

**FARMERS' WILLINGNESS TO PAY FOR COCOA GRAFTING  
IN THE EASTERN REGION OF GHANA**

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

I, Dompseh Eric Brako, do hereby declare that except for the references cited, which have been duly acknowledged, this thesis titled “*Farmers’ Willingness to Pay for Cocoa Grafting in the Eastern Region of Ghana*” is the product of my own research work in the Department of Agricultural Economics and Agribusiness, University of Ghana from July 2014 to July, 2015. I also declare that this thesis has not been presented either in whole or in part for another degree in this University or elsewhere.

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## **DEDICATION**

I dedicate this work to my inspiring aunt, Miss Augustina Afum and to my parents Mr. Maxwell Dompoh and Esther Ampomaah.



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## ABSTRACT

Cocoa production is very critical to the livelihood and survival of many smallholder farmers in Ghana. However, one of the challenges of the sector is low yields which is partly attributed to the widespread presence of old cocoa trees. It is therefore imperative to provide solutions to improve yield, of which the side grafting technology is a proven method. The study assesses Farmers' Willingness to Pay for Cocoa Grafting in the Eastern region of Ghana. The research sought to find the level of awareness of side grafting in cocoa among farmers, the amount farmers are willing to pay for cocoa side grafting as well as the factors influencing willingness to pay amount. The multi-stage sampling technique was used to sample 217 cocoa farmers in the Eastern region. A well-structured questionnaire was used to solicit data from farmers. The contingent valuation method was used to estimate the willingness to pay amount of cocoa farmers. The double hurdle model was then used to estimate the factors influencing willingness to pay for side grafting. From the analysis of the data, it was realized that majority (87%) of the cocoa farmers are unaware of side grafting as a canopy substitution method, with majority (89%) willing to adopt the technology should it be introduced. The contingent valuation analysis also revealed that the maximum amount farmers are willing to pay for a side grafted cocoa tree is GHC10 and the minimum amount is GHC.10. The average WTP amount is GHC2.84. On adoption of side grafting, farmers' yield of 0.98 tons is higher as compared to the national average of 0.4 tons. The percentile distribution of WTP amounts show that at the 25<sup>th</sup> percentile, farmers are willing to pay GHC0.50 or less. The result also showed that education, frequency of extension visit, age of cocoa farm, income from cocoa and household head status positively influence farmers' WTP for side grafting while farm size negatively influences WTP. Furthermore, education, frequency of extension visit, age of farm, awareness, income from cocoa, and household head status positively influence farmers' WTP amount for side grafting while farm size and yield negatively influences farmers' WTP amount. The study recommends that demonstration centers should be set up in various areas of the region to aid acceptance of cocoa side grafting among farmers. Moreover, FBOs should be supported to enhance their capacity so they can effectively educate farmers on the technology. For a wider coverage of the side grafting technology, implementing institutions could peg the price for side grafting a cocoa tree at GHC0.50 or less. Produce buying companies and NGOs could also intervene by providing the technology for farmers on deferred payment.

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**LIST OF ABBREVIATION**

COCOBOD	Ghana Cocoa Board
CODAPEC	Cocoa Disease and Pest Control Programme
CORIP	Cocoa Rehabilitation and Intensification Programme
CRIG	Cocoa Research Institute of Ghana
CRP	Cocoa Rehabilitation Programme
CSSV	Cocoa Swollen Shoot Virus
CSSVDU	Cocoa Swollen Shoot Virus Disease Unit
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization
GAIN	Global Agricultural Information Network
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
Hi-TECH	High Technology
ICCO	International Cocoa Organization
ISSER	Institute of Statistical Social and Economic Research
MoFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organization

OECD	Organization of Economic Co-operation and Development
RSC	Rural Service Centre
SWAC	Sahel and West Africa Club
UNCTAD	United Nation Conference on Trade and Development
UNDP	United Nation Development Programme
WCF	World Cocoa Foundation
WTP	Willingness to Pay

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background

Tree crops, particularly cocoa, coffee, oil palm, and rubber, have being the main agricultural exports in Ghana. Among the tree crops, cocoa is key to Ghana's exports (Danso-Abbeam, Addai, & Ehiakpor, 2012; ISSER, 2012). Ghana is a second producer of cocoa in the world after Cote d'Ivoire (Dormon *et al.*, 2004). Cocoa production in Ghana is concentrated in six regions namely Ashanti, Brong-Ahafo, Central, Eastern, Western, and Volta with the three northern regions and Greater Accra not conducive for production. The main cocoa-producing region is presently the Western Region, which has been divided into two zones as a result of the high production levels, to aid better administration (Anim-Kwapong & Frimpong, 2004). The Ashanti region follows as second and then Brong Ahafo region and the fourth leading producer being the Central region. Eastern region is the fifth leading producing of cocoa in Ghana.

It is worthy to note that the Eastern region had been the leading producer of cocoa until farms were plagued with pests and diseases in the 1930s which eventually led to production declines in the region and in the nation at large (Omane-Adjepong, 2012). The region is very important in the cocoa sector because it was the first point of introduction of the crop. Since the Eastern region was the first area of introduction of the crop means majority of the cocoa trees are overgrown and passed their productive life. This has contributed to the relatively low production quantities recorded annually. To address this production shortfall, there is the need to rehabilitate old farms in the region to improve both regional and local production quantities.

In 2011, growth in the cocoa sector overtook the crop and the livestock sectors, and grew by about 14% leading to the realization of government's target of achieving one million metric tons of cocoa production per year. By this, foreign exchange revenue realized from cocoa exports stood at 23% of the total export earnings (ISSER, 2012). Overall, the land area allocated to cocoa production is 1.6 million hectares with an average yield of about 400kg per Ha (MoFA, 2011). This production occurs in rural areas. According to Vos, Krauss, Petithuguenin, Perreira, and Nanga (2002), cocoa is an essential component of the rural livelihood system, with farmers highly committed to the cultivation of the crop. Cocoa cultivation is a way of life and farmers are very much attached to the crop socio-culturally, hence the economic and social importance of cocoa can scarcely be exaggerated. Mensah (2006) stated that there are few Ghanaians whose welfare is entirely independent on cocoa. According to Wegner (2012), around 6.3 million Ghanaians derive their source of livelihood from cocoa production, representing nearly 30% of the population. Estimates of per capita income show that households' mean per capita daily income from cocoa was US\$0.42 out of a total income of US\$ 0.63 in 2008 (Mensah, 2006). This indicates that household's heavily depend on cocoa for their livelihood.

As a result of the importance attached to the crop by farmers, Ghana is highly competitive in its production of bulk cocoa. This has been made possible by the specialized skills of farmers in producing high quality beans under hygienic and environmentally friendly conditions. Thus, Ghana's cocoa is highly appreciated and has almost unlimited demand on the global market (Mensah, 2006). From the above discourse, it is clear that cocoa is an important and the premier cash crop both in terms of quality and bulk value.

To increase the contribution of the cocoa sector, Ghana introduced various interventions that were geared towards enhancing production, productivity and quality. Owusu and Frimpong (2014) in their research reiterated that the cocoa sub-sector in Ghana has benefited immensely from the introduction of several programmes over the years, to increase production and productivity. These programmes include the Cocoa Disease and Pest Control (CODAPEC) programme and the Cocoa Hi-TECH programme. These were technology-based programmes to address some production challenges of the cocoa sector and also have both social and economic objectives that seek to improve the income and living standards of farm families, maximize foreign exchange contribution to the economy of Ghana, reduce poverty among cocoa farmers and to encourage the youth to go into cocoa farming. These technologies consist of attributes which could eliminate the two major cocoa pests; capsids and black pod disease, and increase productivity for that matter. As a result of these programmes, COCOBOD reported an unparalleled cocoa production level of 1,004,194 MT in 2011 (Baffoe-Asare, Danquah, & Annor-Frimpong, 2013).

Besides these and other programmes implemented, government has long established institutions such as the Cocoa Research Institute of Ghana (CRIG), The Seed Production Unit (SPU) as well as the Cocoa Swollen Shoot Virus and Diseases Unit (CSSVDU) under the Ghana Cocoa Board to coordinate programmes to improve production. The primary focus of these projects and the mandates of these institutions is the rehabilitation of cocoa farms, developing cocoa hybrids resistant to field challenges like diseases and pests, raising clones and seedlings for improved production (COCOBOD & UNDP, 2013)

Despite some major achievements, the level of cocoa productivity is still below the achievable yield of 1 metric tonne per hectare (MoFA, 2011). One technology that has proven useful in addressing the challenge of low productivity is the use of side grafting technique to rehabilitate farms (Effendy, Hanani, Setiawan, & Muhaimin, 2013). Pina and Errea (2005) define grafting as the natural or deliberate fusion of plant parts so that there is vascular continuity and the resulting composite organism functions as a single plant. With this process, two adjacent intact plant parts or different branches of the same plant can become naturally or intentionally/artificially grafted together. Artificial grafting of which side grafting is an example, involves inserting a previously cut shoot or scion into an opening in another plant growing (known as the root stock). To provide suitable environment for the grafting process the rootstock which is also referred to as the understock must be in its active growth phase (Mudge, Janick, Scoffield, & Goldschmidt, 2009). This method has various uses such as vegetative propagation, cultivar change, avoidance of juvenility, repair, size control as well as biotic and abiotic resistance. Grafting has been introduced in the cocoa sector in many countries to improve yield and help plants to develop resistant varieties (Vos, Ritchie, & Flood, 2003).

The Seed Production Unit in Ghana produces grafted seedlings from improved varieties obtained from CRIG and markets them to farmers for onward cultivation. This process involves top grafting improved varieties on resistant rootstock. Farmers can then obtain these top grafted plants or purchase pods at a low price from seed gardens scattered throughout the six cocoa growing regions, and nurse them for later transplant. These grafted plants are however good for starting new farms and not suitable for rehabilitating old farms. However, cutting down cocoa trees entirely and planting grafted seedlings has been the primary way by which farmers rehabilitate their farms.

Using this method for rehabilitating farms takes quite a long time to mature because the plants still have to go through the juvenile stage until they mature, which takes about three years. This means that farmers' income will be reduced as a result of cutting down of old cocoa trees in order to start new ones. Despite this challenge of farmers possibly having a sharp decline in income, cocoa farmers have only that option of cutting entirely their cocoa trees to rehabilitate their farms. The side grafting on the other hand overcomes this challenge by grafting a bud wood to the side of an old tree. As such, farmers' incomes are stabilized in addition to yield increases in later years. However, this all important technology has not been officially introduced to farmers.

## **1.2 Problem statement**

More than 90 percent of cocoa beans produced globally is grown on 5.5 million smallholder farms (Wegner, 2012). Ghana is no exception with cocoa widely characterized by small-scale production. Cultivated area per household is 2 hectares or less (Barrientos *et al.*, 2008). According to MoFA (2011), the average yield per hectare of cocoa is 0.4 ton which is relatively low compared to on-station research trials that have an achievable yield of about one ton. This level of productivity is on the low side compared to per hectare yields of 1.8tons/ha, 0.8tons/ha and 0.8tons/ha in Malaysia, Indonesia and Cote d'Ivoire respectively (Danso-Abbeam *et al.*, 2012). Though the country has been able to realize total output above the 1 million tons target, increase in production is largely due to the increase in the area cultivated rather than by improving yield or productivity levels (MoFA, 2006; COCOBOD, 2007). Cocoa yields in Ghana is therefore described as been below global production averages (FAO, 2005; ICCO, 2007).

Out of the six cocoa growing regions, the major production region which is currently the Western Region is the only region for the expansion of cocoa acreage given the presence of unexploited

forest areas (Asare, 2005; Gockowski & Sonwa, 2008). In spite of the growth possibilities of the Western region, the Eastern region which initially was the leading producer of cocoa does not have the benefit of such growth.

One challenge that must be addressed to improve productivity in Ghana is that about 25% of cocoa-trees are over 30 years old and hence have passed their productive life, leading to yield and productivity falls (Anim-Kwapong & Frimpong, 2004). Dormon *et al.* (2004), also identified the issue of low productivity of cocoa farms in Ghana and opined that these production shortfalls could be attributed to non-adoption of improved technologies. Cocoa farms are major income sources for farmers implying that any decline in yield has worrying effects on farmers' survival and living standards.

Though the practice of cutting down old cocoa trees and replanting has good intentions of increasing yield, it exposes farmers to several survival shocks because their income source is drastically reduced. As a result, many farmers have not subscribed to the cutting down of their old cocoa trees. It is therefore imperative to implement technologies in a way that sustains the income of farmers. The technology of cocoa side grafting proves a very important technology that surmounts these challenges. Side grafting is done by inserting a bud wood on an opening on the bark of old cocoa trees. Whilst the bud fuses with the established tree, the old branches continue to bear. The old branches are then cut down after the scion matures and is ready to bear fruits. This ensures continuous flow of income whilst improving the yield of the farm.

Effendy, Hanani, Setiawan, and Muhaimin (2013) in their research on the adoption of side grafting in the Sigi Regency of Indonesia stated that side-grafting can increase productivity of cocoa farms. They further explained that normally cocoa produce fruits after 2-3 years of cultivation, but when

side-grafted reduces the fruiting to a year or less with production ranging from 1.8 to 2.75 tons/ha, about 4-7 times yields in Ghana. Consequently, Indonesian farmers doubled or tripled their yields by replacing old trees with high-yielding varieties or grafting bud wood from superior varieties onto old trees (Mars, 2015). This method having been introduced in Southern Bahia, Brazil by Cargill also helped farmers increase their production by 180% during the first two years of introducing the technology to them (Cargill, 2015).

Ghana can take advantage of this rehabilitation technique given that the yield of cocoa farms in Ghana are low compared to other cocoa growing countries. The only hurdle to this technique is that varieties that better withstand Ghana's major soil borne diseases should be planted and side grafted in later years to ensure smooth implementation of the technology.

One drawback is that this technology entails significant cost given the level of expert knowledge and experience required to execute the procedure. This will require awareness creation among farmers to encourage easy adoption. Asrat, Belay, and Hamito, (2004) found that farmers are willing to pay for technology if they are aware of the benefits associated with its adoption. However, given the way cocoa farmers have been treated over the years in terms of distribution of free cocoa pods for rehabilitation and expansion of their farms, free spraying of farms and other incentives, their willingness to pay for such a technology is doubtful and needs researching into.

This study addresses the following research questions

- i. Are farmers aware of the technology of cocoa side grafting?
- ii. How much are farmers willing to pay for grafting cocoa farms?
- iii. What are the factors influencing farmers' willingness to pay for cocoa side grafting?

### **1.3 Objectives of the study**

The main objective of this study is to analyze the willingness of cocoa farmers in the Eastern Region of Ghana to pay for cocoa grafting. The main objective will be pursued as follows;

- i. Describe farmers' awareness of the technology of side grafting
- ii. Determine the amount farmers are willing to pay for grafting trees on a cocoa farm
- iii. Identify and estimate the factors influencing farmers willingness to pay amount for side grafting

### **1.4 Relevance of the study**

Cocoa is a major contributor to the GDP of Ghana also to farmers' incomes. Efforts at improving the agricultural sector must target the cocoa sector. This research will provide valuable information to promote the adoption of technologies that will improve cocoa production in Ghana. In addition, their yields are low relative to achievable yields and therefore very essential to be included in yield improvement schemes. This research will make recommendations for efficient policy making. This study will also make valuable methodological contribution to understanding issues facing the cocoa sector.

### **1.5 Organization of the study**

The study is organized into five chapters. Chapter two reviews relevant literature on global perspectives on cocoa production, cocoa production in Ghana, cocoa rehabilitation, and methodology used in willingness to pay assessments. Chapter three discusses the methods used in achieving the study objectives. Empirical results of the survey conducted is presented in chapter four. Finally, Chapter five presents the findings, conclusion and policy recommendations.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Cocoa production: Global Perspectives

According to Amos (2007), cocoa originated from the upper Amazon region of South America and subsequently gained widespread attention with the discovery of varied uses of the beans. The primary cocoa growing regions are Africa, Asia, and Latin America (World Cocoa Foundation, 2014). Africa continues to lead global cocoa production with the supply of 70% of cocoa beans to the market, followed by Asia and Oceania occupying 17% and the Americas supplying 15% of global cocoa beans (World Cocoa Foundation, 2014). Countries other than the south Americas from where cocoa began became lead producers due to favourable weather conditions. In West Africa, cocoa is a major agricultural export as well as a livelihood supporting crop contributing about 70% of the world market of cocoa. The increased efforts in cocoa production in this region helped to increase global production levels.

In terms of annual production, the eight largest cocoa-producing countries are Côte D'Ivoire, Ghana, Indonesia, Nigeria, Cameroon, Brazil, Ecuador and Malaysia. These countries represent 90 percent of world production with Côte D'Ivoire alone representing about 40 percent of global cocoa supply. This market share is estimated to account for about 1.2 million metric tonnes per annum of overall cocoa supplied (United Nations Conference on Trade and Development, 2009). Cocoa is a major contributor to the Ivoirian economy accounting for 80% of the country's commodity exports, over 50 percent of all exported goods and services, and a 21 percent of GDP (Bogetic, Noer, & Espina, 2007). Ghana and Nigeria contribute about 20 percent and 7 percent respectively to the World Market (Lundstedt & Pärssinen, 2009). The Americas including Brazil

and Ecuador however supply relatively small quantities to the world market with a heavy concentration on fine flavor cocoa beans used in premium chocolates. Globally, the supply of cocoa has depended almost entirely on smallholder farms, who supply between 80 to 90 percent of cocoa beans. Despite the large quantities of cocoa beans supplied by Africa and Asia as compared to the Americas as seen in Table 2.1, the yield differences are very remarkable. It is estimated that a typical cocoa farm in Africa and Asia covers two to four hectares with each hectare producing about 400 kg of cocoa beans. Cocoa farms in the Americas as a result of the vast adoption of technologies are comparatively high yielding, producing about 550 kg of cocoa beans per hectare (World Cocoa Foundation, 2014).

The realization of this high global cocoa production levels has over the years experienced major setbacks due to structural adjustment policies, crop infestations, diseases as well as market speculation issues (ECOWAS-SWAC/OECD, 2007). These problems facing the cocoa economies are exacerbated by changing weather patterns. The World Cocoa Foundation predicts that increase in global cocoa production may be reduced in the future since cocoa trees are sensitive to changing weather patterns (World Cocoa Foundation, 2014).

To help formulate international and national policies geared at providing effective solutions to the problems facing this sector, the International Cocoa Organization (ICCO) was set up in 1973 and led to the enactment of the first International Cocoa Agreement under the auspices of the United Nations (Eskes & Efron, 2006). This was after development partners realized that cocoa imports and prices are minor issues for cocoa consuming countries whilst changes in prices of the commodity adversely affect the producing countries. To help address this conflicting interest and to ensure sustainable cocoa economies, the ICCO consisting of both importing and exporting

countries meet intermittently to design new agreements and strategies that meets current and future challenges of the sector. Moreover, the World Cocoa Foundation also puts forward development projects that help develop the sector. One of the latest projects of the foundation is targeted at the four major producers in the West African sub-region including Ghana, Cote D'Ivoire, Nigeria and Cameroon. The project targets farmers to improve their capacity to increase production (World Cocoa Foundation, 2015).

**Table 2. 1: Global cocoa production**

	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	07/08 to 11/12
	Total	Total	Total	Total	Total	% Change
<b>Total Production (000 tonnes)</b>	3,667	3,507	3,569	4,197	3,987	8.73%
<b>% Change</b>	7.2%	-4.4%	1.8%	17.6%	-5.0%	
<b>Total Africa</b>	2,603	2,451	2,428	3,076	2,801	7.61%
<b>% Change</b>	9.5%	-5.8%	-0.9%	26.7%	-8.9%	
Cameroon	188	210	205	230	220	17.02%
Cote d'Ivoire	1,431	1,234	1,184	1,668	1,400	-2.17%
Ghana	730	730	740	860	870	19.18%
Nigeria	200	210	230	240	230	15.00%
Other Africa	55	67	69	78	81	47.27%
<b>Total Asia &amp; Oceania</b>	614	596	642	563	623	1.47%
<b>% Change</b>	-3.3%	-2.9%	7.7%	-12.3%	10.7%	
Indonesia	500	490	530	450	500	0.00%
Malaysia	32	25	20	18	18	-43.75%
Other Asia	82	81	92	95	105	28.05%
<b>Total Americas</b>	450	459	499	558	563	25.11%
<b>% Change</b>	10.7%	2.1%	8.5%	12.0%	0.8%	
Brazil	170	155	159	197	185	8.82%
Ecuador	115	130	150	160	170	47.83%
Other Latin America	165	174	189	201	208	26.06%

Source: (World Cocoa Foundation, 2012)

## 2.2 Overview of Cocoa Industry in Ghana

Cocoa cultivation started in Ghana in 1871. During this early period, the major area of cocoa cultivation was in the Eastern Region and was encouraged by the missionaries. In spite of advocacy to increase propagation, widespread adoption of the crop was low until Tetteh Quarshie in 1876 brought cocoa from Fernando Po and cultivated it in his garden in the Eastern region where

farmers appreciated it and took seeds to cultivate. Its cultivation was promoted by the botanical gardens, following the wake of the road and rail infrastructure gradually being developed (ECOWAS-SWAC/OECD, 2007). Exports of cocoa to Great Britain followed in 1881, a major boost to farmers to increase their source of income. In order to supplement the pods being supplied from the farms of Tetteh Quarshie, Sir William Brandford Griffith, the then Governor of the Gold Coast, also facilitated importation of cocoa pods from Sao Tome in 1886. From these pods, cocoa seedlings were produced at Aburi Botanical Garden for broader distribution to farmers (Asuming-Brempong, Sarpong, Asenso-Okyere, & Amoo, 2007). Interest in cocoa growing grew and Ghana emerged as the leading producer of cocoa in the world. However, the infestation of crops with black pod and swollen shoot virus disease threatened the sector and has since the 1970s kept Ghana as the second producer of cocoa.

Despite the disease challenge, Ghana has been able to increase its production and export from a low of 63 tons in 1937 to over 1 million tons in 2011 (ISSER, 2012; Grossman-Greene & Bayer, 2009)). Once the government recognized the great contribution of the cocoa sector it established the Ghana Cocoa Marketing Board (CMB), now reconstituted into the Ghana Cocoa Board to develop the cocoa industry in Ghana. For proper management and administration, COCOBOD organized the cocoa growing areas into six major areas namely: Eastern, Central, Brong-Ahafo, Volta, Ashanti and Western regions. The Western region is further divided into two zones due to its high production levels (Omane-Adjepong, 2012). The Eastern region was the largest producer of cocoa until the infestation of the swollen shoot virus disease in the region by the cocoa swollen shoot virus disease. Ashanti region became the largest producer of cocoa from the late 1960s to the early part of 1980s after which the region suffered from the black pod disease and the cocoa

swollen shoot virus. The Western region remains the last frontier for cocoa expansion and is currently the largest cocoa producer in Ghana (Anim-Kwapong & Frimpong, 2004) and accounts for more than 50% of national production.

Ghana's success in cocoa production is dependent on about 700,000 households cultivating cocoa mostly on plots of about 2.5 ha (Asante-Poku & Angelucci, 2013). Ghana previously cultivated the "Amazons" and "Amelonado" cocoa varieties which are low-yielding. Government introduced hybrid varieties in 1984 which are better in terms of productivity than the Amelonado and the Amazons. The introduction of hybrid varieties helped the Western region to achieve the high yields (Asante-Poku & Angelucci, 2013). Vigneri (2005) in his study points out that as a result of the huge production potential, farmers adopted the hybrid variety to the extent that more than half of cocoa farmers in the three major growing areas took to the cultivation of the hybrid varieties. In addition to the high yielding ability, the gestation period of the hybrids is shorter compared to the older varieties (Kolavalli & Vigneri, 2011). This characteristic also adds to why the hybrid varieties are widely cultivated in Ghana.

One would have expected that such adoption level should significantly impact the productivity levels. The reason for the lower than expected yields is that hybrid varieties need more care and have the highest output in the presence of optimal weather conditions, in addition to the application of additional farming practices such as fertilizer application, pruning and spraying of pesticides. These additional requirements have not been met by farmers who depend almost entirely on traditional methods of cultivation (Global Agricultural Information Network, 2012). Mohammed, Asamoah, and Asiedu- Appiah (2011) found that Ghana's yield is about 25% below the yield of the ten major producers of the crop and about 40% below the yield of Cote d'Ivoire. One

explanation of this low yield is that more than 25% of cocoa trees are above 30 years old and have passed their productive life.

In addition to Ghana governments efforts at improving the sector there are several initiatives by organizations to improve this sector. For example, the World Cocoa Foundation through the Cocoa Livelihoods Programme, is helping farmers by expanding access to credit, inputs and improved planting materials. Also, certification programmes such as undertaken by GTZ have provided support to the sector by encouraging farmers to adopt recommended technologies. Farmers are encouraged to continue recommended methods as they are offered premium price for their produce. This leads to increased adoption and improvement in yields (UNDP/COCOBOD, n.d.).

### **2.3 Cocoa Yield Improvement Intervention Strategies**

Several intervention strategies have been established to improve the cocoa sector given the major contribution of the sector to Ghana's economy. These strategies include the Cocoa Diseases and Pest Control Program (CODAPEC), the High Technology Programme (Hi-Tech programme) as well as National Cocoa Rehabilitation Programme (Owusu-Achaw, 2012; Mensah, 2006).

Two major diseases have ravaged the country, since the beginning of cocoa farming in Ghana. Out of these two pests, the first to be discovered was Capsid which was identified in 1910. Its spread was so fast that after three years of its discovery it had become rife throughout the cocoa growing regions. This resulted in about 25 percent of cocoa trees being damaged within that period.

Shortly after that the Cocoa Swollen Shoot Virus (CSSV) disease also surfaced in 1936. CSSV nearly destroyed Ghana's entire cocoa industry and in response, the state took drastic control measures. These measures involved the cutting down of over 81, 000 trees on 300 farms

(Grossman-Greene & Bayer, 2009). These measures could not completely eliminate the virus and by 1938 the virus was prevalent in the Eastern region and spreading to the other cocoa growing areas. To strengthen efforts in eliminating the disease, the colonial government emphasized research by establishing the Central Cocoa Research Station now Cocoa Research Institute of Ghana (Grossman-Greene & Bayer, 2009).

The CODAPEC programme is a national pest and disease control programme initiated in 2001 by the Government of Ghana to address the decline in cocoa production. The programme also aims at assisting farmers to maintain production levels and generate the needed foreign exchange for the development of Ghana. The “CODAPEC” programme is made up of two components: the maintenance of cocoa farms which includes weeding twice, or thrice in a year; general pruning and pruning of mistletoes and chupons, and spraying against diseases and pests, twice or thrice a year (Owusu-Achaw, 2012). Out of the CODAPEC programme the mass spraying exercise received massive acceptance by government and is consistently carried out to curb the spread of diseases and pests.

The ‘high technology’ of cocoa production (Cocoa HI TECH) is a holistic approach to sustainable cocoa production in which all the recommended technologies by CRIG are contained in a single package. It is defined as “sustainable cocoa production by which the farmer increases and maintains productivity, through soil fertility maintenance at levels that are economically viable, ecologically sound and culturally acceptable using efficient management of resources”. The aim of the project is to assist the farmer to increase yields by application of high technology package developed by CRIG (Anim-Kwapong & Frimpong, 2004; Appiah, 2004).

Various studies including the one by Aneani, Anchirinah, Owusu-Ansah, and Asamoah (2012) have indicated varied rates of adoption of cocoa high technology components. For example, adoption of fungicides had a rate of about 7.5% and adoption of hybrid had a rate of 44%. This varied rates of adoption could be because farmers easily adopt less expensive technologies as compared to technologies that are cost involving. Moreover, their experience with technologies in terms of its ability to yield the required result will also influence the adoption of the yet to be introduced side grafting technology.

### **Cocoa Rehabilitation Programme**

According UNDP/COCOBOD (n.d.), due to unsustainable farming methods farmers have spread to other forest areas. These practices with little consideration on improving productivity per area have left cocoa farmers a few acres of land for further expansion. Since cocoa production occupies a sensitive portion of Ghana's economic activities, many cocoa farms need to be rehabilitated to offset productivity declines (Danso-Abbeam *et al.*, 2014). This option despite the many promises it holds pose a great threat to farmers' livelihoods and hence they have little incentive and capital to undertake. In response to this, Cocoa Rehabilitation Programmes have been enacted by Ghanaian governments such that before 1988 about two rehabilitation programmes had been fully enacted with little success (Amoah, 1995). The Cocoa Rehabilitation Programme I and II failed to arrest the decline in Ghana's cocoa production. This was attributed to the fact that farmers had no or little incentive to rehabilitate their farms as farmers were paid low prices for their commodity, which resulted in the neglect and abandonment of farms.

For future rehabilitation programmes, such as the side grafting technology, farmers who adopt the technology could be given incentives that will encourage other farmers to adopt the technology.

This could be in the form of providing input subsidies and price premiums for a period after the side grafting tree begins to bear. By this, farmers will have enough reason to subscribe to the technology and ultimately lead to expected increased yields.

CRP III, enacted between 1988–1996 was designed to address the challenge of low producer price after these rehabilitation programmes failed. The produce price of cocoa was increased by government which encouraged farmers to rehabilitate their farms. This resulted in an initial success by increasing production to 300,000 metric tonnes in 1988/89 and to about 400, 000 tons in 1995/1996 cocoa season, further increasing productivity from 210kg to 400kg per hectare, due to the rehabilitation and maintenance of abandoned and neglected farms by farmers (Kolavalli, Vigneri, Maamah, & Poku, 2012). The programme had in itself a commitment by the government to compensate farmers that replanted trees infected with swollen shoot virus. This led to substantial rehabilitation, with a large number of farms replanting higher-yielding cocoa tree varieties developed by CRIG (Kolavalli *et al.*, 2012). This programme was however abrogated due to financial reasons on the part of government and farmers.

Currently, COCOBOD has commenced the National Cocoa Rehabilitation Programme to address the challenge of low productivity through rehabilitation and replanting of old and diseased cocoa trees. The programme which was launched in 2010 through the advice of CRIG has two main components of replacing old, moribund cocoa stock with hybrid variety, and also removal of mistletoes and application of fertilizer.

The objectives of the programme are:

- *“To embark on an aggressive nationwide control of mistletoes;*

- *To replace the old unproductive cocoa trees with hybrid cocoa variety, that is high yielding, disease tolerant and early maturing;*
- *To encourage farmers to adopt Good Agronomic Practices, and use medium to high farming technologies, through back-up efficient Extension services;*
- *To enhance food production in scheme areas, through the cultivation of grains, tubers and plantain to ensure food security;*
- *To incorporate planting of economic shade trees as an alternate livelihood for farmers and improve the ecosystem in the long term;*
- *To provide jobs for the rural communities particularly the youth to enhance their incomes and living standards, and motivate them to take up cocoa cultivation;*
- *To assist farmers to achieve higher productivity in the rehabilitated and replanted farms and thereby increase income” (COCOBOD, 2013).*

### **Side Grafting as a Cocoa Rehabilitation Technique in Ghana**

Grafting is a proven way of joining living tissues from different plants to become a single plant. It is normally done on plants to induce individual plant superiority into a single plant. For instance, rootstock with resistance to soil borne diseases are used whilst high yielding scions are grafted on them (Mudge *et al.*, 2009). Some of the techniques include cleft grafting, veneer grafting, whip graft as well as side grafting. The side grafting technology employs the technique of slipping an improved rootstock to an already existing plant to induce superior qualities in the already existing tree after the graft has taken and grown to maturity. This method has proven to be an effective procedure for rehabilitating cocoa farms in cocoa producing countries in North America and Asia.

It has been widely accepted because it is a proven way to increase yield in the face of farmer concerns on income safety.

In Indonesia for instance, the Indonesian Coffee and Cocoa Research Institute with the objective of expanding the cultivation of fine flavor cocoa undertook a lot of experiments, which sadly failed due to the fact that the fine flavor are susceptible to pests and diseases found in Indonesia. Convinced that the low cocoa yields in Indonesia are due to the age and variety of the existing tree stock (Saxbøl, 2014), the government of Indonesia launched the Gernas project in 2009 with the objective of side-grafting old cocoa trees throughout Sulawesi with superior planting material. Normally, replanting a farm with improved variety takes about two to three years. However, when side grafted, the plant matures in less than a year. This helped the Indonesia farmers to more than double their yield whilst ensuring a steady flow of income.

It is based on the success of this technology that government in collaboration with the Embassy of the Kingdom of the Netherlands has initiated the Cocoa Rehabilitation and Intensification programme. It is aimed at providing support services to cocoa farmers through improvement in the cocoa production system. As part of the project, rehabilitation of farms will take place through Rural Service Centers, who will side-graft old cocoa trees for farmers at a fee. Currently, establishment of demonstration centers is on-going in all the cocoa regions to aid farmer appreciation of the technology.

#### **2.4 Measuring Willingness-To-Pay**

Mwaura, Muwanika, and Okoboi (2010) define Willingness To Pay (WTP) for a service as the maximum amount of money that the target person would be willing to pay for a product given that the person has enough information on the product. Estimations of willingness to pay for a particular

technology or service is very critical and of great importance in all aspects of research. This is because it is very useful in making policy recommendations through the expression of choices in a non-market situation (Telser & Zweifel, 2002). It involves targeted patrons for services in establishing the preferences of the services presented and the amount of money the respondents are ready to pay for the product or service.

WTP studies are widely used in analyzing markets, goods, services, entrepreneurs and for environmental valuation. It has been used in the agricultural sector by several researchers in analyzing the amount of money farmers and other stakeholders are willing to pay for a particular service. Zakaria, Abujaja, Adam, and Nabila (2014) used this method in analyzing farmers' willingness to pay for improved irrigation service in Northern Ghana. The use of this method enabled the researchers to recommend to management to repair broken canals in order to raise farmers' willingness to pay. Taneja, *et al.* (2014) also employed this method in determining farmers' willingness to pay for climate smart agriculture technologies. Several other researchers including Danso-Abbeam, Addai, and Ehiakpor (2014), Kouame and Komenan (2012) and Falola, Ayinde, and Agboola (2013) have used this method in eliciting how much farmers are willing to pay for agricultural services such as insurance and water treatment.

For determining the willingness to pay for a product or service, two main methods have been employed. These methods are the revealed preference and stated preference which includes the contingent valuation method and choice experiment. In the case of the revealed preference method, it is assumed that a relationship of substitutability exist between a good already on the market and a nonmarket good being researched (Taneja *et al.*, 2014). This method works best in instances

where there is full market information about a product and the provision of information on already experienced good. In stated preference methods, however, such as the contingent valuation, respondents are asked about their preferences for a nonmarket good and how much they are willing to pay for the good. Stated preference methods have therefore proved useful in situations where market information about the product is very little or does not exist (Liu & Zhang, 2011).

## **2.5 Contingent Valuation Method and Elicitation methods**

According to Shavell (1993), contingent valuation is a method of asking hypothetical questions to respondents to find out the value they place on the good. This helps to simulate the concept of choice in a market situation as respondents have the opportunity to accept or reject the product.

As a result of the effectiveness of the contingent valuation method, it has been widely used in various agriculture related studies where it was used to elicit farmers' willingness to pay for a service, product or technology. For instance, Ulimwengu and Sanyal (2011) adopted the method in analyzing farmers' willingness to pay for agricultural services and the method was further used by Danso-Abbeam *et al.* (2014) and Kwadzo, Kuwornu, and Amadu (2013). According to Taneja *et al.* (2014), the contingent valuation method makes use of surveys that are particularly intended for measuring preferences and Willingness To Pay. In this case to avoid biases that will widely affect elicitation results, questions should be framed appropriately, noting that assessing the true Willingness To Pay for a good or service depends on how the questions are framed and how much the respondents are informed about the product or service. If not adequately handled, it could result in disparities between stated and actual Willingness To Pay (Cohen & Zilberman, 1997).

The ways in which willingness to pay questions are framed is referred to as elicitation methods. According to Damschroder, Ubel, Riis, and Smith (2007), early Willingness To Pay studies elicited values through the use of open-ended questions from a self-interest standpoint to obtain WTP values. As such, these questions elicited values without a starting point and without following a search procedure to aid respondents determine the value they place on a good. This procedure is susceptible to many problems including bias values that might be too low or high compared to the actual value of the good or service. Moreover, there is a high possibility of non-response or zero values. Also, there is a lot of brain activity involved with the respondents' decision. According to Damschroder *et al.* (2007), the results of open-ended elicited WTPs are heavily biased. This led researchers to design new elicitation methods that are meant to address the challenges of the early methods, hence the close ended methods were introduced. According to Nakanyike (2014), close-ended questions are simpler and more often reveal market-realistic WTPs as a result of the reduction in starting point bias. Some types of closed-ended methods are single-bounded dichotomous choice model and double bounded dichotomous model.

The single bounded method is implemented with respondent offered only one bid on a product, technology or service, to accept or reject. In the end, respondents will only provide positive responses if their utility is greater than or equal to the bid presented hence compatible with the individual's strategic interest (Mitchell & Carson, 1989). Moreover, this technique mimics real market situation faced by farmers in their adoption of technology, following a take it or leave it scenario and could be very reliable in eliciting WTPs. However, the main challenge with this method is that it results in limited information about the respondent's economic value on a good or service. As a result in order to get estimates of good precision large sample size is required which could also increase cost (Hanemann, Loomis, & Kanninen, 1991).

The double bounded on the other hand is an approach that follows up with another question after the first question in the single bounded technique is asked. This method has been used by many researchers including Liu and Zhang (2011), who showed that that one could use a double sampling framework to ask a second binary discrete choice question conditional on the response to the first. So that in an instance of the first question eliciting a yes response, the question was repeated with a higher value for the product or service. If “no,” it was repeated with a lower value for the product. This could help gather more information on respondents’ welfare for better analysis. However, Damschroder *et al.* (2007) point out that this approach is also statistically inefficient as a result of starting point bias. Moreover, economic value placed on a product may vary as uncertainty in the market increases.

The price card method was also introduced to bring out respondent welfare pertaining to a product or service. With this method, respondents are presented with a sequence of bids from which they are asked to choose an amount that represents their maximum willingness to pay for the product or service. The price card method has the advantage of not inducing a starting point bias. Moreover, it is more informative and yields little cognitive burden on respondents as compared to open-ended method. Stewart, O’Shea, Donaldson, and Shackley (2002) employed the use of the price card method in evaluating WTP for health care by presenting a set of monetary values to respondents to indicate how much they are willing to pay for healthcare services. Stewart *et al.* (2002) gave opportunity for respondents to indicate a higher amount they so considered to be their maximum WTP. Respondents however gave no response as a result of the additional cognitive burden. In addition, the price card is cheaper to implement as compared to close-ended methods. In spite of these advantages, it is prone to range bias which implies that the willingness to pay amount will

depend on how the range of monetary value is set (Damschroder *et al.*, 2007). That notwithstanding, Zakaria *et al.* (2014) adopted the method to evaluate the WTP of farmers to pay for improved irrigation water. It was adopted because they realized that direct inquiry on a farmer's willingness to pay for improved irrigation could be sensitive. The price range was therefore displayed on cards for the farmers to indicate their choice of the prices that represent their WTP amounts.

The bidding game is an elicitation method that employs a series of iterative questions. This method starts with asking respondents about their decision on an initial economic value for a service. The amount is then changed until the respondent accepts to pay the final amount. This then is recorded as the Willingness To Pay amount (Namyenya, Sserunkuuma, & Bagamba, 2014). Despite being prone to starting point bias in the sense that the final WTP is related to the starting point WTP, the method is efficient in developing countries as compared to developed countries. This is because developing country respondents understand the concept of bargaining and is a common practice in everyday market transactions unlike developed countries where bargains are rarely done (Whittington, Briscoe, Mu, & Baron, 1990). This has therefore been employed by researchers including Namyenya *et al.* (2014) who employed the bidding game in assessing farmers willingness to pay for irrigation water.

## **2.6 Factors influencing willingness to pay for technology**

Several authors have discussed the factors influencing farmers' willingness to pay for technologies (Adesina & Baidu-Forson, 1995; Chiputwa, Langyintuo, & Wall, 2011; Falola, Banjoko, & Ukpebor, 2012; Tiamiyu, Akintola, & Rahji, 2009; Ulimwengu & Sanyal, 2011). These authors have suggested factors such as age of farmer, gender, age of farm, educational attainment, income

of farmer, access to credit, frequency of extension visits, membership in Farmer Based Organizations (FBOs), yield of the farm, farm size, being a household head as well as being aware of the benefits of side grafting as factors that are likely to influence farmers' willingness to pay for a technology (Adesina & Baidu-Forson, 1995; Ulimwengu & Sanyal, 2011; Zakaria *et al.*, 2014). These factors are characterized broadly into socioeconomic characteristics, farm characteristics, and institutional characteristics.

### **2.6.1 Socioeconomic characteristics**

Socioeconomic characteristics, also referred to as personal characteristics are very relevant in determining the willingness to pay decisions for agricultural technology. Some of these factors include age, gender, educational attainment, income as well as household head.

#### **2.6.1.1 Age**

Age of a farmer has consistently been viewed by many researchers as an important factor that influences farmers' willingness to adopt technology (Adesina & Baidu-Forson, 1995; Ntege-Nanyeenya, Mugisa-Mutetikka, Mwangi, & Verkuijl, 1997; Tihamiyu *et al.*, 2009). It is expected that younger farmers are more likely to adopt new agricultural technologies under the assumption of available cash resources. For older farmers, their tendency of adopting a technology is dependent on how much physical labour is required in executing the technology. In the cocoa sector specifically, older farmers are less likely to adopt side grafting since the technology requires parting away with money which might not benefit them in the immediate future hence risky (Baffoe-Asare *et al.*, 2013). For this reason younger cocoa farmers are more likely to invest in side grafting than older (Wiredu, Mensah-Bonsu, Andah, & Fosu, 2011).

### **2.6.1.2 Gender**

Gender is also an important factor influencing the adoption of technologies. Doss and Morris, (2001) found that gender-related disparities in the adoption and willingness to pay for modern maize varieties and chemical fertilizer is not only an isolated case but also has a bearing on gender-related disparities in access to complementary inputs such as land, labour and access to credit. Due to this women adopt technology at a lower rate as compared to men. Tanellari, Kostandini, and Bonabana (2013) found that male farmers are more likely to adopt new technology.

### **2.6.1.3 Educational attainment**

Education exposes farmers to easily understand the concepts of technologies and the benefits associated with them. As a result several researchers have included an education level variable in studying farmers' willingness to pay for agricultural technologies. Mwaura *et al.* (2010) in their research on the willingness to pay for extension services found educational level of respondents to have had a positive significant relationship with willingness to pay for extension service. Other authors have also emphasized the importance of education in determining willingness to pay for technologies though have been measured in various ways including educational level and number of years of education (Danso-Abbeam *et al.*, 2014; Haba, 2004; Zakaria *et al.*, 2014).

### **2.6.1.4 Income**

Farm income as well as nonfarm income are often considered as a factor influencing willingness to pay for agricultural technologies. Ndetewio, Mwakaje, Mujwahuzi, and Ngana (2013) hypothesized income to have an impact on the willingness to invest in watershed irrigation. In their study, this hypothesis proved true as farmers' income had a positive relationship with the WTP values. According to Pender and Kerr (1998) and Holden and Shiferaw (2002), nonfarm income

is likely to have a positive effect, under the hypothesis that broadening out of agriculture would allow farmers to expand their income, thereby making more money available for on-farm development investments. Whilst non-farm income helps farmers to easily adopt technology, Ulimwengu and Sanyal (2011) also found a statistically significant relationship between agricultural income and the willingness of farmers to pay for agricultural services. Other studies that have found a positive significant relationship between the level of income of farmers and willingness to pay for agricultural technologies are Agyekum, Ohene-Yankyera, Keraita, Fialor, and Abaidoo (2014), Taneja *et al.* (2014) and Zakaria *et al.* (2014).

### **2.6.1.5 Household Head**

Household heads influence the adoption of technologies. This is because the head of the household is responsible for taking major decisions of the household such as decisions on farm investments. As a result of the role household heads play in the Ghanaian society, Baffoe-Asare *et al.* (2013) hypothesized a statistically significant positive relationship between the age of the farmer household head and adoption of technologies. Fadare, Akerele, and Toritseju (2014) modelled the factors that influence the adoption decisions of maize farmers in Nigeria using the educational level of household head and found a positive relationship. This implies a strong linkage between a farmer being a household head and adoption of agricultural technologies.

## **2.6.2 Farm characteristics**

### **2.6.2.1 Age of the farm**

In a study by Danso-Abbeam *et al.* (2014), age of cocoa farm was included as a factor that influenced cocoa farmers' willingness to pay for crop insurance. The study found that the age of

the cocoa farm was positively statistically related to insurance but age squared was negatively statistically related to insurance decision. This is because at the beginning of the productive life of the cocoa tree, it has high yields but as the trees age and their productive capacity reduces, yields are reduced so that cocoa farmers are less willing to pay for insurance. Kazianga (2002) also found that cocoa output increases significantly at the beginning of the productive life of the crop and then declines in later years. The age of the cocoa trees is hypothesized to have a positive influence on farmers' willingness to pay for the side grafting technology. This is because the higher the age the lower the yield influencing farmers to look for technologies to increase their yields and maintain a steady income.

#### **2.6.2.2 Farm size**

Farm size influences the decision by farmers to pay for a farm service such as side grafting (Abu, Taangahar, & Ekpebu, 2011; Kwadzo *et al.*, 2013; Zakaria *et al.*, 2014). A farmer who owns a large farm land, they are more likely to adopt yield enhancement technologies. This is because farmers with larger farm lands are likely to commit larger sums of money into their farm in order to realize yield increases. On the other hand, farmers cultivating smaller farms will be less willing to pay for agricultural technology as a result of the low output. This outcome is explained by Adrian, Norwood, and Mask (2005) who found that farm size influences the willingness to adopt and also pay for agricultural technologies. In a study by Liu and Zhang (2011), farm size was found to have a statistically significant positive relationship with the willingness to adopt soil testing technology.

### **2.6.2.3 Yield**

The yield of a cocoa farm influences the adoption of technologies. The yield of farm affects the income that accrues to a farmer. If the yield decreases it directly affects the income of the farmer. Farmers experiencing low yields are willing to pay for side grafting. Aneani, Anchirinah, Owusu-Ansah, and Asamoah (2012) examined the yield of cocoa farms as a function of the adoption of cocoa production technologies using a multinomial logistic regression. They found different levels of association between different technologies and yield of cocoa. For example, there was a positive statistically significant relationship between yield and weeding frequency, partial adopters of cocoa spraying and full adopters of cocoa spraying. The analysis varied levels of significance at 5% for weeding frequency, 5% for partial adopters and 1% for full adopters.

## **2.6.3 Institutional characteristics**

### **2.6.3.1 Membership in FBOs**

Farmer Based Organizations (FBOs) serve as platforms where information is disseminated among farmers. In effect, farmers are exposed to new technology as they engage with extension officers and industry players on an ongoing basis. Danso-Abbeam *et al.* (2014) modelled FBO membership as a factor in willingness to pay for crop insurance. A positive relationship was observed but the relationship was not statistically significant. However, Uaiene (2011) in his research on the determinants of agricultural adoption in Mozambique found FBO membership to be statistically significant using cross –sectional data and discrete choice methods; probit and logit models.

### **2.6.3.2 Access to Credit**

Different authors have expressed different views of how access to credit influences the Willingness To Pay for a service or technology. Omondi, Mbogoh, and Munei (2014) found a statistically significantly relationship between access to credit and WTP for irrigation water. Similarly, studies

by Poulton, Dorward, and Kydd (2005) found that inadequate access to credit for enhancing farm activities also restricts agricultural productivity increase that rely on the use of inputs not directly available to the farmer. Hence, in the sense of cocoa grafting adoption, farmers' access to credit might make them willing to pay for side grafting. Omondi *et al.* (2014) in their study measured the credit variable as a dummy with 1 representing access and 0 indicating no access. This way of measurement ignored the amount accessed through credit but lumped all those who accessed credit as having a higher probability of adopting. However, the amount of credit accessed could have an influence on adoption of agricultural technologies. As a result of the difficulty on the part of respondents in providing accurate figures on the amount of credit. Most researchers have measured access to credit as a dummy variable.

### **2.6.3.3 Frequency of Extension Visits**

Extension agents are tasked to provide services to farmers on matters concerning their production. The agents serve as technology transfer agents and provide the needed information to farmers on a technology. Some researchers model effect of extension service on adoption using a dummy variable of access or no access. Others also model effect of extension using the number of extension visits, meaning that the frequency of visits to farmers will influence their level of adoption or not. Fadare *et al.* (2014) and Yu, Nin-Pratt, Funes and Gemessa (2011) who used a dummy variable for extension visits, found a positive relationship between access to extension visits and the adoption of agricultural technology. Tihamiyu *et al.* (2009) however modelled extension services using the frequency of extension visits and found a positive relationship with adoption of NERICA rice. One may argue that merely being visited by an extension agent is not adequate when measuring effect of extension on adoption. This is because the more farmers are

visited, the more they are exposed to information on available technology. Thus, lumping all farmers who have been visited could conceal actual effects on adoption.

## **2.7 Models used in farmers' willingness to pay decisions estimations**

Various models have been used to measure the effects of factors influencing farmers' willingness to pay. For instance, Tiwari (1998) used the logistic regression model to estimate the factors influencing farmers' willingness to pay for irrigation water. He however used this model in the case where the dependent variables were captured as close-ended responses. The author presented the actual amount farmers should pay for irrigation water and then asked whether they are willing to pay such amount or not. Thus, the WTP is captured as a binary dependent variable (Horna, Smale, & Oppen, 2005). Though such estimations may be useful, it does not help the researcher in bringing out strategic recommendations as to the actual amount farmers are willing to pay or what has been described in the literature as intensity. The challenges encountered with using the logit models are as follows; they cannot be used to denote random taste variation, they only give room for restrictive substitution patterns and they cannot be used with panel data when unobserved factors are correlated over time (Train, 2009).

As a result of these challenges, other authors have modified the specifications of the logit model and have adopted the mixed logit model. Chung, Briggeman and Han (2008) found the mixed logit as a superior approach, in estimating WTP because it yields better estimates in the sense that it is able to account for heterogeneity in preferences of attributes. Whiles being effective in this sense, it fails to account for the sources of the heterogeneity in the preferences. To overcome these challenges, the Tobit model, the Heckman's model as well the double hurdle model have been the

commonest methods of estimating factors influencing farmers' willingness to pay decisions for agricultural technologies, depending on the assumptions one adopts in the analysis.

### **2.7.1 Tobit model**

The Tobit model measures not only the probability that cocoa farmers will adopt the grafting technology but also the amount of money farmers are willing to pay, otherwise referred to as intensity in the use of the grafting technology (Adesina & Zinnah, 1993). The Tobit model is therefore a simultaneous and stochastic decision model. Furthermore, the Tobit regression model also interprets all the zero observations in the data set as corner solution. This means that the cocoa farmer will be assumed to be an adopter having a zero outcome. The Tobit model also assumes that both the willingness to pay for the cocoa side grafting technology and willingness to pay amount are explained by the same variables. It is therefore hypothesized that, the variables that increase the probability of cocoa grafting adoption and willingness to pay also increases the amount farmers are willing to pay. That is, the willingness to pay for cocoa grafting and the willingness to pay amount are jointly determined (Sindi, 2008). Basarir, Sayili and Muhammad (2009) used the Tobit model to analyze producers' willingness to pay for high quality irrigation water. The authors found that large proportions of producers were not willing to pay any amount of money for increased water quality hence recorded zero in the survey. The Tobit model therefore proved an appropriate model for analyzing such a scenario as compared to ordinary least squares regression. Cho, Yen, Bowker and Newman (2008) applied the Tobit model in their analysis of the WTP for land conservation easement. The respondents' decision is estimated as a joint procedure that involves the choice to reveal and the choice to value (willingness to pay amount). The choice to reveal part of the joint process was modeled as a binary response, and a Tobit was

used to model the WTP amount, taking into account zero Willingness To Pay amount. Despite the advantages of the Tobit model, it is too restrictive as it assumes all the zeros in the WTP amounts to be the result of the respondents' deliberate choices which might not necessarily be the case.

### **2.7.2 Heckman's sample selection model**

Heckman sample selection model is one of the models that guard against sample selection bias. This model in contrast to the Tobit regression model is based on the assumption that the decision to pay for side grafting a hectare of cocoa farm and the decision on the amount the cocoa farmer is willing to pay may not necessarily be jointly determined by the same set of factors (Musah, 2013). Cocoa is widely cultivated in six regions of Ghana. However, over 25% of cocoa farms are 30 years old and therefore require an effective and efficient way of rehabilitating farms that will not erode completely farmers' income within the period of the rehabilitation. Due to the complicated nature of the side grafting process, Rural Service Centres (RSC) will be established to provide side grafting services to farmers at a fee. With this, cocoa farmers are likely to decide first to adopt the technology and pay for it after which they will decide on the amount they are willing to pay. From this, it is clear that the decision to adopt and pay an amount of money for the service could precede that of the amount the farmer is Willing-To-Pay (Norris & Batie, 1987).

For instance, there is high probability that a cocoa farmer will only pay a particular amount for the side grafting technology if he knows the returns over the years are greater than the amount he is paying. In such instance, the decision to pay determinants and the factors that influence decision on the actual amount cocoa farmers are willing to pay could be different. Heckman therefore models these decisions as two separate processes. The first being whether to adopt and pay or not

for side grafting one hectare of cocoa farm, with the second being how much to pay as fee for grafting a cocoa farm (Sindi, 2008).

### **2.7.3 Double hurdle model**

Zero responses are common in research. Respondents give zero WTPs but their marginal utility of the technology might not be zero, perhaps because they think other stakeholders like government, NGOs or other international organizations, rather than themselves, should pay for adoption of the grafting technology. In other situations, valid zeros are those who truly have a zero marginal utility of the side grafting technology. Moreover, zero responses may be generated as a result of the fact that cocoa farmer respondents refuse to answer due to a lack of knowledge or how complex the questions are perceived to be. Also, some cocoa farmers may only have partial information concerning their Willingness To Pay (Yu & Abler, 2010). For such a case, it is possible farmer respondents cannot give a number representing their WTP but may recognize the fact that they have a positive WTP. Such responses are classified as incomplete responses and are often dropped during analysis. Treating responses this way may result in sample selection bias because they are not missing at random.

To deal with such scenarios, Cragg (1971) suggested a double-hurdle model in which adoption behavior consists of two decisions: an adoption decision, which is a binary choice modelled using a Probit; and a WTP amount decision, which is a truncated regression model. The Double hurdle, is used in a situation where an event may occur or not and when it does, it takes on continuous positive values (Gabre-Madhin, Barret, & Dorosh, 2003). It is assumed that, the cocoa farmer is faced with a two stage decision making process. In so doing, the decision to pay is made first

followed by the decision on how much to pay for side grafting a cocoa farm. The two equations are assumed to be independent.

The Heckman sample selection model and the double-hurdle model are similar in terms of recognizing discrete (zero or positive) outcomes. The two models bring out the fact that WTP decision outcomes are expressed by the choice to adopt and willingness to pay amount otherwise referred to as intensity. As such, they allow for the estimation of both the first and second stage equations with different sets of explanatory factors. In spite of this similarities, the Heckman sample selection model assumes that no zero response will be present in the second hurdle of the analysis once the first hurdle is passed.

The double-hurdle on the other hand recognizes the possibility of zero observations in the second stage (Wodjao, 2008). In analyzing the decision to sell staple crops in Mozambique and the quantity to sell, Salvucci (n.d.) first used the Heckman model of estimation and then used the double hurdle model to check the robustness of the estimation since the Heckman model might not recognize the possibility of a zero quantity of sale. The results obtained were very similar in signs and therefore robust.

## **2.8 Conclusion**

It is evident from literature that as various studies have sought to adequately model WTP analysis in terms of factor measurements and choice of model, there are still gaps. To cater for zero responses, the study will adopt the Double hurdle model to adequately predict the effects.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

This chapter presents the methods used in achieving the objectives of the study. First, description of the study area, data collection methods, types and sources of data, and sampling procedures are presented. The conceptual and analytical frameworks underlining cocoa farmers' willingness to pay for side grafting is discussed. Variables used in the study are also described.

#### **3.2 Study Area**

The Eastern Region located on 19,323 kilometers stretch of land. With this land mass, it is the sixth largest region in Ghana. The region is bounded by the Greater Accra, Central, Ashanti, Brong Ahafo and Volta Regions. It has 27 political administrative districts and municipalities ([www.ghanadisriacts.org](http://www.ghanadisriacts.org)).

The region has a population of 1,227,612 people. Out of this overall population, 75.5% are economically active and 24.5% are not economically active. The main occupations of the economically active population in the region is Agriculture and related work (GSS, 2012). This shows that agriculture is very important in the region.

The region is located within the wet semi-equatorial zone. As such, the region experiences double maxima rainfall which occurs in June and October. The first experience of rain is from May to June with the second rainy season occurring between September and October. The favourable weather conditions in the Eastern region has made it very conducive for the cultivation of both cash and food crops such as cocoa, kola-nuts, citrus, oil palm and staple food crops such as cassava, yam, cocoyam, maize, rice and vegetables. The Eastern region is the first point of introduction of cocoa by Tetteh Quarhie before it spread to other areas and therefore has a high incidence of over

grown cocoa trees. Though the region lost its place as the largest producer of cocoa in Ghana, it contributes significantly to the total production of cocoa (ghanadistricts.com). The importance of the region in terms of cocoa production led government to establish the Cocoa Research Institute of Ghana in Tafo in the Eastern Region to conduct research into curbing the incidence of the swollen shoot virus disease and other diseases which has plagued the cocoa sector.

### **3.3 Data Collection**

#### **3.3.1 Types and Sources of Data**

The study used primary data for the analysis. Respondents were interviewed from 6 cocoa growing communities within the Tafo Cocoa district. The study utilized a structured questionnaire as survey instrument where cocoa farmers were asked questions in a face to face interview.

The questionnaire was divided into five sections. The first section included questions on the demographic characteristics of farmers. Questions on age, gender, educational level, marital status and years of cocoa farming were asked. The second section asked questions on farm characteristics. This included the number of cocoa farms, acreage of the farms, the number of bags of cocoa harvested in the 2013/2014 cocoa production year as well as the price at which it was sold. The third section is related to the institutional characteristics of farmers. The questions included membership in a FBO, credit access and extension visits. The fourth section captured farmers' knowledge and use of existing cocoa production technologies. Questions asked included knowledge of CODAPEC, hi-tech/mass spraying, use of fertilizer, spacing on the farm, number of trees per acre as well as disease control. The last section asked questions pertaining to farmer's awareness of side grafting and the elicitation of the willingness to pay amounts. The questionnaire captures the lower, medium and higher bids.

In eliciting the maximum willingness to pay, grafting was explained to the respondent and then cocoa side grafting. The benefits and costs associated with cocoa side grafting were explained to the respondent. He/she was then asked if he is willing to adopt side grafting on his cocoa farm. If the farmer answers yes, the respondent is asked if he is willing to pay for side grafting. If the answer is yes, the respondent is asked to choose between the bids. The questions relating to the chosen bidding level are then asked. If the first answer is a yes, then the respondent is asked a higher amount. If the answer is no, the respondent is asked if he is willing to pay a lower amount. After this step in each case, the respondent is asked to give the maximum amount he is willing to pay. This is taken as the willingness to pay amount.

### **3.3.2 Sampling procedure**

The study utilized the multistage sampling procedure where it started with a purposive selection of the Eastern region. It was selected because it is one of the oldest cocoa growing regions in Ghana and likely to have old cocoa trees. Moreover, it is home to the Cocoa Research Institute of Ghana where technologies are developed or tested. The Tafo Cocoa District was randomly selected using the lottery system of picking without replacement from the list of cocoa districts in the Eastern region. From the District level, six cocoa growing communities were randomly selected from the district. The communities included Anyinasin, Ettokrom, Tontro, Hemang, Dome and Bosuso. The sample size was calculated using sample size formula suggested by Miller and Brewer (2003) from a farmer population of 474 obtained from the Cocoa Health and Extension Division, Tafo Cocoa District. The systematic random sampling technique was then used to select farmers from the individual communities for interviewing. The proportion of respondents from each community is calculated by finding the percentage of respondents. The interval at which the nth respondent is picked from the farmer list obtained from the Cocoa Health and Extension Division

of the Tafo Cocoa District was also calculated using the individual population and sample size from each community. The interval was calculated by dividing the overall number of cocoa farmers in the individual communities by the proportion of the sample size from the respective communities. Overall, 217 respondents were sampled and interviewed. The distribution of the respondents in each community is shown in Table 3.1.

**Table 3. 1: The distribution of farmer respondents**

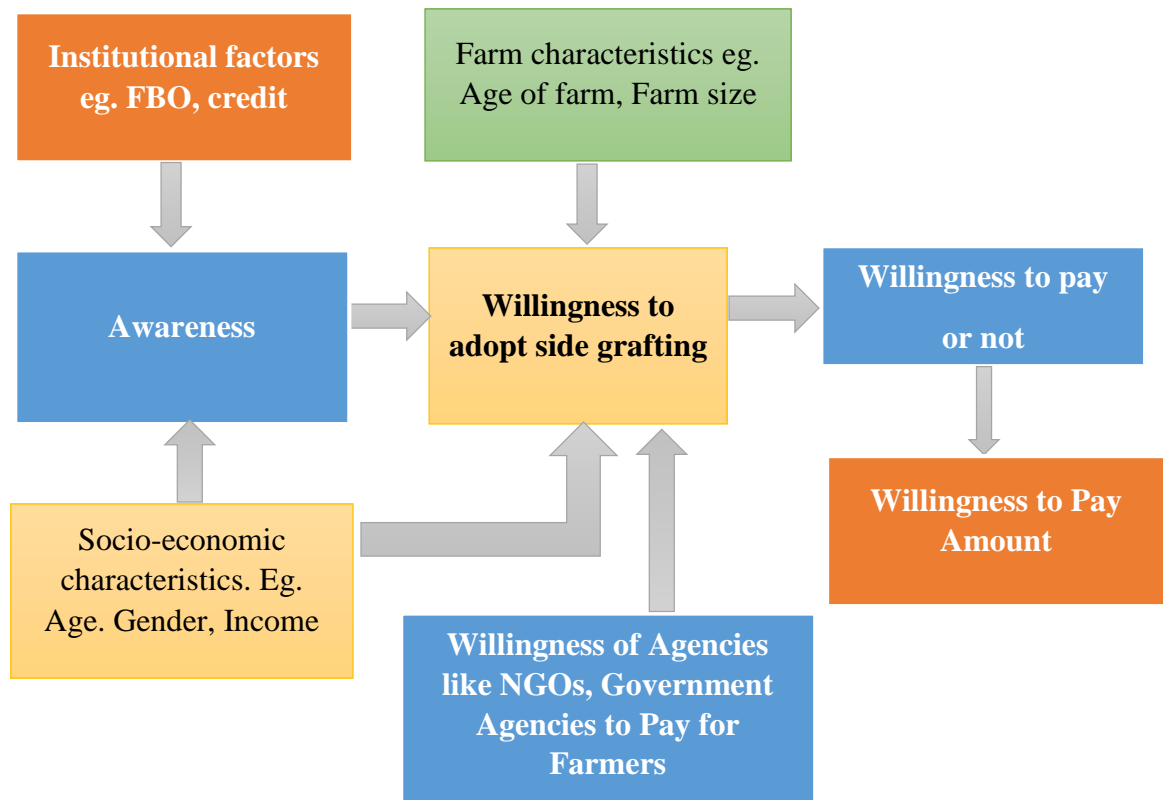
<b>Community</b>	<b>Population</b>	<b>Sampled farmers</b>
<b>Tontro</b>	103	47
<b>Anyinasin</b>	92	42
<b>Ettokrom</b>	37	17
<b>Dome</b>	96	44
<b>Hemang</b>	50	23
<b>Bosuso</b>	96	44

### **3.4 Conceptual Framework**

The conceptual framework for the analysis in this research is presented in Figure 3.1. Apart from the traditional rehabilitation method recommended by COCOBOD by cutting down cocoa trees entirely and starting with new seedlings, side grafting is also useful for rehabilitation. In the case of the side grafting technology, sharp decline in income is averted as well as reducing the number of years to rehabilitate a farm. Farmers' decision to adopt the side grafting method of canopy substitution or rehabilitation is highly a matter of choice. It is based on whether they will be able to get the required utility in relation to the amount invested and in the face of other available choices. Considering the benefits and costs of the technology, farmers may decide to adopt, which will also

affect their willingness to pay for the technology. Farmers' willingness to adopt the grafting technology is influenced by many factors such as socioeconomic characteristics of farmers (age, education, and being a household head); farm characteristics (farm size, age of farm, and yield); institutional factors (credit access and membership in FBO); as well as farmers' awareness of the technology (see Figure 3.1). These factors influence the decision of farmers to adopt side grafting. Moreover, as a result of lack of funding, farmers might be willing to adopt the technology if agencies like NGOs and government institutions are willing to pay for the side grafting technology on their behalf. A farmer's decision to adopt side grafting also influences his willingness to pay and subsequently the amount he is willing to pay.

**Figure 3. 1: Conceptual Framework for Factors Influencing Willingness to Pay for Side Grafting**



### **3.5 Theoretical Framework**

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

The innovation-diffusion model opines that a farmers' decision to adopt a technology is dependent on the farmers' level of information on the technology and that the higher the understanding of the farmer about the advantages and consequences of the technology, the better the farmer can make an informed choice (Rogers, 2003). The author defines diffusion as a "process through which information is passed through channels among members of a social system". Before a technology will be adopted by a farmer, the right communication channels that allows effective exchange of information within a planned space of time from the source and the target population should be used (Sahin, 2006). Channels such as extension, on-farm trials and field demonstrations should be used to expose farmers to help reduce the level of uncertainty and ultimately decide to adopt cocoa

side grafting. In this regard, variables that have been used by many researchers in technology adoption studies include level of education, extension contact as well as membership in Farmer Based Organizations (Feder, Just, & Zilberman, 1985; Ulimwengu & Sanyal, 2011).

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

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

It is observed that farmers have a level of utility they want to meet and therefore make choices based on that. For instance, given a number of utility levels  $M$ , a farmer will choose a level that conforms to the highest level of utility given his budget. Such discrete choice scenarios are modelled using the random utility theory (Lubungu, Chapoto, & Tembo, 2012).

The utility of a farmer is given as  $U_{ij}$ , from choosing alternative  $j$ . A cocoa farmer will choose whether or not to adopt side grafting depending on the relative utility levels associated with the two choices. Therefore, the probability that alternative  $j$  will be chosen is given by

$$P(y_i = j) = p(U_{ij} \geq U_{ik} | X, \phi k = j) = P(\varepsilon_{ik} - \varepsilon_{ij} \leq X_{ij}' \beta_j - X_{ij}' \beta_k | X, \phi k \neq j) \quad (3.1)$$

Where  $y_i$  is the observed outcome for the  $i^{th}$  observation.  $i=1 \dots N$  indexes the cocoa farmer,  $j=1$  and  $k=1 \dots k$  are the alternatives being considered and  $\varepsilon$  are the random errors. Even though the difference in the utilities,  $V_i$  of adoption and non-adoption are unobserved,

$$V_i = U_{ij} - U_{ik} \quad (3.2)$$

The decision of a household is taken as a binary outcome such that

$$J_i \in j = \{1 \text{ if } V_i > 0, 0 \text{ otherwise}\} \quad (3.3)$$

It is assumed from this that the cocoa farmer selects the alternative choices of adoption and non-adoption of cocoa side grafting based on the highest level of utility, implying that if adoption will enhance his/her highest level of utility, then the farmer will choose that option. Following Holden and Shiferaw (2002), the minimum expenditure level required to achieve the initial utility level is given as

$$e(p, EU_0, F_0) \quad (3.4)$$

Where  $p$  is the vector of prices,  $EU_0$  is the current expected utility level and  $F_0$  is the set of old agricultural services (cutting down old cocoa trees and replanting) and farm characteristics. It follows that the Willingness to Pay in order to sustain current productivity is given by

$$WTP = e(p, EU_0, F_0) - e(p, EU_0, F_1) \quad (3.5)$$

The WTP is the amount that leaves the cocoa farmer indifferent between the expected marginal utility under the old system of farm rehabilitation and the discounted expected marginal utility of the change in future incomes as a result of the adoption of side grafting.  $F_1$  is the new side grafting technique and farm characteristics. Assuming the cocoa farmer maximizes expected utility,

$$E[-U_{i0}(C_{i0}) + U_{i0}(C_{i0} - WTP_i) + \sum_{t=1}^{\infty} (1 + \delta i)^{-t} U_{it}(C_{1it} - C_{0it})] = 0 \quad (3.6)$$

$\delta i$  represents constant rate of time preferences;  $C$  is the household consumption and  $U_{it}(C_{1it} - C_{0it})$  is the utility level available to cocoa farmers  $i$  from the difference in productivity as a result of the introduction of side grafting. The WTP is therefore given as

$$WTP = \sum_{t=1}^{\infty} (1 + \delta i)^{-t} \{EU'(C_{it}) / U'_{i0}(C_{i0})\} dC_{it} \quad (3.7)$$

It is however thought that the choice of side grafting will depend on the attributes of the side grafting technique and that of the cocoa farmer (Lubungu *et al.*, 2012). The attributes of the cocoa farmer are observed but that of the side grafting technique is unobserved.

### 3.6 Measuring Willingness to Pay

Amount of money (bids) that would have been paid for side grafting was obtained from information gotten from lead institutes and units under COCOBOD. Farmers were given the option of choosing between high, medium and low opening bids. Close-ended dichotomous questions were asked, if respondents answered yes, the amount is increased, if no, the amount is reduced. After that farmers were given the opportunity to state their maximum willingness to pay amounts which was captured as an open-ended question (what is the maximum amount of money you are willing to pay for side grafting one cocoa tree?). This helped reduce starting point bias, stating of

WTP amounts too much above or below the price of the service and also increased the efficiency of the measurement process.

### **3.7 Analytical framework**

#### **3.7.1 Farmers' Awareness of Cocoa Side Grafting**

Simple descriptive statistics using percentages and frequencies was used to describe the awareness of side grafting of farmers. Cross tabulation was used to ascertain the relationship between awareness of side grafting and willingness to adopt side grafting. In addition, farmers were asked questions on their awareness and use of other cocoa production techniques recommended by COCOBOD. The results are presented in a table and pie chart (Tables 4.2 and Table 4.4) to show the awareness and use of current cocoa production technologies in addition to side grafting.

#### **3.7.2 Factors Influencing Farmers' Willingness to Pay for Side Grafting**

The Double Hurdle model is a parametric generalization of the Tobit model in which the decision to pay for side grafting and the WTP amounts are determined by two separate stochastic processes and therefore, two equations (Moffatt, 2003). It is used in situations where an event may occur or not and when it does it takes on continuous values. The first equation in the Double-Hurdle relates to the willingness to pay. A probit regression on the willingness to pay or not is modelled using all the variables and it can be expressed as follows:

$$WTP_i = 1 \text{ if } WTP^*_i > 0 \text{ and}$$

$$WTP_i = 0, \text{ if } WTP^*_i \leq 0$$

$$WTP^* = z_i' \alpha + \varepsilon_i \tag{3.8}$$

$WTP$  is the latent variable (Willingness to Pay) that assumes a value of 1 and 0 otherwise,  $z$  is a vector of farmer, farm and institutional characteristics, which are non-linear,  $\alpha$  is a vector of parameters and  $\varepsilon_i$  is the error term, which is assumed to be normally distributed, independent, and has constant variance .

The second hurdle is a regression truncated at zero. It is expressed as

$$WTP_{amt_i} = WTP_{amt_i}^* \text{ if } WTP_{amt_i}^* > 0$$

$$WTP_{amt_i}^* = 0 \text{ if otherwise}$$

$$WTP_{amt_i}^* = x_i' \beta + u_i \tag{3.9}$$

Where  $WTP_{amt_i}^*$  is the observed response on how much cocoa farmers are willing to pay for a side grafted cocoa tree.  $x$  is the vector of farmer, farm, and institutional characteristics,  $\beta$  is a vector of parameters and  $u_i$  is the error term which is randomly distributed.

To estimate the factors influencing farmers' willingness to pay for side grafting technique on their farm, the double hurdle model was used. This is because willingness to pay or not to pay for side grafting is in two stages where the first stage is the decision of farmers to pay or not to pay. This is modelled as a latent discrete choice (yes/no) and is thus modelled using the probit model. This is specified as follows;

$$\begin{aligned} WTP_i = f[\beta_0 + \beta_1 Educ + \beta_2 freqofext + \beta_3 Gender + \beta_4 cocinc + \beta_5 toha \\ + \beta_6 agefarmdum + \beta_7 Yield + \beta_8 memFBO + \beta_9 Actocre + \beta_{10} awareness \\ + \beta_{11} Age + \beta_{11a} Hhead + \varepsilon_i] \end{aligned} \tag{3.10}$$

$WTP_i$  is the probability that  $i$ th cocoa farmer is willing to pay for side grafting technology.  $\beta_i$  is the coefficients of the independent or the predictor variables and with the respective predictor

variables. Since the coefficients are non-linear, the coefficients cannot be directly used to explain the relationship between the dependent and the independent variables. The marginal effects is thus calculated (Sonmez, 2013).

The second step in the adoption process is the amount of money the cocoa farmers are willing to pay which is modelled as a generalized linear regression model. It is specified as follows;

$$WTP_{amti} = f[\beta_0 + \beta_1 Educ + \beta_2 freqofext + \beta_3 Gender + \beta_4 cocinc + \beta_5 toha + \beta_6 agefarmdum + \beta_7 Yield + \beta_8 memFBO + \beta_9 Actocre + \beta_{10} awareness + \beta_{11} Age + \beta_{12} Hhead + \varepsilon_i] \quad (3.11)$$

### 3.7.3 Definition of variables

**Educational attainment (Educ):** Education is highly linked to the adoption of side grafting. The higher the level of education the greater the possibility of adopting side grafting. Hence, it is positively related to adoption of side grafting. It is measured in this study as the number of years respondent has spent in formal education.

**Frequency of extension visit (freqofext):** This is measured as the number of times a cocoa farmer was visited by extension agents within the 2013/2014 production year. It is modelled in this study to have a positive relationship with willingness to pay and the amount farmers are willing to pay.

**Gender:** Gender is measured as a dichotomous variable with male=1 and female=0. The literature on gender shows that males have a higher probability of adopting technologies compared to females. This is because males are more resource endowed compared to females.

**Income from cocoa (Cocinc):** Generally, the income of a farmer does not influence the decision to adopt side grafting but how much the farmer is willing to pay (Ulimwengu & Sanyal, 2011). It

is measured in this study as the income from dried cocoa beans sold in the 2013/2014 production year. Cocoa income is used because it is the major occupation of the farmers.

**Farm size (toha):** Farm size is measured in hectares. The relationship between farm size and the adoption of side grafting is indeterminate. It could be positive or negative (Chandrasekaran, Devarajulu, & Kuppannan, 2009; Olwande & Mathenge, 2012). This is because the farm size of the cocoa farmers point to the importance given to cocoa cultivation and as such imply farmers' willingness to adopt and pay for the technology. On the other hand, as the farm size increases, the farmers face the reality of adopting the side grafting technology because as the number of cocoa trees increases, the amount farmers will pay will increase. The farmer might decide not to adopt the technology.

**Age of farm (agefarmdum):** Age of the farm is measured in this study as the age of the cocoa trees. It is measured as a dummy with 1= farms 20 years or more and 0= less than 20 years. Age of farm has a positive relationship with willingness to adopt and pay for side grafting. As the farm ages, productivity increases to a point around 20 years old and then begins to decline. Farmers are more willing to adopt side grafting at this point of the production cycle (Gockowski *et al.*, 2011).

**Membership in FBOs (memFBO):** Membership in FBOs is expressed as a dummy (yes=1, no=0). It is expected that membership in FBOs is likely to increase the adoption of side grafting. This is because members could have been educated to understand technology and hence speed up adoption (Tiamiyu *et al.*, 2009).

**Access to Credit (Actocre):** Credit in this study is measured as a dummy variable. It is hypothesized to have a positive relationship with adoption of side grafting. It is assumed that access

to credit will enable farmers to have a certain level of financial ease in adopting and paying for the cost of side grafting (Abu *et al.*, 2011).

**Awareness (awareness):** Awareness is thought to have a positive relationship with adopting and paying for side grafting technology. Awareness is measured in this study as a dichotomous variable with 1=aware and 0= not aware. It is hypothesized that as farmers become aware of side grafting, it settles their uncertainties about the technology and increases their chances of adopting and paying for the technology (Aryal, Kamal, Chaudhary, Pandit, & Sharma, 2009).

**Age of the farmer (age):** Age is measured in this study as the number of complete years the cocoa farmer has attained. Age is assumed to influence the adoption and willingness to pay for side grafting either positively or negatively. As farmers grow, they gather experience in their farming activities which might make it easy for them to adopt. In another sense, farmers may be risk averse as they grow in relation with making high investments on their cocoa farm.

**Household head (Hhead):** Household head status is measured in this study as a dummy variable with 1= farmer being a household head and 0= farmer not being a household head. Household head status is hypothesized to have a positive relationship with adoption and willingness to pay for side grafting. This is because heads take major decisions of the family including on-farm investments.

**Yield (Yieldkg):** Yield of the farm is measured as the number of bags of dried cocoa per hectare obtained during the 2013/2014 production year. It is hypothesized that there is a negative relationship with willingness to pay and the amount farmers are willing to pay.

**Hypothesis statement****Table 3. 2: Variable description**

<b>Variables</b>	<b>Description</b>	<b>Measurement</b>	<b>Apriori expectation</b>	<b>Null Hypothesis H<sub>0</sub></b>	<b>Alternate hypothesis H<sub>A</sub></b>
Educ	Years of education	Years of formal education	+	$\beta = 0$	$\beta > 0$
Freqofext	Frequency of extension visit	Number of times visited	+	$\beta = 0$	$\beta > 0$
Gender	Gender	Male=1, Female=0	+	$\beta = 0$	$\beta > 0$
Cocinc	Income	GHS	+	$\beta = 0$	$\beta > 0$
Toha	Farm size	Hectares	+/-	$\beta = 0$	$\beta \neq 0$
Agefarmdum	Age of cocoa trees	20 years and above=1, below 20years=0	+	$\beta = 0$	$\beta > 0$
Yield	Yield	Number of bags/ha	-	$\beta = 0$	$\beta \geq 0$
memFBO	Membership in FBO	Yes=1, No=0	+	$\beta = 0$	$\beta > 0$
Actocre	Access to credit	Yes=1, No=0	+	$\beta = 0$	$\beta > 0$
Awareness	Awareness of side grafting	Yes=1, No=0	+	$\beta = 0$	$\beta > 0$
Age	Age of farmer	Number of years	+/-	$\beta = 0$	$\beta \neq 0$
Hhead	Household head	1=yes, 0=no	+	$\beta = 0$	$\beta > 0$

**Validation of hypothesis**

The hypothesis are validated using the Z test. It is expressed as

$$z = \frac{\beta_i}{SE(\beta_i)}$$

$B_i$  are the coefficients of the variables and SE is the respective standard errors

If  $Z_{calculated} > Z_{critical}$  reject the null hypothesis

Otherwise do not reject

## CHAPTER FOUR

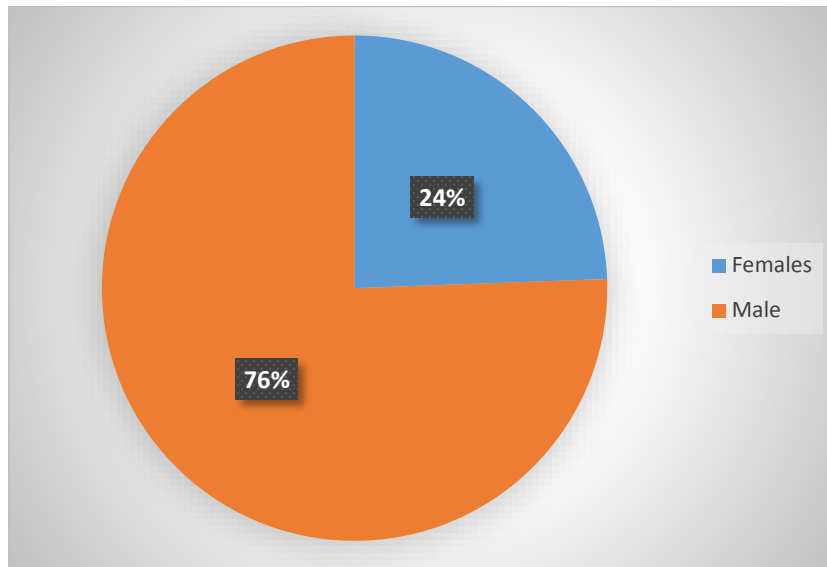
### RESULTS AND DISCUSSION

#### 4.1 Introduction

This chapter presents the results and discussion of the study. The chapter begins with a description of the socioeconomic characteristics of cocoa farmers. It also presents the level of awareness of side grafting and willingness to adopt side grafting. The results of the contingent valuation analysis is also presented. The results of the Double Hurdle regression model is also presented and discussed.

#### 4.2 Socioeconomic Characteristics of Cocoa Farmers

From the study, males are the majority (76%) of cocoa farmers in the Eastern region whilst females make up about 24% of cocoa farmers (Figure 4.1). This is consistent with the results of Aneani *et al.* (2012) who found 80% of sampled farmers being males and 20% being females in the Ghanaian cocoa sector. This might be because in the traditional Ghanaian setting cultivation of cash crops is mostly done by men whilst the women support the home with the cultivation of food crops. Moreover, out of the overall number of cocoa farmers who are household heads, 82% of the respondents were males and 18% were females (Table 4.1). These household heads have better access to inputs such as land as compared to their female counterparts. The findings of this study is consistent with reports by the GSS (2012), which reported male headed households as being the majority.

**Figure 4. 1: Gender of farmers**

*Source: Computation from field data, 2015*

**Table 4. 1: Household heads by gender**

		Gender	
		Female	Male
Head of household	No	64.52%	35.48%
	Yes	17.74%	82.26%

*Source: Computation from survey data, 2015*

**Table 4. 2: Descriptive statistics of socio-economic characteristics of cocoa farmers**

<b>Variables</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Mode</b>	<b>Std. Deviation</b>
<b>Age</b>	21.00	85.00	51.79	45	13.72
<b>Years of formal education</b>	.00	19.00	8.52	9	3.62
<b>Household size</b>	1.00	20.00	5.73	6	3.32
<b>Cocoa farming experience</b>	1.00	51.00	15.23	20	10.52
<b>Size of cocoa farm (ha)</b>	0.4	18.00	3.2	1.6	2.8
<b>Age of cocoa trees</b>	1	80	14.89	4	12.80
<b>Yield (kg/ha)</b>	0	1600	179.31	80	2.97
<b>Income from cocoa</b>	.00	23645	2270.61	2800	2839.46
<b>Income from other non-cocoa activities</b>	.00	1500	167.99	0	253.36
<b>Total income</b>	50.00	23995.00	2438.61	2800	2869.44

*Source: Computation from survey data, 2015*

The survey results show that the mean age of cocoa farmers in the study is 52 with minimum and maximum age as 21 and 85 respectively (Table 4.2). This implies that the average cocoa farmer is 52 years old but typically, a cocoa farmer is 45 years old as observed with the modal age. This shows that cocoa farmers in the study area are largely older farmers with fewer young ones getting into cocoa production. The finding is consistent with (Baffoe-Asare *et al.*, 2013) who recorded an older cocoa farming population. Aneani *et al.* (2012) also found the average age of cocoa farmers to be 52 years. This could be because the older generation might not willing to take on further risk in improving their productivity.

From Table 4.2, the study also recorded the average number of years of formal education by cocoa farmers as nine (9) years, meaning most farmers have only junior high school education. Anim-Kwapong and Frimpong (2004) also found that the majority of cocoa farmers have basic education

particularly up to the junior high school level. This in effect should make them amenable to adopting cocoa technologies.

The average household size is 5.7 according to the study as reported in Table 4.2. This figure is higher than the national average household size of 4.4 and that of the Eastern region which recorded a household size of 4.1 according to the 2010 Population and Housing Census (GSS, 2012).

The average cocoa farming experience in the study area is 15 years (see Table 4.2). This implies a vast wealth of experience in cocoa cultivation and as such should be able to appreciate technology and adopt accordingly. Previous experience in farming makes farmers make informed decisions on adoption (Egyir, 2008).

On average, a cocoa farm in the Eastern region is 14 years old. This age is below the years (20 years) after which productivity declines. Farms in the Eastern region are therefore thought to be in their productive years. This in a way could be misleading because many farmers in the study area are converting their food crop farms to cocoa farms and hence farms are very young. This could have overshadowed the many older farms in the study area. Increase in acreage of production is very good for the cocoa sector but then productivity enhancement is very important.

The mean size of cocoa farms in the Eastern region is 8.2 acres, translating into 3.2ha (Table 4.2). However, a typical cocoa farm in the Eastern Region is 1.6ha. This size is lower than the reported average of cocoa farms per household of two hectares or less (Barrientos *et al.*, 2008). The average quantity harvested is 2.8 bags which translates into 0.179tons/ha, which is below the current national average of 0.4 tons/ha. It still lags behind other cocoa producing countries like Cote D'Ivoire, Malaysia and Brazil (Danso-Abbeam *et al.*, 2014; MoFA, 2011).

The average income from cocoa is GH¢2270.61 and that of other activities is GH¢167.99 and the overall average for total income of cocoa farmers is GH¢2438.61 (Table 4.2). Typically, a cocoa farmer has an annual income of GH¢2800 translating into US\$877.74 (US\$1:3.19). This figure is not adequate to sustain a good livelihood standard. Compared to indices of poverty in Ghana (US\$1.25/day) most of these farmer households fall below the poverty line.

### **4.3 Current use of cocoa technology and practices**

Majority of the respondents adopt cultural practices in cocoa cultivation (Table 4.3). Some of these practices are recommended number of cocoa trees per acre, line and pegging, number of times farm was weeded, mode of planting using seedlings, pruning and use of hybrid seeds. However, most farmers (52%) did not adopt the right spacing of 10 feet by 10 feet whilst 85% of the cocoa farmers did not adopt soil test before cultivating their cocoa farm.

It was also observed from the survey that 100% of the respondents use the recommended sun drying method for drying their cocoa beans. Cocoa Research Institute of Ghana does not recommend mechanical heating systems for drying beans since there is the danger of smoke contamination and high acid retention. About 83% of the respondents do not store their pods for more than three days before breaking whilst 92% of the respondents followed the recommended number of days for fermentation (5-7 days). Moreover 97% of respondents use the recommended mats raised on support for drying their cocoa as presented in Table 4.3. They avoided drying on bare floors, using polythene sheets and drying on asphalt roads. Most farmers followed this technology because it is the direct point preceding sale of cocoa beans. Any undesirable method in handling the beans could lead to poor quality and may not be bought by cocoa purchasing clerks. Most farmers did not adopt the recommended method of stirring the cocoa heap during the fermentation process. The stirring is done to ensure even distribution of temperature and oxygen

for maximum fermentation. This could be because most of the farms are farther away from the farmers' home and farmers could not go to their farms frequently to stir the beans.

**Table 4. 3: Adoption of common cocoa cultural practices and technologies**

<b>Technology/practices</b>	<b>Components</b>	<b>Adopters</b>	<b>Non-adopters</b>
<b>Basic farm practices</b>	Spacing	47.5%	52.5%
	Line and pegging	59%	41%
	Number of times farm was weeded (3-4 times)	70.5%	29.5%
	Mode of planting (seedlings)	68.2%	31.8%
	Pruning	88.9%	11.1%
	Soil test	14.7%	85.3%
	Use of hybrid seeds	71.4%	28.6%
<b>Fermentation and drying</b>	Use of sun drying	100%	0%
	Recommended length of storage before breaking pods. (within 2-3 days)	82.9%	17.1%
	Recommended number of days for fermentation (5-7 days)	91.7%	8.3%
	Use of mats raised on support for drying	97.2%	2.8%
	Stirring of cocoa beans during fermentation	45.6%	54.4%
<b>Rehabilitation</b>	Cutting down cocoa and starting with seedlings	23%)	77%
	Starting new seedlings in between existing older cocoa	8%)	92%
	Coppicing	98%)	2%

*Source: Computation from survey data, 2015*

From Table 4.3, 77% of the respondents have never adopted the rehabilitation method of cutting the entire cocoa trees down and starting with new seedlings while 23% had adopted. Also, 92% of the respondents have never adopted the rehabilitation method of starting new seedlings whilst old trees are still on the field. Also, 98% of the respondents had ever adopted coppicing as a method

for rehabilitating their farms. The reason for the wide non-adoption of cutting trees entirely and starting with new ones could be because farmers are very mindful of their incomes and that any technology that lead to a sharp decline in their income will likely not be adopted. The coppicing method leads to more vigorous offshoot development at a very short time as compared to the recommended method of cutting down cocoa plants entirely. Though the coppicing method could lead to the retention of systemic diseases like swollen shoot, it is still more preferred.

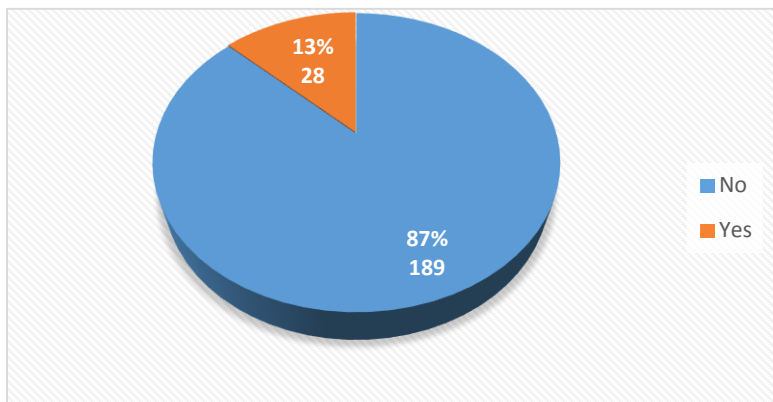
#### **4.4 Analysis of the Level of Awareness of Side Grafting Among Cocoa Farmers**

Awareness of a farmer about a technology, how it operates and the associated benefits will enable the farmer to make informed choices about its adoption. The result of the survey shows that the awareness about cocoa side grafting is very low. About 87% of the respondents said they have never heard about side grafting with 13% declaring awareness of the technology (see Figure 4.2). This indicates that before an institution decides to roll out this technology, proper education on the technology as well as field trials and demonstration centers should be provided to enable easy adoption decisions to be made by farmers. Despite the fact that majority of farmers had never heard of side grafting, a greater portion (89%) of the respondents are willing to adopt cocoa side grafting (see Figure 4.3). This is because they saw the potential in addressing their productivity challenges while maintaining their income.

The study showed that out of the 87.1% of the respondents who were not aware of side grafting, 79.3% were willing to adopt side grafting. Out of the 12.9% of respondents who reported awareness of side grafting, 10.1% of them agreed to adopt side grafting (see Table 4.4). This implies a greater level of farmers' willingness to adopt side grafting. Farmers had been thoroughly

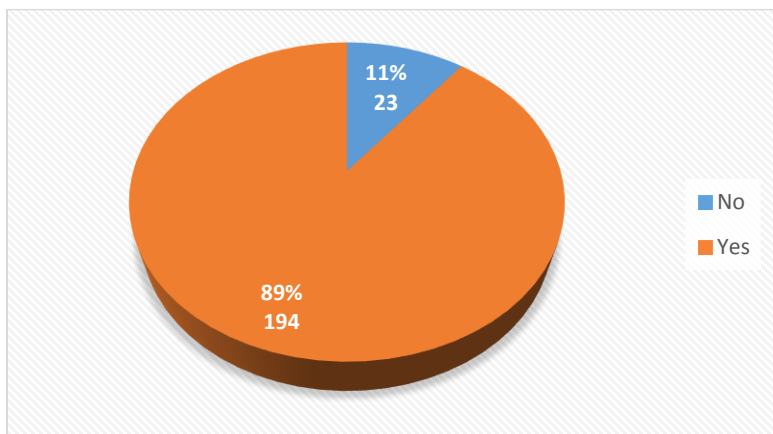
educated on the technology with its benefits and cost, and they appreciate its place in helping to improve their productivity.

**Figure 4. 2: Awareness of cocoa side grafting**



*Source: Computation from survey data, 2015*

**Figure 4. 3: Willingness to adopt side grafting**



*Source: Computation from survey data, 2015*

**Table 4. 4: Cross tabulation of awareness of side grafting and willingness to adopt**

		Willingness to adopt side grafting		Total
		No	Yes	
Awareness of side grafting	No	7.8%	79.3%	<b>87.1%</b>
	Yes	2.8%	10.1	<b>12.9%</b>
<b>Total</b>		<b>10.6%</b>	<b>89.4%</b>	<b>100%</b>

*Source: Computation from survey data, 2015*

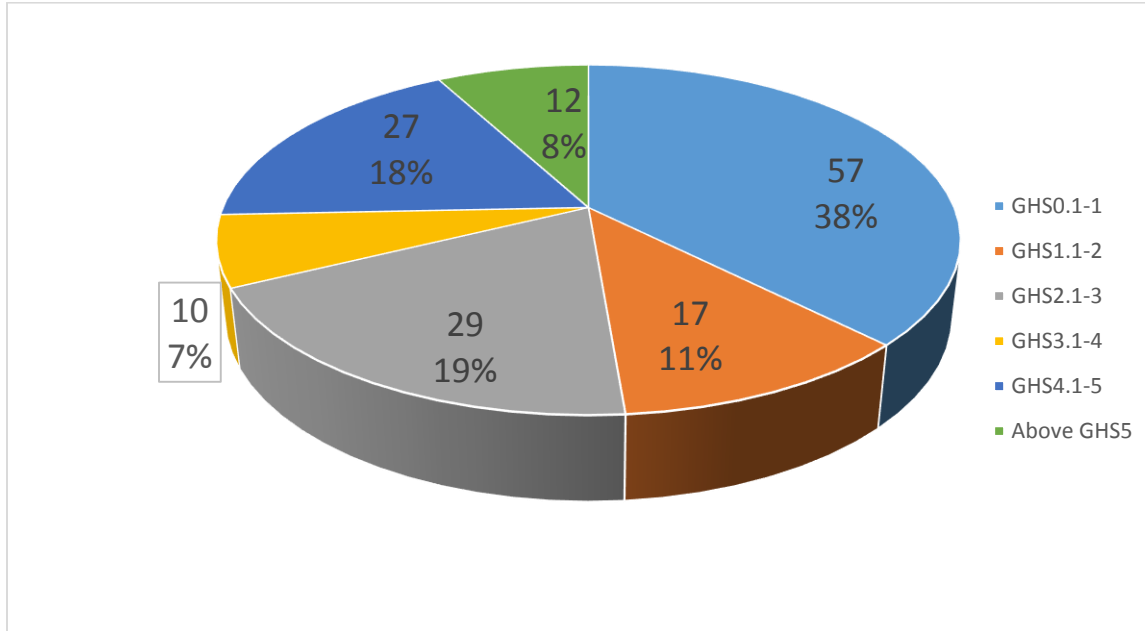
#### 4.5 Analysis of Willingness to Pay Amount for Side Grafting a Cocoa Farm

Data from the survey indicates that the minimum amount farmers are willing to pay per cocoa tree is GHC0.10 and the maximum amount is GHC10. Overall, the average cocoa farmer is willing to pay GHC2.84 per side grafted cocoa tree which translates into GHC3,124 per hectare of side grafted cocoa farm as seen in Table 4.5.

**Table 4. 5: Cocoa Farmers' Willingness to Pay Amount for Cocoa Side Grafting**

	Minimum	Maximum	Mean	Mode	Median	Std. Deviation
<b>Maximum WTP amount per tree (GHC)</b>	.10	10.00	2.84	5	2.20	2.62
<b>Maximum WTP amount per ha(1100trees) (GHC)</b>	110.00	11,000.00	3,124	5,500	2,420	2,882.00

*Source: Computation from survey data, 2015*

**Figure 4. 4: Distribution of Willingness to Pay Amount for Cocoa Farmers**

*Source: Computation from survey data, 2015*

The amount farmers are willing to pay is relatively low compared to the amount charged in some countries that have implemented the side grafting technology. For instance, a cocoa side grafting business that operated in Indonesia in 2010 charged farmers US\$1.3 (GH¢4.15)<sup>1</sup> per side grafted cocoa tree (Mars, 2015). Transferring this figure into Ghana, very few are willing to pay such an amount of money. Cocoacare, an organization in Indonesia also charged cocoa farmers US\$2 (GH¢6.38) per side grafted cocoa tree (Cocoa Care, 2015). Moriarty, Elchinger, Hill, and Katz (2014) estimates the cost of side grafting a cocoa tree at IDR5000 (GH¢1.40)<sup>2</sup>, a figure that is lower than the amount farmers are willing to pay for side grafting in Ghana.

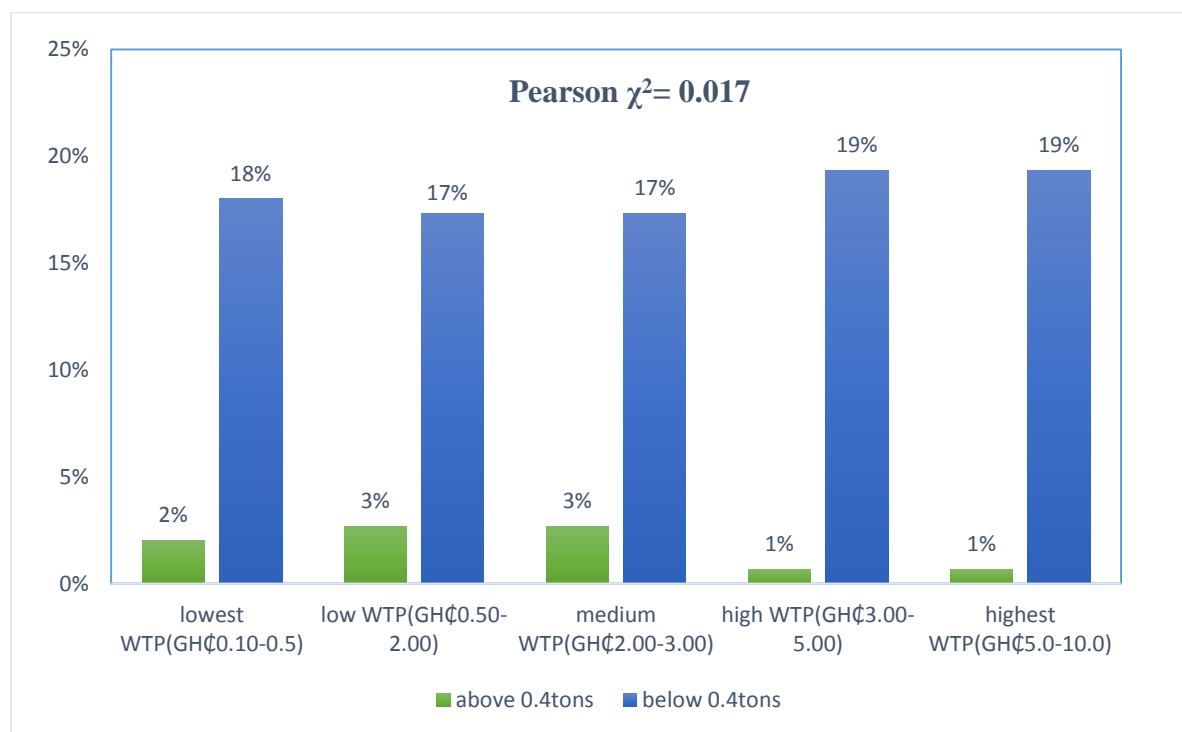
In spite of the fact that the mean WTP amount is GH¢2.84 per tree, the estimated standard deviation of 2.62 suggests that majority of the respondents are clustered around the minimum

<sup>1</sup> US\$1=GH¢3.19 (21 January, 2015)

<sup>2</sup> Indonesian Rupees: IDR1= GH¢0.00028 (21 January, 2015)

WTP. This mean WTP is approximately 45% of the amount of money charged for side grafting a cocoa tree in Indonesia. From Figure 4.4, majority (38%) of the respondents agreed to pay between GH¢0.1 and GH¢1. 11% agreed to pay between GH¢1.1 and GH¢2 whilst 19% agreed to pay between GH¢2.1 and GH¢3. Respondents willing to pay above GH¢5 is only 8% (see Figure 4.4). This implies that cocoa farmers are willing to pay for side grafting their cocoa farms but the amount is relatively low compared to other countries. This willingness to pay amount could be somewhat associated with the amount paid for purchasing cocoa seedlings or pods for nursing. Since cocoa pods were sold to farmers at a cost of about GH¢0.4 and seedlings for GH¢0.10, and currently offered free to farmers, farmers also somehow want this technology of side grafting offered at close to no charge (GH¢0.1 and GH¢1).

**Figure 4. 5: Quintile distribution of Farmers' Willingness to Pay Amount**



*Source: Computation from survey data, 2015*

**Table 4. 6: Percentile distribution of willingness to pay amounts**

Percentiles	Willingness to Pay Values
25	.50
40	2.0
50	2.20
60	3.0
75	5.0

*Source: Computation from survey data, 2015*

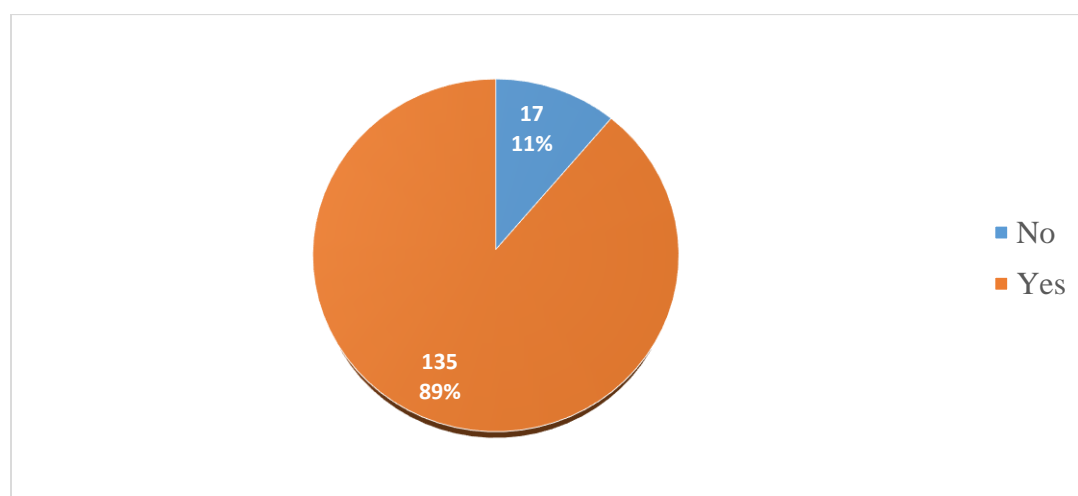
The Pearson chi- square value of 0.017 shows that there is a significant relationship between yield of the cocoa farmers and how much they are willing to pay for side grafting. A quintile distribution of the farmers' WTP amount shows that for those having the lowest WTP (GHC0.10-0.5), 18% of them were farmers with yield below national average of 0.4 tons, with farmers above the national average occupying 2%. Hence, farmers with yields below the national average were in the majority within the first percentile. This persisted to even the highest WTP (GHC5.0-10.0), where the majority of the respondents were farmers whose yield was below the national average (see Figure 4.5). This implies that COCOBOD and other organizations who want to implement this technology could first target farmers with yields below the national average. As they adopt, other farmers in other yield brackets could adopt when they see the yield increase of other farmers.

Moreover, at 25th percentile, cocoa farmers are willing to pay GHC0.50 or less for side grafting a cocoa tree. Also, at the 50<sup>th</sup> percentile, cocoa farmers are willing to pay GHC2.20 or less for side grafting. At the 75<sup>th</sup> percentile, cocoa farmers are willing to pay GHC5.00 or less for side grafting a cocoa tree (see Table 4.6). This implies that if organizations are going to implement the side grafting technology, then charging above GHC5.00 could mean they are only targeting 25% of

farmers. To attract a wider net of farmers, organizations could charge GHC0.50 or less which could cover 75% or more of farmers.

Figure 4.6 shows that 89% of farmers prefer to pay with cocoa beans and not instant cash payment. The remaining 11% would pay for the technology. This preference for in-kind payment using cocoa beans offers an important option for organizations that are in the business of promoting technology adoption and productivity in the cocoa sector.

**Figure 4. 6: Willingness to pay in-kind (cocoa beans)**



*Source: Computation from survey data, 2015*

**Table 4. 7: Projected increase in yield and income due to side grafting**

Items	Projected figures
Number of trees	1,100
Number of pods	27,500
Quantity of dried cocoa beans (kg)	982.14
Number of bags of dried cocoa beans	15.71
Income to farmer (GHC)	5,500

*Source: Computation from survey data, 2015*

## Assumptions

- Farmer follows recommended farm practices
- 1 cocoa tree bears 25pods/year
- 28 cocoa pods give 1kg of dried cocoa beans
- Farm has the standard number of cocoa trees per ha (1100 trees)
- Same number of pods are harvested per year

Table 4.7 shows that a farmer harvests approximately 0.98 tons of dried cocoa beans per hectare per year if the farmer adopts side grafting. This estimate is more than double the national average of 0.4 tons. The associated income is GHC5,500 per hectare per year if the farmer adopts cocoa side grafting. The income is higher than the amount the farmer is willing to pay (GHC3,124). This income could be used to pay-off the cost of side grafting after which the income from subsequent years of production will be used for other farm improvements and help to improve the livelihood of the farmers. It is therefore economically expedient on the part of cocoa farmers to adopt the side grafting technology.

## 4.6 Factors Influencing Farmers' WTP and WTP Amount for Cocoa Side Grafting

This section presents information and discussion of the factors that influences farmers' willingness to pay and the amount willing to pay for side grafting a cocoa tree. The double hurdle estimations of the various variables of interest are presented in Table 4.8.

**Table 4. 8: Double Hurdle Model of Factors Influencing Farmers' Willingness to Pay for Side Grafting**

Variable	Probit			GLM		
	dy/dx	Std. Error.	P>z	Coeff.	Std. Error.	P>z
<b>Educ</b>	0.114**	0.05102	0.026	0.0491**	0.025094	0.05
<b>toha</b>	-0.167**	0.08032	0.039	-0.0792**	0.038147	0.038
<b>agefarmdum</b>	1.12**	0.50591	0.027	0.403**	0.181954	0.027
<b>Yieldkg</b>	-0.00157	0.00133	0.24	-0.00109*	0.000597	0.067
<b>Gender</b>	0.0194	0.41081	0.962	0.0428	0.19661	0.828
<b>memFBO</b>	0.0234	0.3471	0.946	-0.163	0.169284	0.337
<b>Actocre</b>	-0.150	0.44658	0.737	-0.0676	0.221249	0.76
<b>Awareness</b>	0.663	0.68404	0.332	0.462*	0.249674	0.064
<b>Hhead</b>	1.118***	0.34723	0.001	0.526**	0.26382	0.046
<b>Age</b>	-0.0189	0.01302	0.148	-0.00477	0.006151	0.438
<b>cocoinc</b>	0.00019*	0.00011	0.082	0.0000887*	5.21E-05	0.089
<b>freqofext</b>	0.278***	0.10273	0.007	0.102**	0.045891	0.026
<b>Cons</b>	-	-	-	0.310	0.436429	0.478

*NB: \*, \*\* and \*\*\* denotes 10%, 5% and 1% significant levels respectively*

#### Model Statistics

Parameter	Value
Number of observations	217
Log likelihood	-123.42
LR chi2(12)	21.42
Prob > chi2	0.0445
Pseudo R2	0.0799

*Source: Computation from survey data, 2015*

#### 4.6.1 Education (Educ)

Education has positive and statistically significant influence on cocoa farmers' decision to pay for side grafting and the amount they are willing to pay for side grafting as seen in Table 4.8. This is because as farmers' level of education increases, it increases their ability to be able to appreciate technology so that they are easily willing to pay. This is particularly different from less educated

farmers who sometimes find it difficult to access and accept technologies. Such farmers may adopt and pay for the technology but at a later time. This result is consistent with that of D'Souza, Cyphers, and Phipps (1993), Agyekum *et al.* (2014) and Tiarniyu *et al.* (2009) who found a significant relationship between farmers' education and adoption of agricultural technologies.

#### **4.6.2 Frequency of extension visits (freqofext)**

Frequency of extension visits was seen to have a significant positive relationship with the willingness to pay and the amount farmers are willing to pay (see Table 4.8). This emphasizes the role of extension agents as conduit for technology transfer. This is because the more farmers are visited by extension officers the more they educate them on production technologies and better ways of managing cocoa farms. They are therefore in a better position to appreciate the side grafting technology as compared to other farmers. Respondents who had many times of visit by the extension agents are seen to be easy adopters of side grafting. Effendy *et al.* (2013) found a significant relationship between adoption of side grafting and extension contact. Other studies such as Yu *et al.* (2011) and Wiredu *et al.* (2011) have also found a significant relationship between extension contacts and the adoption of technology, implying the important role of extension agents in technology adoption.

#### **4.6.3 The size of the cocoa farm (toha)**

The size of the cocoa farm has a negative and significant relationship with willingness to pay and the amount of money farmers are willing to pay for side grafting (see Table 4.8). It is significant at 10%, implying that as the farm size increases by 1 ha, a farmer's willingness to pay for side grafting decreases by 0.16 margin. Moreover, as the farm size increases by 1 ha, the farmer is willing to pay GHC0.08 less and vice versa. This is because as the farm size increases then farmers begin to realize the full amount they are paying for the side grafting technology and may even

decide to avoid adopting and paying for the technology. Chandrasekaran, Devarajulu and Kuppannan (2009) also found a negative relationship between farm size and willingness to pay for irrigation services. Tiarniyu *et al.* (2009) however reported no significant relationship between farm size and willingness to adopt technology (NERICA rice).

#### **4.6.4 The age of the cocoa trees (agefarmdum)**

The age of cocoa trees is positively and significant at 5% in predicting the willingness of farmers to pay for cocoa side grafting and the amount they are willing to pay for side grafting (see Table 4.8). Kouame and Komenan (2012) also found the age of cocoa trees to have a positive significant relationship with the adoption of crop insurance. This is because as the trees age the productivity level increases at the early stages to a point and then increases at an increasing rate. Afterwards production level begins to decline when the tree is 20 years and over. At this stage, farmers will be more willing to invest in productivity enhancing technologies since the marginal yield is reduced.

#### **4.6.5 Awareness of side grafting (awareness)**

Awareness of side grafting does not influence farmers' willingness to pay but positively influences the amount they are willing to pay for side grafting as seen in Table 4.8. This implies that the more farmers are aware, the more it increases their Willingness To Pay amount for side grafting. Asrat *et al.* (2004) also found that farmers' awareness of agricultural technology influences their willingness to pay amount for agricultural technologies. This is because as they become aware of the technologies, fear of adopting the technology are allayed and are therefore willing to pay more for the technology due to their understanding of the benefits.

#### **4.6.6 Total yield of the farm (Yield)**

Total yield of farm, which is the kilogram of dry beans per ha, does not influence the willingness of cocoa farmers to pay for side grafting but negatively influences the amount they are willing to pay. This implies that as yield decreases, farmers are willing to pay more for side grafting. Results from the study (Table 4.8) shows that as yield of cocoa decreases by 1kg per hectare, the WTP amount also increases by GHC0.001. A yield decline leads to a reduction in farmers' income and as such farmers will be willing to adopt technologies that will boost their production and consequently, income. Gockowski *et al.* (2011) explains that as cocoa trees grow the yield declines at a point and therefore it is at this point farmers are more willing to pay more for technologies.

#### **4.6.7 Household head (Hhead)**

Being a household head positively and significantly influence cocoa farmers' willingness to pay and the amount they are Willing To Pay for side grafting. From the result in Table 4.8, farmer household heads have a greater tendency of WTP and increases the amount they are willing to pay. Household heads are responsible for making major decisions of the family including decisions on farm investments. Hence, being a household head influences farmers' decision to pay for side grafting and the amount they are willing to pay. This is consistent with the work of Falola, Banjoko and Ukpebor (2012) who found that age of the household head significantly influences the WTP for agricultural insurance.

#### **4.6.8 Income from cocoa (cocinc)**

Farmers' income from the sale of cocoa has a positive and significant relationship with willingness to pay for side grafting and the amount farmers are willing to pay for side grafting (see Table 4.8). This result is consistent with that of Ulimwengu and Sanyal (2011) who found that the income of a farmer influences the willingness of the farmer to pay for agricultural services. To be able to

effectively adopt technologies on cocoa farms, financial capital is very much involved since the inputs are sold. Hence farmers with higher income are more likely to adopt since they have the money to pay for the technology.

#### **4.6.9 Gender (Gender)**

Gender in this study does not statistically and significantly influence farmers' willingness to pay and the amount they are willing to pay for side grafting. (Table 4.8). One would have thought that the level of adoption of males and the amount they are willing to pay will be higher compared to their female counterparts. This is because males are thought to have better access to resources including credit and hence could have better side grafting adoption rates. However, the study contradicted the claim despite the fact that males dominate cocoa production in Ghana. Wiredu *et al.* (2011) report no significant relationship between gender and cocoa technology adoption. On the other hand, Baffoe-Asare *et al.* (2013) report a positive relationship between gender and adoption of CODAPEC and Cocoa Hi-Tech production packages. This difference could be due to the differences in data used (study area).

#### **4.6.10 Membership in Farmer Based organizations (memFBO)**

Farmers' membership in farmer based organizations is not significant in determining willingness to pay and the willingness to pay amount for side grafting as shown in Table 4.8. According to Tiarniyu *et al.* (2009), membership in FBOs is expected to assist farmers to acquire information on technologies as well as being able to access credit to aid technology adoption. Their study however found an insignificant relationship between adoption of the technology and FBO membership as also is the case for this study. On field observations gave an idea that farmers joined FBOs purposely to get inputs and some souvenirs but it's not really a conduit for technology

transfer. The biases in the sharing of souvenirs also makes people reluctant to join the existing FBOs.

#### **4.6.11 Access to credit (Actocre)**

Access to credit negatively influences farmers' willingness to pay and the amount they are willing to pay for side grafting their cocoa farm as seen in Table 4.8. However, this relationship is not significant. Ntege-Nanyeenya *et al.* (1997) found no significant relationship between access to credit and adoption of maize production technologies. They found that out of the 17% of respondent farmers who had access to credit only 5% used the credit to access the technology. The negative relationship between access to credit and willingness to pay is because farmers use credit to engage in non-farm activities which are likely to have higher returns than agricultural production (Alabi *et al.*, 2014).

#### **4.6.12 Age of farmer (Age)**

Age of the farmer does not influence the WTP of farmers and the WTP amount of farmers for side grafting as observed in Table 4.8. As cocoa farmers age, studies have shown that they become more risk averse and unwilling to take further risk (Effendy *et al.*, 2013). The results in this study is at variance with what Effendy *et al.* (2013) found.

## CHAPTER FIVE

### SUMMARY, CONCLUSION AND RECOMMENDATION

#### 5.1 Introduction

This chapter presents a summary of the findings of the study. Conclusions are then made and followed with recommendations for policy consideration and sub-sector improvement.

#### 5.2 Summary

Cocoa cultivation is very important to the economy of Ghana. This major cash crop provides a source of livelihood to many people. However, one of the challenges facing the sector is reduced yield. This is attributable to the large number of old cocoa trees on farms today. To address the problem, Ghana Cocoa Board introduced the conventional method of cutting down cocoa trees entirely and starting with new seedlings. Despite its advantages, this technology leads to sharp decline in production and consequently reduces income of farmers. The side grafting method provides a solution to this challenge by reducing the sharp decline in income and therefore could be adopted in the cocoa sector.

This study therefore assessed farmers' willingness to pay for side grafting in the Eastern region. The study employed simple descriptive statistics, contingent valuation method as well as the double hurdle model in estimating the relationship between selected factors and farmers' willingness to pay and willingness to pay amount. Descriptive statistics was used to show the awareness and willingness to adopt side grafting, with the contingent valuation method used to determine the amount farmers are willing to pay. The double hurdle model was used to determine factors influencing the willingness to pay amount of cocoa farmers.

Results from the survey shows that 87% of the respondents were not aware of side grafting. Also, majority (89%) of the respondents are willing to adopt side grafting. The minimum amount farmers are willing to pay is GHC0.10 and the maximum amount is GHC10. On average, a cocoa farmer is willing to pay GHC2.84 for side grafting per tree. However, majority of the respondents willing to pay close to no charge (GHC0.1-1) for side grafting a cocoa tree. Majority of the farmers who are willing to pay for cocoa side grafting have yields below the national average (0.4 tons). Hence, adopting side grafting will increase their yields to close to 1 metric tons per hectare. At the 25<sup>th</sup> percentile, farmers' WTP amount is GHC0.50 or less. Education, frequency of extension visits, age of farm, income from cocoa and household head were positively statistically significant in influencing farmers' decision to pay for side grafting while farm size negatively. Education, frequency of extension visits, age of farm, awareness of cocoa side grafting, income from cocoa and household head were positively statistically significant in influencing how much farmers' are willing to pay while farm size and yield negatively influences how much farmers are willing to pay.

### **5.3 Conclusions and Implication of Findings**

The study draws the following conclusions from the results obtained for the various objectives:

- i. Majority of the cocoa farmers had never been aware of side grafting prior to the study. However, majority of them are willing to adopt side grafting on their farms when the technology was described to them.
- ii. Though on average a cocoa farmer is willing to pay GHC2.84, cocoa farmers are willing to pay close to no charge (GHC0.1-1) for side grafting. Cocoa farmers who are willing to adopt and pay for side grafting are those within yield levels below 0.4 tons. Majority of the farmers are willing to pay for side grafting on deferred payment or in-

kind using cocoa beans. Farmers' yield and income as a result of adopting side grafting is higher in comparison to the national average of 0.4tons. To help in encouraging adoption, the price of side grafting a cocoa tree could be pegged at GH¢0.50 or less.

- iii. Number of years of formal education of farmers, frequency of extension visits, age of the cocoa trees, income from cocoa and farmer being a household head increases the chances of a farmer to pay for side grafting. Moreover, as the farm size increases, farmers are less willing to pay for side grafting. Also, number of years of formal education of farmers, frequency of extension visits, awareness of side grafting, age of the cocoa trees, income from cocoa and farmer being a household head increases farmers' WTP amount for side grafting. On the other hand, farm size and yield of cocoa farm decreases the amount farmers are willing to pay for side grafting.

#### **5.4 Policy Recommendation**

From the conclusions proffered above, the following recommendations are made to help in the implementation of side grafting in the cocoa sector:

- i. For a successful implementation of the side grafting technology, COCOBOD should actively educate farmers on the technology. In addition, COCOBOD should establish many demonstration centers in addition to the ones that are already been done to increase farmers level of awareness and provide evidence for easy adoption.
- ii. COCOBOD should provide enough support to farmer base organizations to strengthen their capacity in terms of educating farmers on the technology. In addition, COCOBOD and other organizations could partner financial institutions so that farmers could be supported with credit facilities to enable them adopt and pay for the cocoa side grafting

- technology. More extension officers should be recruited so that farmers will be visited many times to aid effective technology transfer
- iii. COCOBOD and other NGOs could first target farmers whose yields are below 0.4 tons/ha. This is because they have the highest willingness to pay amounts within all the percentile classifications.
  - iv. Moreover, cocoa farmers with yields below 0.4tons could be targeted since they express the urgent need to increase their productivity. In addition, for a wider coverage of the side grafting technology, the price per cocoa tree could be set at GH¢0.50 or less.
  - v. Produce buying companies and NGOs could intervene by offering the technology to farmers on deferred payment so they can pay with cocoa beans at a later date. This will reduce the level of disparity among males and females in terms of adoption of the technology.

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**APPENDICES****APPENDIX 1: QUESTIONNAIRE****UNIVERSITY OF GHANA: DEPARTMENT OF AGRICULTURAL ECONOMICS AND  
AGRIBUSINESS**

This study is carried out by Eric Brako Dompseh, a graduate student of the University of Ghana, Legon on the topic *Cocoa Grafting Perceptions Among Cocoa Farmers in the Eastern Region of Ghana*, in partial fulfilment of the award of Master of Philosophy degree in Agribusiness. All information gathered will be treated with confidentiality and would solely be for academic purposes. Your support and contribution will be appreciated. Further enquiries, please contact me at [myeric86@yahoo.com](mailto:myeric86@yahoo.com) or call 0269613373 or my supervisor (Dr. Henry Anim Somuah-0509719762, Prof. Daniel Bruce Sarpong-0244737745).

**Identification**

Date \_\_\_\_\_

Enumerator name \_\_\_\_\_

Interview start time \_\_\_\_\_ End time \_\_\_\_\_

Administrative District \_\_\_\_\_ Cocoa district \_\_\_\_\_

Area \_\_\_\_\_ Name of Village \_\_\_\_\_

Name of respondent \_\_\_\_\_

Contact number \_\_\_\_\_

**To be completed by Supervisor**

Respondent code \_\_\_\_\_

Call back required \_\_\_\_\_

Call back Completed \_\_\_\_\_ Data entered \_\_\_\_\_

**Section A: Farmer demographics**

A1. Gender of respondent Male [ ] 0. Female [ ]	A2. Age of farmer (years)	
A3. Head of Household Yes [ ] 0. No [ ]	A4. Marital status Married [ ] 2. Single [ ] 3. Divorced [ ]	
A5. Religious affiliation Christian [ ] 2. Muslim [ ] 3. Traditional [ ] 4. Other [ ]	A6. Years of formal education (highest level). ** .....	
A7. Number of household members (including respondent).....	A8. Number of dependents	
	Below 18	Above 18
A9. Years of cocoa farming.....	A10. Which is your major occupation? Agriculture-cocoa [ ] agriculture-food crop [ ] Trading [ ] Teaching [ ] Artisan [ ] Other (specify).....	
A11. How much do you generate from the major occupation per month, if not cocoa farmer as major occupation? GHS.....	A12. Which is your minor economic activity? Agriculture-cocoa [ ] Agriculture-food crop [ ] Trading [ ] Teaching [ ] Artisan [ ] Other (specify).....	
A13. How much do you get from the minor occupation per month? GHS.....		

**\*\*Education**

None=0	Undergraduate=3/4
Primary=6	Polytechnic=3
JHS/Middle school= 3	Teacher training=3
O-level=4	Postgraduate= 2
A-level=2	Other (specify)
SSS/SHS=3	

**B. Farm characteristics**

B1. How many parcels of cocoa farms do you have? ..... .....	<b>B2. What is the size, age, yield, land holding nature</b>					
		<b>Local name</b>	<b>Size (acres)</b>	<b>Age (years)</b>	<b>Yield (bags/64kg)</b>	<b>Price per bag/64kg</b>
	<b>Parcel1</b>					
	<b>Parcel2</b>					
	<b>Parcel3</b>					
	<b>Parcel4</b>					
	<b>Parcel5</b>					

**C. Institutional Characteristics**

C1. Membership in FBO? Yes [ ] No [ ]	C2. If Yes, how long have you been with the FBO? (months) .....
C3. Do you pay dues? Yes [ ] No [ ]	C4. How much do you pay monthly (GHS)? .....
C5. What benefits have you derived from the FBO so far? Information and Training on new technology [ ] Information on price [ ] Mobilization of funds [ ] Book keeping training [ ] Agronomic training [ ] Credit management [ ]	C5. Do you have access to credit? Yes [ ] No [ ]
C6. If yes, from which source? Formal [ ] Informal [ ] Both [ ]	C7. If formal, which main source? Commercial Bank [ ] Rural Bank [ ] Microfinance [ ]
C8. How much did you receive within the 2013/2014 cocoa production year from formal sources (GHS)? .....	C9. If informal, from which main source? Susu [ ] Family & Friends [ ] FBO [ ] other (specify) .....
C10. How much did you receive within the 2013/2014 cocoa production year from informal sources (GHS)? .....	C.11 How often did you have extension agents come to visit you within the 2013/2014 cocoa production year? Once [ ] Twice [ ] Monthly [ ] None [ ] other (specify) .....
C.12.Which extension agents? MoFa agents [ ] Private extension agents [ ] NGOs [ ] COCOBOD agents [ ] Marketing Firms [ ] Farmer organizations [ ] Other (specify)	C.13 How much did you pay for their services? GHS.....

**D. Knowledge of other cocoa production techniques**

D1. Have you adopted any cocoa technologies before? Yes [ ] No [ ]

D2. If Yes, which ones? CODAPEC [ ] Hi-Tech/Mass spraying [ ] Certification bodies eg. Rainforest Alliance, UTZ, etc [ ] other (specify) ..... **-choose as many as apply**

D3. Did you apply fertilizers for the last production season? Yes [ ] No [ ]

D4. Which fertilizer did you use and month? Asaasewura [ ] Sidalco [ ] Cocofeed [ ] other (specify).....

D5. Apart from the mass spraying, did you spray your farm against pests and diseases? Yes [ ] No [ ]

D6. If yes, how many times and in which months? Times ..... Months.....

D7. If no, why? No money [ ] Mass spraying is enough [ ] No diseases or pests on my farm like others [ ]

D8. Does your farm suffer from black pod? Yes [ ] No [ ] Not aware [ ]

D9. If Yes, how do you control it? Remove infected pods [ ] provide adequate drainage [ ]  
Reduce shade [ ] others (specify).....

D10. Do you use fungicide to control blackpod? Yes [ ] No [ ]

D11. Which fungicide did you use? Ridomil [ ] Nordox [ ] Champion [ ] Funguran [ ]  
Kocide [ ] Gold 66 [ ] Other (specify) .....

D12. Does your farm suffer from swollen shoot virus disease? Yes [ ] No [ ] Not aware [ ]

D13. If Yes, how do you control it? Uproot infected and surrounding trees [ ] Call in CSSVD  
workers to treat [ ] Cut off affected parts [ ] No control [ ]

D14. How many permanent shade trees do you have on your farm/s?

Parcel 1 ..... Parcel 2..... Parcel 3 ..... Parcel 4..... Parcel 5 .....

D15. What spacing do you have on your farm? 10 feet by 10 feet [ 1 ] 8 feet by 8 feet [2 ]  
Random[3 ] other [ 4 ]

Parcel of lands	Spacing	Trees/acre	Mode of planting*	Line and pegging (Yes/no)	Where obtained planting material**	Number of times farm was weeded	Was pruning done (Yes/no)
1							
2							
3							
4							
5							

\*Mode of planting: Planting seeds at stake [1] Transplanted seedlings [ 2 ]

\*\*Planting material obtained: Farmers farm [ 1 ] own nursery [ 2 ] Private nursery [ 3 ] SPU of COCOBOD [ 4 ]

\*\*\*Times weeded: Once [ 1 ] Twice [ 2 ] Thrice [ 3 ] more than thrice [ 4 ] None [ 0 ]

D16. Do you use hybrid seeds on your farm? Yes [ ] No [ ]

D17. How often do you harvest pods? Anytime pods are ripe [ ] When most pods are ripe [ ]  
When all pods are ripe [ ] Weekly [ ] Fortnightly [ ] Monthly [ ] others  
(specify).....

D18. How long (days) after harvesting do you open the pods to remove? .....

D19. How do you break pods to remove the beans? Use wooden club [ ] use machete [ ] Use  
machine [ ] Knock pods on the ground [ ] Knock pods together [ ] Other .....

D20. How do you ferment your cocoa beans? In baskets [ ] Boxes [ ] Heaps of plantain  
leaves [ ] Others .....

D21. How long do you ferment your cocoa beans? ..... days

D22. How often do you stir your cocoa beans during fermentation? 48hrs [ ] 24hrs [ ] 12hrs [ ]  
No stirring [ ]

D23. How do you dry your beans? Spread on bare cement floor [ ] Spread on polythene sheets on floor [ ] Spread on polythene sheets on supports [ ] Spread on mats raised on support [ ] Spread on mats on floor [ ] Movable dryer [ ]

D24. Did you do soil test Yes [ ] No [ ]

D25. Did you use of herbicide Yes [ ] No [ ]

D26. Did you bury all pod debris after pod breaking Yes [ ] No [ ]

D25. Do you have any idea of how farm rehabilitation is done? Yes [ ] No [ ]

D26. What are the methods you know?

Cutting down cocoa plants entirely and starting with seedlings [ ]

Starting new cocoa seedlings in between already existing older cocoa plants [ ]

Haphazardly planting cocoa seeds directly into the ground whilst plants are on the farm [ ]

Other (specify).....

D27. Which of the methods have you previously used?

Cutting down cocoa plants entirely and starting with seedlings [ ]

Starting new cocoa seedlings in between already existing older cocoa plants [ ]

Haphazardly planting cocoa seeds directly into the ground whilst plants are on the farm [ ]

None [ ]

Other (specify).....

D28. If you ever used any of these methods, how much did you spend? GHS.....

#### **E. Awareness of side grafting and Willingness to Pay (WTP)**

*Grafting refers to the natural or deliberate fusion of plant parts so that there is vascular continuity and the resulting composite organism functions as a single plant. Side grafting involves inserting a previously cut shoot or scion into an opening on the side of another already growing plant. It is done on plants eg. cocoa to infuse superior qualities into an already growing plant. For old trees, hybrid scions could be inserted onto the growing plant to take the place of old branches after about 9 to 12 months of grafting. The old shoot is then cut to allow the new branch to grow. It has been adopted in many cocoa growing areas to improve productivity.*

Cost	Benefit
<b>Possibility of grafting diseased scions on healthy trees</b>	Productive years extend by 15 to 20 years
<b>Money involved</b>	Productivity increases between 80 and 100%
<b>Bad weather could destroy the grafts</b>	Steady flow of income from not felling down cocoa trees
<b>Possibility of diseases in the main plant attacking the graft</b>	

E1. Have you heard of cocoa side grafting? Yes [  ] No [  ]

E2. If Yes, where/whom did you hear about cocoa side grafting? FBO [  ] Extension agent [  ] Books [  ] Seminars & Workshops [  ] Other farmers [  ] COCOBOD [  ] Cocoa NGOs [  ] Others (specify).....

E3. Given the benefits and costs provided about “*Side grafting*”: Are you willing to **adopt side grafting for rehabilitation of your cocoa farm**?

1.Yes [  ] 2.No [  ]

E4. If Yes to E3, what will be your motivation to adopt side grafting? Increased productivity [  ] Desire to increase income [  ] Major source of livelihood [  ] Limited land to start new farm [  ] others (specify) ..... (skip to E.7)

E5. If No to E.3, what will discourage you from **adopting** side grafting? Possibility of failing [  ] limited money [  ] intention to quit cocoa farming [  ] cocoa farm is a minor activity [  ] other (specify) .....

E.6 What are your fears for not adopting the side grafting? Possibility of failing [  ] Seeds may not be viable [  ] May require additional cost [  ]

E.7 If willing to adopt, are you willing **to pay** for *side grafting*? 1. Yes [  ] 2. No [  ]

#### A. Low opening bid

E.5.1 If Yes to E.5, are you willing to pay **GHC 2 only** per side grafted cocoa tree? (if yes go to E.5.2 and if no go to E.5.3) 1.Yes [  ] 2.No [  ]

E.5.2 What if the price is **GHC 2.20 only** per side grafted cocoa tree? (No matter the answer, go to E5.4) 1.Yes [  ] 2.No [  ]

E.5.3 What if the price is **GHC 1 only** per side grafted cocoa tree? (No matter the answer, go to E.5.4) 1.Yes [  ] 2.No [  ]

E.5.4 What is the maximum amount that you are willing to pay for *side grafting* 1 cocoa tree? GHC\_\_\_\_\_

E.5.5 Are you willing to pay with cocoa beans if you are assisted financially? Yes [  ] No [  ]

#### B. Medium opening bid

E.5.1 If Yes to E.5, are you willing to pay **GHC 2.5 only** per side grafted cocoa tree? (if yes go to E.5.2 and if no go to E.5.3)

1.Yes [  ] 2.No [  ]

E.5.2 What if the price is **GHC3 only** per side grafted cocoa tree? (No matter the answer, go to E.5.4)

1.Yes [  ] 2.No [  ]

E.5.3 What if the price is **GHC 2 only** per side grafted cocoa tree? (No matter the answer, go to E.5.4)

1.Yes [  ] 2.No [  ]

E.5.4 What is the maximum amount that you are willing to pay per side grafted cocoa tree? GHC\_\_\_\_\_

E.5.5 Are you willing to pay with cocoa beans if you are assisted financially? Yes [  ] No [  ]

**C. High opening bid**

E.5.1 If Yes to E.5, are you willing to pay **GHC 3 only** per side grafted cocoa tree? (if yes go to E.5.2 and if no go to E.5.3)

1.Yes [ ]                      2.No [ ]

E.5.2 What if the price is **GHC 3.5 only** per side grafted cocoa tree? (No matter the answer, go to E.5.4)

1.Yes [ ]                      2.No [ ]

E.5.3 What if the price is **GHC 2.5 only** per side grafted cocoa tree? (No matter the answer, go to E.5.4)

1.Yes [ ]                      2.No [ ]

E.5.4 What is the maximum amount you are willing to pay per side grafted cocoa tree? GHC\_\_\_\_\_

E.5.5 Are you willing to pay with cocoa beans if you are assisted financially? Yes [ ]    No [ ]

E.5.6 Though you have opted to adopt the side grafting, what are your fears?

Possibility of failure [ ]    Seeds may not be viable [ ]    May require additional cost [ ]    Others (specify)  
.....

E.6 If **“No” to all bid levels**, what are your reasons? Lack of money [ ]    Government/other bodies should sponsor [ ]    Other (specify) .....

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**Thank you!**



**Part 2: glm**

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	<b>Number of obs = 150</b>	
<b>Deviance</b>	<b>= 146.7767981</b>	<b>(1/df) Deviance = 1.071363</b>
<b>Pearson</b>	<b>= 108.5139522</b>	<b>(1/df) Pearson = .7920726</b>
<b>Variance function: <math>V(u) = u^2</math></b>		<b>[Gamma]</b>
<b>Link function : <math>g(u) = \ln(u)</math></b>		<b>[Log]</b>
		<b>AIC = 4.128069</b>
<b>Log likelihood = -296.6051485</b>		<b>BIC = -539.6802</b>

Wtpamt	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Probit						
Educ	0.029563	0.026377	1.12	0.262	-0.02213	0.08126
Toha	-0.02745	0.046615	-0.59	0.556	-0.11882	0.06391
agefarmdum	0.298776	0.243925	1.22	0.221	-0.17931	0.776859
Yieldkg	0.000458	0.000898	0.51	0.61	-0.0013	0.002218
Gender	-0.06748	0.256248	-0.26	0.792	-0.56972	0.434759
memFBO	0.394642	0.228007	1.73	0.083	-0.05224	0.841527
Actocre	-0.03834	0.293508	-0.13	0.896	-0.6136	0.536929
Awareness	-0.25611	0.271391	-0.94	0.345	-0.78803	0.275803
Hhead	0.502754	0.296612	1.69	0.09	-0.0786	1.084103
Age	-0.01187	0.007954	-1.49	0.136	-0.02746	0.003718
Cocoinc	3.86E-05	6.68E-05	0.58	0.563	-9.2E-05	0.00017
Freqofext	0.108849	0.067894	1.6	0.109	-0.02422	0.241919
_cons	0.184306	0.54642	0.34	0.736	-0.88666	1.25527
Glm						
Educ	0.049105	0.025094	1.96	0.05	-7.8E-05	0.098287
Toha	-0.07923	0.038147	-2.08	0.038	-0.154	-0.00447
agefarmdum	0.403003	0.181954	2.21	0.027	0.046379	0.759627
Yieldkg	-0.00109	0.000597	-1.83	0.067	-0.00226	7.73E-05
Gender	0.042784	0.19661	0.22	0.828	-0.34256	0.428132
memFBO	-0.16257	0.169284	-0.96	0.337	-0.49436	0.169219
Actocre	-0.06757	0.221249	-0.31	0.76	-0.50121	0.36607
Awareness	0.462248	0.249674	1.85	0.064	-0.0271	0.951599
Hhead	0.525778	0.26382	1.99	0.046	0.0087	1.042856
Age	-0.00477	0.006151	-0.77	0.438	-0.01682	0.00729
Cocoinc	8.86E-05	5.21E-05	1.7	0.089	-1.3E-05	0.000191
Freqofext	0.102331	0.045891	2.23	0.026	0.012386	0.192277
_cons	0.309925	0.436429	0.71	0.478	-0.54546	1.165311

. mfx

### Marginal effects after tpm

$y = \text{tpm combined expected values (predict)}$

$= 1.7971327$

variable	dy/dx	Std. Err.	z	P>z	[ 95%	C.l. ]	X
Educ	0.113852	0.05102	2.23	0.026	0.013846	0.213859	8.52074
toha	-0.16617	0.08032	-2.07	0.039	-0.3236	-0.00874	3.27875
agefa~um*	1.11867	0.50591	2.21	0.027	0.127109	2.11023	0.235023
Yieldkg	-0.00157	0.00133	-1.18	0.24	-0.00417	0.001043	175.11
Gender*	0.019419	0.41081	0.05	0.962	-0.78576	0.824593	0.75576
memFBO*	0.02343	0.3471	0.07	0.946	-0.65687	0.703733	0.299539
Actocre*	-0.15023	0.44658	-0.34	0.737	-1.0255	0.725045	0.124424
awaren~s*	0.663229	0.68404	0.97	0.332	-0.67747	2.00392	0.129032
Hhead*	1.117901	0.34723	3.22	0.001	0.437342	1.79846	0.857143
Age	-0.01885	0.01302	-1.45	0.148	-0.04437	0.006677	51.7972
cocoinc	0.000193	0.00011	1.74	0.082	-2.5E-05	0.00041	2270.61
freqof~t	0.27818	0.10273	2.71	0.007	0.076836	0.479523	1.13825

(\*) dy/dx is for discrete change of dummy variable from 0 to 1