ISSN No:-2456-2165

The Correlational Evidence between Cocoa Farmers Compliance with Quality Control Measures and the Bean Quality of Cocoa

Felicia Adu-Berko[1,2*]; Simon C. Fialor[2]; Robert Aidoo[2]; Bright O. Asante[2]; Maxwell Boakye-Agyeman[3]
[1]Quality Control Company Limited, P. O. Box 204, Takoradi Port, Ghana.
[2]Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and Technology, Private Mail Bag, University Post Office, Kumasi, Ghana
[3]FIC, Accra, Ghana

Corresponding Author:- Felicia Adu-Berko[1,2*]

Abstract:- The goal of best practices, which often come under the purview of quality standards enhances efficiency and production. As effort to improve quality and food safety intensifies, compliance with quality standards has recently gained significant attention. The study evaluated how well cocoa farmers complied with quality control protocols for cocoa beans and how this affected the quality of the cocoa output. 400 cocoa farmers provided information via pre-tested standardized questionnaires. The survey data was fitted with an equation model for the compliance index. The study's findings showed that, male farmers were actively involved in cocoa farming than females. 260 farmers representing 65% were males. From the analysis, the pattern of significance regarding farmers' compliance with cocoa quality standards basically revolves around all the five quality control measures. The pattern brings to bear the specific quality control measures whose standards are highly complied with. The overall compliance level of the farmers was 0.75 (75%). This indicates a low compliance level. The total cocoa defects found in the cocoa of the sampled farmers showed that, all the cocoa had high purple and slaty beans which is an indication of poor fermentation. The average purity percentages for Ashanti and Western South were 71.3% and 62.7% respectively. Factors that influenced the cocoa farmers to comply with the quality standards were also considered. Key amongst them were extension services, government interventional support, access to labour, off-farm activities and occupational experience which positively and significantly influenced the farmers compliance. It is advised that the government make a sincere effort to spread extension information on cocoa quality requirements and government support for farmers in light of the study's findings.

Keywords:- *Compliance, Quality Standards, Output Quality, Cut Test Analysis, Determinants.*

I. INTRODUCTION

Cocoa is one of Ghana's highest exports commodities. It is a cash crop that has significant global economic importance (Krahmer *et. al*., 2015). Cocoa serves as the primary agricultural export product for a number of West African producers, including Cote d'Ivoire and Nigeria. Ghana ranks as the world's second-largest cocoa bean producer. Ghana saw a notable decline in cocoa production during the 1970s and 1980s, but regained its position as one of the world's leading producers over time. In terms of jobs and incomes, cocoa is quite important to the national economy. According to Breisinger *et. al.,* (2008), Ghana's socioeconomic development will continue to be dependent on export revenue from cocoa.

Cocoa beans with suitable quality must be consistently and reliably supplied to the global cocoa business. If the quality of the cocoa beans is low, customers will switch to alternative snack foods and the industry as a whole will suffer (CAOBISCO/ECA/FCC, 2015). Therefore, a healthy global cocoa economy depends on high-quality cocoa beans, as stated in the Global Cocoa Agenda. It has been widely acknowledged that post-harvest protocols and quality evaluation are necessary to increase cocoa quality. Sustainability in cocoa bean production and intensification are critical to the cocoa sector, according to Breisinger *et. al*., (2008). According to research by Gwynne-Jones (1974), enhancing and sustaining cocoa bean quality from the farmers' perspective entails a difficult task and takes a lot of time. The procedure entails setting up the farm, maintaining the plantation, harvesting, gathering the pods in one spot on the farm, opening the pods, removing the beans, fermenting, and drying the beans. The best cocoa beans can only be produced by adhering to procedures. Ghana was chosen as an illustrative country for the case study analysis because the bean quality of its cocoa was utilized as a benchmark to judge the quality standard of cocoa from other producing nations, which is both practically and significantly acceptable. Although the farmers have implemented quality control procedures, rigorous quality tests at the village level (at the depots) and Take-Over Centers of Ghana Cocoa Board identifies quite a number of quality infractions. The study therefore seeks to establish an empirical relationship between the farmer's compliance with the quality control measures and the quality of the bean through a very detailed methodology and comprehensive analysis.

This paper aims to evaluate the extent to which cocoa farmers adhere to quality control protocols for cocoa beans and the impact this has on adjusted quality output. A compliance index was created and regressed against the several variables that affect compliance. By creating a compliance index, the paper contributes to the body of literature. The quality control measures are given varying weights, which form the basis of the index. Because of this procedure's availability and capacity to generate a consistent numerical compliance value, researchers will be able to evaluate, compare, and understand the compliance of cocoa farmers in a range of contexts. The standardized value of compliance can be measured at regular periods, allowing organizations to track farmers' compliance development over time. Additionally, it will establish the framework for future investigations to ascertain Ghanaian cocoa farmers' compliance levels.

II. STUDY AREAS AND METHODOLOGY

The study was conducted in two of the seven (7) cocoa growing regions of Ghana. These regions are recognized as the primary producing areas of the nation, according to national statistics displayed in Figure 1 below. The percentage contribution of cocoa production by the two regions to the national production are 21.1 and 21.6 for Ashanti region and 26.2 and 26.3 for Western South region for the 2018/19 and 2019/20 crop years. This production statistics give credence to the selection of the two regions as the study areas.

$$n = \frac{N}{1 + Ne^2} \quad \text{.......................................1}$$

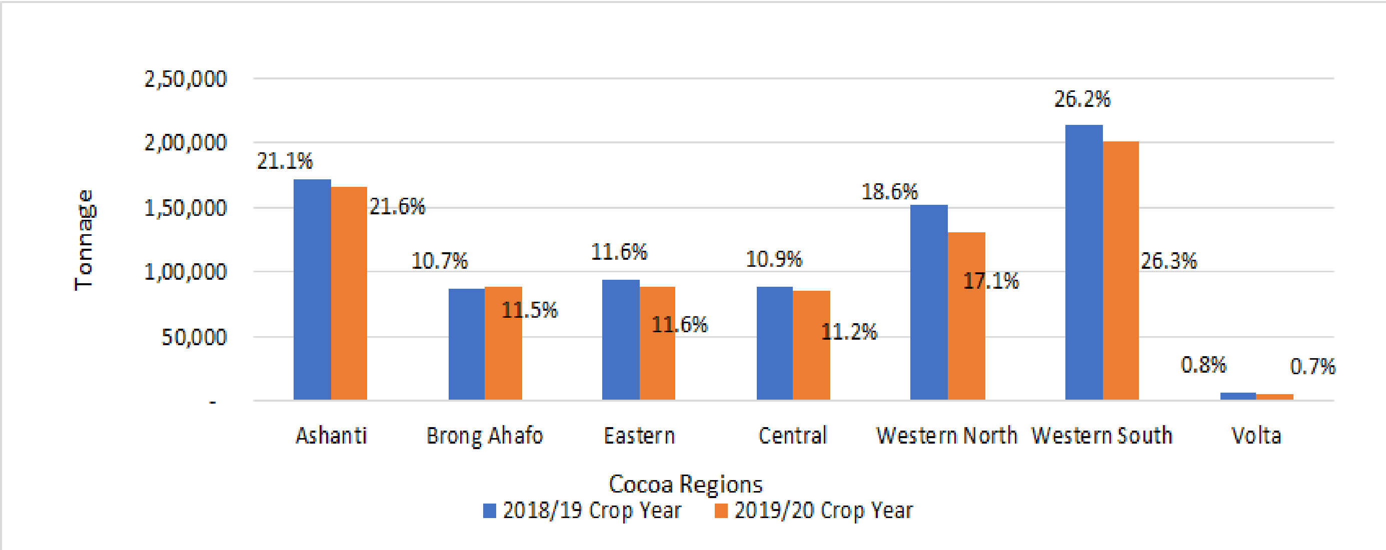

Fig 1 Cocoa Production in Ghana
Source: COCOBOD

The study employed a multistage sampling approach to choose participants for the investigation. In the first stage, the Ashanti and Western South cocoa regions were selected purposively. Additionally, in the second stage, the cocoa districts of Samreboi and Takoradi in the Western South Region and Offinso and Bekwai in the Ashanti Region were purposively picked. Based on the amount of cocoa produced in the areas, these districts were chosen. During the third phase, the District Cocoa Officer of the Ghana Cocoa Board's Cocoa Health and Extension Division assisted in enlisting cocoa-growing communities in each district. Communities were chosen through balloting in each district in a proportional and random manner. In the Samreboi district, the selected communities were Nwansema Camp, Amoaku, Ohiamatuo, Woman No Good and Nyameyekrom. For the Takoradi district, the selected communities were Ainyinase, Santaso, Sarpongkrom Asanta, Elubo and Ebi. In the Offinso district, the selected communities were Samposo, Koforidua, Kwamang and Amoawi whereas Pampaso, Patase, Danyase, Poano and Behenase were also selected in the Bekwai district. Figures 2 and 3 are the maps of the study area comprising of the chosen districts as well as the communities that are selected. The Ghana Cocoa Board's Cocoa Health and Extension Division's Community Extension Agents provided a list of the community's cocoa farmers for the fourth stage. Twenty (20) farmers were chosen at random by ballot in each community. The sample size was determined using the formula created by Yamane (1967) and adopted by Stephanie (2020).

Where: n is the sample size, N is the population, and e is the margin of error, which is taken to be 0.05 with a 95% confidence range.

$$n = \frac{75{,}199}{1 + (75{,}199)(0.05)^2} \quad n = 397.88 \quad n = 400$$

ISSN No:-2456-2165

Table 1 Selected Cocoa Districts and their Cocoa Farmers population

Region	District	Communities	Total farmers	Sampled Farmers
Ashanti	Offinso	4	15,039	80
	Bekwai	5	18,800	100
Western South	Samreboi	5	18,800	100
	Takoradi	6	22,560	120
Total	**4**	**20**	**75,199**	**400**

Source: CHED, 2022

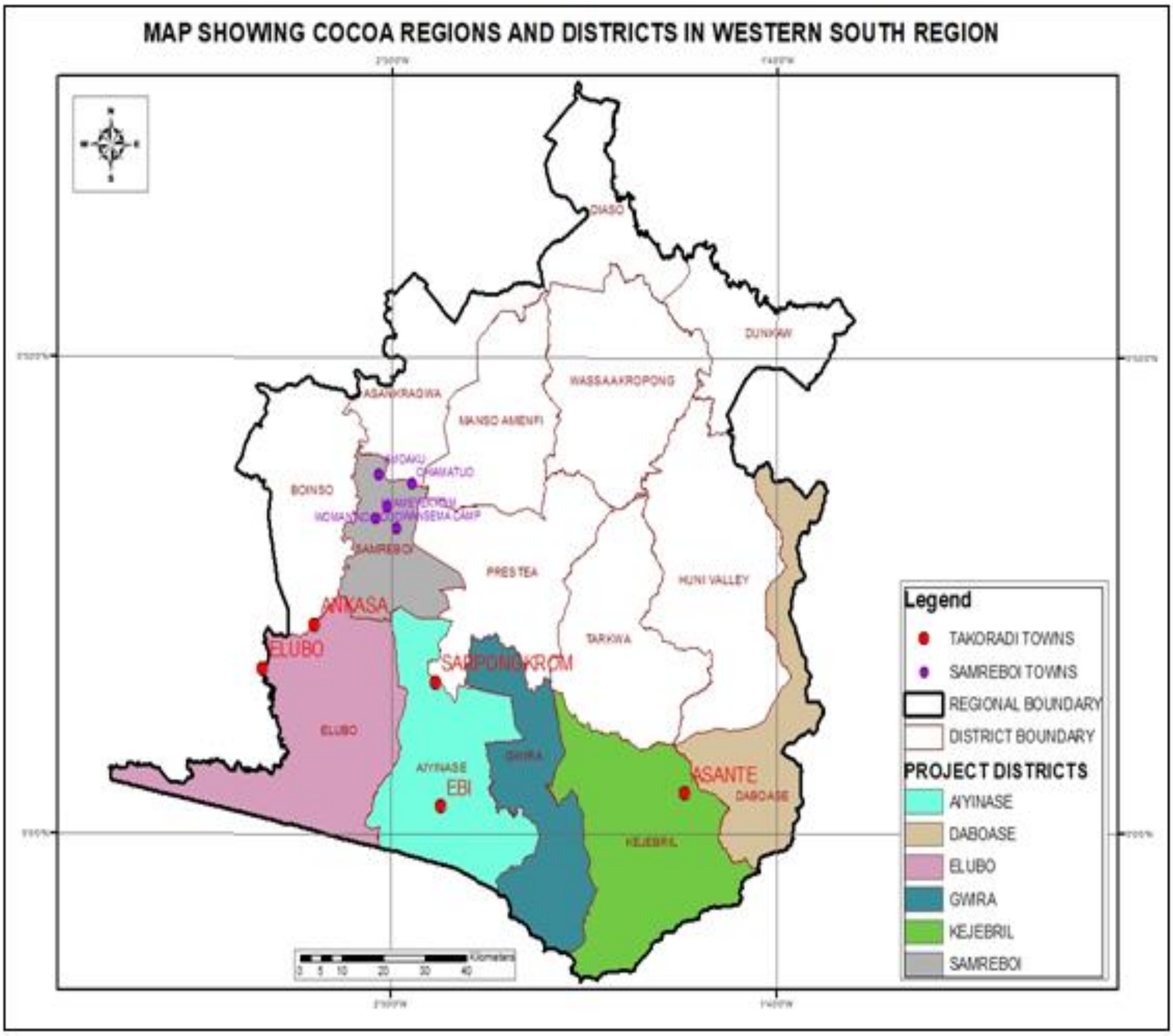

Fig 2 Map of Wester South Region, the Districts and Selected Communities

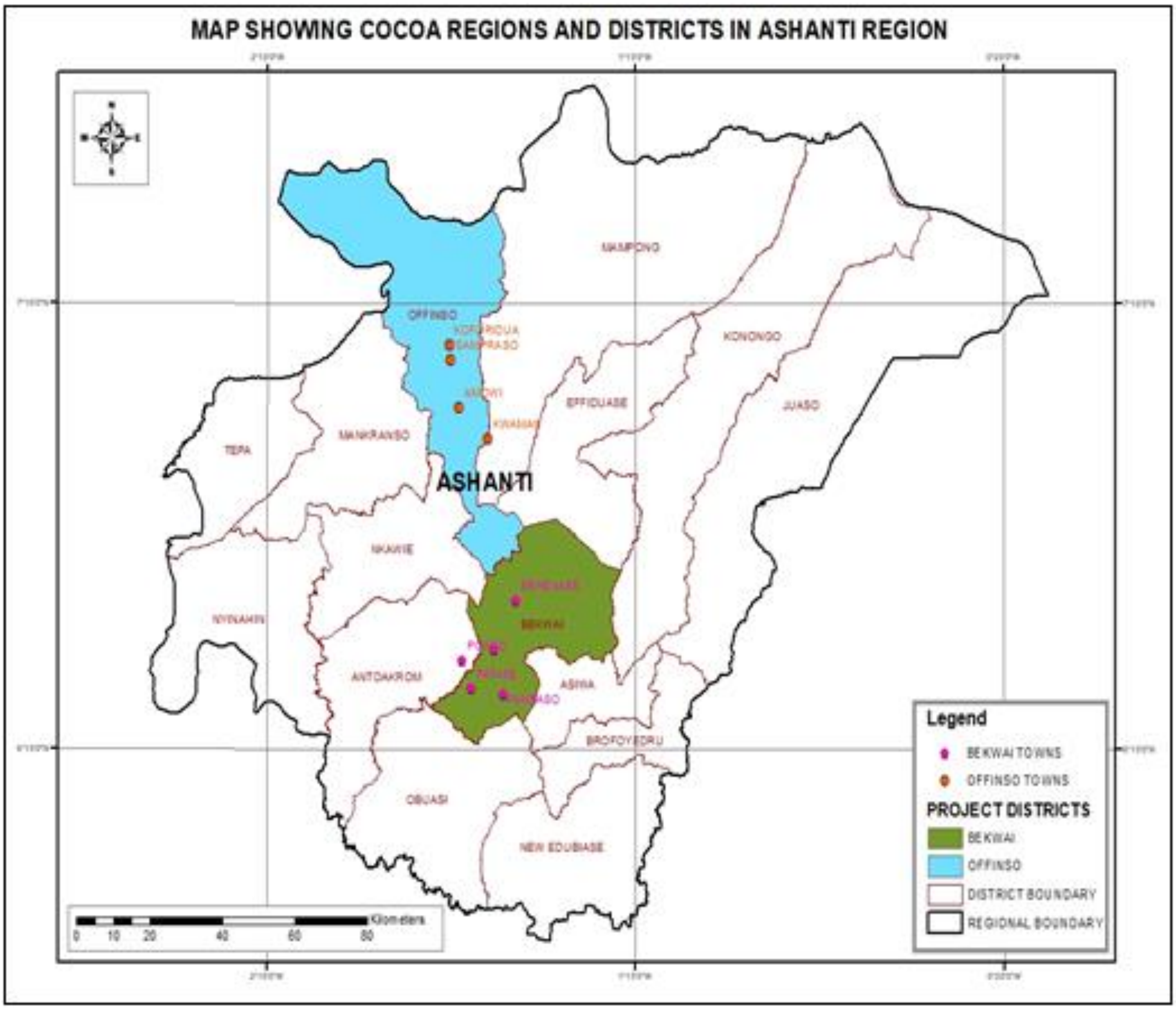

Fig 3 Map of Ashanti Region, Districts and Selected Communities

➢ *Data Sources and the Sampling Process*

A structured questionnaire was utilized to assist in the collection of primary data. As indicated in Table 1, data were gathered from 400 cocoa farmers in the two randomly chosen regions using a multistage sampling technique. Prior to the interview with respondents, a pre-test of the questionnaire was conducted in order to evaluate and obtain the data collection instrument. Data on socioeconomic characteristics, farmers' awareness of quality control procedures and standards, farmers' level of compliance with standards, and quality-adjusted output were all collected. A cut test analysis of individual farmers' cocoa was also used to determine the quality adjusted output. How compliance affected the quality adjusted output was evaluated.

III. THEORETICAL AND EMPIRICAL REVIEW

➢ *Compliance Index*

According to Okumah (2018), compliance refers to a condition when farmers adhere to all regulations that are relevant to their farms, taking into account the type, nature, and expected environmental effects of their agricultural activities. Compliance entails following rules and regulations. It is appropriate to use farmers' compliance with standards to illustrate how they decide to adopt new farming practices (Lin, 2016). This offers a thorough analysis of all the factors that affect a farmer's decision to adhere to agricultural standards (Annor, 2017). To assess farmers' compliance level, the implications of compliance with production standards must be pursued (Jongeneel, 2007). Thus, according to Jongeneel, (2007), a farmer who meets specified requirements does comply with standards.

Compliance with standards improve over time when production facilities are enhanced. Unsustainable agricultural production is frequently the result of a farmer's failure to adhere to good agricultural standards (Kassem *et. al.*, 2021). A good strategy for promoting sustainable agriculture is for farmers to comply with agricultural standards to the fullest extent possible (Nicetic *et. al.*, 2010). Compliance with good agricultural practices is one of the often-used quality control measures, according to Mushobozi (2010) and Holzapfel and Wollni (2014). Farmers' partial compliance with agricultural standards, according to Talukder *et. al*. (2017), can be due to their lack of knowledge and excessive reliance on their personal experiences.

A new method that uses computed values to assess conformity with standards has been adopted. The method is reliable for calculating compliance values with respect to any specified standards. When reviewing compliance-related data, the approach helps researchers to get comparable results and reliable conclusions (du-Preez and Pieterse, 2006). According to Pitaro (2015), compliance measurement must be highly successful. Eloff and Ellof (2005) stated that the usage of a numerical value can be used to illustrate compliance level. A compliance index expressed in the form of a number or a numerical value conveys an effective measurement approach (Metzenbaum, 2006).

The main advantage of employing the compliance index for evaluating compliance, according to DeGabriele, Peck, and Acker (2009), is that it enables the researcher to record a higher level of the extent of compliance. The degree to which mandatory standards are followed is indicated by the compliance index metric (Ramos *et. al*., 2006). One important consideration when developing a compliance index is its intended application. According to DeGabriele, Peck and Acker (2009), compliance index measures compliance on a scale. This assertion was corroborated by Shimshack (2009) who revealed that compliance index is numerical or count value. The main advantage of utilizing a compliance index to measure compliance, according to DeGabriele, Peck, and Acker (2009), is that it enables the researcher to better understand the scope of compliance. The degree of standard compliance is indicated by the compliance index metric (Ramos *et. al*., 2006). A compliance index's intended function will ultimately influence how it is created. DeGabriele, Peck, and Acker (2009) claimed that, the compliance index uses a scale to quantify compliance. Shimshack (2009), who discovered that the compliance index is a count value, supported this claim.

A variety of Likert scales have been employed in several research to facilitates the measure of compliance. Comparative analysis is made simpler by studies that employ Likert scale grading at each level of compliance (Motamed *et. al*., 2006; Reda *et. al*., 2009). Researchers can compare, assess, and interpret compliance in a range of scenarios because of the procedure's accessibility and ability to produce a standardized numerical compliance value.

The indicators (standards) are weighted in the computation of compliance to emphasize their influence on the compliance measure. Weights, according to Castoldi and Bechini (2010), describe the magnitude of potential effects and the various levels of significance of the indicators (standards). According to Ganti (2020), a weighted average takes into account the indicators' relative value in respect to the standards' frequency of occurrence. Thus, weights are more accurate and descriptive, according to Ganti (2020). A weighted average takes into account each item's relative contribution while calculating the average. It consequently gives greater weight to the average elements that occur relatively more frequently.

A study on the usage of personal protective equipment and adherence to safety protocols when spraying agrochemicals by cocoa producers in Cameroon was conducted by Oyekale (2018). The findings revealed that the average area of a cocoa farm was 2.82 hectares in the Center zone and 3.55 hectares in the South West region, with 89% and 42% of the farmers using insecticides in accordance with the manufacturer's recommendations.

Muriithi (2008) also undertook a study on compliance with standards on good agricultural practices. The aim of the study was to evaluate smallholder farmers' knowledge of excellent agricultural practices and identify the key variables affecting their adherence to them. The findings showed that the high costs of investment necessary for standard compliance were a significant barrier for smallholder farmers.

➢ *Cut Test Analysis*

Cocoa beans are graded for the market using the cut-test (CAOBISCO/ECA/FCC, 2015). ISO 2451: 2017 (E). explains the terminology and guidelines used to categorize cocoa beans. The cut test, which enables the identification of some severe flavor defects, serves as the foundation for the grade criteria. The International Standards Office (ISO) publishes the standards which are based on ISO-2451:2017 (E), which is the grading requirements of numerous nations that process cocoa. The most frequently used type of quality test for cocoa beans is the cut-test. It is predicated on a visual inspection of a sample of beans' cut surfaces and an estimation of the quantity of defective beans (Dand, 2010). The cut test analysis, which involves cutting the cocoa beans lengthwise and visually examining them, is used by international standards to assess the quality of cocoa beans. The approach outlined by Hii *et. al*., (2006), CAOBISCO/ECA/FCC (2015), QCC (2023), and Hamid and Lopex (2000) is used to execute the cut test. By using a penknife, a cut is made through the center lengthwise of the dried cocoa beans. Based on the colour of the beans' cross-section, the cotyledon, or half of each bean, is inspected in the light. Beans that are chipped, slate, mouldy, insect-damaged, flat, clamped, or clustered are all observed. The entire amount of slate, mouldy, and other defects in the beans is the total defective amount.

➢ *Bayesian Analysis*

A statistical method used to assess the strength and significance of relationships is correlational analysis. It is appropriate to do a correlational analysis solely to examine the association between variables; a causal relationship should not be inferred. The basic assumption of any correlational analysis is that there must be a linear relationship between the two variables. The scale used to quantify the correlation coefficient ranges from + 1 to – 1. The Bayesian approach is one alternative for estimating correlational variables.

Traditional hypothesis testing can be supplemented or replaced using Bayesian techniques to data analysis. Simple Bayesian analyses, as opposed to P-values, can give researchers a clear indication of the degree of evidence supporting and refuting a study hypothesis. This information can be useful in the interpretation and decision-making processes related to the results. According to Roshani *et. al*., (2012), Bayesian analysis explains the validity of a relationship between variables. It provides a thorough explanation of a conditional probability on the basis of a Posterior distribution. Based on a posterior distribution the correlational evidenced between two variables are determined. Prior probability information is revised using the Bayes theorem as new information becomes available. The information being conditioned upon is the additional information. The revised likelihood based on the new knowledge is known as the posterior probability, while the probability that existed before extra information became available is known as the prior probability. The probability that farmers' compliance with quality standards will enhance the quality of the bean is examined based on the posterior mean. The quality of the bean is conditioned on the farmers' compliance. The prior knowledge of the bean quality depends on the quality standards. However, the additional information on how the quality of the bean is enhanced depends on the farmers compliance with the quality standards.

➢ *Multiple Linear Regression*

Regression analysis is a statistical technique for determining the relationship between variables that have a cause-and-effect relationship. The statistical method uses multiple explanatory factors to predict a response variable's outcome. The multiple linear regression is an extension of linear (OLS) regression that uses a single explanatory variable (Uyanik, 2013). Highlighting further on this concept, Uyanik (2013) indicated that, to find the correlation between two or more variables that have a cause-and-effect connection, regression analysis is used. Multivariate or multiple linear regression models have more than one independent variable and one dependent variable (Buyukozturk, 2002). A multiple linear regression approach explains the variations of the independent factors in the dependent variable (Unver and Gamgam, 1999). The assumptions of linearity and normality form the basis of the multiple linear regression model. The relationship between the independent and dependent variables is linear (Buyukozturk, 2002). Regression analysis is use to ascertain how a dependent variable change in response to changes in one or more independent variables. Bevans (2020) explains that a multiple linear regression model can be used to investigate the strength of the association between one dependent variable and two or more independent variables given the value of the dependent variable at a particular value of the independent variables.

According to Ramos *et. al*., (2006), compliance index measures the extent to which required standards are complied with. DeGabriele, Peck and Acker (2009) showed that compliance index could measure compliance on a scale. This assertion by DeGabriele, Peck and Acker (2009) was corroborated by Shimshack (2009). Shimshack (2009), revealed that compliance index is numerical or count values. According to Eguez (2020) the existence and estimation of a compliance index makes the observations of a dependent compliance variable continuous and not dichotomous. For a continuous dependent variable for compliance amidst several independent variables, the adopted model is multiple linear regression model for compliance and is estimated using Ordinary Least Squared (OLS).

Eguez (2020) carried out an empirical investigation to determine the degree to which environmental regulations and income affect European member states' adherence to waste management requirements. The survey was carried out in 26 nations that are members of the EU. A continuous dependent variable led to the development of the compliance index model. Regression analysis was used to examine compliance in relation to income, environmental regulatory enforcement, and other variables. Compliance was positively impacted by environmental regulations' strictness and enforcement.

➢ *Determinants of Compliance*

- *Farm Size*

The output from a farm will increase with the number of hectares it has, especially if it is provided the desired agronomic management practices (Karugia *et. al*., 2006). Farmers with higher yields are more likely than those with lower yields to adhere to standards (Kassem *et. al*., 2008). This means, according to Snider *et. al*., (2016), that farmers are encouraged to adhere to regulations and good agricultural practices when a greater yield translates into increased farm income. Empirical research by Schoneveld *et. al*., (2019) shows a positive relationship between compliance and the size of a large farm. Therefore, it is anticipated that farm size will have a favorable impact on compliance. The farmers' desire to adhere to agricultural standards increases when a larger yield from a vast amount of land translates into revenue.

- *Occupational Experience*

A farmer who has been farming for a longer period of time tends to have more agricultural experience, according to Benaim *et. al*., (2004). They indicated that, farmers with higher experience appear to be more productive than farmers with inadequate farming experience because they have better managerial skills from experience. In addition, Benaim *et. al*., (2004) claimed that farmers with lack of farming experience might not be able to swiftly comply with regulations and implement certain agronomic methods given the relevance of land, labor, and capital in farm output. It is anticipated that a farmer's professional experience will positively impact their degree of compliance. In research on the impact of anxiety on farmers' compliance, Marwanti (2020) found that occupational experience had a positive relationship with farmers' compliance levels.

- *Educational Level*

The farmers' ability to innovate as well as learn about and apply agricultural standards is enhanced by their education level. Agricultural standards adoption and compliance, as well as the use of current farming technologies, depend on the farmer's education and farming experience (Ahmed *et. al*., 2002). According to Chambers and Leach (1989), agricultural development in many developing countries now fully acknowledges the importance of taking the educational level of farmers into account. Formal education is one of the main capacity variables that Prokopy *et. al*., (2008) and Baumgart-Getz *et. al*., (2012) believe to be crucial in influencing farmers' behavior. Higher levels of formal education among farmers are associated with higher levels of compliance, according to the estimated parameter of the education variable in a study by Marwanti (2020). The results of Marwanti (2020) support those of Cowell (2006), Ganpat *et. al*., (2014), Pongvinyoo *et. al*., (2014) and Pandit *et. al*., (2017). Those with more years of schooling have greater levels of awareness and understanding, which increases their compliance.

- *Extension*

Agricultural extension services are designed to help farmers become more knowledgeable about best practices and to change their adverse opinions about agricultural advancements. In order to generate knowledge about agricultural technologies, extension and training play a critical role (Scherr, 1992). Through extension contact, farmers gain fresh perspectives and improve their administrative abilities. Information access improves farmers' understanding of current management approaches and their ability to evaluate them (Lambrecht *et. al*., 2014 and Prokopy *et. al*., 2008). Based on their requirements and past experiences, this in turn affects farmers' opinions about the techniques.

- *Household Size*

Although a bigger family size places more strain on farm income for food and clothes, it does ensure that there is enough family labor to complete farming tasks on schedule. It is impossible to emphasize the influence that household size has on farmers' compliance in this regard. Since many households cannot afford to pay wage laborers, families still provide the majority of farm labor in many developing nations (Marenya *et. al*., 2007). A large household should contribute more labor to the economy. According to an empirical study by Muriithi (2008), home size had a favorable impact on standard compliance. Marwanti (2020) contends that despite what an insignificant estimated parameter between household size and compliance suggests, the size of the family does not significantly affect compliance. Therefore, it is possible to anticipate that household size will either positively or negatively impact the farmer's compliance level.

- *Access to Labour*

Labor is an important component of many, if not most, agricultural enterprises (Paggi *et. al*., 2013). According to Adewoye (2008), there is greater reliance on human labour in carrying out many farm operations in several developing countries. The application of different farm management techniques is hampered by the insufficient workforce on the farm (Kamau et al., 2018). Labor availability is a critical productivity element determining effective farm management methods, according to research by Ebanyat *et. al*., (2010). Higher economic motivation farmers are able to hire labor and are more likely to adhere to agricultural standards than lower economic motivation farmers (Parikhani *et. al*., 2015). Therefore, it is anticipated that having access to labor will have a good impact on farmers' compliance levels.

- *Gender*

Given how labor-intensive and difficult farming is, the contribution of male work can be highlighted. According to this theory, homes with more male labor are more effective than households with less male labor (Tesfay *et. al*., 2005). According to Muriithi's (2008) empirical investigation, gender had a beneficial impact on compliance. As expected, the farmers' level of compliance will positively correlate with their gender.

- *Age of Cocoa Farm*

Cocoa yields decline when trees age (Breisinger *et. al*., 2007). Bloomberg (2012) states that aging tree stocks represent a significant issue. According to the World Bank (2011), aging tree stocks are one of the main causes of falling agriculture output. For Ghanaian households that grow cocoa, low productivity means low income.

Retaining cocoa trees beyond their commercially viable life is thought to be one of the main causes of declining cocoa yields, according to Asare and David (2010). It is anticipated that the age of the cocoa tree will have a detrimental effect on the farmers' degree of compliance.

- *Off-Farm Activities*

Dethier and Effenberger (2012) and Minten and Barrett (2008) both assert that most low-income households in developing nations get their food, income, and means of sustenance from agriculture. Off-farm activities boost agricultural output, especially in underdeveloped nations where farmers face financing restrictions, claims Daidone (2010). Agricultural technology that increases production, such as improved seed, fertilizer and machinery can be purchased by farmers through their off-farm operations and also hire labour (Stampini and Davis 2009). Farmers who work off-farm also develop their own insurance. Bojnec and Ferto (2013) and Babatunde (2013) found that off-farm income had a considerable favorable impact on farm productivity. Participating in off-farm activities can potentially have a negative impact on farming activity, according to Chang and Wen (2011) and Kilic *et. al*., (2009). They asserted that farmers may pay less attention to farming operations and allocate more family time and effort to off-farm pursuits if the revenue from these pursuits is more alluring than from farming. Research has shown that farmers who engage in non-farm activities earn extra money, which boosts their productivity and allows them to implement high agricultural standards (Ahmed, 2018). Consequently, it is possible to anticipate that off-farm activities may either positively or negatively impact farmers' compliance level.

- *Government interventional support*

Over 50% of Ghana's labor force is employed in agriculture, primarily as smallholders who work their own land alongside their families. Government assistance is necessary for sustainable cocoa production (Laven and Boomsma, 2012). The hand pollination program, which is still continuing strong and increasing yields, fertilizer subsidies, and the technical assistance of extension agents are examples of government interventional support in the sector.

A considerable rise in cocoa production was found by Maurice (2012) in his empirical study on the effects of government assistance in the cocoa sector. Given that increased output translates into increased farmer income, it is reasonable to assume that government interventional support will have a favorable impact on farmers' compliance levels.

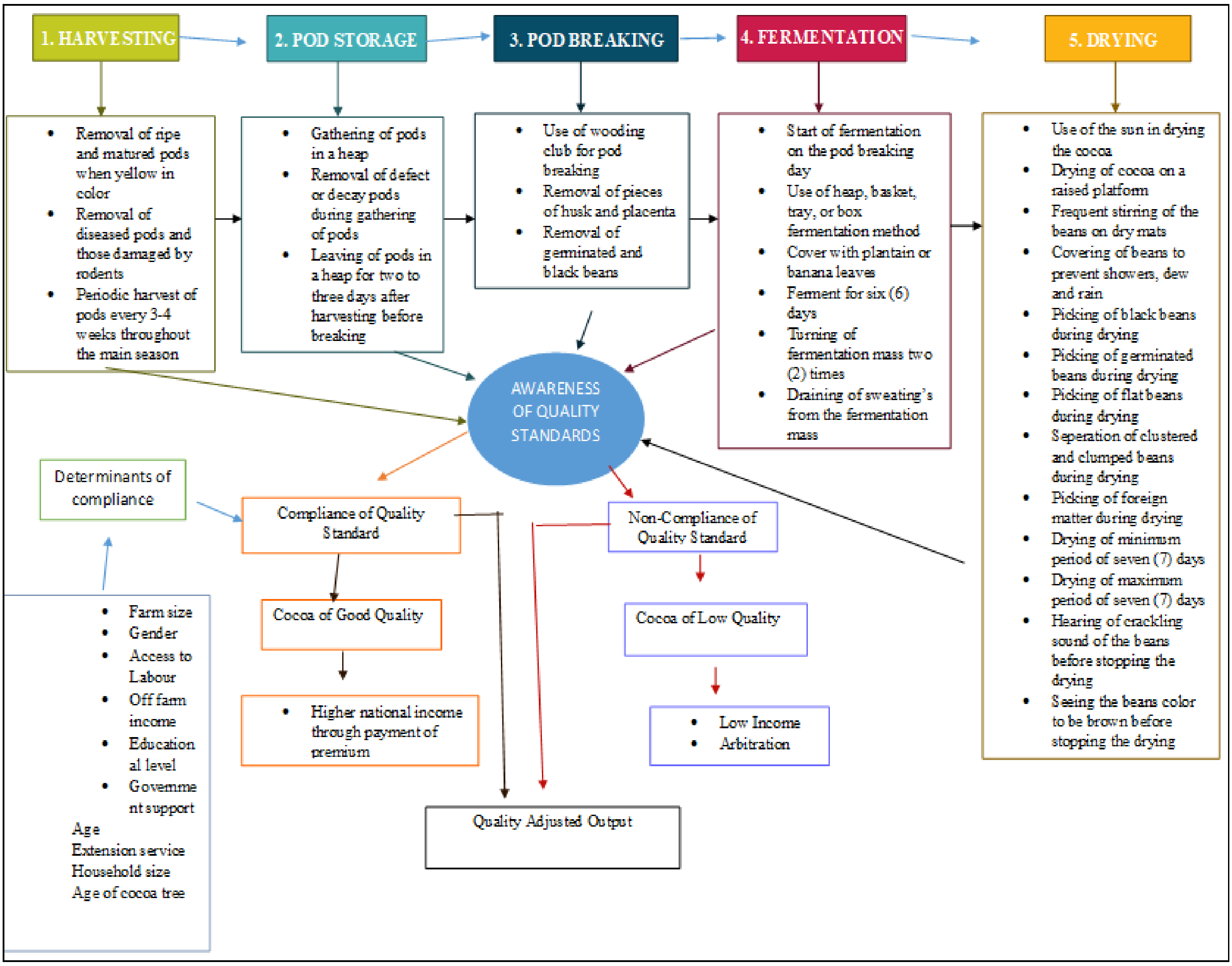

Fig 4 Conceptual Framework of Compliance with Quality Control Measures and the Determinants of Compliance

The study's conceptual framework is shown in Figure 4. The quality control standards are five indicators, namely; harvesting, pod storage, pod breaking, fermentation and drying. There are specific protocols to be complied under each of the five quality indicators as detailed in Figure 4. Complying with or not complying with the standards will be determined by awareness. The quality indicators' pattern of significance is established by farmers' adherence to quality standards analysis. The depiction of a systematic pattern of the quality indicators (from harvesting through to drying) reflects what the farmer does in connection with the ideal practices which necessitate the bean quality. From the analysis, the pattern of significance regarding farmers' compliance with cocoa quality standards basically revolves around all the five quality control measures. Farmers' compliance with the quality control standards are influenced by farm size, occupational experience, educational level, extension service, household size, age of cocoa tree, gender, access to labour, off-farm activities and government interventional support.

- *Analytical Framework*

According to Miller *et. al.*, (2006), it has been established empirically that, the quality of a cocoa bean is done by the farmer. This is an indication that, the farmer is responsible for the bean quality of cocoa. This testament corroborates with the chocolate and cocoa bean quality requirements by ISO. 2451 (2017) and CAOBISCO/ECA/FCC, (2015). The reports indicate that, the quality regime for cocoa is embedded at the farmer level. The farmer uses a thorough and exhaustive method to determine the cocoa bean's quality. The process is systematic and thorough. Thus, the farmer starts with the harvesting and finishes with drying the cocoa bean. The farmer must first follow the guidelines for harvesting quality indicators and then adhere to the drying requirements in order to acquire the cocoa bean's quality. The percentage of farmers who met the requirements for each quality indicator was calculated using a 5-point Likert scale.

To ascertain the farmers' degree of compliance with the quality control procedures, the compliance index equation, which was adopted by Kotz & Johnson (1981), du-Preez and Pieterse (2006), and Eguez (2021), was utilized.

- *Compliance Index Equation is given below as;*

$$cq = \frac{x}{y} \quad \text{.......2}$$

$$CINDEX = \sum_{i=1}^{n} X_i W_i / m \quad \text{.......3}$$

$$\bar{X} = \sum_{i=1}^{n} X_i W_i / \sum_{i=1}^{n} W_i \quad \text{.......4}$$

$$CINDEX = \frac{1}{\sum w} \sum_{i=1}^{n} X_i W_i \quad \text{.......5}$$

$$\sum_{i=1}^{n} X_i W_i = W_1(X_1) + W_2(X_2) + W_3(X_3) + W_K(X_K) / W_1. + W_2. + W_3. + W_K \quad \text{.......6}$$

$$CINDEX = W_1(X_1) + W_2(X_2) + W_3(X_3) + W_K(X_K) / W_1. + W_2 + W_3 + W_4 \quad \text{.......7}$$

- ✓ CINDEX: Represents the compliance index
- ✓ cq: Compliance to each question
- ✓ x: Represents the response rating selected by the farmer
- ✓ y: The maximum possible rating
- ✓ W: corresponding weights of each quality indicator. The weighted mean is defined as the total number of sub-standards within a standard per the total number of sub-standards for all the quality control measures. The construction of the weights as adopted by du-Preez and Pieterse (2006) and Skrondal, (2010).
- ✓ $\bar{x}$: Weighted compliance factor

- *Measurement of Quality Adjusted Output*

The quality adjusted output was measured by the multiplication of the farmer's total cocoa output (bags) by the percentage purity. The percentage purity value for each cocoa farmer was obtained through a cut test analysis. A visual inspection of a sample of beans' cut surfaces served as the basis for the cut test analysis, and the quantity of defective beans was counted. The cut test was conducted using the methodology outlined in the following sources: QCC (2023), Hamid and Lopex (2000), Hii *et. al.*, (2006), CAOBISCO/ECA/FCC (2015), and Cocoa Industry Regulation (1989). A sample of the dried cocoa beans was taken from each farmer. The cocoa was spread evenly on the dry mat as thinly as possible so that the depth does not at any point exceed 10cm (4 inches). The sample was hand drawn at random from the heap. For each handful taken from the surface of the heap, a handful was taken from below the surface. It was ensured that, sufficient representative samples are drawn from the parcel concerned.

To create a composite sample of 900 beans, the samples from each farmer were carefully combined and then "quartered." For each bag, 100 beans were cut, and for multiple bags, 300 beans. A penknife was used to cut the beans lengthwise through the middle. In the light of day, the cotyledon (half of each bean), was inspected based on the color of the bean cross-section. Observations were made regarding mouldy beans, slate, purple, beans damaged by insects, flat, clamped, or clustered beans, as well as chipped beans. Each kind and quantity of defective bean was counted independently. As shown below, the percentage of each defective bean was noted.

$$\%Mouldybeans(M) = \frac{Number of mouldy beans}{Total number of beans cut} * 100 \quad \text{......8}$$

$$\%Slatybeans(S) = \frac{Number of slaty beans}{Total number of beans cut} * 100 \quad \text{......9}$$

$$\%Germinated(G) = \frac{Total number of germinated beans}{Total number of beans cut} * 100 \quad \text{....10}$$

$$\%Weevil(W) = \frac{Total number of weevily beans}{Total number of beans cut} * 100 \quad \text{.....11}$$

$$\%Purplebeans(P) = \frac{Total number of purple beans}{Total number of beans cut} * 100 \quad \text{......12}$$

$$\%OtherDefects(OD) = \frac{Total number of other defects}{Total number of beans cut} * 100 \quad \text{......13}$$

$$\%AllOtherDefects(AOD) = \%G + \%W + \%P + \%OD \quad \text{.............}14$$

The total defective percentage were estimated. Base on the total cocoa defects for the various farmers, the percentage purity and the quality adjusted output were estimated.

$$\%Purity(P) = 100 - [M + S + AOD] \quad \text{.................}15$$

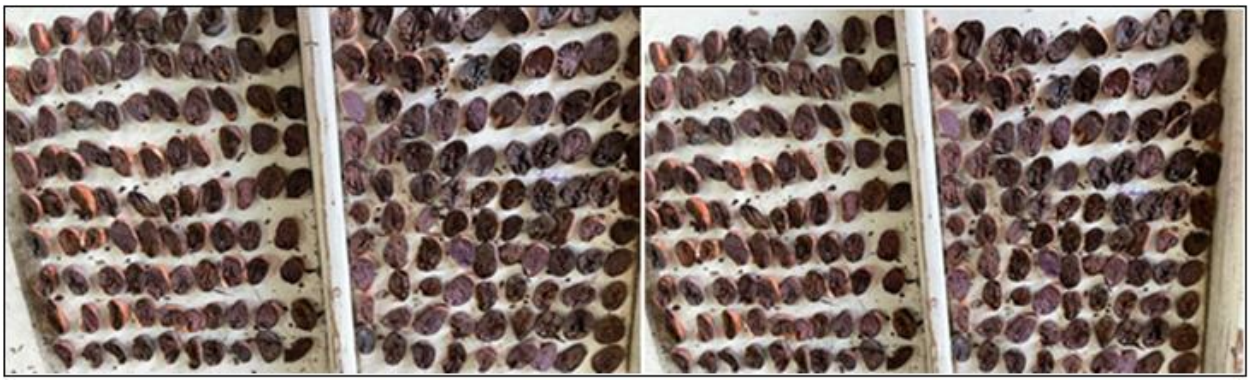

Plate 1: Cut Surface of Cocoa for the Cut Test Analysis

- *The Evidence of Correlation between Compliance and Cocoa Bean Quality.*

According to Roshani *et. al*., (2012), Bayesian analysis explains the validity of a relationship between variables. It provides a thorough explanation of a conditional probability on the basis of a Posterior distribution. Based on a posterior distribution the correlational evidenced between two variables (compliance and adjusted quality output) were determined.

- *The Study Employed a Bayes' Theorem Formula*

$$f(y, x) \quad \text{...}16$$

- *The Conditional Distribution of y given x*

$$fy / x = fx, y(x, y) / fx(x) \quad \text{.........................}17$$

$$p(y / x) = p(y \cap x) / p(x) \quad \text{.................}18$$

$$p(y / x) = p(y).p(x / y) / p(x) \quad \text{.................}19$$

$$r_{yx} \quad \text{..}20$$

$$r = (x - \bar{x})(y - \bar{y}) / \sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2} \quad \text{.................}21$$

Where:

- ✓ Y is the Adjusted cocoa quality output
- ✓ X is the compliance levels of farmers
- ✓ r is the correlation

- *Determinants of Compliance*

Multiple linear regression model for compliance as adopted by Eguez (2020) was employed for the study.

$$C = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \mu \quad .22$$

Where:

- ✓ Compliance is represented by the dependent variable C.
- ✓ C= Compliance, was measured by the farmer's level of compliance (given by the compliance index equation for each farmer)
- ✓ X_1 = Farm size, was measured in hectares
- ✓ X_2=Occupational experience, was measured by the farmers years in cocoa farming.
- ✓ X_3=Education level, was measured by the level of formal education the farmer has
- ✓ X_4=Extension service, was measured by the number of times a farmer attends training programs on quality control measures by an extension officer.
- ✓ X5= Household size was determined by counting the number of individuals who live with the farmer and are involved in the production process.
- ✓ X_6= Age of the cocoa tree, was measured by the years span of the cocoa tree on the farm.
- ✓ X7 = Gender was determined using a dummy variable that indicate 0 otherwise and 1 if the farmer is a man.
- ✓ X8= Access to Labor was determined by the number of workers a farmer could hire to help out on the farm.
- ✓ X_9= Off-farm activities, was measured by the number of other incomes generating venture undertaken by the farmer
- ✓ X10 = Government interventional support was calculated by counting the number of times in which the government provided assistance to the farmer (e.g., free fertilizer distribution and pesticide delivery).

IV. RESULTS AND DISCUSSION

Table 2 Descriptive Statistics

Variable	Description	%	
		Wester South Region	**Ashanti Region**
Age group	< 36 years	26.4	15.6
	36-50 years	45.5	26.1
	51-60 years	17.7	22.8
	> 60 years	10.5	35.6
Educational Level	No formal education	42.3	20
	Basic Education	44.1	63.9
	Secondary Education	10.5	11.7
	Tertiary	3.2	4.4
Gender	Male	70	59.4
	Female	30	40.6
Marital Status	Married	84.5	68.9
	Single	8.2	6.1
	Widow	3.2	12.8
	Divorce	4.1	12.2

Source: Field Survey, 2022

According to Table 2's data, 45.5% of the respondents were in the 36–50 age range, which is considered an active age group. The fact that most farmers were in the active age range is indicative of this. Basic education was held by 53% of the farmers in the sample. More male farmers than female farmers actively cultivated cocoa, and 79.3% of farmers overall were married.

Table 3 findings indicate that farmers with secondary occupations engaged in an average of one off-farm activity. The average number of times farmers in the Western South Region received government support was **3** times in a year. Farmers in the Ashanti Region received government support averagely once every year. The result further indicates that, on the average, the number of times farmers in both regions access extension service was 5 times in year. The average cocoa output of the farmers as shown in Table 3 was 7.3 bags (thus 64kg per bag) per hectare. Farmers in the Ashanti Region and Western Region had average farm sizes of 2.15 hectares and 2.94 hectares, respectively, according to the results of the study. The record on the access to labour was approximately 11 on the average.

Table 3 Descriptive Statistics

Variable	Description	Western South Region	Ashanti Region
		Mean (SD)	**Mean (SD)**
Household Size	Number of dependents in household	6 (3.52)	6 (3.73)
Educational Level	Years of formal education	5 (4.97)	8 (4.83)
Off-farm activities	Number of other incomes generating ventures undertaken by the farmer	1.14 (0.43)	1.32 (0.61)
Government Interventional Support	Number of times the farmers receive input support from government	3 (1.581)	1 (0.971)
Farm Size	ha	2.94 (2.36)	2.15 (1.45)
Access to Labour	Number of people that works for the farmer	11.76 (7.65)	9.64 (7.87)
Age of cocoa farm	Years	16.11 (9.21)	18.79 (9.41)
Extension Service	**N**umber of times a farmer attends training	4 (1.29)	6(2.84)
Occupational Experience	Years of cocoa farming	16.11 (8.89)	18.78 (9.41)
Output	64 kg bag/ha	8.88 (7.47)	5.30 (5.20)

Source: Field Survey,2022

Because Ghana Cocoa Board provided farmers with extension service training, the study aimed to investigate the farmers' awareness of quality control standards. For harvesting standards, results in the Figure 5 below indicate that, the farmers were not oblivious to the harvesting standards. With the exception of the few farmers representing 0.5% who were not aware of the harvesting of pods every 3-4 weeks, all the sampled farmers were aware of the harvesting standards.

For pod storage standards, significant number of the farmers were aware of the standards except for the few farmers representing 15.2% who were not aware that pods must be left in a heap after harvesting for 2-3 days before pod breaking. This is seen in Figure 6.

For pod breaking standards, majority of the farmers were aware with most of the pod breaking standards except for the use of wooden club for pod breaking. Majority of the farmers representing 76.5 % were not aware of the use of wooden club as the ideal pod breaking equipment as indicated in Figure. 7.

All the farmers were aware of the fermentation standards as specified in Figure 8.

The drying standards were known to the farmers. However, as shown in Figure 9, 14.5% of farmers did not know that the lowest drying standards were seven days, and 15.7% of farmers did not know that the maximum drying standards were fourteen days. Opoku (2019) asserts that a knowledgeable farmer will produce pure cocoa beans with the best possible flavor and appearance. However, variations in bean quality may occur as a result of the farmer's adoption of the knowledge garnered from the training on good agronomic practices and cocoa quality standards.

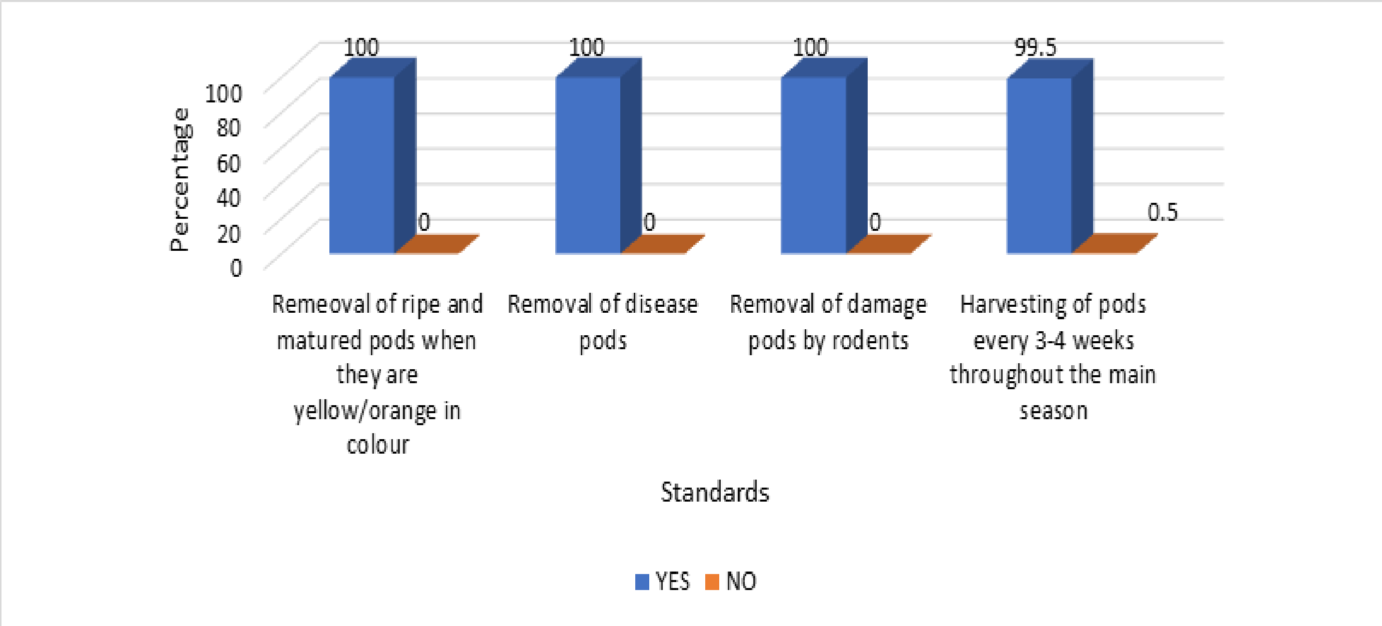

Fig 5 Farmer’s Awareness of Harvesting Standards
Source: Field Survey, 2022

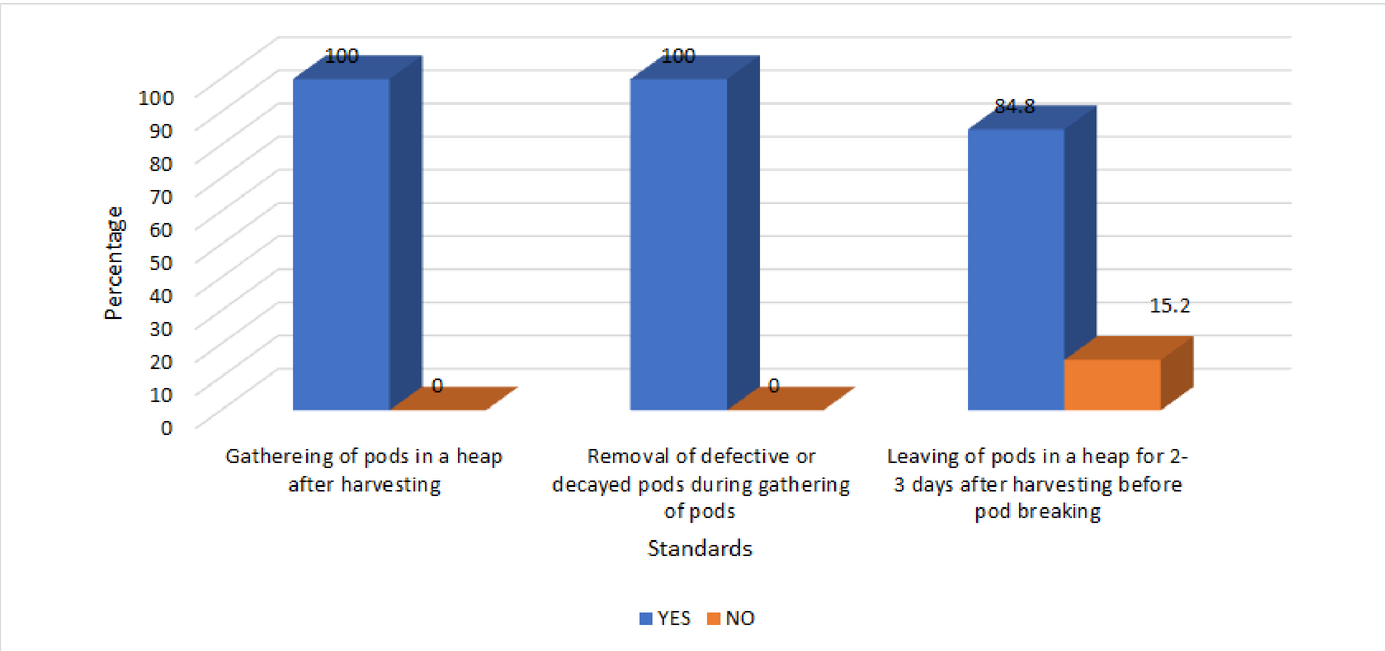

Fig 6 Farmer's Awareness of Pod Storage Standards
Source: Field Survey, 2022

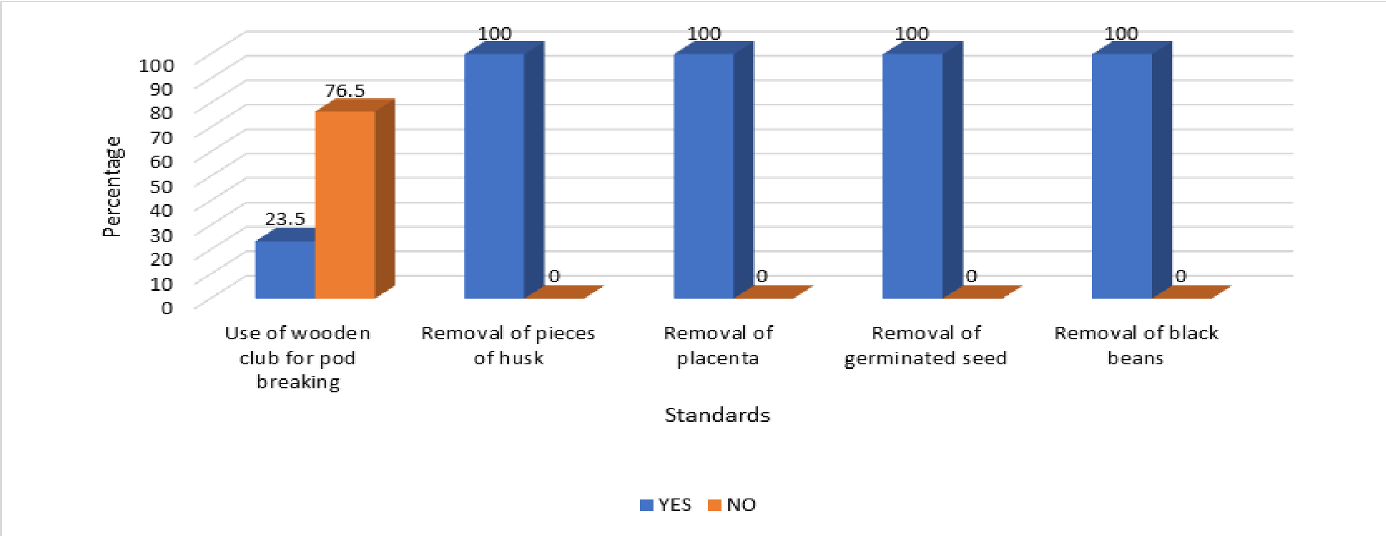

Fig 7 Farmer's Awareness of Pod Breaking Standards
Source: Field Survey, 2022

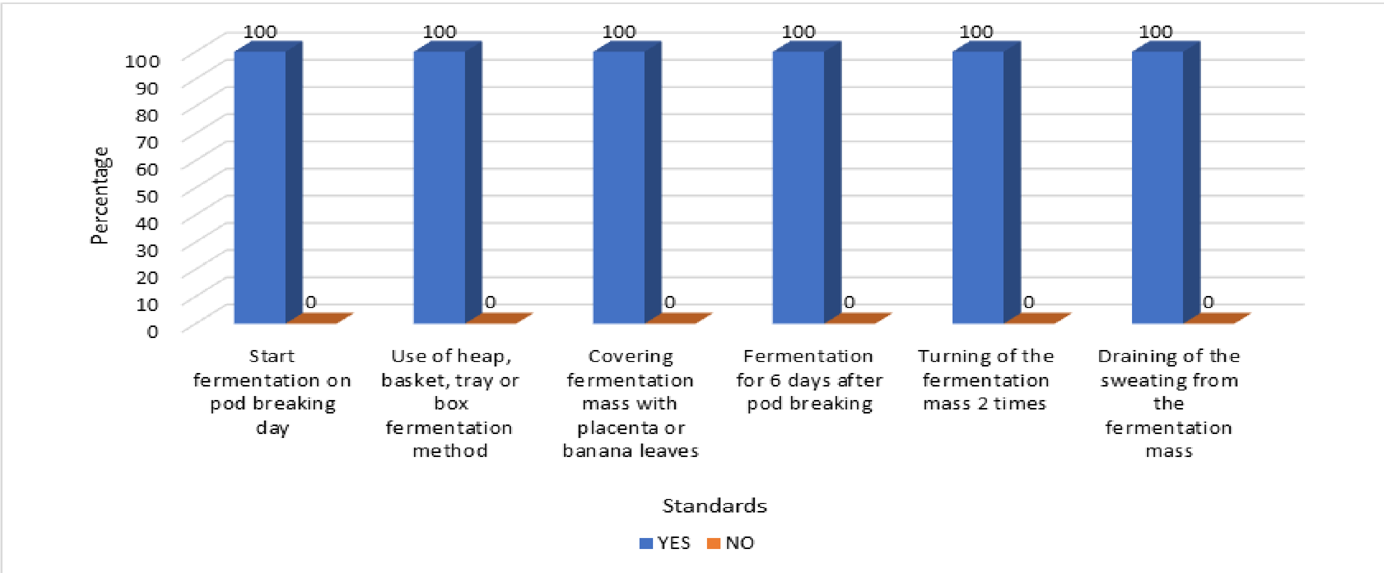

Fig 8 Farmer's Awareness of Fermentation Standards
Source: Field Survey, 2022

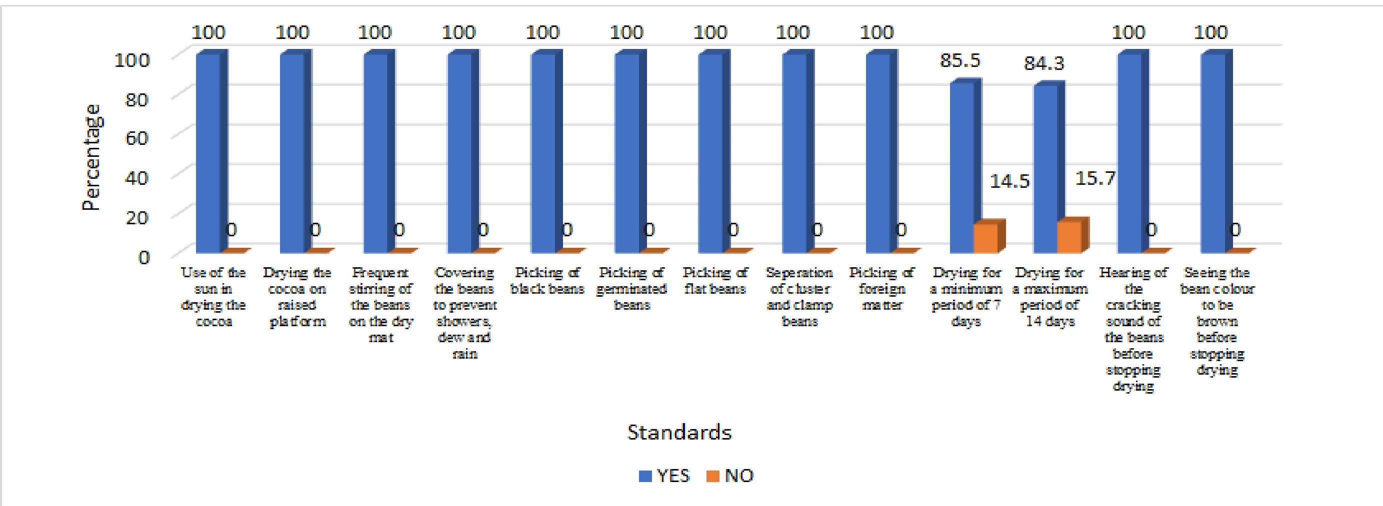

Fig 9 Farmer's Awareness of Drying Standards
Source: Field Survey,2022

Table 4 Farmer's Level of Compliance

Cocoa bean quality control measures/standards	**Western South**	**Ashanti**	**Significant Test using Anova**	
			F-value	**P-value**
Harvesting				
Removal of ripe and matured pods when they are yellow/orange in colour.	0.93	0.92		
Removal of diseased pods	0.51	0.56		
Removal of damaged pods by rodents	0.66	0.72		
Harvesting of pods every 3-4 weeks throughout the main season	0.56	0.60		
Overall compliance for harvesting	**0.66**	**0.70**		
Between Standards			15.277	0.0108***
Between Regions			0.1934	0.6828
Pod Storage				
Gathering of pods in a heap after harvest	0.99	0.92		
Removal of defective or decayed pods during gathering of pods	0.73	0.72		
Leaving of pods in a heap for 2-3 days after harvesting before pod breaking	0.72	0.88		
Overall compliance for pod storage	**0.81**	**0.84**		
Between Standards			3.8495	0.1487
Between Regions			0.2700	0.6392
Pod breaking				
Use of wooden club for pod breaking	0.23	0.40		
Removal of pieces of husk	0.74	0.71		
Removal of placenta	0.51	0.71		
Removal of germinated beans	0.74	0.72		
Removal of black beans	0.75	0.72		
Overall compliance for pod breaking	**0.59**	**0.65**		
Between standards			9.318	0.0143***
Between regions			1.805	0.2368
Fermentation				
Start fermentation on the pod breaking day	0.96	0.93		
Use of heap, basket, tray or box fermentation method	0.63	0.57		
Covering fermentation mass with plantain or banana leaves	0.75	0.87		
Fermentation for 6 days after pod breaking	0.46	0.51		
Turning of the fermentation mass two (2) times	0.76	0.88		
Draining of the sweatings from the fermentation mass	0.99	0.94		
Overall compliance for fermentation	**0.76**	**0.78**		
Between standards			21.289	0.0008***
Between regions			0.7889	0.4086
Drying				
Use of the sun in drying the cocoa	1	1		
Drying the cocoa on a raised platform	1	1		
Frequent stirring of the beans on the dry mat	0.89	0.93		
Covering the beans to prevent showers, dew and rain	1	1		
Picking of black beans	0.79	0.81		
Picking of germinated beans	0.69	0.71		
Picking of flat beans	0.79	0.81		
Separation of cluster and clump beans	0.70	0.81		
Picking of foreign matter	0.80	0.83		
Drying for a minimum period of seven (7) days	0.68	0.74		
Drying for a maximum of fourteen (14) days	0.53	0.58		
Hearing of the cracking sound of the beans before stopping drying	0.89	0.99		
Seeing the bean colour to be brown before stopping drying	0.91	0.95		
Overall compliance for drying	**0.82**	**0.86**		
Between standards			21.6621	1.11

Between regions			1.2049	0.2922
Overall compliance for the farmers	**0.75**			

Source: Field Survey, 2022

Base on the empirical study by Jongeneel *et. al.*, (2007), the compliance levels estimated were categorized into low, medium and high compliance. Farmer's compliance levels > 0.9 (>90%) were classified as high where as farmers with compliance levels of 0.8-0.9 (80-90%) and 0-0.79(0-79%) were classified as medium and low compliance.

Results from Table 4 indicate that, harvesting has four (4) standards. Out of the four (4) standards, the farmers' level of compliance was high for the removal of ripe and mature pods when yellow/orange in colour. The results overall compliance for the harvesting standards was 0.66 (66%) for farmers in Western South whereas the compliance for farmers in Ashanti region was 0.70 (70%).

Among the three standards under the pod storage quality indicators, the farmers compliance level with the gathering of pods into heap standard was high. The results from Table 4 indicates that, the farmers compliance was 0.99 (99%) for the farmers in Western South Region and 0.92 (92%) for farmers in the Ashanti Region. The farmers compliance level for the duration of pod storage (leaving the pods in a heap for 2-3 days) was also low, thus 0.72 (72%) for farmers in Western South Region but medium for farmers in Ashanti Region (0.88, thus 88%). Khairul and Tajul (2015) reported that applying pod storage before the fermentation process reduces the slaty percentage while simultaneously increasing the likelihood of a totally brown existence. This implies that, the medium compliance by farmers in Ashanti Region will help increase the quality of the cocoa beans by having cocoa beans of full brown colour and less slaty bean percentage. Since research by Khairul and Tajul (2015) showed that pod storage has a significant effect on the colour characteristic of dried beans, the Western South Region farmers' low compliance levels with leaving pods in a heap for 2-3 days after harvesting before pod breaking standard could have a negative effect on the dried beans' colour characteristics.

Pod breaking is the next quality indicator after pod storage. The results showed that the farmers' compliance level with the standard breaking equipment (wooden club) was very low. It was 0.23 (23%) and 0.4 (40%) for the Western South and Ashanti Region respectively. This was because the majority of the farmers who responded to the survey did not use the wooden club as their primary tool for breaking pods. The farmers overall compliance level for pod breaking was low for both regions. The compliance levels were 0.59 (59%) for Western South and 0.65 (65%) for farmers in Ashanti Region. According to Opoku's (2019) research, farmers who adhere to the guidelines for breaking cocoa pods which include removing the placenta from the beans after breaking them and removing any broken pod pieces or foreign objects that might have mixed in with the beans before starting the fermentation process, create a distinctive flavor during the fermentation process. However, farmers that don't follow these quality guidelines are unable to produce products of the same caliber. This suggests that because of the poor levels of compliance, the farmers will be producing low-quality cocoa.

After pod breaking, the cocoa farmers undertake fermentation. The overall compliance for the fermentation standard was 0.76 (76%) and 0.78 (78%) for farmers in both Western South and Ashanti region respectively. This indicates low compliance levels by the farmers.

Out of the thirteen drying standards, use of the sun in drying the cocoa, drying of the cocoa on raised platform and covering of the beans to prevent showers, dew and rain standards were highly complied with by the famers. The compliance rates were 100% as shown in the Table 4. The overall compliance level for the drying standards was 0.82 (82%) and 0.86 (86%) for the farmers in Western South and Ashanti Region respectively. This indicates medium compliance. Although the farmers' compliance was medium, they still needed to meet the drying standards at a high level since effective drying promotes the development or realization of the desired chocolate flavor (Dand, 1997).

In conclusion, the farmers compliance level with quality standards analysis establishes the pattern of significance for the quality indicators. The depiction of a systematic pattern of the quality indicators reflects what the farmer does in connection with the ideal practices which necessitate the bean quality. From the analysis, the pattern of significance regarding farmers' compliance with cocoa quality standards basically revolves around all the five quality control measures. The pattern brings to bear the specific quality control measures whose standards are highly complied with. The overall compliance level of the farmers for all the standards from harvesting through to drying was 0.75 (75%). This indicates a low compliance level.

It is essential to emphasize the significance of this analysis by pointing out that, of the five (5) cocoa quality control measures (harvesting, pod storage, pod breaking, fermentation, and drying) that were critically evaluated, pod storage, fermentation, and drying are responsible for maintaining the quality of Ghanaian cocoa beans in terms of consistency and significance.

Empirical data from a study by Opoku (2019) demonstrated the importance of drying and fermentation standards for bean quality. He did find in his study that the farmers generate high-quality cocoa beans through labor-intensive processes like fermenting. He underlined this point by pointing out that the farmers' handling of the cocoa beans during their sun-drying on mats and fermentation processes implied a series of quality control procedures.

➢ *Cut Test Analysis*

Table 5 below displays the cut test results for the farmers in the sample. The findings indicated that farmers in the Ashanti Region had less defects in their cocoa than those in the Western South Region, based on the assessment of quality defects. The total cocoa defects found in the cocoa of the sampled farmers' shows that, all the cocoa had high purple and slaty beans which is an indication of poor fermentation. The average purity percentages for Ashanti and Western South were 71.3% and 62.7% respectively. However, since the brown-coloured beans are more than 60%, that is per the percentage purity, it implies that, the cocoa is of good quality. This is consistent with a report by Khairul and Tajul (2015), which says that if the batch of dried cocoa has more than 60% totally brown beans, it will be deemed good. Based on the purity percentages for the various farmers, the quality adjusted output was estimated. The purity percentage for each farmer was multiplied with their respective output to get the adjusted quality output as indicated in Table 5.

Table 5 Cut Test Results and the Adjusted Quality Output

Defects/Purity Percentage	**Pooled Sample**		**Ashanti Region**		**Western South Region**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Mould	0.3	0.182	0.3	0.165	0.3	0.195
Slate	7.3	1.755	7.3	1.796	7.3	1.723
Germinate	0.3	0.127	0.3	0.128	0.3	0.126
Weevil	0.3	0.119	0.3	0.130	0.3	0.105
Purple	24.7	3.164	20	1.860	28.7	2.629
All Other Defects	0.3	0.183	0.3	0.176	0.3	0.188
Total Mould	0.3	0.171	0.3	0.165	0.3	0.176
Total Slate	7.3	1.755	7.3	1.796	7.3	1.723
Total Other Defects	25.7	3.145	21	1.844	29.7	2.651
Purity Percentage	**66.7**	**3.77**	**71.3**	**2.93**	**62.7**	**3.19**
Quality Adjusted Output	**16.8**	**3.385**	**7.10**	**2.24**	**12.44**	**3.525**

Table 6 Evidence of Correlation between Output Quality and Compliance

Quality Control Standards	**Bayesian Factor**	**Posterior Mean**	**Significance**
Ashanti			
Harvesting	-0.32	0.625	0.883
Pod storage	0.54	0.636	0.000***
Pod breaking	-0.55	0.521	0.684
Fermentation	0.46	0.681	0.035**
Drying	0.63	0.823	0.005***
Western South			
Harvesting	-0.45	0.328	0.541
Pod storage	0.65	0.491	0.051**
Pod breaking	-0.21	0.503	0.392
Fermentation	0.53	0.626	0.008***
Drying	0.31	0.701	0.000***

The Bayesian Factor was used to assess the correlational evidence between compliance and quality of cocoa beans. The Bayesian Factor Analysis was presented in Table 6. The results indicate that in the Ashanti region, the Bayesian factor for harvesting was -0.32 which fell within the negative critical region of 0 to -1. Therefore, the farmers compliance with harvesting standards was rejected in the Ashanti region. Similarly, the results for Western South as shown in Table 6 indicates that, the Bayesian factor for harvesting was -0.45 fell within the negative critical region of 0 to -1.

In respect of pod storage, the Bayesian factor in the Ashanti region was 0.54. This fell within the acceptable region of 0 to 1, hence the farmers compliance with the pod storage standards was accepted. The posterior mean was 0.636. This implies that, the farmers compliance with pod storage standards influenced the quality of the bean by 64% at 1% Significant level.

The Bayesian factor for pod breaking in the Ashanti region was -0.55. This fell within the negative critical region of 0 to -1. Therefore, the farmers compliance with pod breaking standards was rejected in the Ashanti region.

The Bayesian factor for fermentation standards in the Ashanti region was 0.46. This fell within the acceptable region of 0 to 1, hence the farmers compliance with fermentation standards was accepted. The posterior mean was 0.681. This suggests that the farmers' adherence to fermentation guidelines had a 68% at 5% Significant impact on the bean's quality. Similarly, in terms of pod storage, the Bayesian factor for Western South Region was 0.65. This fell within the acceptable region of 0 to 1, hence the farmers compliance with the pod storage standards was accepted. The posterior mean was 0.491 this means the farmers compliance with pod storage standards influenced the quality of the bean by 49% at 5% significant level.

Subsequently, the Bayesian factor for drying in the Ashanti region was 0.63. This fell within the acceptable region of 0 to 1. Hence, the farmers compliance with drying standards was accepted. The posterior means of 0.823 suggests that, at a 1% significant level, farmers' adherence to drying standards affected bean quality by 83%.

The Bayesian factor for pod breaking in the Western South Region was -0.28, this fell within the negative region of 0 to -1, hence the farmers compliance with the breaking of pod standards was rejected.

In respect of Fermentation for Western South Region, the Bayesian factor was 0.53. This fell within the acceptable region of 0 to 1, hence the farmers compliance with fermentation standards was accepted. The posterior means of 0.626 indicates that, at the 5% Significant level, farmers' adherence to fermentation standards affected bean quality by 63%.

The Bayesian factor for drying in the Western South Region was 0.31. The farmers' compliance with drying standards was accepted because this was within the acceptable range of 0 to 1. The posterior mean, therefore, was 0.701, meaning that farmers' adherence to drying guidelines affected bean quality by 70% at a 10% significant level.

Table 7 OLS estimates of the determinants of compliance with quality control standards

Multiple Linear Regression Results				
Variable	**Coefficient**	**Std. Error**	**t-statistics**	**Prob.**
Constant	9.028	2.003	4.507	0.001***
Farm size	0.423	0.144	2.937	0.000***
Occupational experience	0.631	0.121	5.214	0.041*
Education	-0.037	0.159	-0.232	0.524
Extension	0.701	0.203	3.453	0.029**
Household size	-0.037	0.159	-0.232	0.817
Age of the cocoa tree	-0.024	0.101	-0.237	0.356
Gender	0.682	0.212	3.216	0.013***
Access to labor	0.671	0.091	7.373	0.000***
Off-farm Activities	0.432	0.102	4.235	0.046**
Government Interventional Support	0.560	0.091	6.153	0.012***
Statistical test of significance: F ratio = 187 Prob>F=0.000*** R-Squared= 0.862 Normality Test Chi2=649.21 Prob>chi2 =0.000***				

***, ** and * indicates 1% significant level, 5% significant level, and 10% significant level
Source: Field survey, 2022

- *Farm Size*

Farmers with high yield due to large farm sizes have high tendency to comply with standards than farmers with lower yield (Kassem *et. al.*, 2008). This suggests that farmers are encouraged to adhere to standards and good agricultural practices when increased production translates into farm income, according to Krause *et. al.*, (2016).

Results from Table 7. depict that, Farm size significantly influenced the farmers' compliance levels. As expected, Table 7 shows that the size of the farm had a positive effect on the farmers' compliance. This suggests that a farmer's compliance level will grow by 0.423 for every hectare that the farm's size is increased.

- *Occupational Experience*

Results from Tables 7 showed that, the farmers occupational experience had the expected positive significant relationship with the farmers compliance. According to the findings, a farmer's occupational experience increase of one unit will have a 0.631% impact on their compliance level. The relationship between the farmers compliance and occupational experience had been empirically explained by Benaim *et. al.*, (2004). Benaim *et. al.*, (2004) state that an individual's level of experience increases with the number of years they have worked as a cocoa farmer.

- *Education*

From the results in Table 7, it was found out that, education had negative relationship with the farmers' compliance level. In addition to the inverse relationship, education was also not significant. This implies that the farmers' level of compliance with cocoa bean quality standards is not contingent on the farmers' level of formal education.

- *Extension*

Farmers are more aware of better technologies that are more suitable and adaptable to their local conditions when they have access to information through extension agents and programs. Meijer *et. al.*, (2015) emphasized in their research the importance of providing farmers with high-quality information through extension.

Results from Tables 7 depicts that the farmers compliance level was significantly influenced by the extension services that was rendered to them. The estimated coefficient for extension was 0.701 and this was significant at 5%. Access to extension services and farmers' compliance level are significantly correlated, according to empirical studies by Kirumba and Pinard (2010). It was anticipated that the farmers' degree of compliance would be influenced by extension service.

- *Household Size*

It was anticipated that the size of the farmer's household, determined by the number of individuals who live there and participate in the production process would affect whether or not the farmer complies with regulations. Household size contributes to labour as it ensures that farming operations are performed on time by additional labour. A large household is expected to supply more labour to production. (Marenya *et*. *al*., 2007). Nonetheless, the household size estimate's coefficient was insignificant and negative. This is empirically in line with a study that Marwanti (2020) carried out. According to Marwanti (2020), family size does not significantly affect compliance.

- *Age of the Cocoa Tree*

Cocoa yields decline when trees age (Breisinger *et*. *al*., 2007). It was therefore expected that age of the cocoa tree would not influence the farmers' compliance level. As a confirmation, results from Table 7 indicate that age of the cocoa tree had a negative estimated coefficient and insignificant.

- *Gender*

I Results from Table 7 depicts that gender increases compliance such that when the number of male cocoa farmers increase by 1, compliance shall increase by 0.682. This shows that male cocoa farmers comply with cocoa bean quality standards than their female counterparts. This outcome is consistent with the research conducted by Ekunwe and Emokaro (2009), which demonstrated empirically that male farmers are more productive than female farmers.

- *Access to Labour.*

Ebanyat *et. al*., (2010), revealed that labour availability enhances efficient farm management practices. In respect of the results as depicted by Table 7, access to labour was positively related to the farmers' compliance. This explains the fact that access to labour increases compliance. In Table 7, if the number of people that assist the farmer on the farm increases by 1, compliance shall increase by 0.671. The results are in agreement with the research carried out by Ebanyat *et. al.,* (2010).

- *Off-Farm Activities.*

Higher economic motivation farmers are able to recruit labor and are more likely to adhere to agricultural standards than lower economic motivation farmers (Parikani *et. al*., 2015). Indications from the empirical results in Tables 7 confirms the positive effect of off-farm activities on compliance such that off-farm activities can increase compliance.

Table 7 indicates that an increase of one unit in the number of additional income-generating ventures the farmer undertakes will result in a 0.432 rise in compliance. Table 7 indicates that an increase of one unit in the number of additional income-generating ventures the farmer undertakes will result in a 0.432 rise in compliance.

- *Government Interventional Support*

According to Laven and Boomsma, (2012), government interventional support is essential for sustainable cocoa production. It was therefore expected that government interventional support would positively influence the farmers' compliance. From the results as depicted by Table 7, the estimated coefficient was positive and significant. This is an indication that, an increase in government interventional support will increases compliance by 0.56. The results are consistent with an empirical study conducted by Maurice (2012) regarding the effects of government assistance for intervention in the cocoa sector, which showed a notable rise in cocoa production.

V. CONCLUSION

The fundamental reasons for the reduction in cocoa quality was one of the main conclusions the study aimed to determine. The results showed that farmers' poor adherence to the necessary requirements for cocoa quality (75%) was the cause of the reduction in cocoa quality. The compliance levels of majority of the farmers were significantly low relative to the number of farmers whose compliance level was high. Two out the five quality indicators whose standards were thoroughly accessed were also rejected by the Bayesian analysis. This is on the basis of the correlational evidence. As a result of the low compliance levels, purity percentage which is a quality measure was low for most of the farmers. The highest percentage defects under the quality measure (cut test analysis) were slate and purple beans which are indication of under fermentation or no fermentation at all. The key determinants of compliance were farm size, extension service, gender, access to labour, government interventional support and off-farm activities are also contributing factors of compliance to quality control standards by the farmers.

Empirical results of the study showed that farmers' adherence to fermentation and drying quality requirements has a major role in maintaining the quality of Ghana's cocoa beans, hence the government through the Ghana Cocoa Board must intensify its effort to disseminate extension information on cocoa quality requirements as well as provide farmers with subsidies for inputs.

REFERENCES

[1]. Adewoye, O. (2008). National agency for Science and Engineering Infrastructure (NASENI) Annual Report, 3, 4.

[2]. Ahmad, D., Afzal, M., & Rauf, A. (2020). Environmental risks among rice farmers and factors influencing their risk perceptions and attitudes in Punjab, Pakistan. *Environmental Science and Pollution Research*, *27*, 21953-21964.

[3]. Andrea Krähmer, Annika Engel, Daniel Kadow, Naailah Ali, Pathmanathan Umaharan, Lothar W. Kroh, Hartwig Schulz, (2015). Fast and neat – Determination of biochemical quality parameters in cocoa using near infrared spectroscopy, Food Chemistry, Volume 181, 2015, Pages 152-159, ISSN 0308-8146

[4]. Annor, P. B. (2017). Global GAP standard compliance and profitability: a case study of smallholder pineapple farmers in Akuapem South of Ghana. *International Journal of Agricultural Management and Development*, *7*(2), 165-177.

[5]. Are, L. A., & Gwynne Jones, D. R. G. (1974). *Cacao in West Africa*. Oxford University Press.

[6]. Asare, R., & David, S. (2010). *Planting, replanting and tree diversification in cocoa systems-learning about sustainable cocoa production: a guide for participatory farmer training* (No. 13). Forest & Landscape Denmark.

[7]. Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of environmental management*, *96*(1), 17-25.

[8]. Beniam NJ, Tonye J, Wandji N, Nyambi G, Akoa M (2004). "Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon

[9]. Bevan-Dye, A. L. (2020). Antecedents of Generation Y consumers' usage frequency of online consumer reviews. *Spanish Journal of Marketing-ESIC*, *24*(2), 193-212.

[10]. Bloomberg, 2012. Ghana plans to boost cocoa output to 1.2 million metric tons. Accessed February 2012, available at http://www.bloomberg.com/news/2011-07-18/ghana-aims-to-produce-1-2-million-tons-of-cocoa-a-year-by-2015-board-says.html

[11]. Bojnec, Š., & Fertő, I. (2013). Farm income sources, farm size and farm technical efficiency in Slovenia. *Post-Communist Economies*, *25*(3), 343-356.

[12]. Breisinger, C., Thurlow, J., & Duncan, M. (2007). A 2005 social accounting matrix (SAM) for Ghana. *International Food Policy Research Institute (IFPRI)*, 3-4.

[13]. Büyüköztürk, ù., (2002). Sosyal bilimler için veri analizi el kitabÕ. Pegem-a yayÕncÕlÕk, Ankara

[14]. CAOBISCO/ECA/FCC Cocoa Beans: Chocolate and Industry Quality Requirements. September 2015 (Ends, M. J. and Dand, R., Editors)

[15]. Castoldi N, and Bechini L (2010) Integrated sustainability assessment of cropping systems with agro–ecological and economic indicators in northern Italy. Eur J Agron 32(1):59–72

[16]. Chambers, R., & Leach, M. (1989). Trees as savings and security for the rural poor. *World Development*, *17*(3), 329-342.

[17]. Chang, H. H., & Wen, F. I. (2011). Off-farm work, technical efficiency, and rice production risk in Taiwan. *Agricultural economics*, *42*(2), 269-278.

[18]. Cocoa Industry (Regulation) (Consolidation) Decree, 1968. Decrees and Legislation on Quality Control Company Limited of the Ghana Cocoa Board. Republic of Ghana.

[19]. Cowell, A. J. (2006). The relationship between education and health behavior: some empirical evidence. *Health economics*, *15*(2), 125-146.

[20]. Daidone, S. (2010). Essays in health economics and in development.

[21]. D W du Preez and V Pieterse (2006), Calculating compliance standards Department of Computer Science University of Pretoria, 0002 Pretoria, South Africa, Conference Paper,2006.

[22]. DeGabriele Steven, Peck Susan and Acker Tara (2009). The States Common Measures Project. June 19, 2009.

[23]. Dethier, J. J., & Effenberger, A. (2012). Agriculture and development: A brief review of the literature. *Economic systems*, *36*(2), 175-205.

[24]. Ebanyat, P., de Ridder, N., De Jager, A., Delve, R. J., Bekunda, M. A., & Giller, K. E. (2010). Drivers of land use change and household determinants of sustainability in smallholder farming systems of Eastern Uganda. *Population and environment*, *31*, 474-506.

[25]. Egüez, A. (2020). *Energy efficiency, district heating and waste management: essays on environmental economics* (Doctoral dissertation, Umeå University).

[26]. Ekunwe, P. A and Emokaro, C. O. (2009). Technical Efficiency of Catfish Farmers in Kaduna, Nigeria. Journal of Applied Sciences Research 5(7): 802-80

[27]. Ellen, Stephanie (2020). "Slovin's Formula Sampling Techniques" sciencing.com, https://sciencing.com/slovins-formula-sampling-techniques-5475547.html. Retrieved on 18 April 2021

[28]. Eloff J.H.P., Eloff M.M. (2005). Information Security Architecture, Computer Fraud and Security, November 2005, pp. 10 – 16.

[29]. Ganpat, W., Badrie, N., Walter, S., Roberts, L., Nandlal, J., & Smith, N. (2014). Compliance with Good Agricultural Practices (GAPs) by state-registered and non-registered vegetable farmers in Trinidad, West Indies. *Food Security*, *6*, 61-69.

[30]. Hamid, A. and A.S. Lopez, 2000. Quality and weight changes in cocoa beans stored under two warehouses' conditions in East Malaysia. The planter, Kuala Lumpur, 76: 619-637

[31]. Hii, C. L., Abdul Rahman, R., Jinap, S., & Che Man, Y. B. (2006). Quality of cocoa beans dried using a direct solar dryer at different loadings. Journal of the Science of Food and Agriculture, 86(8), 1237-1243.

[32]. Holzapfel, S., & Wollni, M. (2014). Is GlobalGAP certification of small-scale farmers sustainable? Evidence from Thailand. *Journal of Development Studies*, *50*(5), 731-747.

[33]. Jongeneel, R. (2007, September). Compliance with regulations in EU agriculture vis-a-vis its main competitors; an explorative and comparative overview with a focus on cross-compliance. In *Conference on the Science and Education of Land Use: A transatlantic, multidisciplinary and comparative approach, Washington, DC* (pp. 24-26).

[34]. Jongeneel, R., Brouwer, F. M., Farmer, M., Müssner, R., De Roest, K., Poux, X., and Ortéga, C. (2007). Compliance with mandatory standards in agriculture: a comparative approach of the EU vis-à-vis the United States, Canada and New Zealand. LEI.

[35]. Kamau, J. W., Stellmacher, T., Biber-Freudenberger, L., & Borgemeister, C. (2018). Organic and conventional agriculture in Kenya: A typology of smallholder farms in Kajiado and Murang'a counties. *Journal of Rural Studies*, *57*, 171-185.

[36]. Karugia, J., Massawe, S., Guthiga, P., Ogada, M., Nwafor, M., Chilonda, P., & Musaba, E. (2016). Factors influencing the effectiveness of productivity-enhancing interventions: an assessment of selected programs. *Trends, Patterns, and Determinants*, 247.

[37]. Kassem, H. S., Alotaibi, B. A., Aldosari, F. O., Herab, A., & Ghozy, R. (2021). Factors influencing smallholder orange farmers for compliance with GobalGAP standards. *Saudi Journal of Biological Sciences*, *28*(2), 1365-1373.

[38]. Kilic, T., Carletto, C., Miluka, J., & Savastano, S. (2009). Rural nonfarm income and its impact on agriculture: evidence from Albania. *Agricultural Economics*, *40*(2), 139-160.

[39]. Kirumba EG & Pinard F (2010). Determinants of farmers' compliance with coffee eco-certification standards in Mt. Kenya region. *Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19–23, 2010.*

[40]. Kotz, S., & Johnson, N. (1981). Arithmetic Mean. In The Encyclopedia of Statistical Sciences, New York: John Wiley & Sons, (Vol. 1, p. 126), (Vol. 3, p. 397), (Vol. 6, p. 256), (Vol. 9, p. 477), (Vol. 1, p. 644), (Vol. 9, p. 111), (Vol. 9, pp. 580-581), (Vol. U2, p. 508), (Vol. U3, p. 371).

[41]. Lambrecht, I., Vanlauwe, B., Merckx, R., & Maertens, M. (2014). Understanding the process of agricultural technology adoption: mineral fertilizer in eastern DR Congo. *World development*, *59*, 132-146.

[42]. Laven, A., & Boomsma, M. (2012). Incentives for sustainable cocoa production in Ghana. *Royal Tropical Institute, Amsterdam*, *49*.

[43]. Lin, T. C. (2016). Compliance, technology, and modern finance. *Brook. J. Corp. Fin. & Com. L.*, *11*, 159.

[44]. Marenya, P. P., & Barrett, C. B. (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya. *Food policy*, *32*(4), 515-536.

[45]. Marwanti, S., & Antriyandarti, E. (2020). The Effect of Anxiety on Farmers' Compliance in Implementing COVID-19 Preventive Health Protocol in Daily Life: A Case Study in Rural Java. *Revista Argentina De Clinica Psicologica*, 743-52.

[46]. Maurice, C. 2012. The Maurice Academy of Design and Craft Ltd, 3rd Caribbean Fine Cocoa Conference and Chocolate Expo 2012, Fine Cocoa: Transforming Caribbean rural economies in the 21st Century accessed: 12/11/2012 page 4.

[47]. Meijer, S. S., Catacutan, D., Ajayi, O. C., Sileshi, G. W., & Nieuwenhuis, M. (2015). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International journal of agricultural sustainability*, *13*(1), 40-54.

[48]. Metzenbaum, S. (2007). Compliance ad Deterrence Research Project: Measuring Compliance Assistance Outcomes State of Science and Practice White Paper.

[49]. Miller, K. B., Stuart, D. A., Smith, N. L., Lee, C. Y., McHale, N. L., Flanagan, J. A., ... & Hurst, W. J. (2006). Antioxidant activity and polyphenol and procyanidin contents of selected commercially available cocoa-containing and chocolate products in the United States. *Journal of agricultural and food chemistry*, *54*(11), 4062-4068.

[50]. Minten, B., & Barrett, C. B. (2008). Agricultural technology, productivity, and poverty in Madagascar. *World Development*, *36*(5), 797-822.

[51]. Motamed, N., Baba Mahmoodi, F., Khalilian, A., Peykanheirati, M., & Nozari, M. (2006). Knowledge and practices of health care workers and medical students towards universal precautions in hospitals in Mazandaran Province. *EMHJ-Eastern Mediterranean Health Journal, 12 (5), 653-661, 2006*.

[52]. Muriithi, B. W. (2008). *Compliance with EUREPGAP standards: Determinants, costs and implications on profitability among smallholder French beans exporters in Kirinyaga District, Kenya* (No. 634-2016-41498).

[53]. Mushobozi, W. L. (2010). Good Agricultural Practices on horticultural production for extension staff in Tanzania.

[54]. Nicetic, O., Fliert, E., Chien, H. O., Mai, V. and Cuong, L. (2010). Good Agricultural Practice (GAP) as a vehicle for transformation to sustainable citrus production in the Mekong Delta of Vietnam. The 9th European IFSA Symposium, Vienna, pp.1893-1901.

[55]. Okumah, M., Martin-Ortega, J., & Novo, P. (2018). Effects of awareness on farmers' compliance with diffuse pollution mitigation measures: A conditional process modelling. *Land Use Policy*, *76*, 36-45.

[56]. Opoku, E. A. (2019). *Strategies to Obtain Certification for Cocoa Bean Production* (Doctoral dissertation, Walden University).

[57]. Oyekale, A. S. (2018). Cocoa farmers' compliance with safety precautions in spraying agrochemicals and use of personal protective equipment (PPE) in Cameroon. *International journal of environmental research and public health*, *15*(2), 327.

[58]. Paggi, M. S., Yamazaki, F., Ribera, L., Palma, M., & Knutson, R. (2013). Domestic and Trade Implications of Leafy Green MarketingAgreement Type Policies and the Food Safety Modernization Act for theSouthern Produce Industry. *Journal of Agricultural and Applied Economics*, *45*(3), 453-464.

[59]. Panahzadeh Parikhani, M., Razzaghi Borkhani, F., Shabanali Fami, H., Motiee, N., & Hosseinpoor, A. (2015). Major barriers to application of Good Agricultural Practices (GAPs) technologies in sustainability of livestock units. *International Journal of Agricultural Management and Development*, *5*(3), 169-178.

[60]. Pandit, U., Nain, M. S., Singh, R., Kumar, S. H. I. V., & Chahal, V. P. (2017). Adoption of Good Agricultural Practices (GAPs) in Basmati (Scented) rice: A study of prospects and retrospect. *Indian Journal of Agricultural Sciences*, *87*(1), 36-41.

[61]. Pongvinyoo, P., Yamao, M., & Hosono, K. (2014). Factors affecting the implementation of good agricultural practices (GAP) among coffee farmers in Chumphon Province, Thailand. *American journal of rural development*, *2*(2), 34-39.

[62]. Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of soil and water conservation*, *63*(5), 300-311.

[63]. Quality Control Company, (2023). Inspection and grading of cocoa general procedure and instruction. Revised Edition: 2023

[64]. Ramos, T. B., Alves, I., Subtil, R., & de Melo, J. J. (2007). Environmental performance policy indicators for the public sector: The case of the defence sector. *Journal of Environmental management*, *82*(4), 410-432.

[65]. Reda Taha, M. M., Neidigk, S., & Noureldin, A. (2009). Variable stiffness rheological model for interrelating creep and stress relaxation in ligaments. *International Journal of Experimental and Computational Biomechanics*, *1*(1), 96-113.

[66]. Roshani, A. R., Mosaedi, A., Sedghi, H., Babazadeh, H., & Manshouri, M. (2012). Estimation of sedimentation in Karaj and Torogh Dam reservoirs (Iran) by hydrological models and comparison with actual sediment. *Ecology Environment and Conservation*, *18*(2), 835–847.

[67]. Scherr, S. J. (1992). Not out of the woods yet: challenges for economics research on agroforestry. *American journal of agricultural economics*, *74*(3), 802-808.

[68]. Schoneveld, G. C., Van Der Haar, S., Ekowati, D., Andrianto, A., Komarudin, H., Okarda, B., ... & Pacheco, P. (2019). Certification, good agricultural practice and smallholder heterogeneity: Differentiated pathways for resolving compliance gaps in the Indonesian oil palm sector. *Global Environmental Change*, *57*, 101933.

[69]. Shimshack, J. (2009). The Performance of Clean Water Act Monitoring and Enforcement. *Hearing on "The Clean Water Act after*, *37*.

[70]. Snider, A., Kraus, E., Sibelet, N., Bosselmann, A. S., & Faure, G. (2016). Influence of voluntary coffee certifications on cooperatives' advisory services and agricultural practices of smallholder farmers in Costa Rica. *The Journal of Agricultural Education and Extension*, *22*(5), 435-453.

[71]. Stampini, M., & Davis, B. (2009). Does nonagricultural labor relax farmers' credit constraints? Evidence from longitudinal data for Vietnam. *Agricultural economics*, *40*(2), 177-188.

[72]. Talukder MAI, Shahjahan M, Haque MN, Islam MS, Rahman SM, Yeasmin MN, Munira S, Habib MR, Salahuddin M, Billah MM and Miah MAH (2017). Socio-economic condition, cattle production and management system in a community at Pabna district of Bangladesh. Research in Agriculture Livestock and Fisheries, 4(3): 181-185.

[73]. Tesfay G., R. Ruben, J. Pender and A. Kuyvenhoven (2005) Resource use efficiency on own and sharecropped plots in Northern Ethiopia: determinants and implications for sustainability

[74]. Uyanık, G. K., & Güler, N. (2013). A study on multiple linear regression analysis. *Procedia-Social and Behavioral Sciences*, *106*, 234-240.

[75]. World Bank. (2011). *The world bank annual report 2011*. The World Bank.

[76]. Yamene, T. "Statistics: an introductory text." (1967). New York: Harper & Row