SUSTAINED NO-TILL ADOPTION IN THE AGRO-ECOSYSTEMS OF GHANA: A FRAMEWORK FOR FINANCIAL AND RISK MANAGEMENT OPTIONS

A Thesis

by

KWADWO AMPONSAH

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee, Frederick Boadu
Co-chair of Committee, Edwin Price
Committee Member, Chanda Elbert
Head of Department, Parr Rosson

May 2017

Major Subject: Agricultural Economics

ABSTRACT

The conservation agricultural practice of no-till is known to improve soil physical and chemical properties through enriching soil organic matter, improving soil moisture conservation, labor saving and the ability to sustain the productivity of land for a long period of time. No-till is considered one practice for sustainable food production in Sub- Saharan African and the rest of the world to meet the food demands of the growing population. Farmers are encouraged to adopt the no-till technology as scientific research has proven the comparative soil improvement potential of the system. However, there is little knowledge on the socio-economic aspects of no-till practice in terms of the profitability of the practice and the financial risks associated with no-till. This paper uses enterprise farm budgets to analyze the labor use, cost and profitability of no-till and conventional tillage in four agro-ecological zones in Ghana and uses these budgets as analytical tools to help farmers manage risk.

Two data sets were used in the study. The first data set was used in building budget models and was based on the daily farm activities of 24 farms located in the 4 agro-ecological zones. Three no-till farmers and three conventional farmers were selected at random from the ecological zones. The second data set is an economic-anthropological survey to track farmers' farming histories and views on the sustainability of the small farm in Ghana giving the aging population and the lack of youth interest in agriculture as a profession.

The budgets show labor need and cost for no-till and conventional tillage varying in different ecological zones and with different farm activities. Yields of cereals were higher for no-till in all ecological zones. Profits realized from no-till farmers who practiced mono-cropping with maize were higher than conventional farmers. However, mixed cropping was more profitable under each system, particularly when tomatoes were grown. Farm produce prices were lower in the bumper seasons and higher in the lean seasons. The increase in energy prices and removal of subsidies on farm inputs reduced farm profits.

The budgets should be considered as policy and risk management tools in agricultural research institutions such as Ministry of Food and Agriculture Ghana (MOFA) and the No-till Center to help farmers make better decisions in managing risk to increase their profits.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Fred Boadu, and my committee members, Dr. Edwin Price, and Dr. Chanda Elbert for their guidance and support throughout the course of this research.

Thanks also go to Mr. Kofi Boa, Director of the Center for No-till Agriculture for his assistance in the collection of data and supply of other valuable information on no-till agriculture. Again I would like to show my sincere gratitude to the extension officers in the various districts who offered their time and effort in collecting and sending of the data. A big thank you also goes to the 24 farmers across the ecological zones who willingly provided the necessary information needed for the study.

Thanks also go to my friends and colleagues and the department faculty and staff for making my stay at Texas A&M University a great experience. I also want to extend my gratitude to the Center for Conflict and Development, which provided the assistantship and funding for the study.

Finally, thanks to my mother and my family for their encouragement and love.

NOMENCLATURE

APPL.	Application
AVC	Average Variable Cost
CSO	Civil Society Organization
DAES	Directorate of Agricultural Extension
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHC	Ghana Cedi
GSS	Ghana Statistical Service
HR	Hour
MOFA	Ministry of Food and Agriculture
No.	Number
SSA	Sub-Saharan Africa
TC	Total Cost
TR	Total Revenue
USDA	United States Department of Agriculture
QTY	Quantity

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

1. INTRODUCTION AND LITERATURE REVIEW

Agriculture is the predominant sector in many Sub-Saharan African (SSA) economies and in Ghana accounted for about 22% of the Gross Domestic Product (GDP) in 2013 (Ghana Statistical Services (GSS) 2014). The sector is characterized by small-scale farmers who produce for subsistence as a means of their basic livelihood. According to Rosen and Shapouri (2012) more than 80% of grain supply in SSA is from domestic production. There was an average growth rate of 4.1% per year on grain production in the region between 2000 and 2010 yet there is still an increase in food importation since yield growth still falls short. This presents the need to increase food production in the Sub-Saharan region, but productivity is still low due to the degradation of the physical, chemical and biological properties of the soil. According to Conway (1998) there is a greater risk in causing land degradation through intensification of agriculture with the use of inputs, especially when incentives are lacking. Continuous intensification would eventually lead to lose of soil fertility which would impact negatively on food production and economic growth thereby increasing poverty in the Sub-Saharan Region. Agriculture in Ghana is saddled with these myriads of problems found in other SSA countries.

The decline in soil fertility and threats to food security have led to an interest in using agricultural practices that do little damage to the soil in terms of nutrient loss. No-till agriculture has emerged as an alternative to the traditional slash and burn agriculture practiced in Ghana. The challenge is to gain an understanding of how risk, profitability, labor use and other critical factors of production are affected by the choice of crop production technology. “No-till or no-tillage” is described by Friedrich and Kassam (2012) as a cropping system which does not adopt the use of mechanical tillage as a means of crop establishment in the soil. It is “the planting of crops in previously unprepared soil by opening a narrow slot, trench or band only of sufficient width and depth to obtain proper seed coverage” (Derpsch 1999).There is no performance of extra soil preparation under no-till (Phillips and Young, 1973). Crop residues of the previous cropping season are left on top of the soil.

Farmers in Ghana have to make difficult decisions regarding, what crop to produce, how to produce, where to sell, and in some cases how much to save for home consumption. Farmers face uncertainties due to policy changes that affect input and output prices, production uncertainties since agriculture is primarily rain-fed, and lack of appropriate technologies due to ineffective agriculture extension systems that have failed to deliver relevant information to farmers. Probably, the biggest knowledge gap in farming operations in Ghana is the inability to estimate profits or losses during the farming season because of lack of farming records. In the absence of reliable records, farmers are deprived of an essential management tool that would guide them in making decisions under risk. As Garcia-Parbon (2009) points out, “planning the farm business is a key aspect of the farm operation, although it may not be the most enjoyable task for the farmer.” “Without a firm footing in farm financial management and farm records, the farm is in jeopardy; you wouldn't know where you are going and you sure wouldn't know when you get there!" (Hipp, 2009). Improving the basic business management skills of farmers contributes to the productivity and profitability of farming as farmers realize both the short and long run objectives of their activities. In a broad economic development context, any or all of the factors elaborated can have a multiplier effect on food security, income, nutrition and the environment.

The overall objective of this thesis is to assemble case studies of farmers in different cropping system/agro-ecological zones of Ghana to determine how the choice of farming practice influences incomes, profitability, and farm input use, especially labor. Specifically, the research will:

1. Develop a computerized decision support system that can be used in risk analysis and in simulating financial future of an agricultural production firm/business in Ghana.
2. Use the model to develop representative farm budget modules (12 no-till farms and 12 conventional farms) from 4 agro-ecological regions in Ghana.
3. Use the representative farm budgets to determine farm income levels, labor use, alternative tillage systems; cash costs, and the profitability of alternative systems.
4. Use the representative farm budgets to determine the impacts of alternative risk scenarios such as changes in yields due to stochastic rainfall pattern,

policy impacts such as input, output, and energy price changes, and optimal crop mixes.

5. Recommend a roadmap for integrating the budget modules into the training programs at the No-Till Center in Ghana, and also share with extension personnel to improve farm management practices in Ghana.

Literature Review

Risk Management in Farming

Agriculture in Ghana is heavily dependent on circumstances that are unpredictable such as the weather, fluctuation in prices, diseases and pest, and also government policies. These unpredictable circumstances or factors are classified as a risk which has major repercussions on financial incomes of a farming business. According to Patrick (1992), farmers do not invest in a farming business which is risky except they have a chance of making money. "…higher profits are typically associated with higher risks. It is to their advantage that these risky but potentially profitable situations be managed as carefully as possible". The higher risk makes decision-making the predominant activity of farm management (Kahan 2013). One way of managing risk is by predicting the difficulties likely to be faced and having the forethought of minimizing the outcome of such risk (Patrick, 1992).

Farmers may have different attitudes in dealing with risk. A risk loving farmer has the tendency to invest in more risky circumstances in the farming business whiles a risk-averse farmer would try his or her possible best to avoid risky scenarios. However, access to detailed and resourceful information is essential if good risk management decisions are to be made. "Good information can help a farmer make rational risk management decisions" (Kahan 2013).

Farm Budgets

Farm budgets are risk management tools used by farmers to help assess the performance of a farm business. Farmers always face challenges on how best to organize their business in a manner that is consistent with their goals and objectives. Budgeting provides tangible information which helps answer and provide solutions to farmers' challenging questions when they are properly used. Farmers or farm managers have the responsibility to organize resources and skills to achieve the maximum economic returns of the farm enterprise. According to the Oklahoma Cooperative Extension Factsheet[1], budgets help farmers and farm managers to answer questions such as:

1. How may the available resources best be used?
2. What enterprises (crops and/or livestock) can be produced and which will contribute most to returns to owned resources?
3. How much of the controlled land should be devoted to each enterprise?
4. What equipment and machinery will be needed to produce the potential enterprises?
5. What production practices should be used to produce each of the enterprises?

---

[1] Oklahoma Cooperative Extention Factsheet (Web source: http://osufacts.okstate.edu/docushare/dsweb/Get/Document-1682/AGEC-139web.pdf) (Viewed: 03/28/2015)

6. How much labor (both family and hired) will be needed on the farm?
7. What are the capital requirements?

Three types of budgets are commonly used in a farm business decision-making process. The whole-farm budget, enterprise budget, and the partial budget.

The whole-farm budget is used to project the anticipated returns of an entire farm's production by taking into consideration the profitable goals and objectives of the farmer. It provides comprehensive abstracts of the major physical assets and financial components of the farm and how they are related to each other. In other words, it provides an aggregate of the projected total income and expenditure of the whole farm venture. In developing a whole-farm budget; farmers need to profile the entire production process by incorporating into the profile the type and volume of production, identify resources needed for production and project the expected expenditure and gains from each section of the plan. When these factors are well organized into a detailed projection, the result is a whole-farm budget (Oklahoma Cooperative Extension Factsheet).

An enterprise budget provides projections on the income and expenses per unit of the production farm enterprise. It estimates the cost and returns from producing a particular commodity. An enterprise as used in this context refers to a singles crop (such as cocoa, maize, millet, tomato, etc.) or livestock (such as cattle, sheep, goat, pigs, etc.) that produces a sellable product. It consists of basically three components:

1. income/receipts

2. Variable/operational expenses
3. Fixed expenses.

An Enterprise Budget can be developed for each single enterprise to estimate its profitability by taking into consideration anticipated expenses and income. It helps farmers to make decisions on which particular enterprise is more profitable for their investments and those that should be eliminated or shut down. An Enterprise budget developed for different cropping systems can provide farmers with insights regarding which system is much profitable by comparing the profitability of the two techniques or systems. For instance no-till versus conventional till (Oklahoma Cooperative Extension Factsheet; Harper et al. 2013).

A partial budget is a budget that projects and analyzes the net change in income or expenditure as a result of certain changes in the production process or farm management changes. It focuses mainly on the changes in returns which arise as a result of changes in production alternatives and ignores profits earned by unchanging resources or production alternatives or decisions on the farm. It helps farmers plan and make decisions based on the cost and returns of alternatives they face in running the farm business. Partial budgets help to decide how a particular decision would affect the whole farm of its profitability when instituted. In developing a partial budget the farm needs to:

1. Outline the changes on the farm which need to be analyzed
2. Gather all the necessary information on the aspect of the farming business that is supposed to be affected by the change

3. Categorize all the impacts that occur, such as, increase or decrease in cost or revenue.

When the change is expected to increase net returns or decrease the cost of the production process it is referred to as a positive economic effect while an increase in the cost or decrease in returns is termed as negative economic effect.

Reasons for Farm Budgeting

According to Sahs (1998) budgets, whether they are whole-farm, enterprise, or partial, are a management tool that is invaluable when evaluating the profit potential of the farming business. Although managers lack the information needed to make perfect decisions, they are forced to make decisions on the basis of information available and must accept the risk associated with those decisions. Knowledge of budgeting and the ability to use them will help them make the right decisions.

Senyolo (2011) reported that, in making a decision about a business investment or future strategic choice, farmers have to consider such questions as: what future activity gross margins is realistic to use in farm planning? Will the present subsidy scheme change in the future, and if so how? When borrowing money, will there be any changes in the interest rates over the next few years? What about the labor requirement for different activities - how many hours will be required per unit? Will there be a need to hire labor, and if so, how much? What price might be obtainable if quota could be sold in the future? Answers to these questions are critically dependent on how well a farm budget reflects the actual performance of a farm enterprise.

Moschini and Hennessy (2001) emphasized the complexity in decision-making as a result of the interplay between physical and economic forces on agriculture. The author emphasizes the need to understand the nature of risk and uncertainty to gather appropriate information to understand them.

Farmers in Ghana do not have the relevant information and the technical expertise to make proper financial decisions about their farming operations. This could be attributed partly to the high illiteracy rate of farmers and the weak nature of the agricultural extension service in the country. Extension agents in Ghana lack the necessary skills and technical ability to develop financial management tools for assessing farm risk and decision-making on behalf of farmers in Ghana.

Cropping Systems in Ghana

A cropping system is defined as crops and crop sequence and management techniques used on a particular field over a period of years (Nafziger 2009). It refers to "...the crop production activity of a farm. It comprises all cropping patterns grown on the farm and their interaction with farm resources, other household enterprises and the physical, biological, technological and sociological factors or environments" (IRRI 1978). The cropping system in Ghana has evolved from an extensive to a more intensive system over the years. According to Boserup (1965) cropping systems have historically evolved from the extensive stages of the forest, bush and short fallow to an intensive stage of continues annual cultivation. The

West African region is located in the tropical zone and over the years farmers adapted the long-fallow system as a way of conserving and rejuvenating soil fertility. In addition, it served as a way of adapting to special climatic conditions in the tropical region. Tropical soils were not favorable for other systems of cultivation such as intensive cultivation. Therefore, the fallow systems were seen as the most convenient method. The fallow system was easy to implement and adapt then because settlements were scattered and there was less concentration of people dwelling in specific areas at a time. This made it easy for extensive cultivation with fallow. Gourou (1974) published in his book *The Tropical Word* that "most of the tropics is sparsely populated because the land is unable to support cultivation for more than one year out of twenty and, therefore, unable to support a numerous population" however the "number of people in the tropics has grown to what the territory can carry, and that additional population must largely be accommodated by means of industrialization and reliance on foreign trade."

The increase in population, demand for food and the high demand of land for other alternative purposes have led to the transition from an extensive cropping system to a more intensive cultivation. Fallow has gradually been eliminated and slashing and burning is not currently a sustainable method of crop production as it was before. Manure is currently not sufficient in quality and quantity to sustain soil fertility due to continues cropping on small land areas. 60 persons per square kilometers was the sustainable population density level for bush fallow in Ghana, but the fallow period kept decreasing with subsequent increase in the country's population which tend to cause harm to the soil (Boateng 1962). According to Guyslain et al. (2011) there is a positive correlation between the density of the population and farm intensification in Ghana.

Though bush fallowing and shifting cultivation are rarely practiced today, the old farming system (traditional system) has not changed. Farmers still practice slash and burn method of farming and in the absence of fallowing and this causes major damage to the soil's physical and chemical properties through erosion and degradation. The outcome is a general reduction in the nutrients in the soil and its inability to sustain plant growth. Modern day agriculture in the tropics needs new soil management practices that can help adopt sustainable intensification in crop production. The conventional system of farming is not a practical answer to the growing food problem if environmental and social resources have to bear the cost of the system. A group of government policy leaders, agricultural experts and development partners produced what is known as the Montpellier Panel Report (2013), recommended that Governments in the developed countries and in Africa – in partnerships with the private sector, Civil Society Organizations and Non-Governmental Organizations (NGOs) – recognize and act on the paradigm of sustainable intensification through, 1. Adoption of policies and plans that combine intensification with sustainable solutions and a focus on the food security needs of people, 2. Increased financial support for global and domestic research and innovation to develop and identify suitable technologies and processes, 3. Scaling up and out of appropriate and effective technologies and processes, 4. Increased investment in rural agricultural market systems and linkages that support the spread and demand for Sustainable Intensification, 5. Greater emphasis on ensuring that inputs and credit are accessible and that rights to land and water are secure for African smallholder farmers and 6. Building on and sharing the expertise of African smallholder farmers in the practice of Sustainable Intensification.

The Montpellier Panel recommendations suggest that addressing the food security problems facing SSA's would require a broader framework for instituting sustainable conservation agricultural practices as well as proper farm management techniques to generate income and profits. There is a need for proper agricultural extension training to help educate farmers on how best to adopt the new paradigm.

What is No-till?

There is confusion in defining some agricultural terms such as no-tillage (Fredrich and Kassam 2012). Generally, any farming system that reduces the magnitude of extreme tillage (that is, completely turning upside down the soil with a plow) is categories as a "reduced or minimum tillage" practice. With minimum tillage, there is little disturbance to the soil whereas the soil is not to be disturbed under pure no-till as claimed by hardcore no-tillers. However, both techniques are classified under conservation tillage which The United States Department of Agriculture (USDA) defines as any method of farming that leaves at least 30% of the soil surface covered with the previous year's crop residue before planting. No-till thus fits under the broader definition of conservation agriculture as defined by USDA.

Why the Need for No-till

A major problem facing agriculture in the tropics is the steady decline in soil fertility, which is closely correlated with the duration of soil use (Derpsch and Moriya 1998). In order to maintain and improve soil fertility and achieve a sustainable agriculture in the tropics and subtropics, it is necessary to stop mechanical soil preparation and keep a permanent cover of the soil (Derpsch, Florentín and Moriya 2006) as soil erosion and loss of organic matter are associated with conventional tillage practices that leave the soil bare and unprotected in times of heavy rainfall and heat (Derpsch and Moriya 1998).The sustainability of agriculture in the tropics cannot be achieved with intensive mechanical soil preparation. There is always the need to take into consideration the law of diminishing productivity of the soil in relation to agricultural production because to disrespect these laws is to promote soil degradation and loss of soil fertility. Sustainable agriculture cannot be achieved if the law of diminishing productivity of the soil is neglected (Derpsch et al. 2010). This according to Derpsch, Florentín, and Moriya (2006) makes no-till with manure cover instituted in a crop rotational system an authentic sustainable production system in most forms of tropical and subtropical agriculture.

Economics of No-till

Labor Use:

Labor saving is considered to be one of the most important advantages of no-till. The total amount of time used in preparing the field by tillage is reduced when substituted with no-till[2]. A survey conducted by USDA which compared the time used for soybean and maize crops report a range of 0.4 hours to 0.6 hours per acre spent in conventional tillage systems with only 0.1 to 0.3 per acre in no-till (Bull and Sandretto, 1995).

A study conducted at the University of Missouri estimated labor cost to decrease by $2.09 per acre with no-till use than conventional tillage under corn production (Massey, 1997). However, the reduction in the cost of labor is realized when labor is hired on an hourly basis, therefore workers work fewer hours and are able to do other activities that provide income since they are using no-till. In the context of the farmer, the time saving is the result of using that time for other profitable activities or using the supplementary labor to execute other activities on the farm such as increasing farm size, finding a market for produce or purchasing inputs and implements for the farm.

According to Ekboir et al. (2002) farm lands are cleared at the beginning of every cropping season with simple tools such as cutlasses and hoes in Ghana. The land preparation activity demands a considerable amount of labor hours and effort. However, the amount of labor needed for this operation depends on whether the land to be cultivated was left to fallow or is already under cultivation. Less labor is required when preparing a field already in cultivation since it has just grasses and simple broadleaf weeds as compared to a land left to fallow. Under the traditional

[2] No-Till and Conservation Buffers in the Midwest, (Web Source: http://www.ctic.org/media/pdf/Economic%20Benefits.pdf) (viewed: 03/30/2015)

system, a fallowed land can sustain efficient crop production for about three years after which it has to be left to fallow and new land needs to be cleared. No-till saves the extra labor needed in clearing a new fallowed land as soil nutrients are maintained and conserved under no-till and the same field can be planted over an unspecified period of time. Nevertheless, fertilizer use should be a complement of the intensification system under no-till in order to compensate for the increase proportionate take out of soil nutrients.

A study conducted by the University of Arkansas on the benefits of no-till in a rice-soybean rotation (Hignight et al. 2009) also found no-till reduces the cost of labor. Specifically, the study reported the estimated cost of labor of an acre no-till rice and soybean as US$ 12.26 and US$ 6.45 respectively whereas the cost of labor for an acre rice and soybean was estimated at US$ 17.29 and US$ 11.60 under conventional tillage.

Although most no-till literature regards the technology to be labor saving there are instances where this savings is offset by an increase in the use of herbicide and their cost of application. According to (Vogel, 1994, Vogel, 1995 and Kayode and Ademiluyi, 2004) the soil is not tilled under no-till, and with no soil till there is an increase in the pressure of weeds. Weeding, therefore, would require a high amount of labor and this counterbalance the labor savings gained by not plowing unless weedicides are applied. Continues maize cultivation in North America led to the emergence of perennial weeds although weedicides were applied in reduced tillage practices (Locke et al., 2002). The basic method of weeding with cutlasses and hoes are not the best control measure to combat perennial weeds that emerge due to reduced tillage practices if herbicides are not used (Vogel 1995). However the cost expenditure in herbicide use and the ineffective chain of supply in regions such as SSA makes implementing a productive technology like no-till quite problematic although it has the tendency to increase the productivity of smallholder farmers (Giller et al., 2009).

Crop Yield:

Toliver (2010) has explained that different crops and different soil types respond to no-till in several different ways when crop yields are put into consideration. Silty soils reduce crop productivity when no-till is practiced. Though there are several instances where no-till does not contribute to increased yield or might even lead to yield reduction, no-till and conservational agriculture advocates assert that it is better yielding and has the tendency of stabilizing crop yields (African Conservation Tillage Network, 2008).

Research conducted by (Gill and Aulakn 1990) reported the importance of crop residue to wheat yield. In conclusion, no-till with mulch (crop residue) was found to increase wheat yield in Zambia whereas the absence of crop residue led to a lower yield. The mean yield of no-till after the 3-year experiment was 1688 kg ha^{-1} whiles conventional yielded 1285 kg ha^{-1}. The only importance specified for tilling is to help control weeds.

According to Mbagwu (1990) water transmissivity was decreased by 79% for a tilled unmulched field whiles that of a no-till field was decreased by just 22%.

Likewise, maize yields were observed to be higher on untilled-mulched fields than tilled-unmulched fields within each season (Table 1).

Table 1. Grain Yield of Maize as Influence by Tillage and Mulch Treatments

Treatments	1982		1983		1984	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
UM	5.06	3.75	5.71	4.46	5.42	4.27
TU	4.72	2.59	4.30	2.37	4.53	2.29

Note: UM = untilled-mulched; TU = tilled-mulched
Source: Mbagwu (1990)

Again Lal (1991) reported in his paper "Tillage and agricultural sustainability" which focused on two studies for a period of 8 years and concluded with the findings that maize yields under no-till with mulch were higher than plough-based systems. There are other instances where no-till may lead to less yield. In southwestern Nigeria, the yield of cowpea was higher with ridge tillage than no-tillage (Akinyemi et al., 2003). Also in the highlands of Ethiopia, farmers prefer traditional till because it enhances filtration, decreases run-off and reduces evaporation (Temesgen et al., 2008). Nicou et al. (1993) have argued that in the semi-arid regions of West Africa, soil tillage is an excellent technique of improving soil physical properties and crop yield in the early years of crop production.

The literature part to variations between the long run yield outcomes and the short-run yield outcomes under no-till. In the short run, crop yield under no-till is found to be inconsistent. According to (Giller et al., 2009) the introduction of no-till has a long run effect on crop yield but in the short run there are possibilities of reduced yield or no benefits in yield which can be up to 10years. Thus, there are suggestions for further studies to research and identify the observed yield decrease with no-till in the short run and how it could be solved.

Profitability of No-till versus Conventional Tillage:

According to (Ribera et al., 2004) it is easier to identify the agronomic benefits of no-till agriculture than its economic benefits. No-till is proven to be labor saving, cost efficient in fuel use, machinery repairs, and depreciation, but there are instances where herbicide use offsets the benefits. Several studies have been conducted to compare the net income of no-till and conventional tillage and the results have been conflicting. In the studies by (Harman et al., 1996 and Haack and Haskins 1999) which were conducted on sorghum-corn-wheat rotation in Blackland Prairie, Texas and on winter wheat and corn in Ontario, Canada respectively, no-till had lower yields than conventional but the variable cost of production for no-till was highly significant in some cases.

Bremer et al., (2001) found no-till to be more profitable than traditional tillage based on a study on cotton and sorghum conducted in Refugio County, Texas. This is similar to (Ekboir et al. 2002) in which 87% of the participating farmers reported higher income with no-till adoption in three different ecological zones of Ghana.

The common threat in the studies discussed above is that they only compare the average net incomes realized from no-till and conventional tillage whiles omitting the profit which is economically the most important factor as it has an effect on the risk of the farm enterprise. "The effect of alternative production systems on mean net income and variation in net income need to be considered when comparing production systems" (Ribera et al., 2004).

Role of the Extension System

Agriculture extension was introduced "to enlarge and improve the abilities of farm people to adopt more appropriate and often new practices and to adjust to changing conditions and societal needs" (Jones and Garforth 1997). Traditional agricultural extension helps farmers through education for better agricultural systems and procedures, expanding the efficiency of output and income, adopting a more sustainable farming system, raising living standards in both social and educational aspects of rural life's (FAO 1984; Rasmussen 1989). In Ghana, the Directorate of Agricultural Extension Services (DAES) is responsible for managing and educating farmers on various agricultural practices and technologies. The primary objective of the service is to "establish an efficient and demand-driven extension service in a decentralized system through a partnership between the government and the private sector for the provision of quality service to our clients" (MOFA 2015)[3]. The extension service follows the decentralization policy of the government so that all regions and districts in Ghana have access to agricultural management information. Direct collaboration at the regional and district levels of administration are established to ensure that extension services contribute efficiently and effectively towards the social and economic development

[3] MOFA (Web source: http://mofa.gov.gh/site/?page_id=74) (Viewed : 4/20/2015)

of the country. The idea is for the service to contribute to the improvement of general farmer welfare and to strengthen their ability to adopt innovative ideas and to improve performance.

2. STUDY AREA, SURVEY, AND DESCRIPTIVE STATISTICS

Study Area

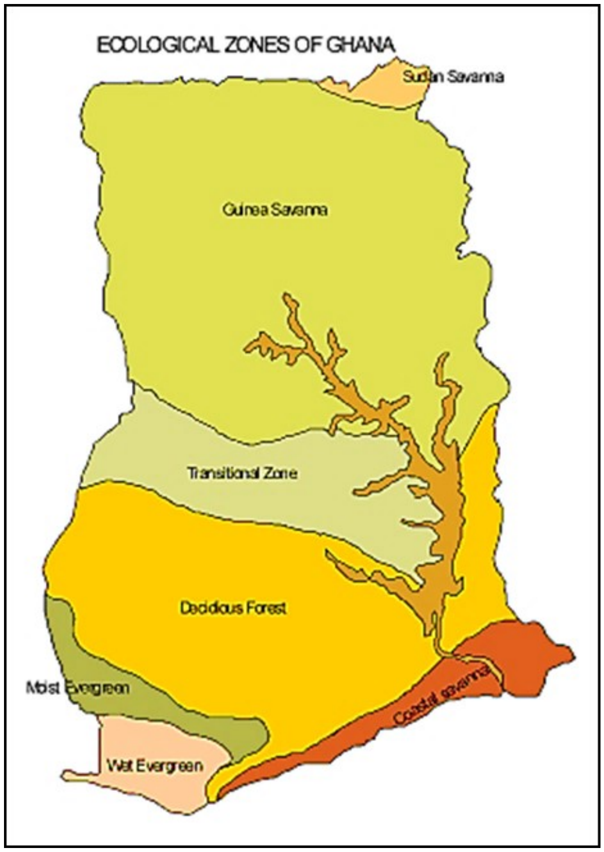

Figure 1. Agro-ecological Map of Ghana

Source: Germer and Saureborn (2008)

The study was conducted in the four major agro-ecological zones of Ghana (Figure 1). Ghana is located along the coast of West Africa and shares boundaries with Burkina Faso in the north, Cote d'Ivoire in the west, Togo in the east and the Gulf of Guinea and Atlantic Ocean in the south. The recent population and housing census in 2010 estimated the population of Ghana to be 24.7 million with an annual growth rate of 2.4 percent (Ghana Statistical Service (GSS) 2012)

Agriculture in Ghana is dominated by small-scale farmers. Although there are larger rubber, oil palm, cocoa and maize plantations, about 90% of farm sizes are less than 5acres (GMOFA 2010). The traditional system of farming still dominates with the use of simple farm implements such as hoes and cutlasses.

The estimated total land area of the country is 23 million hectares of which 57 percent of the area is under cultivation (GMOFA 2010). Ghana is a constitutional democracy and is divided into ten administrative regions. Ecologically, the country can broadly be divided into four ecological zones namely: The Forest Zone (Rain Forest and Deciduous Forest), Transition Zone, Coastal Savannah zone and The Northern Savannah (Guinea and Sudan Savannah) as shown in figure 1 (GMOFA 2010). The Northern Savannah vegetation occupies the three Northern Regions of the country with the coast characterized by the Coastal savannah vegetation. In the middle lies the Forest Vegetation with the Transition Zone lying between the Forest and Guinea Savannah Zones.

Four districts were selected; one from each ecological zone where the case studies were undertaken. The districts were Atwima Nwabiagya in the Forest Zone, Ejura Sekyedumasi in the Transition Zone, Ga West District in the Coastal Savannah Zone and East Manprusi in the Guinea Savannah Zone. Details about the districts were taken based on information from GhanaDistricts.com.

Atwima Nwabiagya (Forest Zone)

Atwima Nwabiagya District is located in the Ashanti Region of Ghana and has Nkawie as its capital. The semi-deciduous forest kind of vegetation is the most dominant in this area. Rainfall distribution in the district is bimodal with double maximum rainfall ranging between 1700mm-1850mm. There are two cropping seasons, namely the major season (mid-March – July) and the minor season (September – November). Rainfall is not distributed throughout the whole year and this makes rain-fed agriculture unreliable in the district.

The total population of the district is 149,025 with 77,077 (51.7%) being female and 71,948 male (48.3%) (GSS, *Population and Housing Census 2010*). The total number of people employed in the district is 56,553. According to the 2010 census figures, about 31.5% of the total population lives in the rural area. The district is a few miles from Kumasi, which is the capital of the Ashanti Region and is a major avenue for marketing agricultural produce such as fruits and vegetables. However, the proximity of the district to the Kumasi Metropolis puts pressure on agricultural lands as they are being converted to the housing to accommodate an expanding population and urbanization. The loss of agricultural lands leads mostly to unemployment of unskilled labor since most of the unskilled labor force is into agriculture. Again, the prevalence of illegal gold mining "galamsey" in the area creates a labor constraint for agriculture. Most of the eligible youth find these mining activities generally attractive since they earn more income than working on a farm.

Ejura Sekyedumasi (Transition Zone)

Ejura-Sekyedumasi is a municipal assembly located in the Ashanti Region of Ghana. The district lies between the Forest and Guinea Savannah zone which implies experiencing the climatic conditions of both ecologies. It has a semi-deciduous forest in the south and savannah vegetation in the north. There are two rainfall patterns in the district owing to its location. It experiences a bi-modal rainfall pattern in the south and a uni-modal in the north. The rainy season for the area is between April and November with April to August as the major season and August to November as the minor. Annual rainfall in the district ranges between 1,200mm to 1,500mm. Likewise, rainfall is unreliable for crop production.

The total population of the district is 85,446 with 50.2% as male and 49.8% as female (Ghana Statistical Service, Population and Housing Census 2010). Out of the total population, 50.3% live in urban centers whiles 49.7% are in rural communities. There has been a gradual transition of the district from a rural to an urban community since the year 2000. The total population of the labor force in the district is 34,389 (Ghana Statistical Service, Population and Housing Census 2010). The structure of the district's economy is dominated by the primary sector. This makes the economy agrarian and it absorbs about 68.2% of the labor force in the district. Farmers in the district practice both mono-cropping and mix cropping. Most crops are grown for subsistence use with the surplus offered for sale. Maize is the most dominant crop cultivated in the area. About 68.2% of the farmers in the district have access to extension service.

The district is a major marketing center for food crops especially for maize and yams and it provides a source of ready market for the farmers. About 62.4% of the farmers in the district have a ready market for their produce.

Ga West District (Coastal Savannah)

Ga West Municipal was created in 2004 with Amasaman as the capital. The coastal savannah vegetation is the type of vegetation found in this area and it is characterized by clusters of shrubs and small trees. The rainfall pattern in this area is bi-modal with the average annual rainfall ranging between 750mm-810mm.

The total population of the district is 262,742 (Ghana Statistical Service, *Population and Housing Census* 2010). Male and female represent 49% and 51% of the total population of the district respectively. 114,478 represent the number of people between the ages of 15 and 64 who constitute the labor force of the district. The municipality is predominantly urban. About 69% of its inhabitants live in urban centers. Agriculture, industry and commerce represent the major economic activities in the district with agriculture absorbing about 55% of the total working population who are into farming, fishing and livestock development. Most of the farms in the district are small scale with a few large scale farms. Fruits and vegetables are the most common crops grown in this area coupled with some root and tuber crops. Crops like a pineapple, pawpaw, chili paper and other vegetables are produced commercially whiles cassava is one of the common root crops grown in this area.

Access to land for farming is limited due to the high demand for land for estate development, sand winning, and quarrying. This is one of the factors that caused farm sizes to be very small in this area. These lands are being over-exploited and they lack proper soil improvement practices.

Although there is a huge market for farm produce and foodstuffs, farmers still do not get appreciable prices for their produce since they lack information from the market and are mostly exploited by middlemen and women. The farmers find it difficult to enter the market because of the market power the middle men and women already have presented in the market.

East Mamprusi (Guinea Savannah)

The East Mamprusi District is located in the north-eastern part of the Northern Region of Ghana. The district shares borders with Talensi-Nabdam, Bawku West and Garu-Tempane District in the north, Bunkpurugu-Yunyoo District in the east, boarded in the west by West Mamprusi and Gusheigu District in the south. The capital of the district is Gambaga. East Mamprusi occupies a total land area of 1660 sq. km and is about 2.2% the total area of the Northern Region. The size of the land is environmentally conducive for animal rearing and farming. The district lies in the interior woodland savannah vegetation zone and is characterized by grasses growing in tussocks which are mainly three or more meters tall with drought resistant trees such as Shea nut, Baobab and Acacia cluttered around. The district experiences just a single rainfall season which last between April to October with an annual average rainfall of 1000mm - 1150mm. The district, like all the other districts in the three northern regions, is drier than its southern counterparts. This is due to the Harmattan winds that blow from the Sahara during the dry season (November to April).

The district has a total population of 121,009 out of which 49.1% are male and 50.9% are female (GSS, Population and Housing Census 2010). The total labor force of the economically active population is 45,889 which represent about 37.9% of the total population. The district is mainly rural. About 67.6% of the total population of the district lives in the rural communities.

The major occupation of the adults in the district is agriculture. The agricultural sector employs about 90% of the total labor force in the district. Farms in the district are small in scale and production is mainly on a subsistence basis and is labor intensive. Lands in this district are mainly family owned and is inherited from generation to generation. Crops commonly grown in the district include cereals such as maize, millet, rice, sorghum; legumes such as cowpea, groundnut, soya bean; root and tuber crops like yam, cassava, potatoes; vegetables like tomatoes, pepper, onions; and export crops like cotton and cashew.

Table 2. Descriptive Summary of Study Areas

DISTRICTS	Total Population	% < 15 years	%16-64 years	% > 65 years	% Agric	Labor Force
Forest	149025	43.2	50.65	6.2		60373
Transition	85448	40	53	7		35313
Coastal Savannah.	262742	34.8	62.2	3	55	122402
Northern Savannah	121009	54	47	4.5	90	45889

Source: Ghana Statistical Service, *Population and Housing Census* 2010.

Survey

The data for the study was categorized into two sections. Firstly, an economic-anthropological survey following the work of Polly Hill (1963), *Migrant Cocoa Farmers of Southern Ghana* was undertaken. This was a face-to-face interview of farmers. The objective was to gain insights into farmers' daily lives and vision of the future for agriculture in the region of study. The interview was structured in a way to make farmers narrate a story about their life from infancy to present and their reasons for farming. It also explores farmers' reasons for adopting the farming methods they currently are using and why they are not using the alternative method. The survey explored the farmers' views on the current generation following their footsteps and becoming farmers as well. The structure of the interview is presented in appendix A. This effort was to address the sustainability of the effort devoted to the training and education of farmers in the study area. We obtained very valuable information about farmers' expectations and visions of the future. The information is valuable in assessing the recruitment of the youth into agriculture and the nature of policy interventions needed to accomplish this objective. The results of this survey are presented in the first section of chapter four.

The second set of data used in the study consist of a daily record of all farm activities was collected from September 2012 to September 2014 by local extension agents visiting farmers each week within the data collection period to collect data on their daily activities for the week. Data collectors were professional field agricultural officers who are employees of the Ministry of Food and Agriculture in the survey areas. The records included hours of labor use for each crop operation, type of farm operation performed, the number of people undertaking the operation and the cost associated with them. This information was used to develop farm budgets to examine labor use in alternative tillage systems, cash costs of alternative systems and the profitability of alternative systems. Activities such as land preparation, planting, weed control and harvesting were compared between no-till and conventional in and across various ecological zones.

Descriptive Statistics

Data on 24 farmers was collected over approximately two years. 12 of the 24 farmers selected at random used the no-till farming technology and the other 12 farmers used the conventional technology. Each district under the study had 6 farmers of which 3 were no-till farmers and the other 3 were conventional farmers. Out of the 24 farmers, 2 were female and 22 were males. The gender of farmers in the survey is consistent with the distribution of farm ownership by gender in Ghana

(FAO 2012) which reported that men hold 3.2 times more of the total farms than women, and 8.1 times more of the medium and large-sized farms (of 5 acres or more). All the female farmers practiced the conventional system. 8 male farmers practiced conventional and 12 male farmers practiced no-till agriculture (Table 3).

Table 3. Age and Gender of Farmers

	Atwima Nwabiagya		**Ga West**		**Ejura-Sekyedumasi**		**East Mamprusi**	
	C	N	C	N	C	N	C	N
1	40 (F)	45 (M)	51 (M)	47 (M)	64 (M)	53 (M)	52 (M)	28 (M)
2	40 (M)	43 (M)	52 (M)	57 (M)	47 (F)	48 (M)	58 (M)	60 (M)
3	45 (M)	51 (M)	42 (M)	45 (M)	54 (M)	50 (M)	40 (M)	42 (M)
Average	44		49		53		47	

Average of all 24 farmers: 48
Note: C=Conventional, F=Female, M=Male, N=No-till.

The average age of the 24 farmers in the case study was 48 years with the minimum age of 28 years and the maximum of 64 years. Ejura-Sekyeduramsi was the district with the oldest farmers on average of 53-year whiles Atwima Nwabiagya had the youngest farmers with an average of 44 years (Table 3). The immediate implication of the observed age structure is the sustainability of no-till in the future. This is consistent with the observation in the Ghana Country report which states that; agriculture in Ghana is threatened since it is dominated by the aged (MIPAA 2007). Five out of the 24 farmers had no education; however, 8 had a basic primary education with just one farmer having a university degree. 79 percent of the farmers have had a basic primary education (Table 4). Currently, a large number of the youth in Ghana are pursuing higher education. The educational trend is positive to encourage the youth to engage in agriculture so long as policies and programs are introduced to emphasize the “agribusiness” opportunity available to individuals who wish to bring modern management skills to the sector. Yet the age structure of the farmers in the survey shows that the youth is not interested in farming. The youth of Ghana is less interested in farming as their main occupation since they recognize it as a low income generating job and a job for the rural poor and uneducated (MOFA 2011).

Table 4. Educational Levels of Farmers

Educational level	No. of Farmers	No. of years in school
No education	5	0
Primary level	8	6
Junior Secondary level	5	9
Senior Secondary level	5	12
University/Tertiary level	1	16
Total	24	

The average size of farms in the survey was 2.9 acres. The farms in the guinea savannah zone were larger with an average land size of 4.2 acres whiles the farms in the coastal savannah zone were the smallest with an average of 2.1 acres (Table 5). The larger land size in the north can be attributed to the availability and less scarcity of land in the three northern regions of Ghana for farming purposes as compared to the scarcity of land resource in the coastal and forest areas which are predominantly peri-urban. Land can be put to alternative uses such as estate construction and for sand winning at the expense of farming. Household sizes were larger on average in the transition and guinea savannah area 9 and 10 respectively than the forest and coastal regions 5 and 6 respectively. There was a positive relationship between average farm sizes and average household sizes. Larger average farm sizes in the transition and guinea savannah corresponded to the larger average household sizes in those areas (Table 5).

Table 5. Average Household Size and Farm Size (Acre)

	Forest		**transition**		**coastal savannah**		**guinea savannah**	
	household	land size	household	land size	household	land size	household	land size
1	5	2.5	7	1.3	7	3.08	7	2.6
2	5	1.66	11	5	9	2.5	4	0.84
3	5	2.32	7	3	7	4	10	0.5
4	5	5.2	8	4	5	1.4	10	2
5	5	1	12	1.9	5	1	8	16
6	6	1.3	7	2	5	0.8	11	3
Average	5	2.3	9	2.9	6	2.1	8	4.2
total average household size			7					
total average land size			2.9					

The survey shows that farmers grow a variety of crops such as maize, cowpea, millet, groundnut, plantain and also vegetables (tomato, pepper, cabbage). However, maize is the most widely cultivated crop. All the 24 farmers cultivated maize at least for a season within the two-year study period. Mixed cropping of cereal crops, legumes, root and tuber crops, and vegetables was common in all study areas except the farmers in the transition zone who practiced mono-cropping with maize (Table 6). The variety of crops is positive for the future of no-till farming since it opens the door to exploiting a growing urban market, and the possibility of supplying to institutional buyers, including restaurants, schools, hospitals, and exporters.

Table 6. Type of Crops Grown

	Atwima Nwabiagya.		**Ga West**		**Ejura-Sekyedumasi**		**East Mamprusi**	
Crops grown	C	N	C	N	C	N	C	N
1	M,C,P	M,C,Pe,C	M,Pe	M,C,Pe	M	M	M,Mi,Co	M,Mi
2	M,C,P,Co,G	M	M,T,Pe	M,C	M	M	M,Mi,Gn	M,T,Co
3	M,T,Pe,Ca	M,C,Co	M,C	M,C,S	M	M	M,Mi,Gn	M,Mi,Se,

Note: M=Maize; C=Cassava; Ca=Cabbage; P=Plantain; Co=Cowpea; G=Ginger, T=Tomato; Pe=Pepper; Mi=Millet; Gn=Groundnut; Se=Sesame.

Equipment use is rare in the area of study. All the farmers in the survey use simple farm implements such as hoe, cutlass, garden lines and the knapsack sprayer. With the exception of conventional farmers in the forest area who only burn their land in the land preparation process, all the other conventional farmers in the other three zones plow or till their land with a tractor pulled plow or bullocks. Only one farmer in the coastal savannah area had an irrigation system.

Labor is seen as the most important factor of production in the survey. It comprised of family labor and hired labor. Mostly, labor was hired for activities such as planting, weeding, fertilizer application, and harvesting. These activities were seen to be more tedious for farmers whose family labor source comprised of their wife and kids. Therefore, labor was hired and paid a daily rate which is known as “by day” or sometimes contracted to perform specific activities on the farm for a fee charged mostly on an acre basis. The daily rate paid to laborers varied between activities and also across ecological zones. There was not much uniformity in the rates of payment even within the same ecological zone. Within the same cropping season, different laborers are paid different rates for the same activity (appendix B). However, it could be observed from the Atwima Nwabiagya district that the daily wage rate for activities such as weeding, planting and harvesting increased from the 2012/2013 minor seasonal rate of GHc7 to GHc8 and GHc10 for the 2013 major season and 2013/2014 minor season respectively. However, contracted charges were based on the bargaining power of laborers and farmers as rates differed significantly from one activity to the other.

3. METHODOLOGY

Labor and cost information from the daily dataset was used to develop 72 enterprise budgets models. Three budgets were developed for each farmer for the minor season of 2012/2013, major season of 2013 and minor season of 2013/2014 with the exception of farmers in the guinea savannah region where one budget was built each year for 2012, 2013 and 2014 cropping seasons due to the single cropping season in the northern part of the country. Secondly, a general budget model was developed using Simetar tools to estimate the future cost and revenue of a crop farm enterprise. This budget tool is to help analyze risk and estimate financial characteristics of a farm enterprise.

Method for Building the 72 Crop Budgets

The information collected from the daily data was categorized into the major labor activities performed on the farm field on a daily basis. The activities included weeding, planting, spraying, harvesting, post-harvest, plowing, nursery bed preparation, burning and fire belt maintenance as well as other minor activities that were performed individually by farmers or activities that were area specific. This was the information that was used in calculating the labor cost of all activities.

Labor cost and wages paid for labor activities were not charged on an hourly base. Wages are paid on labor activities on a daily basis, not on the number of hours worked. A fixed among of money is charged by a laborer performing a particular labor activity. This form of payment for labor is referred to as “by day”.

In this study, the main focus was to determine the average cost of labor per hour. This was essential because it was used to compare the cost of performing each activity and which zones had the least or highest cost of labor. To be able to analyze and compare the cost advantages and disadvantages of implementing machinery use in agriculture, labor cost had to be on an hourly basis since the equipment is measured as cost per machine hours. The formula for calculating the average cost of labor per hour was:

(1) $$\text{Average Cost/hour} = \frac{\text{No. of hours x Cost/worker}}{\text{No. of hours worked}}$$

Input cost was calculated by adding the cost of all farm inputs used within a particular cropping season that was reported in the daily data. Inputs such as weedicide, insecticide, fertilizers and manure were the most commonly reported input being used across all ecological zones. Input cost was added to the total cost of labor to derive the total variable cost of production.

(2) Total Variable Cost of Production (TVCP) = Labor Cost + Input Cost

Total revenue (TR) was calculated by summing up all the sales of farm products within a particular cropping season. Profits were then calculated by subtracting the TVCP from the TR.

(3) Profit (P) = Total Revenue (TR) – Total Variable Cost of Production (TVCP)

72 farm budgets were built using actual data gathered from the farmer's field (Appendix B), but for uniformity in the analysis all cost, profits, and revenue were calculated on per acre basis. This was to facilitate comparison between

different practices and to determine which ecological zone is well suited for a particular farming system.

Scenarios such as the effect of fertilizer subsidy removal and the effect of fuel price changes on the cost and profit of a farm enterprise were analyzed with selected farm budgets. This was to illustrate how farm budgets could help evaluate the effects of the risk events on the profitability of a farm enterprise. Farmers could, however, predict their cost and returns in advance based on the current situation of the economy or the agricultural sector.

Financial Futures Budget Building

A general budget was built to forecast the financial future of farm business using the spreadsheet Add-in simulation package built into Microsoft Excel known as Simetar (Appendix E). Simetar with its risk analysis tool is known to efficiently develop statistical risk solutions. An Economic analysis based on deterministic variables do not take into consideration risk and only report point estimates of key output variables (KOV's) instead of determining the probability distributions that discloses the chances of failure and success (Hardaker et al., 2004). With deterministic variables, decisions are only made based on strategies that are most suitable in risk-free scenarios. However, in making a decision in a risky environment such as making a decision on the farm, a single rule of calculating a non-random deterministic value is not feasible since economic return for each alternative is a distribution of returns rather than a single value. According to

(Pouliquen 1970) Monte Carlo Simulation[4] gives managers and economists random values of important KOV's and their possible chances weighted for both favorable and unfavorable results. Simetar allows the researcher simulate different risky alternatives to estimate their distributions so as to make important economic decisions based on the simulated results.

In building this budget, the average number of hours and the average cost per hour for performing different activities and the input cost were estimated using the uniform distribution function. Uniform distribution is also a closed distribution with two parameters (minimum and maximum) of variable X and every equal length interval of the variable X over the minimum and maximum range has an equal probability of being observed and the domain include all real numbers (Richardson 2005). The uniform distribution was used because the distribution of the variables was unknown.

(4) UNIFORM = (Max, Min)

The expected value for labor hours and cost of the various labor activities from the uniform distribution were used to estimate the average labor cost that can be realized. In addition, average expected value for the quantity of inputs needed and the cost of these inputs were also used in calculating the average input cost. The uniform distribution was also used to estimate the expected yield value based on the minimum and maximum yield values that are likely to be obtained and the

[4] Monte Carlo simulation is a type of simulation that relies on repeated random sampling and statistical analysis to compute the results. This method of simulation is very closely related to random experiments, experiments for which the specific result is not known in advance.

expected price for selling a unit of the product and this was used to estimate the expected revenue from product sales. Profit is then calculated by addition the expected labor cost and the expected cost of input and subtracting the expected total cost of production from the expected total revenue figure.

One major reason why the uniform distribution is favorable in estimating the expected values is because farmers in Ghana can only predict the range of what the price of farm produce, the yield of farm produce and cost of particular labor activities would be. This budget would give farmers an overview of what the economic returns on their farm enterprise would likely be and would help them adjust and make good decisions.

4. RESULTS AND DISCUSSION

The first section of this chapter presents the finding from the anthropological survey conducted in the December of 2013. The second section analyzes the no-till and conventional budgets and compares the labor usage, cost and profitability of both systems in the various ecological regions of the study.

Anthropological Survey Report

With the exception of one farmer in the Ga West district who had a university education and a professional career in dairy farming, 5 of the farmers had no education and 18 farmers had some form of education but dropped out of school at an early stage. Farmers reported that they got into farming mainly because there was no financial support to help them continue their education and their inability to find alternative jobs that required less technical skills and knowledge led them to become farmers.

The conventional farming practice was the farming system adopted by farmers at the initial stage of their farming careers. Farmers generally learned the practice from parents and close relatives who already used the practice since it was handed over from generation to generation. However, currently some of the farmers have converted to the use of the no-till system. When asked how no-till farmers got to know of the no-till technology, farmers claimed they got to know and learn the technology from the agricultural extension agents in their respective areas. Extension agencies organized field days and established demonstration field to teach farmers the system. This was a way of helping farmers to experience and appreciate no-till agriculture which is more environmentally friendly and sustainable.

Farmers who still used the conventional system knew of the no-till system and its scientific advantages. Others had practiced no-till before but stopped using it whiles others were willing to adopt the system the following cropping season. The majority of the conventional farmers reported that although they know of the soil and environmental improvement qualities of no-till, the system is not easy to adopt. Farmers claimed it was difficult to adopt no-till in areas and on fields which are weedier. Again, they concluded that crop residue left on top of the soil to serve as mulch serves as habitats for particular insect species which cause harm to germinating plants. This they said reduced crop population. Lastly, in the guinea savannah zone a farmer who tilled the soil claimed that the soils in the area were compact and for better aeration and water absorption the land needed to be tilled.

Farmers preferred their children going to school to acquire skills and knowledge that would help them obtain professional and skilled jobs in government or private business than becoming a farmer. Farmers in the north preferred children going to school and having mini-farms as part-time jobs since they felt that could provide them with a double income. Farmers consider education and professional career jobs to be better-paying since it provides higher income and a better living standard as opposed to farming which highly depends on manual labor.

Farming generally was the main income source for all the farmers although some had supplementary income sources such as buying and selling of agricultural inputs and owning provision stores that provided them with extra income. Farmers wished for other jobs aside working on the farm so as to complement the income earned from the farming business.

The availability of land for farming purposes was dependent on the particular ecological zone. Access to land for farming in the transition and guinea savannah zones was not a problem since most farmlands were inherited through family. Farmlands were passed onto the current generation from the previous. However, an increase in family size is decreasing the size of land that could be available for an individual farmer to cultivate. Land availability for farming in the forest and coastal savannah zones were subject to constraints since land could be put to several alternative uses in these areas. Demand for farm lands for estate development and for sand winning in the coastal areas and for illegal mining "galamsey" has created a scarcity of land for agricultural purposes. Farmers in these areas mostly rent or lease the land on which they farm and stand the chance of losing the land anytime the landowner decides to put their land to alternative uses.

In the transition and guinea savannah zones, labor is readily available but farmers face major financial constraints. Farmers claimed it was costly to hire labor to work on the farm. Again, due to galamsey in the forest zone and estate construction in the coastal savannah zone labor availability was scarce. These activities offer higher wages to laborers than what they are being paid working on the farm. The scarcity of labor and higher alternative source of income from other well-paid jobs make it relatively expensive to hire laborers to work on the farm. In addition, labor is hard to find when school is in session and the children cannot replace hired labor which is scarce. The transcribed narrative of one of the farmers in the survey is presented in appendix A.

Labor Requirement and Cost of Labor for No-till and Convectional Till

Labor was seen as an important factor of production for the farmers in the study. Labor was hired for weeding, planting, fertilizer application and harvesting and these were the activities that required the most effort and time. Laborers are paid a daily rate known as “by day” or sometimes the activity is contracted based on the land size per acre. Different rates are paid for different activities whiles the amount also differs from one location to the other.

Forest Zone

The average total labor hours required for farming an acre of land was higher for no-till in all three cropping seasons, minor season 2012/2013 (237), major season 2013 (193) and minor season 2013/2014 (239). The corresponding labor hours for conventional till was (137), (173) and (191) for minor season 2012/2013, major season 2013 and minor season 2013/2014 respectively (Figure 2). Harvesting, fertilizer application, and planting are the three major activities that demanded the most labor. Harvesting and fertilizer application labor was higher for no-till in both major season 2013 and minor season 2013/2014. More labor was required for planting under no-till than conventional. In general, the labor hours required for spraying was higher for no-till but more labor hours were used in weeding the fields under conventional tillage (Figure 3).

Figure 2. Average Total Labor Hours for each Cropping Season (Forest Zone)

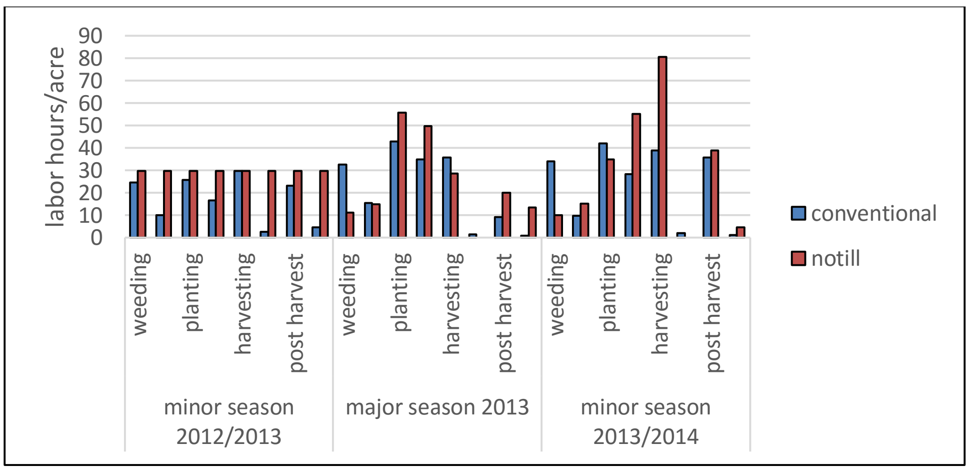

Figure 3. Labor Requirement for Farming Activities per Acre (Forest Zone)

The aggregate average total cost for weeding, spraying, planting and harvesting an acre no-till field was lower than conventional. The average total cost of labor for an acre no-till farm was GHc 223, GHc 237 and GHc 279 in minor

2012/2013, major 2013 and minor 2013/2014 respectively and for conventional it was (GHc 252), (GHc 301) and (GHc 294) for minor 2012/2013, major 2013 and minor 2013/2014 respectively (Figure 4). The cost of weeding was observed to be higher in all seasons for conventional whiles spraying cost was higher for no-till (Figure 5). The cost of planting was 6 percent and 11 percent higher for no-till in minor 2012/2013 seasons and major 2013 season respectively but was 7 percent lower than the planting cost of conventional in the minor season of 2013/2014. The cost of harvesting under no-till in the first two seasons of minor season 2012/2013 and major season 2013 was GHc 55.17 and GHc 63.60 which was lower than the cost of harvesting in the same periods under conventional tillage of GHc 77.87 and GHc 98.91. But in the minor season of 2013/2014 the harvesting cost for no-till (GHc 142.50) was 14 percent higher than the harvesting cost of conventional (GHc 106.71) (Figure 5).

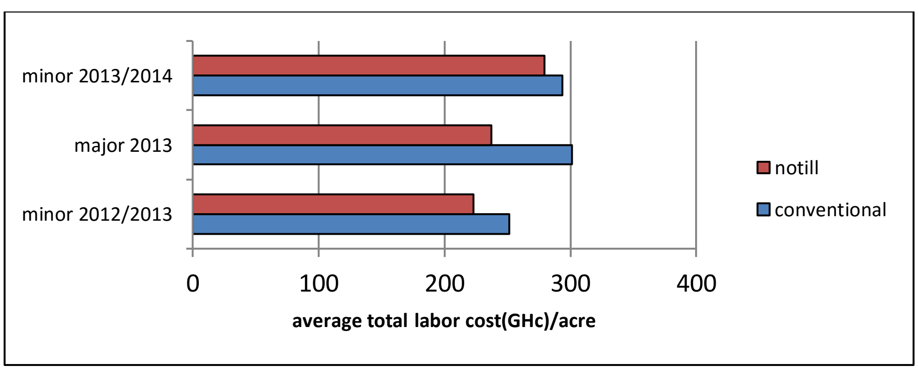

Figure 4. Average Total Labor Cost per Acre (Forest Zone)

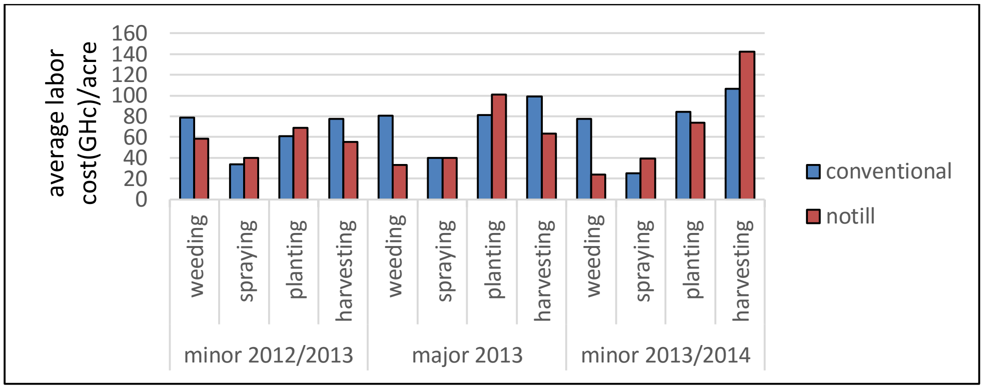

Figure 5. Average Labor Cost for Major Farming Activities (Forest Zone)

Guinea Savannah Zone

More labor hours were used in the performance of various activities in the guinea savannah zone than the other ecological zones in the study. The total average labor hours required for an acre no-till farm was 235 hours for 2012 season, 169 hours for 2013 season and 200 hours for 2014 season compared to 236 hours, 312 hours and 234 hours respectively. No-till was seen to be more labor-saving than conventional till in the guinea savannah zone (Figure 6). Harvesting was the major activity that required the most hours of labor. More hours were spent in harvesting the conventional fields, 2012 season (96 hours), 2013 season (124 hours) and 2014 season (89 hours) than no-till in which 81 hours, 42 hours and 51 hours were used respectively for harvesting. Labor hours used for weeding was shown to be higher for under conventional tillage in all seasons but spraying cost was higher for no-till (Figure 7). Planting hours were greater in 2012 (48 hours) and 2013 (61 hours) for conventional but were about 3 percent less than the hours used for planting under no-till in the 2014 season.

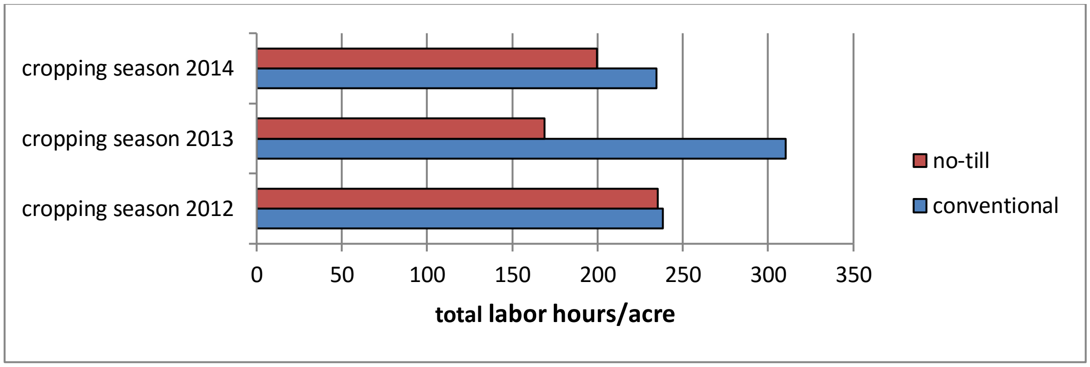

Figure 6. Average Total Labor Hours for each Cropping Season (Guinea Savannah)

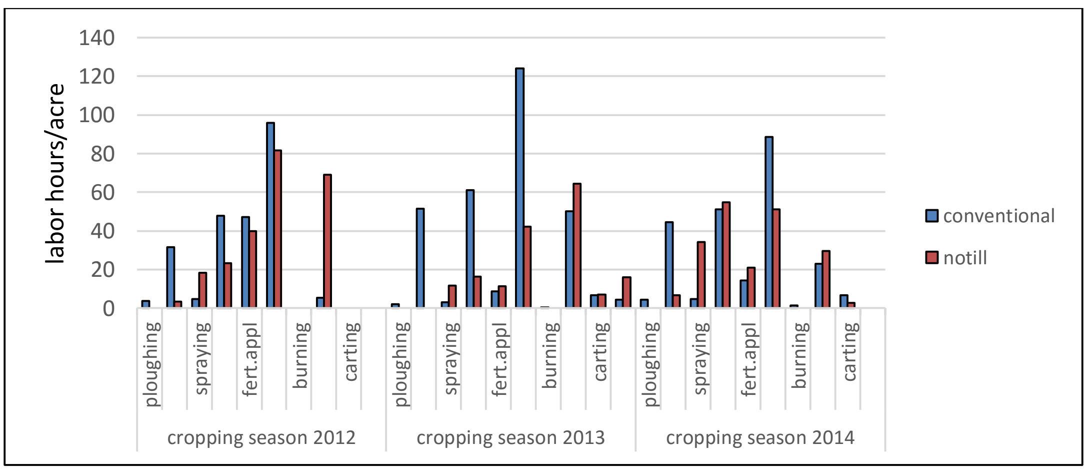

Figure 7. Labor Requirement for Farming Activities per Acre (Guinea Savannah)

Average total cost for the major activities were comparatively higher for conventional tillage than no-till. The labor cost for 2012, 2013 and 2014 was GHc 149.9, GHc 295 and GHc 264.9 respectively for conventional tillage and for no-till were GHc 110.9, GHc 118.9 and GHc 160.9 respectively for the same period

(Figure 8). Harvesting under conventional in the 2013 season was the activity with the highest cost (GHc 85.23) in this region, however, the cost of weeding was observed to be higher for conventional throughout the whole period from 2012 (GHc 52.05) to 2014 (GHc 77.32) whiles spraying cost was generally higher for no-till. (Figure 9).

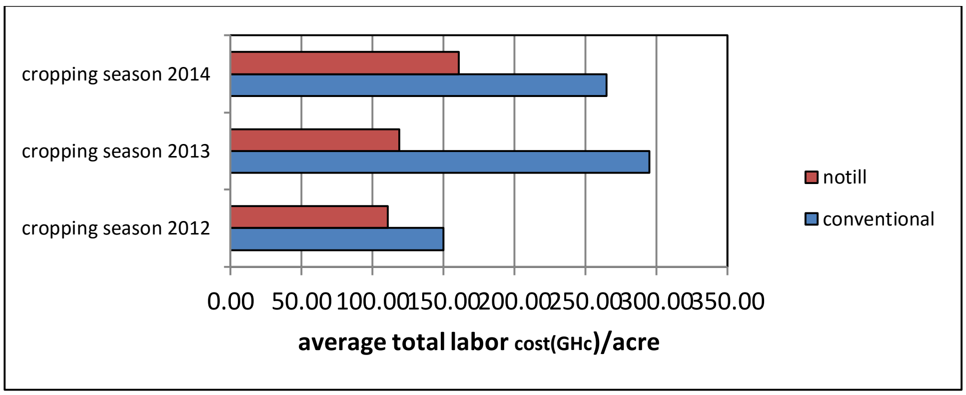

Figure 8. Average Total Labor Cost per Acre (Guinea Savannah)

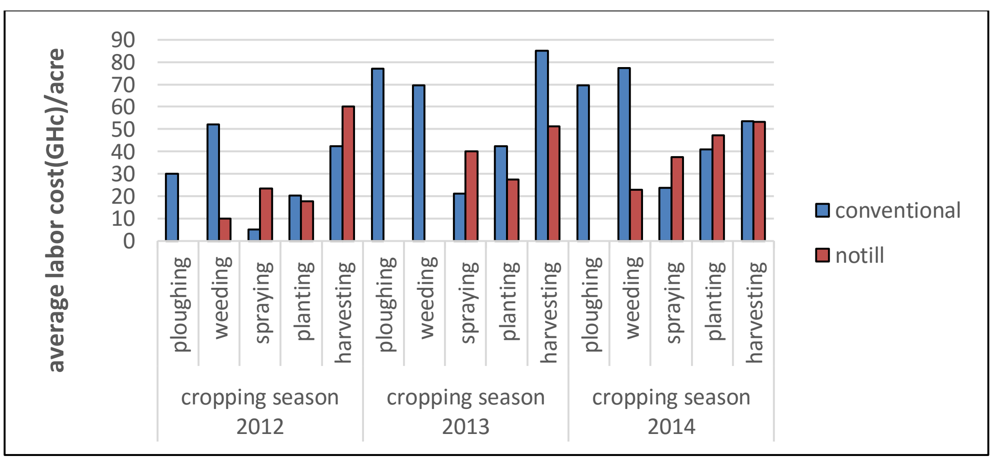

Figure 9. Average Labor Cost for Major Activities (Guinea Savannah)

Transition Zone

The total hours of labor required for farming activities was higher for conventional tillage than no-till in all seasons. The minor season 2012/2013, major season 2013 and minor season 2013/2014 average labor hours required for conventional tillage of 100, 96 and 101 were 9.8 percent, 1.5 percent and 16 percent more than the no-till labor hours of 82, 95 and 73 respectively (Figure 10). Harvesting was observed to be the activity which required the most labor hours to complete. It was greater for conventional in the two minor seasons of 2012/2013 (28 hours) and 2013/2014 (31 hours) but higher for no-till in the major season of 2013 (34 hours) (Figure 11). Cost of weeding was higher for no-till in both minor seasons, 2012/2013 (12 hours) and 2013/2014 (18 hours) which was 14.2 percent and 16 percent greater than the labor hours required for conventional in 2012/2013 (9 hours) and 2013/2014 (13 hours). Hours spent in applying fertilizer on the average was 42.8 percent, 50 percent, and 46percent higher for conventional tillage in the minor season 2012/2013, major season 2013 and minor season 2013/2014 respectively (Figure 11).

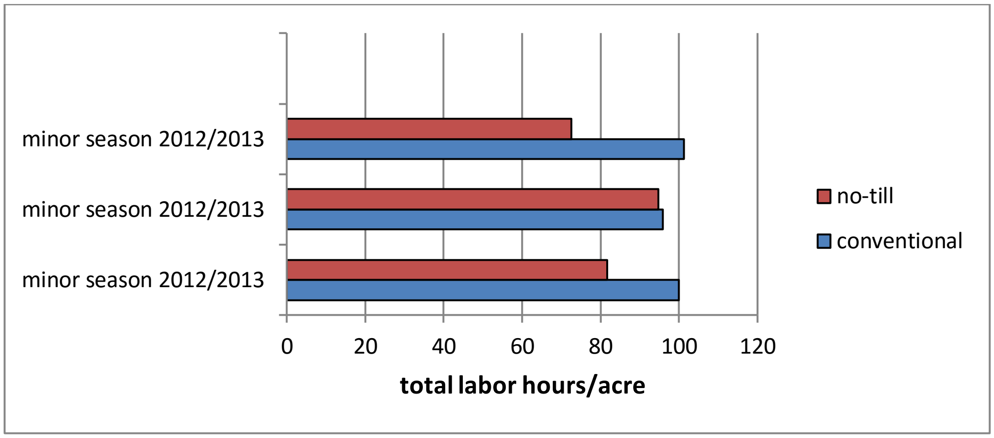

Figure 10. Average Total Labor Hours for each Cropping Season (Transition Zone)

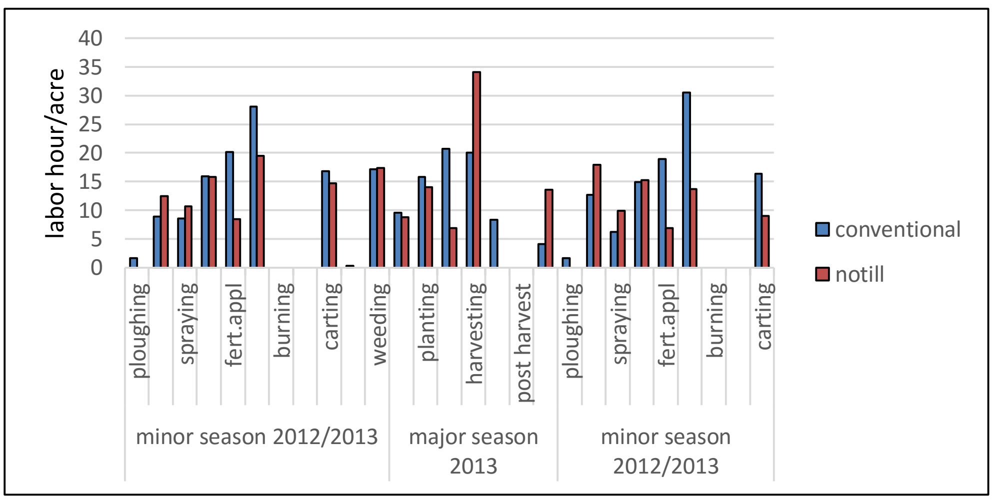

Figure 11. Labor Requirement for Farming Activities per Acre (Transition Zone)

The total cost was higher for conventional in the two minor seasons. Total labor cost for the major farm activities were GHc 208.68 and GHc 173.89 for minor seasons 2012/2013 and 2013/2014 respectively (Figure 12). The cost of planting (GHc 77.16) for no-till in the major season of 2013 was the activity with the highest cost within the study period. Variation in cost was also observed. The cost of weeding for conventional was lower than no-till in the minor seasons of 2012/2013 and 2013/2014 (GHc 13.39: GHc 23.81 and GHc 22.89:GHc 26.27) and was higher in the major season of 2013 (GHc 61.81: GHc 44.04) (Figure 13).

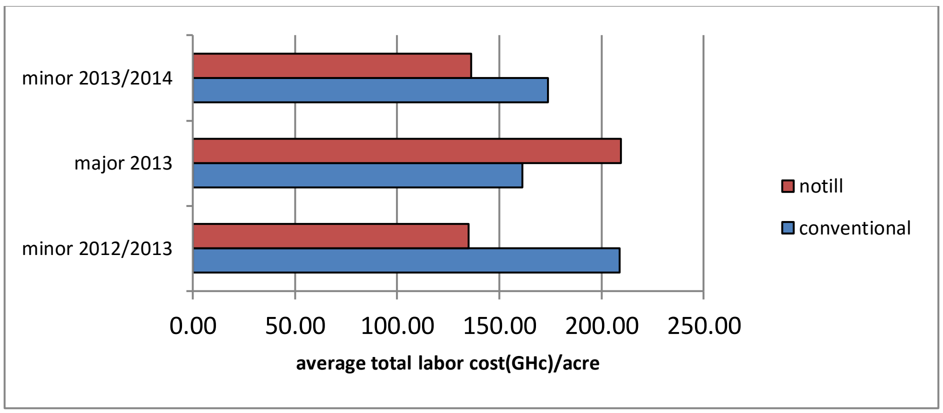

Figure 12. Average Total Cost per Acre (Transition Zone)

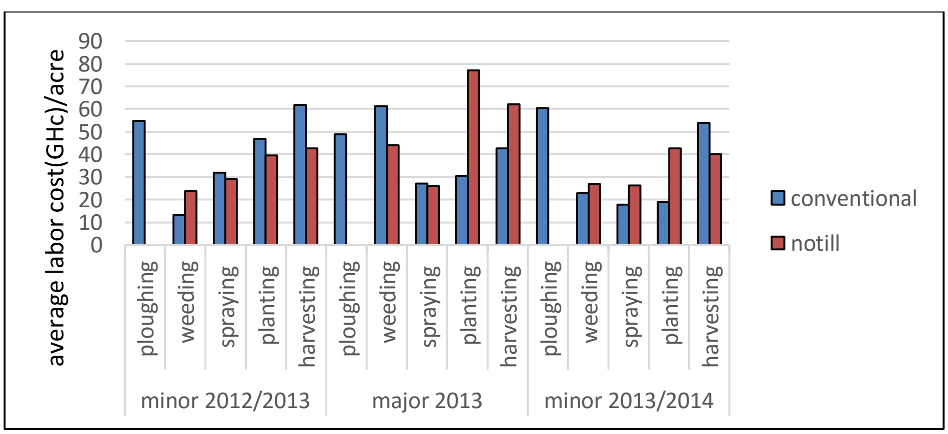

Figure 13. Average Labor Cost for Major Farming Activities (Transition Zone)

Coastal Savannah Zone

The overall demand of labor hours for no-till was higher than conventional in the Coastal Savannah region (Figure 14). The total hours of labor required for farming on a no-till field was higher in all seasons under the study, minor season 2012/2013 (158 hours), major season (89 hours) and minor season 2013/2014 (87 hours) compare to 89 hours, 58 hours and 44 hours for conventional respectively. Although the hours required for no-till was higher, the total number of hours used in farming kept decreasing in subsequent seasons. The most time-consuming activities on the field were weeding, planting, fertilizer application. Harvesting under no-till in all seasons was the activity that required the most hours of labor (Figure 15). The total hours required for harvesting under no-till was 25.4 percent, 62.7 percent, and 44.6 percent higher than conventional in the 2012/2013 minor season, 2013 major season and 2013/2014 minor season respectively.

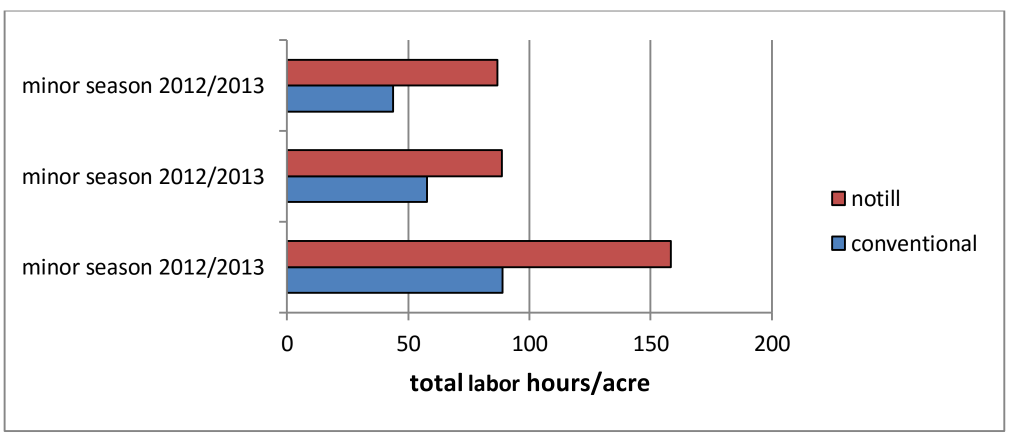

Figure 14. Average Total Labor Hours for each Cropping Season (Coastal Savannah)

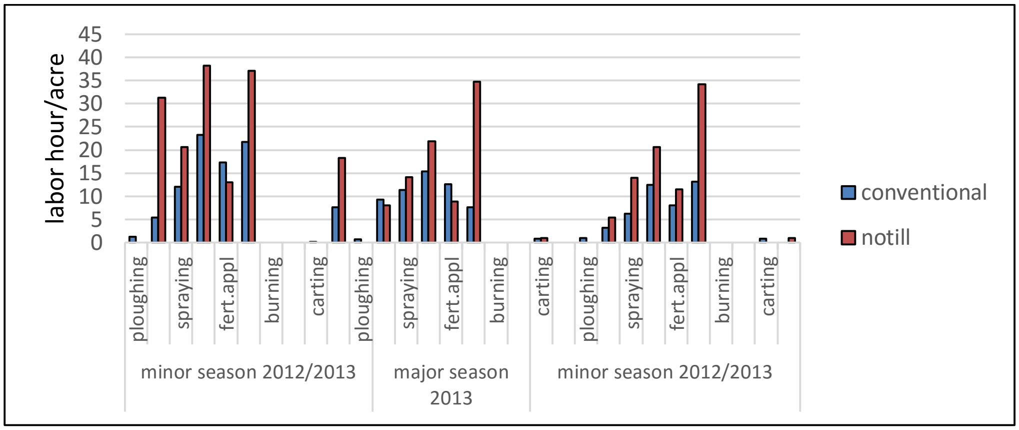

Figure 15. Labor Requirement for Farming Activities per Acre (Coastal Savannah)

The increase in labor hours had a direct impact on the total cost of production for the major cropping activities. The cost of production was higher for no-till in all three seasons (Figure 16). The cost of almost all activities was higher for no-till than conventional (Figure 17). However, the no-till cost of harvesting was the activity with the highest cost, GHc 101.95 in the minor season of 2012/2013, GHc 101.33 in the major season of 2013 and GHc 97.96 in the minor season of 2013/2014.

Plowing was a major practice of conventional farmers in all ecological zones except those in the Forest zone. Conventional farmers in the forest zone only slashed and burnt their farmlands before cultivating.

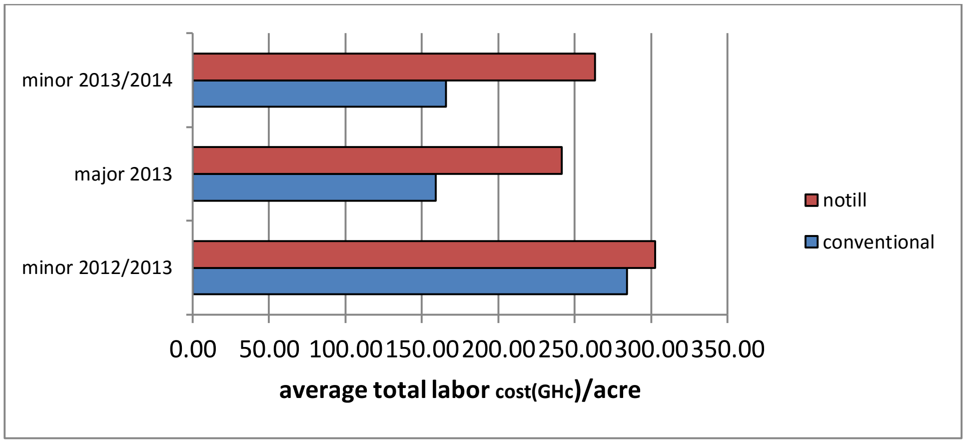

Figure 16. Average Total Labor Cost per Acre (Coastal Savannah)

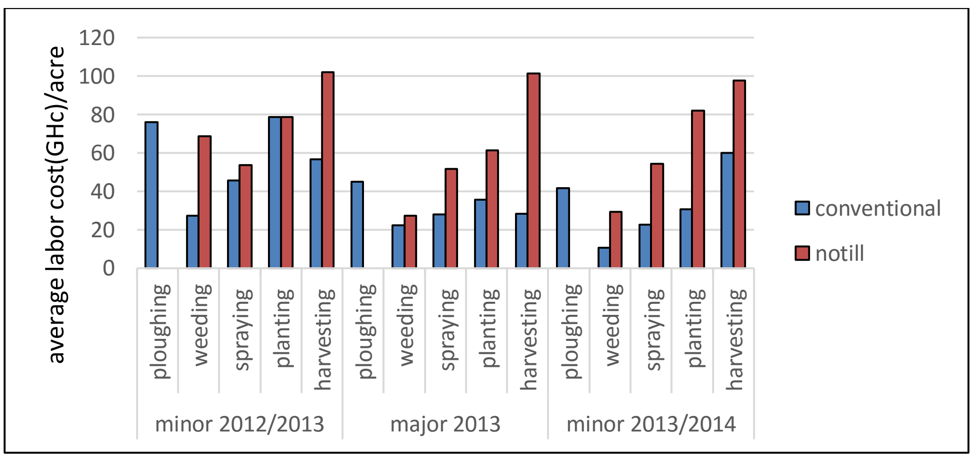

Figure 17. Average Labor Cost for Major Farming Activities (Coastal Savannah)

Labor Cost per Hour Comparison

Results from the average labor cost per hour comparison (Figure 18), shows that the hourly rate of labor is higher in the coastal savannah zone and lower in the guinea savannah zone. This explains why the total cost of labor is higher in the coastal savannah. The hourly rate of labor in the coastal savannah is higher than the average of all four ecological zones. The average cost of labor per hour for all activities on aggregate was GHc 3.37, GHc 2.40, GHc 1.60 and GHc 2.50 respectively for the coastal savannah, transition, guinea savannah and forest zone (Table 7). The cost of labor per hour varied for all activities, between seasons and ecological zones.

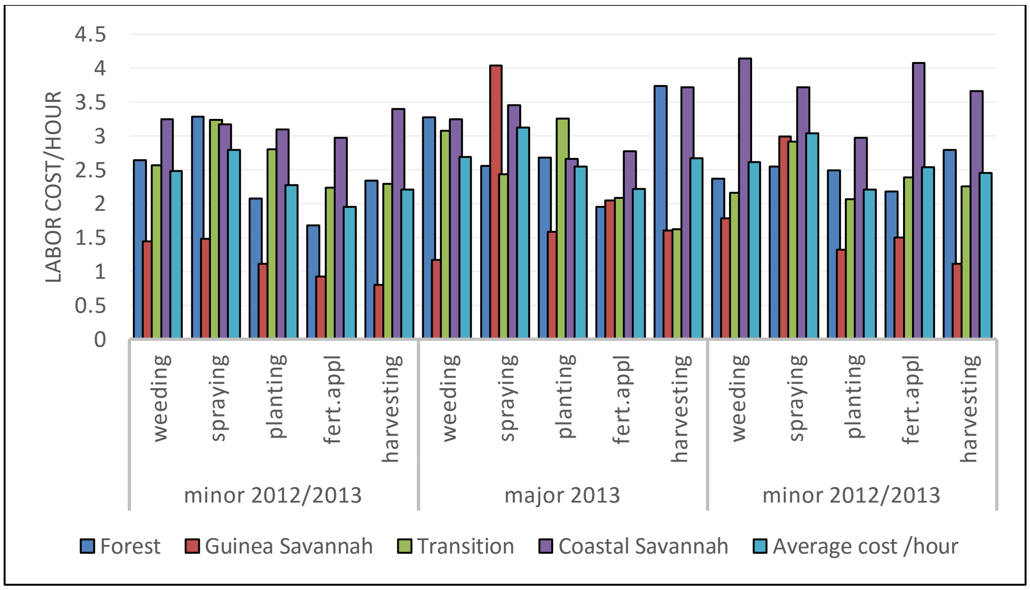

Figure 18. Average Labor Cost per Hour Comparison for all Ecological Zones

Table 7. Aggregate Average Cost of Labor per Hour in each Ecological Zone

Ecological zone	Average labor cost
Forest	2.5
Guinea Savannah	1.6
Transition	2.4
Coastal Savannah	3.3

The weeding cost per hour in the coastal savannah zone was 26.8 percent higher for conventional in the minor season of 2012/2013 but was 18.7 percent and 17.5 percent higher for no-till in the major season of 2013 and the minor season 2013/2014 (Figure 19). With the exception of the 2012/2013 minor season where the average cost per hour for farm activities was higher for no-till, cost per hour was observed to be lower for conventional than no-till in the transition zone (Figure 19). Although the total cost of spraying in the guinea savannah zone was higher in 2013 and 2014 for no-till (Figure 9), the cost of spraying per hour was 21 percent and 51.5 percent higher in both years respectively for conventional tillage. The average cost per hour for no-till is relatively higher in the guinea savannah zone as illustrated in figure 19. The peaks in the labor cost per hour of GHc 4 for spraying in the 2013 season in the guinea savannah zone was as a result of the activity being very technical and expects being hired to accomplish the task.

The average labor cost per hour was generally lower for no-till than conventional in the forest zone except for weeding and spraying in the major season of 2013 and harvesting in the 2013/2014 season. The average weeding and spraying cost for no-till in the major season of 2013 was GHc 3.5 and GHc 3.1 respectively and under conventional it was GHc 3.0 for weeding and GHc 2.1 for spraying (Figure 19). The average cost per hour for harvesting the no-till acre field in the forest zone was 14 percent higher in the 2013/2014 minor season.

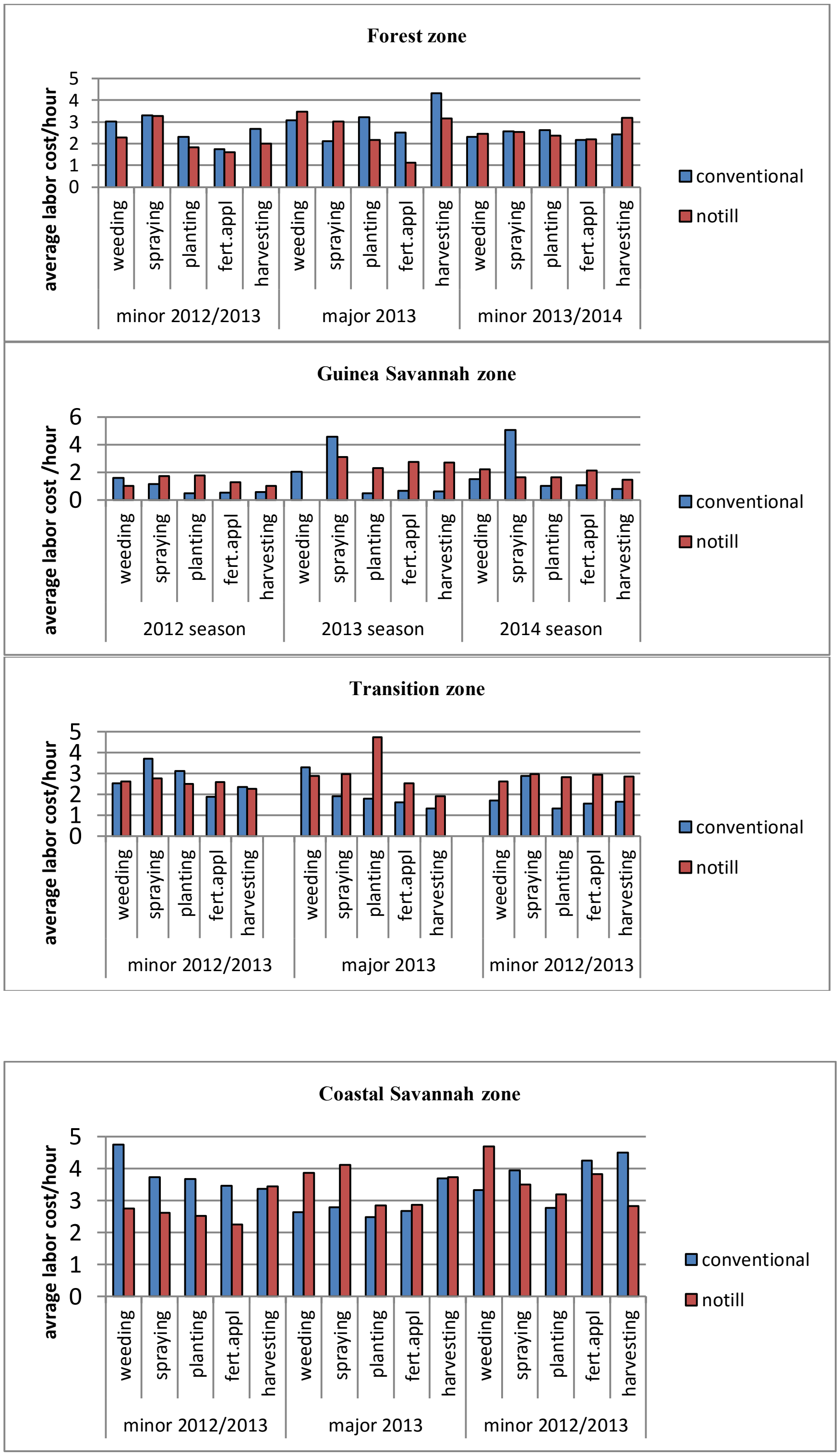

Figure 19. Average Labor Cost per Hour for Major Farming Activities

Crop Yields and Average Prices of Farm Produce

The average yields of maize in all ecological zones for all three seasons studied were higher under the no-till system than conventional (Figure 10). Yield figures of no-till maize in the forest zone were 21.3%, 19.6%, and 15.9 % higher than conventional in the minor season of 2012/2013, the major season of 2013 and minor season of 2013/2014 respectively. In comparison, no-till yields in minor season 2012/2013, the major season 2013 and minor season 2013/2014 in the coastal savannah zone was (507 kg), (664 kg) and (630 kg) respectively and was (460 kg), (505 kg) and (470 kg) for conventional. In other words, although labor cost and labor hours for accomplishing task were higher for no-till in the coastal savannah zone yields gained from no-till maize fields turned to be higher. Generally, the yields of maize in the forest zone where observed to be the highest and that of the coastal savannah zone the lowest. Average maize yields within the three cropping seasons in the forest zone were about 18.2 percent higher than yields in the coastal savannah. In the guinea savannah zone, the average yields of millet for no-till (600kg) were 50 percent greater than the average yields of conventional (300kg) as shown in figure 21.

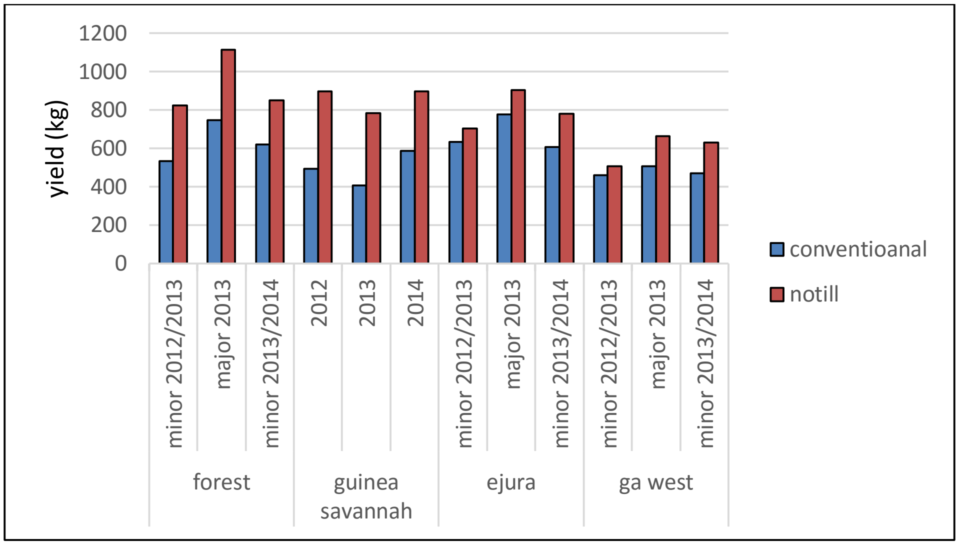

Figure 20. Average Yield of Maize per Acre

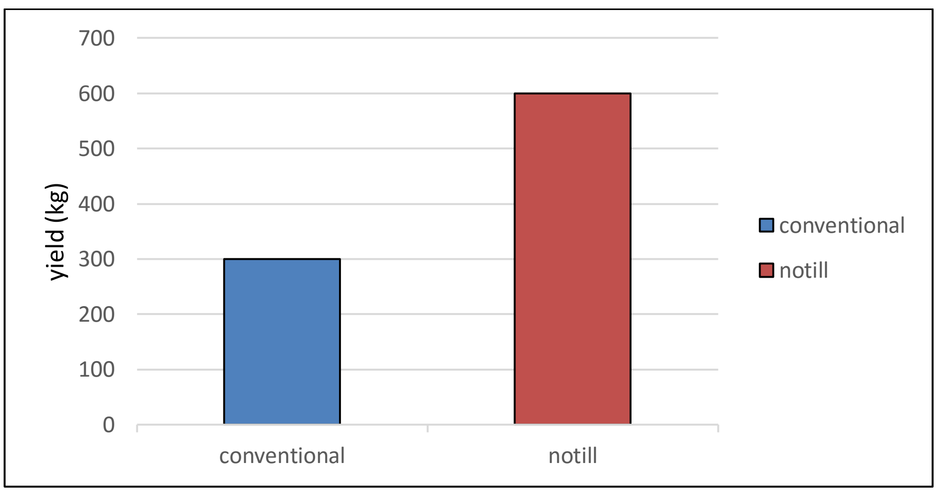

Figure 21. Average Millet Yields (Guinea Savannah)

Tomato yields seem to be higher in the forest zone although the majority of the farmers in the survey did not grow tomato. In the minor season, tomato yields in the forest zone (780kg) was 16% and 28.3% higher than tomato yields in the guinea savannah (520 kg) and coastal savannah zones (312kg) respectively.

Observing from the minor and major season yields of tomato in the forest zone (Table 8), it could be concluded that, favorable weather conditions in the major season boost tomato yields than the harsh dry conditions of the minor season. The yields of tomato under no-till and conventional could not be compared since it was not widely cultivated as maize.

Table 8. Average Tomato Yields per Acre

Ecological zone	yield (kg)	
	minor season	major season
Forest	780	1248
Guinea Savannah	520	
Coastal Savannah	321	

Prices of farm produce were observed to be higher in the lean season when there is less production and lower in periods of a bumper harvest. The average price of maize per 122kg bag (Figure 22) was higher in the minor seasons and lower in the major seasons. Likewise, the average price of a 52kg crate of tomato could be as high as GHc 200 or more in the lean season when there is a shortage of tomato and as low as GHc 40 or less when there is a surplus (appendix B: Atwima Nwabiagya conventional farmer 3a and 3b). Generally, the results illustrate an inverse relationship between the price and yields of most farm products.

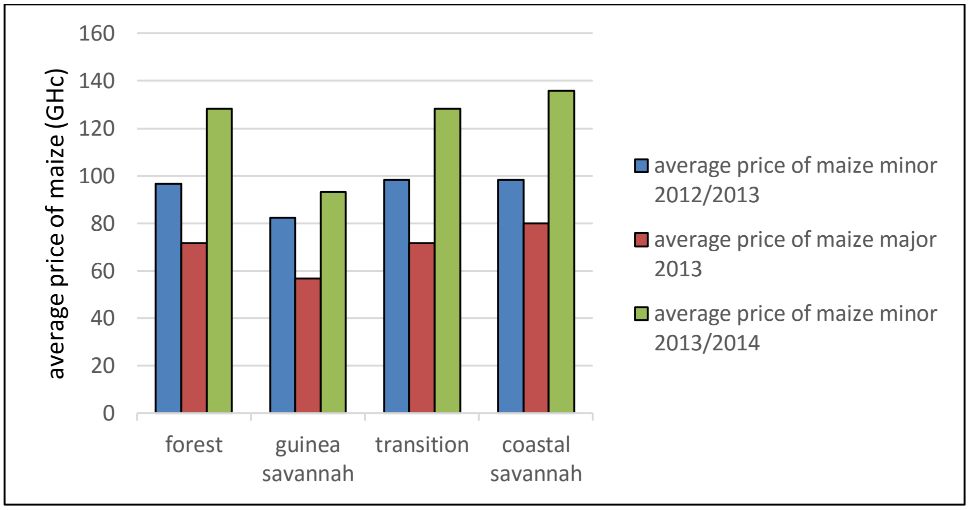

Figure 22. Average Price of Maize

Profitability of Farming Systems and Alternative Crop Mix

Figures 23 to 26 shows the profitability of no-till and conventional across the four different ecological zones based on an acre estimation. With the exception of the Transition zone, at least a farmer in each of the ecological zones practiced mixed cropping. Farmers in the forest and coastal savannah mixed maize with either cassava, cowpea or vegetables. A particular farmer who practiced conventional till in the forest zone mixed maize with ginger in the major season of 2013 and the minor season of 2013/2014 (appendix B: Atwima Nwabiagya conventional farmer 2b and 2c). In comparison, it was realized that the profit share of no-till farmers was higher than conventional. In the transition zone where maize was the only crop cultivated, the average profit earned by no-till farmers in the three cropping seasons (GHc 274.06) was 22 percent greater than the profits earned by conventional farmers (GHc 172.47) (Figure 26). Likewise, the profit from no-till mono-cropping was 24.8 percent and 29.4 percent higher than conventional in the coastal savannah (Figure 25) and guinea savannah (Figure 26) respectively. But unlike the transition zone and coastal savannah zone, millet was sometimes planted as the sole crop in the guinea savannah zone.

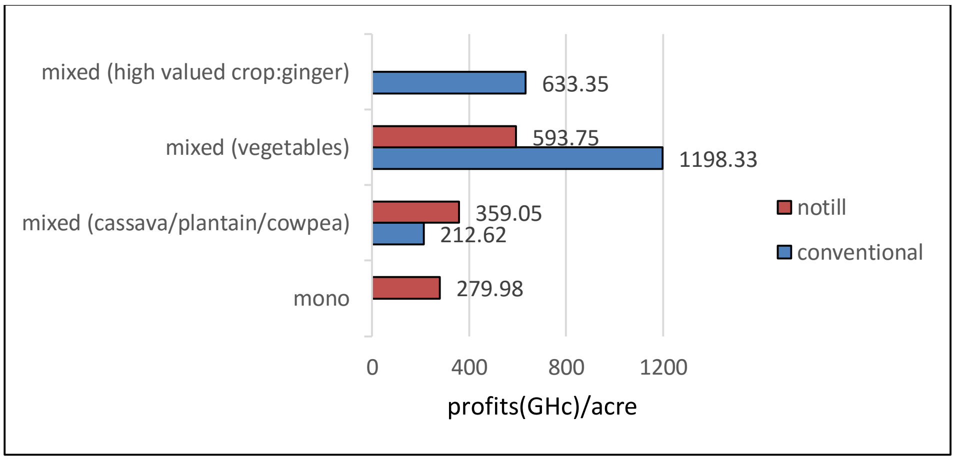

Figure 23. Profit per Acre (Forest Zone)

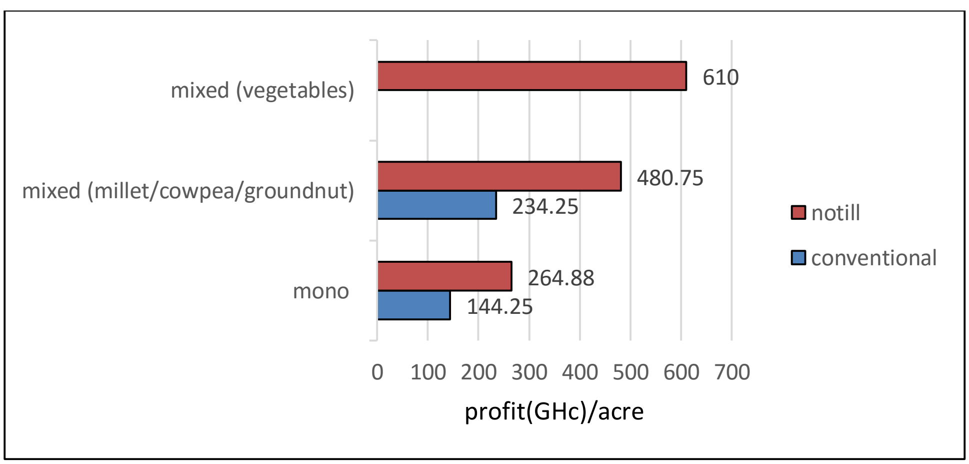

Figure 24. Profits per Acre (Guinea Savannah)

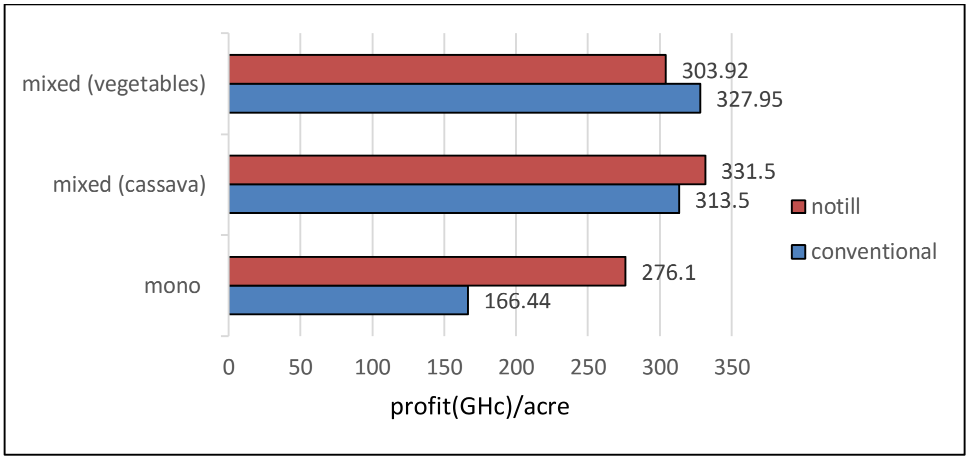

Figure 25. Profits per Acre (Coastal Savannah)

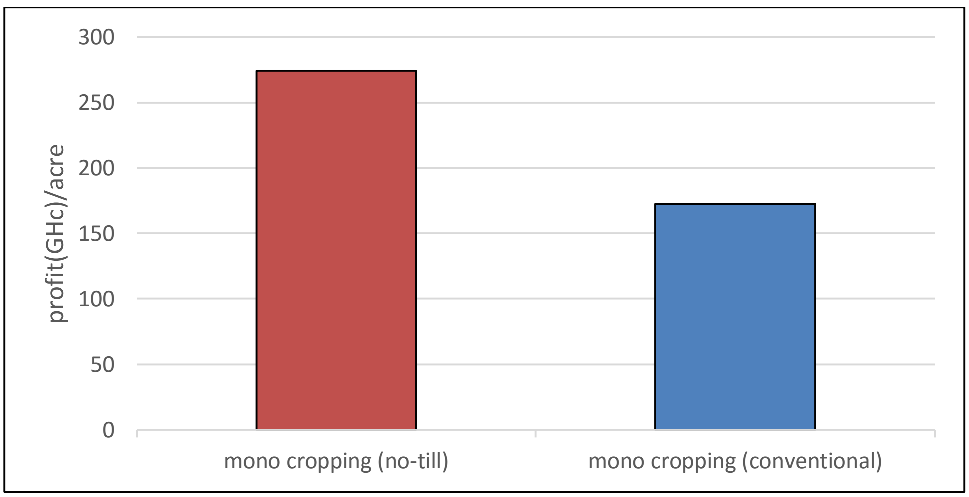

Figure 26. Profits per Acre (Transition Zone)

Mixed cropping was shown to provide higher profits in both systems. Specifically, mixed cropping with vegetables provided the highest profits. In the forest zone vegetable mixed cropped fields generated average profits of GHc 593.75 and GHc 1198.33 for no-till and conventional respectively (Figures 23). However, the higher profits from conventional were due to the farmer growing multiple crops (tomato and cabbage) whiles the no-till farmers mixed only pepper which had a lower market value compare to tomato. The price of a 52kg crate of tomato could be as high as GHc 200 during the lean season when tomato becomes scares as and it could also be as low as GHc 40 during the bumper season when there is surplus. The low price and lower profit risk in vegetable production are therefore greater in periods with surplus production as the budget reveals (appendix B: Atwima Nwabiagya conventional farmer 3a and 3b). Mixed cropping of maize with vegetables and cassava in the coastal savannah zone also generated higher profits than mono-cropping for both systems.

Farmers are therefore better off when they cultivate multiple crops since the market value of crops differ. Crops such as cowpea and other leguminous crops could also be grown to help fix nitrogen into the soil as a form of soil management practice in conjunction with no-till agriculture.

Input Costs and Their Effect on Profits

Input cost generally showed an increasing trend. The cost of the major weedicide glyphosate increased by 3.4 percent from GHc 7 in 2012 to GHc 7.5 in 2013 and by 9.1 percent in 2014 to GHc 9 (Table 9). Same applies to the price of fertilizer. However, the increase in the price of fertilizer; NPK (15:15:15) by 30 percent, ammonia by 31.5 percent and urea by 31 percent between the major season of 2013 and the minor season of 2013/2014 2014 was as a result of the government taking off the subsidy on fertilizers.

Table 9. Average Price of Selected Farm Inputs

	price(GHc)		
inputs	minor season 2012/2013	major season 2013	minor season 2013/2014
glyphosate	7	7.5	9
gramozone	7	8	9.5
atrazine	7.5	9.5	10
npk(15:15:15)	39	51	95
ammonia	35	44	85
urea	38	50	95

The fertilizer subsidy program was instituted by the Ministry of Food and Agriculture Ghana (MOFA) in response to obvious food and fertilizer price increase in 2007. The program sought to encourage the use of 50kg NPK (15:15:15), urea and ammonia fertilizer in the country and to help increase crop production above the 2007 level which was primarily due to higher energy and fertilizer prices (MOFA, 2008). In a news item publish in the Ghana news agency website on the 16th of April 2013, the prices of NPK, urea and ammonia were subsided by 21 percent on average and farmers had to pay GHc 51, GHc 50 and GHc 44 for these inorganic fertilizers listed above respectively. In addition, seed price for maize was also reduced by 36 percent. According to the newsletter (Ghana News Agency, 2013), the purpose of the subsidy was to help ensure that the farmer has higher yields.

A scenario was created to analyze the effects on production cost and on profits if the subsidy was removed and farmers had to pay the amount of the fertilizer subsidy that was taking by the government themselves whiles every other thing is held constant. No-till farmer 2b in the Atwima Nwabiagya district's 2013 major season budget was used as the base for the analysis. The actual cost (NPK 15:15:15) and ammonia were GHc71.5 and GHc 64.5 since government subsided them by GHC 20.5. Seed cost of maize was also assumed to increase by 36 percent which is the percentage of the subsidy. The subsidy removal caused input cost to increase by 27.9% (GHc 326 to GHc 417) and profits to decrease by 15.3% (GHc 593 to GHc 502). The effects of the subsidy removal can be found in appendix B: No-till farmer 2bi budget.

Energy Prices and Their Effects on Farm Profits

Domestically, an increase in fuel prices have an adverse effect on the general price of goods and services in the country. According to FAPDRRD (2008) fuel price increase directly affects transportation fares and eventually lead to an increase in general prices of goods and services specifically prices of foodstuff. On the August of 2014, the National Petroleum Authority (NPA) announced a 20% increase in petroleum products in Ghana. This led to an increase in the price of a liter of gasoline from GHc 2.73 to GHc 3.36. In response to the increase in fuel prices, the Ghana Road Transport Coordinating Council (GRTCC) made up of the Ministry of Transport and transport operators announced a 15% increase in transport fares with effect from the day the fuel price increase commenced[5]. The

[5] My Joyonline, (Web Source: http://www.myjoyonline.com/business/2014/july-13th/fuel-prices-go-up-by-over-20-from-monday.php) (viewed: 3/25/2015)

transportation fare increase led to a proportional increase in the prices of most marketable commodity ranging between about 9% increase to about 30% increase on various commodities. [6]. This goes to prove that there is a direct relationship between fuel prices and cost of production and cost of running any business in the country.

A scenario was created using the 20% petroleum product price increase to analyze the effects on production cost and profit whiles revenues were held constant. The general price of goods and services were assumed in this analysis to have increased by the average of the range of the actual price increase of 9% and 30% which was 19.5%. Fertilizer and seed prices were also held constant since it was assumed that there was a government subsidy present. However, since carting cost is related to transportation it was assumed to have increased by 15%. The analysis was made using the budget information from No-till farmer 2c in the Atwima Nwabiagya district's 2013/2014 data. The results were a 2.63% increase in input cost (GHc 601 to GHc 616.8), 19% increase in labor cost (GHc 581 to 691.1) and a 16.19% decrease in profits (GHc 778 to 652.1). This is represented in appendix B: No-till farmer 2ci budget.

[6] GhanaWeb (Web Source: http://www.ghanaweb.com/GhanaHomePage/business/artikel.php?ID=317649) (viewed : 3/26/2015)

5. DISCUSSION AND CONCLUSION

Discussion

It was observed that the average labor cost for activities where not fixed. Although at times uniform rates were charged "by day" for the major farm activities, bargaining power between farmers and laborers in most instances played a role as to what rate is charged. For instance, in some cropping seasons farmers could be paying different laborers different rates for performing the same activity. From the sample calculation sheet, there was an instance where farmers paid GHc 7 and GHc 8 for weeding as a by-day labor charge for the same activity within the same cropping season (appendix B: sample calculation sheet).

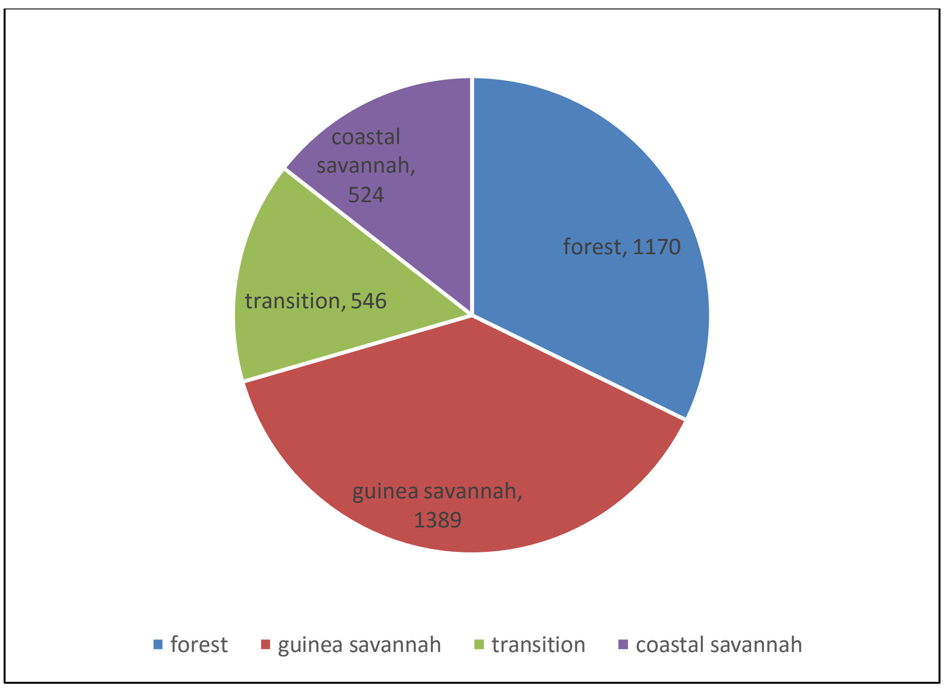

Figure 27. Average Total Labor Hours for all Ecological Zones

Results imply that more labor hours are employed on a no-till farm in the Forest and Coastal Savannah zones while fewer hours are used on no-till farms in the Guinea Savannah and Transition zone. However, the aggregate hours of labor used in the Guinea Savannah zone within the three cropping seasons (1389 hours) was greater than Forest (1170 hours), Transition (546 hours) and the Coastal Savannah zone (524 hours) (Figure 27). Total average cost for no-till in both the Forest and the Guinea Savannah zone were lower for no-till. The lower cost of labor in the forest zone thus explain why the hours spend on farm activities are generally high. No-till farmers can work on their farms for longer hours, but the rate charged for their activities are lower than conventional. Plowing was not a feature of conventional farming in the forest zone this is due to the undulating topography in the area. Therefore, plowing of conventional fields as is done in the other zones is unfavorable. Instead, conventional farmers just slash and burn. In addition, tractor plowing was the most common form of plowing amongst conventional farmers who ploughed. Plowing was the major form of machinery use as shown in the study although tractors were sometimes used in carting harvested produce. Mechanization in no-till agriculture is very low.

In the coastal savannah zone, the hours of labor and the cost of production were greater for no-till but the yields per acre from no-till maize fields were higher than that of conventional (Figure 20). The higher yields mainly explain why the cost of no-till harvesting is higher in the area. In comparison, no-till yields in minor season 2012/2013, major season 2013 and minor season 2013/2014 was (506.67

kg), (664 kg) and (630 kg) respectively and (460.44kg), (505.24kg) and (470.4 kg) for conventional. The greater yields from no-till in the coastal savannah zone compensate for higher cost and hours spent on farm activities.

In general, no-till maize yields were higher in all four ecological zones (Figure 10). The water retention ability of no-till and the decomposition of organic matter help enrich the soil to support plant growth (Derpsch 1999). The forest zone was the highest yielding zone (781.32 kg) whiles the Coastal savannah region had the lowest yields (539.49 kg) when the average yields of all the ecological zones were observed. Guinea savannah and transition zone yielded (677.33 kg) and (734.56 kg) respectively. The higher yields in the Forest zone are mostly due to the soil conditions and soil type being favorable for crop production. According to the Encyclopedia Britannica[7], the soils in the forest zone of Ghana are the best for agriculture.

Results from the average labor cost per hour comparison (Figure 19), reveals that the hourly rate of labor is higher in the coastal savannah zone and lower in the guinea savannah zone. This explains why the total cost of labor is higher in the coastal savannah. The hourly rate of labor in the coastal savannah is higher than the average of all four ecological zones together. The proximity to the nation's capital, the higher cost of living and the competitive demand for labor for construction work explains why the labor rate per hour is higher in the coastal

[7]Encyclopedia Britannica(Web source: http://www.britannica.com/EBchecked/topic/232376/Ghana/55171/Soils) (viewed: 5/27/2015)

savannah region. In contrast, the northern belt of the country has a lower living cost and labor cost comparatively is lower than the southern belt of the country. This makes the low labor rate for the guinea savannah zone very reasonable. The peaks in the labor cost per hour figure of GHc 4 for spraying in the 2013 season in the guinea savannah zone was as a result of the activity being very technical and expects being hired to accomplish the task. Higher rates are mostly charged for activities that required extra technical skills such as spraying.

The average price of maize (Figure 22) shows that, the average price of maize is always higher in the minor seasons but fall during the major season. Yields are higher in the major cropping season since rains fall frequently than the minor season and conditions are mostly favorable for crop production. There is bumper harvest during the major cropping season and therefore prices fall. This follows the economic principle of surpluses leading to a reduction in prices and shortages leading to an increase in prices. In addition, there are no standardized markets for grain crops as there is for cocoa in the form of the Cocoa Marketing Board. Farmers get lower prices for their produce since there is no standardized market to set farm produce prices. The market forces of demand and supply, however, dictates prices of maize, other grains, and most farm commodities. In the opposite direction, the lower harvest in the lean season and the higher demand for the crops increases the price of maize in the minor season.

Vegetables mixed with cereal in a mixed cropping system were known to be more profitable than cereals mono-cropped. There was a significant increase in the production of tomato from 176 metric tons to 340 metric tons in 2011 (Ghana Veg Program 2014, *Vegetable Business Opportunities in Ghana 2014*). Vegetable consumption and production in Ghana has double to about 12 percent per annum and the overall turnover of vegetables in the country is about $800 million whiles economic growth is 7 percent (Vegetable fact sheet). There is known to be an increasing demand for fruit and vegetables in Ghana as a result of the countries sustained economic growth leading to the emergence of middle class consumers who patronize fresh fruits and vegetables and thereby creating larger markets for such produce. This clarifies the results from the budgets since tomato is classified as a high-valued crop which can be cultivated on a smaller land area and still be very profitable. Although vegetables are profitable there is the perishability risk as well as the price risk. The prices of tomato from the budgets looked highly volatile due to changes in demand and supply of the market for tomato.

Input cost has a negative relationship with the profits that can be realized after production. Since, the cost of inputs is part of the production cost, and the increase will generally cause a decrease in the total profits all thing being equal. Subsidies, however decrease the cost of production when all other things are held constant. Farmers can purchase more fertilizers to help increase crop yields when the price of fertilizers is subsided by the government. The reverse is the opposite. For instance, a news article reported Peasant Farmers Association claiming that it was going to be disastrous should the government decide not to subsidize fertilizer. They predicted the economic situation of the country to worsen as food production would decrease due to the removal of the subsidy, and therefore, more food would have to be imported.

Similar to input cost, energy prices also influence farm profits. There is a negative relationship between the two. These two scenarios, therefore, have negative economic effects on profit. Since a rise in energy prices lead to an increase in production cost as illustrated in appendix B with the 2013/2014 minor season budget of no-till farmer 2c profits reduced. However, the rate of reduction of profits depends on the rate of increase in general prices of goods and services as a result of the fuel price increase.

Conclusion

A farmer's decision as to what crops to cultivate and which farming practice, when adopted, would be most sustainable and highly profitable is made easier if he has a form of management instrument available at his disposal. The idea behind the building these simple farm budgets was to help the local farmer in Ghana acquire a simple decision making tool which is less complex and easily helps in analyzing the financial risk of farm enterprises and to assist in projecting and estimating farm revenues, cost and profits. Data from 24 farmers collected from the four major ecological zones were used in building the farm budgets to access labor, revenue, cost and profitability of no-till and conventional tillage for three deferent cropping seasons (minor season 2012/2013, major season 2013 and minor season 2013/2014). This was basically to highlight planning and decision-making risk which farmers face in their farming enterprise and to provide an avenue to help them make important decisions in managing the financial risk they face in their farm enterprise.

The budget templates in appendix B can all be manipulated. Farmers in each ecological zone whose farming practice is similar to any of the budgets could use the templet and input their current data or alternative numbers to analyze different scenarios even before making a final decision. This would help farmers estimate their cost, revenue, and profits. Profits, cost, and revenues can be estimated even before the actual cropping season begins based on historical data compiled in the specific location and this would help make the necessary adjustments when results are not favorable. Likewise, the farm budget in appendix C built with simitar tools also has the tendency of helping evaluate the profits of the farm when the farmer estimates figures and put into the budget template. The stochastic profit figure can then be simulated and a cumulative distribution (CDF) chart can be used to evaluate the probability of a farmer gaining positive or negative profits. This tool helps farmers to make the necessary adjustments since they become aware of the risk they face and what necessary adjustments they can take to make things better.

In advanced countries like America, research and extension institution have similar management tools used as policy tools to enable farmers to estimate their returns even before cultivating. Tools like these at the disposal of the extension service of Ghana and various research institutions like the Center for No-till Agriculture would be very useful in helping local farmers analyze their farming risk. Extension officers could easily be trained to be familiar with how such a tool works and can easily explain to farmers their chances of gaining or losing profits.

The sustainability of Ghana's agriculture in the distant future could be in jeopardy observing the results of the anthropological survey. The aging population forms the major farmer population in the country with the average as 48 years. The energetic youth with the ability to adopt new and improved agricultural practices that are very sustainable are not interested in agriculture. Most farmers in Ghana did not choose to be farmers at their will but by economic circumstances which prevented them from furthering their education. The majority of farmers do not want their children becoming farmers but prefer them landing white color jobs. This is due to the negative perception which farmers themselves and the youth have about farming. The key to eradicating this problem is to erase the negative perception which people have about farming as a job for the uneducated, unskilled and generates low returns. The budgets reinforce issued raised earlier about the introduction of an agribusiness and exploring the urban and peri-urban markets as a way of attracting the youth into agriculture and likewise no-till farming. Considering the profits earned by the mixed tomato farmers, it could be realized the farmers earn such higher profits because they invested in the cultivation of a higher valued crop like a tomato. The growing of specialty crops, particularly fruits and vegetables need to be thoroughly explored as a response in addressing the issue of sustainability of no-till farming. The Youth in Agriculture Program (YIAP) which was initiated by MOFA through the government's youth policy with the objectives of “promotion of youth in modern agriculture as variable career opportunity for the youth and as an economic and business option” and “the provision of resources for the participation of the youth in modern agriculture” (National Youth Policy Ghana 2010) could be an avenue for integrating the agribusiness program.

Study Limitations and Future Research

The study was to use the farm budgets to analyze the labor use, cost and profitability of a farm enterprise. Budgets constructed where not whole farm budgets since the information provided by the data were limited to the construction of an enterprise and partial budgets. Secondly, the profitability of machinery use in no-till could not be analyzed since there was no data provided in the daily farm data for such analysis. However, expansion of no-till would largely depend on the mechanization of the system. Any future studies should incorporate the use of machinery in no-till in order to access the profitability and comparative advantage of machinery use in the system.

REFERENCES

A Montpellier Panel Report. (2013). *Susutainable Intensification: A New Paradigm for African Agriculture.* London.

African Conservation Tillage Network. (2008). *African Conservation Tillage Network*. Retrieved 04 01, 2015, from www.act-africa.org/

Akinyemi, J. O., Akinpelu, O. E., & Olaleye, A. O. (2003). Performance of cowpea under three tillage systems on an Oxic Paleustaif in southwestern Nigeria. *Soil.Till.Rec, 72*, 75-83.

Atwima Nwabiagya District Assembly. (2013). *The Composite Budget For The Fiscal Year.* http://www.mofep.gov.gh/sites/default/files/budget/2013/AR/Atwima_Nwabiagya.pdf.

Baoteng, E. A. (1968). Population and Land Use in the Forest Zone of Ghana. *Bulletin of the Ghana Geographical Association, 7*.

Bolliger, A., Magid, J., Amado, T. J., Neto, F. S., Ribeiro, M. D., Calegari, A., . . . De Neegaard, A. (2006). Taking stock of the Brizillian zero till revolution: A review of landmark research and farmers' practice. *Advances in Agronomy, 91*, 47-110.

Boserup, E. (1965). *The Conditions of Agricultural Growth:The Economics of Agrarian Change Under Population Pressure.* London,UK: George Allen and Union.

Boudreax Karol, & Sacks, D. (2009). Land Tenure Security and Agricultural Productivity. *Marcatus Policy No.57*.

Bremer, J. E., Livingston, S. D., Parker, R. D., & Stichler, C. R. (2001). *Conservation tillage applications.* Texas A&M Univ. Syst.,College Station: Texas Coop. Ext.

Brunner , E., Mariki, W., Elwell, H., & Benites (ed), J. (1998). Available technology in conservation tillage;Theme1:technologies in conservation tillage. *International Workshop on Conservation Tillage for Sustainable Agriculture.Harare (Zimbabwe), 22-27 Jun 1998* (pp. 87-92). Eschborn (Germany): GTZ.

Bull, L., & Sandretto, C. (1995). The economics of agricultural tillage systems.In Farming for a Better Environment. *Soil and Water Conservation Society*, 35-37.

Burton, E. S., & Rajalahti, R. (2010). *Strengthening Agricultural Extension and Advicory Systems:Procedure for Assessing Transforming and Evaluating Extension Systems.* Washington, DC: International Bank for Reconstruction and Development/The World Bank.

Chamberlin, J. (2007). *Defining smallholder agriculture in Ghana: Who are smallholders, what do they do and how are they linked with markets?* Washington, DC: IFPRI: GSSP Background Paper 6.

Chambers, R. (1993). *Challenging the professions: Frontiers for rural Development.* London: International Technology Publications Ltd.

Christoplos, I. (2009). *Food Security: Astrategy interface on the human dimension of climate change.* Stockholm: Commision of Climate and Development.

Claire, S. C. (2014). Agricultural Value Chains in Sub Saharan Africa. In *From a development challenge to business opportunity* (p. 3).

Conway, G. (1998). *The Doubly Revolution:Food for all in the twenty-first century.* Cornell University Press.

Derpsch, R. (1999). Frontiers of conservation tillage and advances in conservation Practice. *No- Tillage, Sustainable Agriculture in the New Millennium.* West Lafayette: In., (Proceedings in Print).

Derpsch, R., & Fredrich, T. (2009). Innovations for Improving Efficiency, Equity and Environment. *Global overview of Conservation Agriculture adoption.* New Delhi, India: 4th World Congress on Conservation Agriculture.

Derpsch, R., & Moriya, K. (1998). Implications of no-tillage versus soil preparation on sustainability of agricultural production. *Sustained Land Use-Further Cooperation Between People and Institutions, Advances in Geoecology 31.Vol 2* (pp. 1179-1186). Catena Verlag, Reiskirchen: Internation Soil Conservation Organisation (ISCO), Bonn.In.

Derpsch, R., Florentin, M., & Moriya, K. (2006). The laws of diminishing yields in the tropics. *Proceedings on CD, 17th ISTRO Conference*, (pp. 1218-1223). Kiel,Germany.

Derpsch, R., Friedrich, T., Kassam, A., & Hongwan, L. (2010). Current status of adoption of no-till in the world and some of its main benefits. *International Journal of Agricultural and Biological Engineering, 3(1)*.

Doya, D. *Budgets:Their Use in Farm Management.* Retrieved from http://osufacts.okstate.edu/docushare/dsweb/Get/Document-1682/AGEC-139web.pdf

Ekboir, J., Boa, K., & Dankyi, A. A. (2002). *Impact of No-Till Technology in Ghana.* CIMMYT.

Eneyew, A. (2013). Untied efforts: The challenges for improved research,extension and education linkages. *Global Journal of Agricultural Economics,Extension and Rural Development, 1(1)*, 001-008.

Findaly, J. R., & Hutchinson, N. C. (1999). Development of Conservation Tillage in African Countries: A partner Approach. In: Breth, S. (ed.). *Partnerships for Rural Development in Sub Saharan Africa.* Geneva, Switzerland: Center for Applied Studies in International Negotiation.

Food and Agriculture Oganisation. (2010). *Basic principles of conservation agriculture.* http://www.fao.org/ag/ca/.

Food and Agriculture Organisation. (1984). *Agricultural extension: A reference manual.* Roma.

Friedrich, T., & Kassam, A. (2012). No-till Farming And The Environment:Do No-till Systems Require More Chemicals? *Outlook on Pest Management*, pp. 153-157.

Garcia-Parbon, J. (2009). Planning for success: a Business Plan Guide for Minority farmers. *Small Farm Digest;Farm Financial Management, 13*.

Germer, J., & Saureborn, J. (2008). *Ecological Zones ofGhana.* Retrieved October 2, 2015, from (https://www.unihohenheim.de/respta/climate.php

Ghana Districts.com. Retrieved from http://www.ghanadistricts.com/home/

Ghana Ministry of Food and Agriculture. (2008). *Press briefing on fertilizer susbsidy .* Accra.

Ghana Statistical Resrearch and Information Direct. (2010). *Agriculture in Ghana: Facts and Figures.* May 2011.Accra. Retrieved May 2011.

Ghana Statistical Service. (2010). *Population and Housing Census.* http://www.statsghana.gov.gh/docfiles/pop_by_region_district_age_groups_and_sex_2010.pdf.

Ghana Statistical Service. (2010). *Population by region,district,age group and sex.* Retrieved from Ghana Statistical Services: http://www.statsghana.gov.gh/docfiles/pop_by_region_district_age_groups_and_sex_2010.pdf

Ghana Statistical Service. (2014). *Population projection by sex, 2010 to 2014.* Accra.

Ghana Veg Report. (2014). *Vegetable Opportunities in Ghana.* Netgerlands: Wageningen UR.

Gill, K. S., & Aulakh, B. S. (1990). Wheat yield and soil bulk-density response to some tillage systems on Oxisol. *Soil.Till.Rec, 18*, 37-45.

Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crop Research, 114*(1), 23-34.

Gourou, P. (1974). *The Tropical World: Its Social and Economic Conditions and Its Future Status.*

Guyslain, K., Owusu, N. R., Kimpo, J., & Kolavalli, S. (2011). *Cropping Practices and Labor Requirements in Field Operation for Major Crop in Ghana.What Needs to Be Mechanized.* IFPRI Discusion Paper 01074.

Haack, R., & Haskins, D. (1999). An economic evaluation of tillage 2000 demonstration plot data (1986-1988). *Rep.10. Soil and Water Environ. .* Enhancement Prog.,Ontario, Canada.

Hardaker, J. B., Huirne, R. M., Anderson, J. R., & Lien, G. (2004). *Coping With Risk in Agriculture.* Wallingford,Oxfordshire,U.K: CBI Publishing.

Harman, W. L., David, R. M., Morrison, J. E., & Potter, K. N. (1996). Economics of wide-bed farming systems for vertisol (clay) soils: Chisel tillage vs. no-tillage. *J. Am. Soc. Farm Manage, Rural Appraisers 19*, 129-134.

Hignight, J., Watkins, K. B., & Anders, M. M. (2009). Economic Benefits of No-Till in a Rice-Soybean Rotation. *University of Arkansas Extension Service Fact Sheet.* Little Rock, AR: University of Arkansas Division of Agriculture. Retrieved from http://www.uaex.edu/Other_Areas/publications/PDF/FSA-38.pdf

Hipp, J. (2009). Why Farmers Should Care About Farm Financial Management. *Small Frm Financial Digest; Farm Financial Management, 13*.

Huggins , D. R., & Reganold, J. R. (2008). No-Till: the Quiet Revolution. *Scientific American, 299(1)*, 70-77.

International Monetary Fund. (2008). *Food and Fuel Price-Recent Development,Macroeconomic Impact and Policy Responses.* Washinton DC, September. Retrieved 3 23, 2015, from ww.imf.org.external/np/pp/2008/091908.pdf

International Rice Research Institute. (1978). *Annual Report for 1978.* Los Baños, Philippines.

Jones , G. E. (1994). Agricultural advisory work in England and Wales: The beginnings. Agricultural Progress. *69, 55-69Journal d'Agriculture Pratique (1874),38th year, 2*.

Kahan, D., & Food and Agricultural Organisation of the United Nation, i. b. (2013). *Managing risk in farming.* Rome: Food and Agricultural Organisation of the United Nations.

Kayode, J., & Ademiluyi, B. (2004). Effects of tillage methods on weed control and maize performance in southwestern Nigeria. *J.Susut.Agric, 23*, 39-45.

Kimenye, L. N. (2006). Research extension farmer linkages for market orientationResearch. *A paper presented at the second networking symposiumSecond networking symposium on innovations in agricultural advisory services in Sub-SaharanAfrica.* Kampala,Uganda.

Klose, S., & Outlaw, L. (2005). Financial and Risk Management Assistance: Decision Support for Agriculture. *Journal of Agricultural and Applied Economices, 32*(2), 415-423.

Lal, R. (1991). Tillage and agricultural sustainability. *Soil.Till.Rec, 20*, 133-146.

Locke, M. A., Reddy, K. N., & Zablotowicz, R. M. (2002). Weed management in conservation crop production systems. *WeedBio.Manage, 2*, 123-132.

Madhvani, S., Pehu, E., & Birner, R. (2010). *Gender and Governance in Agricultural Extension Services: Insights from India, Ghana, and Ethiopia.* Washinton DC: World Bank: Agriculture and Rural Development Notes, Issue 53.

Madrid International Plan of Action on the Ageing . (2007). *Ghana Country Report.* National Population Council.

Massey, R. (1997). Notill and Conservation tillage: Economic Consideration. University of Missouri, Columbia, MO.

Mbagwu, J. (1990). Mulch and tillage effects on water transmission characteristics of an Ultisol and miaze grain yield in SE Nigeria. *Pedologie, 40*, 155-168.

Ministry of Food and Agriculture. (2011). *Agriculture in Ghana: Facts and Figures.* Statistics,Research and Infromation Directorate (SRID).http://mofa.gov.gh/site/wp-content/uploads/2011/10/AGRICULTURE-IN-GHANA-FF-2010.pdf.

Ministry of Food and Agriculture Ghana. (2013). *Directorate of Agricultural Extension Services*. Retrieved February 9, 2015, from Ministry of Food and Agriculture Republic of Ghana: http://mofa.gov.gh/site/?page_id=74

Mora, C. (2014). Revisiting the environmental and socioeconomic effects of population growth: a fundamental but fading issue in modern scientific, public, and political circles. Ecology and Society. *Ecology and Society 19(1)*, 38.

Moschini, G., & Hennessy, D. A. (2001). Uncertainty risk aversion, and risk management for agricultural producers. *In Handbook of agricultural economics,(eds B. L. Gardner & G. C. Rausser), 1*, 87-153.

Nafziger, E. (2009). Cropping Systems. In *Illinois Agronomy Handbook 24* (pp. 49-63).

National Youth Employment Policy. (2010). *Theme: Towards An Empowered Youth, Impacting Positively on National Development.* Accra.

Netherlands-African Business Council. (2014). *Factsheet-Vegetables Ghana.* Netherlands. Retrieved 5 31, 2015, from http://www.ondernemeninontwikkelingslanden.nl/sites/default/files/partnerkennis/Factsheet%20GhanaVeg.pdf

Nicou, R., Charreau, C., & Chopart , J. L. (1993). Tillage and soil physical properties in semiarid West Africa. *Soil.Till.Rec*(27), 125-147.

Oklahoma Cooperative Extention Factsheet. Retrieved 03 23, 2015, from http://osufacts.okstate.edu/docushare/dsweb/Get/Document-1682/AGEC-139web.pdf)

Patrick, G. F. (1992). *Managing Risk in Agriculture.* Purdue University,West Lafayette: Purdue University Cooperative Extension Service, No. NCR-406.

Percy, R. (2000). Gender analysis and participatory rural appraisal: Assessing the current debate through an Ethiopian case study involving agricultural extension work. *International Journal of Educational Development,19(6)*, Retrieved January 24,2009 from http://www.sciencedirect.com/science.

Philips, S. H., & Young Jr, H. M. (1973). No tillage farming. *Reiman Associates*, (p. 224). Milwaukee, Wisconsin.

Pouliquen, L. Y. (1970). Risk analysis in project appraisal. *Word Bank Stuff Occasional Paper (11).* International Bank for Reconstruction and Development: The John Hopkins University Press.

Rasmussen, W. D. (1989). *Taking the university to the people:seventy-five years of coooperative extension.* Ames,IA: Iowa State University Press.

Reijntjes, C., Haverkort, B., & Water-Bayer, A. (1992). *Farming for the Future: An Introduction to Low-external-input and Sustainable Agriculture.* London: Macmillan Press.

Ribera, L. A., Hons, F. M., & Richardson, J. W. (2004). An Economic Comparison between Conventional and No-Tillage Farming Systems in Burleson County, Texas. *Agronomy Journal, 96*, 415-424.

Richardson, J. W. (2005). *Simulation for applied risk management.* Department of Agricultural Economics, Texas A&M University, College Station.

Sachs, J. (2005). *The End of Poverty: Economic Possibility for Our Time* . New York: Penguin Press.

Sahs, R. (1998). *Goat Farm Budgeting.* Langston University, Proc. 13th Ann.Goat Field Day.Langston, OK.

Senyolo, G. M. (2007). *Factors Distinguishing Low Turnover Emerging Farmers from High Turnover Emerging Farmers in South Africa.* MSc Dissertation, University of Limpopo, South Africa.

Swanson, B., & Samy, M. (2002). Decentration of agricultural extension systems: Key elements for success. Retrieved January 24, 2009,from http://info.worldbank.org/tools/docs/library/51025/ZipAgExtension1/ag_extension1/Materials/May6Session1/Decentralization-India4-18_paper.pdf .

Temesgen, M., Rockstrom, J., Savenije, H. G., Hoogmoed, W. B., & Alemu, D. (2008). Determinants of tillage frequency among smallholder farmers in two semi-arid areas in Ethiopia. *Phys.Chem.Earth, 33*, 183-191.

Texas A&M Agrilife Extension Services. (2013). *About The Texas A&M AgriLife Extension Service*. Retrieved February 9, 2015, from Texas A&M AgriLife: http://agrilife.org/agrilife-agencies/extension-home/

Toliver, D. (2010). *Effects of No-Tillage on Crop Yields and Net Returns Across the United States.* Knoxville, TN: Unpublished M.S. Thesis,The University of Tennessee, Department of Agricultural Economics.

.

Touliver, D. K. (2010). *Effects of No-Tillage on Crop Yields and Net Returns Across the United States.* Master's Thesis, University of Tennessee.

Tripathi, A., & Prasad, A. R. (2008). Agricultural Productivity Growth in India. *Journal of Global Economy An International journal*, ISSN: 0975-3931.

Triplett Jr, G. B., & Warren, A. D. (2008). No-tillage crop production: A revolution in agriculture. *Agronomy Journal, 100*, S153-S165.

Tripletts , G. B., & Warren, A. D. (2008). No-Tillage crop production: A revolution in agriculture. *Agron.J.,100*, S153-S165.

Vogel, H. (1994). Weeds in single-crop conservation farming in Zimbabwe. *Soil Till.Res., 31*, 169-185.

Vogel, H. (1995). The need for integrated weed management-systems in smallholder conservation farming in Zinbabwe. *DerTropenlandwirt, 96*, 35-56.

World Bank. (2008). *World development report 2008.* Washinton DC: The World Bank.

Zinnah, M. M., Feakpi, R., Compton, J., & Drafor, I. (2008). Testing decision trees as tools to help agricultural extension staff advise Ghanaian farmers on effective maize storage options. *Journal of International Agricultural Extension Education, 5(3)*, 15-22.

APPENDIX A

TRANSCRIBED NARRATIVE OF ALEX MENSAH (NO-TILL FARMER ATWIMA NWABIAGYA)

Background Information

I am Alex Mensah. I was born in Seidi, a village in the Ashanti Region of Ghana. A few years after my birth, my parents migrated to Wasa Domenase, a town in the Western Region of Ghana. The reason for their migration was to state a cocoa farm and this region of the country was well noted for cocoa cultivation. I started elementary school at Domenase and continued to the form four level in 1985.I was not able to continue my education from this level since my parent did not have the necessary financial aid to help me through so I dropped out.

I moved from Domenase to Atonsu, a suburb of Kumasi (Capital of Ashanti Region) to learn a trade. I became an apprentice at a shoe-making shop and learned how to make shoes and became really good that the trade. After leveling in Kumasi for about 3 years I moved back to my hometown seidi since the landlord of the apartment I rented asked us to evacuate the house since he was going to continue further construction of the building.

Back home in seidi I had no job, so I decided to start a farm. My family personally had no farmland, but my mother had had a land on which she shared cropped and cultivated cocoa and I started helping her on the farm. When the cocoa was ready for harvest, the landowner came claiming he wanted to sell the land. We had a disagreement with him and the case was taken to the law court. Unfortunately, we lost the case and had no compensation. We were left with no land to farm.

Access to farmland was quite difficult to come by at the initial stage. Fortunately for me the woman I got married to had land which she inherited from her parents. This gave me access to land to farm and over the years I was also able to lease extra land.

The traditional slash and burn farming system was the system I initially practiced. I use to plant portions of the land and moved to different portions for the soil at the former regains its fertility. I had no access to extension service at that time so did things my own way. I got exposed to an extension when a Non-Governmental Organization (NGO) came around our community and wanted to help promote the cultivation of a particular breed of pepper known as Legon 18. It was through this program that I got exposed to agricultural extension and attended several lectures and workshop to study and known of the new and improved sustainable soil practices known as no-till. As I got enlightened in the practice, I realized that my old practice was unsustainable and less environmentally friendly.

Other Occupation Aside Farming

Aside cultivating the various crops, I also rear sheep. I had a couple and got extra ones from the MOFA livestock program which was to support livestock farmers multiple their stock. I was also trained on how to raise chicken as part of the program. Aside all these, I am also into the agrochemical trade and own a small agrochemical shop. The shop provides me with supplementary income and also helps the local farmers get ready access to farm inputs.

Would you want any of your children to be farmers?

I know of the importance of farming and know how important food is to the survival of society. We would not be alive if we all decide to go into government paid jobs. People can own farms thou they have government paid jobs. I would prefer my children to go to school and acquire higher levels of education, but they could have farms too. I say this because I see farming as important.

Access to Land

Land is very hard to come by. And financial cost also makes it difficult to rent or lease.

Access to Labor

Access to labor is very difficult due to the "galamsy" (illegal mining) which is very popular in this area. The prices charged have increased since there is a limited amount of people available to work on the farm. Also, the young energetic men who use to work on the farm find it highly profitable to be involved in galamsy works than on the farm since it is highly profitable in comparison. The cost and number of labor to hire is also reduced during weekends when the kids are home or on holiday and vacation when they get to help on the farm.

Challenges in No-till

The initial stage of no-till adoption is the most challenging period. This is because I had been exposed to it for the first time and was not used to it but with time and highly qualified personnel to train me I was able to overcome the challenges. People who are currently being introduced complain of some insects and rodents biting the emerging leaf of mainly maize. My advice to them is always to spray as soon as you plant with insecticide and again when the plants begin to grow.

Comparison between No-till and Slash and Burn

In estimation, the cost involved in slash and burn is more costly than that of no-till. The moisture content of the soil and its fertility is reduced under slash and burn as compared to no-till with mulch. The cost involved with weeding is higher with slash and burn because the weeds germinate faster and one might spray the plot about three times before harvesting whiles it might be just once or twice when the land is mulched. In addition, you could be at a risk of losing your life by burning if you are not lucky enough.

APPENDIX B

FARM BUDGETS

Atwima Nwabiagya (no-till)

No-till Farmer 1(2012/2013 minor season) farm size: 1.66acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	11	11	100	1100	
cowpea	4	3	120	360	
revenue					**1460**

INPUT COST

	qty	cost/unit	total	
weedicide(litre/bottle)				
Glyphosate	6	7	42	
fertilizer(bags)				
NPK(15:15:15)	2	40	80	
Manure	7	5	35	
				157

LABOR COST

	no.of hrs	average cost/hr	ATC
weeding	20.0	1.05	21
spraying	7	5.00	35
planting			
Maize	38.3	1.96	75
Cowpea	8	1.88	15
fertilizer appl.			
	72	2.04	147
harvesting			
Maize	25	2.00	50
Cowpea	8.3	2.41	20

post-harvest	74	1.95	144	
carting	1	50.00	50	
Total				**557**
Profit	**746**			

No-till Farmer 2a (2012/2013 minor season) farm size: 2.3acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	16	15	100		
revenue					**1500**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	4	7	28	
gramozone	4	7.5	30	
insecticide(litre bottles)				
lambda	1	12	12	
fungicide			20	
fertilizer(bags)				
NPK(15:15:15)	4	39	156	
ammonia	2	35	70	
				316

LABOR COST

	no.of hrs	average cost/hr	ATC
spraying	31	2.48	77
weeding	14	4.14	58

planting				
maize	102	1.47	150	
fertilizer application				
	73	1.44	105	
harvesting				
maize	59	2.17	128	
post-harvest	122	0.79	96	
carting	1.5	35.00	52.5	
				666.5
TOTAL				**982.5**
profit	**517.5**			

No-till Farmer 2b (2013 major season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	23		22	75	
revenue					**1650**

INPUT COST

	qty	cost/unit	total
weedicide(litre bottle)			
glyphosate	4	7.5	30
gramozone	3	8	24
insecticide(litre bottles)			
lambda	1	12	12
pyrinix	1	15	15
fertilizer(bags)			
NPK(15:15:15)	2	51	102
ammonia	2	44	88

manure	5	6	30	
maize seed cost			25	
				326
LABOR COST				
	no.of hrs	average cost/hr	ATC	
weeding	10	4.80	48	
spraying	17	3.59	61	
planting maize	81	1.68	136	
fertilizer application	128	0.94	120	
harvesting maize	74	2.05	152	
carting	2	35.00	70	
post-harvest	45	3.20	144	
				731
TOTAL				**1057**
profit	**593**			

No-till Farmer 2bi (2013 major season). **No fertilizer subsidy**

crop	**yield**	**qty sold**	**unit price**	**total**	
maize	bag/112kg		ghc	ghc	
	23	22	75		
revenue					**1650**
INPUT COST					
		qty	cost/unit	total	
weedicide(litre bottle)					
glyphosate		4	7.5	30	

gramozone	3	8	24	
insecticide(litre bottles)				
lambda	1	12	12	
pyrinix	1	15	15	
fertilizer(bags)				
NPK(15:15:15)	2	71.5	143	
ammonia	2	64.5	129	
manure	5	6	30	
maize seed cost			34	
				417

LABOR COST

	no.of hrs	average cost/hr	ATC	
weeding	10	4.80	48	
spraying	17	3.59	61	
planting maize	81	1.68	136	
fertilizer application	128	0.94	120	
harvesting maize	74	2.05	152	
carting	2	35.00	70	
post-harvest	45	3.20	144	
				731
TOTAL				**1148**
profit	**502**			

No-till Farmer 2c (2013/2014 minor season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	15	14	140		
revenue					**1960**
INPUT COST					
		qty	cost/unit	total	
weedicide(litre bottle)					
glyphosate		6	9.5	57	
fertilizer(bags)					
NPK(15:15:15)		3	110	330	
urea		2	85	170	
manure		4	6	24	
maize seed				20	
					601
LABOR COST					
		no.of hrs	average cost/hr	ATC	
weeding		24	2.50	60	
spraying		29	2.10	61	
planting					
maize		28	3.21	90	
fertilizer application					
		81	1.98	160	
harvesting					
maize		48	2.92	140	
carting		1	70.00	70	
					581
TOTAL					**1182**
profit	**778**				

No-till Farmer 2ci (2013/2014 minor season) **Fuel Price Increase**

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
		15	14	140	
revenue					**1960**
INPUT COST					
		qty	cost/unit	total	
weedicide(litre bottle)					
glyphosate		6	11.35	68.115	
fertilizer(bags)					
NPK(15:15:15)		3	110	330	
urea		2	85	170	
manure		4	7.17	28.68	
maize seed				20	
					616.795
LABOR COST					
		no.of hrs	average cost/hr	ATC	
weeding		24	2.99	71.7	
spraying		29	2.51	72.895	
planting					
maize		28	3.84	107.55	
fertilizer application					
		81	2.36	191.2	
harvesting					
maize		48	3.49	167.3	
carting		1	80.50	80.5	
					691.145
TOTAL					**1307.94**
profit	**652.06**				

Conventional Farmer 2a (2012/2013 minor season) farm size: 5.3acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	26	25	90	2250	
cowpea		12	105	1260	
revenue					**3510**

INPUT COST

	qty	cost/unit	total	
weedicide				
glyphosate	10	7.5	75	
insecticide				
	2	10	20	
fertilizer				
NPK(15:15:15)	8	40	320	
				415

LABOR COST

	no.of hrs	average cost/hrs	ATC
weeding	152	4.01	609
spraying	20	2.10	42
planting			
maize	42	2.67	112
cowpea	50	1.32	66
fertilizer appl.			
npk(15:15:15)	42	1.50	63

harvesting				
maize	105	1.90	200	
cowpea	29	1.69	49	
post-harvest	55	2.04	112	
others(burning)	7	3.86	27	
carting	2	70.00	140	
				1420
TOTAL				**1835**
profit **1675**				

Conventional Farmer 2b (2013 major season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
		29	70	2030	
cowpea		13	85	1105	
ginger		30	60	1800	
revenue					**4935**

INPUT COST

	qty	cost/unit	total
weedicide(litre bottle)			
glyphosate	9	7.5	67.5
insecticide(litre bottles)			
	2	10	20
fertilizer(bags)			
NPK(15:15:15)	8	51	408
urea	4	50	200
manure	5	7	35

ginger planting material			30	
				760.5
LABOR COST				
	no.of hrs	average cost/hr	ATC	
weeding	274.2	1.50	410	
spraying	48.4	1.57	76	
planting				
maize	44	6.06	266.65	
cowpea	27	2.67	72	
ginger	60	1.60	96	
fertilizer appl.				
	113	2.41	272	
harvesting				
maize	104	2.23	232	
cowpea	7	4.57	32	
cassava&plantain	2	8.00	16	
others(burning)	3	2.67	8	
carting				
carting	1	60.00	60	
loading	3	8.00	24	
				1564.65
TOTAL				**2325.15**
profit	**2609.85**			

Conventional Farmer 2c (2013/2014 minor season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
		22	120	2640	
cowpea		13	150	1950	
ginger		25	80	2000	
revenue					**6590**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	8	9.5	76	
paraquat	3	9	27	
atrazine WP(100g)	12	12	144	
atrazine	2	6.5	13	
insecticide(litre bottles)				
chlorpyriphos	1	13	13	
fertilizer(bags)				
NPK(15:15:15)	7	90	630	
urea	3	80	240	
manure	5	7	35	
maize seeds			45	
				1223

LABOR COST

	no.of hrs	average cost/hr	ATC
weeding	120.5	1.54	186
spraying	29.4	2.52	74
planting			
maize	73.45	1.09	80
cowpea	32	6.25	200

fertilizer appl.				
	98	1.53	150	
harvesting				
maize	70	2.14	150	
cowpea	34	2.65	90	
ginger	76	2.11	160	
gathering	8	10.00	80	
carting	2	30.00	60	
post-harvest	84	1.90	160	
				1390
TOTAL				**2613**
profit **3977**				

Conventional Farmer 3a (2012/2013 minor season) farm size: 1.1acre

crop	yield	qty sold	unit price	total	
maize		bag/112kg	ghc	ghc	
	5	4	80	320	
pepper	rubbers				
	18	16	4	64	
tomato	boxes				
	17	15	200	3000	
revenue					**3384**

INPUT COST

	qty	cost/unit	total
weedicide(litre bottle)			
glyphosate	3	7.5	22.5
fungicide(50g)	1	10	10

insecticide(litre bottles)				
	1	10	10	
fertilizer(bags)				
NPK(15:15:15)	1	40	40	
foliar fertilizer	1	30	30	
				112.5
LABOR COST				
	no.of hrs	average cost/hr	ATC	
weeding	30.0	2.80	84	
spraying	15.3	5.36	82	
planting				
maize	31.6	3.80	120	
fertilizer appl.				
	23	2.17	50	
harvesting				
maize	24.3	3.95	96	
vegetables	15	3.93	59	
watering	14	4.14	58	
carting	14	4.00	56	
post-harvest	36	1.33	48	
				653
TOTAL				**765.5**
profit	**2618.5**			

Conventional Farmer 3b (2013 major season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	8	8	65	520	
pepper	rubbers				
	25	20	4	80	
tomato	boxes				
	26.5	23.5	40	940	
cabbage	bags				
	30	28	25	700	
revnue					**2240**
INPUT COST					
		qty	cost/unit	total	
weedicide(litre bottle)					
glyphosate		2	7.5	15	
fungicide(50g)		1	10	10	
insecticide(litre bottles)					
		1	10	10	
fertilizer(bags)					
NPK(15:15:15)		2	51	102	
ammonia		2	44	88	
manure		5	5	25	
maize seeds				12	
cabbage seed				50	
					312
LABOR COST					
		no.of hrs	average cost/hr	ATC	
preparing nursery		6	2.67	16	

weeding	23.0	5.22	120	
spraying	23.3	3.18	74	
planting				
maize	70.3	1.82	128	
fertilizer appl.				
	47.3	3.72	176	
harvesting				
maize	14.5	4.97	72	
vegetables	28	3.71	104	
watering	6	5.00	30	
				720
TOTAL				**1032**
profit	**1208**			

Conventional Farmer 3c (2013/2014 minor season)

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	7	6	110	660	
cabbage	bags				
	25	24	70	1680	
revenue					**2340**

INPUT COST

	qty	cost/unit	total
weedicide(litre bottle)			
glyphosate	4	9	36

fungicide(50g)	2	27	54	
fertilizer(bags)				
NPK(15:15:15)	2	100	200	
liquid fertilizer	1	30	30	
manure	4	5	20	
maize seeds			10	
cabbage seed			50	
				400
LABOR COST				
	no.of hrs	average cost/hr	ATC	
weeding	35.0	3.77	132	
spraying	13	2.92	38	
planting				
maize	24	2.17	52	
cabbage	80	1.75	140	
fertilizer appl.				
	42	3.33	140	
harvesting				
maize	40	3.00	120	
vegetables	7	8.57	60	
watering	24	0.83	20	
post-harvest	68	2.65	180	
carting	1.5	40.00	60	
				942
TOTAL				**1342**
profit **998**				

East Mamprusi (no-till)

No-till farmer 1 (2012 season) farm size: 0.84 acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		Ghc	ghc	
	8	7	95	665	
millet	5	4	110	440	
revenue					**1105**
INPUT COST					
		qty	cost/unit	total	
weedicide(litre bottle)					
weedicide		3	7.5	22.5	
fertilizer(bags)					
NPK(15:15:15)		4	39	156	
ammonia		3	35	105	
					283.5
LABOR COST					
		no.of hrs	average cost/hr	ATC	
planting					
		38	0.68	26	
spraying		20	1.50	30	
fertilizer application					
		33.5	1.43	48	
harvesting					
		130.5	1.07	140	
post-harvest					
		70	0.71	50	
					294

TOTAL		**577.5**
profit	**527.5**	

East Mamprusi (Conventional)

Conventional farmer 2 (2012 season)				farm size: 2acres	
crop	**yield**	**qty sold**	**unit price**	**total**	
maize	bag/112kg		ghc	ghc	
	9	9	100	900	
revenue					**900**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
weedicide	4	7.5	30	
fertilizer(bags)				
NPK(15:15:15)	6	40	240	
ammonia	3	35	105	
maize seed			45	
				420

LABOR COST

	no.of hrs	average cost/hr	ATC
ploughing	16	1.88	30
weeding	64	0.63	40
planting	40	0.50	20
spraying	16	0.63	10
fertilizer application	49.5	0.81	40
harvesting	77	0.91	70

re-ridging	30	1.33	40	
				250
TOTAL				**670**
profit	**230**			

Conventional farmer 3(2012 season) farm size: 16acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	60	60	100	6000	
revenue					**6000**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	15	7	105	
atrazine	5	8	40	
fertilizer(bags)				
ammonia	8	35	280	
NPK(15:15:15)	12	39	468	
maize seed			200	
				1093

LABOR COST

	no.of hrs	average cost/hr	ATC
ploughing	8	50.00	400
weeding	398	1.61	640
planting			
	295	0.50	147
spraying	97.5	1.64	160
fertilizer application			

		319	0.39	126	
harvesting					
		485	0.51	248	
threshing (machine)		5.5	54.55	300	
other activities		16.5	6.67	110	
					2131
total					**3224**
profit	**2776**				

No-till farmer 1 (2012/2013 minor season) farm size: 1.4 acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
		5	100	500	
fresh harvest				200	
pepper				430	
revenue					1130

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	4	7	28	
atrazine	1	7.5	7.5	
insecticide(litre bottles)				
	1	12	12	
fertilizer(bags)				
folliar			30	
maize seeds			45	
				122.5

LABOR COST

	no.of hrs	average cost/hr	ATC
weeding	50.0	2.40	120
spraying	22	2.45	54
planting			
maize	22	1.82	40
pepper	16	2.50	40
cassava	30	2.00	60
harvesting			
maize	32	2.50	80

pepper		28.5	2.74	78	
watering		25.5	1.37	35	
total					**582** **704.5**
profit	**425.5**				

Ga West (Conventional)

Conventional 1 (2012/2013 minor season) farm size: 3 acres

Crop	yield	qty sold	unit price	total	
Maize	bag/112kg		ghc	ghc	
		7	90	630	
fresh maize sales				400	
Pepper		bages			
		40	15	600	
Revenue					**1630**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
Glyphosate	6	7	42	
Atrazine	3	7.5	22.5	
fertilizer(bags)				
NPK(15:15:15)	5	39	195	
liquid fertilizer			60	
maize seeds			45	
pepper seeds			30	
				394.5

LABOR COST

	no.of hrs	average cost/hr	ATC
land preparation tomato	1	5.00	5
Ploughing			
	3	40.00	120
Spraying			
	24	2.50	60

planting					
Maize		24	3.33	80	
Pepper		8	4.25	34	
Watering		0.9	4.44	4	
fertilizer appl.					
		26	2.31	60	
Handpicking		1	10.00	10	
harvesting					
Maize		108	1.57	170	
Pepper		6	1.67	10	
					553
Total					**947.5**
Profit	**682.5**				

Ejura Sekyedumasi (No-till)

No-till farmer 1 (2012/2013 minor season) farm size: 4 acres

crop	yield	qty sold	unit price	total	
maize	bag/112kg		ghc	ghc	
	22	20	90		
revenue					**1800**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	10	7.5	75	
insecticide			40	
fertilizer(bags)				
NPK(15:15:15)	8	42	336	
maize seeds			30	
				481

LABOR COST

	no.of hrs	*average cost/hr*	*ATC*	
spraying	38	2.63	100	
planting maize	53	2.64	140	
weeding	10	4.00	40	
fertilizer appl.	17	3.53	60	
harvesting maize	34	2.35	80	
loading /parking	71	1.41	100	
				520

total		**1001**
profit	**799**	

Ejura-Sekyedumasi (Conventional)

Conventional farmer 1 (2012/2013 season) farm size: 1.6 acres

crop	**yield**	**qty sold**	**unit price**	**total**	
maize	bag/112kg		ghc	ghc	
	9	9	110		
revenue					**990**

INPUT COST

	qty	cost/unit	total	
weedicide(litre bottle)				
glyphosate	4	7	28	
insecticide	1	10	10	
fertilizer(bags)				
NPK(15:15:15)	3	40	120	
				158

LABOR COST

	no.of hrs	average cost/hr	ATC
ploughing			
	3	16.67	50
spraying			
	17	3.82	65
planting			
maize	20	4.50	90
weeding	31	0.90	28
fertilizer appl.			
	40	1.20	48
harvesting			
maize	40	3.75	150

carting		10	5.00	50	
					481
total					**639**
profit	**351**				

Sample calculation of cost of production

	NO.HRS	NO. WORKERS	COST/WORKER	TOTAL	average cost/hr	average tc	Uniform (min,max)	Total
WEEDING								
hand picking of weeds	3	2	7	14	4.67	14		
hand picking of weeds	3	2	7	14	4.67	14		
weeding	2	1	7	7	3.50	7		
weeding	2	1	7	7	3.50	7		
weeding	2	1	8	8	4.00	8		
weeding	2	1	8	8	4.00	8		
	14	**8**	**44**	**58**	**4.14**	**58**	**3.53**	**49.45**
SPRAYING								
spraying of glyphosate	3	1	7	7	2.33	7		
spraying of glyphosate	5	1	7	7	1.40	7		
spraying of glyphosate	4	1	7	7	1.75	7		
spraying of herbicide	2	1	7	7	3.50	7		
spraying of herbicide	4	1	7	7	1.75	7		
spraying of herbicide	4	1	7	7	1.75	7		
spraying of insecticide	2	1	7	7	3.50	7		
spraying of insecticide	2	1	7	7	3.50	7		
spraying of fungicide	2	1	7	7	3.50	7		

spraying of fungicide	1	1	7	7	7.00	7		
spraying of insecticide	2	1	7	7	3.50	7		
	31	**11**	**77**	**77**	**2.48**	**77**	**1.51**	**46.85**
PLANTING								
planting of maize	21	3	30	30	1.43	30		
planting of maize	21	3	30	30	1.43	30		
planting of maize	28	4	40	40	1.43	40		
planting of maize	28	4	40	40	1.43	40		
thinning	2	1	5	5	2.50	5		
thinning	2	1	5	5	2.50	5		
	102	**16**	**150**	**150**	**1.47**	**150**	**2.08**	**211.92**
FERT. APPL								
application of fertilizer	12	2	14	14	1.17	14		
application of fertilizer	12	2	14	14	1.17	14		
application of fertilizer	12	2	14	14	1.17	14		
application of fertilizer	3	1	7	7	2.33	7		
2nd fertilizer application	5	1	7	7	1.40	7		
2nd fertilizer application	5	1	7	7	1.40	7		
2nd fertilizer application	12	3	21	21	1.75	21		
2nd fertilizer application	12	3	21	21	1.75	21		

	73	**15**	**105**	**105**	**1.44**	**105**	**1.59**	**116.27**
HARVESTING								
harvesting of maize	14	7	8	56	4.00	56		
harvesting of maize	15	3	8	24	1.60	24		
gathering of harvested produce	15	3	8	24	1.60	24		
gathering of harvested produce	15	3	8	24	1.60	24		
	59	**16**	**32**	**128**	**2.17**	**128**	**3.94**	**232.60**
POST HAREST								
shelling of maize	22	2	8	16	0.73	16		
shelling of maize	24	2	8	16	0.67	16		
shelling of maize	20	2	8	16	0.80	16		
shelling of maize	20	2	8	16	0.80	16		
shelling of maize	18	2	8	16	0.89	16		
shelling of maize	18	2	8	16	0.89	16		
	122	**12**	**48**	**96**	**0.79**	**96**	**0.67**	**81.46**
carting of harvested products	1.5		52.5	52.5	35.00	52.5	MACHIN E HOURS	**52.5**
	402.5	**78**	**508.5**	**666.5**	**47.49**	**666.5**	**791.05**	TOTAL COST FOR MINOR 2012/2013

APPENDIX C

FINANCIAL FUTURES BUDGET

labor details	**no.hrs**			**cost/worker**			
input data	**min**	**max**	**average no. of hrs(uniform)**	**min**	**max**		
burning			0.4			0.2	=UNIFORM(F4,G4)
plough1			0.9			0.7	=UNIFORM(F5,G5)
spraying 1			0.1			0.8	=UNIFORM(F6,G6)
spraying 2			0.6			0.6	=UNIFORM(F7,G7)
weeding			0.5			0.3	=UNIFORM(F8,G8)
planting (crop1)			0.9			0.9	=UNIFORM(F9,G9)
planting (crop2)			0.2			0.8	=UNIFORM(F10,G10)
planting (crop3)			0.4			0.6	=UNIFORM(F11,G11)
1st fert. Application			0.1			0.7	=UNIFORM(F12,G12)
2nd fert. Application			0.1			0.4	=UNIFORM(F13,G13)
harvesting (crop1)			0.8			1.0	=UNIFORM(F14,G14)
harvesting (crop2)			0.6			0.4	=UNIFORM(F15,G15)
harvesting (crop3)			0.6			0.2	=UNIFORM(F16,G16)
carting (vehicle)			0.2			0.2	=UNIFORM(F17,G17)
carting (manually)			0.4			0.8	=UNIFORM(F18,G18)
watering			0.9			0.5	=UNIFORM(F19,G19)

input data	qty		Average qty	unit price		Average price
weedicide	min	max		min	max	
1			0			0.25
2			1			0.57
3			0			0.26
insectide						
1			1			0.91
2			1			0.25
3			0			0.04
Fertilizer						
1			0			0.94
2			1			0.62
3			1			0.40

yield data	yield			price/unit		
	min	max	avg. yield	min	max	avg selling price
crop 1			0.9			0.75
crop2			0.5			0.66
crop3			0.2			0.44
crop4			0.2			0.16
crop5			0.4			0.04

sales			
crops	yield	unit price	TR
1	0.9	0.75	0.69
2	0.5	0.66	0.30
3	0.2	0.44	0.09
4	0.2	0.16	0.03
5	0.4	0.04	0.01
		TR	**1.12**

labor cost					
	no.hrs	no.wrkers	cost/wrker	tc	cost/hr
Burning	0.9		0.2	0	-
ploughing	0.8		0.2	0	-
spraying 1	0.6		0.6	0	-
spraying2	0.6		0.7	0	-
Weeding	0.3		0.2	0	-
planting1	1.0		0.8	0	-
planting2	0.4		0.7	0	-
planting3	0.1		0.7	0	-

1st fert. Appl.	0.2	0.6	0	-	
2nd fert. Appl.	0.0	0.6	0	-	
harvesting1	0.2	0.3	0	-	
harvesting2	0.1	0.7	0	-	
harvesting3	0.2	0.9	0	-	
carting(vehicle)	0.1	0.9	0	-	
carting(manually)	0.6	0.2	0	-	
watering	0.8	0.8	0	-	
					-

input	qty	Average price	tc	
Weedicide				
1	1	0.78	0.68	
2	0	0.48	0.00	
3	0	0.57	0.07	
Insecticide				
1	1	0.26	0.19	
2	1	0.20	0.17	
3	0	0.19	0.07	
fertilizer				
1	0	0.85	0.23	
2	1	0.80	0.43	
3	0	0.47	0.18	
				2.00
		TC		**-**
		PROFIT	**-**	