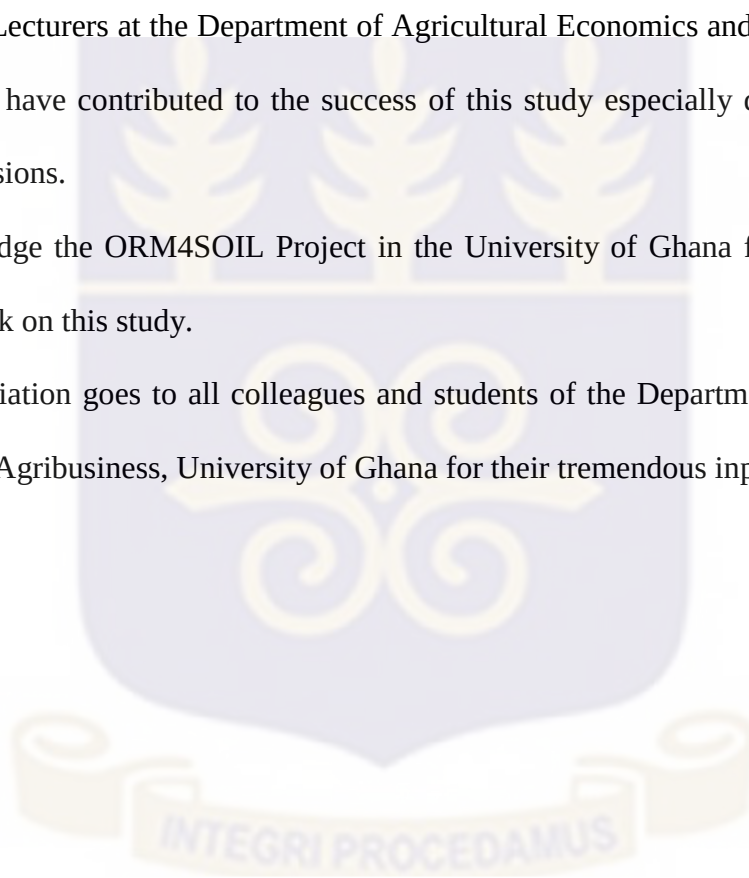
My endless gratitude goes to the almighty God for his divine guidance, direction and protection during my memorable post graduate studies.

My uttermost appreciation also goes to my supervisors, Professor Daniel Bruce Sarpong and Professor Kwabena Ofosu-Budu who have been more than supervisors to me, despite their tight and busy schedules. May the almighty God increase their wisdom and replenish all the vital opportunities they might have lost in the course of attending to me.

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## ABSTRACT

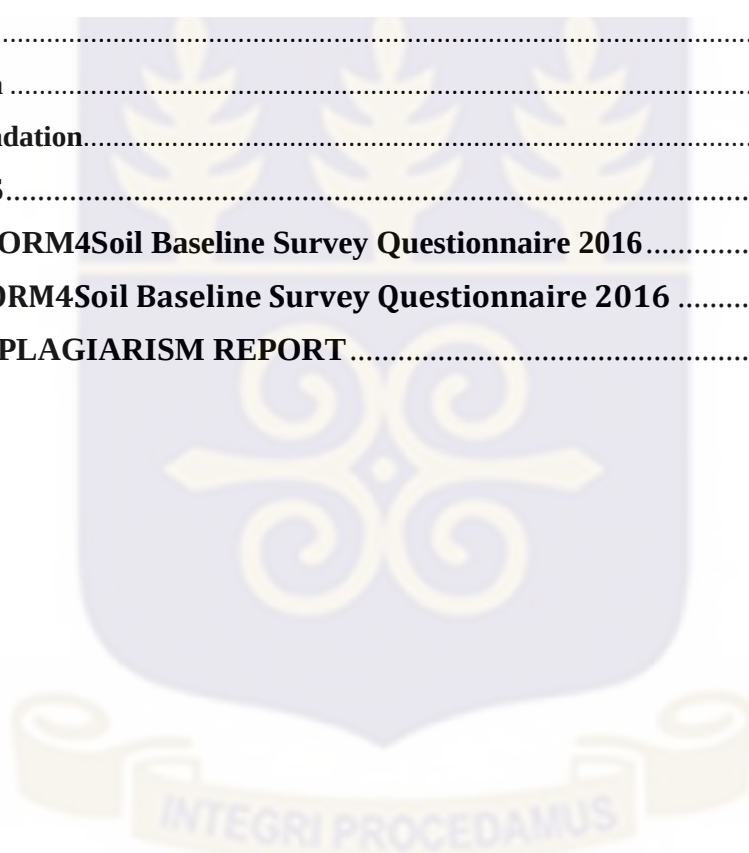
The Organic Resource Management for the improvement of Soil Fertility (ORM4SOIL) Project at the University of Ghana aims at improving soil fertility with concentration on adoption of local organic resources and cost effective ways of improving soil fertility in its study area. This involves a multidisciplinary approach which engages farmers, researchers, Universities, Government and Non-Governmental organizations. This study sought to determine the factors that influence the intensity of adoption of local organic resources for soil fertility improvement in one of the study areas (Ada West District of Ghana). Primary data was collected by the ORM4SOIL Project in the Ada West district of Ghana from crop farmers. The primary data was analyzed using descriptive statistics, Tobit model, partial budget and break-even analysis. Even though all crop farmers use one form or the other of a local organic resource for soil fertility improvement, in total, about 88.7% of the crop farmers use organic material: other animal manure (animal dropping other than cow dung) (49.5%) and matured cow dung (39.2%) as their local organic resource. Focusing on the two main local organic resources used for soil fertility improvement in the area, the intensity of use of other animal manure is 0.43. This implies that crop farmers using other animal manure for soil fertility improvement on the average apply other animal manure to about 43% of their farming land while the intensity of use of matured cow dung is 0.65. This implies that crop farmers who use matured cow dung for soil fertility improvement on the average apply matured cow dung to about 65% of their farm land. The factors that influence the intensity of adoption of matured cow dung or animal manure are their cost, access to credit by farmers, educational level of farmers, farmers membership of FBOs and farmers ownership of their lands. The partial budget shows that, pepper farmers record a net loss when they replace inorganic fertilizer with matured cow dung. The break-even point for pepper farmers using matured cow dung in soil fertility improvement is approximately 3 bags of pepper at a selling price of GHS 400. The most pressing constraint of crop farmers in the use of matured cow dung and other animal manure for soil fertility improvement is its labour intensiveness. It is recommended that extension agents concentrate on training farmers on how to blend matured cow dung and other animal manure with inorganic fertilizer in the right quantity to maximize production. The opinion leaders must lobby relevant stakeholders in the government and private sectors to invest in cattle farming in the area as this will directly influence availability of cow dung. Both cattle farmers and crop farmers should be given technical training in compost preparation to reduce the bulkiness and labour intensiveness of dealing with cow dung and other animal manure. The use of Organic manure is encouraged because holistically, scientific research has it that organic manure has a better impact on soil organic matter, soil structure and the biological life of the soil as compared to the inorganic fertilizer.

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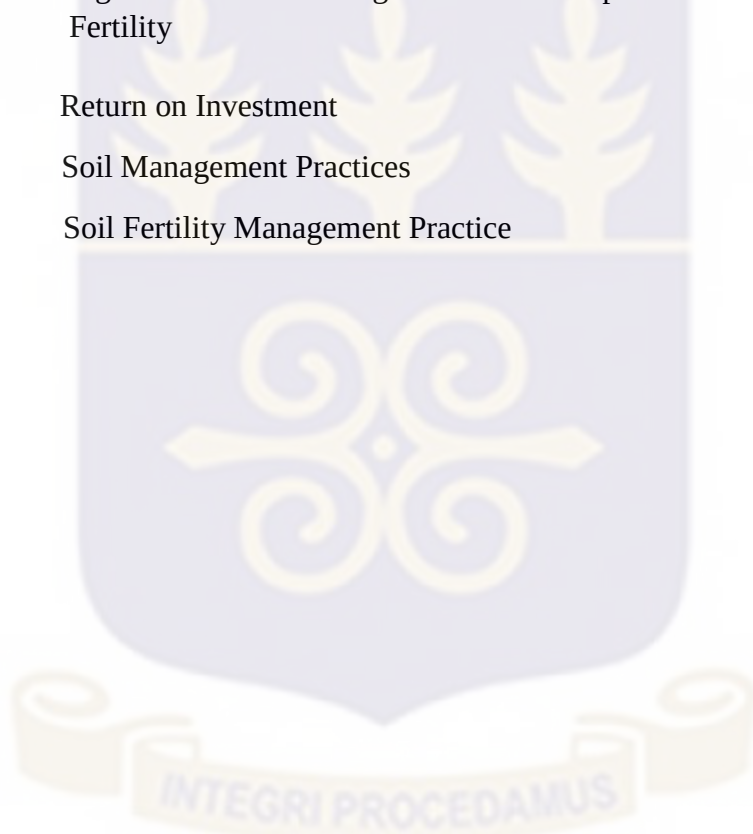
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## LIST OF ACRONYMS

|          |                                                                   |
|----------|-------------------------------------------------------------------|
| BCR      | Benefit-Cost Ratio                                                |
| FAO      | Food and Agriculture Organization                                 |
| GR       | Gross Return                                                      |
| HDRA     | Henry Doubleday Research Association                              |
| IFOAM    | International Federation of Organic Agriculture Movements         |
| IFPRI    | International Food Policy and Research Institute                  |
| NPK      | Nitrogen Phosphorus and Potassium                                 |
| ORM4SOIL | Organic Resource Management for the Improvement of Soil Fertility |
| ROI      | Return on Investment                                              |
| SMP      | Soil Management Practices                                         |
| SFMP     | Soil Fertility Management Practice                                |





## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background to the Study

Ghana's overall land size is about 23,853,900 ha out of which 13,628,179 ha representing 57.1% is good for agriculture purpose but are generally low in fertility (IFPRI *et al.* 2015).

Soil fertility decline reflects the deterioration of the chemical, physical and biological properties of the soil. Some of the identified causes of soil fertility decline are erosion, decrease in organic matter and soil biological activities, destruction of the soil structure and loss of important physical qualities of the soil, inadequacy of important nutrients such as N, P, K and other micro-nutrients in the soil and finally the effect of acidification and pollution increasing the toxicity of the soil (Greenland *et al* 2001).

Across Africa, there is a trend of declining soil fertility, which has resulted in decreasing agriculture productivity (Agwe *et al.* 2007). This has posed a challenge to Africa's development and sustainable solutions are needed to address this in form of adoption of improved crop, water and land management practices (Agwe *et al.* 2007). This is not different in Ghana, as studies have shown continuous decline in soil fertility and this has largely been attributed to poor agronomic practices and low adoption of new agriculture technology by farmers (Duku *et al.*, 2011). Further research in Ghana has also supported the above study that, physical properties of Ghanaian soil, such as poor water holding capacity, low soil depth and challenges of erosion have influenced crop productivity, meanwhile the use of organic fertilizer will help improve the challenges of these properties (Amegashie *et al.* 2012)

The agriculture sector in Ghana has experienced rapid production growth since 1990 and has supported the country's economic transformation (IFPRI *et al.* 2015). However the sustenance

of this agricultural growth is unassured. Over the years the agriculture sector has experienced low yield in cereal crops and it continues rising very slowly over the period (IFPRI *et al.* 2015). The country is rapidly becoming one of the nations with the highest rate of soil nutrient depletion in sub-Saharan Africa with an annual projected loss of 35 kg N, 4kg P and 20kg K per hectare. Nitrogen and phosphorus are the most affected nutrients and these cuts across all of the agro-ecological zones in the country (IFPRI *et al.* 2015). Most of the nutrients lost during crop harvest are not replaced by other means of plant nutrients to enrich the soil for further cultivation purposes (IFPRI *et al.* 2015).

Research is now being focused on how to increase the productivity of newly cultivated lands and also the already cultivated lands globally in order to meet the demand of increasing population while ensuring there is no adverse effect on the environment (Collison *et al.* 2009). There is the need for increased crop yield without causing further degradation to the soil. Farmers will have to resort to innovative means of increasing and sustaining the fertility of their soil. Agricultural scientist must also make available, variety of ways of making the soil fertile. Social scientist and economist must also take a center stage in this research to ensure the proposed innovations are economically viable and socially acceptable (Greenland *et al.* 2001). This has called for the intensification of soil fertility management practices. Innovative methods are needed to increase and maintain soil nutrient and for the management and conservation of soil quality and enhancing productivity (Greenland *et al.* 2001).

Practices targeted at Soil management are tailored to provide improved soil fertility and support crop nutrition sufficiently avoiding the adverse impact it can have on the environment.

Therefore Soil Management Practices aim at reducing the impact of Pest and disease actions on crops (Tamm *et al.* 2016). Soil management practices (e.g. soil tillage, crop rotation, organic amendments to soil) have Impact on identified properties of the soil such as the soil erosion resistance, availability of nutrient, ability to hold water and when done helps to improve the

ability of the soil to properly function in this direction. The effective performance of the soil fauna is greatly impacted in the short and long term by Soil management practices (Mäder *et al.* 2002).

In Ghana, farmer's use both inorganic and organic fertilizer in crop production. However research has shown that, farmers are using the inorganic fertilizer indiscriminately and in ways that are not prescribed. This is posing environmental and health risk to farmers and consumers alike (Osei, 2008).

The sustainability and environmental friendliness of agriculture practices has become a growing concern. Consumers are now demanding healthy and environmentally friendly products (Sam, 2015). This has increased demand for organic agriculture and the use of local organic resources in farming because, its aim is to enhance ecological processes that improve plant nutrient and help in soil and water conservation (Uematsu and Mishra, 2012). There is the need to develop more sustainable methods of improving soil fertility in agriculture especially using organic materials which are economically, ecologically and socially sustainable (Glover, 2010). Currently the demand for organic products have outstripped its supply hence it is economically wise to encourage farmers to adopt organic methods of farming especially if they want to be globally competitive (Osei-Asare, 2009)

Findings are varied on the profitability of organic farming as against inorganic farming. Some studies say yield from organic farms are relatively lower than those of inorganic farms (Morris *et al.* 2001; Mader *et al.* 2002 and Offermann and Nieberg, 2000). However current studies showed that, with the availability of premium on organic agriculture globally, both organic and inorganic farming are profitable and in some cases organic being more profitable (Bolwig *et al.* 2007; Chavas *et al.* 2009; Delbridge *et al.* 2011 and Sam, 2015). It is important to note that, transition from the use of inorganic fertilizer to organic fertilizer just like in the case of adopting any new technology will come at an initial high cost (Shackley *et al.*, 2011).

Organic farming in Ghana is more concentrated on cash crops such as Cocoa, studies are few in cases of the use of organic materials in non-cash crop farming and its profitability to farmers. Ghanaian non-cash crop farmers need more information on the use of local organic resources in soil fertility enhancement.

## **1.2 Problem Statement**

Most farm lands in sub Saharan Africa have been used for farming without much attention paid to replenishing the nutrient of the soil. The use of fertilizer and mulch have proved to be helpful but farmers are discouraged in adopting them because of the cost involved in buying and hiring labour to apply them (Greenland *et al.* 2001) . This has led to the decrease in productivity of most of the lands in sub Saharan Africa and has led to decrease in harvest of major staple food crops such as cassava. All these have existed in spite of efforts to help boost productivity by farmers. Among the many factors that have contributed to low crop yield, changes in soil conditions have been a leading cause. Most farmers in Africa depend on natural fallow to help make their soil fertile (Greenland *et al.* 2001).

Most soils in Ghana were formed from parent materials that are old and have been leached over so many years. Their organic matter content is low and they have low inherent fertility (Sanginga *et al.* 2009). Most Ghanaian soils lack major nutrients like nitrogen and phosphorus. Most materials that could serve as organic matter for the soil is used for fuel at home, animal feed and even building materials. Also during the dry season which is relatively long, most of the grasses that serve as soil cover are killed off by the harshness of the weather hence when the rainy season begins, most of the soils become heavily eroded since they are exposed. All these actions tend to aggravate the low soil fertility problem in Ghana (IFPRI *et al.* 2015).

The challenges from low soil fertility poses a national threat hence requires attention so as not to become an impediment to the growth of the agriculture sector in Ghana. The country will

become over dependent on agricultural import since population is increasing and the farmers as a result of low soil fertility cannot provide for the demand of the populace (IFPRI *et al.* 2015). Due to this, Ghana will have to work on sustainable means of replacing its soil nutrient.

As a result of the problem of low soil fertility, scientist have come to a conclusion that, decline of soil fertility on farms of smallholder farmers in Africa has a direct relationship with decrease in per capita food production hence issues of replacing the fertility of our soils on the continent must be treated as a natural resource capital investment (Bationo, 2009).

Soil scientists over the years have been working on various ways of helping to improve the fertility of soils in sub Saharan Africa. This involved various soil fertility trials, including various application rates for nutrients such as nitrogen (N), phosphorous (P) and Potassium (K) i.e NPK on various types of soils. However over the years, the blanket application of inorganic fertilizers on all kinds of soils is proving ineffective because soils are very complex and management specific. Also before farmers adopt a soil fertility improvement method, they are informed by many factors such as its socio-economic impact and the user friendliness of the method. The modern ways of improving the fertility of soils by relying largely on inorganic fertilizers is no longer feasible. Constraints such as high cost of input, unavailability of fertilizer in right quantity and period for farmers to access and the negative impact inorganic fertilizers have on the soil and the environment at large have characterized the use of inorganic fertilizer among smallholder farmers in Sub-Sahara Africa and Ghana for that matter (Savci, 2012 and Lavison 2013).



### 1.3 Conceptual Framework

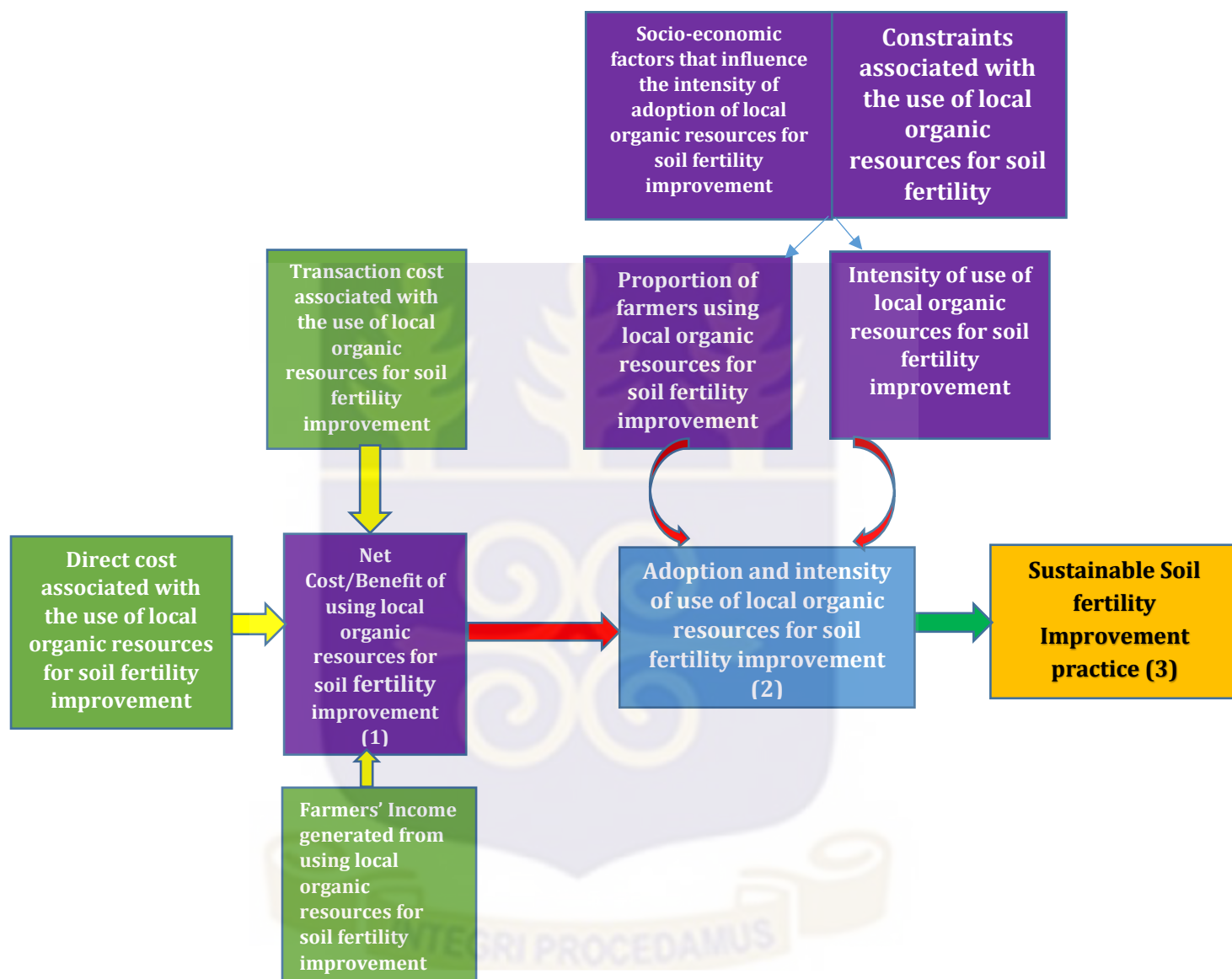
The use of organic fertilizers contributes to the improvement of soil physical properties, most importantly soil bulk density and water holding capacity (Alimi *et al.* 2006). The yield of crops is increased when they use organic fertilizers hence this results in a financial boost to the income of the farmers (Alimi *et al.* 2006). However literature has it that farmers will only continue with a particular technology when there is financial gain out of using it (Barnard and Nix, 1979). Literature also explains that a decision or choice a farmer makes from a given number of alternatives is influenced by the ability of that alternative to assist in problem solving (Ndah *et al.* 2010).

Crop farmers in Ada West District have various options of improving the fertility and productivity of their soil. Some have that choice of using only local organic resources, only inorganic fertilizer or resorting to using both. A number of factors will inform a farmer's decision to adopt a particular option. Among these will be cost of material/fertilizer, farmers perception of the fertility of his soils, land tenure, educational level, age, membership of a farmer based organization or network, access to media information, farm size, distance of materials of the various options, knowledge of the practice of soil fertility management, off-farm income (Bonabana-Wabbi, 2002). A farmer in Ada West District can only be considered as an adopter of any of the aforementioned options of improving soil fertility if he or she has been using it consistently for a period of three to four years or more (Mutala *et al.* 2016). Adoption can then be concluded to be influenced most importantly by the farmer's own characteristics, the environmental characteristics as well as societal and institutional factors (Bonabana-Wabbi 2002 and Ajewole, 2010).

Figure 1.1 conceptualizes the research issues. The adoption of a particular technology by farmers is hinged to the Benefit/Cost involved in using it, socio economic factors, proportion

of farmers using it, constraints associated with the use of it and the intensity of use of the said technology which all contribute to a sustainable soil fertility improvement practice adoption.

**Figure 1.1: Conceptual Framework for the Study**



Source: Author's Conceptualization of the Study

Peculiar constraints could accompany the use of a particular technology. Farmers using organic resources may be constrained by its labour intensiveness, bulkiness hence difficulty in transporting, unreliability of its availability, cost of machinery used in applying them on the field, its support of weed growth, among others. Adoption of organic resources by farmers will hence be enhanced if the various constraints can be minimized (Bonabana-Wabbi, 2002).

The transaction and direct cost involved in using local organic resources coupled with the income generated by the farmer as a result of using local organic resources for soil fertility improvement in crop production, all contribute to the Net Cost and benefit of using local organic resources in soil fertility improvement (Bonabana-Wabbi, 2002). This eventually influences a farmer's adoption of local organic resource in soil fertility improvement in crop production.

The portion of total farm size in use a farmer commits to the use of local organic resources determines the intensity and severity of the farmers' use of local organic resources. All these influence the adoption of local organic resources in soil fertility improvement.

Even though farmers know of the use of organic manure and other local organic resources in enhancing fertility of soils its adoption and use is largely low. The search for multiple ways of addressing soil fertility decline problems is a more sustainable way of addressing the challenge (Mutala *et al.* 2016).

The focus of the ORM4SOIL Project in Ghana facilitates the improvement of soil fertility in target communities (semi-arid and humid zones) representing Ada West (Sege) and Kwaebibirem (Kade) districts of Ghana respectively in a multidisciplinary approach with particular emphasis on the usage of local organic resources. The ORM4SOIL Project provides a platform that engages farmers, researchers, Universities, Government and NGOS's on finding measurable solution to improving soil fertility using common and local organic materials in

farmers immediate environment or locality. Within the project ORM4SOIL at the University of Ghana, the focus of this study is on finding the factors influencing the adoption of local organic resources in improving soil fertility in Ada West District of Ghana. The issues raised are:

1. What is the proportion of crop farmers using local organic resources in improving soil fertility in Ada West District?
2. What is the intensity of use of local organic resource in improving soil fertility by crop farmers in Ada West District?
3. What are the factors that influence the intensity of adoption of animal manure or matured cow dung in improving soil fertility by crop farmers in Ada West District?
4. What is the cost and returns of using matured cow dung as a soil fertility medium by crop farmers in Ada West District?
5. What are the challenges of using animal manure or matured cow dung in soil fertility improvement by crop farmers in Ada West District?

#### **1.4 Objectives of the Study**

The main objective of the study is to analyze the factors that influence the adoption of local organic resources used in improving soil fertility by crop farmers in Ada West District. The specific objectives of the study are to:

1. Estimate the proportion of crop farmers using local organic resources in improving soil fertility in Ada West District.
2. Determine the intensity of use of local organic resources in improving soil fertility by crop farmers in Ada West District.
3. Analyze the factors that influence the intensity of adoption of animal manure or matured cow dung in improving soil fertility by crop farmers in Ada West District.
4. Estimate the cost and returns of using matured cow dung as a soil fertility medium by crop farmers in Ada West District.
5. Analyze the constraints of using animal manure or matured cow dung in soil fertility improvement by crop farmers in Ada West District.

### **1.5 Relevance of the Study**

Through the study, the understanding level of smallholder farmers on the use of local organic resources will be appreciated and this will help stakeholders such as government and research institutions to increase the intensity of their work and for them to touch on very relevant topics during their education to the smallholder farmers.

The research will bring forth the challenges that smallholder farmers face in Ada West District and Ghana at large in using local organic resources. Hence the relevant stakeholders i.e. Ministry of Food and Agriculture (MOFA), Ada West District Assembly, developmental research oriented organizations, private sector investors etc. can help address them to enable an onward improvement in the Ghanaian agricultural sector and the sub Saharan Africa region as a whole.

For the ORM4SOIL Project, this research will reveal timely information on the socio-economic characteristics of the smallholder farmers they intend training in the Ada West District. It will also inform them on the local organic resources readily available to use for soil fertility enhancement in the area for their on-farm trials practical in the District. The research will also provide information to the project on the factors that influence smallholder farmer's decision to adopt their fertility enhancing materials, in this case being matured cow dung and animal manure, so that those factors will be given the relevant attention. The ORM4SOIL project has an Innovative Platform group in Ada West District geared towards finding solution to soil infertility problems using local organic resources. Hence the research findings will contribute to discussions on the platform on the current state of the farmers in terms of the use of local organic resources in farming and how best to improve.

Finally the study will add up to relevant literature that exist on Local Organic Resources and Soil Fertility Management Practices and will help supply available information to researchers and scientist on Soil Fertility Management Practices.

### **1.6 Limitation and Scope of Study**

The ORM4SOIL Project at the University of Ghana targeted smallholder farmers in the Ada West District (Sege) of the Greater Accra Region and Kwaebibirem (Kade) Districts of Ghana. The study considered the local organic resources used to improve soil fertility in their crop production. Data collected was for the crop production year of 2016. Questions were asked on farmers' use of animal manure, crop rotation, fallowing, inorganic fertilizer, green manure, soil fertility enhancing trees, compost, terracing, minimum or zero tillage, mulch, intercropping with legumes e.g. *Gliricidia Sepium*, etc. The cost and benefit of using the various local organic resources in improving soil fertility in crop production and the challenges that come with them. The findings apply mainly to the study area of Ada West District and do not reflect the views of all smallholder farmers of Ghana since the factors that influence the adoption of local organic resources and the intensity of their use in soil fertility improvement in crop production might differ between various districts or geographical area. The type of local organic resources might also vary according to each district or geographical area. The quantitative data obtained from farmers were mere approximations often recalled from memory. This is because most of the farmers hardly kept records on the exact quantities of inputs used and output realized. However, the combined use of questionnaire information, personal interviews, and critical observations where necessary were made to ensure least distortions in information gathered.

### **1.7 Organization of the Thesis**

The thesis is organized into five chapters. Chapter one explains the background to the study, the chapter two reviews the relevant literature concerning the study. Chapter three outlines the methodology used to achieve the various objectives of the study. Chapter Four contains the results and discussions of the study. Chapter five has the summary, conclusion and the recommendations of the study.



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter reviews the literature related to the study. Issues reviewed are Organic Agriculture, the sources, state of use, and nutrient content of common local organic resources for soil fertility improvement in Ghana. Crop production in coastal savannah vegetation of Ghana (Vegetation of Ada West district). The definition and concept of adoption and factors that influence the adoption of farming technologies.

The chapter also presents empirical evidence of how tobit model is used for analysing factors that influence the intensity of adoption. It also explains the transaction cost involved in organic farming, net gains and benefit.

Finally it assesses the constraints associated with the use of local organic resources in farming and provides a summary of the whole literature review.

#### **2.2 Organic Agriculture**

The Henry Doubleday Research Association (HDRA) describes organic agriculture as a “farming system that involves using techniques to achieve good crop yields without harming the natural environment or the people who live and work in it”. Some of such techniques involves the use of recycled and composted crop waste, animal manures, crop rotation, green manures and legumes. All these are to ensure we keep and build the structure of the soil properly and improve fertility of it (HDRA, 1998)

The International Federation of Organic Agriculture Movement (IFOAM) defines organic agriculture as a “production system that sustains the health of soils, ecosystems and people. Which relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects”. It explains that organic agriculture embodies



traditional, science and innovation all put together to promote quality life and maintain the environment for the benefit of all living things (IFOAM, 2015).

The above two definitions clearly show the effort of the agriculture community globally in promoting the use of readily available and biological materials in the process of farming. The stress is also made on innovation of farmers in farming and the application of basic and local science in making farming more productive.

### **2.3 The Sources, State of use and Nutrient Content of Common Local Organic Resources Used in Soil Fertility Improvement in Ghana**

In Ghana there are a number of local organic resources that can be used in farming which are rich in many essential nutrients that will enhance the fertility of the soil and improve crop growth.

Some of these resources can be classified in groups such as “(a) Domestic or household waste example (cooked or uncooked food scraps); (b) Agricultural residue like (e.g. stover of crops, rice husks, etc.); (c) Commercially produced organic waste for example (waste generated from schools, hotels, restaurants etc.); (d) Human faecal residue and finally; (e) Animal residue such as (dung and manures)” (Issaka *et al.* 2012).

Research by Issaka *et al.* showed that in all 366,000 Mt and 63,000 Mt of rice straw and rice husk respectively were produced as waste in the year 2007. These in equivalent of nutrient is approximately 2500 Mt of N, 1000 Mt of  $P_2O_5$  and 5,500 Mt of  $K_2O$  (Issaka *et al.* 2012).

A lot of the firms that produce timber are in the Ashanti, Brong Ahafo and Eastern regions of Ghana while some are also in the Central and Western regions of the country. All of these firms produce large quantities of saw dust which happens to go waste instead of being used in improving soil fertility (Issaka *et al.* 2012).

Likewise, the resources from the animal sources i.e. poultry manure, cow dung and those from sheep, goats and pig are also equally under used in Ghana even though available in large quantities. Northern Region, Upper East and Upper West Regions together produce approximately 1.2 million metric tonnes of cow dung in a year, greater part of which go waste likewise the Greater Accra and Ashanti Regions together produce about 150,000Mt of poultry dropping annually. Approximately 6000Mt of N, 3500Mt of  $P_2O_5$ , 3000Mt of  $K_2O$ , 17600Mt of CaO 14500Mt of MgO is unutilized annually (Issaka *et al*, 2012).

According to the Participatory Rural Appraisal report of the ORM4SOIL project, the local organic resources available for use in soil fertility improvement in Ada West district is largely cow dung, water melon residues and swine droppings (Mutala *et al*. 2016). A typical cow manure when fresh contains 0.5 percent N, 0.3 percent P, 0.5 percent K, 0.3 percent Ca, 0.1Mg, 16.7 percent organic matter and the rest is moisture meanwhile; a dried cow manure contains 2.0%N, 1.5%P, 2.2%K, 2.9%Ca, 0.7%Mg, 69.9% organic matter and the rest is moisture (Mutala *et al*, 2016).

#### **2.4 Crop Production in Coastal Savannah Vegetation of Ghana**

Ghana's coastal savannah region in total covers 4 500km<sup>2</sup> it runs along the coast and widens towards the eastern part of the country. Farmers in this zone mostly grow maize, cassava, vegetables and fruits (Morris *et al*. 1999).

The annual rainfall within the coastal savannah belt is bimodally distributed and totals about 800mm/year (FAO, 2005). The coastal savannah region has short growing savannah grass and mixed with shrubs and short trees; production within this vegetation is generally low because of its nature of soil. The length of the major rainy season within the vegetation is approximately 100-110 days whiles that of the minor season is 50 days approximately and the dominated land use is for annual food crop (FAO, 2005).

The type of soils that characterize Ghana's coastal savannah zone are ochrosols, lithosols, ochrosol-lithosol intergrads, tropical black and brown clays, gleisols, tropical grey clays, sodium vleisols and savannah regosols (CEPA, 2000). The Ada West district has the sodium vleisols type of soil, which is comprised of black or dark grey clays and described by soil scientist as one of the worst in Ghana (CEPA, 2000). It is normally sticky when wet and hard when dry and it develops clay encrusted salt crystals at the surface because of its nearness to the lagoon (CEPA, 2000).

## **2.5 Definition and Concept of Adoption**

Adoption is defined by different authors in different ways. "Adoption commonly refers to the decision to use a new technology or practice by economic units on a regular basis" (Abera, 2008). "Adoption is an outcome of a decision to accept a given innovation" (Bonabana-Wabbi, 2002; p.24). Rogers defined "adoption" as use or non- use of a new technology by a farmer at a given period of time" (Rogers, 1983). Feder, Just and Zilberman in their study in 1985 while using Roger's earlier work defined the word adoption as "a mental process an individual passes from first hearing about an innovation to final utilization" (Feder *et al.* 1985 p.256). They however identified farm level adoption from aggregate adoption of a technology. Farm level adoption refers to a farmer's decisions to integrate new technology into their production process whereas aggregate adoption which is also called diffusion of a technology was defined as the process of spread out of a new technology within the whole region or population which represents the collective use of a particular technology within an area or locality as measured by aggregate adoption (Abera, 2008). Some still opted to conceptualize adoption in terms of its rate of adoption and intensity of adoption. One should differentiate them clearly before dealing with the concept of adoption. Bonabana-Wabbi (2002) put this definition as follows: "Most of the academic work and study on adoption is on rate of adoption and its intensity. The two however are different and must be treated as such, since they have varying policy

implications. The rate of an adoption describes the relative speed with which an innovation is adopted by a group of farmers or targeted people and here time is very essential. Meanwhile intensity of adoption describes the level at which a group of people or in this case farmers are using a given technology at any period of time” (Bonabana-Wabbi, 2002; p.24).

Meanwhile a technology can be defined as the actual application of a certain accumulated knowledge (Abara and Singh,1993).

Static models have widely been used by researchers in addressing determinants of adoption or not of a particular agricultural innovation or technology rather than dynamic models (Abera, 2008). The static model in adoption studies takes into consideration a farmer’s decision to adopt an improved or advanced technology within a specified period of time at a given place. The static model focuses on addressing the challenge of determinants of adoption of a given technology and the pattern of adoption within a specified time. However in different studies there have been divergent views on various variables and their influence in different adoption studies (Ghadim and Pannell, 1999). Moreover, static model fails to capture the timing of adoption (i.e. when is the right moment to adopt). The approach focuses at a single point in time and tries to identify who is using the technology and who is not. But, technology adoption is a dynamic process as indicated above. This means early adopters differ from later adopters and current non-adopters may eventually adopt the technology in the future. The static approach, therefore, fails to consider the adoption speed and the impact of time dependent factors in influencing adoption (Butler, J.S. and Moser, C., 2010). The other limitation of the static approach is its inability to control for farmer heterogeneity even when panel data is available (Butler, J.S. and Moser, C., 2010).

Regardless of these major drawbacks of the static model, many adoption studies continue to use logit and probit models which are all forms of the static model (Jansen, 1992, Rauniyar *et*

al 1993 and Polson and Spencer, 1991). In all these studies, it has been about adoption or non-adoption of an innovation or technology. This involves econometric analysis of the influence of a set of dependent variables on the probability of adoption. The probit model normally follows the normal distribution while the logit model follows the logistic distribution. Feders' study in 1985 shows how the logit and probit model are used to explain the effect of regressors on adoption, an example being using a probit model to analyse a farmer's adoption of fertilizer. Whether he adopts the recommended level of fertilizer or another farmer applies the same recommendation partly is considered equal.

Econometric models like Tobit model are used to analyse data when information is needed on the intensity of adoption i.e. information on the percentage of area a certain innovation has been applied. Dealing with a set of data that has to do with quantity or area, some data points will have 0 value for non-users. When this occurs the dependent variable has to be censored especially when there are missing data in some of the range of the sample. The condition is described as truncated if the information on explanatory variable can only be observed if the independent variable is observable (Kennedey, 1992).

These shortfalls are addressed in dynamic adoption models (Abera, 2008). These models accept changes in adoption decisions of farmers as they obtain skills and knowledge in a technology from year to year.

Dynamic models have several advantages over static models dealing with adoption decision. First, they take advantage of more information, meaning the timing of adoption, which cannot be used in logit or probit models. Thus, they permit continuous-time analysis irrespective of the time frame used in the data themselves. This means that in these type of models, the predicted probabilities are obtainable over a period of a year irrespective of the number of periods observed. Second, they also consider the evolution of the adoption of the technology



and its determinants over time. Thirdly, duration analysis is appropriate to use when it is well known that the farmer did not adopt the technology, especially considering a given period in reference (Poolsawas and Napasintuwong, 2012). These “right-censored observations contribute to the hazard rate with their survival information” (Coetzee, 2006). Fourth and the last, duration models can be used to control for unmeasured heterogeneity (Deaton, 1997; Butler and Moser, 2010).

A further advantage of duration model is the ability to control for unmeasured heterogeneity without the need for a full panel data set. Recently, this model has been getting growing concern and applied in a number of agricultural economics studies to explain the varying concerns espoused on the adoption of technologies. Few of these studies are stated in this paragraph below.

Fuglie and Kascak (2001) estimated the long-term trends in adoption and diffusion of conservation tillage by U.S. farmers; Burton *et.al.* (2003) explored the determinants of adoption of organic horticulture in the UK; Dadi *et.al.* (2004) estimated the impact of variables on the timing of agricultural technology adoption by smallholders in Ethiopia; Abdulai and Huffman (2005) explained the diffusion and farmer’s adoption of crossbred cow technologies in Tanzania; D’Emden *et al.* (2006) investigated significant variables on the soil-conserving adoption by grain farmers in Australia; Matuschke and Qaim did a similar study on pearl millet adoption in India in 2008; Beyene (2008) studied on Adoption of improved Tef and wheat production technologies in Ethiopia; Odendo *et.al.* (2010) examined the determinants of the speed of adoption of fertilizer, manure and composting in western Kenya; Pornpratansombat *et.al.* (2011) investigated the factors affecting the speed of organic rice farming adoption in Thailand and the others.

The Tobit model is able to provide information on effect of a change in a certain variable on the probability of adoption of a new technology and the expected intensity of use of a particular technology (Dong and Saha, 1998).

## **2.6 Factors that Influence Adoption of a Technology**

Factors that influence the adoption of agricultural technologies have been captured under socio-economics, resource characteristics and institutional factors. Under socio-economics factors, variables such as household labour size, gender, age and experience can be found. Under resource characteristics, variables such as cost, availability and labour intensity associated with the resource is important. Institutional factors also have to do with access to extension, membership of FBO and access to credit among others.

Household labour size is vital in technology adoption. Studies have shown that, household labour size positively affects adoption of farm technology (Mignouna *et al.* 2011). This is because the availability of more hands will enhance higher coverage in terms of the application of the technology. It also influences the intensity of adoption because more hands are available to support in the application of the technology. However in related studies, the influence of household labour size is not significant in adoption of farm technology. This is in the case of adoption and intensity of use of improved box hive technology (Gebremichael and Gebremedhin, 2014).

Farming experience is also very significant in technology adoption in agriculture. Studies have shown that, more experience has a positive influence on technology adoption (Alarima *et al.* 2013). This is because experienced farmers have the desire to try new technologies that help them to improve their productivity, counting on past experience. However studies have also stated that, farm experience is ambiguous in influencing adoption of technologies (Tiamiyu *et al.* 2009)



In terms of gender, studies say that male farmers are more likely to adopt organic soil management practices as compared to the female ones (Ayuya *et al.* 2012). This is because female farmers are more risk averse as compared to the males. This has been corroborated by further studies where male farmers are said to control more productive resources hence likely to adopt new technologies faster (Akudugu *et al.* 2012).

Farmers who have alternative means of income are likely to adopt new technologies. This is because new technologies normally come with financial burdens hence poorer farmers are negatively affected by this. Several studies have supported this stand, saying poorer farmers are adamant to adopting new technologies while farmers who have alternative means of income are more likely to adopt new technology (Martey *et al.*, 2013; Hanschuch & Wollni, 2013).

Access to extension has proved to be very relevant in information dissemination to farmers. In the case of new technology, this is more important. Extension personnel are better educated and properly trained to understand these technologies, they will hence better transfer this technology to farmers who are ill-informed about them. Research has supported this in several studies, where access to extension services showed to have positive influence on exposure and familiarity with new technology (Mignouna *et al.* 2011 and Beshir, 2014).

Farmers who are educated are believed to be better informed on input use and new technology reception. They are better positioned to easily understand new technology and to be able to do independent enquiries on them. The more formally educated farmers are, the easier for them to embrace innovations and new technologies. Studies have corroborated this, whereby level of education has positive influence and correlation with intensity of adoption of farming technology and innovation (Chiputwa *et al.* 2011; Olagunju & Salimonu, 2010).

The cost of a new technology has influence on farmer's ability to adopt it. Definitely, an expensive technology will have low adoption rate by farmers. This is because most farmers are already resource constrained and will prefer not to go the extra mile in spending on a new technology they have not tested before. Studies in this relation also posited that, increased cost of technology discourage adoption, hence support the earlier assertion (Scholz *et al.* 2014 and Zhou *et al.* (2010).

Farmer's perception of a new technology influence adoption of technology. Studies have shown that, when farmers perceive a particular technology to be complex its adoption is discouraged. It is however important to introduce technologies that are simple, less expensive and relatively available and has its resources easily available to farmers. This position has been supported by previous studies which states that, farmer's perception of a technology has a positive relation with adoption of technology (Mensah, 2006; Farouque & Takeya, 2007).

Land ownership status is significant in farmer's adoption of a technology. This is because most owners of farmlands are more confident in investing in productivity of their land since they are more secured. This comes at the backdrop of the fact that adopting a technology to improve fertility of the soil has a long term impact on the productivity of the soil. (Anumu, 2013 and Asare, 2013).

Access to credit has significant influence on adoption of technology (Wanyama *et al.* 2006). This is because farmers who have access to credit, are more financially capable to buy items related to the use of any new technology introduced to them. This is corroborated in related studies which stated access to credit to have a positive and significant influence on technology adoption (Glover, 2010).

Membership of farmer-based organizations have a positive and significant influence on adoption of new technology (Antwi, 2014). This is because most farmer based organizations use the platform to enrol in series of farmer educational programs and are normally monitored to implement them to the later and this greatly enhances their opportunity to be introduced to new farming technology (Akpan *et al.* 2012).

Farmers in Ghana prefer a particular input to the other based on factors such as availability of the input, market price, their income status, previous experience with a particular type of fertilizer as well as economic factors such as labour, capital and land (Boateng, 2000). Also some factors run across farmers in different areas while others may change from place to place depending on prevailing conditions (Bonabana-Wabbi, 2002). There are a number of factors that determine whether a farmer would adopt a given technology or not and some of these factors include Government policies towards a technology, technological change, market forces, environmental factors such as nature of the soil and soil fertility, demographic factors such as age and education, institutional factors such as access to information and the mechanisms for delivering the technology (Bonabana-Wabbi, 2002).

However for a given technology, not all the factors may apply in influencing its use, thus a regression analysis is a way of knowing which ones would apply in a particular scenario. These include: Market factors including availability of labour, resource requirements of the technology, size of the farm, farmers' expected profit and the farmers' effort required to apply the said technology. Other factors such as farmer age, social standing of the farmer, farmers' household size, educational level, experience of farmer and the gender of the farmer, membership to farmer based organizations. Management factors like Access to credit and Institutional/ technology delivery mechanism such as the access to information and extension contacts and prior experience with using the technology, environmental health concerns (BonabanaWabbi, 2002).

Factors that influence the adoption of new agriculture technologies in Ethiopia were described to be broadly grouped under Social, Physical and Economic factors (Kebede *et al.* 1990). Significant among the factors that influenced adoption of manure in Kenya were extension contacts, organization membership, size of household, hired labour for application of manure, off farm income (Makokha *et al.* 2001). In a related studies in Kenya, factors such as farmer characteristics, farm characteristics among others determine the adoption of fertilizer and manure by smallholder farmers using a pair of Tobit models for the analysis (Waithaka *et al.*, 2007). Adoption is termed as the acceptance of a technology by a target group (Bonabana-Wabbi, 2002). Based on this, the factors that influence the adoption of integrated pest management in cowpea, sorghum and groundnut cultivation in Uganda using the Probit, Logit and Tobit regression models were fertilizer availability, off-farm income, participation in on-farm trials and farm labour availability (Bonabana-Wabbi, 2002).

Socio-economic, institutional and technical factors were important in influencing improved maize variety adoption in Ethiopia (Degu *et al.* 2000). Regression results indicate that membership of organisation, livestock ownership, educational level and access to credit have significant influences on smallholder farmer's adoption decisions in the country. Livestock ownership was used as a proxy for off-farm income, which is a source of higher income for procurement of inputs (Degu *et al.* 2000). An adoption study on the use of fertilizer on maize and tef in Ethiopia, revealed that, decision to adopt a technology by farmers is influenced by farmers age, credit availability, access to extension services, ownership of livestock and extra income generated from off-farm economic activities (Million, 2001).

In adoption of improved wheat technologies in Tanzania, results indicated that adopters were more educated, younger, had relatively larger family labour, had smaller farm sizes, had more access to credit, had access to more off-farm income, but had fewer years of farming experience (Mussei *et al.* 2001). Also, to explain how improved soil conservation innovations adoption is

affected by various adoption behaviours of smallholder farmers in Tanzania, the research concluded that farmers' decision to adopt is dictated by factors such as socio-economic and institutional ones. These include family labour, farm size, off-farm income, household's educational level, household's economic rank, institutional support (credit), level of extension visits and membership of labour sharing group (Semgalawe, 1998). Relevant factors considered as important in adoption of farm technology are farmer characteristics (age, education, experience in farming and contact with information source) and farm attributes (size and yield) (Lopez and Requena, 2002). Institutional factors (input constraints, extension influence, and credit) and farmer characteristics (including off-farm employment) were major determinants of adoption of coffee production in Kenya according to findings in the research on the coffee sector (Ngatia and Kabara, 1976).

Among factors that influenced the adoption manure in Nigeria were institutional factors (inaccessibility to inorganic fertiliser, extension services, etc) and farmer characteristics such as membership of cooperative society and ownership of livestock (Adejobi and Kormawa, 2002). In determining factors that influence fertilizer adoption in Ethiopia, results were that, off-farm income, availability of labour, availability of credit and being a contact farmer (extension) are significant in fertiliser adoption; while credit, extension and membership of an organisation were found to be determinants of improved maize adoption in Ethiopia (Degu *et al.* 2000). Related studies have also identified farmer characteristics and institutional factors to be associated with adoption (Daberkow and McBride, 1998; Khanna, 2001; Croppenstedt and Demeke, 1996).

Findings from a research in Kenya stated credit and access to manure as the factors that influence adoption of soil fertility management practices (Njagi, 1980). A study on adoption of weed control practices also stated its adoption to be influenced by factors such as labour cost and availability of labour and also financial constraints (Kamau, 1980). This was buttressed by



a study on fertilizer adoption, where institutional factors significantly influence adoption of fertilizer in Malawi (Green and Ng'ong'ola, 1993). Determinants such as size of farm, size of family, income and educational level coupled with variables such as farmers information access influences fertilizer adoption in Ethiopia (Kebede *et al*, 1990).

Perception of an end user for which a technology is meant also defines or determines whether they will adopt that technology (Hooks *et al*. 1983). In adoption studies, inconsistencies exist with regards to the socio-economic variables that influences decisions to adopt and also on the nature of the effect (Ajewole, 2010). To enhance access to fertilizer, they must be available and affordable. Hence availability and affordability of a technology are major factors that must be considered in an adoption studies (Odhiambo and Magandini, 2008).

Econometric models were used to analyse factors that influence the adoption and intensity of use of fertilizer. The results showed that farmers' age, educational level, access to credit among others influence a farmers' probability of adopting fertilizer. Same study also showed that, the most influential explanatory variables that influence intensity of fertilizer use are market distance, gender of farmer, credit availability, availability of extension services and the agro ecological potential of the area (Martey *et al*. 2013).

Studies on agricultural innovation adoption states tenure arrangement, credit constraint, farm size, labor availability, risk exposure and ability to bear the risk, human capital and access to markets for agricultural products as major determinants of innovation adoption (Feder *et al*. 1985). Studies, particularly those done after the year 2000s are replete with expanded lists of factors that influence speed of agricultural technologies adoption. In Malawi, experience of farming, land quality and extension contacts plays important factors in affecting the speed of soil erosion-control technologies adoption (Mangisoni *et al*. 2001). In other adoption studies extension contact, experience in farming, membership of social organizations, access to credit,



primary education attendance and land per capita are significant factors affecting the speed of technology adoption of land and water management by maize farmers in Ghana (Fosu-Mensah *et al.* 2012). Years of farming, farming as a full time job, profitability and mixed farming significantly influence the speed of pest management technology adoption among farmers (Sharma *et al.* 2011).

It is very important in all adoption studies to consider the socio-economic characteristics of the respondents. Also management and institutional factors should be included in the study as well as any other important factor observed within the study area that can have a bearing on the adoption decision of the respondents.

## **2.7 Empirical Applications of Tobit Model in Intensity of Adoption Studies**

To help estimate the factors that influence seed yam use intensity, the tobit model was used in a regression analysis to estimate the influence of various explanatory variables on seed yam use intensity. Overall, the explanatory variables were significant at 1%, whiles gender, farm size, access to credit, labour and annual income significantly influenced farmers intensity of use of seed yam. Availability of seed yam and educational level however had positive relation with intensity of use of seed yam even though they were not significant (Ofori-Kuragu, 2016).

To determine factors that influence the use intensity of inorganic fertilizer, the Tobit model was used in a regression analysis with explanatory variables such as yield, agrochemicals, extension contact, primary education, household size membership of FBO, improved seed, access to credit and age of farmer. After the tobit regression analysis, household size, membership of FBO and use of improved seed significantly influenced the use intensity of inorganic fertilizer. Access to credit and age of farmer had a positive relation with the use intensity of inorganic fertilizer (Salaam, 2016).

A study on 'Effects of Adoption of Nerica Rice on market participation and Income among Rice Farming Households in Northern Region of Ghana' used the Tobit model in addressing its objective of estimating the determinants of intensity of adoption of Nerica rice. The explanatory variables that were included in the tobit regression analysis were age, sex years of schooling, experience, participation in farmer field school, availability of nerica seeds, distance to nearest sales point of nerica, access to credit, extension visit and area cultivated. The results of the Tobit regression analysis showed that, distance to the nearest sales point of nerica, extension contact, participation in farmer field school, access to credit and availability of nerica seed were the significant factors that influenced the intensity of adoption of Nerica (Abdulai, 2014).

In analysing the effect of socio-economics characteristics on adoption level of cassava improved production technology, the Tobit model was used in a regression analysis to determine the socio-economic characteristics that influence adoption level. The significant characteristics that influence adoption level were level of education, off-farm income, distance to market, land cultivated, and access to credit, yield and land cultivated (Obisesan, 2014).

In her study on fertilizer use by farmers, the Tobit regression model was used in determining factors that influence total fertilizer use intensity. The explanatory variables that were used are gender, age, household size, extension contact, years of formal education, off-farm income, land ownership status and rent paid for land use. The significant variables that influenced total fertilizer use intensity were age, extension contact, off-farm income and rent paid for land use (Asare, 2013).

In estimating the intensity of adoption of organic cocoa, the Tobit model was used in a regression analysis to determine the explanatory variables that influence the intensity of adoption of organic cocoa. Factors that were significant in influencing intensity of adoption of

organic cocoa were household size, premium on organic cocoa, output from conventional cocoa and adoption index (Glover, 2010).

In analysing the factors that influence farmers' adoption of fertilizer in production of cereal, the Tobit model was used in the analysis. Sixteen independent variables was used in the model and the results showed that, education, extension services, area under improved seed, total livestock owned, access to input credit, number of active family labour, access to hired labour and gender were the variables that positively influence the probability of fertilizer adoption and its intensity of use (Techane, 2002). Other factors such as illness of the household head, off-farm employment and ratio of steep slope land to total cultivated land were negatively significant. Other factors that proved to influence the probability of adoption and intensity of fertilizer use were regional differentials (this gives further elaboration to the fact that households operate under different natural conditions, different input supply system, and vary in their accessibility to infrastructure that would facilitate the adoption of fertilizers).

Studies on factors that influence farmer's decision to adopt improved rice varieties and their intensity of its use, outcome showed that, characteristics of farmers coupled with farmers perception of technology-specific factors influence their decision to adopt improved rice varieties and intensity of its use. The study used the Tobit regression analysis in its analysis, the research recommendations at the backdrop of the results went on to suggest that, farmers must play a key role in making input in the rice breeding program. 400 respondents were considered from the casamance area of Senegal during the research (Sall *et al.* 2000).

The tobit model helped in analysing the data on land enhancing technology adoption in Niger. The tobit model offers a good background to studies on adoption and intensity of use of an innovation or practice. The explanatory variables that were significant were farmers' access to extension education, lower risk aversion, an increased percentage of degraded farmland and

short-term profit availability to farmers. The study went on to reveal that for the tassa and half-crescent shaped earthen mounds to be adopted effectively it must be introduced in areas where most farmlands are highly degraded. Because age was not significant, policy recommendation had it that during implementation of the technology there should be no special attention on age brackets (Baidu-Forson, 1999).

In an agricultural technology adoption study in Sierra Leone where the tobit model was used for the regression analysis, the findings showed that not paying attention to evaluations of farmers' attributes of various technology may negatively influence farmers' adoption decision of technologies. It further showed that, the main factor influencing farmers' adoption and intensity of use of the varieties of technologies is farmer's perception (Adesina and Zinnah, 1993).

The tobit model was used for the analysis of data in an intensity of adoption study on chicken pea in India. Some of the dependent variables that were significant in influencing intensity of adoption were size of farm, risk in yield to be harvested, experience of farmers and the period crop takes to mature and be ready for harvest. The impact of the dependent variables on adoption translated to farmers obtaining better income from their farm as compared to previous, much productivity was also realized from labour, farmers had enough surplus to sell out, farmers had price premium and the prices of farmers' goods became stabilized throughout the season even in periods of bad weather. The tobit model sufficiently helped in addressing the problem of measuring probability of adoption and also went on to satisfy the determination of variables that influence the intensity of adoption (Shiyani, 2002).

In an adoption study in Burkina Faso and Guinea, the tobit model again was used in the analysis. This study analysed factors that influence farmers' perception to choose a particular agricultural technology. This research came at the backdrop of several research findings that

sought to say that perception of individuals about a certain innovation or technology greatly influence their agreement to use it. The research findings corroborated the hypothesis and previous views on the impact of perception on adoption. The hypothesis was tested with four different technologies and it proved that perception really influences individuals (farmers) probability and intensity of adopting a particular innovation and technology. This comes to add up to the already existing literature of traditionally known variables that influence farmers' technology adoption (Adesina and Baidu-Forson, 1995).

From the above reviewed literature it is conspicuous that the Tobit model is the most suitable means of analysing the proportion of adoption and intensity of use of a particular technology.

## **2.8 Partial Budget Analysis**

Partial budget is a decision-making tool which helps to study incremental changes in a farm business (Forster and Erven, 1981). Unlike enterprise budget and a whole farm budget, partial budget does not include all cost involved in an enterprise operation. It is hence much simpler in computation as compared to a whole or enterprise farm budget. The partial budget takes into factor the cost and revenues that will be affected if there is a change in farm technology. It hence makes room for the advantages and disadvantages that come with the introduction of the new technology (Powers, 2002). The partial budget analyses informs the farm manager as to whether the new technology is better than the old in terms of its cost and benefit (Powers, 2002). The partial budget can be used as a method to evaluate the economic consequences of adjustments in a farming business (Rymbai *et al.* 2017).

Partial budget can be used in various farm level decisions. It can influence decisions such as changing ones enterprise, technology change, hiring workers, leasing instead of buying a machine, modifying production practices and choosing to specialize in a particular production (Roth, 2002). In a partial budget preparation you need to take note of very important items such as; the proposed change in technology, the added returns, reduced cost, added cost, reduced



returns, net effects and finally the non-economic factors such as social aspect of having less labour (Roth, 2002).

The partial budget was used in assessing the costs and benefits associated with specific technological changes in sorghum farms in Egypt. Different levels of nitrogen fertilizer were being tried to know their cost and benefit in the study where the research was interested in the effect of the various technological changes on net benefit of production. The partial budget helped to distinguish between the three treatments on the level of cost and benefit (Soha, 2014).

The partial budget analysis helped in estimating the net gains of using organic resources as fertility enhancing material in place of inorganic fertilizer in vegetable production in Accra. However unlike this study, organic fertilizer realized a net gain in the aforementioned study. This can be attributed to the fact that the aforementioned study included more variables in its transaction cost of using inorganic fertilizer as compared to organic fertilizer. Some of these variables are communication cost (Phone calls and SMS), cost of searching for information about inorganic fertilizer on the internet, bargaining cost etc. all of which were not available in the ORM4SOIL data (Lavison, 2013).

A proposed change in technology may results in an additional income for the farmer, especially if this leads to an increase in output. So, if organic fertilizer is being used to replace inorganic fertilizer, the income generated as a result of using the organic fertilizer is an added income (Roth, 2002 and Rymbai *et al*, 2017).

This consist of any new cost that comes with the use of the new technology. This covers all fixed and variable cost involved in the new technology of the enterprise. Example; cost of seed, depreciation, rent, hired labour, repairs, taxes etc (Roth, 2002 and Rymbai *et al*, 2017).



If organic fertilizer is replacing inorganic fertilizer in an enterprise, then the cost associated with not using inorganic fertilizer in this case is the reduced cost. This also covers both variable and fixed cost of operation in the enterprise (Roth, 2002 and Rymbai *et al*, 2017).

Changes in farm technology may result in reduction in farm income because of changes in production practices. So if an individual decide to reduce or stop using inorganic fertilizer and resort to the use of organic fertilizer. The reduction in income as a result of this change will be calculated and recorded on the partial budget table (Roth, 2002 and Rymbai *et al*, 2017).

Net returns is the outcome of subtracting the cost elements from the benefit as a result of change in a technology of an enterprise (CIMMYT, 1988). This serves as a justification for the farm owner/enterprise to make decision on the suitability of the new technology. Because every business person wants a gain at the end of operations and from the economic assumption of rationality every businessman will need the outcome of his or her net returns to make a decision in the enterprise (Koutsoyiannis, 2005).

Break-even analysis is used as a decision tool after a partial budget is analysed. It calculates the minimum level of output or input to justify production (Tsorakidis *et al*. 2011). The break-even analysis uses the break-even point to inform the business owner, in this case the pepper farmer who uses matured cow dung, on the minimum quantity of production that keeps him or her at a break-even point or zero profit level (Steenburgh and Avery, 2016). The outcome informs the farmer on the minimum production level required to cover the specified cost at the expected selling price (Powers, 2002).

## **2.9 Constraints Associated with the Use of Local Organic Resource in Crop Production**

Study on adoption of organic fertilizer identified the most pressing constraint associated with organic fertilizer use as the bulky nature of the fertilizer, followed by difficulty in transportation, offensive odour, slow acting, and doubtful efficacy. The other constraints included, the need for more storage space as a result of its bulkiness, need for drying, health

risks such as blocked sinuses and headaches brought on by the offensive smell, among others (Lavison, 2013).

Another study on organic fertilizer use in Nigeria, identified constraints such as bulkiness, offensive odour, slow acting, difficulty to transport and doubtful efficacy about the use of organic fertilizer in crop production (Alima *et al.* 2006).

The Participatory Rural Appraisal for the ORM4SOIL Project identified a number of constraints dealt with as a result of farmers using local organic resources for farming. Among them are the high cost of local organic resources, the difficult task of transporting from long distances to the community and the associated foul smell of the organic resources (Mutala *et al.* 2016).

From literature it can be concluded that the constraints that come with the use of organic fertilizer are its high cost, difficulty of transport, foul smell, slow acting and its bulkiness among others.

## **2.10 Summary of Literature Review**

Factors that influence adoption of agricultural technologies can broadly be captured under social, economic and physical factors. Some other factors are policy of the Government towards the technology, market forces, environmental forces such as soil nature and its fertility status, demographic factors, access to information and also the mechanism through which the technology is been introduced or delivered to the people. In same stead, research work on adoption decisions that affect farmer's use of fertilizer and manure said, the factors that influence farmer's adoption decision are broadly under the influence of farmer and farm characteristics. Inference from these previous studies and others captured in the literature review helped in categorizing the variables that influence the adoption of local organic resources in crop production used in this study under Socio-economics, resource characteristics, Institutional factors and fourthly other factors which captured variables such as

access to information and farmers perception of fertility of the land. Learning from the above literature, this study applies this knowledge in a different study area which is semi- arid in nature and with its focus solely on smallholder farmers' use of local organic resources in improving soil fertility.

Partial Budget (Net returns) and Break-even analysis are decision making tools that enterprises use in assessing their resolution to move from the use of one technology to another. Partial budget uses added income, added cost, reduced cost and reduced income to calculate the net returns for a farmer to make an informed decision in times of a technology change. The Break-even analysis on the other hand uses the selected cost (Fixed and Variable) and selling price to calculate the break-even point (yield). This helps to inform the farmer on the minimum production level required to cover the specified cost at an expected selling price. This study draws relevant information from this two decision making tools to reach a conclusion in the study.

On the choice of model to use for a study that involves both factors that influence adoption and Intensity of adoption, relevant literature on intensity of adoption of agricultural technologies cited, who all used the Tobit model in analysis served as a guidance. The inference from the available literature provided guidance to this study in the use of the Tobit model in determining the factors that influence the adoption and intensity of use of local organic resources in crop production. The study follows similar analogy but applies it in a different study area in Ghana (Ada West District) on farmer's probability of adoption and intensity of use of local organic resources in crop production.

Previous studies on organic fertilizer provided literature on constraints that come with organic material use for soil fertility improvement. Some of these constrains are its; Bulkiness, transportation difficulty, inadequacy, cost, labour intensive and lack of required tools to use for

handling animal manure for use. This study focused on the response farmers gave on these constraints across the Ada West District.



## CHAPTER THREE

### METHODOLOGY

#### 3.1 Introduction

This chapter gives a detailed explanation to the theoretical framework of the study and the methods adopted to ensure the objectives of the study are met. It provides information on tools and ideas used for the collection and analyses of the data. The chapter hence provides information on the methods of analysis of the objectives of estimating the proportion of crop farmers using local organic resources in soil fertility improvement. It also presents the methodology on determining the intensity of use of local organic resources in soil fertility improvement by crop farmers. The chapter presents the methodology used in analysing the factors that influence the intensity of adoption of local organic resources in soil fertility improvement by crop farmers. The methodology for estimating the cost and benefit of using local organic resources in soil fertility improvement by crop farmers is also captured. Finally chapter three presents the methodology adopted in analysing the constraints of crop farmers in using local organic resources in soil fertility improvement.

#### 3.2 Theoretical Framework

Farmer's adoption of a particular technology is a deliberate effort and some of the factors that influence this are accessibility and cost (Ajzen, 1985). This brings forth the relevance of adoption theories in agricultural research. Economic models have been found to concentrate more on interest and profit maximization and they give minimal explanation to the action of farmers and how they make various decisions (Ndah *et al.* 2010). Another shortfall of economic models in agricultural research is that, they fail to conceptualize the social aspect of knowledge, communication, information or even the rationality of farmers in decision making (Ndah *et al.* 2010). Adoption theories hence satisfy the shortfalls of economic theories in agricultural research.

In the adoption of a technology, farmers can be described not only as producers but also consumers (Ulimwengu & Sanyal, 2011). On the production side, farmers combine resources such as land and agro-inputs to produce an output. They are also consuming resources, such as agrochemicals and seeds to produce the final output. This means that farmers can best fit into the theory of farm households where farmers make critical decisions as a result of the complex interrelation between production and consumption (Findeis, 2002). As such, farmers do not only make decisions on the adoption of technologies based solely on profit maximization but also on their being able to achieve the highest level of utility (McConnell, Brue, & Flynn, 2009; Sadoulet, Janvry, & Benjamin, 1996). The decision to adopt agricultural technologies given the utility maximization problem is influenced by factors that are explained by the innovation-diffusion model, economic constraint model as well as the user's perception model, which this study follows.

The innovation-diffusion model opines that a farmers' decision to adopt a technology is dependent on the farmers' level of information on the technology and that the higher the understanding of the farmer about the advantages and consequences of the technology, the better the farmer can make an informed choice (Rogers, 2003).

Rogers defines diffusion as a process through which information is passed through channels among members of a social system (Rogers, 2003). Before a technology will be adopted by a farmer, the right communication channels that allow effective exchange of information within a planned space of time from the source and the target population should be used (Sahin, 2006). Channels such as extension, on-farm trials and field demonstrations should be used to expose farmers to help reduce the level of uncertainty and doubt on the decision to adopt local organic resources in soil fertility improvement. In this regard, variables that have been used by many researchers in technology adoption studies include level of education, extension contact as well



as membership in Farmer Based Organizations (Feder, Just, & Zilberman, 1985; Ulimwengu and Sanyal, 2011).

According to the economic constraint model, the distribution of economic resources determines the patterns of adoption. It is argued that though different people might have been informed about a particular technology, not all people will adopt or the intensity of adoption will vary across groups as a result of access to economic resources such as land, labour and credit (Tesema, 2006). Such variables have been infused in many research works as variables that influence adoption of agricultural technologies (Doss and Morris, 2001). They put it that women adopt high yielding varieties and improved technologies at low rates than male farmers. This is somehow related to the fact that women have lower access to economic resources compared to men hence, are not able to access the needed resources to adopt the technology.

The user's perception model reveals that the perception of farmers in relation to a technology influences their level of adoption (Tesema, 2006). According to Adesina and Baidu-Forson (1995), the perceptions of farmers influence the adoption of technologies. It is possible an earlier technology they adopted did not prove worthwhile and as such future introduction to new technology could be met with stiff opposition or reduced adoption.

### **3.3 Methods of Analysis**

#### **3.3.1 Estimating the Proportion of Crop Farmers Using Local Organic Resources for Soil Fertility Improvement**

This objective was achieved by asking respondents of the type of materials they use to support the fertility of their soil. To show the various proportional distributions of resources farmers use for soil fertility improvement, with concentration on local organic resources most importantly, the proportion of crop farmers using local organic resources for soil fertility improvement is computed as follows:

$$P = \frac{N}{T} * 100$$

Where;

P = Proportion of crop farmers using a particular local organic resource for soil fertility improvement.

N= Number of respondents (farmers) who use a particular local organic resources in soil fertility improvement.

T= Total number of farmers interviewed.

SPSS statistics 22 was used for the analysis

The computed proportions from the respondents was then analysed using descriptive statistics such as frequency tables and bar charts.

### **3.3.2 Determining the Intensity of Use of Local Organic Resources for Soil Fertility Improvement**

This objective is to help ascertain the level of application of the local organic resource after it has been adopted by a farmer for soil fertility improvement. This refers to the total land area of farmland committed to the use of local organic resource out of the total farmland used by the farmer for farming purposes. The method used for the calculation is similar to that of the acceptability index proposed by Waugh (1982) and cited in Engmann (1993) where Y represents the proportion of the area under the new practice, which then gives an estimate of use intensity. The index is computed as the percentage of identified farmers using the innovation multiplied by the percentage of land area being used for the technology (Engmann (1993). For this study, the Level of intensity of use  $Q_i = L_s/L_t$

Where  $L_s$ = area of farm land committed to the use of local organic resources

$L_t$ = Total space of farm land actually used for farming.

Using the designed questionnaire, information was gathered from farmers on available farm land size in all and also portion of total farm land size committed to the application of each

material adopted as local organic resource for soil fertility improvement.. Information from this was used for the calculation. The magnitude in these were described.

### **3.3.3 Analysing the Factors that Influence the Intensity of Adoption of Local Organic Resources for Soil Fertility Improvement in Crop Production**

#### **3.3.3.1 Theoretical Background**

The appropriate econometric model adopted for the above objective is the tobit model. The tobit model was used to describe the determinants of adoption and intensity of use of local organic resources for soil fertility improvement by the crop farmers. The factors influencing adoption and the intensity of use of local organic resources were obtained by analysing their impact on the proportion or extent of farm land size committed to local organic resources use. The proportion of land size committed to the use of local organic resource has a censored distribution; this is because it will be zero for those not adopting local organic resources for their soil fertility improvement (referred to as non-adopters). This makes it obvious that, OLS regression will not be sufficient for the attainment of this objective but Tobit model is the most appropriate (Tobin, 1958). Tobit model has been widely adopted for similar studies and its advantage is that it measures both probability and intensity of Adoption (Adesina and Zinnah, 1993).

The function for the tobit model is given as:

Level of intensity ( $Q_i$ ) = f(Socio-economic factors, organic resource material characteristics, Institutional factors).

The assumption used for examining the influence of the independent variables on the adoption and intensity of use of the local organic resources is that the latter decision is taken together and at same time (Chukwuji and Ogisi, 2006) and is represented as follows:

Level of intensity ( $Q_1$ ) =  $\beta_0 + \beta_1 \text{HHLABSIZ} + \dots + \beta_2 \text{OFFINC} + \beta_3 \text{GENDER} + \beta_4 \text{FMEXP} + \beta_5 \text{EXP\_2} + \beta_6 \text{PRIMATT} + \beta_7 \text{SECATT} + \beta_8 \text{EXPENSIV} + \beta_9 \text{NONAVAIL} + \beta_{10} \text{RENTLAND} +$

$$\beta_{11} \text{INSUFAN} + \beta_{12} \text{LACKEQ} + \beta_{13} \text{LABINT} + \beta_{14} \text{ACCEXT} + \beta_{15} \text{ACCREDIT} + \beta_{16} \text{MEMFMG} + \beta_{17} \text{F\_LHOLD} + \beta_{18} \text{PESOFET} + \beta_{19} \text{VEHICLE} + \beta_{20} \text{ACINFO} + \beta_{21} \text{CONFINV} + \beta_{22} \text{FMLAND} + \beta_{23} \text{OTHERFMS} + U$$

The signs of the Tobit coefficients shows the effect of the change brought as a result of the signals shown by the probability of adoption changes and the marginal intensity of adoption changes, this were caused by the various changes in the independent variables (Amemiya, 1985; Maddala, 1986; Goodwin, 1992). This brought up the introduction of model of McDonald and Mofit developed in 1980 to help in the interpretation of the outcomes of the regression analysis.

From the model expression it can be deduced that the expression  $\frac{\partial E(Q_i)}{\partial X} = f(Z)\beta$  represents the marginal effect of the independent variables on the expected value of dependent variables.

Also, the change in the probability of adopting a technology as explanatory variable changes

$$\text{is: } \frac{\partial F(Z)}{\partial X} = f(Z) \frac{\beta}{\sigma}$$

And, the change in intensity of adoption as a result of a change in an independent variable

$$\text{among adopters is: } \frac{\partial E(Q_i/Q_i > 0)}{\partial X} = \beta \frac{1 - Z \frac{f(Z)}{F(Z)}}{F(Z)} - \left( \frac{f(Z)}{F(Z)} \right)^2$$

### 3.3.3.2 Detailed Description of Explanatory Variables

**Active labor ratio in the household:** This seeks to show the active household labour numerical strength. This will help us to know the available work hands in the household. Concentration here is on the working age group above 18 years that provide labor on the household farm. It is hypothesised here that those with higher ratio will positively impact the intensity and use of local organic resources on the farm in terms of relationship.

**Off-farm income:** The availability of funds affects the purchase of items by a farmer. Therefore farmers who are engaged in extra income activities or have other sources of income are better positioned financially to use more local organic resources so this will have positive impact in terms of relationship on intensity and use of local organic resources. Braun et al.

(1991) in a similar study grouped the variable into dummies and observed that farmers with higher proportions of off-farming income in total income were encouraged to purchase inputs required for application of the innovation in Rwanda. So 1 represented farmers who had higher proportions of income outside proceeds of farming (above 50%) and 0 represented otherwise.

**Perception on Soil Fertility:** This was measured based on the perception of the farmer on the fertility of his farmland. This was based on the idea that after the farmer has continuously tilled the land for some years they should be able to develop a perception about how fertile or otherwise the soil is. This hence is not based on a scientific test by the farmer but perception. This was then dummied whereby, a perceived land with soil fertility problem is 1 and a land without soil fertility problem is 0. A farmer who perceives his or her land not to be fertile has a higher tendency of using local organic resources and his intensity of use should be more.

**Membership of Farmers Association:** Farmer based organizations are mostly receptive to innovations and tend to accept new ideas. The participation or membership of a farmer-based organization has the tendency of positively influencing him or her to use local organic resources in soil fertility improvement. This variable was also dummied, 1 for farmers belonging to farmer-based organizations or groups and 0 for farmers who do not belong to farmer-based organization or groups with such objectives.

**Farmer's working experience:** This describes the farmer's accumulated experience over the years in crop production. The a priori expectation was that this will have a positive relation with a farmer's use of local organic resources since he or she will be better informed after several years of practical exposure to various fertility enhancing methods. This was measured by the farmer's number of years in crop production.

**Access to credit:** Crop farmers who have obtained loan or credit facility are in a better financial position as compared to the ones who did not obtain loans. Crop farming is capital intensive especially at the initial stages where farmers need to clear their lands, plough and pay for all

labor-oriented works. A farmer who has benefited from a loan facility will be in a better position to purchase local organic resources than a farmer who has not benefited from such. Therefore, access to credit is hypothesized to have a positive relationship with a crop farmer using local organic resources. Dummied as Yes to access to loan=1 and no access to loan=0

**Farmer's access to information on Soil Fertility Management:** This variable is to ascertain if the farmer has access to information on soil fertility from sources such as family, neighbors and friends, other farmers, opinion leaders in farming, extension officers, research institutes, agro dealers and trader's buyer's cooperatives. Each of the categories is measured independently as a dummy, 1 representing Yes responds and 0 a No responds.

#### **Gender of Farmer**

Gender of farmer was considered either male or female. This was dummied, 1=male and 0=Female. Because dealing with local organic resources is a little bit difficult, men were perceived to use it more than women.

#### **Cost of local organic resource (Expensive)**

This variable describes whether the farmer perceive the price of the local organic resource to be expensive. This is a view of the farmer relative to his financial status and his income level. It was dummied. 1=Yes it is expensive, 0=No it is not expensive. The expectation here is that farmers who see the to be expensive will not adopt or their intensity of use will be relatively low

#### **Non-availability of animal manure**

This is to know if the animal manure is readily available to the farmers to access or there are restrictions to attaining it and some difficulties in accessing it both within their locality and extended to the whole of the District. This was dummied. Yes it is not available=1 and No it is available=0. If the animal manure is not readily available and they would have to struggle to obtain it, this will affect the intensity of use to be lower than expected.



### **Vehicle**

This variable describes farmer's difficulty in accessing transport or transporting the local organic resource from one place in his community to his or her farm. This place a crucial role in farmer's use of local resources because farmers that find it difficult will either not use it or will use it but the intensity will be low. This was dummied. Farmers who have transport difficulty (Yes=1) and farmers who do not have transport difficulty (No=0).

### **Inadequacy of animal manure**

This variable describes whether one of the commonest local organic resource in the district which is matured cow dung is obtained in sufficient quantity by a farmer as and when he wants it. This can affect negatively the intensity of adoption because a farmer who does not have it in the right quantity will use it lesser. This was dummied. Yes it is inadequate= 1 and No it is not inadequate=0.

### **Lack of equipment**

This variable describes farmer's lack of access or ownership of machinery and equipment that will further enhance his or her handling of local organic resources. It was dummied. Yes (farmer lacks equipment) =1 and No (Farmer does not lack equipment)=0. This was from the taught that farmers who lack this equipment will have a low intensity of adaption.

### **Labour intensive**

This variable describes how a farmer perceive using local organic resources in crop fertility improvement. Farmers who perceive it to be labour intensive are likely to use it less intensively as compared to those who do not. This was dummied. If a farmer perceive it to be labour intensive (Yes=1) and not labour intensive (No=0)

### **Access to Extension**

This is to ascertain if the farmer had any interaction with an extension agent that influenced his use of the local organic resource in soil fertility improvement. Because extension officers have

much influence on smallholder farmers, it is expected that farmers who have that interaction with extension officers will adopt and use local organic resources more in improving soil fertility if they were introduced to it. This was dummied. Yes I have interaction with extension officers on this subject matter=1 and No I had no interaction with an extension officer on this subject matter= 0.

### **Confidence to Invest**

This variable was to know whether the farmer has that confidence to invest a substantial amount of labor or capital in the land he or she is using currently. Making reference to activities such as fallowing, agroforestry and spending on local organic resources. This was dummied. Yes (farmer has that confidence) = 1 and No (farmer does not have that confidence)=0

### **Primary Education**

A wide number of farmers had primary education. This variable was selected to help ascertain the influence of a farmer being exposed to that level of education on his or her adoption of local organic resource. This variable was dummied. Yes (farmer had primary education)=1 and No (Farmer does not have primary education)= 0.

### **Secondary Education**

A number of farmers also had secondary education hence this variable sought to help ascertain the influence of secondary education on farmers' adoption of local organic resources. This variable was dummied. Yes (farmer had secondary education) =1 and No (Farmer does not have secondary education) = 0.

### **Family Land**

Farmers' access to land influences a lot of technological decisions a farmer takes in farming. A farmer having access to a family land is a very common practice in the Ada West district. It is anticipated that those with these lands can adopt the use of local organic resources. The

variable was dummied. Yes (farmer uses family land)=1 and No ( farmer does not use family land)= 0.

### **Freehold Land**

The same principle from family land is applied here and the variable was dummied for the regression analysis. Yes (farmer uses freehold land)=1 and No ( farmer does not use freehold land)= 0.

### **Rented land**

Farmers have a lower tendency of adopting technologies that have longer term effect on their soil when a land does not belong to them, since their objective will be to obtain their maximum benefit from that land for the given period of ownership. This variable was also dummied. Yes (farmer uses rented land)=1 and No ( farmer does not use rented land)= 0.

### **Other famers influence**

Farmers do influence each other a lot in technology adoption especially when the technology is paying off. Most farmers after observing a technology is working for their neighboring farmer try to learn from them. This variable sought to describe whether a farmer using local organic resources for fertility improvement was influenced by colleague farmers. This was dummied. Yes =1 and No=0.



**Table 3.1: Description of Variables Used in the Tobit Model and their Expected signs**

Dependent variable: Intensity of use of animal manure/matured cow dung

| Variables | Definition                        | Description of Variable                                                                                                | Expected Sign |
|-----------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------|
| HHLABSIZ  | Active Household Labor Ratio      | Describes ratio of household workforce on the farm                                                                     | +             |
| OFFINC    | Off -farm Income                  | Proportion of farmers income obtained from non-farming activities                                                      | +             |
| PESOFET   | Perception on Soil Fertility      | This describes a farmer's perception about the fertility of his or her soil. Dummy( fertile=0, Not fertile=1)          | +             |
| RENTLAND  | Farmer using rented land          | This describes whether a farmer rented his farm land or not. Dummy ( Yes=1, No=0)                                      | -             |
| FMLAND    | Ownership of family land          | This describes whether a farmer uses a family land or not. Dummy ( Yes=1, No=0)                                        | +             |
| F_LHOLD   | Freehold of Land                  | This describes whether farmer owns land by himself. Dummy ( Yes=1, No=0)                                               | +             |
| MEMFMG    | Membership of Farmers Association | Describes farmers' involvement in any farmer based group that gives them education on this issues. Dummy (Yes=1, No=0) | +             |
| ACCINF    | Farmers access to information on  | Describes if farmer has any access to information from a number of stated sources. Dummy(Yes=1, No=0)                  | +             |

|          |                                                        |                                                                                                                       |   |
|----------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---|
| PRIMATT  | soil fertility management<br>Primary School Attendance | Describes whether farmer had primary education. Dummy(Yes=1, No=0)                                                    | + |
| FMEXP    | Farmer's working experience                            | Describes farmers number of years in crop production and experience accumulated(Continuous)                           | + |
| SECATT   | Secondary School Attendance                            | Describes whether farmer had secondary education. Dummy(Yes=1, No=0)                                                  | + |
| ACCREDIT | Access to credit                                       | Whether farmer has benefited from a credit facility. Dummy (Yes=1 and No=0)                                           | + |
| GENDER   | Sex of farmer                                          | Whether farmer is male or female. Dummied(Male=1, female=0)                                                           | + |
| EXPENSIV | Cost of local organic resources                        | Whether farmers perceive the cost of organic materials to be expensive. Dummied(Yes Expensive=1, No, not expensive=0) | - |
| NONAVAIL | Non availability of animal manure                      | Whether animal manure is not available. Dummied Yes, not available=1,No, available=0                                  | + |
|          |                                                        | Whether it is difficult for farmer to transport organic                                                               |   |

|          |                                                  |                                                                                                          |   |
|----------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------|---|
| VEHICLE  | Difficulty in transportation of organic resource | to his farm. Dummied(Yes=1,N0=0)                                                                         | - |
| INSUFAN  | Inadequacy of animal manure                      | Whether farmers have access to adequate animal manure to use Dummied. Not available=1 , available=0)     | + |
| LACKEQ   | Lack of equipment                                | Whether farmer lacks equipment to help him handle cow dung easily. Dummied. Yes lack=1, No does' lack=0) | + |
| LABINT   | Labor intensiveness of handling animal manure    | Whether it is labor intensive in handling animal manure. Dummied (Yes=1, No=0)                           | - |
| ACCEXT   | Access to extension                              | Whether farmer has access to extension education on the use of organic resource. Dummied(Yes=1, No=0)    | + |
| CONFINV  | Confidence to invest in farm activities          | Whether farmer has confidence to invest in resources of his farm                                         | + |
| OTHERFMS | Other farmers influence                          | Whether farmers use of organic resource was influenced by other farmers. Dummied (Yes=1, No=0)           | + |



### Testing of Hypotheses

The hypotheses tested are,

Ho: Farmer's Access to Information on soil fertility management has no effect on the intensity and use of local organic resource.

Ha (1): Farmer's Access to Information on soil fertility management has positive effect on the intensity of use of local organic resources.

Ho: Cost has no effect on the intensity of use of local organic material

Ha (2): Cost has negative effect on the intensity of use of local organic resources.

**NB:**

Ha (1), is for explanatory variables with positive a prior expectations and Ha (2), is for explanatory variables with negative a prior expectations.

Where Ho is the null and Ha is the alternative hypotheses.

This is repeated for the rest of the explanatory variables that have positive a prior expectations like, farmers perception of the fertility of their soils, Educational level, Age, membership of a farmer based organization or network, Farm Size, Knowledge of the practice of Soil Fertility Management, Off-farm income, Access to credit, farmers experience, Perception on soil fertility, Active labour ratio in the household and the ones with negative a prior expectation like land tenure, labour intensive and difficulty in transportation.

### Hypotheses Validation

The Z- statistics is used to measure the level of significance of the estimated coefficient, where

$$Z \text{ calculated} = \beta_i / SE(\beta_i)$$

If the  $Z \text{ calculated} > Z \text{ critical}$ , the null hypothesis is rejected.

The goodness of fit statistic was estimated using the Mc-Fadden R-Squared. The likelihood ratio (LR) test is used to determine the joint significance of the explanatory variables in the model.

### **3.3.4 Estimating the Cost and Benefit of Using Local Organic Resources in Improving Soil Fertility in Crop Production**

#### **3.3.4.1 Partial Budget**

The under-listed components were considered during the partial budgeting;

##### **Revenue**

The revenue is computed by multiplying the quantity of produce obtained under a hectare of land using matured cow dung and inorganic fertilizer and the average farm gate price of the produce as reported by the farmers.

##### **Labour Cost**

Labour is engaged in the use of both matured cow dung and inorganic fertilizer in soil fertility enhancement, hence all labour and transport cost are factored in here. Total Labour days and cost of hiring a unit of labour is used in the calculation.

##### **Cost of Matured Cow Dung and Inorganic Fertilizer**

To measure the cost of the two resources used in soil fertility enhancement, the average amount of matured cow dung and inorganic fertilizer used by a farmer on a hectare of land and the average cost involved in purchasing it is used.

##### **Other Cost**

This cost involves the cost of fighting pest and other diseases that arise during the period of farming. Depreciation value of the equipment used and the transaction cost associated are also included in the calculation.

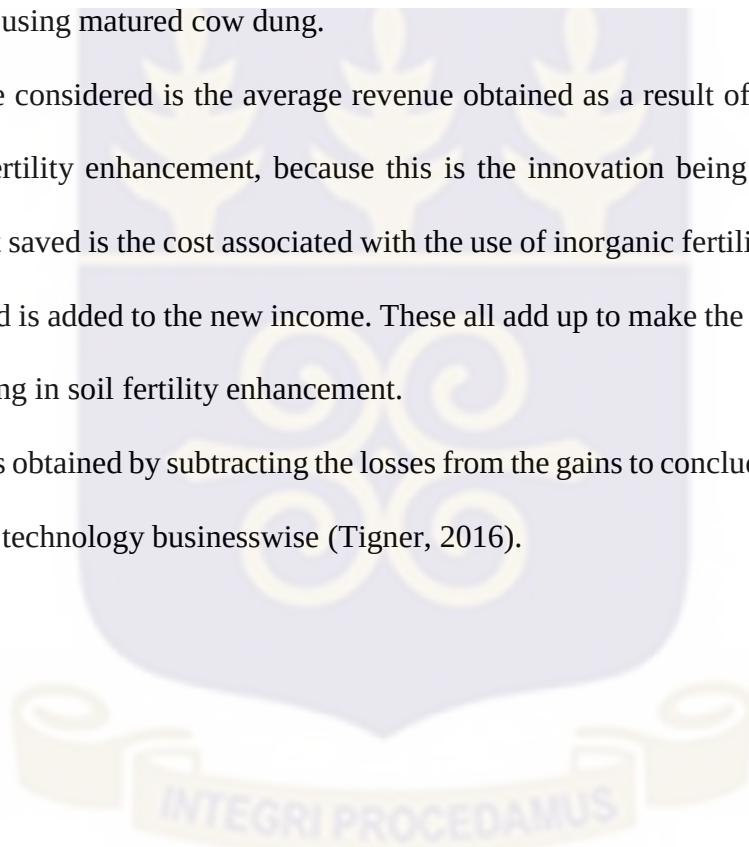
#### **3.3.4.2 Procedure for Preparing the Partial Budget**

The gains considered here consist of the income obtained from using the matured cow dung and the cost that is related to the farmer not using inorganic fertilizer rather. The income loss in this calculation is the revenue a farmer would have obtained if he or she used the inorganic fertilizer. The average total revenue from farmer's proceeds from the pepper farm was used. A standard one acre pepper farm produces 8bags (16kg per bag) of pepper.

The new cost consist of cost of matured cow dung, transportation cost, labour cost, cost of application equipment. This is then added to the income loss figure and that of the transaction cost involved in using matured cow dung.

The new income considered is the average revenue obtained as a result of using the matured cow dung for fertility enhancement, because this is the innovation being encouraged in the district. The cost saved is the cost associated with the use of inorganic fertilizer for soil fertility enhancement and is added to the new income. These all add up to make the total gains of using matured cow dung in soil fertility enhancement.

The net returns is obtained by subtracting the losses from the gains to conclude on the suitability of the change in technology businesswise (Tigner, 2016).



**Table 3.2: Partial Budget Analysis for the Use of Matured Cow Dung as Soil Fertility Enhancing Material in Replacement of Inorganic Fertilizer**

Table 3.2 presents the format that is used for the calculation

| <b>COST</b>                  | <b>BENEFIT</b>               |
|------------------------------|------------------------------|
| REVENUE LOST                 | NEW REVENUE                  |
| NEW COST                     | COST SAVED                   |
| NET GAIN (IF GAINS > LOSSES) | NET LOSS (IF LOSSES > GAINS) |

### 3.3.4.3 Break-Even Analysis

Break-Even analysis is used to determine the minimum level of sales that will ensure the business does not run at a loss. It helps the business to know how to remain profitable in phases of varying conditions and helps to determine the economic feasibility of a new business (Tsorakidis *et al.* 2011). The break-even analysis uses the break-even point to calculate figures to help inform a business of the right quantity and selling price to operate at in order to remain profitable.

#### 3.3.4.3.1 Break-Even Point

In break-even analysis, the break-even point is when the businesses total revenue is equal to total cost of production. This point helps a business to determine the least quantity of goods to produce to break-even or make zero profit (Steenburgh and Avery, 2016). After the partial budget analysis, the study uses the break-even analysis to determine the quantity of yield and selling price that will help the smallholder farmers using matured cow dung to improve soil fertility operate at a break-even or zero profit level. The break-even point is calculated as;

$$BP = \frac{FC}{P - VC}$$

Where BP = Break-Even point

FC= Average annual fixed cost of production of pepper farmers that use matured cow dung.

P = Average per unit selling price of pepper of a farmer that uses matured cow dung

VC = Average per unit variable cost of production of pepper of a farmer that use Matured cow dung.

**NB**

$P - VC = \text{Contribution Margin (CM)}$

The CM shows the amount that each additional product, in this case bag of pepper will add to profit.

### **3.3.5 Constraints of Using Local Organic Resources**

The use of local organic resources by crop farmers will definitely come with several challenges and setbacks. Drawing from experience on the field during the Participatory Rural Appraisal of the ORM4SOIL project in the University of Ghana, some challenges common to the use of local organic resources were identified, among them were, its labor intensiveness, transportation difficulty (bulkiness, weight problem), inadequate or non-availability of animal manure, lack of machinery/equipment to use and high cost of animal manure. These challenges will be analyzed with the help of descriptive statistics such as bar charts in order to display the responses of the farmers on these challenges.

### **3.4 Data Collection**

The data collection was undertaken by the ORM4SOIL project in the University of Ghana using well-structured questionnaires. A total of ten graduate students with three supervisors and two Researchers were part of the data collection team. Data was collected in six selected communities in the district based on their location on the map of the district with Sege as reference point and other towns within 10 Km radius. Two towns were selected at the upper region of the district, two within the middle region and the last two at the lower or bottom region of the district. This was to ensure a fair coverage of the district.

### **3.5 Types and Sources of Data**

Primary data was collected from the study area by the ORM4SOIL project in the University of Ghana. This touched on Household and farm characteristics of the interviewees, their access to markets/processing units, extent of commercialization, access to water, access to machinery/implements, access to loan, land tenure, workforce and family size, Off-farm income, food security, Agronomy, perception on soil fertility, perception on soil fertility management options, cost and benefit involved in their system of farming, current practice of organic soil fertility management, challenges of using local organic resources and also issues involved in communication and information on their farming practices and soil fertility.

Farmers were interviewed in the various farming communities; hence farmers were targeted in their homes. The concentration was on vegetable and fruit farmers.

### **3.6 Sample Size and Sampling Technique**

A total of 317 vegetable and fruit farming household heads were interviewed in six (6) selected communities in the Ada West district by the ORM4SOIL project of the University of Ghana. The data for the analysis and the number of respondents were made available for this research by the ORM4SOIL project. The clusters used were Upper region, middle region and lower region hence two communities were selected within these demarcations from the district. The communities, namely Koni and Badzohe (Upper Region), Toflokpo and Hwakpo (middle



region), Tugakope and Aditcherekope (lower region) in the district were visited and interviewed.

Random walk technique was used in the collection of the data by the ORM4SOIL project in the University of Ghana. Concentration was on the next two households during the walk. The random walk is a data collection technique which ensures equal coverage of enumerators in a particular study area. When the team gets to each community, the community is divided into four sections and each team with a random walk collects data from households.

Random walk involves taking the left turn after situating your starting point (market, church, chief's house etc). The team counts and interviews every fourth house (depending on population of the community) until it meets a major diversion to the right which must be taken and the counting continues from there. After a right turn, the next possible turn will be a left turn (ie if there is a route diversion).

In the case of having multiple households within a compound, the Kish grid is used for the selection of farmer to interview. The Kish grid presents a table of number of households within a compound as against the ages of their household heads. The grid has a table to help check for the appropriate household head to interview to prevent partiality.

### **3.7 Survey Instrument**

Open and closed ended questions were used on a well-structured questionnaire. Data was collected through direct field observation and personal interviews.

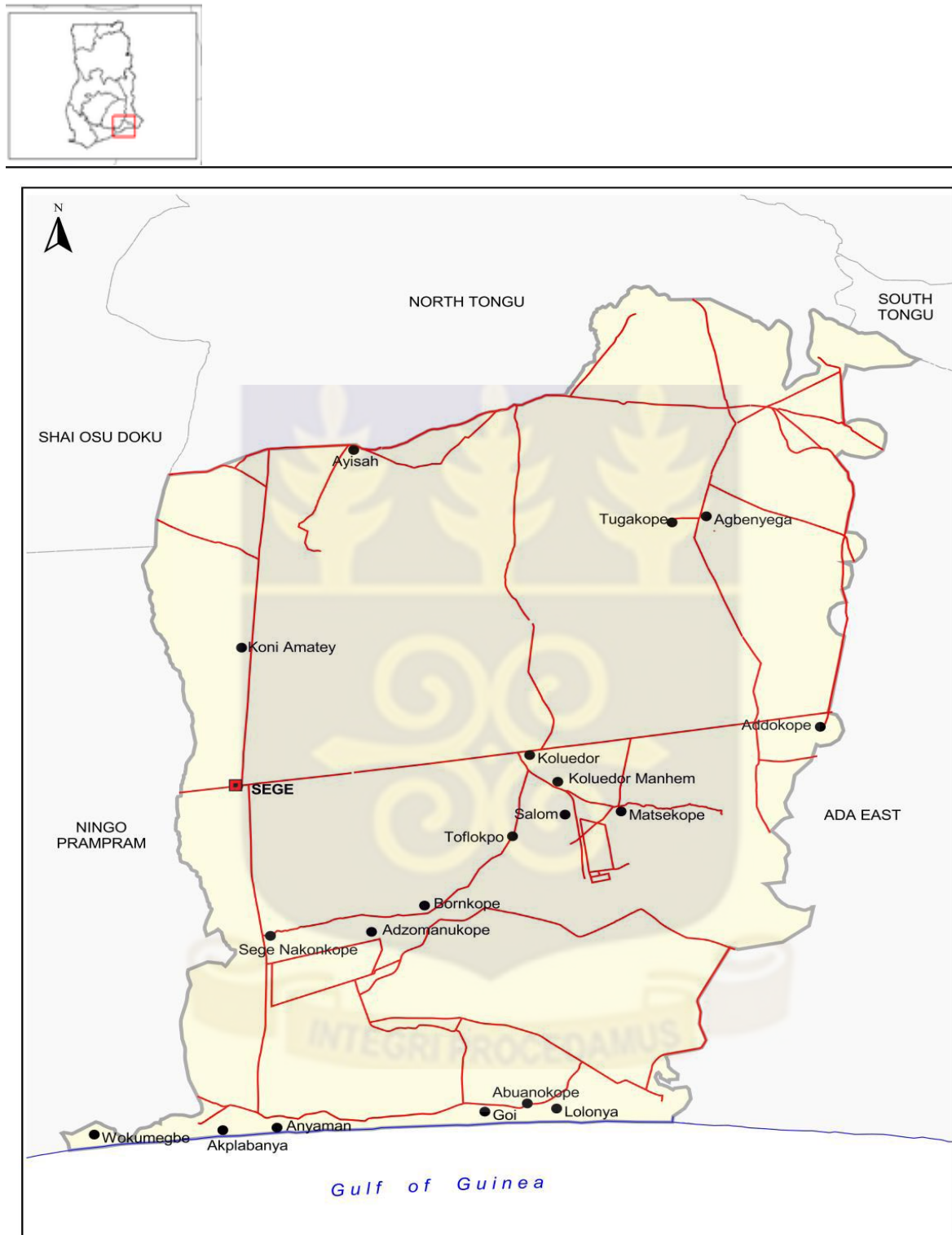
### 3.8 Study Area

The Ada West district was carved out of the former Dangme East District in the Greater Accra Region with its capital at Sege. The District shares boundaries with North Tongu District to the North, Ada East District and Ningo Prampram to the East and West respectively. It is bounded to the South by the Gulf of Guinea which stretches from Akplabanya to Goi. It is approximately 80 Kilometers from Accra, the regional capital. The total land size of the district is about 323.721 square kilometers.

The average temperature of the area spans from about 23 degrees to 28 degrees. The main rainfall period for the area is from March of each year to the September of same year. The harmattan season is severe in the area as rainfall is hardly experienced during this period. The area is surrounded by waterbodies like river Volta and the Sea. The relatively high temperature of the area is favorable for their salt mining activities. It has the coastal savannah vegetation and its plains covered with shrubs, short growing trees and savannah grasses. It has got coconut trees growing on most parts of its vegetation.

The current Housing and Population Census of 2010 placed the area's population size at 59,124. The populace are engaged in activities such as agriculture ( $\approx 42\%$ ), forestry and fishery has  $\approx 19\%$  and the rest are normally engaged in trade related economic activities. About 90% of the populace do works in the informal sector of the area's economy.

**Figure 3.1: Map of Ada West District**



Source: Ghana Statistical Service (2005)

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

#### **4.1 Introduction**

Chapter four discusses the results obtained from the analyses of the primary data collected and also discusses the results. The main areas covered were the crop farmers' socio-economic characteristics and the proportion of farmers using each of the local organic resources. The chapter also discusses the intensity of use of the local organic resources, the factors that influence the intensity of adoption of matured cow dung and animal manure, the detailed cost benefit analysis of cultivating an acre of Pepper under matured cow dung only usage, matured cow dung and inorganic fertilizer usage and lastly only inorganic fertilizer usage involved in practices each of the classifications (organic, inorganic and the use of both) and finally it analyses the various constraints that come with the use of animal manures in soil fertility improvement.

#### **4.2 The Socio-Economic Characteristics of the Respondents**

The socioeconomic information concentrates on the users of matured cow dung (dried cow dung) because it is the single most used local organic resource for improving soil fertility unlike animal manure that consists of the use of swine droppings, duck droppings and other poultry droppings combined. From the results, more male farmers (64.4%) use the matured cow dung than the female farmers (35.6%). This is because farming is dominated by males in the area.

Greater section of the farmers representing 57% who use the matured cow dung are above the age of 40 years. This shows the low level of participation of the youth (who in this study are captured as individuals below the age of 40 years) in the use of local organic resources. The likely cause of this is that the youth will find it more comfortable managing inorganic fertilizer than an organic one that is relatively unattractive in terms of management.

The descriptive statistics also show that the more a farmer is educated the lesser his or her affinity for local organic resources. This can be attributed to their engagement in other economic activities since most of them are likely to have multiple jobs, hence will not have much time managing the matured cow dung as compared to a traditional farmer who is less educated and is into full time farming and has more time for the farm work and can have ample time to manage the matured cow dung.

Greater percentage of households that adopt the matured cow dung are headed by males who are the decision makers. This is as a result of the fact that managing matured cow dung is a little difficult and is more appealing to males than females, who have more confidence and strength in management of the matured cow dung.

Individuals with less farm experience adopt matured cow dung more because they are likely to be open to trying many means to enrich their soil to experience the returns they get from each.

Farmers with Larger household sizes from 6 onward constitute less than 10% of the adopters of matured cow dung. The possible cause of this is that, these farmers have more financial responsibilities at home hence unable to save more money towards purchasing matured cow dung.

About 91.3% of adopters of matured cow dung do not belong to FBOs. Matured cow dung is the most popular local resource for improving soil fertility in the area. Farmers who are part of FBOs are introduced to several soil fertility enhancing materials and test the use of these materials. Farmers who are not part of FBOs in the community also do what they know traditionally that helps them improve the fertility of their soil.

Table 4.1 presents relevant information on the socioeconomic characteristics of the respondents in the study area.

**Table 4.1: Summary of Socio-Economic Characteristics of Respondents**

| Category                                    | Matured cow dung users |          | Non matured cow dung users |          | Total |          |
|---------------------------------------------|------------------------|----------|----------------------------|----------|-------|----------|
|                                             | Freq                   | Perc.(%) | Freq                       | Perc.(%) | Freq  | Perc.(%) |
| <b>Gender</b>                               |                        |          |                            |          |       |          |
| Male                                        | 96                     | 64.4     | 85                         | 50.6     | 181   | 57.1     |
| Female                                      | 53                     | 35.6     | 83                         | 49.4     | 136   | 42.9     |
| <b>Age</b>                                  |                        |          |                            |          |       |          |
| Youth ( $\leq 40$ )                         | 64                     | 43.0     | 82                         | 49.0     | 146   | 46.2     |
| Adult ( $> 40$ )                            | 85                     | 57.0     | 85                         | 51.0     | 170   | 53.8     |
| <b>Education</b>                            |                        |          |                            |          |       |          |
| Never went to Sch                           | 49                     | 32.9     | 64                         | 38.3     | 113   | 35.8     |
| Prim sch attended                           | 37                     | 24.8     | 55                         | 32.9     | 92    | 29.1     |
| Prim sch compt                              | 42                     | 28.2     | 36                         | 21.6     | 78    | 24.7     |
| Sec Sch attended                            | 5                      | 3.4      | 6                          | 3.6      | 11    | 3.5      |
| Sec Sch completed                           | 12                     | 8.1      | 5                          | 3.0      | 17    | 5.4      |
| Tert coll attended                          | 1                      | 0.7      | 1                          | 0.6      | 2     | 0.6      |
| Tert comp (Dip, Cert)                       | 2                      | 1.3      | 0                          | 0        | 2     | 0.6      |
| Bach degree                                 | 1                      | 0.7      | 0                          | 0        | 1     | 0.3      |
| <b>Decision taker on farming activities</b> |                        |          |                            |          |       |          |
| Male head of HH                             | 78                     | 53.8     | 64                         | 39.0     | 142   | 46.0     |
| Female head of HH                           | 32                     | 22.1     | 62                         | 37.8     | 94    | 30.4     |
| Both Spouse                                 | 32                     | 22.1     | 38                         | 23.2     | 70    | 22.7     |
| Both Spouse &                               |                        |          |                            |          |       |          |
| Elder Child                                 | 2                      | 1.4      | 0                          | 0        | 2     | 0.6      |
| Someone else                                | 1                      | 0.7      | 0                          | 0        | 1     | 0.3      |
| <b>Member of Farmer based group</b>         |                        |          |                            |          |       |          |
| Yes                                         | 13                     | 8.7      | 4                          | 2.4      | 17    | 5.4      |
| No                                          | 136                    | 91.3     | 164                        | 97.6     | 300   | 94.6     |
| <b>Household Size</b>                       |                        |          |                            |          |       |          |
| 1-5                                         | 127                    | 89.4     | 148                        | 96.1     | 275   | 92.9     |
| 6-10                                        | 14                     | 9.9      | 6                          | 3.9      | 20    | 6.8      |
| >10                                         | 1                      | 0.70     | 0                          | 0        | 1     | 0.3      |
| <b>Land Ownership</b>                       |                        |          |                            |          |       |          |
| Yes, owns all                               | 38                     | 25.5     | 61                         | 36.3     | 99    | 31.2     |
| Yes, owns part                              | 30                     | 20.1     | 28                         | 16.7     | 58    | 18.3     |
| No, I don't                                 | 81                     | 54.4     | 79                         | 47.0     | 160   | 50.5     |
| <b>Farm Experience</b>                      |                        |          |                            |          |       |          |
| <11                                         | 52                     | 36.9     | 64                         | 39.8     | 116   | 38.4     |
| 11-20                                       | 40                     | 28.4     | 37                         | 23.0     | 77    | 25.5     |
| 21-30                                       | 19                     | 13.5     | 30                         | 18.6     | 49    | 16.2     |
| 31-40                                       | 18                     | 12.8     | 19                         | 11.8     | 37    | 12.3     |
| >40                                         | 12                     | 8.5      | 11                         | 6.8      | 23    | 7.6      |

Source: Authors computation from field data



**NB:**

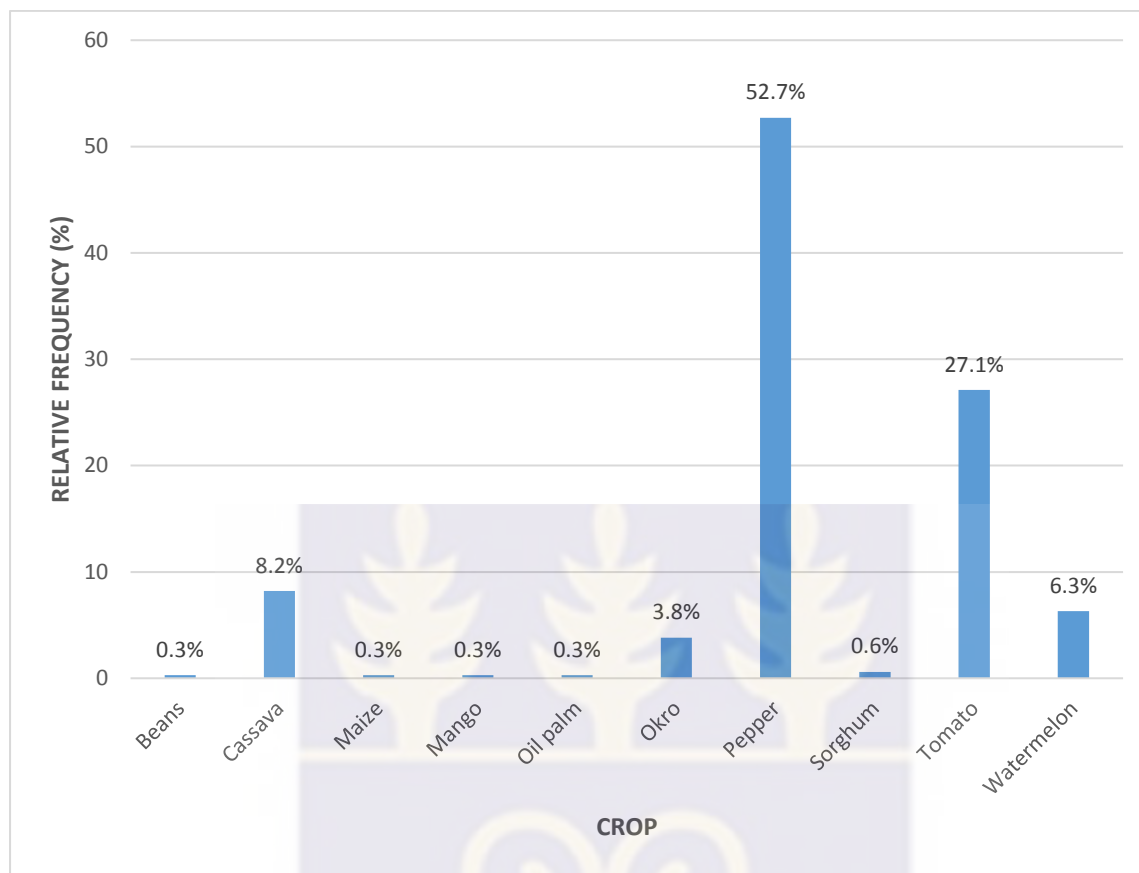
The non-matured cow dung users as mentioned in the table represents farmers who use the other local organic resources in soil fertility improvement other than the research's main concentration (matured cow dung). Hence it refers to legume, green manure, soil fertility enhancing trees and cow dung compost. Matured cow dung is singled out because it is the single most used local organic resource in the district. This is because animal manure consist of swine droppings, duck droppings and other poultry droppings hence not a single material.

Table 4.2 presents relevant statistics on farmer's farm size in the Ada West District. The mean farm size of farmers interviewed is 7.904 acres, which is about 3.16 hectares

**Table 4.2: Statistics on Farm Size**

|                       | Total<br>number of<br>respondents | Minimum<br>Farm size<br>(Acres) | Maximum<br>Farm size<br>(Acres) | Mean Farm<br>size | Std. Deviation |
|-----------------------|-----------------------------------|---------------------------------|---------------------------------|-------------------|----------------|
| Respondents (Farmers) | 317                               | 1.0                             | 60.0                            | 7.904             | 7.3742         |
| Valid N (listwise)    | 317                               |                                 |                                 |                   |                |

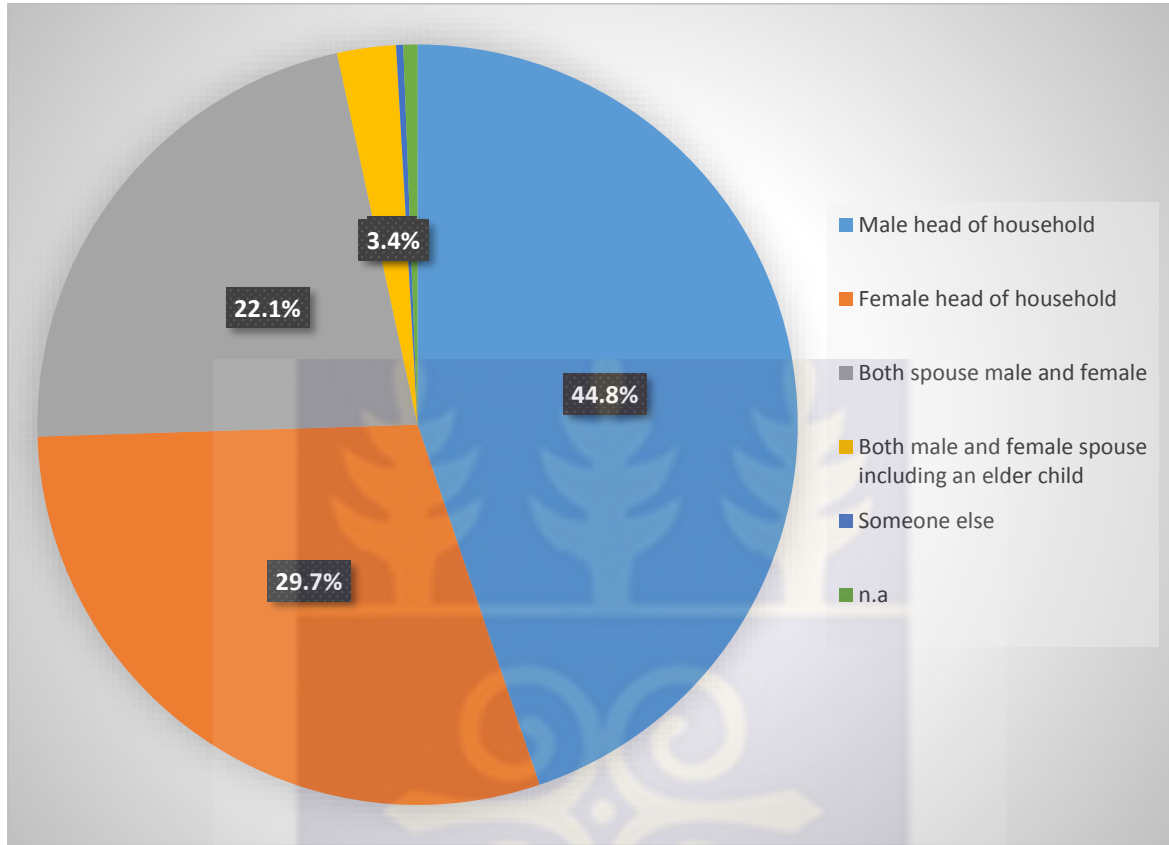
Source: Authors computation from field data

**Figure 4.1: Distribution of Farmer's Main Crops Grown.**

Among the respondents interviewed, 52.7% grow Pepper as their main crop of production, followed by Tomato with 27.1% and Cassava, 8.2% (see figure 4.1). The least grown crops were beans, maize, mango and oil palm (0.3% each).

Figure 4.2 presents information on farmer's response to who makes the major decision in farming activities in the household.

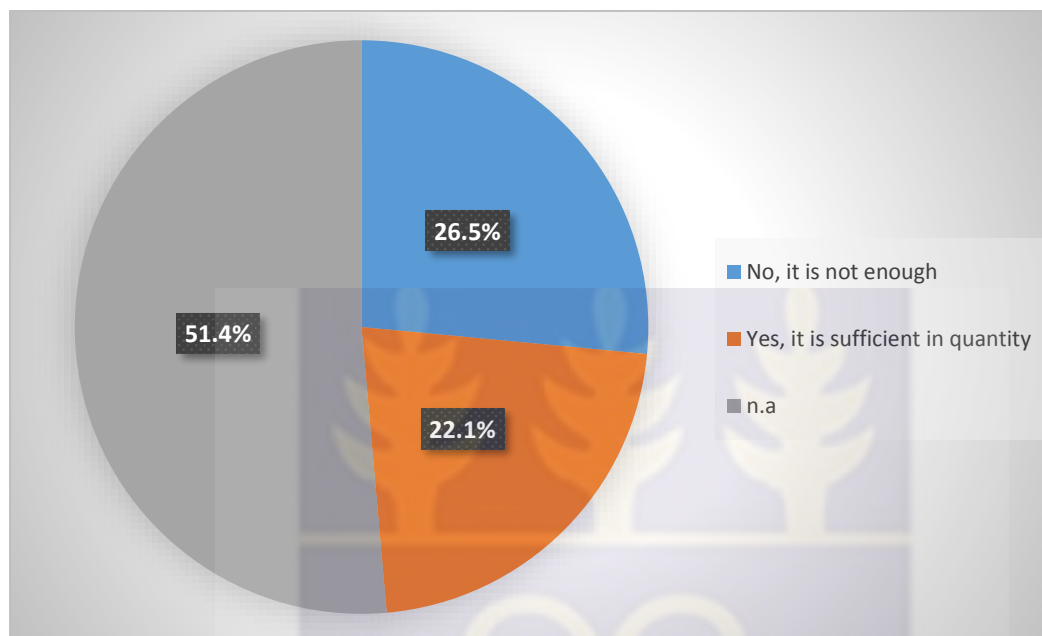
**Figure 4.2 Decision Maker on Farming Activities in Household**



In terms of household decision making (see figure 4.2) on farming activities, the male household heads dominate, representing 44.8% of individuals who make decisions about farming activities in the household. This is followed by female household heads with 29.7% and both spouses (Male and Female) with 22.1%.

Figure 4.3 shows the farmers' assessment of the information they obtain on soil fertility management and whether it is sufficient to help them in their farming practices.

**Figure 4.3: Assessment of Soil Fertility Management Information Received by Farmers**



About 51.4% farmers responded not applicable to the question of whether the information they get on soil fertility is sufficient in quantity and also opt not to answer. This is because these farmers say they have no source of information at all on Soil Fertility Management. See figure 4.3

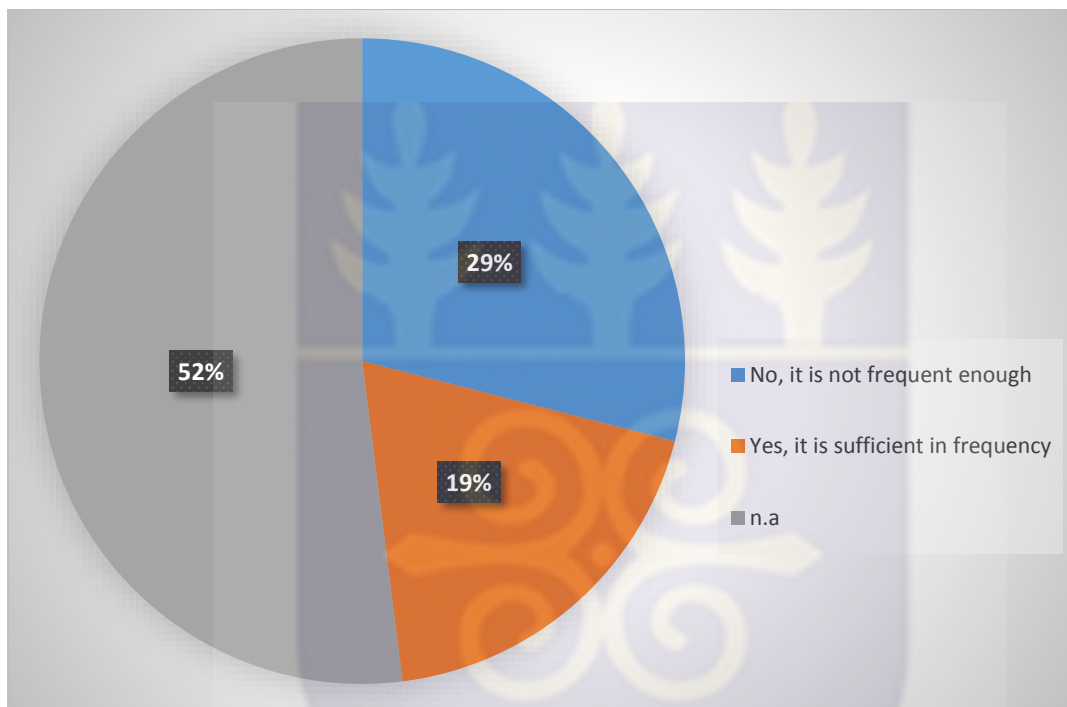
About 26.5% farmers responded that they have access to information on Soil Fertility Management but the information they get is not enough in quantity.

About 22.1% of the farmers who were interviewed responded that the information they receive from their source on Soil Fertility Management is sufficient.

Hence it can be concluded that a greater percentage of farmers do not access information at all on soil fertility management in the Ada West district of Ghana.

Figure 4.4 shows the response of farmers on whether the information they obtain on soil fertility is sufficient in frequency. This comes in the form of the number of visits by a technical personnel who offers this service or through the media or any other avenue of obtaining this information.

**Figure 4.4 Sufficiency of Frequency of Information on Soil Fertility**



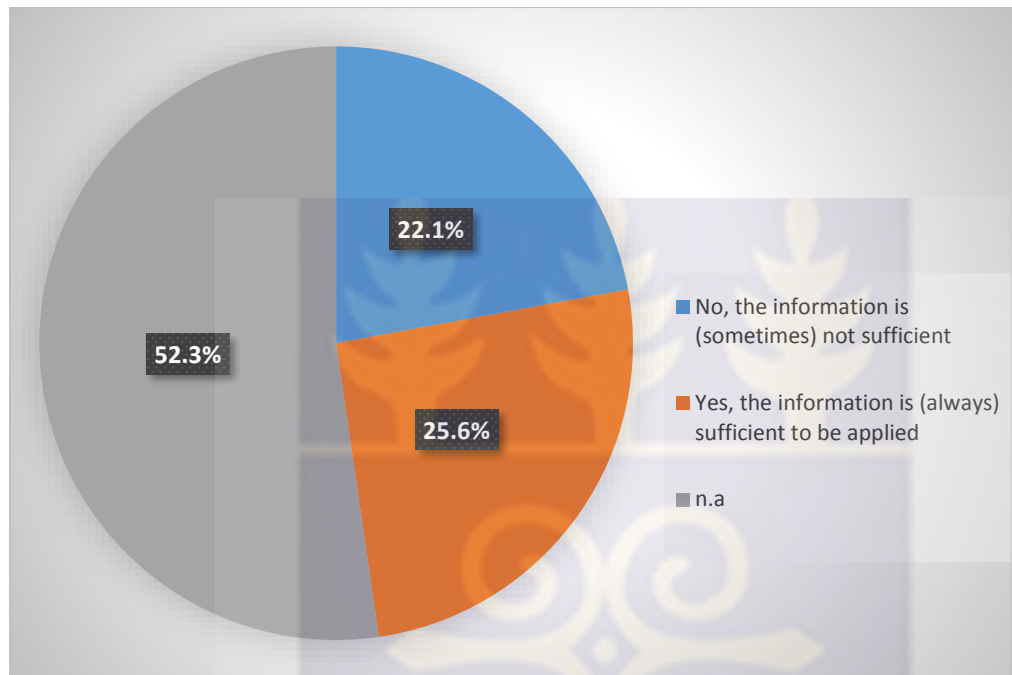
In terms of sufficiency in frequency of information obtained on soil fertility, 52% of the farmer's responded not applicable meaning they don't have access to information on Soil Fertility Management at all and also opt not to answer.

About 29% of the farmers responded that no, it is not sufficient in frequency.

About 19% of the farmers responded that the information they get on Soil Fertility Management is sufficient in frequency.

Figure 4.5 shows the response from farmers on the question as to whether the information they obtain on soil fertility hold such relevance and contain the right message they need to help improve their soil fertility and apply soil fertility management practices.

**Figure 4.5 Relevance of Information to SFM Practices**



On whether the information farmers receive contain what they need to know in order to apply Soil Fertility Management, About 52.3% of the farmers responded not applicable which may imply they don't get the information.

About 22.1% of the farmers responded that no, the information is sometimes not sufficient.

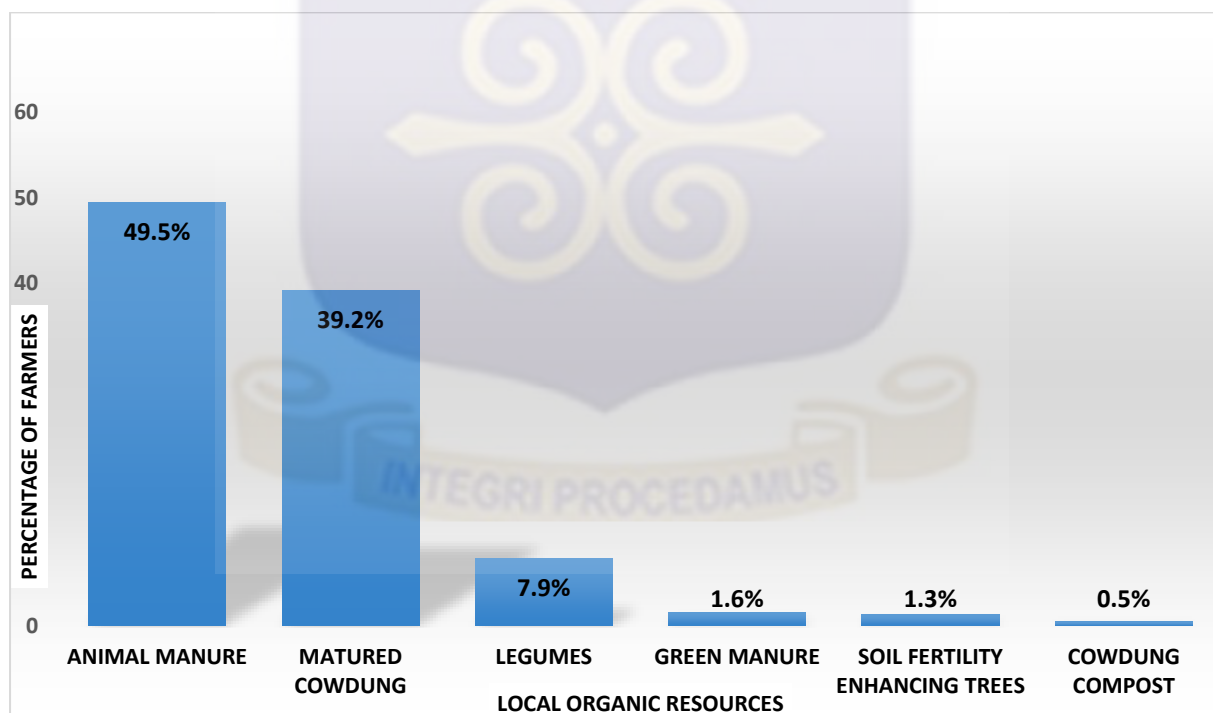
About 25.6% of the farmers responded that yes, they information they receive on Soil Fertility Management is always sufficient to be applied.



### 4.3 Proportion of Crop Farmers Using Local Organic Resources in Soil Fertility Improvement

Per the results in Figure 4.6, all farmers use one form or the other of local organic resources in improving the fertility of their soil. However the use of animal manure and matured cow dung proved to be dominant. Among the 317 farmers interviewed, 49.5% use animal manure while 39.2% use matured cow dung in improving the fertility of their soil. Altogether 88.7% of smallholder farmers in Ada use both animal manure (swine droppings, duck droppings, and other poultry droppings combined) and matured cow dung in improving the fertility of their soil. Animal manure as used by the ORM4SOIL project in the University of Ghana includes swine droppings, poultry dropping and all other ruminant droppings apart from cattle). These are normally obtained by farmers from rearing these animals domestically or within their neighbourhood.

**Figure 4.6 Proportion of Crop Farmers using Local Organic Resources**



The question asked above is, what type of local organic resource do you use for soil fertility improvement? Farmers are presented with all the above options to choose. There is room for multiple choices hence the total height of bars is expected to be above 100.

**Source: Authors computation from field data**

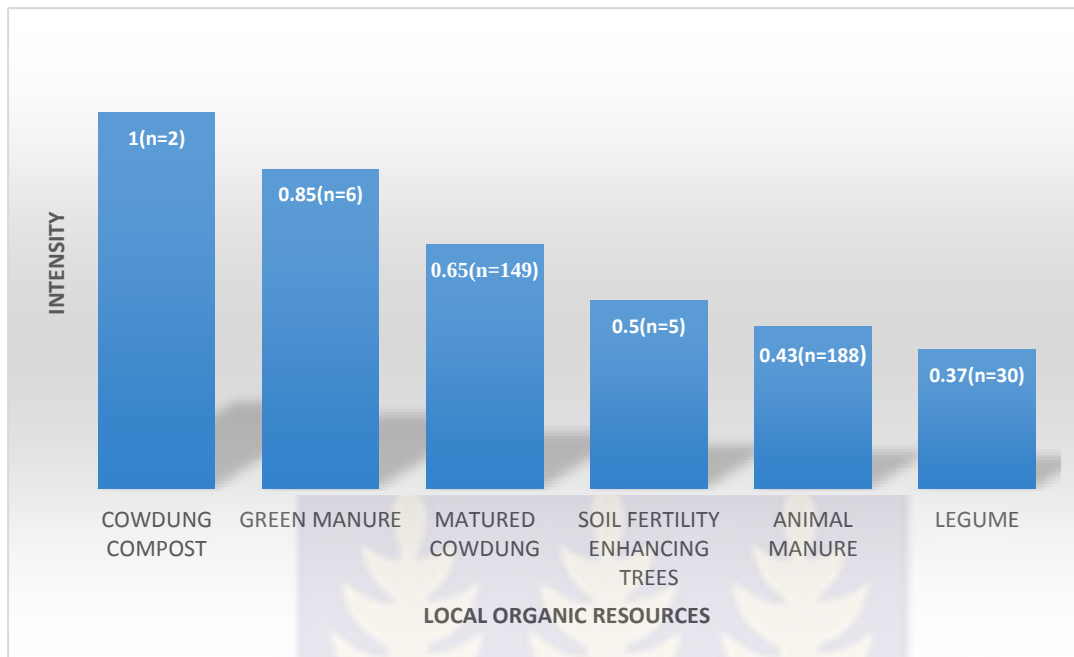
Lavison (2013) adoption study on organic fertilizer results indicated that most of the farmers (about 96.3% of the total respondents) were using poultry manure as their most preferred organic manure as compared to cow dung and other ruminant droppings. This was highly influenced by the proximity of the organic material to the farmers.

This is consistent with the assertion of Ajewole (2010) that, the closeness of a raw material has a positive impact on its use in an organic fertilizer adoption study in Nigeria.

The availability of animal manure within the locality coupled with the fact that it is not being purchased for use by the farmers is an influential factor in majority of them using it. The use of matured cow dung which comes second is also as a result of the fact that the Ada West District and its neighbouring Districts and communities are into cattle rearing. Unlike the animal manure, they usually buy the cow dung from the cattle farmers at determined prices.

#### **4.4 Intensity of Use of Local Organic Resources by Crop Farmers in Soil Fertility Improvement**

The mean intensity of use of the various local organic resources are presented in figure 4.7. The most patronized local organic resources in the District is on the use of animal manure and matured cow dung. The mean intensity of use of animal manure is 0.43. This implies that smallholder farmers who use animal manure in improving the fertility of their soil, apply it to about 43% of their farmland in total. The mean intensity of matured cow dung is 0.65. This implies that smallholder farmers who use matured cow dung in improving the fertility of their soil, apply it to about 65% of their farmland in total.

**Figure 4.7 Intensity of Use of Local Organic Materials**

Numbers in bracket ( ) represent the frequency of farmers using that local organic resource.

Source: Authors computation from field data

In relative comparison, even though higher percentage of farmers (49.5%) are using animal manure as compared to matured cow dung (39.2%) in terms of proportional representation of usage, the farmers who use matured cow dung use it more intensely as compared to the farmers who use animal manure. This can be related to the fact that the matured cow dung has a better structured market in the locality hence a more reliable source of supplier for use. The animal manure however does not have a structured market as compared to the matured cow dung hence its supply is not dependable and this can influence negatively its availability and hence contribute to its relatively low intensity of use. Most users of animal manure depend on the benevolence of neighbours who keep it and supply to them.

Okyere (2003) in his adoption study on Cocoa in the Ashanti Region of Ghana used similar method in achieving his objective of determining the extent of use of black pod control technology among adopters. He had an extent of use result of 0.746 of which he explained that, adopters committed 75% of their cocoa land area to the use of the technology.

#### **4.5 Factors that Influence the Intensity of Adoption of Animal Manure and Matured Cow dung**

The Wald test result for the factors that influence the Intensity of adoption of matured cow dung and animal manure had a chi-square probability value less than 0.001. This is less than the significance level of 0.05 hence we reject the null hypothesis and conclude that there is a significant association between the independent variables and the intensity of adoption of matured cow dung and animal manure (see table 4.3 and 4.4).

The probability values of the F-test of overall significance, for the Wald test of factors that influence intensity of adoption of animal manure and mature cow dung are both less than the significance value of 0.05, hence we reject the null hypothesis and conclude that the model provides the best fit for the regression analysis (see table 4.3 and 4.4). The residual sum of squares, which is a measure of the discrepancies between the data and the estimation model records values of 5.701 and 4.487 for animal manure and matured cow dung respectively. The small level of these figures indicates a tight fit of the model to the data (see table 4.5).

Table (4.6) provides values of the marginal effect of factors that influence the intensity of adoption of animal manure and matured cow dung. The computed marginal effects measure the sensitivity of intensity of adoption of animal manure and matured cow dung to the various explanatory variables. The discussion concentrates on significant variables that met the a prior expectation. A percentage increase in the cost of animal manure and matured cow dung leads to 0.035% and 0.023% decrease in intensity of use of them respectively. A percentage increase in pepper farmer's access to credit will lead to 0.001% increase in intensity of use of animal manure and matured cow dung respectively. A farmer's ownership of farmland increases his intensity of use of animal manure and mature cow dung by 0.033% and 0.022% respectively.

A percentage increase in farmer's access to transport increases their intensity of use of animal manure and matured cow dung by 0.065% and 0.052% respectively.

Farmer access to credit is significant at 5% and 1% respectively for the regression results of factors that influence the adoption and intensity of adoption of animal manure and matured cow dung respectively in soil fertility improvement and met the a priori expectation. This is because farmers' access to funds through credit medium will increase their capital status and give them that ability to buy more of the animal manure and matured cow dung if that need be for application on their farm. This outcome agrees with previous studies carried out by Chukwuji *et al.* (2006) on adoption and intensity of use of fertilizer by cassava farmers in the Delta State of Nigeria and Eric (2012) in his soil management practices (SMP) adoption study in Kenya. They both found access to credit to be very significant to the adoption of and intensity of their practices.

The Ownership of freehold land is significant at 5% and 10% respectively for animal manure (swine droppings, duck droppings and other poultry droppings combined) and matured cow dung. This implies that freehold land ownership positively influencing the adoption of both animal manure and matured cow dung and also influences the intensity of their use by the various farmers in soil fertility improvement. This is acceptable because the use of local organic resources is a major farm investment and also requires some time to decay and has long term impact on a farmers land productivity. A farmer who is not having a secured land will not like to commit himself to the intensive use of a practice that normally takes time to influence the fertility of his or land. This result agrees with that of Mwirigi *et al.* (2009) on land tenure security and adoption of a new technology in Nakuru District, Kenya. Their result stated that, land tenure security is a decisive factor in adoption of a technology by farmers especially in terms of farmers thinking of future return on investment of their effort.

Farmer's access to transport met the expected sign and is significant at 1% and 10% for animal manure and matured cow dung respectively. This means farmer's access to transport is very influential in farmers' adoption and intensity of use of animal manure and matured cow dung for soil fertility improvement. This is because the conveyance of the cow dung and animal manure has proven to be a major challenge to the smallholder farmers in Ada West. There is much difficulty with transporting the local organic resources from their various sources to their farms and sites as a result of its bulky nature and the fact that it cannot be conveyed by all kinds of cars. This conforms to Matlon (1994) work on soil fertility in Burkina Faso in which distance to input source had negative influence on adoption. The work of Khanna (2001) on adoption of site-specific technologies also buttresses this. In line with work a farmer's possession of a means of transport enables him to easily access the source of input.

Household labour size did not meet the expected sign and was not significant in adoption of animal manure. However for matured cow dung even though it did not meet the expected sign the value was significant. This means household size negatively influences adoption of matured cow dung and intensity of its use. This is contrary to assertions by Eric (2012) and Okyere (2003) in adoption and intensity of use of agricultural technologies. Because, household size positively influenced adoption and intensity of use of the respective agricultural technologies in their study.

Off-farm income was not significant for both animal manure and matured cow dung. The variable however met the expected sign of having a positive relationship with the adoption and intensity of use of animal manure and matured cow dung. This outcome is in line with the results of Odendo *et al.* (2009) in their study of factors that influence adoption of various integrated soil fertility management practices in Western Kenya, results in the study showed that even though off farm income was not significant in the adoption of manure it had a positive relationship with its adoption as it did with this study. The same can be said of Jatoe (2000)



where non-farm income was not significant in influencing the adoption of improved sorghum varieties in the Upper West Region of Ghana, however the variable had positive influence on the adoption of the improved sorghum varieties which satisfied the expected sign.

Gender of farmer was not significant for both animal manure and matured cow dung adoption but positively influenced the adoption and intensity of use of animal manure and matured cow dung and this met the a priori expectation in that direction. This agrees with the study results of Lavison (2013) and Eric (2012) in which Gender was observed to positively influence the adoption and intensity of use of the respective technologies in question even though it was not significant. In both cases Gender was dummied with Male=1 and female =0 as used in this study.

All the stages of education were not significant and did not meet the a priori expectation. Hence educational level had no significant influence on the adoption and intensity of use of animal manure and cow dung in soil fertility improvement. This is in line with Okyere (2003) in his Cocoa technology adoption study where all levels of education were not significant to the adoption of the technology. This is however contrary to Eric (2012) where educational level positively influenced the adoption and intensity of use of Organic Soil Management Practices.

The cost of animal manure was significant at the 5% level and the expected sign was met. However the cost of matured cow dung was not significant but its expected negative+ sign was met and hence agreed with the a priori expectation. This corroborates with the study by Kheralla *et al.* (2001) and also that of Okyere (2003) where the price of fertilizer and cocoa pest disease control technology respectively were seen to have been negatively related to adoption and intensity of their use.

Non availability of animal manure was not significant and did not meet the a priori expectation. Responses from non-availability of matured cow dung were too correlated with the dependent variable hence was not included in its analysis. The results from the non-availability of animal

manure does not agree with literature especially the finding of Hailu *et al.* (2014) in their study ‘Adoption and impact of irrigation on household income in Ethiopia. The availability of water which is the primary resource for irrigation had a positive impact on adoption of irrigation in terms of relationship and was significant.

Even though farmer’s membership of a farmer based organization was not significant it was positively related to intensity of adoption of both animal manure and matured cow dung. This relationship agrees with the findings of Nkamleu (2007) in his work on farmers decisions in sub-Saharan Africa’ and that of Nchinda *et al.* (2010) in his adoption studies in Cameroun. Both works supported the analogy of FBO membership being significant in farmer’s decision to adopt new technologies and in both instances the variable had a positive impact on the dependent variable in terms of relationship.

Perception of infertility of farmers land was not significant for both animal manure and matured cow dung use. However it met the expected sign and relationship. The variable had a positive relation with intensity of adoption of animal manure and cow dung. This falls in place because a farmer who feels his land has much fertility problem will want to adopt all reliable kinds of fertility enhancing methods to regain fertility of his or her land. This however corroborates with Chinangwa (2006) adoption study in Southern Malawi. Results of his study showed that perception of farmers about the infertility of their soil is positively related to adoption of soil fertility improvement technologies.

Farmers’ access to information on issues of soil fertility was not significant in both cases of the use of animal manure and matured cow dung, however the expected sign was met. Farmer’s access to information on issues of soil fertility is positively related to farmer’s intensity of adoption of animal manure and matured cow dung. This is in line with Roger (1995) and the study of Abdulai and Huffman (2005) in which they all concluded that human capital formation contributes to increase in the adoption of a particular technology by an adopter. Farmer’s

confidence to invest in their farm is negatively related to intensity of adoption of both animal manure and matured cow dung. This does not meet the a priori expectation even though this variable was significant for animal manure.

Other farmers influence is positively related to farmer's intensity of adoption of both animal manure and matured cow dung even though the variable was not significant. This falls in line with the a priori expectation because farmers feel confident about a practice that works out for their neighbouring farmer and would also want to adopt it.



Table 4.3 presents the Wald test results from E-views software conducted on the variables used for the regression analysis of factors that influence intensity of adoption of matured cow dung.

**Table 4.3: Wald Test Result for Intensity of Adoption of Matured Cow Dung**

WaldTest: MATURED COWDUNG

Equation: Untitled

| Test Statistic | Value    | Df       | Probability |
|----------------|----------|----------|-------------|
| F-statistic    | 18.77648 | (24, 40) | 0.0000      |
| Chi-square     | 450.6355 | 24       | 0.0000      |

Null Hypothesis:  
 $C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0, C(8)=0, C(9)=0, C(10)=0, C(11)=0, C(12)=0, C(13)=0, C(14)=0, C(15)=0, C(16)=0, C(17)=0, C(18)=0, C(19)=0, C(20)=0, C(21)=0, C(22)=0, C(23)=0, C(24)=0$

Null Hypothesis Summary:

| Normalized Restriction (= 0) | Value  | Std. Err. |
|------------------------------|--------|-----------|
| C                            | 0.446  | 0.251     |
| HOUSEHOLD LABOUR SIZE        | -0.027 | 0.020     |
| OFF-FARM INCOME              | 0.008  | 0.056     |
| ACCESS TO CREDIT             | 0.003  | 0.001     |
| GENDER                       | 0.067  | 0.088     |
| FARM EXPERIENCE              | -0.015 | 0.010     |
| EXPERINCE SQUARED            | 0.000  | 0.000     |
| PRIMARY EDUCATION            | -0.103 | 0.106     |
| SECONDARY EDUCATION          | -0.105 | 0.154     |
| EXPENSIVE                    | -0.124 | 0.084     |
| INSUFFICIENT MANURE          | -0.037 | 0.088     |
| LACK OF EQUIPEMENT           | 0.077  | 0.211     |
| ACCESS TO EXTENSION          | -0.047 | 0.079     |
| MEMBER OF FBO                | 0.119  | 0.117     |
| FAMILY LAND                  | 0.237  | 0.082     |
| FREEHOLD                     | 0.099  | 0.071     |
| RENTED                       | 0.135  | 0.081     |
| PECEPTION OF INFERTILITY     | 0.042  | 0.091     |
| ACCESS TO INFORMATION        | 0.010  | 0.084     |
| CONFIDENCE TO INVEST         | 0.000  | 0.002     |
| VEHICLE                      | 0.230  | 0.133     |
| LABOUR INTENSIVE             | 0.140  | 0.087     |
| OTHER FARMERS                | 0.046  | 0.079     |

Restrictions are linear in coefficients.

Table 4.4 presents the Wald test results from E-views software conducted on the variables used for the regression analysis of factors that influence intensity of adoption of animal manure.

**Table 4.4: Wald Test Result for Intensity of Adoption of Animal Manure**

Wald Test: ANIMAL MANURE

Equation: Untitled

| Test Statistic | Value    | Df       | Probability |
|----------------|----------|----------|-------------|
| F-statistic    | 22.48738 | (25, 58) | 0.0000      |
| Chi-square     | 562.1844 | 25       | 0.0000      |

Null Hypothesis:  
 $C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0, C(8)=0, C(9)=0, C(10)=0, C(11)=0, C(12)=0, C(13)=0, C(14)=0, C(15)=0, C(16)=0, C(17)=0, C(18)=0, C(19)=0, C(20)=0, C(21)=0, C(22)=0, C(23)=0, C(24)=0, C(25)=0$

Null Hypothesis Summary:

| Normalized Restriction (= 0) | Value  | Std. Err. |
|------------------------------|--------|-----------|
| C                            | 0.378  | 0.189     |
| HOUSEHOLD LABOUR SIZE        | -0.012 | 0.016     |
| OFF-FARM INCOME              | 0.032  | 0.032     |
| ACCESS TO CREDIT             | 0.002  | 0.001     |
| GENDER                       | 0.058  | 0.068     |
| FARM EXPERIENCE              | -0.019 | 0.010     |
| EXPERIENCE SQUARED           | 0.000  | 0.000     |
| PRIMARY EDUCATION            | 0.045  | 0.072     |
| SECONDARY EDUCATION          | -0.153 | 0.122     |
| EXPENSIVE                    | -0.152 | 0.075     |
| NON-AVAILABILITY             | -0.080 | 0.335     |
| INSUFFICIENT MANURE          | -0.006 | 0.076     |
| LACK OF EQUIPEMENT           | 0.183  | 0.212     |
| LABOUR INTENSIVE             | 0.170  | 0.073     |
| ACCESS TO EXTENSION          | -0.066 | 0.067     |
| MEMBER OF FBO                | 0.013  | 0.102     |
| FAMILY LAND                  | 0.176  | 0.065     |
| FREEHOLD                     | 0.142  | 0.061     |
| RENTED LAND                  | 0.120  | 0.071     |
| PECEPTION OF INFERTILITY     | 0.021  | 0.073     |
| VEHICLE                      | 0.281  | 0.114     |
| ACCESS TO INFORMATION        | 0.041  | 0.068     |
| CONFIDENCE TO INVEST         | -0.004 | 0.002     |
| OTHER FARMERS                | 0.066  | 0.067     |

Restrictions are linear in coefficients.

Table 4.5 presents the tobit regression results of factors that influence the intensity of Adoption of animal manure and matured cow dung which are the two most used and classified soil fertility management materials identified in Ada West district, the study area.

**Table 4.5 Factors that Influence the Intensity of Adoption of Animal Manure and Matured Cow dung**

| VARIABLES                        | ANIMAL MANURE |         | MATURED COW DUNG |         |
|----------------------------------|---------------|---------|------------------|---------|
|                                  | COEFFICIENT   | Z-stats | COEFFICIENT      | Z-stats |
| <b>SOCIO-ECONOMICS</b>           |               |         |                  |         |
| HOUSEHOLD LABOUR SIZE            | -0.012        | -0.747  | -0.027*          | -1.325  |
| OFF-FARM INCOME                  | 0.032         | 0.991   | 0.007            | 0.134   |
| GENDER                           | 0.058         | 0.864   | 0.067            | 0.754   |
| FARMING EXPERIENCE               | -0.019*       | -1.879  | -0.015*          | -1.564  |
| FARMING EXPERIENCE SQUARED       | 0.000         | 1.531   | 0.000*           | 1.429   |
| PRIMARY EDUCATION                | 0.045         | 0.632   | -0.103           | -0.978  |
| SECONDARY EDUCATION              | -0.153        | -1.253  | -0.105           | -0.683  |
| <b>RESOURCE CHARACTERISTIC</b>   |               |         |                  |         |
| EXPENSIVE                        | -0.152**      | -2.022  | -0.103           | -1.479  |
| NON-AVAILABILITY                 | -0.080        | -0.238  | -                | -       |
| INSUFFICIENT ANIMAL MANURE       | -0.006        | -0.082  | -0.037           | -0.422  |
| LACK OF EQUIPEMENT               | 0.183         | 0.863   | 0.077            | 0.363   |
| LABOUR INTENSIVE                 | 0.170**       | 2.327   | 0.140            | 1.622   |
| <b>INSTITUTIONAL FACTORS</b>     |               |         |                  |         |
| ACCESS TO EXTENSION              | -0.066        | -0.984  | -0.047           | -0.590  |
| ACCESS TO CREDIT                 | 0.002**       | 2.363   | 0.003***         | 2.106   |
| MEMBER OF FBO                    | 0.013         | 0.125   | 0.119            | 1.025   |
| FAMILY LAND                      | 0.176         | 2.706   | 0.237            | 2.895   |
| FREEHOLD                         | 0.142**       | 2.311   | 0.099*           | 1.408   |
| RENTED LAND                      | 0.120         | 1.705   | 0.135            | 1.668   |
| <b>OTHER FACTORS</b>             |               |         |                  |         |
| PECEPTION OF INFERTILITY OF LAND | 0.021         | 0.288   | 0.042            | 0.459   |
| VEHICLE                          | 0.281***      | 2.472   | 0.230*           | 1.735   |
| ACCESS TO INFORMATION            | 0.041         | 0.593   | 0.009            | 0.106   |
| CONFIDENCE TO INVEST             | -0.004**      | -2.316  | 0.000            | -0.127  |
| OTHER FARMERS                    | 0.066         | 0.983   | 0.046            | 0.585   |
| <b>C</b>                         | 0.378         | 2.006   | 0.446            | 1.774   |
| N                                | 316           |         | 316              |         |
| Mean dependant var               | 0.638         |         | 0.658            |         |
| S.E. of regression               | 0.311         |         | 0.331            |         |
| Sum squared resid                | 5.701         |         | 4.487            |         |
| Log likelihood                   | -6.330        |         | -5.298           |         |
| S.D. dependant var               | 0.344         |         | 0.340            |         |
| Akaike info criterion            | 0.770         |         | 0.932            |         |
| Schwarz criterion                | 1.522         |         | 1.769            |         |
| Hannan-Quinn criterion           | 1.072         |         | 1.262            |         |

\*\*\*=1% significant level, \*\*=5% significant level and \*=10% significant level

Source: Authors computation from field data



Table 4.6 presents the marginal effect values of the explanatory variables in the regression analysis of estimating factors that influence the intensity of adoption of animal manure and matured cow dung.

**Table 4.6: Marginal Effect of Explanatory Variables**

| EXPLANATORY VARIABLE              | MARGINAL EFFECT OF ANIMAL MANURE | MARGINAL EFFECT OF MATURED COW DUNG |
|-----------------------------------|----------------------------------|-------------------------------------|
| HOUSEHOLD LABOUR SIZE             | -0.003                           | -0.006*                             |
| OFF-FARM INCOME                   | 0.007                            | 0.002                               |
| GENDER                            | 0.013                            | 0.015                               |
| FARMING EXPERIENCE                | -0.004*                          | -0.003*                             |
| FARMING EXPERIENCE SQUARED        | 0.000                            | 0.000*                              |
| PRIMARY EDUCATION                 | 0.010                            | -0.023                              |
| SECONDARY EDUCATION               | -0.035                           | -0.024                              |
| EXPENSIVE                         | -0.035**                         | -0.023                              |
| NON-AVAILABILITY                  | -0.018                           | 0.000                               |
| INSUFFICIENT ANIMAL MANURE        | -0.001                           | -0.008                              |
| LACK OF EQUIPEMENT                | 0.042                            | 0.017                               |
| LABOUR INTENSIVE                  | 0.039**                          | 0.032                               |
| ACCESS TO EXTENSION               | -0.015                           | -0.011                              |
| ACCESS TO CREDIT                  | 0.001**                          | 0.001***                            |
| MEMBER OF FBO                     | 0.003                            | 0.027                               |
| FAMILY LAND                       | 0.041                            | 0.053                               |
| FREEHOLD                          | 0.033**                          | 0.022*                              |
| RENTED LAND                       | 0.028                            | 0.030                               |
| PERCEPTION OF INFERTILITY OF LAND | 0.005                            | 0.009                               |
| VEHICLE                           | 0.065***                         | 0.052*                              |
| ACCESS TO INFORMATION             | 0.009                            | 0.002                               |
| CONFIDENCE TO INVEST              | -0.001**                         | 0.000                               |
| OTHER FARMERS                     | 0.015                            | 0.010                               |

#### **4.6 Estimating the Cost and Benefit of Using Local Organic Resources for Soil Fertility Improvement by Crop Farmers**

In this section the partial Budget is used to ascertain farmer's adoption of matured cow dung in place of the use of inorganic fertilizer. Hence the net returns is calculated to help reach a conclusion. The partial budget takes into consideration the available cost and benefit of choosing matured cow dung over inorganic fertilizer. The main components of the calculation fall under new cost, revenue lost, cost saved and new revenue. This is followed by a break-even analysis to inform the pepper farmers who use matured cow dung on the level of output that keeps them at a break-even point or zero profit level. This information will help the farmers to make profit since they will target output levels above the break-even point.

##### **4.6.1 Partial Budget**

A pepper farmers decision to use matured cow dung instead of inorganic fertilizer resulted in a net loss of GHS 699.50 (see table 4.7). This means the decision by pepper farmers to use matured cow dung in place of inorganic fertilizer is not financially wise. However certain information on the transaction cost of both matured cow dung and inorganic fertilizer such as phone call cost, messages cost, bargaining cost , cost incurred in ensuring quality product is purchased were not captured in the ORM4SOIL data that was analysed. The participatory evaluation study on the use of fertilizer on upland rice however in its application of partial budget concluded that, the use of N and P fertilizer in place of fallow period which is an organic method of soil fertility enhancement resulted in a net benefit (Dereje *et al.* 2017).

**Table 4.7: Partial Budget Result**

| <b>COST</b>                       | <b>GHS</b>     | <b>BENEFIT</b>                        | <b>GHS</b>     |
|-----------------------------------|----------------|---------------------------------------|----------------|
| <b>REVENUE LOST</b>               |                | <b>NEW REVENUE</b>                    |                |
| Inorganic fertilizer revenue      | 8000.00        | Matured Cow Dung revenue              | 8000.00        |
| <b>NEW COST</b>                   |                | <b>COST SAVED</b>                     |                |
| Matured Cow Dung Labour cost      | 582.00         | Inorganic fertilizer labour cost      | 607.50         |
| Direct Matured Cow Dung Cost      | 875.00         | Direct Inorganic fertilizer cost      | 150.00         |
| Matured Cow Dung transaction cost | 226.61         | Inorganic Fertilizer transaction cost | 226.61         |
| <b>Total Loss:</b>                | <b>9683.61</b> | <b>Total Gain:</b>                    | <b>8984.11</b> |
| <b>Net Loss:</b>                  | <b>699.50</b>  |                                       |                |

The revenue is calculated through average values taken from farmer's sale of bags of pepper obtained from the farm. All cost values are the average cost from respondents on labour cost, fertility enhancing material cost and transaction cost. All calculations were done on per hectare basis.

#### **4.6.2 Break-Even Analysis**

The break-even point of production is 3.252 bags (16kg bag) of pepper which is approximately 3 bags of pepper per acre. At this quantity of production, pepper farmer's total revenue equals their total cost of production, meaning profit is zero. Hence any pepper farmer using matured cow dung for soil fertility improvement that produces more than 3 bags of pepper per acre will make profit, all things being equal.

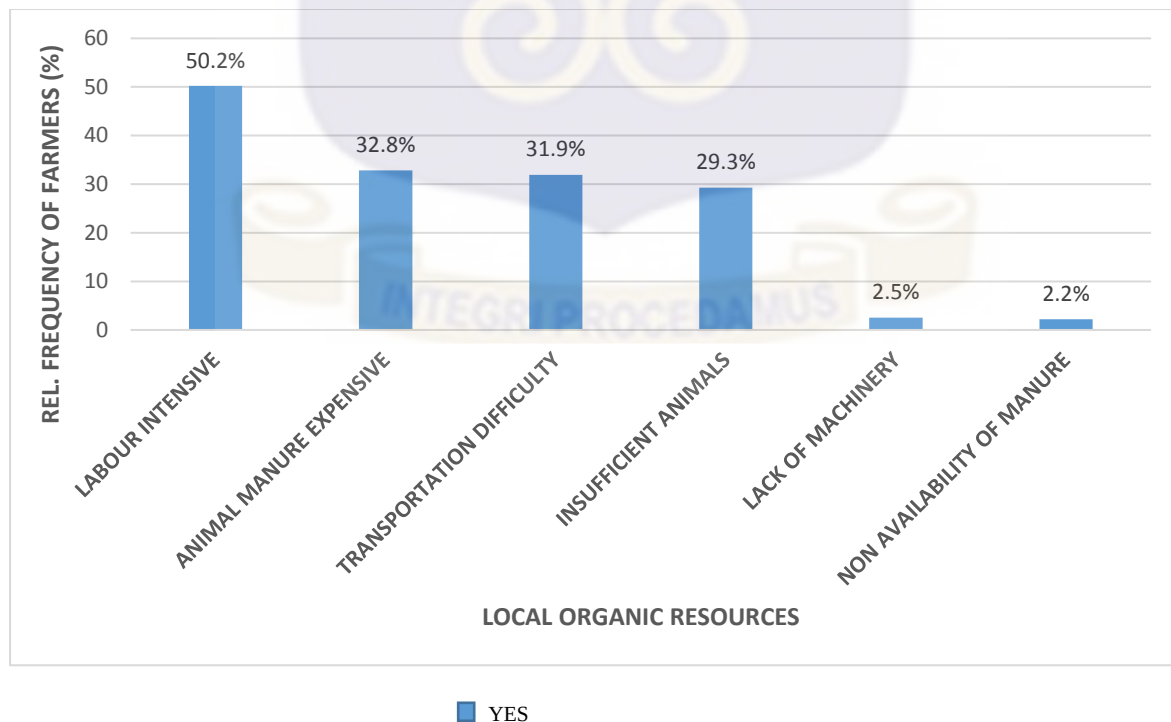
The break-even analysis shows that pepper farmers using matured cow dung are producing at a profitable level (see table 4.8). With an average quantity of production at 8 bags of pepper per acre. They are making a profit of GHS 1309.79 which is above the break-even profit level of zero (0).

**Table 4.8: Break-Even Analysis Result**

|                                    | Farmer's Current State of Production | Break-Even State of Production |
|------------------------------------|--------------------------------------|--------------------------------|
| Quantity of Pepper sold (16kg bag) | 8                                    | 3.252                          |
| Price of a bag of pepper           | 400.00                               | 400.00                         |
| Total Revenue                      | 3200                                 | 1300.8                         |
| Total Variable Cost                | 1006.60                              | 409.19                         |
| Total Contribution Margin          | 2193.40                              | 891.61                         |
| Total Fixed Cost                   | 891.61                               | 891.61                         |
| Profit/ (Loss)                     | 1301.79                              | 0                              |

#### 4.7 Analyses of the Constraints of Crop Farmers in Using Local Organic Resources for Soil Fertility Improvement

Taking each challenge as realised from a PRA exercise, the farmers were asked to respond to the option of YES or NO if they really face each of the challenges emanated from the PRA as a result of their use of local organic resources in soil fertility improvement (cow dung). The results are displayed in figure 4.8;

**Figure 4.8 Distribution of Farmers by Constraints**

Source: Authors computation from field data

The analyses in figure 4.8 shows that the main challenges of crop farmers in the use of matured cow dung are its Labour intensiveness, its expensiveness, its transportation difficulty and finally the insufficiency number of animals to produce manure. The least among their challenges are non-availability of animal manure from external sources and lack of machinery/equipment to use.

#### **4.7.1 Labour intensive**

About 50.2% of the farmers describe labour intensive as the major challenge. This results from the fact that farmers need to work on the cow dung, turn it over frequently to ensure that it is thoroughly dried by the sun. Since the odour is unpleasant managing it becomes very difficult for most farmers that deal with it. The use of cow dung also according to farmers promotes weed growth hence few weeks after application farmers have to deal with the tedious activity of weed control.

#### **4.7.2 Expensive (high cost of matured cow dung)**

About 32.8% of the farmers said the cost of matured cow dung is their major challenge. Due to the reduction in the number of cattle farmers, the few farmers involved in cattle farming in order to make more money sell the cow dung at relatively high prices to the farmers. This just makes economic sense as demand is outwitting supply. Farmers buy a ton of cow dung at GHS 117.00 when they compare this to the use of inorganic fertilizer to find it cheaper and easier to handle.

#### **4.7.3 Transportation difficulty**

About 31.9% of the farmers said transportation difficulty is their major challenge. Since cattle farmers usually leave a little far from township farmers in their quest to mobilize enough cow dung move from one farmer to the other. It hence becomes difficult to mobilize enough if

means of transport becomes a problem to the farmer. The farmer is restricted in his coverage of cattle farmers and will not be able to mobilize enough cow dung.

#### **4.7.4 Insufficient animal**

About 29.3% of the farmers said Insufficient animal i.e. cattle is the major challenge. This describes the insufficiency of cattle to meet the demands of the farmers. This limits farmers as to the quantity of cow dung they can access. This factor has resulted in many farmers not meeting their intensity target as they are limited to manage the available amount of cow dung. Also, most cattle farmers do this on free range hence it is difficult to gather the cow dung in high concentration.

#### **4.7.5 Lack of machinery and non-availability of animal manure**

About 4.7% of the farmers said lack of machinery and non-availability of animal manure is their major challenge. However, lack of tools and implements to work with was not a huge challenge because most farmers have the basic tools to work with and to use to support their farming activities. Animal manure is however a resource that is available in the locality but the mobilization of it becomes the tedious exercise. The Ada West district is one of the few districts with a high interest in cattle rearing, the missing factor is that most of the farmers have not made that deliberate effort to keep cow dung for sale to farmers.

The above results corresponds to the findings of the Participatory Rural Appraisal report of the ORM4SOIL project in the University of Ghana in the year 2016 which states that, the major challenges to the adoption of animal manure in the Ada West District is its promotion of weed growth, its smell i.e. difficulty to manage and labour intensiveness, its expensiveness and the fact that it is not readily available.



## **CHAPTER FIVE**

### **SUMMARY, CONCLUSION AND RECOMMENDATION**

#### **5.1 Introduction**

This section presents the summary of the results of all the findings of this study, it states the conclusions drawn and the recommendations to the respective findings.

#### **5.2 Summary**

This study sought to estimate the proportion of crop farmers using local organic resources in soil fertility improvement in Ada West District. The analysis of data involved descriptive statistics such as bar chart, to determine the intensity of adoption of the various local organic resources in soil fertility improvement. The proportion of farm land out of a farmer's total farmland committed to the use of each local organic resource was calculated and the results were analyzed using descriptive statistics. The tobit model was used to analyze the factors that influence the intensity of adoption of animal manure and matured cow dung respectively as they are the most used local organic resources in soil fertility improvement in the Ada West District. To estimate the cost and benefit of using matured cow dung in soil fertility improvement in crop production, the study used the partial budget and break-even analysis to inform farmers on the best decision to take. Lastly descriptive statistics was used to analyze farmers' responds to the various challenges to adopting animal manure and this response were presented on a bar chart.

A greater proportion of crop farmers in the District use animal manure other than cow dung (49.5%) in improving the fertility of their soil. This consist of all forms of animal droppings aside cow dung (fowl dropping, swine dropping, goat). This was closely followed by the use of matured cow dung which has 39.2% of the population of crop farmers in the District using

it for soil fertility improvement. Altogether about 88.7% of the total population in the district use the two sets of local organic resources in soil fertility improvement.

Concentrating on the two most used local organic resources for soil fertility improvement in the District, matured cow dung is used more intensely at a rate of 0.65 (65% of cultivated land) as compared to animal manure which has an intensity of use of 0.43. This corroborates with the fact that matured cow dung is easier to access at a go in larger quantity than the other types of animal manure's in the District.

Factors that influence the intensity of adoption of both animal manure and matured cow dung are; farmers access to credit, farmers ownership of land and farmers ownership of a means of transport. Also factors having positive relation with the adoption of these two organic resources are; farmers' perception of the infertility of their soil, off-income, farmers' membership of FBO and farmers access to information on soil fertility enhancing local materials.

Replacing inorganic fertilizer with matured cow dung in soil fertility improvement results in a net loss of GHS 699.50 per hectare. The break-even point of production for pepper farmers is 3.252 bags of pepper at a selling price of GHS 400.00. Averagely, pepper farmers who are currently using matured cow dung for soil fertility improvement are making a profit of GHS 1309.79 per hectare of production.

The most pressing challenge of using animal manure for soil fertility improvement in the Ada West District is labor intensive, followed by its expensiveness, transportation difficulty, insufficiency, lack of equipment to adequately handle animal manure and finally non availability of animal manure in that order respectively.

### 5.3 Conclusion

Despite the widely anticipated use of a variety of local organic resources for soil fertility improvement by crop farmers in Ada West District, majority of them use animal manure and matured cow dung. The use of animal manure is however not well structured since most of it is obtained from neighbors and this is not done on wide scale basis as compared to the matured cow dung which can be obtained from cattle farmers who are very much conspicuous in the district, operate on commercial basis and easier to locate.

Farmers who use matured cow dung use it more intensely as compared to those who use animal manure for soil fertility improvement. The intensity of use of matured cow dung is above average on a ratio scale of 1, given its value of 0.65 (65% of cultivated land) whiles that of animal manure is below average on the same scale given its value of 0.43 (43% of cultivated land).

The factors that influence the intensity of adoption of matured cow dung or animal manure are their cost, access to credit by farmers, educational level of farmers, farmers membership of FBOs and farmers ownership of their own lands.

The study concludes that, replacing inorganic fertilizer with matured cow dung in soil fertility improvement, comparatively leaves the farmer at a financial loss. However, the use of matured cow dung independently as a soil fertility enhancing material is profitable to the pepper farmer's during the break-even analysis.

The most pressing challenge in using local organic resources by farmers in soil fertility improvement is its labor intensiveness which encompasses the process of its mobilization, processing and preparation for use and finally its application to the soil.

#### **5.4 Recommendation**

The usage of matured cow dung and animal manure is common among the farmers in the District, an important thing to do will be for extension agents to help train farmers on effective animal manure and matured cow dung handling and quantity of usage of the animal manure and matured cow dung. This will influence farmers' choice of local organic resource and the intensity of its use.

Farmers should form cooperatives and farmer based groups and this will increase their opportunity of access to credit facilities from financial and micro credit facilities within and outside the district. Farmers can also engage in collective purchase of animal manure or matured cow dung so that they have a greater bargaining power to buy at a lesser price compared to the amount at which they buy now since cost of local organic resource is an important determinant in adoption of animal manure or matured cow dung in soil fertility improvement. The existence of the farmer groups will give them a platform of learning to be able to lobby agricultural research organizations and public and private extension service providers to engage them in education.

In order to address the challenge of high cost of matured cow dung, stakeholders should work at increasing the quantity of cattle production in the area to directly influence the quantity of cow dung available. The private sector must be engaged to support and invest in this initiative. The chiefs, opinion leaders and political leadership of the district should lobby for government initiatives to promote public private partnership in cattle production in the area.

To ameliorate the stress that comes with managing raw cow dung, both crop and cattle farmers should be trained in preparation of compost. This can be done by lobbying private sector and government into establishing micro-compost centers in identified communities where cow dung can be obtained in larger quantities. If this is done, farmers will be saved the task of

dealing with excessive smell of cow dung, bulkiness of cow dung which makes it more laborious to handle and apply on the field. The use of the matured cow dung at the composted stage also facilitate easy release of nutrients to the plant for assimilation.

Farmers should complement the use of matured cow dung and animal manure with inorganic fertilizer in their quest to improve the fertility of their soil in crop production since this makes their farming business more profitable.

The study recommends the use of the local organic resources (matured cow dung and animal manure) for soil fertility improvement because it is profitable to the pepper farmers and research supports it to have a better influence on the organic matter content, structural make up, flora and fauna life of the soil coupled with its environmental friendliness (Glover, 2010). In the long term, the nutritional value of manure (e.g. matured cow dung and animal manure) is also five (5) times the nutritional value of inorganic fertilizer of same quantum according to previous studies by Lekasi *et al.* 1998, hence farmers and consumers in the long run stand a better chance of benefiting when using local organic resources for soil fertility improvement.



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## APPENDIX 1: ORM4Soil Baseline Survey Questionnaire 2016

*(This questionnaire shall only be administered to those who are the **main decision makers in the farm** and are 18 years of age and above)*

**Introduction by Enumerator**

Name.....

*"Hello, Good morning / Good afternoon*

*I am ...NAME OF ENUMERATOR.....from ...the University of GHANA*

ICE BREAKING: Try to find a good introduction into the conversation (e.g talk about something that caught your attention as you approached the home, like animals or crops, OR you could talk about the weather, rain etc.) After some time you can introduce the survey as follows:

*"We are conducting a study about Soil Fertility and farmers' activities with regard to soil fertility in this area. For this interview, it would help us a great deal to talk to the person in this household who makes the decisions about farming. Is that person available, and could we talk to him or her?"*

*Thank you!*

*Proceed with the introduction*

*We are asking close to 300 farming households in this area about their farming practices, especially on soil fertility, and the kind of information they receive about soil fertility. We would like to understand the major practices already being used to improve and/or sustain soil fertility and the major challenges and hindrances to using those technologies. Some researchers are working with a few farmers in this area to test old and new soil fertility management techniques which will be made known to the farmers in this area. After three years, we will come back to find out if you will have heard about the tested technologies found to be suitable for your area, and which of the technologies you will probably be using at that time. For that we need your help. The research can only succeed if we can learn from you.*

*Your household has been selected to participate in this study using a random method based on register where we identified the households by specific rules for "random" selection*

*Your participation in this research is very important because we would like to obtain a realistic overview of the situation and we need to learn from all type of farmers. Therefore it is essential that we receive true answers that reflect your experiences.*

*This is an international research that is being conducted not only here in Ghana..., but also in Zambia, Kenya and Mali. The research here in Ghana is being conducted by researchers from the University of Ghana. The results of this research are expected to help the farming community in preserving or increasing soil fertility, increasing yields and income from farming, and ensuring food security. We assure you that the information you provide is completely confidential and your name will not be disclosed to any other person outside our research team.*

*If you have any questions or concerns regarding this research, you can pose them now before we start. If you have any questions after I have left, you may direct them to **Prof Ofosu-Budu**, of the University of Ghana, who is the Principal Researcher in Ghana. He can be reached on the following phone number (0244428199).*

*We hope that you can give us your time for this exercise. The interview will last about an hour. So can you avail yourself for the interview?"*

**Wait for answer from interviewee**

*If answer is "Yes", start the interview; if No, say thank you to the person spoken to, and say good-bye in a polite manner.*

## **BEFORE START:**

### **Interviewer**

*Please write down the location of that interview, and make clear which site it belongs to.*

**Location of Interview:** .....

**Study area/Site:** (please tick)

- ☐ Sege
- ☐ Kade

**Gender of Interviewee** (Please indicate WITHOUT ASKING)

- ☐ Male
- ☐ Female



## **NOW START**

**Date of interview**

.....

Starting time \_\_: \_\_ AM/PM

**Name of Interviewee: (needed for clear identification)**

.....

**Phone contact**

*Please collect the phone contacts of the interviewee*

**Phone No.....**

**Alternative Phone No. ....**

### **PART 1**

#### **Section A: Household and farm**

**1. What is the land size (ropes/poles) that you have available in this household?**

- Number and name of land size unit (eg. 30 ropes/poles): .....

**2. What is the land size that you are actually working on for farming purposes? (ropes, local acre)**

- Number and name of land size unit (eg. 30 ropes/poles): .....

**3. What type of livestock and how many of each type do you keep on your farm?**

| Type of livestock          | How many? |
|----------------------------|-----------|
| Poultry (specify)          |           |
| Turkey                     |           |
| Duck                       |           |
| Guinea                     |           |
| chicken (layers, broilers) |           |
| Chicken local              |           |
| Goats                      |           |
| Sheep                      |           |
| Pigs                       |           |
| Cattle                     |           |
| Donkeys                    |           |
| Any other specify          |           |

**4. Which main crops do you actually cultivate? – OPEN (max. 4 crops)**

|   | Type of crop | Land area under cultivation<br>(no. of ropes/poles) |
|---|--------------|-----------------------------------------------------|
| 1 |              |                                                     |
| 2 |              |                                                     |
| 3 |              |                                                     |
| 4 |              |                                                     |
|   |              |                                                     |

**Section B: Access to markets/processing unit (main crops)****5. How far is the nearest buyer for your first main crop produce (name first crop mentioned in table on Q4)?**

- Please give approximate distance in kilometers from farm gate/household:

.....

**6. How far is the nearest buyer for your second main produce?**

- Please give approximate distance in kilometers from farm gate/household:

.....

**7. How far do you have to travel to reach your nearest agro-dealer?**

Please give approximate distance in kilometers from your farmgate

.....

**8. What is the distance from your farm to the next tarred road?**

- Please give approximate distance in kilometers from farm gate

.....

**Section C: Extent of Commercialization**

**9. How much of your main crop(s) did you harvest in the last harvest?**

**How much did you sell?**

Last harvest : (for food crops: June-July.2016)

(for cash crops: Oil Palm and Cocoa, 2015 cumulative harvest)

| Type of crop                            | No. of Units<br>harvested(bags<br>?, tons?) | No units sold |
|-----------------------------------------|---------------------------------------------|---------------|
| Main crop <b>production</b><br>(Crop 1) |                                             |               |
| (Crop 2)                                |                                             |               |
| (Crop 3)                                |                                             |               |
| (Crop 4)                                |                                             |               |

**Section D: Access to water (for farming)**

**10. What is your source of water for farming purposes?** Tick where appropriate, use the list to probe

- Rain fall
- Access to boreholes, wells,
- Irrigation (incl. irrigation projects)
- Access to river
- Other (please specify): .....





**Section 1e: Access to machinery/implements**

11. Do you have access to the following farm equipment/implement (“access” includes both ownership and renting) Please tick ✓

|                                                          | Yes | No |
|----------------------------------------------------------|-----|----|
| Animal drawn power (Oxen, Donkey, Camel etc.)            |     |    |
| Tractor or smaller machinery(power tiller) to work soils |     |    |
| Hand hoe                                                 |     |    |
| cutlass                                                  |     |    |
| Other (please specify):                                  |     |    |

**Section F: Access to loan (not grant!!)**

12. Have you ever applied for a loan to finance your farm operations in the last 3 years?

- ☐ Yes
- ☐ No

*Interviewer: If Yes, go straight to question 14, If No, go to 13 and skip 14-16.*

13. If you have never applied for a loan, please explain why

.....

14. If yes, to whom did you apply for a loan to finance your farm operations?

- ☐ Commercial Bank
- ☐ Government credit programme (MASLOC)
- ☐ Farmer Based Organization
- ☐ Microcredit scheme
- ☐ Susu (for example: savings group, “Merry-go-round” or any other scheme)
- ☐ Online credit ( for example Mshwari in Kenya)
- ☐ Lima Credit Scheme in Zambia
- ☐ Money lender
- ☐ Any other source, specify

.....

**15. Was your application for a loan approved/accepted?**

- ☐ Yes
- ☐ No

**16. If No, why was your application for a loan not approved/accepted? - please explain**

.....

### **Section G: Land tenure**

**17. Are you farming on family land?**

- ☐ Yes, all my farmland is family land
- ☐ Yes, part of my farmland is family land
- ☐ No, I don't have family land

**18. Do you have ownership of the land you are cultivating currently? (Freehold/leasehold)**

- ☐ Yes, all my farmland is freehold/leasehold
- ☐ Yes, part of my farmland is freehold/leasehold
- ☐ No, I don't have freehold/leasehold

**19. Are you farming on community land?**

- ☐ Yes, all my farmland is community land
- ☐ Yes, part of my farmland is community land
- ☐ No, I don't have community land

**20. Are you farming on any land that you have rented?**

- ☐ Yes, all my farmland is rented
- ☐ Yes, part of my farmland is rented
- ☐ No, I do not farm on rented

*Interviewer: if answer is No, go directly to question 23*

**21. Who owns the rented land you are currently farming on?**

- ☐ Owners of the land are family member(s)
- ☐ Owners are not family members

**22. For how many years have you rented the land you are farming on? (please tick)**

- ☐ Less than 1 year
- ☐ 1 year to 2 years
- ☐ More than 2 years to 3 years
- ☐ More than 3 years to 5 years
- ☐ More than 5 years

23. **Do you feel secure regarding the land tenure** system here, i.e. continuing working on this piece of land?

- ☐ Yes
- ☐ No

24. **Do you have the confidence** to invest a substantial amount of labor or capital in the land you are currently farming on? E.g. make terraces, agroforestry, fallowing?

- ☐ Yes
- ☐ No

25. **Please give reasons for your answer:**

.....

#### **Section H: Workforce and family size**

26. **Who takes decisions about farming activities in your household?**

- ☐ Male head of household
- ☐ Female head of household
- ☐ Both spouse male and female
- ☐ Both male and female spouse including an elder child
- ☐ Someone else (please specify): .....

27. **How many adults live in this household (Aged 18 years and above and eat from the same pot)?**

- ☐ Number: .....

28. **How many children live in this household (Aged below 18 years)?**

- ☐ Number: .....

29. **How many adult members of your household work mainly on the farm** (over the past year, not considering some casual work with neighbors etc.)

- ☐ Number: .....

30. **How many adult members of your household work mainly outside the farm** (not considering some help on harvest or when visiting)

- ☐ Number: .....

31. How many casual workers did you hire to work on your farm during last season ((March-July. 2016 and for how long?

| Farm Operation | No of casual workers? | For how long? | Units (days, weeks) |
|----------------|-----------------------|---------------|---------------------|
| ploughing      |                       |               |                     |
| weeding        |                       |               |                     |
| sowing         |                       |               |                     |
| harvesting     |                       |               |                     |

### Section I: Off-farm income

32. How much of the total income of this household comes from outside the farm (remittances, salaried work outside farm etc.).

- None (Picture 1)
- 1-25% (Picture 2)
- 26-50% (Picture 3)
- 51-75% (Picture 4 first picture in second row)
- 76-100% (Picture 5 second picture in second row)

(INTERVIEWER: a scorecard should be shown here that visualizes the answer options in a graphic form)

### Section J: Food security

33. On the average, how many meals are taken in your household in a day?

- One meal
- Two meals
- Three meals
- More than three meals

34. Does your household have enough food throughout the year (including both from your own produce or food purchases)?

- Yes, throughout the year
- No, not the entire year (there are times of shortage)

INTERVIEWER: if Yes, go straight to question 37

35. How long within a year when members of your household do not have enough to eat?

- Less than a month
- 1 to 2 months
- More than 2 to 4 months
- More than 4 months

**36. How many meals per day are taken in your household during times of shortage?**

- ☐ No meal
- ☐ One meal
- ☐ Two meals
- ☐ Three meals
- ☐ More than three meals
- ☐ Any other time, please specify: .....

## **PART 2: Agronomy**

*We now want to know a little bit more about soil fertility in your farm.*

**37. In your personal view and your own words, what do you understand by the term “soil fertility”?**

.....

### **Section A; Perception of soil fertility**

**38. Is soil fertility a problem on your farm?**

- ☐ Yes, it is a major problem
- ☐ Yes, it is only a minor problem
- ☐ No, it is not

**39. How would you rate the level of soil fertility in your farm? (Tick one of the options below)**

- ☐ Soil fertility is very good on my farm
- ☐ Soil fertility is good
- ☐ Soil fertility is not good /not bad (fair)
- ☐ Soil fertility is bad
- ☐ Soil fertility is very bad

**40. Have you observed a change in soil fertility over the last 5 to 10 years? (Please tick one of the options)**

- ☐ Yes, soil fertility has declined tremendously
- ☐ Yes, soil fertility has declined
- ☐ No change, soil fertility has remained stable
- ☐ Yes, soil fertility has somewhat improved
- ☐ Yes, soil fertility has improved tremendously

**41. Could you give us a reason for declining, stable or improving soil fertility:**

.....

### **SECTION B: Knowledge on Soil Fertility Management Options**

42. Do you know of the practice of using animal manure for the improvement and maintenance of soil fertility?

- ☐ Yes
- ☐ No

If the answer is yes, proceed to question 43, if the answer is No, proceed with question 44.

43. How do you think manure should be handled from the source (cow dung, pig dropping, chicken manure, chicken run, etc.) till it is applied to the crop?

.....

44. Do you know of the practice of using trees (& shrubs) to improve soil fertility?

- ☐ Yes
- ☐ No

If no, go to question 47.

45. If yes, which trees ( & shrubs) can be used (up to 4 mentioned)

.....

46. Do you know compost?

- ☐ Yes
- ☐ No

b. How do you prepare compost for your farm?

.....

47. Do you know of the practice of intercropping with legumes (e.g. beans, groundnuts, cow peas)

- ☐ Yes
- ☐ No

If yes, go to question 48, if No, go to question 49

48. Why do you think intercropping with legumes is practiced with regard to soil fertility?

.....



**49. Do you know *Gliricidia sepium* ?**

- ☐ Yes
- ☐ No

If yes, continue, if no, go straight to question 51

**50. How can you use *Gliricidia sepium* to improve soil fertility :**

*Interviewer: Don't read the list of answer options*

- ☐ *Gliricidia sepium* can be cut and used as mulch
- ☐ *Gliricidia sepium* can be used as forage
- ☐ *Gliricidia sepium* can be cut and composted.
- ☐ *Gliricidia sepium* can be made into liquid or used as foliar
- ☐ Don't know

**51. Do you know the benefits of retaining crop residue (e.g. EFB or CPH) in the field after harvest?**

**Kindly explain**

.....

**51\_b: Do you know the practice of Bio-char?**

- ☐ Yes
- ☐ No



**SECTION C: Current Practice of Organic Soil Fertility Management****52. How do you practice /apply the following techniques?**

| <b>Technology<br/>Name of practice</b>             | <b>Yes /<br/>No<br/>( Yes =<br/>√;<br/>No =<br/>0)</b> | <b>Used for<br/>how long?</b> | <b>To what extent<br/>do you practice<br/>in terms of<br/>area?</b> | <b>Applied rate<br/><br/>What amount of<br/>manure/<br/>compost/<br/>Fertilizer / crop<br/>residue did you<br/>apply?</b> |
|----------------------------------------------------|--------------------------------------------------------|-------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| 1. Animal manure?                                  |                                                        |                               |                                                                     |                                                                                                                           |
| 2. Crop rotation?                                  |                                                        |                               |                                                                     | n.a                                                                                                                       |
| 3. Fallowing                                       |                                                        |                               |                                                                     | n.a.                                                                                                                      |
| 4. Mineral/Inorganic fertilizer                    |                                                        |                               |                                                                     |                                                                                                                           |
| 5. Green manure?                                   |                                                        |                               |                                                                     | n.a.                                                                                                                      |
| 6. Soil fertility enhancing trees?                 |                                                        |                               |                                                                     | <i>Interviewer : ask<br/>for trees used:</i>                                                                              |
| 7. Compost?                                        |                                                        |                               |                                                                     |                                                                                                                           |
| 8. Terracing /Green strips/ Anti-Erosion           |                                                        |                               |                                                                     | n.a.                                                                                                                      |
| 9. Minimum or zero tillage                         |                                                        |                               |                                                                     |                                                                                                                           |
| 10. Crop residues on soil (mulch or incorporation) |                                                        |                               |                                                                     | n.a                                                                                                                       |
| 11. Intercropping with Legumes                     |                                                        |                               |                                                                     | n.a.                                                                                                                      |
| 12. <i>Gliricidia Sepuim</i>                       |                                                        |                               |                                                                     | n.a.                                                                                                                      |

|                                                 |  |  |  |      |
|-------------------------------------------------|--|--|--|------|
| 13. EFB/CPH<br>(decomposed)                     |  |  |  |      |
| 14. EFB/CPH (co-compost)                        |  |  |  |      |
| 15. EFB/CPH (compost)+biochar                   |  |  |  |      |
| 16. Mature cowdung                              |  |  |  | n.a. |
| 17. cowdung compost                             |  |  |  |      |
| 18. co-composted + biochar                      |  |  |  |      |
| 19. Mineral fertilizer + EFB/CPH (decomposed)   |  |  |  |      |
| 20. Mineral fertilizer + EFB/CPH (co-compost)   |  |  |  |      |
| 21. Mineral fertilizer + EFB/CPH+biochar        |  |  |  |      |
| 22. Mineral fertilizer + Mature cowdung         |  |  |  |      |
| 23. Mineral fertilizer + cowdung compost        |  |  |  |      |
| 24. Mineral fertilizer + co-composted + biochar |  |  |  |      |

53. **What motivates/makes you to practice organic soil fertility management technologies? (open question)** Please list the reasons

.....

*INTERVIEWER: We now want to ask you about the challenges you face in applying those technologies*

#### **SECTION D: Challenges**

*INTERVIEWER: All questions (54-61) need to be posed, even if farmer doesn't practice at the moment. Please ask first without reading the answer options. After the first answer please probe with some options from the list.*

**54. What challenges do you face in the application of animal manure? (Several answers possible)**

- labour intensive
- Transportation difficulties (bulkiness, weight problems)
- Inadequate animal manure
- Lack of machinery/equipment to use
- Non-availability of Animal manure from external sources
- Animal manure is too expensive to buy
- Not applicable (only in case farmer doesn't know the technique)
- Others (please specify) :

.....

**55. What challenges do you face in the use of compost? (Several answers possible)**

- labour intensive
- Transportation difficulties (bulkiness, weight problems)
- Insufficient amount of material to make compost
- Lack of machinery/equipment to produce or apply to the field
- Non-availability of Compost
- Compost is too expensive to buy
- Inadequate knowledge about compost making
- Not applicable (only in case farmer doesn't know the technique)
- Others (please specify) :

.....

**56. What challenges do you face in the use of crop residue as soil cover (mulch) or as organic material?**

- We use crop residues as fodder
- Crop residues are used as fuel wood
- Free grazing animals just feed on it
- Too much labour needed to collect and distribute crop residues
- Not many crop residue available
- Crop residues are not available to buy (for sale)
- Not applicable (only in case farmer doesn't know the technique)
- Others(please specify):

.....

**57. What challenges do you face when practising intercropping?**

- Too much labour required
- Competition to main crop
- Difficulties in harvesting
- No seeds available
- Not applicable (only in case farmer doesn't know the technique)
- Others(please specify):  
The birds eat the beans  
.....

**58. What challenges do you face when using Gliricidia Sepium?**

- Never heard of Gliricidia Sepium
- X Lack of knowledge on how to use it
- We don't know whether Gliricidia Sepium is good or not
- Availability of seed/ planting material to plant on our farm
- Unavailable to buy from neighbours and others
- Not applicable (only in case farmer doesn't know the technique)
- Others(please specify):  
○  
.....not secure of land tenure.....

**59. What challenges do you face when applying inorganic fertilizer? (Several answers possible)**

- Fertilizer is too costly
- Fertilizer negatively affect the soil
- Appropriate fertilizer is not available
- Yields are not convincing
- Fertilizer doesn't pay off
- Don't know the recommended rates to use
- Other reasons (please specify):  
If you are not in the right party, you don't get it. It is not available.  
Tomatoes become soft. So they rot early.  
.....

**60. What challenges do you face when using trees to improve soil fertility?**

- Lack of knowledge on which species to use
- Non-availability of planting material
- Competition to use tree leaves as fodder
- Trees compete for water with crops
- Limited availability of land
- Others(please specify):  
.....

**61. What challenges do you face when using minimum tillage?**

- Too many weeds

- Lack of equipment to use
- Herbicides are too costly
- Herbicides are not available
- The ground becomes too hard and crops cannot access water
- Others(please specify):

.....

61\_b: What challenges do you face when practicing bio-char?

- Too much labour required
- Too complicated technique
- Others (please specify) :

.....

**SECTION E: Self-Assessment of farmers regarding readiness for innovation, and readiness to solve problems**

**62.** Have you introduced a new technology or a new plant in your farm in the last three years?

- Yes, a new plant
- Yes, a new technology
- No

**63. Please explain your decision:**

If yes (new plant or technology realized), could you specify?:

.....

- If not (no new plant or technology introduced) , why not?

.....



**PART 3: Communication****SECTION A: Mass media and information channels in general**

**64. What media channels do you use to obtain general information? Tick all applicable.**

- ☐ Local Radio
- ☐ National Radio
- ☐ TV
- ☐ Mobile phones
- ☐ Newspaper
- ☐ Magazine
- ☐ SMS Services
- ☐ Internet
- ☐ Social media
- ☐ Others (please specify):

.....

**SECTION B: Information channels regarding Agriculture**

**65. What media channels and programs do you follow regularly ( at least once a week) to get information about agriculture,**

*(INTERVIEWER writes down the broadcasters and print media VERBATIM, as well as the name of programs)*

| Media Channels                      | Name of Program or Service or Website |
|-------------------------------------|---------------------------------------|
| <b>Name of Radio Station</b>        |                                       |
| 1.                                  |                                       |
| 2.                                  |                                       |
| <b>Name of TV Station</b>           |                                       |
| 1.                                  |                                       |
| 2.                                  |                                       |
| <b>Name of Newspaper / Magazine</b> |                                       |
| 1.                                  |                                       |
| 2.                                  |                                       |
| <b>Name of Mobile Service</b>       |                                       |
| 1.                                  |                                       |
| 2.                                  |                                       |
| <b>Websites</b>                     |                                       |
| 1.                                  |                                       |
| 2.                                  |                                       |

**SECTION C: Information about Soil fertility**

Now we talk about your information sources solely on soil fertility. These can be others than just media sources.

**66. From where in general do you get information about soil fertility, its problems and management? How often do you get such information?**

|                                    | <b>Yes ( = √)<br/>No ( = 0,<br/>never)</b> | <b>rarely<br/>(1-2 times in<br/>3 months of<br/>a season)</b> | <b>often<br/>(3-5 times<br/>in 3 months<br/>of a<br/>season)</b> | <b>very<br/>frequently<br/>(weekly or<br/>even more<br/>often, 2-3<br/>times/week)</b> |
|------------------------------------|--------------------------------------------|---------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. Family                          |                                            |                                                               |                                                                  |                                                                                        |
| 2. Neighbours and friends          |                                            |                                                               |                                                                  |                                                                                        |
| 3. Other farmers                   |                                            |                                                               |                                                                  |                                                                                        |
| 4. Opinion leaders in farming      |                                            |                                                               |                                                                  |                                                                                        |
| 5. Extension officers              |                                            |                                                               |                                                                  |                                                                                        |
| 6. Research Institutes             |                                            |                                                               |                                                                  |                                                                                        |
| 7. Agro dealers                    |                                            |                                                               |                                                                  |                                                                                        |
| 8. Traders Buyers Cooperatives     |                                            |                                                               |                                                                  |                                                                                        |
| 9. Groups in community             |                                            |                                                               |                                                                  |                                                                                        |
| 10. National Radio Station         |                                            |                                                               |                                                                  |                                                                                        |
| 11. Local Radio Station            |                                            |                                                               |                                                                  |                                                                                        |
| 12. TV                             |                                            |                                                               |                                                                  |                                                                                        |
| 13. Internet                       |                                            |                                                               |                                                                  |                                                                                        |
| 14. Social Media                   |                                            |                                                               |                                                                  |                                                                                        |
| 15. Newspapers/Magazines           |                                            |                                                               |                                                                  |                                                                                        |
| 16. Mobile services (SMS Esoko)    |                                            |                                                               |                                                                  |                                                                                        |
| 17. Agricultural Shows             |                                            |                                                               |                                                                  |                                                                                        |
| 18. Church                         |                                            |                                                               |                                                                  |                                                                                        |
| 19. Field days , site visits       |                                            |                                                               |                                                                  |                                                                                        |
| 20. Market days                    |                                            |                                                               |                                                                  |                                                                                        |
| 21. Public community<br>gatherings |                                            |                                                               |                                                                  |                                                                                        |
| 22. Special training workshops     |                                            |                                                               |                                                                  |                                                                                        |
| 23. Others?                        |                                            |                                                               |                                                                  |                                                                                        |

**67. Which three sources of information do you consider as most important in influencing your decisions on matters concerning soil fertility?**

- a).....
- b).....
- c) .....

**SECTION D: Assessment of Information on Soil Fertility Management**

**68. Would you say the information you get on soil fertility is sufficient in quantity (e.g. length of radio program, number of programs)?**

- ☐ Yes, it is sufficient in quantity
- ☐ No, it is not enough

**69. In your view is the information you get on soil fertility sufficient in frequency (e.g. how often per week or month you can listen to a soil fertility program)?**

- ☐ Yes, it is sufficient in frequency
- ☐ No, it is not frequent enough

**70. Is information on soil fertility in mass media provided to you at the right time?**

- ☐ Yes, it is available at the right time
- ☐ No, it is not at the right time

*If yes, go straight to question 72*

**71. If No, please specify, what would be the best time to receive information about soil fertility:**

- ☐ .....

**72. In your opinion, is the information presented in a way that makes understanding easy for many farmers?**

- ☐ Yes, the information is provided in a language that is easy to understand

- No, the information contains a lot of technical jargon which makes it difficult to understand for many farmers

**73. Does the information you receive contain what you need to know in order to apply Soil Fertility Management practices?**

- Yes, the information is (always) sufficient to be applied
- No, the information is (sometimes) not sufficient

**74. If no, what kind of information would you like to receive about soil fertility management practices? (Several answers possible)** Interviewer: Please probe those answer options

- Information about correct rates of application
- Information about profitability and economics
- Information about availability of material like organic matter
- Others(please specify):

.....

**75. What is your assessment of the information on Soil Fertility Management?**

*INTERVIEWER: please explain the options before the farmer answers*

- Information in general presents only/mainly the advantages of SFM
- Information presents only/mainly the disadvantages of SFM technologies
- Information presents both advantages and disadvantages and discuss the pros and cons of new SFM technologies
- There is no assessment (of advantages and disadvantages), it is just description
- Others (please specify):

.....

**76. In which language would you prefer to receive information on Soil fertility?**

- First preference: .....
- Second preference: .....

## PART 4: Society

### SECTION A: Membership in organizations and networks

**77. Are you a member of any of the following organizations or groups? (tick as appropriate ✓)**

- ☐ Farmer groups
- ☐ Saving groups
- ☐ Cooperatives (for produce)
- ☐ Religious groups
- ☐ Youth groups
- ☐ Women groups
- ☐ Other groups, If other group, please specify: .....

**78. Do you have a special role in one or more of these groups?**

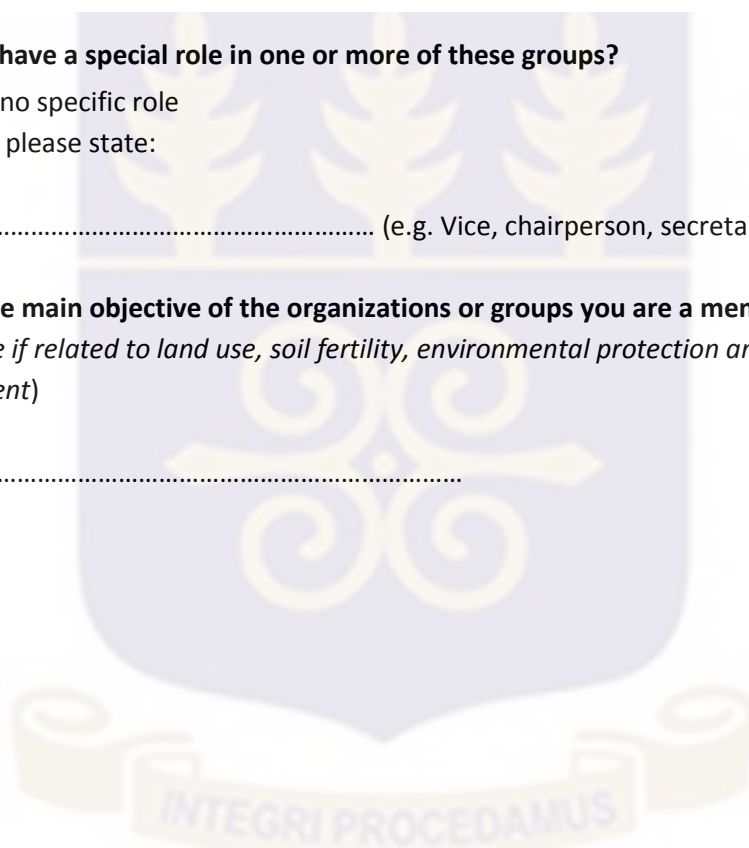
- ☐ No, no specific role
- ☐ Yes, please state:

..... (e.g. Vice, chairperson, secretary, treasurer etc)

**79. What is the main objective of the organizations or groups you are a member of**

*(Only state if related to land use, soil fertility, environmental protection and rural development)*

.....



## SECTION B: Languages

**80. What is your first language / mother tongue**

.....

**81. How well do you understand English?**

- ☐ Not at all
- ☐ A little
- ☐ moderately
- ☐ Well
- ☐ Very well

**82. How well do you understand Twi/Dangme ?** Please tell us from 0 (= not at all) to 5 (= very well, native speaker)

- ☐ Not at all
- ☐ A little
- ☐ moderately
- ☐ Well
- ☐ Very well

## SECTION C: ATTITUDE TOWARDS SOIL FERTILITY MANAGEMENT AND CROP FARMING

**83. Would you like to see your children becoming farmers?**

- ☐ Yes
- ☐ No

Please explain your answer.

.....

**84. Do you think your neighbours care for the soil?**

- ☐ Yes
- ☐ No
- ☐ Don't know

Kindly explain your answer:

.....

**85. What should be done within your community or the larger society in order to restore soil fertility?**



.....

**86. Do you know of any habit, tradition, practice or custom which prevents farmers to improve on soil fertility?**

*INTERVIEWER: Wait for answer first , only if explain answer options as examples when farmer has no idea about the question:*

- Women not allowed to plant trees?
- Women ownership of land restricted?
- Agroforestry restricted on rented land?
- Myths regarding specific plants?
- Other, specify

.....



**PART 5: Individual and Household (of interviewee)****SECTION A: Formal Education****87. What is your highest level of formal education? (Please tick ✓)**

- ☐ Never went to school
- ☐ Primary school attended
- ☐ Primary school completed (JSS in Ghana,)
- ☐ Secondary school attended
- ☐ Secondary school completed (WASSCE/SSSCE in Ghana,)
- ☐ Tertiary College attended
- ☐ Tertiary College completed (Certificate, Diploma, post Diploma)
- ☐ University Undergraduate (Bachelor's degree)
- ☐ University Postgraduate (Masters, PhD)

**SECTION B: Age****88. Would you please tell me your age (Interviewer: please tick ✓)**

- ☐ Below 20 years
- ☐ Between 21 and 30 years
- ☐ Between 31 and 40 years
- ☐ Between 41 and 50 years
- ☐ Between 51 and 60 years
- ☐ 61 years and above

**89. How long have you been a farmer?**

.....

**SECTION C: HOUSEHOLD ASSETS****90. Do you possess the following items: please tick ✓**

|                                                      | Yes = ✓ |
|------------------------------------------------------|---------|
| Wheel barrow                                         |         |
| Water pump/treadle pump                              |         |
| Other irrigation equipment, (e.g., irrigation pipes) |         |
| Solar panel and equipment                            |         |
| Radio                                                |         |
| TV                                                   |         |
| Computer                                             |         |
| Sawing Machine (for timber)                          |         |
| Fridge                                               |         |
| Motorbike                                            |         |
| Bicycle                                              |         |
| Vehicle (car)                                        |         |
| Sewing machine (for clothes)                         |         |
| Piped water in the house                             |         |

## Living standard (Observation only)

**Interviewers observe** the standard of living in the household. Please recall after interview

- Housing:
  - Brick walls
  - Timber walls
  - Mud walls
  - Tiled floor
  - Cemented floor
  - Mud floor
  - Difficult to observe
- Roofing
  - Tiles
  - (iron sheets)
  - Thatched (grass)
- Connection to electricity (national grid or generator, or solar)
  - Yes
  - No
  - Difficult to observe
- Drinking water supply
  - Taps in house
  - Public stand pipe
  - Well close to the house ( 500 meters )
  - River nearby
  - Water source not close to the house
  - Manual pump to water supply
  - Difficult to observe

INTERVIEWER: *We've now come to the end of our interview. Do you have some final remarks? Did we forget to ask something important? Is there something you'd like to add?*

### 91. Additions by interviewee

.....

.....

.....

.....

*Thank you very much for your time. We will now leave, but we wish you a pleasant day. You will hear from us again when we hold our field days about the trials by our researchers. We might also call on you later for the mid-term survey (only Kenya) and the end-line survey.*

INTERVIEWER: DO NOT FORGET TO WRITE DOWN PHONE NUMBER OF INTERVIEWEE AND CHECK IT IMMEDIATELY

**Phone No.....**

**End time: \_\_: \_\_AM/PM**



## APPENDIX 2: ORM4Soil Baseline Survey Questionnaire 2016

### Cost and Benefit of Crop Farmers

**Enumerators Name:** .....

**Farmers Name (including common name):** .....

**Farmers Contact:** .....

**Name of Town/District:** .....

**Date of interview:** .....

1. Farmer's farm size for in/organic fertilizer application.....

2. When did practice start? .....

3. Has farmer made any harvest from practice for the last two major seasons?

**Y/N**

| FERTILITY<br>ENHANCING<br>MATERIAL                         | QUANTITY<br>PURCHASED | COST<br>PER<br>UNIT | TOTAL<br>COST | COST OF<br>TRANSPORT<br>PER UNIT | PROPORTION<br>OF FARMERS<br>FARM SIZE<br>UNDER<br>TECHNOLOGY |
|------------------------------------------------------------|-----------------------|---------------------|---------------|----------------------------------|--------------------------------------------------------------|
| <b>ORGANIC MANURE</b>                                      |                       |                     |               |                                  |                                                              |
| 1. Animal manure                                           |                       |                     |               |                                  |                                                              |
| 2. Mature cowdung                                          |                       |                     |               |                                  |                                                              |
| 3. Legumes<br>e.g. beans,<br>groundnuts, cow<br>peas       |                       |                     |               |                                  |                                                              |
| 4. Compost(IF<br>FARMER BUYS<br>COMPOST)                   |                       |                     |               |                                  |                                                              |
| 5. EFB/CPH<br>(decomposed)                                 |                       |                     |               |                                  |                                                              |
| 6. EFB/CPH (co-<br>compost) (IF<br>FARMER BUYS<br>COMPOST) |                       |                     |               |                                  |                                                              |

|                                                 |  |  |  |  |  |
|-------------------------------------------------|--|--|--|--|--|
| 7. EFB/CPH (compost)+biochar                    |  |  |  |  |  |
| 8. Co-composted + biochar                       |  |  |  |  |  |
| <b>ORGANIC MANURE + MINERAL FERTILIZER</b>      |  |  |  |  |  |
| 9. Mineral/Inorganic fertilizer                 |  |  |  |  |  |
| 10. Mineral fertilizer + EFB/CPH (decomposed)   |  |  |  |  |  |
| 11. Mineral fertilizer + EFB/CPH (co-compost)   |  |  |  |  |  |
| 12. Mineral fertilizer + EFB/CPH+biochar        |  |  |  |  |  |
| 13. Mineral fertilizer + Mature cowdung         |  |  |  |  |  |
| 14. Mineral fertilizer + cowdung compost        |  |  |  |  |  |
| 15. Mineral fertilizer + co-composted + biochar |  |  |  |  |  |
| <b>MINERAL FERTILIZER ONLY</b>                  |  |  |  |  |  |
| 16. FERTILIZER                                  |  |  |  |  |  |



**CASUAL WORKERS**

| FARM OPERATION                      | NO OF CASUAL WORKERS | NUMBER OF MAN DAYS OF WORK | UNIT COST per acre | TOTAL COST |
|-------------------------------------|----------------------|----------------------------|--------------------|------------|
| Land clearing                       |                      |                            |                    |            |
| Ploughing                           |                      |                            |                    |            |
| Weeding                             |                      |                            |                    |            |
| Sowing                              |                      |                            |                    |            |
| Harvesting                          |                      |                            |                    |            |
| Spraying (Chemicals and fertilizer) |                      |                            |                    |            |

**MACHINERY/IMPLEMENTS/OTHERS for the major and minor season**

|                             | NUMBER | UNIT COST | TOTAL COST |
|-----------------------------|--------|-----------|------------|
| Hand hoe                    |        |           |            |
| cutlass                     |        |           |            |
| Sickles                     |        |           |            |
| Planting material           |        |           |            |
| Land (if rented)            |        |           |            |
| Water source                |        |           |            |
| Sprayer                     |        |           |            |
| Transportation (other.....) |        |           |            |
| Other (please specify):     |        |           |            |

**COST OF CREDIT**

4. HOW MUCH credit did you borrow for your practice? .....

5. What was the interest rate? .....

6. What was your period of repayment? .....

**CROP SALES (REVENUE/BENEFIT) major and minor season**

|   | MAIN CROPS | UNIT COST | QUANTITY SOLD | TOTAL REVENUE |
|---|------------|-----------|---------------|---------------|
| 1 |            |           |               |               |
| 2 |            |           |               |               |
| 3 |            |           |               |               |
| 4 |            |           |               |               |

**COMPOSTING (IF FARMER PREPARES OWN COMPOST)**

| <b>MATERIAL COST</b>                              | <b>UNIT COST</b> | <b>QUANTITY<br/>PURCHASED/USED</b> | <b>TOTAL<br/>COST</b> | <b>TOOL FOR<br/>MEASUREMENT</b> |
|---------------------------------------------------|------------------|------------------------------------|-----------------------|---------------------------------|
| EFB                                               |                  |                                    |                       |                                 |
| CPH                                               |                  |                                    |                       |                                 |
| COWDUNG                                           |                  |                                    |                       |                                 |
| FOWL DROPPINGS                                    |                  |                                    |                       |                                 |
| WATER MELON                                       |                  |                                    |                       |                                 |
| OTHER FARM<br>RESIDUE                             |                  |                                    |                       |                                 |
|                                                   |                  |                                    |                       |                                 |
| <b>TRANSPORT COST</b>                             |                  |                                    |                       |                                 |
| EFB                                               |                  |                                    |                       |                                 |
| CPH                                               |                  |                                    |                       |                                 |
| FOWL DROPPINGS                                    |                  |                                    |                       |                                 |
| COWDUNG                                           |                  |                                    |                       |                                 |
| WATER MELON                                       |                  |                                    |                       |                                 |
| OTHER RESIDUE                                     |                  |                                    |                       |                                 |
|                                                   |                  |                                    |                       |                                 |
| <b>LABOR COST</b>                                 |                  |                                    |                       |                                 |
| DIGGING PIT                                       |                  |                                    |                       |                                 |
| MANAGING THE<br>COMPOST(watering,<br>turning etc) |                  |                                    |                       |                                 |
| MOVING COMPOST<br>TO FARM AND<br>APPLICATION      |                  |                                    |                       |                                 |
|                                                   |                  |                                    |                       |                                 |



### APPENDIX 3: PLAGIARISM REPORT



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