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Research Article

Productivity and Economic Analysis of Technical Efficiency of Cocoa Production in Kailahun District, Eastern Sierra Leone

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Abstract: This study measured the profitability of cocoa farms in Kailahun district, eastern Sierra Leone, the largest cocoa producing district. Cocoa is a major export crop of Sierra Leone with high production and export level. This study uses an ex-ante analytical approach to discover the potential for cocoa farmers to develop position markets for an environmentally and sustainably producing using an economic decision criteria and profitability. A stratified random sample of 150 farmers in Kailahun from twelve (12) chiefdoms were selected, using the multistage sampling approach. Individual farmers were interviewed by using questionnaires. Descriptive and inferential analyses of the survey data were performed. Regression analysis was employed to estimate the Cobb-Douglas production function from the farm data for the measurement of cost-effective analysis of technical efficiency of the cocoa farmers. The estimated elasticity from the production function and prices of input and output were subsequently used to calculate the measures of allotment efficiency of resource use by the farmers. Results of the study revealed that Cocoa production has high return on investment of 75.89% and 140% for the farmer and processor. The coefficients for household size, cocoa farm size, quantity of insecticides, quantity of fungicides, and quantity of fertilizer were 0.261, 0.514, 0.273, 0.090 and 0.325, respectively. The quantity of fertilizer applied to the cocoa farm had the highest marginal physical product (133.11 kg/ bag), and that of quantity of fungicides variable (1.39 kg/satchet) was lowest. Household size, farm size, insecticides, fungicides and fertilizer were found to have statistically significant impact on cocoa output. The sum of elasticities of the factors included in the Cobb-Douglas production function was 1.463, which was more than one, implying that the cocoa farmers were operating in the increasing returns to scale. There were incidences of inefficiencies in the management of resources in cocoa cultivation by cocoa farmers since some resources were underutilized and others over-utilized. Farmers are advised to increase the use of household members, insecticides, fungicides and fertilizer while reducing the use of forest land through increased land productivity instead of land expansion to ensure efficient use of resource in cocoa production. However, the ecofriendly impacts of these farm activities should be assessed to ensure sustainable cocoa production.

Keywords: Productivity**,** cocoa production, technical and economic efficiency, Sierra Leone.

Introduction

Agriculture plays an important role in the reduction of poverty and famishment in Africa. It also helps to reduce poverty by generating employment and income. Poverty purge is currently the main objective in Sierra Leone. To realize this goal, cocoa farms have become a priority area. Sierra Leone is well endowed with premium bulk cocoa and is strategically positioned to capture significant market shares for the growing demand in cocoa products on the world market. Cocoa provides employment in many rural communities in the eastern region. Smallholder cocoa is grown mostly under shade trees and either inter-cropped or grown in a semi-natural agro-forestry setting and hence, is a particularly rich and stable habitat for many species. Consumers' taste and preference for differentiated or 'specialty' cocoa based on environmental-and ethically certified cocoa products have been rising over the years.

Agriculture is one of the most important sectors of the economy of Sierra Leone. According to the 2015 housing and population census, out of a total of 4,724,844 persons who were engaged in various economic activities, 3,144,439 (70%) were engaged in agriculture, indicating employment potentials in the agricultural sector. Figures from the economic statistics division of Statistics Sierra Leone are indicating that in 2013, agriculture (crops, livestock, forestry and fishery), contributed 41 percentage share to GDP with crop production contributing a share of 29.3% of total GDP this indicates that agriculture is the engine of growth for the economy of Sierra Leone.

The rapid expansion of extensive low shade systems has been a major cause of deforestation in West Africa (Gockowski and Sonwa, 2011). In Sierra Leone, the eastern Region remains the first frontier for the expansion of cocoa due to the presence of non-reserved and reserved forest in the country (Asare, 2005; Gockowski and Sonwa, 2011). Given the absence of a 'New Forest Frontier', sustaining cocoa production in Sierra Leone will require external soil amendments to replace nutrients lost through episodes of deforestation and forest degradation (Gockowski and Sonwa, 2008). Consequently, cocoa production systems in Sierra Leone are low yielding and have experienced little innovation or productivity growth over the last twenty years. Additionally, concerns over the environmental impact of cocoa farming and its sustainability have been raised. To address the lack of innovation, low returns and perceived lack of production sustainability, a new environmentally friendly production system are examined for Sierra Leonean smallholders.

Productivity and Efficiency of Cocoa Farms

Previous research on the efficiency of cocoa farming is merely available with cross sectional data from African countries (Ogundari and Odefadehan, 2007; Adedeji *et al.,* 2011; Awotide *et al.,* 2015). We use household panel data from surveys conducted in Indonesia between 2001 and 2013.

Our sample size of 1290 observations is larger than any previously used in the efficiency analysis of cocoa production. With the knowledge gain of this data, we can characterize inefficiencies more realistically and that we also can decompose productivity change. Our study applies stochastic frontier analysis (Coelli *et al.,* 2005) to research to what extent and the way the Indonesian cocoa production are often made more productive and technically efficient. In multiple models, we explain cacao bean output as a function of farm size, labor use, chemicals cost, and technological factors. These are augmented by inefficiency variables to express farmers' management capacities and their access to information and productive assets. According to our results, the productivity of Sierra Leonean cocoa farming increased by 70 percent between 2010 and 2021. Technical efficiency growth and therefore the increased chemicals use supported by government subsidies were liable for the bulk of this gain. Furthermore, the calculations show large distortions in input allocation. Hence, policies that encourage the adjustment of the cocoa farms' input use would be highly beneficial. Moreover, the technical change component points to a weather-induced volatility in cocoa production. Thus, policy makers should also promote investment in agricultural research and transfer of drought resistant cocoa varieties to farmers. Additionally, the typical efficiency of cocoa farmers is estimated to be around 50 percent. This result suggests that there's ample scope to expand Indonesian cocoa output without increasing input use. The many factors which will increase efficiency levels are the smallholders' educational attainment and their experience in cocoa farming. Our research also shows the insignificant effect of existing agricultural extension services, farmer associations, and rural credit programs on the technical efficiency of cocoa farming. Hence, public policy should specialise in adjusting the general public extension programs, fostering the mutual benefits within the farmer groups, and developing viable credit institutions.

Statement of Problem
The quantity of cocoa produced in Sierra Leone is partially insufficient. This is because producers mostly rely on natural forest groves. The scanty improved and domesticated varieties are not properly maintained due to lack of technical Know-how and funds to practice and technology. Transportation system for products to be conveyed from sites of production to market sites serves as one of the chief problems due to lack of road network and other needs like communication services. Market conditions are continually changing, which create conflicting interesting among producers and consumers.

Research in cocoa production is essential due to the role this sector plays in the economy. As mentioned in the previous section, cocoa production plays a significant role in the social and economic development of Sierra Leone. It is one of the key GDP components, and it is the engine of the agricultural economy in Sierra Leone. Also, this crop production is the first source of income in the rural area. Moreover, Sierra Leone has not been able to stabilize throughout the year and consequently the prediction of insufficient world production in the near future is imminent. For now, varying results based on analyses and research from independent sources have been found to concur with this observation. Most of the research done takes into consideration the current conditions of farmers in the plantation such as agricultural technique and social development. Therefore, the motivation for the research emerged from a genuinely different viewpoints in the economic analysis. That is, analyzing the impact of cocoa production in the short and long run by investigating the historical, current and forecasting future supply trends which could enable Sierra Leone to reposition itself at the helm of competitive global cocoa production. Implying a pedantic study of the cocoa sector, focusing on the evolution of the industry, to enhance understanding and provide effective proposals. Due to that, the determinants of a probable insufficient production based on a novel approach will significantly improve our understanding of how to salvage the cocoa sector in Sierra Leone.

Aim and Objective
The primary aim of the study is to identify and analyze the productivity and technical efficiency of cocoa production in Sierra Leone. The specific objectives are taken into account on the following assessment:
1) Determine the socio-economic characteristics and estimate the quantitative effect of the production factors that lead to insufficient production among cocoa growers in eastern part of Sierra Leone.
2) Estimate the cost and return with the use of econometric model to test the procedures and identify the significance of each variable associated with Cocoa production.
3) To mention strong action to all relevant departments in charge of the Cocoa sector to implement a vital system of production in Sierra Leone.

Literature Review
Idowu, Osuntogun and Olusola (2009) scholars designated that the adoption of SAP gave an estimated positive gross margin of N1,585.00 per hectare in 1989 compared to negative gross margin of N105.00 per hectare in 1985. Also, the production function estimated by CBN/NISER (1992) in Idowu, Osuntogun and Olusola (2009) also designated that the aggregate output of cocoa is determined by real producer prices, exchange rates, interest rates, farm wage rates, world prices, and SAP dummy variable. They also found that man-days of labour and intensity of chemical used were statistically significant in determining output of cocoa in some areas while farm sizes returned negative signs or effects in some Local Government Areas. In terms of factors influencing productivity of cocoa Amos (2007) noted that the major contributing factors to production efficiency were age of farmers, level of education and family size.

Theoretical and Empirical Framework

Profit maximization is one of the major objectives of companies (Samuelson and Nordhaus, 2005). Schultz (1964) describes the peasant production mode as profit-maximization behavior, where efficiency is defined in a context of perfect competition (i.e., where producers all apply the same prices, workers are paid according to the value of their marginal product, inefficient firms go out of business, and entrepreneurs display no diminishing marginal utility of money income). Conflicting evidence apart, the main caveat in this approach is that profit maximization has both a behavioral content (motivation of the household) and a technical-economic content (economic performance of the farm as a business enterprise (Mendola, 2007). A number of utility maximization theories have been applied to peasant production behaviour too. The main difference between them and the profit maximization theory is that utility maximization approaches encompass the dual character of peasant households as both families and enterprises and thereby take account of the consumption side of peasant decision making. The idea that farm households aim at reducing income risk and therefore may forego profit-maximizing activities (which may include a range of activities) were also reviewed by Mendola (2007) in addition to the above mentioned theories.

For firms to make profit (an indicator of productivity) they need to consider their costs when making pricing decisions (Crawford, 1997). Production costs and efficiency are primarily determined by the prices of inputs including time, labour, capital and technological advances (Samuelson and Nordhaus, 2005). Costs can be broadly categorized as fixed and variable. Fixed costs do not vary with the level of production. Rents, insurances, the salaries of administrative staff and depreciation on capital equipment are all examples of expenditures which do not directly vary with the level of production. If the production of an organization in a given time period were zero, these costs still have to be met. In contrast, variable costs are those expenditures which vary in direct relation to volumes of production. Examples of this class of cost include raw material costs, hourly labour rates and packaging costs. Lau and Yotopoulos (1979) and other economic theorists applied and recommended the use of unit output profit model and a Cobb-Douglass production function to test for productivity of firms.

Net Farm Income (NFI) and Gross Margin (GM): Johnson (1982) and Kay (1986) recommended the use of Net Farm Income in ascertaining the profitability of farmers. NFI, according to them is derived after obtaining the Gross Margin (GM). GM is the amount of money realized after deducting variable expenses or costs from total sales or income. NFI is obtained by adjusting net cash farm income for total depreciation, net inventory changes and value of products consumed at home. NFI, according to Kay (1986) is the only true measure of profit for the accounting period since it includes the above adjustment which could be quite large. NFI is the profit from the year’s operation and represents the return to the farm owner for personal and family labour, management and equity capital used in the rice farm.

Gross Margin = Total Income (TI) – Total Variable Costs (TVC).
NFI = GM – Total Fixed Cost (TFC).

Regression Analysis: According to Gujarati (2006) and Greene (2008) the primary objective of regression analysis is to determine the various factors which cause variations of the dependent variable. SPSS software defined it as the estimation of the linear relationship between a dependent variable and one or more independent variables or covariates.

Research Methodology

Research design of the study

The instruments used in this paper focus on two well-known techniques. Essentially we bond our dependent variable and the independent variables. Annual cocoa production is the result of many selected factor inputs from which we resolve in choosing to explain the yearly change in cocoa production. To begin with, we use the simplified method applied in the field by previous researchers to link dependent and independent variables and then expand to the current reality case study associated with Sierra Leone cocoa production model. The research study employed the descriptive evaluative method. A total of one hundred and fifty (150) cacoa growers/farmers served as respondents in this study. A survey questionnaire was used as the main tool for gathering the necessary data. The questionnaire was pre-tested and consisted of open-ended questions to determine the socio-economic characteristics of farmers. Farm visits, focused group discussion and key informant surveys were conducted to get first-hand information regarding the present status of Cocoa production in Sierra Leone. Document review and analysis of data was also undertaken to confirm and validate the data gathered from the survey. Secondary data consisting of bulletins and annual reports and symposia collected from various sources like Sierra Leone Import and Export Agency (SLIEA). Simple statistical analysis including correlation and regression were done to study the degree relationship between area, production, yield, quantity exported and value of export of cocoa beans and to compare how they affect each other. Analysis of annual growth rates (CGR) and instability were done to measure the past and present performance of production and export of cocoa and to find out the trend in both production and export during three time frames.

Study Areas

Kailahun District is a district in the Eastern Province of Sierra Leone. The district has its largest town called Kailahun. The second most populous town in the district is Segbwema. Other major towns in Kailahun District include Koindu, Pendembu and Daru. As of the 2015 census, the district had a population of 525,372. Kailahun District is subdivided into fourteen chiefdoms. The District of Kailahun borders Kenema District to the west, Kono District to the north, the Republic of Liberia to the east, and the Republic of Guinea to the north. The border of the district with Guinea is formed by a section of the Moa River. The total area of the district is 4,859 km^2 (1,876 sq mi). The population of Kailahun District is largely from the Mende ethnic group, though there are other ethnic groups with significant population in the district, including among them the Kissi, Mandingo and the Fula. The major economic activities in the district are farming, diamond mining and trade. The large majority of the people of Kailahun District are Muslims, though with a significant Christian minority.

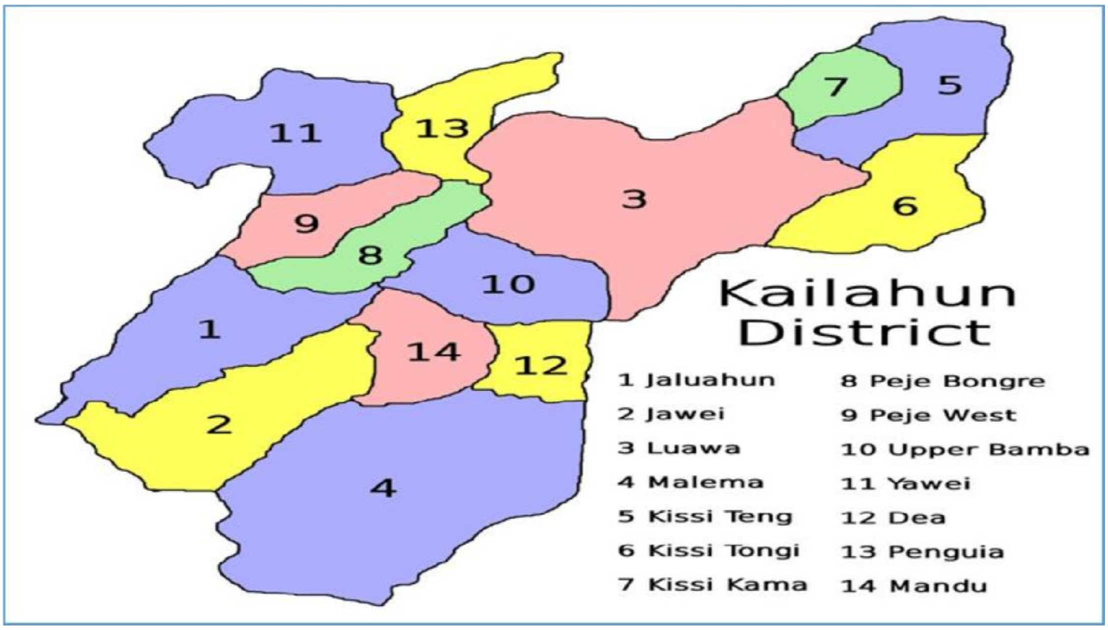

Figure 1. Map showing the various districts where the baseline survey was conducted.

Analytical and Technical efficiency

Technical efficiency in production is the somatic ratio of output to the factor input. The production function is a function that summarizes the conversion of inputs of capital, labour and other factors into outputs of goods and services. The production function approach is employed widely for examining the impact of physical inputs on production. A stochastic frontier model (using CobbDouglas production function) is specified as:

$$Yi = Xi\, \beta i + Vi - Ui \quad \ldots\ldots(1)$$

Where,
Y_i = output of cocoa farmers
X_i = a (1 x k) vector of farm inputs (in natural logarithm)
β = a (k x 1) vector of parameters to be estimated
V_i = the random variation in output (Y_i) due to factors outside the control of the farm such as weather and natural disasters
U_i = the factors (within the control of the farmer) responsible for that farmer inefficiency such as management

V_i is assumed to be identically and independently distributed as N (0, σ_v^2) random variables, independent of U_i which is distributed as a truncated normal (at zero) of the N (U_i, σ^2) distribution. U_i is independently, but not identically distributed. In general, $e_i = V_i - U_i$ is the composed error term. The technical inefficiency effect model can only be estimated if the efficiency effects are present. If the one-sided error term in the production function is not present then our model is an ordinary production function, which can be estimated by Ordinary Least Squares (OLS) regression technique. Otherwise, if U_i is present it implies that it is justifiable to employ the stochastic frontier approach.

A Cobb-Douglas function was fitted to the stochastic frontier production and estimated. This functional form has been employed consistently in related efficiency studies. A more flexible form like the translog function can also be used. The Cobb-Douglas function is employed because it is commonly used in the literature, making estimates comparable with previous studies. The specified multiplicative production function was:

$$Q = A\times X_1^{\beta 1} \times X_2^{\beta 2} \times X_3^{\beta 3} \times X_4^{\beta 4} \times X_5^{\beta 5} \times E \quad \ldots\ldots(2)$$

The linear transformation of (2) is achieved by taking the natural logarithm of both sides of the equation to obtain (3).

$$\text{In } Q = \beta 0 + \beta 1 \text{ In } X1 + \beta 2 \text{ In } X2 + \beta 3 \text{ In } X3 + \beta 4\, X4 + \beta 5 \text{ In } X5 + e \quad \ldots\ldots(3)$$

Where:
Q = Cocoa output in kilogrammes; X_1 = Household size (number of household members) (+); X_2= Cocoa farm size in hectares (+); X_3 = Quantity of insecticides in litres (+); X_4 = Quantity of fungicides in satchets (+); X_5 = Quantity of fertilizer in bags (+); β_i = Parameters (elasticities) to be estimated; e = Composite error term, defined as v-u in equation (1).

Labour could not be measured in man-days or hours since the questionnaire did not capture this as it was not designed for that. However, labour was proxied with household size which provides approximate information on the labour available to the farmer since they tend to use household members for performing their farm activities. Land was too broad to measure since traditionally it comprises of the various natural resources available to the farmer. So it was decided to proxy it with cocoa farm size which was easy to measure and represents the actual land area under cocoa production. Opportunity costs were not considered in this study.

The quantity of insecticides and fungicides were selected as inputs since they are used to control insect pests (capsids) and fungal diseases (blackpod diseases) attacking the cocoa trees. It is assumed that the more quantity the farmer sprays, the better pests and diseases are controlled. Hence, the more pods that the healthy cocoa trees can produce. The cocoa farmers also use fertilizer on their farms to improve the soil fertility to boost cocoa production. The assumption here is that cocoa soils in Ghana are depleted of plant nutrients due to soil mining from prolonged cocoa cultivation. Hence, an increase in the quantity of fertilizer applied to the soil would result in higher cocoa yields.

When all factors of production are increased, it implies a change in the scale of operations (such as change in economies of scale). This can lead to one of the following situations:

For constant returns to scale, $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 = 1$, that is, if all the inputs are increased by a factor of *n*, then the output also increases by a factor of *n*. For increasing returns to scale, $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 > 1$, if all the inputs are increased by a factor of *n*, then the output increases by an amount greater than *n*.

For decreasing returns to scale, $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 < 1$, if all the inputs are increased by a factor of *n*, then output increases by an amount less than *n*.

Measurement of Allotment Efficiency

Allocative efficiency occurs when a firm chooses resources and enterprises in such a way that a given resource is considered efficiently utilized in production if its marginal value product (MVP) is equal to its marginal factor cost (MFC).

$MVP_i = MFC_i = P_{xi}$

Efficiency of resource use was determined by the ratio of MVP to MFC of inputs based on the estimated regression coefficients. The efficiency of resource use, r, was calculated as:

$$r = MVP/MFC \quad \text{..........} (4)$$

The rule of thumb is that when $r = 1$, there is efficient use of a resource; $r > 1$ shows underutilization; while $r < 1$ means over utilization of resource. The values of MVP and MFC were estimated as follows:

$MVP = MPP \times P_Q$

$MPP = \partial Q/\partial Xi$

$MPP = \beta_i \,.\, Q_m/X_{mi}$

$MFC = P_{xi}$

Where,

r = efficiency ratio; MVP = marginal value product of the variable input; MPP = marginal physical product; MFC = marginal factor cost, P_{xi} (Unit price of input X_i); Q_m = mean value of output; X_{mi} = mean value of input considered; P_Q = unit price of output; β_i = output elasticities.

The relative resource adjustment needed for optimal allocation of the resources was calculated as follows:

$D_i = (1- (MFC_i / MVP_i)) \times 100$

Where, D_i = absolute value of the percentage change in MVP of the resource; MFC_i = marginal factor cost of the i^{th} resource; MVP_i = marginal value product of the resource.

Stochastic frontier analysis

Efficiency is that the capability to maximize outputs given a level of inputs utilized in the assembly. Debreu (1951) introduced the primary concept of making a production frontier to live efficiency. This has led to 2 main empirical methods for frontier estimation: the deterministic Data Envelopment Analysis (DEA) and therefore the parametric Stochastic Frontier Analysis (SFA). We assess efficiency using the parametric method since it can differentiate between technical inefficiency and therefore the effects of random shocks (Coelli *et al.,* 2005). It's employed by various researchers including Brümmer *et al.,* (2006).

Based on Coelli *et al.,* (2005), we will write the essential frontier model the subsequent way:

ln yi = ln $f(\boldsymbol{xi};\ \beta i) + vi - ui$ (3.1) where yi represents the output, $f(\boldsymbol{xi};\ \beta i)$ denotes the assembly function at complete efficiency with $\boldsymbol{xi}$ as input vectors and βi because the parameters to be estimated, vi may be a random error term independently and identically distributed as, and ui may be a non-negative unobservable term assumed to be independently and identically distributed as an independent of vi.

The last component measures the shortfall of the output from its maximum attainable level and, therefore, captures the effect of technical inefficiency. During this case, the technical efficiency of farm i are often written as $TEi = exp\ (-ui)$ (3.2). The parameters of the assembly function in equation (3.1) must theoretically satisfy the regularity conditions: monotonicity and curvature (Coelli *et al.,* 2005). We specify a translog production function during this function, the inclusion of squared and interaction terms provides a high level of flexibility.

The extension of our model in equation (3.1) enables us to live how household characteristics influence efficiency. We elect a specification proposed by Coelli *et al.,* (2005), which models the technical inefficiency (ui) as a function of several variables:

$ui = \varphi Zi + ei$ (3.3) where Zi may be a vector with farm-specific factors that are assumed to affect efficiency, may be a vector with the parameters to be estimated, and ei is an independent and identically distributed random error term. If the estimated parameter is positive, then the corresponding variable features a negative influence on technical efficiency.

Estimation issues we've to seem at four problems with the statistical inference: the estimation technique of the frontier model, the estimation technique of the inefficiency model, the estimation with panel data, and endogeneity. First, standard techniques like OLS are inappropriate for estimating the unobservable frontier function from observable input and output data because they specialize in describing average relationships. Therefore, we base the parameters on ML. Before completing the estimation, each variable is normalized by its sample mean. Given this transformation, the first-order coefficients are often viewed as partial production elasticities at the sample mean (Coelli *et al.,* 2005).

Regarding the second inference issue, Greene (2008) points out that researchers often incorporate inefficiency effects using two-step estimation techniques. Within the initiative, the assembly function is specified and therefore the technical inefficiency is predicted. The second step regresses the assumed characteristics on the anticipated inefficiency values via OLS. This approach results in severely biased results. The difficulty is addressed by employing a simultaneous estimation that has the efficiency effects within the production frontier estimation. With the supply of an outsized panel dataset, we will characterize inefficiencies more realistically. However, panel data also causes some issues within the estimation. The common feature of pooled SFA models is that the intercept is that the same across productive units, thus generating a misspecification bias in presence of unobserved time-invariant variables. As a consequence, the inefficiency term may capture the influences of those variables, generating biased results.

Greene (2008) approaches this problem with unit-specific intercepts. In contrast to the pooled model, his true fixed-effect (TFE) and true random-effect (TRE) panel specifications allow to differentiate between time-varying inefficiency and unit-specific unobservable time-invariant heterogeneity. The TFE model assumes the non-randomness while the TRE model the randomness of the unobserved unit-specific heterogeneity. The ML estimation of the TFE specification needs the answer of the so-called incidental parameters problem. This inferential issue arises when the length of the panel is comparatively small compared with the amount of units, causing the inconsistent estimation of the parameters. As shown in Belotti and Ilardi (2012), the dummy variable approach for estimation appears to be suitable only the panel length is large enough ($T > 10$). Our sample is very unbalanced and contains just 5 time periods.

The common method to unravel this problem is predicated on the elimination of the individual effects through within transformation, i.e., working with the deviations from the means. The consistent estimation of the TFE variant is proposed by Belotti and Ilardi (2012). However, the disadvantage of those methods is that they are doing not permit the utilization of time-invariant factors like gender and education, which we assume are significant determinants of inefficiency. In our estimations, we use both the TRE and TFE specifications and choose from the 2 consistent with the Mundlak (1978) approach.

As acknowledged by Greene (2008), neither the pooled nor the "true" formulation is totally satisfactory. Although the "true" model may appear to be the foremost flexible choice, it are often argued that some of the time-invariant unobserved heterogeneity does belong to inefficiency or that these two components shouldn't be disentangled in the least. Therefore, we estimate both extremes: the Coelli *et al.*, (2005) model during which all time invariant unobserved heterogeneity is taken into account as inefficiency and therefore the TRE/TFE specification during which all time-invariant unobserved heterogeneity is ruled out from the inefficiency component.

Finally, the direct inference of a stochastic frontier could also be vulnerable to simultaneity bias that happens if each farmer selects the output and input levels to maximise profit for given prices. But no simultaneity bias ensues if farmers maximize expected instead of actual profit (Coelli *et al.,* 2005). We make this reasonable assumption meaning that technical efficiency is unknown to producers before they create their input decisions. Thus, the quantities of variable inputs are largely predetermined and uncorrelated with technical efficiency.

Total factor productivity change

We base our calculations of total factor productivity (TFP) change on Brümmer *et al.,* (2006). The TFP change is decomposed into technical efficiency change (TEC), scale efficiency change (SEC), allocative efficiency change (AEC), and technical change (TC) to regulate for productivity adjustments connected to those factors: $TFPC1 = TEC + SEC + AEC + TC$ (3.4)

According to Zhu and Lansink (2010), we will disaggregate technical efficiency change further: $TEC = TECEV + TECTC + TECUF$ (3.5)

Where, $TECEV$, $TECTC$, and $TECUF$ are effects of the change in various inefficiency model variables, technical change of the inefficiency component, and unspecified factors.

Description

Our cocoa market model estimates are supported annual global observations covering the years 1963 through 2013. We compose this data set from various sources. The cocoa production and grindings data stem from FAO Statistics and ICCO Quarterly Bulletin of Cocoa.

Statistics

Furthermore, the benchmark commodity prices are drawn from World Bank's Global Economic Monitor, UNCTAD Statistics, and IMF International Financial Statistics. The variable descriptions additionally to the units of measurement are presented in Table 1. An important issue we'd like to tackle is that the exact definition of our variables. The measure of a specific commodity world price are often calculated in numerous ways supported various futures, export, or auction prices from different countries. We plan to use the foremost widespread variable definitions. For instance, the cocoa price springs from the closest three trading months on two key cocoa futures markets. Furthermore, we use the ex-dock NY Arabica/Robusta coffee composite price because the world coffee price.

Table 1. Description of the cocoa market variables

Variable	Description
Supply	World cocoa bean crop (in 1000 metric tons)
Yield	World cocoa bean yield (in kilograms/hectare)
Demand	World cocoa bean grindings (in 1000 metric tons)
Stocks	World cocoa bean ending stocks (in 1000 metric tons)
Cocoa price	Average of real daily cocoa futures prices: New York/London (in US dollars/metric ton)
Coffee price	Average of real daily ex-dock coffee prices: New York (in US dollars/metric ton)
Palm oil price	Average of real daily CIF Rotterdam palm oil prices: Malaysia (in US dollars/metric ton)
GDP	World real GDP (in billion US dollars)

Another issue we are confronted with is the selection of the price deflator to form real commodity prices. In this matter, we accept the recommendation of the World Bank to calculate with its Manufactures Unit Value Index for imported goods. Furthermore, we obtain the real world GDP from the World Bank World Development Indicators (WDI) to capture the effect of economic activity level. Table 2 provides the summary statistics for all the variables in our global cocoa market model before taking natural logarithms.

Table 2. Summary statistics of the cocoa market variables

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Supply	51	2430	960	1221	4373
Yield	51	384	47	266	461
Demand	51	2389	947	1305	4335
Stocks	51	1069	535	263	1892
Cocoa price	51	2742	1362	1116	8283
Coffee price	51	3533	1730	1285	11048
Palm oil price	51	681	255	290	1518
GDP	51	38641	17225	13793	72970

Sources: FAO Stat, ICCO Quarterly Bulletin of Cocoa Statistics, UNCTAD Stat, International Bank for Reconstruction and Development Pink Sheet, International Bank for Reconstruction and Development WDI.

Notes: We deflate the commodity prices with the MUV Index of the plane Bank. The bottom year is 2010. We assess the variables with DF–GLS (Elliott *et al.,* 1996) and KPSS (Kwiatkowski *et al.*, 1992) tests, and, to think about one structural break, with Zivot and Andrews (1992) tests. The KPSS tests have a null hypothesis, while the DF–GLS tests have a null hypothesis of unit root.

Furthermore, the Zivot–Andrews tests have a null hypothesis of unit root without structural break. The results of the three unit root tests are mostly consistent. We discover that almost all the variables at level are integrated and none of our variables have unit roots in first differenced form (Table 3). Additionally, we test for cointegration with the ARDL bounds technique (Pesaran *et al.,* 2001). Table 2 reports the results: the cocoa market equations represent cointegrating relationships.

Table 3. Unit root tests of the cocoa market variables

Variable	KPSS		DF–GLS		Zivot–Andrews		
	Without trend	With trend	Without trend	With trend	Break in const.	Break in trend	Break in both
Supply	1.980***	0.214**	1.518	−2.970*	−6.045***	−5.882***	−7.160***
Yield	1.640***	0.270***	0.020	−1.678	−6.070***	−6.494***	−6.982***
Demand	1.980***	0.302***	2.427	−1.838	−4.088	−3.930	−4.147
Stocks	1.680***	0.186**	−0.423	−1.890	−3.382	−2.553	−3.457
Cocoa price	0.629**	0.191**	−1.326	−1.406	−3.500	−2.084	−3.140
Coffee price	0.899***	0.157**	−2.038*	−2.261	−3.756	−2.736	−3.345
Palm oil price	0.821***	0.242***	−0.992	−1.024	−2.576	−2.399	−3.552
GDP	1.980***	0.392***	1.699	−0.706	−3.021	−3.350	−3.130
ΔSupply	0.046	0.035	−6.554***	−6.539***	−8.276***	−7.654***	−8.204***
ΔYield	0.167	0.038	−7.686***	−7.390***	−9.420***	−9.006***	−9.451***
ΔDemand	0.081	0.071	−4.904***	−4.910***	−7.269***	−7.098***	−8.226***
ΔStocks	0.078	0.070	−4.327***	−4.296***	−6.927***	−6.327***	−6.878***
ΔCocoa price	0.063	0.063	−5.849***	−6.104***	−8.216***	−7.106***	−8.164***
ΔCoffee price	0.077	0.076	−4.844***	−4.832***	−7.033***	−6.522***	−7.008***
ΔPalm oil price	0.119	0.048	−7.864***	−8.492***	−9.589***	−9.505***	−9.603***
ΔGDP	0.872***	0.115	−2.816***	−4.908***	−6.464***	−6.130***	−6.445***

Notes: The KPSS tests (Kwiatkowski *et al.*, 1992) employ the Quadratic Spectral kernel with automatic bandwidth selection. In the Zivot and Andrews (1992) and DF–GLS (Elliott *et al.*, 1996) tests, the Schwarz information criterion selects the lag length with a maximum of 10 lags.
$p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.

Estimator

First, we estimate the cocoa market model with the OLS and 2SLS methods. Within the 2SLS estimation, the instruments contains the lagged endogenous variables. This suggests that each one the equations are over identified. Furthermore, the instrumental variable tests show proper instrument. However, almost like Hameed *et al.*, (2009), we discover no endogeneity problem in our model. Therefore, both the OLS and 2SLS methods are consistent, but the OLS is more efficient.

Table 4. Instrumental variables tests of the cocoa market model.

Model	**Fragile instruments test**	**Over identifying restrictions test**	**Endogeneity test**
Supply equation	27.70	0.1473	0.7135
Demand equation	192.58	0.2854	0.7136
Cocoa price equation	133.81	0.1546	0.9485
Source: Field Survey Data, (2021).			

Notes: The weak instruments test statistics are the F-values of the Kleibergen and Paap (2006) method. Furthermore, the over identifying restrictions and therefore the endogeneity test statistics are the p-values of the Hansen (1982) and Eichenbaum *et al.*, (1988) methods. The tests use the Bartlett kernel with Newey−West automatic bandwidth selection and small-sample adjustments. The instruments contains the lagged endogenous variables. The endogeneity tests have a null hypothesis of exogeneity, and therefore the over identifying restrictions tests have a null hypothesis of instrument exogeneity. As a rule of thumb, the instruments are weak if the Kleibergen and Paap F-statistic is smaller than 10. We re-estimate the cocoa market model with the seemingly unrelated regressions (SUR) method for efficiency gains. This technique estimation method is acceptable when all regressors are assumed to be exogenous. It takes under consideration contemporaneous correlations within the errors across equations and heteroscedasticity (Greene, 2011). In contrast to the 2SLS technique, we discover that the OLS and SUR methods produce largely coherent results. However, we reject the hypothesis of the SUR approach that the regressions are related because the p-value of the Breusch and Pagan (1980) test for independent equations is 0.136. Therefore, we discuss only the OLS leads to detail. The estimates of the cocoa supply model are presented in Table 4, we discover that each one significant coefficients carry the a priori anticipated signs. Consistent with our results, the present and lagged prices of cocoa beans are significant determinants of the worldwide cocoa production. They reflect the effect of the short-run harvesting and therefore the long-run farm investment decisions. Furthermore, we discover that the planet cocoa supply is extremely price-inelastic: the corresponding short-and long-run estimates are 0.07 and 0.57. We attribute this to the long cocoa production cycle and therefore the large fixed farm investments (Dand, 2011). Additionally, the costs of coffee lagged three and 7 years also are factors influencing cocoa supply, which reveals that farmers decide about crop production a few years beforehand. However, coffee appears to be a weak cocoa supply substitute. This is often a plausible result: the land suitable for cocoa is extremely ready to support coffee, but uprooting and replanting an existing plantation costs labor, time, and money, and therefore the new crop gives no return for a few of years (Dand, 2011). Moreover, the yield of cocoa seems to be a big think about the cocoa supply model thanks to its explicit association with production. Finally, the previous years' cocoa production also emerges as a serious determinant. Believing the national cocoa market models, supply adjusts slowly to its equilibrium value, again partially as a results of the long cultivation process.

Table 5. Socio-economic Characteristics of Respondents (cocoa farmers)

Variable	Mean	Standard Deviation	Minimum	Maximum	Sample size (n)
Cocoa Production					
Cocoa output (kg)	797.4	912.1	31.3	5,937.5	257
Cocoa farm size(ha)	3.0	3.7	0.4	36	296
Quantity of insecticides (litres)	6.6	9.3	0.2	60.0	207
Quantity of fungicides (satchets)	47.9	65.9	0.5	380.0	157
Quantity of fertilizer (bags)	5.4	5.1	1	45	101
Household Characteristics					
Age of cocoa farmer (yrs.)	51.5	15.2	15	86	300
Working experience (yrs.)	19.6	13.7	2	65	297
Household size	8.5	5.6	1	50	298
Number of adults working on cocoa farm	3.3	2.8	1	19	197
Educational status	2.8	1.2	1	2	298
Gender	1.2	0.4	1	2	300
Cocoa income (Le)	860.69	920.97	28.12	5,343.75	257
Source: Field Survey Data, (2021)					

Table 5 shows the socio-economic characteristics of selected cocoa growers in Kailahun district eastern region of Sierra Leone. The mean age of the cocoa farmers was 51.5 years. The mean working experience was 19.6 years. The sample farmers have enough experience in cocoa cultivation to enable them to manage their farms properly. However, the mean age implies that cocoa farmers in Sierra Leone are aged and their age could affect cocoa output since they might not have adequate strength to perform the farming activities. Thus, they can employ more adult household members to perform their farming activities, the average number of adults working on the farm was 3.3 people. The educational status of the farmers was low as the majority (52.0%) had middle school education and 21.5% of them were illiterates. Considering gender, 80.0% of the interviewed farmers were males while 20.0% were females. The mean farm size was 3.0 ha, implying that cocoa cultivation is dominated by small-scale farmers who on average had cocoa yield of 370 kg/ha. The cocoa output variable with mean value of 797.4 kg had a bigger standard deviation or variance, which might be due to the differences in farm management practices of the cocoa farmers and varying rainfall amounts and its distribution patterns experienced over the years. The mean income from cocoa was

Le 860.69 with a high standard deviation of Le 920.97, which was due to the high variation in cocoa output.

Table 6. Ordinary Least Square (OLS) estimates of Cobb-Douglas production function

Variable	Parameter	Coefficient	Standard Error	T-Ratio
Constant	β_0	4.434	0.381	11.642***
Household size	β_1	0.261	0.141	1.856*
Cocoa farm size	β_2	0.514	0.112	4.574***
Quantity of insecticides	β_3	0.273	0.083	3.286***
Quantity of fungicides	β_4	0.090	0.062	1.442*
Quantity of fertilizer	β_5	0.325	0.110	2.955***
F test	F(5, 43)	14.19***		
R squared	R^2	0.623		
Adjusted R squared	R^2adj.	0.579		
Durbin-Watson statistic	DW	2.381		
Sample size	N	49		
Note: * sig. at 10 % level, ** sig. at 5 % level, ***sig. at 1% level				
Source: Field Survey Data, (2021).				

The results of the OLS estimates of the Cobb-Douglas production function are in Table 2. The attempt made in estimating the stochastic frontier model based on Cobb-Douglas production function was not successful. This was due to the absence of the one-sided error term, U_i, in the model as indicated by the statistically insignificant sigma-squared (σ^2) and gamma (γ) figures. This implies that the ordinary least square estimation would be adequate representation of the data. Therefore, ordinary production function was estimated using the OLS regression analysis. Although the survey interviewed 300 farmers, the different figures of the total numbers of farmers (n) used in the summaries occurred because there were missing values and these led to the pairwise elimination of some of the cases during the analysis.

The F-test was statistically significant at the 1% level, meaning that the production function existed; that is, all the explanatory variables jointly explained the variations in the output. The R-squared was 0.623, indicating that 62.3% of the variation in the cocoa output was explained by the independent variables included in the model. Autocorrelation was absent in the data as shown by the Durbin-Watson statistic of 2.381. All the independent variables emerged significant. The intercept, cocoa farm size, quantity of insecticides and quantity of fertilizer were significant at the 1% level. The household size and quantity of fungicides were significant at the 10% level. The signs of all the coefficients of the explanatory variables were positive as expected. The sum of elasticities of the factors in the Cobb-Douglas production function was 1.442, which was more than one, implying that the cocoa farmers were operating in the increasing returns to scale. The sum of the elasticities being greater than one implied increasing return to scale. For instance, 100% increase in all the factor levels would result in 146.3% increase in cocoa output.

Table 7. Efficiency of resource use in cocoa production

Factor input	MPP (kg/unit input)	MVP	MFC	r = MVP/MFC	D (%)
Household size	22.64	48.90	3.50	13.97	92.84
Cocoa farm size	126.31	272.83	500.00	0.55	-83.00
Quantity of insecticides	30.49	65.86	25.00	2.63	62.04
Quantity of fungicides	1.39	3.00	0.50	6.00	83.33
Quantity of fertilizer	133.11	287.52	14.70	19.56	94.89
Source: Field Survey Data, (2021).					

Table 7 shows results of the marginal analysis of input utilization. The quantity of fertilizer applied to the cocoa farm had the highest marginal physical product (133.11 kg/ bag), followed by cocoa farm size (126.31 kg/ha), the quantity of insecticides (30.49 kg/litre), household size (22.64 kg/person) and finally, the quantity of fungicides variable (1.39 kg/satchet). The household size, insecticides, fungicides, and fertilizer were underutilized for cultivation of cocoa since their corresponding ‘r’ figures were more than one. For optimal resource allocation in cocoa production, they should be increased by 92.84 %, 62.04 %, 83.33% and 94.89% from the current levels, respectively. However, land represented by cocoa farm size was over-utilized due to the fact that its ‘r’ estimate was less than one and its use should be reduced by 83.0% to ensure efficient production.

The positive values of the MPPs of production resources also emphasize the importance of these resources in cocoa cultivation. This means that these variables or factors are important in increasing cocoa production. Therefore, the government may emphasize the use of these factors in cocoa cultivation.

Cost-benefit and Return Analysis of cocoa production

Table 8. Show Cost and return analysis of cocoa production

		Farmer						**Processor**			
Item	**Cost (Le)**	**Unit**	**No.**	**Qut**	**Total**	**Item**	**Cost (Le)**	**Unit**	**No.**	**Qut**	**Total**
I. Return											
Average Dried Beans (kg)	85, 000	per kilo	700	kls.	63, 750	Sales per kilo	135, 000	Per pack	5	pouches @200g	670
Total Return (P)					63, 750						670
II. Cost						**II. Cost**					
1) Tools (bolo, water hose, scythe)		Lump sum			1,000, 000	1) Dried beans	85	Per kilo	1	kl	85
2) Seedlings	35, 000	Per grafted seedling	450	Pcs	17, 000	2) Brown sugar	68, 000	Per kilo	1	kl	68
3) Materials (jute bag)	5,000	Per bag	15	Bags	1,335	3) Standing pouch	15, 000	Per pc/ 200g	5	Pcs	70
4) Labor	25, 000	Per day	48	Wks	12, 000	4) Grinding	20, 000	Per kilo	1		20
Land prep											
Planting						5)Transportation Cost	20, 000	Trans	10	kls	2
Fertilizer Application						6) Sticker/Label	2	Per label	5	labels/ kl	10
Harvesting											
Total Cost (P)					35, 800						240
Net Return					27, 900						400
Return on Investment					75.89						140

Based on the cost and return analysis in table 4 above, a kg of dried cocoa beans will cost Le 85,000 however, if sorted, the cost can increase between Le 100.00-Le 150.00/kilo. The total sales is Le 750,000 and the total cost is Le 35, 835.00 which is used for buying tools, seedlings, materials and labor. The net return is Le 27, 915.00 with a return on investment of 75.89%. The high return on investment is indicative that cocoa production is highly profitable. On the processor side, a kilo of cocoa will result to a sales value of Le 670.00 and a total cost of Le 260,000. This will give a net return of Le 415.00 and a return on investment of 140%.

Table 9. Income and cost analysis for the Business and return on investment

Est. Income Surplus ($, 000)	69.8	624.47	489.12	467.97
It is recommended that, 50% of the income surplus is put back into investment annually for the first five years so as to increase shareholders dividends.				
Plough Back Profit Policy (50%)	34.9	312.24	244.56	233.85
Return on Investment = (Income Surplus / Total Capital Invested) * 100				
Estimated Return on Investment	17.2%	154%	120.6%	115.36%
Source: Field Survey Data, (2021).				

Note: Total amount of capital already invested into operating Agro Cocoa Investment Limited and setting up the Agro Cocoa Financing Scheme is $ 1,150 and the total amount of capital required from new shareholders to launch and operate the Agro Cocoa Financing Scheme is $ 45,300. The total investment expected into the company for operating the Agro Cocoa Financing Scheme in Sierra Leone in phase one is $ 165,450.

Table 10. The cash flow analysis of cocoa investment per year

Cash flow Analysis				
A. Cash Inflow	**Year 0**	**Year 1**	**Year 2**	**Year 3**
Equity	600,000			
Loan	1,500,000			
Proceeds from microfinance		200,000	300,000	300,000
Contributions and membership fees From Chiefdom Cooperatives	-	5,000	5,000	5,000
Premium on Produce Price	-	30,000	50,000	70,000
Net Profit	-	-1,470	384547	1,012,985
Total Cash Inflow	**2,100,000**	**233,530**	**739,547**	**1,387,985**
B. Cash Outflow				
Loan Repayment (Principal)	-		400,000	1,100,000
Bonuses	-	5,000	5,000	5,000
Total Cash outflow	-	5,000	405,000	1,105,000
Net Cash Flows	2,100,000	223,530	334,547	282,985
Accumulative Cash Inflow	**2,100,000**	**2,323,530**	**2,658,077**	**2,941,062**

Accounting Rate of Return (ARR) = Average net profit/Initial investment *100
ARR = 465354/2100000*100
ARR = 23%

Pay-Back Period = 2-(Initial Investment–total cash flow in year 2)/Initial Investment
= 2-(2100000 -739547)/2100000
=2-(1360453)/2100000
=2-0.647
=1.3 approximately year two

From the above calculation, the loan repayment obligation should start in fourth month of year two.

Cumulative cash flows-breakeven in five years of establishment of cocoa plantation

Figure show a cumulative cash flow–Breakeven in five years of establishment of cocoa plantation by smallholder farmers. The cumulative cash flow-breakeven in five years of establishment of cocoa plantation by smallholder farmers in Sierra Leone reveals that the initial establishment cost of a cocoa estate may require some heavy cash to the tune of US$ 4.9 million (Figure 2). However, from the first to third year of establishment, the cost of establishment and maintenance declines to US$ 1.8 million. This could be attributed to the fact that in Sierra Leone, most cocoa cultivation is done as agroforestry systems wherein food crops are planted in-between the rows of cocoa stands to serve as source of food and income during the initial stage of establishment of the cocoa plantation while farmers await the proceeds from the cocoa plants. In some cases, upland farming is done in the cocoa estates for two consecutive years where crops such as cotton beans, maize, guinea corn, bulrush millet, melon, sesame, cassava, pigeon peas, okra, pumpkin, chilli, tomatoes, cocoyam and yams are planted. Harvests from these crops are used partly for consumption by the farming household and partly as source of income for the family. From the fourth to the sixth year, the cost of maintenance could drastically reduce and income from the estate will increase from US$ 0.3 to 7.8 million. At this stage, farmers will start to realize far above the cost of production, provided conditions for the growth of the crop are favorable.

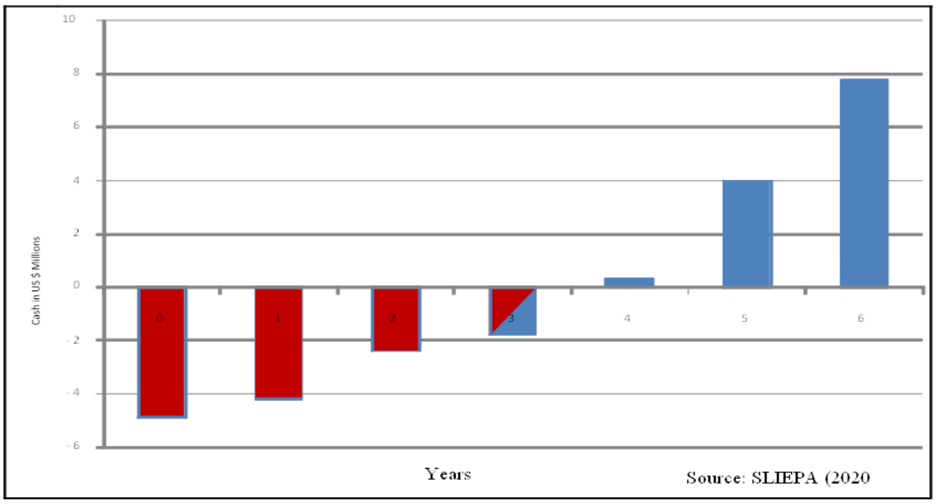

Figure 2. Cumulative cash flows-breakeven in five years of establishment of cocoa plantation.

Conclusion and Recommendations

The economic and increase in Africa and Asia have largely boosted the planet demand cocoa and triggered an unprecedented volatility within the world cocoa price during this new century. This price volatility makes the many cocoa farmers within the developing world highly susceptible to poverty. An outsized volatility within the value of an agricultural commodity is linked to the inelasticity of its supply or demand. Therefore, we test the hypothesis that the worth elasticity of the worldwide cocoa supply and demand are low. The results compare favorably with theory: all significant variables carry the a priori expected signs. Furthermore, we discover that the planet cocoa supply is extremely price-inelastic: the corresponding short-and long-run estimates are 0.07 and 0.57. Additionally, coffee appears to be a weak cocoa supply substitute. The worth elasticity of worldwide cocoa demand also falls into the extremely inelastic range: the short-and long-run estimates are −0.06 and −0.34. Finally, oil seems to be a weak cocoa demand substitute. Supported these empirical results, we consider the prospects for cocoa price stabilization. The cocoa price volatility resulting from factors above was treated with various unsuccessful methods within the past: planned economies, marketing boards, and explicit supply or price manipulations (Dand, 2011). These experiments caused inefficiencies, cause market failures, and are unlikely to win wide support (Sarris and Hallam, 2006). In 1973, the International Cocoa Organization (ICCO) was established to control the worldwide cocoa buffer stocks and production to stabilize world cocoa price during a zone. However, it's been ineffective in maintaining the steadiness of cocoa prices thanks to insufficient funding also because the absence of the most important cocoa consumer (Dand, 2011). Consistent with Piot-Lepetit and M'Barek (2011), a possible solution for reducing the price volatility would be the encouragement of crop diversification. This increases the price elasticity of cocoa supply by adjusting the effort and money allocation between the crops, thus decreasing price volatility. The study concluded that cocoa farming still remains a profitable business in the cocoa belt of Sierra Leone. Since the business is a profitable one, the government and organizations (including NGOs) aimed at providing jobs and profitable livelihood activities for Sierra Leonean, especially in the eastern region of Sierra Leone to promote the production of cocoa.

The study concluded that cocoa farming still remains a profitable business in the cocoa belt of Sierra Leone. Since the business is a profitable one, the government and organizations (including NGOs) aimed at providing jobs and profitable livelihood activities for Sierra Leonean, especially in the eastern region of Sierra Leone to promote the production of cocoa. This will equally boost the foreign exchange earning capacity of this agricultural sub-sector of the economy thus helping in accelerating growth of the agricultural sector of the economy. Parsimoniously Cocoa production is viable with a high return on investment of 75.89% and 140% for the farmer and processor. There is an increasing demand for Cocoa-based products however; the supply is still inadequate at the domestic and global market.

The estimation of the Cobb-Douglas production function demonstrated that the coefficients or elasticities of household size, farm size, insecticides, fungicides and fertilizer had statistically significant and positive impact on cocoa output, implying that they are important in increasing cocoa production. The measurement of the marginal physical product of the household size, farm size, insecticides, fungicides and fertilizer indicated positive values re-emphasizing the importance of these factors in cocoa production. The study also observed some ineptitude in the use of resources in cocoa production based on the fact that some factors of production were underutilized while others were more utilized.

Recommendations

1) Government should pursue programmes that will make improved seedlings, which can guarantee higher yields and higher market values, readily available from the research stations to the cocoa farmers so that their overall output will increase in both quantity and quality.
2) Government and other stake holders such as NGOs, microfinance banks and agricultural agencies should provide farmers with access to credit at affordable interest rates or cost of capital so that then productivity of capital may be guaranteed.
3) Government should focus its effort on the crop protection department in the ministry of Agriculture for assisting cocoa farmers in spraying their farms with insecticides and fungicides for pests and disease control, as well as application of fertilizer to improve soil fertility.
4) There is a need to build the labour capacity through provision of agricultural extension services to the cocoa farmers in the study area.
5) Farmers are advised to involve more adult household members in their farming activities to increase cocoa output. Farmers should increase the use of insecticides, fungicides and fertilizer on their farms as recommended by MAFFS.
6) Farmers should reduce the excessive use of forest land to prevent deforestation through increased land productivity instead of land expansion to ensure efficient use of land in cocoa production. They can replant the old cocoa farms with high yielding cocoa variety or more profitable alternative crops to maximize the overall farm profit.
7) Government should educate farmers on the harmful environmental impacts of their farm activities associated with the use of chemicals and how to avoid them to ensure sustainable cocoa production.
8) Regular trainings aimed at introducing the concepts of participatory extension and promotion of facilitation skills, that could enhance the technical knowledge and skills of extension staff, lead farmers, rural operators (CBO, NGO and Farmers' Associations), to develop an appropriate programme and work plan, to monitor progress and constraints and adjust the programme to new requirements as the global markets will demand from time to time should be organized.

9) Trainings should also aim at the provision of business development services in terms of technical assistance to the farmers especially in marketing. The farmers' training should aim at putting farmers in charge of the analysis and definition of the constraints, rehabilitation and development opportunities and technologies through a participatory appraisal of priorities and their potentials. Farmers' training should focus on their needs and requirements with specific relation to the activities they are engaged in the cocoa value chain. Farmers' capacity should be enhanced through the development of their skills in planning and design, implementation, operation, maintenance and management of cocoa plantations and product of planting material.

Conflicts of interest

The authors declare no conflicts of interest.

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