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Rainfall Pattern and Nigerian Agricultural Value Chain: The Case of Cocoa Production in Etung, Cross River State, Nigeria.

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Abstract

This study empirically examines the relationship between rainfall pattern and value chain in cocoa production in Etung, Cross River State, Nigeria. It employed time series data obtained from the Ministry of Agriculture, Calabar and the Nigeria Metrological (NIMET) station, Ikom, Cross River State. The Augmented Dickey-Fuller and Phillips-Perron unit root tests were used within the framework of the error correction mechanism (ECM) for data analysis. The chi-square statistical tool was also employed to establish the nexus between the various stages in the cocoa value chain and its output. The result shows that annual rainfall, duration of rainfall and annual rainfall intensity has much impact on cocoa production. The result further revealed that the various components of the cocoa value chain such as production, fermentation, and drying of cocoa beans, marketing of cocoa, as well as the manufacturing and consumption of cocoa beans were equally found to have impacted on cocoa output in the area. The study recommends, inter alia, that the cocoa value chain in Etung can be enhanced by adopting drought-tolerant cocoa species such as amazon forester and prinitario groups by farmers. The cocoa value chain can be sustained by introducing irrigation farming to supply enough water during dry season.

Keywords: *Nigerian agricultural value chain, cocoa production, rainfall pattern and intensity.*

Introduction

Cocoa as a cash crop is of considerable importance to both producing and consuming countries, because it generates revenue from export, provides income and offers job opportunities. Cocoa is an important ingredient in the beverage, confectionery and pharmaceutical industries.

Therefore, enhancing the sustainability of cocoa production and improving on its value chain is imperative, particularly at a time when young people do not regard farming (including cocoa farming) as a veritable business choice. In the case of cocoa, this may be due to low profitability of its farming business and the relatively poor economic status of cocoa farmers (Gayi & Tsowou, 2016). Cocoa is the leading agricultural export crop of the country and Nigeria is currently the world's fourth largest producer of cocoa, after Cote d'Ivoire, Indonesia and Ghana and the third largest exporter, after Cote d'Ivoire and Ghana (Verter & Becrarova, 2018). It was a major foreign exchange earner for Nigeria during the 1950s and 1960s. In 1970 the country was the second largest producer in the world, but following investments in the oil sector in the 1970s and 1980s, Nigeria's share of world output declined significantly.

The declining yield in the cocoa sub-sector has been attributed to weather and climatic conditions such as temperature, rainfall, humidity as well as sunshine hours. These factors have aggregative effect on the growth and sustainability of cocoa plants thereby hindering the value chain. Cocoa is cultivated in areas with hot-humid climates and an average rainfall range of 1150mm to 2500mm with a temperature of 18^0C to 32^0C. Such area lies along the equator in West Africa, Central Africa, Central America, and Asia (Okongor, Afangideh & Obong, 2013). A weather condition with prolonged dry season that encourages bush burning is dangerous to cocoa production, and continuous rainfall for many weeks as it usually occurs in July and September easily leads to rapid spread of cocoa black pod diseases which is spreadable and infectious. This poses hardship to farmers because black pod can drastically reduce cocoa yield.

Cocoa was a major foreign exchange earner for Nigeria during the 1950s and 1960s and in 1970 the country was the second largest producers in the world but following investments in oil sector in the 1970s and 1980s, Nigeria's share of world output declined. In 2017, cocoa production in the country accounted for only 0.3 percent of agricultural GDP (FAO, 2018). As a key cash crop, it accounted for 21.0 percent of Nigeria's agricultural exports and generated US$711 million in 2015 (CBN, 2015). Nigeria's cocoa output declined by 38 percent to 284,000 tons between 2010 and 2014, a reflection of decreasing cocoa yield. In Etung, the volume of cocoa output averaged 44.38 and 50.28 metric tonnes between 1978 and 1980, and 1981 and 1990, respectively. The marginal increase has been attributed to inadequate rainfall in the area coupled with lack of improved seedlings and low processing of cocoa beans in the cocoa value chain. It averaged 82.82 and 86.71 metric tonnes between 1991 and 2000, and 2001 and 2010, respectively.

A nation's economic prosperity lies, not merely in her possession of abundant natural resources, but largely on her capacities to add value to them by way of systematic transformation of natural resources to finished or intermediate products. The key to wealth is value added. However, low investment, inappropriate government policies, poor infrastructure and outright lack of technological know-how have plagued the value chain of processing and marketing of agricultural produce (including cocoa) in the country. Processing of cocoa into cocoa derivatives is the highest value adding activity in the cocoa value chain, with the potential to generate significant export revenues. In 2017, cocoa production in the country accounted for only 0.3 percent of agricultural GDP (FAO, 2018). It accounted for 21.0 percent of Nigeria's agricultural exports and generated US$711 million in 2015 (CBN, 2015). Nigeria's cocoa output declined by 38 percent to 284,000 tons between 2010 and 2014, a reflection of decreasing cocoa yield.

Despite policy interventions by different administrations, the agricultural sector is still largely underdeveloped, mainly because the focus is on production rather than enhancing value addition across the value chain segments. For example, an analysis from the cocoa barometer suggests that in the production of a bar of chocolate, a marginal 6.6 percent of the value addition is in the production, while the remaining is in the processing, marketing, and retail segments of the chain. It is expected that this trend should be similar across most agricultural products. However, Nigeria's value chain is characterized by 80.0 percent small holder farmers and a few commercial processors plagued by inadequate inputs, obsolete technology and poor financing (Cocoa Barometer, 2016).

The cocoa value chain links the steps the product takes from the farmers to the consumers, which include research and development, input supplies, production, processing, marketing and finance. Nigeria is the fourth largest producer of cocoa globally with a production volume of 248,000 tons of cocoa beans between 2015 and 2018 (FAO, 2018). However, only 30 percent of the cocoa beans are processed with the remaining exported. Given this context, two questions claim our attention in this paper: (i) what is the impact of annual rainfall on cocoa production? (ii) What is the effect of cocoa value chain on cocoa production? In particular, we hypothesize as follows: (1) that annual rainfall has no significant relationship and impact on cocoa production in Etung, and (2) that cocoa value chain has no significant impact on cocoa production in Etung. Cocoa value chain in this study is measured in terms of the production, marketing as well as manufacturing and consumption of cocoa chocolate in the study area.

The cocoa value chain

The steps involved in the cocoa chocolate value chain includes cocoa production, harvesting, fermenting and drying, marketing, packaging and transportation, roasting and grinding as well as pressing chocolate manufacturing and consumption by final consumers. The cocoa bean production has to do with growing the trees, harvesting the cocoa pods, and fermenting and drying the beans. Cocoa is typically grown by small farm holders in Africa who account for between 80 and 90 percent of global production (Awe, 2012). Cocoa value chain has contributed positively to the overall cocoa production in West and Central Africa. The value chain helps to integrate small scale farmers into global cocoa market and thus helps in mitigating risk (Traore, 2009).

In order to develop chocolate flavor and aroma, the cocoa beans are fermented before drying. Fermentation is a tedious process that requires much attention. The fresh beans are covered with mats, banana leaves or placed in wooden boxes. The heating of the pulp around the bean ferments it. Various factors are involved in the fermentation pods which include cocoa variety, sugar content, beans size, aeration time, materials used and the prevailing climatic condition such as annual rainfall, duration of rainfall and the intensity of rainfall. The marketing of cocoa beans from farm gates to export markets has been carried out by national commodity boards in most producing countries like Nigeria, Cameroon, Ghana, and Togo. The beans are packed in bags and stored until shipment. Unless processing starts locally, an export company will ship the beans to processing locations (Awe, 2012).

The processing of cocoa beans involves roasting and grinding**.** The liquor may be used directly as ingredient for chocolate or pressed through a fine sieve or by using extractive solvents to obtain cocoa butter, leaving a solid material called cocoa cake or press cake. To make chocolate, cocoa liquor and butter are mixed with inputs such as sugar, vanilla, emulsifying agents and milk. The mixture is poured into conches, which stirs and smoothens the mixture under heat. The output of the liquid chocolate may be shipped in tanks or tampered and poured into blocks for sale to downstream sections of the value chain, such as bakers, dairies and confectioners.

The final step in the cocoa-chocolate value-chain includes packaging, commercial marketing and retailing. People around the world enjoy chocolate in many different forms as the products are sold through grocery retail channels, including supermarkets and convenience stores or through discounters and increasingly through online sipping across the globe.

Challenges and reforms in the Nigeria's agricultural value chain

Different administrations have focused on agriculture as a means of diversifying the economy and many policies and programmes have been designed. In 2012, the Agricultural Transformation Agenda (ATA) was initiated to enhance farmers' income, increase food security, generate jobs and transforms the country to a leading player in the food market. The ATA is reported to have increased agriculture yield by 11 percent to 202.9 million tones between 2011 and 2014. The scheme is equally reported to have boosted commercial banks' lending to the agricultural sector from 1 percent in 2011 to 5.0 percent in 2014, as well as reduced the 2014 food import bill by ₦466 billion (Adesina, 2015).

The present administration of Muhammadu Buhari recently launched the Agriculture promotion policy (APP) aimed at resolving food productive shortages as well as improving output quality and quantity in the country. Additionally, the Economic Recovery and Growth Plan

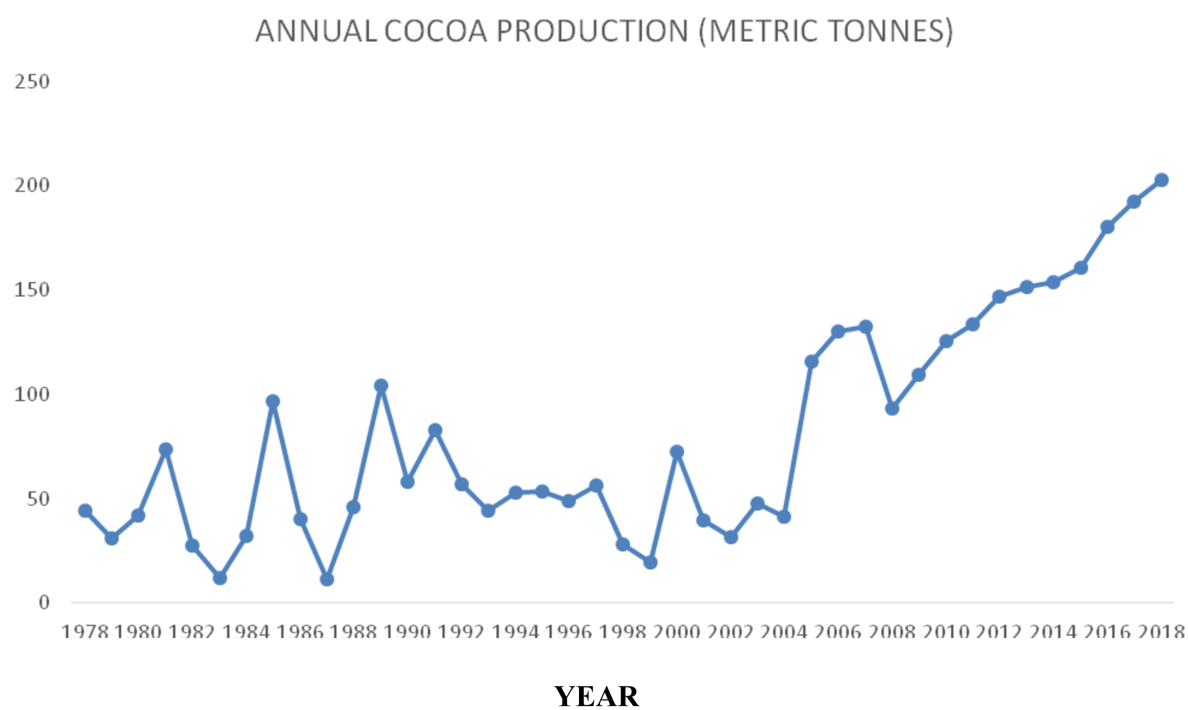
(ERGP) prioritizes food security aimed at achieving food self-sufficiency by 2020. Despite these policy interventions, the agricultural sector is still largely underdeveloped, mainly because the focus is on production rather than enhancing value addition across the value chain segments. For example, an analysis from the cocoa barometer suggests that in the production of a bar of chocolate, a marginal 6.6 percent of the value addition is in the production, while the remaining is in the processing, marketing, and retail segments of the chain. It is expected that this trend should be similar across most agricultural products. However, Nigeria's value chain is characterized by 80.0 percent small holder farmers and a few commercial processors plagued by inadequate inputs, obsolete technology and poor financing (Cocoa Barometer, 2016).

The challenges and recent reforms along the agricultural value chain in Nigeria are input supply, production, storage, processing, research, financing, marketing and trade. Agricultural production in Nigeria over the years has been impacted by limited input availability. The required seedlings, fertilizers and water are lacking by local farmers. The process of land security is equally consuming and expensive and consequently discourages agricultural activities. The input challenge was addressed by the Agricultural Transformation Agenda, which resulted in policies that facilitated the supply of subsidized seedling and fertilizers to 18 percent of farmers in Nigeria between 2011-2014 (Afoloyan, 2017; Nkang, Ajah, Abang & Edet, 2009 and Obasaju, Olayiwola & Okodua, 2016).

High cost of transportation, bad roads, and long distances from farms to markets, inadequate market information and poor logistic infrastructure negatively impact on the marketing of agricultural produce in Nigeria. From the perspective of trade, understanding of key export markets, (United States, United Kingdom and Europe) and low quality of agricultural products have hindered global transaction. It was on this premise that the federal government in 2012 established the Nigerian Expanded Trade and Transport (NEXTT) project funded by USAID to advance trade efficiency along the Lagos-Kano-Jibiya (LAKAJI) corridor. By 2015, the project facilitated a 25 percent reduction in time for importing goods and 5 percent decrease in time for exporting goods through Lagos to Libya border. Furthermore, for good passing through the corridor, a 35 percent decrease in cost-to-import, and 21 percent decrease in cost-to-export was recorded (Crena Corporation, 2017).

Figure 1 portrays the trend of cocoa production in Etung, which at best can be described as unstable. From its recent nadir production of 41.16 metric tonnes in 2004, production rose sharply to 132.64 metric tonnes in 2007, falling drastically the following year to 93.30 metric tonnes. However, from 2009, production has been rising sharply and steadily to its current value of 202.64 metric tonnes in 2018. This improvement is attributed to the consistent patronage of the Cross River State government in the importation of new improved varieties of cocoa seeds and the processing of cocoa beans locally.

Fig.1: Trend of cocoa production in Etung, 1978-2018



Policy framework of the cocoa value chain

Shepherd (2004) submits that there are three policy options that could promote efficiency in the cocoa value chain, which include macro-level policies as well as those that could be implemented by regional economic commissions and national governments. The second set is the meso-level policies, which would contribute to supporting the players along the cocoa value chain so as to bring adequate benefit to cocoa producers. The third are micro level policies, which centres on cocoa farmers. The Oligopsonic structure of the cocoa industry increases the risk of anti-competitive behaviour as has happened in other industries (Shepherd, 2004). Hence, it is extremely relevant to keep the cocoa industry under close scrutiny to ensure it remains competitive.

The first components of macro level policies should ensure proper implementation of competitive laws and policies at the national and international levels, as well as harmonizing at appropriate level. Secondly, considering that the efficiency and profitability of the cocoa sub-sector, and other sectors of the economy, are influenced by the entire national macroeconomic conditions, there is the urgent need for efficient and prudent macroeconomic management covering fiscal, monetary and exchange rate policies. The objective is to ensure stability in the macro-economy, specifically avoiding real currency overvaluation and high rate of inflation that would undermine prices offered to cocoa farmers in the local currency.

A transparent coca market benefits every stakeholder in the cocoa value chain, including the farmers, traders, processors, chocolate manufacturers and consumers. It allows cocoa farmers to gain better access to information on price trend, consumer demand and quality requirement in order to make optional planting and marketing decision. The meso-level polices create a level playing ground for the various entities along the cocoa value chain. These include the promotion of greater transparency in cocoa markets nationally and globally, and creating supportive arrangement that fosters the development of small players in cocoa markets, particularly in producing countries to keep the industry relatively competitive. The policies at the micro level is typically designed to support cocoa farmers. These set of policies should include promoting commercially viable farm based organizations, facilitating farmers' access to finance and price risk management instruments, and fostering cocoa products differentiation.

The Theory

This study is rooted in the theory of comparative cost advantage as propounded by David Richardo (1817). The theory states that nations engage in trade in goods and services for which they have comparative advantage in producing. A country has a comparative advantage in the production of a good provided the opportunity cost of producing that good in terms of other goods is lower in that country related to other countries. With regard to trade terms and trade gains, this hypothesis opines that there is no need for trade between two countries with the same trade terms as it will lead to zero gains from the transaction. To guarantee mutual gains from trade, trade terms have to be within the range of comparative costs (Krugman & Obstfeld, 2003).

The comparative advantage theory is perhaps comparable with the value chain approach in the cocoa industry as nations specialize in the activities that they have the comparative advantage in undertaking. For instance, suppose Ghana has a comparative advantage in producing cocoa beans rather than in processing while Nigeria has a comparative advantage in providing storage facilities and processing it and Cote D'Ivoire has a comparative advantage in branding and distributing the product to consumers, then individual nations ought to specialize in the stage for which they have the comparative advantage in performing. The Ricardian model contributed greatly to the development of trade by the application of relative prices in explaining the pattern of trade mostly agricultural products including cocoa.

Methodology

The research design adopted in this study is both survey and an *ex post facto* design. We adopted this procedure to enable us effectively fulfil the research objectives of this paper. First, because of absence of data on value chain in the cocoa subsector of the agricultural sector, we resorted to primary survey. This included face-to-face interviews and administration of questionnaires to households involved in cocoa production, fermenting, drying, processing and manufacturing. The respondents were farmers, processors, exporters and experts in the cocoa industry. The cocoa survey respondents were drawn from Etung Local Government Area of Cross

River State, Nigeria. The study covered the entire population of Etung which is about 107,854 people. The secondary data on annual rainfall and duration of rainfall were collected from the Nigeria Metrological (NIMET) station in Ikom from 1978-2018. Data on cocoa production (measured in metric tonnes) were obtained from the Produce Department, Ministry of Agriculture and Natural Resources for the corresponding period under study. Data on the intensity of rainfall were derived from the annual rainfall data applying the following formula:

$$\text{Intensity of annual rainfall} = \frac{\text{Total annual rainfall}}{\text{Total annual duration of rainfall}}$$

The time series analysis was carried out to establish the relationship between annual rainfall and volume of cocoa production for the period of 40 years (1978-2018). The design is predicated on various econometric techniques such as Augmented Dickey-Fuller (ADF) and Philip-Peron (PP) unit root tests, Granger causality test, Johansen co-integration test and the error correction mechanism.

Based on the review of literature above, the model is specified as follows:

$$TANP = f(ANRF, DURF, ANIRF) \qquad (1)$$

The above equation can therefore be rewritten as:

$$TANP = \alpha_0 + \alpha_1 ANRFP_t + \alpha_2 DURF_t + \alpha_3 ANIRF_t + V_t \qquad (2)$$

Thus $\alpha_1 \ldots \alpha_3$ are the coefficients of the equation.

The a priori expectation is that $\alpha_1>0$, $\alpha_2>0$, $\alpha_3>0$.

Where:

TANP = Total annual production of cocoa (measured in metric tonnes)

ANRF = Annual rainfall (in millimeters)

DURF = Duration of rainfall (in days)

ANIRF = Annual intensity of rainfall (millimeters/year)

The Taro Yamane formula was used to determine the sample size for the study on the various measures of cocoa value chain such as production, marketing as well as manufacturing and consumption of cocoa chocolate since the information was collected from the entire population of

Etung which is about 107,854 people as at 2018 (using the estimated population growth rate by National Population Commission of 2.5 percent per annum). We use the Taro Yamane (1967) formula to determine the scientific sample size for the study. The Taro's formula is expressed thus:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = sample size

N = population size

e = tolerable error (0.05)

1 = constant

$$n = \frac{107{,}854}{1+107{,}854(e)2}$$

$$n = \frac{107.854}{1+107{,}854\ (0.0025)}$$

$$n = \frac{107{,}854}{270.635}$$

$$= 398.5219$$

$$= \approx \underline{\mathbf{399}}$$

A total of 399 respondents were selected among the population for exhaustive study. Based on the nature of this study, we employed structured questionnaire as a relevant instrument for primary data collection. The questionnaire was designed following the 4-point Likert type scale response options of strongly agreed (SA), agreed (A), disagreed (D) and strongly disagreed (SD). The questionnaire consisted of two sections, A and B. Section A basically contained the respondents' bio-data such as age, gender, marital status and occupation. Section B comprised of questions relating to cocoa value chain in Etung. Descriptive statistics such as frequencies, percentages etc. was employed in most of the analyses in summarizing trends, changes and comparison across certain characteristics. The study employed two different methods of analysis, that is, the chi-square statistic which was used to analyze the qualitative information obtained from the respondents through questionnaire, and the ordinary least squares (OLS) multiple regression analysis which was used to determine the rainfall stressors affecting cocoa production in the area, such as annual rainfall, duration of rainfall and annual intensity of rainfall.

Result and interpretation of data analysis

Table 1 presents analytical details relating to the findings from the respondents. Of the 398 questionnaires distributed to the respondents, 384 copies representing 96.5 percent were correctly filled and returned to the researcher, while 14 copies of the questionnaire representing 3.5 percent were not returned. However, the 384 was considered a workable sample size for the analysis and was the true representation of the study population, as it is above 75 percent required for a good sample size by Yamane (1967).

From table 1 above, the sex of the respondents that returned the questionnaire were 59.9 percent for male and 40.1 percent for female. On the age distribution of respondents, 15.6 percent, 29.4 percent and 36.7 percent were aged between 10-20years, 21-30years and 31-40years, respectively. Those who were 41 years and above represented 18.2 of the total number of respondents. Hence, most of the respondents fall within the average age bracket. The composition of respondents by occupation shows that 15.1 percent and 17.4 percent of them were involved in cocoa production/fermenting/drying and marketing/trading/exporting respectively. Indeed, most of the respondents were consumers. The marital status of the respondents indicates that 91.9 percent of them were married while 8.1 percent were still single.

In order to test for the effect of cocoa value chain on volume of cocoa production (measured in metric tonnes), the production, marketing as well as manufacturing and consumption of cocoa chocolate were used as measures of cocoa value chain in the study.

The statistical analysis used was the chi-square statistical tool. The results of the analysis as presented in table 2 above indicates that the χ^2 value of 9.02 is greater than the critical value of

7.82 at .05 level of significance with 3 degree of freedom. This means that the χ^2 value is statistically significant.

Table 1: Demographic distribution of respondents

Sex	***No. of Respondents***	***Percentage***
Male	*230*	*59.9*
Female	*154*	*40.1*
Total	***384***	***100***
10-20	*60*	*15.6*
21-30	*113*	*29.4*
31-40	*141*	*36.7*
41years and above	*70*	*18.2*
Total	***384***	***100***
Occupation		
Production/fermenting/drying	*58*	*15.1*
Marketing/trading/exporting	*67*	*17.4*
Roasting/grinding/pressing	*79*	*20.6*
Chocolate manufacturing	*89*	*23.2*
Consumption	*91*	*23.7*
Total	***384***	***100***
Marital Status		
Married	*353*	***91.9***
Single	*31*	***8.1***
Total	***384***	***100***

Source: Field survey, 2019.

Table 2: Chi-square analysis of the relationship between cocoa value chain and volume of production

Responses	Positive	Negative	Total	Cal χ^2	Critical χ^2	df
Strongly agreed	*115(103.7)*	*20(31.3)*	*135*			
Agreed	*85(88.3)*	*30(26.7)*	*115*			

Disagreed	*55(57.6)*	*20(17.4)*	*75*	***9.02***	***7.82***	***3***
Strongly disagreed	*40(45.3)*	*19(13.7)*	*59*			
Total	***295***	***89***	***384***			

N=384, significance level = .05; df =3

Thus, the null hypothesis should be rejected while the alternate hypothesis is retained. This implies that there is a significant relationship between cocoa value chain and output of cocoa in Etung.

Unit root test results

The Augmented Dickey Fuller and the Philip-Perron unit root tests were conducted to examine the stationarity condition of the variables. As indicated in Table 3, ANRF, DURF, and ANIRF were stationary at levels in both ADF and PP analyses. In other words, the variables are integrated of order zero (i.e., I (0)). Conversely, TANP became stationary after first difference using both criteria. The aforementioned variables are therefore integrated of order one i.e., they are I (1). Where some of the variables are I (0) while others are I (1), it becomes imperative to perform co-integration tests to determine the presence of equilibrium relationship amongst the variables. The study adopts the Johansen co-integration test to determine the co-integrating relationship among the variables in the model.

Table 3: ADF and Phillips-Perron unit root test results

Variables	Level	ADF 1st Difference	Order of integration	Level	PP 1st Difference	Order of integration
TANP	-1.088667	-7.450171	I(1)	-0.818208	-9.579402	I(1)
ANRF	-5.364733	-7.091554	I(1)	-5.321517	-29.3819	I(1)
DURF	-3.761032	-8.772425	I(1)	-3.900305	-9.503591	I(1)
ANIRF	-5.239199	-9.870763	I(1)	-5.233742	-16.40058	I(1)

Source: Author's computation, 2019.

Granger causality test results

From table 4, a bidirectional relationship was found between annual rainfall and total annual production of cocoa. However, there was a unidirectional relationship between duration of rainfall, annual intensity of rainfall and total annual production of cocoa, with causality running from duration of rainfall, annual intensity of rainfall to total annual production of cocoa.

Table 4: Pair-wise granger causality test results

Variable	Direction of relationship	Variable
ANRF	↔	**TANP**
DURF	→	**TANP**
AIRF	←	**TANP**

Source: Researchers' computation (2019)

Table 5: Co-integration results
Series: TANP ANRF DURF ANIRF
Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
*	0.521374	53.26596	47.85613	0.0142
1	0.348175	24.52933	29.79707	0.1790
2	0.151537	7.838122	15.49471	0.4828
3	0.035986	1.429318	3.841466	0.2319

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
*	0.521374	28.73663	27.58434	0.0355
1	0.348175	16.69121	21.13162	0.1871
2	0.151537	6.408804	14.26460	0.5613
3	0.035986	1.429318	3.841466	0.2319

From the Johansen co-integration result reported in Table 5, long run relationship exists amongst the variables in the estimated equation, given that both the trace and maximum eigen values indicates one co-integrating equation at the five percent level of significance. Therefore, the null hypothesis of absence of co-integration is rejected, while the study proceeds to estimate the long run coefficient of the model.

Error correction model

The error correction result is as reported in table 6. From the table, there exist a positive relationship between annual rainfall (ANRF) and total annual production of cocoa (TANP). This is in tandem with theoretical expectation as it is assumed that the annual yield of cocoa is influenced by amount of rainfall in the humid tropical region. The coefficient indicates that a 1 percent increase in annual rainfall will lead to a rise in cocoa production by 0.75 percent. The result equally indicates a positive relationship exist between duration of annual rainfall (DURF) and total annual production of cocoa (TANP) in Etung. The coefficient of duration of annual rainfall of 3.54 is an indication of the positive impact of duration of rainfall on cocoa production in the study area. It is also statistically significant, implying that the duration of rainfall in Etung is a major factor that influences the volume of cocoa production in the area. Furthermore, the coefficient of the annual intensity of rainfall (ANIRF) of 0.57 indicates that 1 percent increase in annual intensity of rainfall will lead to about 0.5 percent increase in cocoa production in the study area.

The error correction mechanism (ECM) satisfied the three a priori criteria for its acceptability given that it is negative, fractional and statistically significant. Hence, the result confirms the presence of long run relationship among the variables in the model. It also shows that the speed of adjustment is high since about 68 percent of the short run disequilibrium will be corrected each period within the year. The t-statistic of -5.21 shows that the error correction term is statistically significant at 5 percent level of significance.

The R-squared value of 0.59 and the value of R-squared adjusted of 0.54 indicates that about 54 percent of variation in TANP is explained by annual rainfall (ANRF), duration of rainfall (DURF), and annual intensity of rainfall (ANIRF), and about 46 percent was unexplained which may be accounted for by other factors not included in the model. The F-statistic of about 12.59

shows that all the variables in the model are together as a group statistically significant which means that the model has a good fit. Durbin-Watson (D-W) statistic of 2.068 indicates no autocorrelation in the model. Therefore, the results can be used for forecasting and policy simulations.

Table 6: Dependent Variable: LOG (TANP)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(ANRF)	0.752431	0.583634	1.289219	0.2058
LOG(DURF)	3.542799	1.324444	2.674932	0.0113
LOG(ANIRF)	0.567236	0.720590	0.787183	0.4365
C	-18.04475	7.057915	-2.556668	0.0151
ECM(-1)	-0.678549	0.130336	-5.206155	0.0000
R-squared	0.590006			
Adjusted R-squared	0.543150			
F-statistic	12.59178	Durbin-Watson stat		2.068474

Discussion of findings

The findings of the relationship between cocoa value chain and cocoa production showed that a significant relationship exist between cocoa production, fermenting, drying and the output of cocoa in Etung. This study is in tandem with the views of Traore (2009) who opined that the cocoa value chain contributes significantly to the overall cocoa production in West and Central Africa. The cocoa value chain helps to integrate small scale farmers into global value chain and enhances diversification as an essential component of the long term solution to the overdependence on imports and the vulnerability from unfavourable trade terms, as well as mitigating risk. The processing of cocoa beans in the value chain encompasses the flow of products, knowledge and information between smallholder farmers and consumers, which offers the opportunity to capture added value at each stage of the production, marketing and consumption process. Smallholder farmers need to better engage with value chains in order to gain added value for improving their livelihoods, whilst reducing their risks and increasing their resilience in the course of sustaining the value chain. The essence of the value chain in the cocoa industry is to offer pro-poor opportunities for growth, and those markets in which smallholders can have a comparative advantage need to be identified and the producers actively assisted. Smallholders with a strong social network can draw upon their social capital to strengthen their position within a value chain. The structure of the cocoa industry, which is presently characterized by weak and dispersed smallholder farmers continues to undermine efficient value chain in cocoa production. This structure, which prevails across most agricultural commodity value chains in Etung, leaves limited room for farmers to increase revenues to cover production costs and provide them with a margin for a decent livelihood. This is a disincentive to the sustainability of cocoa farming business in the area.

It is revealed from the findings that rain stressors such as annual rainfall, duration, and intensity of rainfall have much impact on the volume of cocoa production in Etung. These findings corroborate with the views of Okongor et al. (2013) who opined that the amount of rainfall in Etung has been on the decrease over the years, which has been attributed to climatic variation globally. This change affected rainfall duration and intensity with a significant impact on cocoa production.

Conclusion

Cocoa as cash crop remains one of the fastest selling and most desirable agricultural commodities in both the local and international markets. This is because the demand is still very high despite the declining yields, moving in tandem with the speedy growth and expansion of chocolate confectioneries and other related products. Cocoa has an added advantage because it is a perennial crop and can survive for over a long period of time. The cocoa value chain starts from growing the seed, harvesting, drying and fermenting the pods, marketing, packaging and transportation, roasting, grinding and pressing as well as chocolate manufacturing and consumption by final consumers. The sustainability of the cocoa value chain for efficient output is equally linked with the amount of rainfall in the study area. This is because the change in climate over the years affect the volume of cocoa production in the area.

Recommendations

The adoption of drought-tolerant cocoa species such as amazon forester and printario groups by farmers will help sustain the cocoa plants in times of drought and during periods of inadequate rainfall. This will help to increase the volume of cocoa production and hence sustain the value chain. The cocoa value chain in Etung could be improved by introducing irrigation farming to supply enough water during dry season. The efforts of the government in diversifying the economy through the non-oil export should be enhanced via the cocoa production value chain segment of the agricultural sector. This should be hinged on the avowed commitment and renewed decision of the Cross River State government to intensify expansion projects for cocoa processing and manufacturing in Ikom.

In order to spur cocoa production and enhance value chain in the country, cocoa beans processing industries should be established in cocoa producing states like Cross River, Ondo, Ogun and Oyo, etc. The government at both federal and state levels should establish firms that will help in the processing of cocoa beans with the aim of enhancing cocoa value chain in the country.

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