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Cocoa Farmer's Perception of Climate Variability and Limitations in Cocoa Production in Kono District, Eastern Sierra Leone

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Abstract— *Every region of our present world is experiencing climate change though its variability varies per region and the type of activities carried out for their livelihood. Cocoa producing communities in Kono District highly depend on the prevailing weather conditions for their production and a shift (variability) affects their production greatly. The aim of this study was to evaluate cocoa farmer's perception of climate variability and its limitations to their production in Sandor Chiefdom, Kono District. The study communities were purposefully selected because cocoa farming was their main livelihood source and therefore had all the variables needed for the completion of this research. The study adapted a longitudinal research design. Respondents perception of climate variability and limitations was explored in the study communities from 2010-2020. Simple random sampling was used to select the respondents thus; four (4) out of nine (9) sections were purposefully selected (Sangba Feh, Senkongo Feh Yawantanda, and Bafin) and fifteen (15) respondents from each section which totals sixty (60). Ten (10) stakeholders were recruited which included staff of Produce Monitoring Board (PMB), Environmental Protection Agency (EPA) and Traditional Leaders/land Owners. The total number of respondents totals seventy (70). Questionnaire and interview schedule were the two (2) data collection tools used and descriptive statistics was used to analyze the data. Weather variability have over the years affected cocoa production in the selected study communities in Sandor Chiefdom, Kono District therefore two key weather parameters (temperature and rainfall) were used to determine climate variability. Respondents' perception was sought on the two weather parameters in exploring climate variability in the study communities. It was discovered that all the respondents were aware of climate variability and its impact on their production. All the respondents stated that there was increased and decrease in temperature and rainfall for some years between 2010 and 2020 which was due to climate variability. Climate variables that limited respondents' cocoa farm activities ranges from inadequate weather information to vulnerability to pest and diseases. It was concluded that the perception of respondents on climate variability was correct. Therefore it was recommended that weather information and agricultural extension services provided for cocoa farmers should be accessible and reliable.*

Keywords— *Climate, variability, Sandor, temperature, rainfall etc.*

I. INTRODUCTION

In Sierra Leone, cocoa was introduced much earlier than other parts of West Africa possibly by the Portuguese in the 15th and 16th centuries. It was estimated that there was 202 ha (500 acres) planted in the country. It was introduced in two ways from Gold Coast (present day Ghana) in 1905 and in 1912 to the Agricultural Experimental Farm at Njala. Unfortunately, the seedlings raised from the 1912 introductions died out because of drought (https://producemonitoringboard.sl/botany#1555506824151-fdbd93el-3944). Cocoa is widely grown in Eastern Sierra Leonean districts of Kailahun, Kenema and Kono due to favourable climatic condition which requires a minimum of 90-100mm rainfall per month with an annual rainfall of 1500-2000mm. Cocoa also need equitable climate with well distributed rainfall. Need a temperature range of 15°-39°C with an optimum of 25°C is considered ideal for its growth. However, it is grown in the southern districts of Bo, Moyamba and Pujehun on low scale. Over the years the required climatic conditions for cocoa production have been affected due to climate variability in the production areas. According to Center for Science Education, climate variability is the aspects of climate such as temperature and precipitation differ from an average and this occurs due to natural and sometimes periodic changes in the circulation of the air and ocean, volcanic eruptions and other related factors. For Locatelli (2011), generalization of climate change may apply to physical drivers including El Niño southern oscillation, global scale impacts such as sea level rise and other global benefits of migration to climate change. In rural cocoa producing communities in Sierra Leone, climate variability is likely understood as farmers knowledge in climatology is narrowed to traditional variations of weather in their communities and is attributed to God/Allah or a powerful spirit. This often results in either over exaggerating, underestimating or ignoring their perceptions of climate variability in cocoa productivity. Communities are not always scientifically accurate in their assessments of climate change, as mentioned in the work of Adimassu et al., (2014) and Becken, et al., (2013), and so there are occasions where climate change and its accompanying repercussions are exaggerated or underestimated. Gandure, et al., (2013) conducted research in Gladstone, South Africa, and found mixed results: farmers' perceptions of significant rainfall variability were supported by meteorological data, whereas their perceptions of rainfall onset were at odds with meteorological evidence. Therefore, understanding climate variability by cocoa farmers through timely updates from the

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Sierra Leone's Meteorological Department and Agency is crucial to cocoa farmers' overall production as it is a determinant. This is similar to the work of Adam & Carl (1999) who suggested that climate is the primary determinant of agricultural productivity hence it is expected to influence crop and livestock production, hydrological balances and other components of agricultural systems. However, with all the criticisms against perception studies, it can bring to the fore community's understanding of local environment and climate as stated by Becken, et al., (2013) of which this study strongly held.

A. Overview of Climate Variability

The Intergovernmental Panel on Climate Change (IPCC, 2012) defined climate change as changes in the climate condition as a result of the changes in the mean and/or the variability of its properties and that which persists for an extended period, typically for decades or longer. To United Nations Framework Convention on Climate Change (UNFCCC, 2011), Climate Change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. The main difference in the two definitions is that UNFCCC's definition attributes climate variability to human activity in both overt and covert form while IPCC stressed their definition on climate variability that occur in a region for a considerable number of years without attributing its causative agent to human beings. Therefore, climate variability can be simply referred to as the climatic parameter of a region varying from its long-term mean. In that regard, climate variability may include all the variations in the climate that last longer than individual weather events. Empirical evidences from the work of (Stige et al., 2006) postulated that changes in climate have led to a reduction in crop production in most parts of the world. If the above suggested evidences are to be upheld, then it is succinct that most agricultural communities will be seriously hit especially cocoa farmlands that depends largely on rainfall and sunshine for its production. This is justified by the work of (Agbongiarhuoyi, et al., 2013) which stated that cocoa crop/plant is highly responsive to environmental and weather variations. In Sierra Leone, agriculture comprises the largest sector of her economy and employment and climate change have threatens food security and livelihoods of most of the population. What have worsened the situation is the change in precipitation and temperature; increasing the risk of droughts, floods etc. and have affected the country's agriculture seriously for the distance past (https://climateknowledgeportal.worldbank.org/country/sierra-leone). Sierra Leone's specific information as presented shows that climate variability is seriously affecting her agricultural sector especially tree crops (cocoa production). Community's perception on climate change can make valuable contributions by providing information on local climatic conditions and knowledge which can be used to inform policy. On this backdrop, the objectives of this study is explore cocoa farmers perception of climate variability and its limitation on their production.

II. METHOD AND MATERIALS

2.1. Main Characteristics of the Study Community

Kono District is found in Eastern Sierra Leone and it is the largest diamond producing region with its headquarters in Koidu City. It borders with Kenema District to the southwest, the Republic of Guinea to the east, Koinadugu District to the northeast and Kailahun District to the southeast (Sierra Leone: Kono District Profile, 2015). According to 2015 Re-Analysis Population and Housing Census, Kono district had a population of 505,767 and Sandor chiefdom had a population of 89, 879 persons. Kono District is located on latitude 8.7663° N or 8°41' 13" and longitude -10.9194° or 10° 55' 10" west (https://mapcarta.com/17160616). The average annual highest temperature in Kono District is 35.1°C (95.2°F), while the lowest average annual temperature records at 16.7°C (62.1°F). It also has an average monthly air temperature ranging between 25°C and 28°C. The district also has an average annual rainfall of over 250mm, 80% occurring between May and November (Johnson, 2002). The study community of Sandor Chiefdom has its headquarters in Kayima. Sandor Chiefdom has a land area of 1,482square Kilometers and is divided into nine sections viz: Yawantanda, Bafin, Feh, Dangbaidu, Sumungee Feh, Sangba Feh, Senkongo Feh, Kawa Feh, Njeko and Fakongo. Each section was engaged in cocoa production as a major livelihood after the glorious days of diamonds. The chiefdom is the lead cocoa producing region in Kono District and therefore it was purposively selected for the completion of this study because it had all variables needed.

2.2 Methodology

A longitudinal research design was used to carry out this study among cocoa farmers in Sandor Chiefdom, Kono District, Eastern Sierra Leone. It investigates events or phenomena (cocoa farmer's perception of climate variability and its limitation on their production) over ten (10) years period. It involves repeated observations of the same variables from (2010-2020). The main focus was to make repetitive investigations and make observations. Longitude research design targets the same group of people and interviews them at regular intervals and through this the behaviours are tracked and variables identified that have caused the change in their behaviours. This research design has an advantage in that it is flexible and therefore can address research questions of all types (why, how, what etc.) and it also help determine the appropriate data collection methods and selection of respondents. However, the main shortcoming of this research design is that, it increase the chances of unpredictable outcomes; for the fact that it involves smaller samples, the result cannot be generalized for a population. This study was conducted among cocoa farmers and major stakeholders dealing with cocoa and climate issues in the selected communities which included; Cocoa Farmers, Environmental Protection Agency (EPA), Produce Monitoring Board and Traditional Rulers/Land Owners. To sample the respondents, two (2) sampling approaches were used. Purposive sampling

was the first method employed. It was used to select major cocoa producing communities in Kono District due to the fact that it had all the variables needed for the completion of this study. Therefore out of the nine (9) sections in the chiefdom, four major cocoa producing sections were purposefully selected (Sangba Feh, Senkongo Feh Yawantanda, and Bafin) because they had the largest tonnage of cocoa than the other five (5) sections according to Produce Monitoring Board (PMB). From each section, fifteen (15) respondents were selected totaling sixty (60) and ten (10) respondents were also recruited from the stakeholder groups (Produce Monitoring Board (PMB) three (3), Environmental Protection Agency (EPA) two (2), and Traditional Rulers/land owners) five (5) totaling seventy (70). The respondents selected included both males and females but more males were selected because they were heads of their household and owned the cocoa farms. The selected communities have experienced climate variability over decades and therefore were equipped enough to give information. Two data collection methods were used; questionnaire and interview schedule. They were tailored based on the study objectives. The instruments were used in field work to obtain primary data from the respondents. Data was analyzed by descriptive statistics; frequency tables and graphs.

III. Result and Discussion

3.1 Cocoa Farmers' Perceptions of Climate Variability in Cocoa Producing Communities in Sandor Chiefdom, Kono District.

Variable	Strongly Disagreed	Disagreed	Neutral	Agreed	Strongly Agreed
Temperature					
Increased temperature experienced over the past 10 years	-	1(1%)	4(6%)	20(29%)	45(64%)
Decreased temperature experienced over the past 10 years	55(79%)	10(14%)	5(7%)	-	-
No change experienced in temperature over the past 10 years	50(71%)	20(29%)	-	-	-
Rainfall					
Increased rainfall experienced over the past 10 years	-	-	1(1%)	7(10%)	62(89%)
Decreased rainfall experienced over the past 10 years	65(93%)	5(7%)	-	-	-
No change experienced in rainfall over the past 10 years.	60(86%)	10(14%)	-	-	-

SOURCE: Field Data, 2022.

Table one: cocoa farmer's perception of climate variability in Sandor chiefdom, Kono District. Data gathered from the study communities indicated 45(64%) of the respondents whostrongly agreed that increased temperature in the communities for the past ten (10) years (2010-2020) and the highest incidence of sun rays was recorded in 2012, 2015 and 2018. This is in line with World Bank (2007) which stated that most farmers in Africa are aware of the effects and existence of climate change occurrence in their areas. For the very fact that the respondents agreed to have experienced high temperature in their communities, it should be regarded as facts and it is worth to go by because they were in majority. High temperature disturbs the required yield of cocoa as it affects untimely ripening of cocoa pods. This was noted by the work of Zuidema, et al., (2005) who opines that high temperature reduces the life expectancy of cocoa leaves, increase the rate of pod ripening thereby increasing the hardness of cocoa butter. The work of Najihah, et al., (2018) also supported the above views as they postulated that variability in temperature increases mortality rates of cocoa seedlings which may adversely influence yields and reduce the size and quality of cocoa beans. No doubt, the respondents reported poor harvest in the years 2012, 2015 and 2018 in Sandor cocoa farm communities. When asked if they ever experienced decrease in temperature in the past ten (10) years on their cocoa farm communities; 79% of the respondents strongly disagreed, 14% of them disagreed while 7% took a neutral posture. Respondents were further asked as to whether no change in temperature was experienced in the communities over the past ten (10) year period under review; 71% of them strongly disagreed and 29% disagreed which means temperature changes was experienced in the communities because all of them agreed. According to the above table 89% of the respondents indicated that, there has been increased in rainfall experienced in the communities over the past ten (10) under review, 10% of them agreed and 1% was neutral on the matter because they had small size cocoa farm and also had alternative livelihood source. Interviews conducted with recruited respondents from stakeholder groups in the study communities' (staff of Sierra Leone Produce Marketing Board and local chiefs/landowners) revealed that too much rainfall was experienced over the past ten (10) years especially in 2011, 2014 and 2020 which changed the farming season they were used to. This according to them affected their production and business. This has link with the work of Bridgemohan and Mohammed (2019) who suggested that intense rainfall leading to flood hinders the capacity of cocoa farmers to manage their crops, enhance leaching of soil nutrients and alter the interaction between leaves, connecting tissues and absorbing roots. The work of Obeng (2014) similarly noted that rainfall has the most tremendous impact on agriculture among all climatic elements. Respondents were further asked as to whether they experienced no change in rainfall over the past ten (10) years, 86% of them strongly disagreed and 14% disagreed but none agreed neither took a neutral posture on the issue. This shows that the study communities experienced changes in the rainfall pattern in different years for the fact that all of the respondents strongly disagreed and disagreed the point that no change in rainfall pattern was experienced in their communities. According to the landowners and local traditional rulers in Sangba Feh, and Senkongo Feh sections in 2011, 2014 and 2020, they experienced more rainfall in their communities which affected cocoa production and other agricultural activities. In Yawantanda, and Bafin sections, landowners and traditional rulers claimed that the rainfall pattern experienced in their communities was unreliable for some years notably 2011, 2014 and 2020. These years according to them had negative

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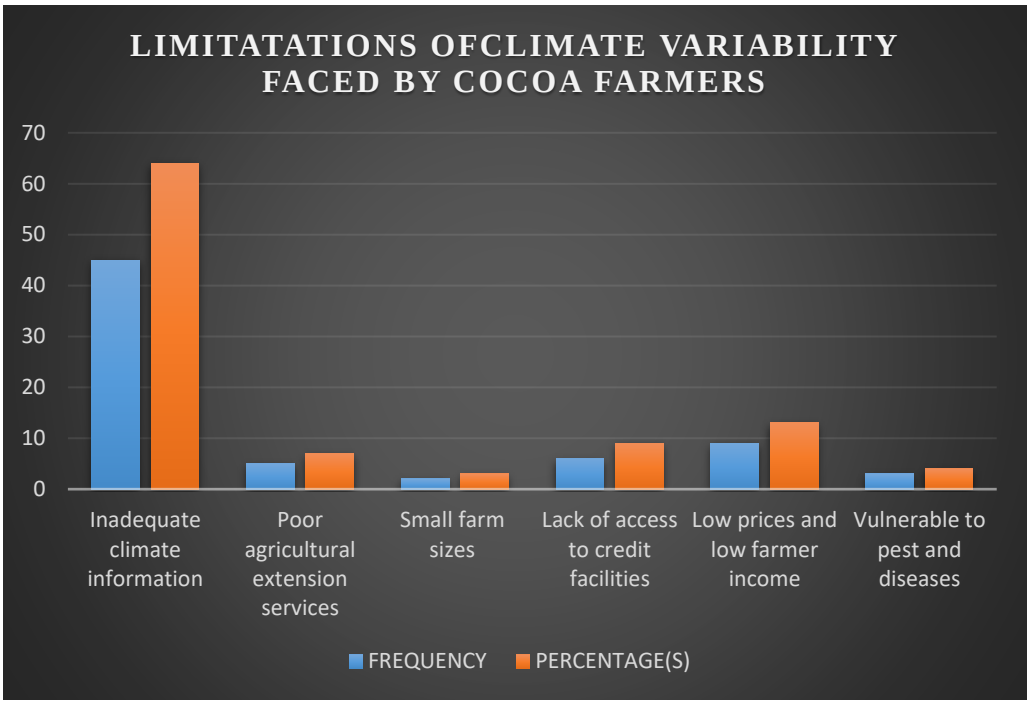
impact on their cocoa production and other agricultural activities which they attributed to climate variability. This was in line with the work of Nelson, et al (2010) who expressed high degree of certainty that climate change in African countries will have adverse effects on agriculture, food security and economic advancement, especially as smallholder farmers are experiencing increased climatic variability and change.

3.2 Limitations of Climate Variability Faced by Cocoa Farmers in Selected Cocoa Producing Communities in Sandor Chiefdom, Kono District.



SOURCE: Field Data, 2022.

Figure one: limitations of climate variability faced by cocoa farmers in selected cocoa producing communities in Sandor chiefdom, Kono District. Limitations are barriers that impedes effective cocoa production as it was stated by respondents in the study communities. To Moser and Ekstrom (2010), barriers are circumstances, situation or obstacles that lessen the efficacy of adaptation approaches. Therefore the words 'limitation and barriers' was used interchangeably in this work. According to figure one above, 64% of the respondents stated that inadequate climate information was one of the main limitation or barrier in their own words that impedes their production due to climate variability in the study communities while 13% indicated low prices and low famer income. In Sierra Leone, especially in agricultural communities, farmers depend on tradition weather forecast based on experiences and observations to carry out their farming activities. Little attention was paid to climate/weather information broadcast by state radio station (Sierra Leone Broadcasting Service), because they considered it as a guess and deceptive. Olsson et al (2004) argued that, prior to the development of contemporary scientific weather and climate forecast systems, people formed regular forecasts based on previous experiences and compared them to current observations. Most of the respondents claimed that, they don't have access to climate/weather information in the study communities. This also had link with the work of Yeboah (2017) who opines that there is lack of real access to reliable and usable weather data across Africa. Weather information is often unavailable and even if it exist, is inaccessible, of poor quality, unknown to those who need it most and above all unreliable. However, it was discovered that cocoa famers in the study communities earned low price for their products due to the remote nature of their communities which was contested by recruited members of the Produce Monitoring Board (PMB) on the grounds that they bought their proceeds based on government's standardized price. Respondents also reported low income gained from their cocoa proceeds. Their claims however, can be attributed to the simple fact that cocoa farmers in Eastern Sierra Leone bore heavy disadvantage in the market, with few opportunities accorded them to negotiate a better price for their products. Moreover, 9% of the respondents also stated lack of access to credit facilities, 7% of them indicated poor agricultural extension services, 4% claimed their vulnerability to pest and diseases and 3% of them stated small farm sizes as limitations or barriers they were faced with in their production processes due to climate variability. It was discovered that bulk of the respondents had never receive credit facilities and were not aware of its existence in the study communities. Traditional rulers and land owners were surprised to would have learnt that such scheme existed. Lack of income and credit facilities had impact on their production and their socio-economic livelihoods more especially when they experienced low yield due to low or excess rainfall and or adverse temperature conditions that disturbs their cocoa plantations. This is in line with the findings of Antwi-Agyei et al. (2013), who found that

there are a variety of barriers to smallholder farmers adapting to climate change, many of which are connected to technological and financial constraints, which limit the scale of adaptation in most developing nations. Respondents also reported of attacks of pest and diseases on the cocoa plantations destroying its pods. Most of the cocoa farms were comparatively small and therefore the spread of pest and diseases often affects it yields. In the study communities, most of the cocoa farms were of small size developed on impoverished diamond landscape once excavated. This has connection with the work of Alemu, et al, (2017) who opines that dominant challenge connected with land fragmentation is the small size, irregular shape and dispersion of parcels. Inadequate agricultural extension services was also another limitation or barrier envisaged by cocoa farmers in the selected study communities in Sandor Chiefdom. It was discovered that agricultural extension services with rural development intent was not carried out in the study communities and bulk of the respondents were illiterates. This was contrary to the view of Falola et al. (2012) who asserted that, the more educated people are, the more they become aware of climate change, its causes, effects and the measures required to reduce exposure to its impacts than their uneducated counterpart. With agricultural services and regular trainings in climate change, cocoa farmers would be capacitated to implement knowledge gained on their cocoa farms without going through formal education system. It should be noted that education (extension services and training) was an important factor in mitigating limitations of climate variability on cocoa farmers in the selected study communities but it was lacking.

IV. Conclusion and Recommendations

Cocoa farmers in the selected study communities were aware of climate variability and its impacts on their production. As earlier mentioned, this totally agrees with World Bank (2007) which noted that most farmers in Africa are aware of the effects and existence of climate change occurrence in their areas. From 2010 -2020 the climate and weather condition of the study communities was erratic. During some years, low rainfall was experienced while for others high rainfall experienced. The same situation was also envisaged in the case of temperature conditions. However, they were limited by several factors ranging from inadequate or poor access to climate information to vulnerability to pest and diseases. The following recommendations were provided for actions:

- Cocoa farmers be encouraged by government and partners in the field of agriculture by strengthening their position to diversify their incomes.
- Providing effective and regular agricultural extension services and skill training for cocoa farmers bordering on ways of protecting themselves from price shocks, crop failures and low prices and development of alternative income sources.
- Provision of local access to regular, reliable and timely weather information to cocoa farmers
- Involvement of educational institutions in communicating climate change knowledge and incorporating local weather predictions and observation skills in their research. This will encourage cocoa farmers to own up the result and implement it.

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