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UNITE DE RECHERCHE ET DE FORMATION DOCTORALE EN SCIENCE
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THE EFFECT OF RAINFALL AND TEMPERATURE VARIATIONS ON FOOD SECURITY IN TUBAH SUB-DIVISION (NORTH WEST REGION, CAMEROON)

A Dissertation Submitted in Partial Fulfilment of the Requirements for the award of a Master's Degree in Geography

SPECIALTY: RISK AND ENVIRONMEMTAL DYNAMICS

By

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Academic year 2021-2022

DEDICATION

To my father Dr Kuotong Nongho Rogers for all the spiritual, financial and material support he has been giving me which has enable me attain success in my education up to this level

ACKNOWLEDGEMENTS

I am indebted in gratitude to everyone who helped me through the entire process of this work. My heart felt gratitude goes first to my supervisor Pr. Enchaw Gabriel Bachange who despite his busy schedule did everything possible to guide me through this exercise. I equally acknowledge his valuable reading, corrections and helpful comments which helped to fine-tuned and shape this work.

My endless gratitude and special thanks goes to the entire staff of the Geography Department of the University of Yaoundé 1 for all the knowledge impacted in me throughout these years of my studies. In this regard, special thanks goes to the Head of Department Pr Tchawa Paul, Pr Moupou Moise, Pr Nkwemoh Clement, Pr Ngoufor Roger, Pr Youta Happi, Pr Zana, Pr Dogmo Louis, Pr Kengne Fodouop, Pr Tchindgang, Pr Mougoue Benoit, Pr Ojuku, Dr Ndi Roland, Dr Bamboye, Dr Mediebou Dr Evoung, Dr Teke, Dr Ngeh and Dr Foyet Delore.

The field work would have been tedious and cumbersome without the help of Dr Suiven of the University of Bamenda. Despite his busy schedule did not relent his effort to see that this work was well done. I am indebted to Tufoin Kilian and Wirsiy Destain for the inspiration they nurtured in me throughout this work and for reading and correcting this work. Equally I extend my sincere appreciation and gratitude to Enow Bakia for reading and correcting the manuscripts and for his word of encouragement.

Worth acknowledging are the effort of those who ceaselessly assisted me in the collection of data .I think here of the entire MINADER staff of the NWR especially to Mme Ngobesing Emilia who guided me throughout the internship, The Regional Delegate of Agriculture and Rural development for the NWR for granting me an opportunity to do an internship in his institution , the Mayor of Tubah , the Fon of Bambili, the director of IRAD .Great thanks to all the farmers of Tubah Sub-division and the various respondents for their mature understanding and unreserved cooperation that helped in obtaining information.

To my family, Dr Kuotong, Kuotong Mary and to all Kuotong's and Nongho's for their sacrifice in my studies up to this level. In realizing this work many people showed me courtesy, love and words of encouragement especially my friends Takoukam Albertine, Akoro Leonel, Suh Yannick and my lovely siblings.

ABSTRACT

The effect of climate variation on food security has been a serious threat to the world at large especially in the 21st century. The changing climatic conditions affect the agricultural system of the country which is largely rain-fed, particularly in Tubah Sub-division where the agricultural calendar has become a victim of the unreliable patterns of rainfall leading to a reduction in agricultural output. This has pushed many farmers to resort to using fertilizers, which often change the taste of most staple food in the study area and affect not only feeding habits of Tubah people but their food security as well. Besides, climate variation has equally brought about seasonal hikes in food prices making some food stuffs less affordable. The ongoing sociopolitical crisis and the high rate of urbanization have adversely impacted the land use in Tubah Sub-division with agricultural land and farm labour reducing.

This work sets out to investigate how the effect of climate variation has influenced food security in Tubah Sub-division. Three hypotheses were set to guide the study and both secondary and primary data were collected. Secondary data was gotten from published and unpublished documents consulted in libraries of different institutions and internet sources. Data for temperature and rainfall was gotten from RDARD and IRAD Bambui from 1965 to 2018.This was used to calculate rainfall variation index, Rainfall Abnormality Index and Standardized Precipitation Index (SPI) to show the changing trend in rainfall pattern. Primary data was gotten through questionnaire administration, interviews, focus group discussions and observations. A total of 170 respondents from 6 villages in Tubah Sub-division responded effectively to the questionnaire. Some observed phenomena were captured using a digital camera. Inferential and non-inferential analyses were done that paved the way for the testing of hypotheses, drawing up of meaningful conclusions and suggestions.

The results of the data collected, processed, analysed and interpreted revealed that response scores of 90% indicate awareness in changing climatic conditions, 60% affirmed unreliable rainfall for agriculture that has negatively affected crop yields and prices, and quantitative food security in Tubah Sub-division. Although analysis on quantitative variation in rainfall is still insignificant, IARA reveals a decline by a factor of R^2=0.0429 while SPI shows more episoof dryness in Tubah Sub-division. This indicates that the patterns of rainfall in the study area do not coincide with the agricultural calendar familiar to the farmers in Tubah Sub-division, and therefore, affecting farming activities and quantitative food security. The degree of food security in the area is dropping with time as just 37.1% of the respondents acknowledged to be food secured while 68.9% were food insecure as compared to the past 5 years. Findings also revealed that the use of fertilizers to boost yields might have affected soil quality or fertilizer application is poor as crop yields no longer respond positively to these inorganic fertilizers. Climate variation has brought about high food prices making food not affordable for all, particularly in the present context of socio-political crisis where food supply from rural areas is difficult and farmland is reducing due to urbanisation. In order to guarantee food security in Tubah Sub-division climate change mitigation and adaptation strategies need to be adopted. The impact of climate change on food production can be mitigated through agroforestry practices. Then, farmers should be provided with weather forecast information, climate resilient crops and crop specific information. The council should create council farms and warehouses where crops will be harvested and sold at affordable prices. Local food shows should be organized with the help of local authorities to sensitize people on cultural meals.

Key words: climate variation, food security, crop production, high food prices, climate change mitigation, climate change adaptation and Tubah Sub-division.

RESUME

L'effet de la variabilité climatique sur la sécurité alimentaire a été une grave menace pour le monde en général, en particulier au 21e siècle. Les conditions climatiques changeantes affectent le système agricole du pays qui est en grande partie pluvial, en particulier dans la sous-division de Tubah où le calendrier agricole est devenu victime des régimes pluviométriques peu fiables entraînant une réduction de la production agricole. Cela a poussé de nombreux agriculteurs à recourir à l'utilisation d'engrais, qui modifient souvent le goût de la plupart des aliments de base dans la zone d'étude et affectent non seulement les habitudes alimentaires des Tubahs, mais aussi leur sécurité alimentaire. En outre, la variabilité climatique a également entraîné des hausses saisonnières des prix des denrées alimentaires, rendant certaines denrées alimentaires moins abordables. La crise sociopolitique actuelle et le taux élevé d'urbanisation ont eu un impact négatif sur l'utilisation des terres dans l'arrondissement Tubah avec une réduction des terres agricoles et de la main-d'œuvre agricole.

Ce travail vise à étudier comment l'effet de la variabilité climatique a influencé la sécurité alimentaire dans l'arrondissement de Tubah. Trois hypothèses ont été formulées pour guider l'étude et des données secondaires et primaires ont été recueillies. Les données secondaires ont été obtenues à partir de documents publiés et non publiés consultés dans les bibliothèques de différentes institutions et sources Internet. Les données sur la température et les précipitations ont été obtenues auprès du RDARD et de l'IRAD Bambui de 1965 à 2018. Elles ont été utilisées pour calculer l'indice de variabilité des précipitations, l'indice d'anomalie des précipitations et l'indice de précipitation standardisé (SPI) pour montrer la tendance changeante des précipitations. Les données primaires ont été obtenues grâce à l'administration du questionnaire, des entretiens, des discussions de groupe et des observations. Au total, 170 personnes interrogées de 6 villages de l'arrondissement de Tubah ont répondu efficacement au questionnaire. Certains phénomènes observés ont été capturés à l'aide d'un appareil photo numérique. Des analyses inférentielles et non inférentielles ont été effectuées qui ont ouvert la voie à la vérification des hypothèses, en élaborant des conclusions et des suggestions significatives.

Les résultats des données collectées, traitées, analysées et interprétées ont révélé que les scores de réponse de 90% indiquent une sensibilisation aux conditions climatiques changeantes, 60% ont affirmé des précipitations peu fiables pour l'agriculture qui ont affecté négativement. Bien que l'analyse de la variation des précipitations montre que les précipitations sont fiables, l'IARA révèle une baisse d'un facteur de $R2 = 0{,}0429$ tandis que SPI montre plus d'épisodes de sécheresse dans l'arrondissement de Tubah. Il a en outre caché que la réduction du rendement agricole avait entraîné l'utilisation d'engrais pour augmenter les rendements. Même si la plupart d'entre eux sont sans instruction et n'ont donc pas une bonne connaissance de son utilisation. En accédant à son implication sur les aliments de base ; on s'est rendu compte qu'il a provoqué un changement dans le goût des aliments affectant ainsi l'adaptabilité socio-culturelle de la population. Cette étude examine également le degré de sécurité alimentaire dans la région et a révélé que 37,1% ont un meilleur accès, 27,6% ont un accès équitable tandis que 24,7% des répondants ont un accès moindre à la nourriture par rapport aux 5 dernières années. Il a également été découvert qu'il n'y a pas de moment précis pour l'insécurité alimentaire, elle peut survenir à tout moment en fonction des points de vue des répondants. La variabilité du climat a entraîné des prix alimentaires élevés, ce qui rend la nourriture non abordable pour tous. Afin de garantir la sécurité alimentaire dans l'arrondissement de Tubah, des stratégies d'atténuation et d'adaptation au changement climatique doivent être adoptées. L'impact du changement climatique sur la production alimentaire peut être atténué par des politiques agroforestières. Ensuite, Le conseil devrait créer des fermes communales et des entrepôts où les récoltes seront récoltées et vendues à des prix abordables. Des salons culinaires locaux devraient être organisés avec l'aide des autorités locales pour sensibiliser les gens aux repas culturels.

Mots clés : variabilité climatique, sécurité alimentaire, production agricole, prix alimentaires élevés, atténuation du changement climatique, adaptation au changement climatique et sous-division de Tubah.

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LIST OF ACRONYMS AND ABREVIATIONS

%:	Percentages
CLA:	Central Intelligence Agency
DSPI:	Decadal Standardized Precipitation Index
ESA:	Water Soil Tree Analysis
ERDAS:	Earth Resource Data Analysis System
FALSS:	Faculty of Arts, Letters and Social Sciences
FAO:	Food and Agriculture Organization
FCFA :	Franc Communauté Financière d'Afrique
FCRN :	Food Climate Research Network
FSLC :	First School Leaving Certificate
GCE:	General Certificate of Education
GDP :	Gross Domestic Product
NGS :	National Geographic Society
GHGs:	Greenhouse Gases
GPS :	Global Positioning System
IPCC:	Intergovernmental Panel on Climate Change
IRAD :	Institut de Recherche Agricole pour le Développement
MINADER:	Ministry of Agriculture and Rural Development
Mm:	Millimeters
NIC:	National Institute of Cartography
NGOs:	Non-Governmental Organizations
NMSA:	National Metrological Service Agency
R^2 :	Coefficient of Determination
RDARD:	Regional Delegation of Agriculture and Rural Development North West Region
SDDARD:	Sub-Divisional Delegation for Agriculture and Rural Development
SDGs:	Sustainable Development Goals
SI:	Seasonality Index
SPI:	Standardized Precipitation Index
SSA:	Sub-Saharan Africa
TCDP:	Tubah Council Development Plan
UNDP:	United Nations Development Program
USGS:	United State Geologic Survey of Earth Explorer
UNECA:	United Nation Economic Commission for Africa
UNFCCC:	United Nations Framework Convention on Climate Change
WFP:	World Food Program
WMO:	World Meteorological Organization

GENERAL INTRODUCTION

0.1 Background to the study

The effect of climate variation on food security has been a serious threat to the world at large, especially in the 21st century. Temperature and rainfall variation negatively affects the basic elements of food production such as soil and water. More broadly it affects the different dimensions of food security: food availability, food accessibility, the stability of the food supply, and the ability of consumers to utilize food including food safety and nutritional value (Food and Agricultural Organization (FAO), 2008). This affects agriculture and food production both directly and indirectly. It impacts food production directly through changes in agro-ecological conditions and indirectly by affecting growth, distribution of incomes, and the demand for agricultural produce (Schmidhuober *et al.,* 2007). The impacts of climate variation are already being felt in global food markets, and are likely to be particularly significant in specific rural locations where crops fail and yields decline (Fern and Climate Analytics, 2018).

This has directly affected food production and food security, especially in sub-Saharan Africa. According to a projection by the Intergovernmental Panel on Climate Change (IPCC) in the coming decades with climate change, rainfall variation and extreme climatic events are expected to adversely affect agricultural production and food security (Christensen *et al.,* 2007). By 2020, yields from Africa's rain-fed farm production could decrease by 50% as a result of changes in climatic conditions (Boko *et al.,* 2007). Changes in temperature and precipitation associated with continuous emissions of greenhouse gases will bring about changes in land suitability and crop yields living thousands of people food insecure in sub-Sahara Africa. For instance, the number of people suffering from chronic hunger has risen from 815 million in 1990 to 1,023 million in 2009 (FAO, 2009). In Cameroon, a significant proportion of households depend on agriculture for their livelihood. This means that agricultural production and distribution should be void from all handicaps.

It is widely recognized that climate variation and the occurrence of extreme weather conditions are among the major risk factors affecting agricultural production and food security in sub-Saharan Africa (SSA). In this region, rainfall patterns are being influenced by large-scale inter-seasonal and inter-annual variation resulting in frequent extreme weather events such as droughts (Haile, 2005). The high rate of rainfall variation in this region has made it very difficult for farmers to situate the planting season as it has altered the agricultural calendar. This is a call for concern for stakeholders as to how to boost crop productivity in other to ensure

food consistency and availability via the use of climate change mitigating agricultural production systems.

Climate, hydrology, and the various soil types of Tubah Sub-division have favoured agricultural activities making agriculture the mainstay of the people. The dominant crops cultivated in this area are; maize, groundnuts, beans, yams, cocoyam, solanum potato potatoes, sweet potatoes, tomatoes, vegetables, which depend on climatic elements such as rainfall and temperature. But for some time, this area has been experiencing variations in climatic elements which affect crop yields thus, affecting food security (Naintoh *et al.,* 2018). This has not changed the fact that most of the population are farmers and they practice subsistent farming and market gardening in the urban (Bambili) and rural areas of Tubah Sub-division. The intension has been to increase food production and to ensure a steady supply and access to food for the fast-growing population. If not of the fact that effective climate change mitigation strategies remain a major challenge in Tubah Sub-division.

In SSA countries such as Cameroon, agriculture is rain-fed especially peasant agriculture. To this effect, food production has become highly vulnerable to these extreme climatic events such as; prolong rainfall early cessation of rains, and prolong periods of sunshine. According to Von Braun (1991), a 10% decline in the amount of rainfall below the long-run average leads to a 4.4 % reduction in a country's national food production. Agriculture is the backbone of Cameroon's economy and about 45% of Her Gross Domestic Product (GDP) comes from agriculture, with close to 80% of Her labour force employed in this sector (Central Intelligence Agency (CIA), 2007). Studies show that the impact of climate variation on agriculture will go a long way to create food insecurity. As rainfall is expected to decline and become more irregular (Funk, et al., 2009) and therefore a need for planning in the agricultural sector of Tubah Sub-division North West region of Cameroon.

The physico-human environment has presented an opportunity for the cultivation of food crops. But with the current trend of climate variation which is manifested in the form of prolong dry season, early cessation of rains, short and intensive rains affect the quantity of food made available in Tubah Sub-division. Weather variation emanating from changes in climatic conditions affect food security and rural households in developing countries such as Cameroon where Tubah Sub-division is found are most affected since their capacity to cope with climatic shocks is low (Enchaw and Fombe, 2020; Downing,1992; Benson and Clay, 1998 and Rosenzweig *et al.,*1995). Climate variation continues to bring about numerous effects on crop production, as crop yields tend to reduce making food to become insecure, and inaccessible as observed by the study.

0.1.1 Justification of the study

The 2007 – 2008 global food crisis took the world by surprise which made millions of people to live in hunger and fear of starvation due to the increase in food prices across the world (FAO, 2010). FAO (2019) revealed that almost 870 million people were chronically undernourished in the year 2010 to 2012. This gives room for questioning the cause of food insecurity. The concept of food insecurity is not just at the level of poverty but it also entails livelihood and the whole food system. This affects every one of us including the people of Tubah. Food security, however, has much to do with climate variation which affects the agricultural calendar, land quality, farming activities, food production and yields. Changes in the quantity and quality of food due to climate variation impact on the cultural value of food in Tubah making people stay hungry even when some other food stuffs are available.

Also, the government development plan of agenda 2035 with the main aim of diversifying agriculture without identifying appropriate measures on how to cope with the effects of climate change which is affecting the agricultural sector.Although Her concept of second generational agriculture instituted by the president entails; the modernization of farming methods, provision of better training to farmers, taking advantage of scientific innovations, and securing innovation financing among others. This agrarian revolution remains a major challenge to the state in as much as it tries to tackle the youths who are unwilling to get in the agricultural sector. Even as the government strives to get to zero hunger and eradicating malnutrition by 2030 as requested by the Sustainable Development Goal (12) making Cameroon food secure (World Food Program, 2019). Is a clear justification why this research work needs to be conducted as it seeks to examine the relationship between climate variation and food security while using agricultural production as the main parameter at the local level. Increasing changing patterns, of rainfall witnessed in the past two decades, have created a setback on food security in Tubah Sub-division (Naintoh *et al.*, 2018). As they appear to be short and at times, very intensive causing climatic hazards which are often manifested in the form of hailstones and strong winds destroying crops. This has contributed to poor agricultural yields, one can say, there is much work for the various stakeholders in this study to ensure, accessibility, availability, and stability of food in Tubah Sub-division especially during off-farming periods when the prices of food are high. The results of this research would serve as a point of reference for developmental works in the farming and industrial sector be it at the local, national, international, or scientific level.

0.2 Delimitation of the study

This study is based on the effect of changing climatic patterns on food security. It is worth mentioning that most SSA countries practice mainly rain-fed agriculture and a majority of the farmers are peasant farmers who cannot afford materials such as; access to improved information, seeds and equipment required to adapt to these climatic variations. They equally lack a good mastery of techniques accompanied with innovational technologies to adapt and to help make farmers more efficient in other to boost food production and stay food secured. While, others are intended on the adaptation strategies to climate variation to ensure crop production or on the effect of climate variation on food insecurity and livelihood. In this study, however, considers rainfall and temperature to be the main parameter of climate variation affecting the availability, accessibility and the sociocultural dimensions of food in Tubah Sub-division. To better situate the research area and give a proper explanation of the research topic, it is important to do a delimitation of the study by, bringing out the thematic, temporal and spatial delimitation of the study area.

0.2.1 Thematic Delimitation

This work focuses on how climate variation, particularly seasonal distortions, rainfall and temperature influence crop cultivation, which is the main determinant of food production to feed populations in Africa. This goes a long way to influence the accessibility, consistency, availability, and price stability of food. Tubah Sub-division is undergoing some transitional changes brought about by seasonal variation this tends to affect crop cultivation. Though focuses on the various dimensions of food security, the quantity, and quality of food produced, the type of crops cultivated, and the feeding habits of the population. The study pays more attention to the quantitative, qualitative and especially on the sociocultural dimension of food. Changes in temperature and precipitation might in the long-term influence consumer's dietary intake. As, it will reduce the rate of productivity of most staple crops making some to become scares and expensive during off-farming seasons. Furthermore, this study also dwells on food prices as it does a comparative analysis on food prices which are believed to be brought about by seasonal variation on crop production in Tubah Sub-division. Though issues of the link between soil degradation and crop production will be discussed, soil analysis will not be done. Moreover, this study does not focus on cash crops but rather on food crops which are also income generative. Terms such as urbanization, sociopolitical crisis and other none- climatic factors are used as reference where necessary. In other to better correlate and evaluate seasonal changes and food security in Tubah Sub-division.

0.2.2 Temporal delimitation

This study covers a time frame of 55 years and span from1963 to 2018. During this period the impact of climate variation in Tubah Sub-division has been significant on food security and has triggered the researcher to concentrate within this time frame. This length of time was also necessary to explicitly examine or to have a period required to study climatic elements and their implication on food security in Tubah Sub-division. Also, 1963 to 2018 is wide enough to capture annual, decadal, and sub-decadal trends in rainfall as well as seasonal variation and to observe the impact on crop cultivation. This period is equally necessary because it helps to study how crop cultivation, feeding habits, and prices of food changes over time due to seasonal distortions. While 2019-2020 is the period during which the whole field survey was carried out. The period 1988-2018 were used to evaluate the land cover evolution with the help of Landsat images.200-2018 represents the urbanisation era, which is fundamental in assessing the regard or opinions of the local people vis-à-vis the changing food prices, changing environmental condition and food security alongside their adaptability strategies.

0.2.3 Spatial delimitation

Tubah Sub-division is located in Mezam Division in the North West Region of Cameroon. It is one of the seven Councils in Mezam Division. Tubah Sub-division lies between longitude 10° 15’25’’ and 10° 16’05” east of the Greenwich meridian and latitude 5° 54’95’’ and 6°09’56’’ north of the equator with an altitude which ranges between 950-1500 m above sea level and it is made up of six villages (Tubah Council Development Plan (TCDP, 2012). It is situated at 15km from the regional capital of the North West Region and boarded by several Sub-divisions (figure 1). To the north by Belo, Bafut in the North West, Santa to the south, while to the west it is boarded by Bamenda and to the east by Balikumbat and Ndop Sub-division. This Sub-division lies strategically along the ring road crisscrossing two other divisions – Boyo and Ngoketungia and opens several opportunities for trade in agricultural produce The study takes into consideration all the six communities in Tubah but lay more emphacies on three of these communities which are considered as urban towns today due to the high concentration of urban functions.However the study focuses mostly on the local population of these comunities which makes up the sub-division by using a sample frame to help capture households to be sampled.Also the othere three villages or communities were used because they are areas characterised with farming activities and the project personnel.

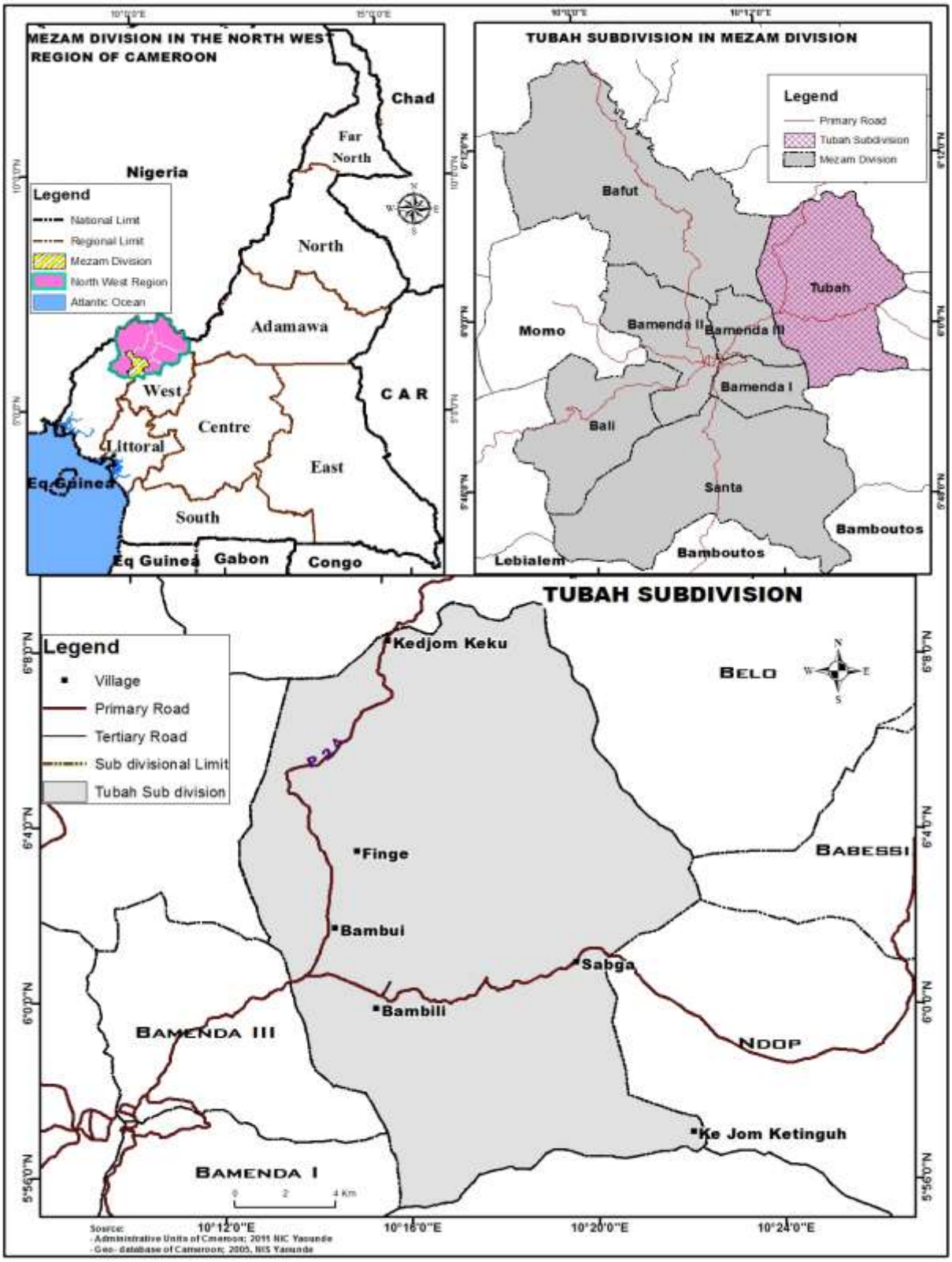

Figure 1: Location of the study area
Source: NIC, 2020

Situating Tubah Sub-division from figure 1, it is seen that the sub-division is bounded to the north by Belo, Bafut in the North West, Santa to the south, while to the west it is boarded by Bamenda and to the east by Balikumbat and Ndop Sub-division. This Sub-division lies

strategically along the ring road crisscrossing two other divisions Boyo and Ngoketungia. According to the 2010 population census statistics, 35,474 people of the population of Tubah Sub-division are rural dwellers while 13,068 are urban dwellers as cited by the Tubah council development plan (TCDP, 2012). This population is fed by agricultural products from the following villages (Bambili, Bambui,Kejiom Ketinghuh, and Kejio m Keku) which make up Tubah Sub-division.

0.3 Statement of the problem

The effect of climate variation on food security has been a serious threat to the world today. Africa is more epitomized and considered as the most vulnerable continent to climate variation. However, the repercussions of these are highly felt on agricultural produce which ultimately affects food security (IPCC, 2002). A study conducted by the World Bank (2016) shows that, the effects of climate variation are real and the consequences are overwhelming, exerting far-reaching consequences on livelihood of many people as agricultural production may decline from 20% to 9% by 2080.In addition, increasing temperatures and changing precipitation patterns are likely to reduce the production of staple food by 50% in SSA. There is no doubt that climate variation has a high risk on food security in sub-Sahara Africa from crop cultivation, storage and distribution. Climatic elements also have a direct effect on planting and harvesting seasons, besides distribution which determines the quantity and quality of food made available for consumption. The variation of climatic elements is glob al and Cameroon is highly affected especially when it concerns food security. Tubah Sub-division is one of the areas where the effects of climate variation are very severe on food production.

Precipitation and temperature statistics of Tubah Sub-division from 1995 to 2015 indicate an increasing mean annual temperature rate of 0.09 °C per year and a slight increasing annual rainfall rate of 25.8 mm per year (Naintoh *et al.*, 2018). This area has two main seasons, which are the rainy and the dry seasons. This helps to better situate the agricultural calendar of the area within these seasons as it determines the type of crop to be planted and the harvesting periods which ultimately influence food security in Tubah Sub-division. Abnormal frequent weather events such as; prolong dry seasons, short and intense rainfall and increasing temperature has led to prolong dryness and scanty rainfall with adverts effect on crop cultivation. Unreliable rainfall has placed farmers in a point of dilemma where, they are sometimes confused when exactly to prepare their farms and seeds for planting. This has gone a long way to distort the agricultural calendar causing a reduction in agricultural produce and a drastic effect on food supply in this area of study. In Tubah Sub-division, it is very common

for the rains to come earlier or later than expected making farmers to plant before the actual planting period or date. Sometimes, the rains are torrential accompanied by winds which destroy the crops. This makes it very difficult for household to have a good nutritious and staple food for an active and healthy life on a day-to-day basis in Tubah Sub-division. Even though, farmers try to adapt by using adaptation strategies for some crops like potato, vegetables, cocoyam and the use of improved seeds, irrigation, fertilizer and planting at the early start of rain as measures to adapt to climate variation and its effect on food security. This area still witnesses these same challenges almost every year.

Also, the impact of rainfall variation on food security has led to the spread of diseases and reduction in yields. This has resulted into the use of fertilizers which affects the taste and quality of staple food and nutritional patterns in Tubah Sub-division. Bringing about a change in feeding habits (staple food) of the people of Tubah as most of the crops cultivated such as; cocoyam, banana, corn, solanum potato, vegetables, potatoes which the peoples mostly consume are affected with diseases. Increased frequency and intensity of extreme events such as prolong dry seasons and scanty rains have affected soil quality and crop yields with locally cultivated food stuffs becoming scarce in local food market. Though, farmers in Tubah try to adapt to this situation through small-scale irrigation, fertilizer application, the use of hybrid and drought resistant seeds, and the use of pesticides and fungicides on crops provided by IRAD Bambui, emerged and re-emerged pests and diseases brought about by seasonal variation have continued to keep yields of most cultural crops such corn for fufu, cocoyam for *achu* and solanum potato for *akwa* low. Even when the crops do well the foreign chemicals tend to change their taste rendering them culturally unacceptable. This has led to the consumption of food items such as rice in the place of *kebain* and, *mbas ksi* (corn fufu and hucklebery) and eru in the place of *achu* and pounded Solanum potato, thus affecting the cultural value of the people. These effects of climate variation on food security are creating problems of food stability in relation to the staple food of Tubah and need to be investigated for appropriate redress.

In addition, the impact of temperature and rainfall variation on food security in Tubah Sub-division has brought about unstable and high prices on food items in the market. Low yields on farm produce due to the unpredictable nature of rain and prolong dry seasons. Causing damages on, food items in the farm and problem of accessing food during the rainy season due to poor farms to market roads while food gets bad in the farm. Moreover, the advent of urbanization and development has brought about several changes in Tubah Sub-division leading to the reduction of most agricultural land cultivated seasonally. For instance, the

coming of the University of Bamenda and other higher institutes of learning has pushed most farmers to reduce the size of agricultural land replacing it with settlements which indirectly plays on arable land. As parcels of lands are reduced and subsidized for settlements giving room for market gardening. This farming method demands huge application of fertilizers for a good output thus, increasing the prices of food in the market. Transportation cost tends to increase due to the poor nature of roads, eventually produce are likely to get bad along the road before they get to the market. Causing food prices to increase in the market most precisely in Bambili and Bambui where, the quantity made available is relatively small for the large growing population to feed on. But the problem persists even though the people of Tubah try to adapt. This issue keeps persisting making people to become food insecure in the means of excess at a local scale.

It is therefore essential for the above stated problems to be synthesized and addressed to better cope or adapt to climate variation which affects food security in Tubah Sub-division. This is very pertinent mindful of the fact that individuals will be able to have enough quantity of food available on consistent bases if the following research questions are investigated or answered.

0.4 Research questions

0.4.1 General research question

- To what extent has the effect of rainfall and temperature variation influence food security in Tubah Sub-division?

0.4.2 Specific research questions

1. How have uncertainties in rainfall and temperature patterns influenced food production in Tubah Sub-division?
2. To what extent has rainfall and temperature variation influenced food availability and accessibility in Tubah Sub-division?
3. How has seasonal variation contributed to food insecurity (food instability) and adaptation strategies in Tubah Sub-division?

0.5 Research Objectives

0.5.1 General Research Objective

- To investigate how the effect of rainfall and temperature variation have influenced food insecurity in Tubah Sub-division

0.5.2 Specific Research Objectives

1. To find out how uncertainties in rainfall and temperature patterns influences food production in Tubah Sub-division.
2. To evaluate the impact of rainfall and temperature variation on food availability and accessibility in Tubah Sub-division.
3. To examine the contributions of seasonal variation to food insecurity and various adaptation strategies implement in Tubah Sub-division.

0.5.3 Research Hypotheses

1. Increase rates of unreliable rainfall pattern and increasing temperature have largely influenced food production in Tubah Sub-division.
2. Rainfall and temperature variations have negatively influenced food availability and accessibility in Tubah Sub-division.
3. Seasonal variations have brought about food insecurity in Tubah Sub-division.

0.6 Interest of the study

The main aim of every research work is to bring in development which can help solve current challenges in the research area and the country at large. It is therefore for this reason, this work is of interest both at the local and national level as climate variation and its effect on food security is one of the greatest challenges faced by many communities today in Cameroon and Africa at large.

0.6.1 At the Local level

At the local level this study will provide useful empirical data for students carrying out research work on climate variation and food security both in Tubah Sub-division and Cameroon at large.

It is scientifically important to researchers carrying out studies on climate variation and food production in relation with agriculture.

This study is important to farmers and the inhabitants of Tubah as it will first help to create awareness of climate variation, its effect on crop production and feeding habits which will go a long way to encourage farmers to adopt new farming techniques so as to boost food security.

It will be of much importance in scientific domain and international organizations, as it examines the impact of climate variation on food prices, quantity, and quantity consumed by the various household.

0.6.2 At the national level

This research work will provide the government with valuable information about the study zone to evaluate the various challenges faced by farmers in boosting food security. Thus, helping them formulate policies which when propagated will yield significant results and benefit both the inhabitants and the environment. It will equally help stakeholders to valorize their culture and what methods they can use to preserve their food. The results of the study can be used to fine-tune and adjust policies aimed at reducing food insecurity and vulnerability in the country.

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0.7 Literature review

It is unethical in this 21st century to carry out a study on climate variation and food security without reviewing the works of other authors. To uncover the knowledge that has been written and stored by various scholars about the research theme. This equally helps to know what they have pondered on in different ways at particular instances, circumstances, and dynamics. Thus, in this light, that a wide range of text, journals, articles, published and unpublished documents, reports, and dissertations were consulted to build a rich and profound literature to proceed with the study. Which permitted the researcher to have an additional idea on climate variation and its effect on food security and equally, to avoid the duplication of work that has already been carried out elsewhere while acknowledging them. These documented works offered diverted points of view which better helped in the understanding of the research topic. Furthermore, this review has been divided into three parts considering works on rainfall patterns and the quantity and quality of food, influence of seasonal variation on crop cultivation and feeding habits while the last part focuses on climate variation and food prices. This helps

to understand what they have done concerning the topic. Then we acknowledge them and try to feel in their gaps to treat the topic more rationally.

0.7.1 Variation of seasonal patterns

Anuforom (2004) and Ndo *et al.,* (2016) working on rainfall noted that rainfall is characterized by inter-annual variation and crops are very sensitive to rainfall variation. While drawing evidence from the last ten years pigeonholed by undefined periods of dryness and wetness. Adejuwon, (2005) stressed the fact that, when rainfall supply is adequate, crop yield would be fixed while, a lapse in rainfall and water supply, causes a plunging shift in certain plant species and increased incidence of diseases on crops. These authors concluded that the inter-annual variation of rainfall influences food security in the Bamenda high lands of Cameroon. Without taking into consideration the inter-monthly variation of rainfall which is sometimes manifested in the form of seasonal abnormalities. These seasonal abnormalities are the key element crating variation in the quantity and quality of food made available at a local scale. This study looks at how uncertainties in rainfall patterns influence the quantity and quality of crops which affect food security in Tubah Sub-division making the availability of food a problem.

According to the IPCC (2004), change in yield will occur when rainfall and moisture supply stretch its critical minimum. Rashid and Ghulam (2008) and Amawa *et al.,* (2015) stressed on the negative correlation which exists between climate and market gardening crops and maize. According to these researchers, a probability level of 0.5(95%) rainfall has a critical effect on market garden yields. Whereas, temperature had no significant on making food security a problem. Grappling with the conventional pre- and post-harvest problems which plague the agricultural sector in Cameroon. Even though they laid more emphasis on market gardening crops while failing to identify food crops that are more tolerant to these climatic changes and how farmers turn to adapt to this through irrigation systems and other strategies. This still forms a base for this research work as it analyzes the effect of climate variation on both market grading and food crops from a local scale and how their adaptation strategies turn to have a negative impact on the culture of the people and prices of these crops cultivated. This work equally looks at how climate variation affects the quantity and quality of food in Tubah Sub-division.

Kipkoech *et al.,* (2012) pointed out the fact that there exists a direct relationship between climate change and global food security by identifying climatic variables which influence food production such as; precipitation, sunshine, humidity, and extreme climatic

events. According to FAO (2018), these projections may affect many aspects of the food security pillars. As they turn to have a direct effect on planting and harvesting periods, transport and transportation thereby, determining the quantity and quality of food made available and accessible. These authors identified the various climatic variables which affect food security but were not specific on a particular variable. Thus, this work seeks to use rainfall variation as a main climatic element to show how food security is being affected in relation to the cultural value of the people of Tubah.

Nkengla-Asi *et al.*, (2017) carried out a comparative study on men and women in the Southwest region of Cameroon on their vulnerability and their coping strategies for climate change impacts. They concluded that Climate change has major impacts on the food security and livelihoods of smallholder farmers in Africa south of the Sahara. Thu the vulnerability of female farmers to the vagaries of weather is high and they are more negatively affected by climate change and seasonal changes than male farmers. Molua (2002) also examined household vulnerability to food availability relating to climate and reviewed the interplay of climate, agriculture, and prospects for food security in the region. By, relating econometric function directly with farmers' income and precipitation, to statistically estimate the significance of farmers' adaptation methods. Their study was carried out in the southwest region of Cameroon and concentrated mostly on the impact of climate variation on food security and livelihoods of smallholder farmers (female farmers) without identifying the climatic elements which cause this variation. But this work will be focusing on rainfall variation as the principal element of climate variation and the effect it has on food security in Tubah Sub-division.

In the same line, Badolo and Somlanar (2015) and (2019) in a study analysed the impact of climatic variation on food security for 71 developing countries. The analysis reviled that climatic variation reduces food supply and increases the proportion of undernourished people in developing countries. These scholars failed to identify the climatic elements and were more focused on food supply and nutrition in Africa while using a broad range of decadal data. However, this work focuses on a local scale which is Tubah while identifying rainfall as a principal determinant of food security in this area of study.

Chabejong (2016) assessed the impact of climate variation on food security in the Sahel region of Cameroon. The researcher laid infancies on the indirect impact of climate variation on human health. With the use of two complementary indicators of food security (food supply and proportion of undernourished people), and concluded that the adverse effect of rainfall variation on food security is exacerbated in countries under conflict. While affirming that the

negative effects of climatic variation are exacerbated in the presence of civil conflicts and are high for the countries that are vulnerable to food price shocks. This research is centered on the effect of climate variation on food security in Tubah Sub-division thus, serves as a base for the development of this research theme.

Agba *et al.,* (2017) analysed the effect of climate change on crop output in Nigeria by dividing the factors into climate change factors and non-climate change factors on crop output. The analysis shows that in the short run, only rainfall tested significantly positive to crop output among the climate change factors but there is evidence of significant effects of all climate change factors on crop output in the long run. For example, temperature, carbon dioxide emission, carbon emission, and rainfall were tested significantly to crop output. Furthermore, non-climate change factors like economically active population, gross capital formation, and land area equipped for irrigation were significantly positive to crop output. The only remarkable difference is that they based their work in Nigeria while this research work remains at the level of Tubah Sub-division which focused on mainly climate variation and its effect on food security. This is determined by the quantity and quality of agricultural output.

The National Metrological Service Agency (NMSA,2001) in a study indicated that the mean temperature and precipitation have been changing. As they showed how the annual average minimum temperature has been increasing by about 0.25 °C every 10 years and the maximum by 0.1°C every decade. Over time, the amount of rainfall is also exhibiting a declining trend with increasing variation. While the World Bank concluded that," If seasonal rainfall fails or its amount or timing deviates from the norm, agricultural production will be negatively affected" (World Bank 2006). NMSA and World Bank examine the extent to which rainfall affects agricultural production without identifying it as a parameter that determines food security. This study goes a long way to investigate how climate variation (unreliable patterns of rainfall) affects agricultural production the key determinant of food security in Tubah.

0.7.2. The influence of seasonal variation on crop cultivation and culture

Africa is a major producer of several kinds of cereal. But, maize, has overtaken these traditional cereals while wheat is widely cultivated in North Africa, Sudan, and Ethiopia United Nations Economic Commission for Africa, (UNECA, 2015). Looking at the case of sub-Saharan Africa (SSA), they carried out a study on the cultivation of cereals on a large scale in SSA where Maize is a major staple food crop grown in diverse agro-ecological zones and

farming systems and consumed by people with varying food preferences and socio-economic backgrounds. These authors conclude that Cereals like Sorghum, Millets, Wheat, Maize, and Rice are major staple foods of most people. Their study was focus only on cereals mean while tubers like cocoyam, solanum potato, and vegetable constitute the staple food of some countries thus, the reason for their cultivation on large scale. The UNECA work relates to this research work and thus, forms a foundation to this work as it will try to show how people turn to change the types of crops cultivated to suit consumer preferences while modifying their culture over time in Tubah Sub-division to ensure food security.

Land-use patterns are complex, involving the production of a wide variety of food crops for domestic consumption; this strategy ensured a varied diet and helped to stabilize food supply against climatic and seasonal shortages. However, with increasing numbers of people, more settled cropping patterns were established, and the fallow period was gradually reduced. Thus, resulting in more intensive methods of cultivation as effective strategies to maximize land productivity without endangering soil fertility (Thornmton *et al.,* 2014). These scholars found out that, agriculture was more sustainable under a lower population density. This however is not different from what was observed in Tubah Sub-division as farmers turn to practice diverse methods of cultivating crops so as to stabilize food supply due to climate variation.

In another dimension, Njumbe *et al.*, (2018) compared the food and nutrition perceptions of households along the rural-urban continuum of Limbe and Bamenda in Cameroon. Where they identified the occurrence of seasonal variation, availability, and variety of food, but there was no significant difference across urban, peri-urban, and rural zones of both cities. Therefore, concluded that urbanized areas provide opportunities for better health needs and services, educational infrastructure, and livelihood diversification but deplete forest and agricultural lands by converting them to other uses to meet the needs of the ever-growing urban population at the expense of environment and natural resources integrity as well as food security. Even they limited their work to seasonal variation, which was linked to the ever-growing population and development. This study goes further to examine seasonal variation while looking at rainfall as the principal mechanism influencing crop productivity which determines food security. As the population of Tubah turns to substitute agricultural land for other activities thereby affecting food security in this study area.

0.7.3. Seasonal Variation and Food Prices

Ndoh *et al.,* (2019) carried out a study on the effects of climate variation on the yield of subsistence and cash crop production in highland ecosystems of Bamenda. They made use of climatic data on plant species within rain-fed agricultural systems in the Bamenda Highlands of Cameroon to assess the trends and effects of climate variation on the reproductive processes of plants. Their results reviled that, for subsistence crops, temperature and rainfall had a negative effect on crop yields. As a result, this low yield has led to high prices on food items in the market. While neither rainfall nor temperature significantly predicted cash crop yield but, suggesting that decline in production could be as a result of extraneous variables. This research was carried out on a regional scale and the scholars gave attention to both food crop and cash crop while examining temperature and rainfall as the main causes of poor yield. This study reveals the effect of climate variation on food prices differently. As it points out how seasonal variation has affected crop production and the feeding habits of the people of Tubah due to an increment in food prices as a result of low yields.

Lobell *et al.,* (2011). Researching on the causes of high food prices, pointed out that, production of major commodities has declined since 1980 due to global warming. While, concluding that the impact of climate variation will affect global agriculture due to the evidence of global warming. Their analysis of climate variation was based mainly on global warming and focused their research on a global scale. This study identifies seasonal variation and its contribution to the rise of food prices in Tubah Sub-division and how it affects the livelihood of the people. Since an increase in food prices leads to a fall in the affordability power of food.

Yong (2013) analyzed the economic impact of climate change on agriculture in Cameroon which was based on crop farming activities in the Sudano-Sahelian area of Cameroon. Using the Ricardian model which was based on farm data generated from a survey carried out in the framework of the ESA (Water-Soil-Tree) project between 2008 and 2009 on producers in 10 villages of the Lake Lagdo watershed. These scholar's findings show that increasing temperature and decreasing precipitation are detrimental to agricultural productivity. From this analysis, an annual increase in temperature will harm irrigated and dryland farms in the area. But, a marginal impact of increasing precipitation will increase crop revenue for dry land farms. This appears to be true for Tubah Sub-division as the increasing temperature has a negative impact on irrigational farming which turns to an increase in the prices of food during the dry season. Thus, this study goes further to throw more light on

climate variation as a deficiency in one of the variables directly lead to the increase in the prices of agricultural produce which affects the staple food of the people of Tubah Sub-division.

Tume *et al.,* (2020) assessed the impact of climate change on food security in the Bamenda high lands where they made use of climatic and food crop data collected from stations across all ecological zones and time series were established. Rainfall Anomaly Index (RAI) was employed to establish climate variation and change, with positive and negative anomalies. Results reveal declining rainfall (increasing RAI) and decreasing crop production trends, which turns to affect all aspects of food security including food access, utilization, and price stability. This study is very much related to this work and thus, forms a foundation as this work looks at how seasonal variation will cause a rise or fall in the prices of agricultural products in the local market of Tuba Sub-division.

Studies carried out in Cameroon reveals that a widespread food crisis may occur as was the case in 2008 if food prices increase continuously alongside a drop in agricultural output. The impacts will be highly felt in urban centers since rural areas feed the urban VHJIO centers. This can go a long way to riots in urban households especially the urban poor. (Fraser *et al.,* 2015). These scholars found out that, a rise in food price can cause instability by cross-examining the following factors; local context, including demographic factors and dietary patterns, predisposes some groups of people to riot when food prices increase. To examine the relationship between household's demographic characteristics and reported intent to riot due to future food price rises; and (2) the relationships between people's diets and their reported intent to riot due to future food price rises. This work focuses on the effects of climate variation as a key driver to a rise in food prices in Tubah Sub-division among other issues which seriously affect food consistency and affordability which are aspects that the above-mentioned authors did not through enough light on.

Sneyd (2013) carried out a study on wild food consumption in urban areas of Cameroon. The survey data pointed out that many wild/traditional foods are physically available in Cameroonian cities most of the time, including fruits, vegetables, spices, and insects. Cameroonians spend considerable sums of their food budget on wild foods. However, low wages and the high cost of city living constrain the social and economic access most people have to these foods. The data also advocates that imports of non-traditional staple foods, such as low-cost rice, have increasingly pushed potentially nutritious or safe traditional local foods out of markets after the 2008 food price crisis. As a result, diets are changing in Cameroon and people turn to eat cheaper imported foods such as refined rice or to eating less frequently. Sneyd researched on the effect of food prices on traditional food in Cameroon and how they

adapted to it but did not identify climatic factors as a reason for this change in feeding habits. This work focuses on how seasonal variation influences the prices of food items and how the people of Tubah turn to substitute their staple food with other foods made available in the market in Tubah Sub-division.

Molua, (2012) carried out a study to established household- level food security risks associated with climatic variation and how households respond to these risks. In Northern Cameroon, where subsistence women have limited control over resources required to support food production, they largely depend on crop cultivation which to some extent depends on rainfall. The Author found out that, stresses related to food production and availability, low income, and food accessibility, and utilisation of food supplies, are heightened by real and perceived effects of the variation of the current climate. While, short term coping choices such as; diversification of livelihood turns to influence food accessibility and consumer's choices. The author did not bring out the climatic elements which cause risk to food security and equally failed to recognize the fact that everyone is exposed to this climatic risk in a community. Thus, this work will throw more light on how environmental changes affect the feeding habits and the livelihood of people in Tubah Sub-division.

In another dimension, Sen (1983) researching the effect of a rise in food prices on consumers concluded that an unfavorable shift in exchange conditions can be the cause of food insecurity. Since a fall in the rate of employment in the economy reduces people's ability to acquire an adequate amount of food. In other words, a change in relative prices of products or wage rate vis-à-vis food price can cause food insecurity. Sen identified economic factors which affect food security this is in line with this work. As it takes into consideration the rise of food prices in this study area as a result of urbanization and the negative effect of climate variation on food production. As observed in the field, people were unable to purchase their staple food as a result of an increase in food prices due to poor agricultural output and socioeconomic crisis.

Barnett (2003) in a study established a relationship between civil conflicts and hunger in developing countries. According to this author, countries in conflict, suffer disruptions in livelihoods, assets, nutrition, and health. This may also go further to disrupt markets, destroy crops, livestock, roads, and land. Also, deliberate asset-stripping of households in conflict regions may cause households to lose other sources of livelihood as the ongoing conflict leads to breakdowns in production, trade, and social networks. The disruption of markets, schools, and infrastructure removes additional resources required for food production, distribution, safety, and household livelihoods. These consequences aggravate food insecurity in countries

of conflict, this holds true in Tubah Sub–division as it was observed during fieldwork. Since the area is currently undergoing an ongoing sociopolitical crisis. This has disrupted many economic activities in the area including agricultural activity. This work goes a long way to show how other factors apart from climate variation are equally responsible for an increase in the prices of food.

Using a theoretical model, Ringler *et al.,* (2010) found out that, climatic variation increases childhood malnutrition in Sub-Saharan Africa through higher food prices. Moreover, Aker (2010) considers that climatic variation may affect traders' entry and exit in response to the profitability of food trading. Indeed, climatic variation may lead to an increase (decrease) in profits which can incite the traders to enter (or exit) the local market. As markets are not well integrated and the dispersion of food (agriculture goods, cattle) prices is high in the less developed countries (Aker 2010; Araujo *et al.,* 2005), climatic shocks may amplify them and harm food security. This research will be focused on the effect of changing environmental conditions and how they bring about an increase in the prices of food in this area.

Nhemachena *et al.,* (2009) in a study, showed how rainfall variation and high average temperatures negatively affect households' income. Especially food crop farmers in Africa as their income depends on the produce harvested from the farm which is being sold in the market. From which they derive a steady income flow. Also, Sen (1983) researched on the effects of climate variation on the agricultural sector, discovered that climatic variation adversely affects the labor market in rural areas, thus leading to a decrease in households' incomes and a decrease in the food basket. These authors concentrated on how climate variation affects household incomes while this work throws more light on how a fall in agricultural production will cause a change in peasant farmers' income alongside other factors which bring about a change in household income in Tubah Sub-division. This indirectly affects the affordability of food in this area making some households stay food insecure.

Tingem *et al.,* (2009) and Tchawa (2000) identified the need for adaptation and innovation options that could offset climate variation impacts on Cameroon's agriculture. Investment in improved technology, and promote the use of various seeds with more tolerance as the only way out mindful of the fact that it would lead to an increase in crop yield. While advocating that, changing sowing dates is ineffective in counteracting adverse climatic effects. Because of the narrow rainfall band that strictly determines the timing of farm operations in Cameroon. These scholars did not take into account the adverts effect of extra cost which would be endured by farmers as a result of innovation and adaptation strategies to boost agricultural output.

Low-income producers and consumers are likely to be most affected because of a lack of resources to invest in adaptation and diversification measures (UNCCD, 2017; Bailey *et al.,* 2015). The effect of this is the increase in the prices of food items in the market, making, accessibility, availability, and consistency of food a problem. This work, however, focuses on the need for innovation and adaptation to climatic variation which causes a change in consumer's preferences as a result of low income. Therefore, making food accessibility and availability an issue of concern as they go a long way to determine food security. These reviewed works paved way for the conceptual and theoretical framework of the study.

0.8. Conceptual and theoretical framework of the study

Several concepts and theories were examined and reviewed to show their significance in this work in the domain of climate variation and food security in which the study dwells. In total, five theories and two concepts were used in this study. They include the theory of spatial diffusion of innovation, environmental determinism and environmental possibilism, Malthusian theory of population, and the Esther Boserup theory with two concepts which are; the concept of climate variation and that of food security.

0.8.1 Conceptual framework of the study

In other to get a clear insight on the theme, some concepts were identified and defined to guide the understanding of the study. Concepts such as climate variation and food security which are directly linked to the topic have been carefully defined and conceptualized. While concepts not directly linked such as; climate and climate change have been identified and used to ease the understanding of this write-up. The definitions adopted are conceptual and theoretical to articulate terms around the context and the background of the research questions. To capture the perception of the local population of Tubah Sub-division thus giving them their meaning and significance through a cumulative development in knowledge.

0.8.2. Climate

Climate is generally defined as the weather conditions prevailing in an area over a long time. This is liable to change from hour to hour, day-to-day, month-to-month, or even year-to-year. A region's weather pattern is usually tracked for at least 30 years before it can be considered as climate (National Geographic Society, 2017). According to IPCC, 2001 climate is the statistical description in terms of the mean and variation of relevant quantities over a period ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization

(WMO, 2007). Its relevant quantities are most often surface variables such as temperature, precipitation, and wind. The climate in a wider sense is the statistical description of the weather system which can be influenced. The climate of any particular place is influenced by a host of interacting factors. These include factors such as; latitude, elevation, nearby water, ocean currents, topography, vegetation, and prevailing winds. Also, the global climate system and any changes that occur within it can control the local climate. In the context of this study, climate is considered to be the varying conditions of temperature and rainfall over a wide period which influences crop productivity.

0.8.3. Climate change

"Climate change refers to a change in the state of climate which could be identified (using statistical tests) by changes in the mean or the variation of its properties and that persists for an extended period, typically decades or longer" (IPCC,2004). Article 1 of the United Nations Framework Convention on Climate Change defines climate change as, "a change of climate which can be attributed directly or indirectly to human activities altering the composition of the global atmosphere added to the natural climatic variation observed over comparable periods". In a similar way, NASA (2020) delineates climate change as *"a broad range of global phenomena created predominantly by burning fossil fuels, adding heat-trapping gases to Earth's atmosphere. These phenomena have brought about an increase in temperature trends described by global warming, and also encompass changes such as sea-level rise through ice mass loss in Greenland, Antarctica, the Arctic, and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events."* Therefore, climate change considers only changes that have occurred over a longer time, typically over decades or longer.

0.8.4. Concept of rainfall variation

Rainfall variation is the variation of rainfall within a given climate type relatively or simply the degree to which rainfal**l** amounts vary across an area. Such variation may cause the annual average to be greater, lesser, or equal to the average of the considered period (IPCC, 2001). This is referred to as the fluctuation of rainfall annually or seasonally above or below a long-term value. At a specific time, the rainfall of a place can be different, either above or below normal. This also depends on the physiographic setting of the area.

According to the English Dictionary (Glosbe 2008), rainfall variation is the semi-arid conditions affecting large areas, seasonal droughts, very high rainfall variation, and sudden high intensive rainfall. It can also be viewed in two main dimensions, spatial and temporal dimensions. Spatial variation refers to the variation of rainfall amounts across a region for a specific time interval. This type of variation takes into consideration, a large or broad surface area. Temporal variation is the variation of rainfall amounts in a given location within a given time interval. It is thus, the type of variation on which this study passes attention.

Rainfall variation manifests itself in two phases in Tubah Sub-division which are the short rainy seasons (March-May) and much more variable rainfall periods between June and September. Rainfall at times tends to be short, unsteady, intense, and at times characterized by very strong winds and diseases that affect plant growth. But at times the rains tend to be less frequent and earlier than what farmers expected thus prompting them to saw very early than the normal sawing date since they lack farming calendars. More so negative abnormalities in rainfall patterns tend to affect crop nutrients gotten from the soil and therefore affecting plants' growth. As extreme rainfall washes away the nutrients from the soil through leaching and at times causes flooding thereby, destroying crops in the farm. This negative abnormality of rainfall variation in Tubah Sun-division turns to affect food security in this area due to its propensity for disrupting food availability, reducing access to food, and negatively impacting food quality. As the rains are usually erratic, intensive, untimely, and characterized by the wind.

0.8.5 The concept of climate variation

In other to better understand the term climate variation there is a need to first make a clear difference between climate variation and change. Climate change is the persistence of "anomalous" conditions when events that used to be rare occur more frequently, or vice-versa. Several authors have worked on the concept of climate variation viewing it in different ways.

Meteorologists and climatologists delineated climate variation as the year-to-year variations in atmospheric conditions around a mean state (WMO, 1992). Climate variation looks at changes that occur within smaller timeframes, such as a month, a season, or a year. In statistical terms, it is the curve of the frequency distribution representing the probability of specific meteorological events changes. The curve may be modified either in amplitude, shifted about a new mean, or both (WMO, 2019)

While the IPCC (2001) viewed climate variation as a component of climate change by referring to it as, a climatic parameter of a region varying from its long-term mean. Every year, these means are different. Some years have below-average rainfall systems some have averages

above-average rainfall and temperature (IPCC, 2001). According to FAO, 2008 there is no agreement on how to define the term "climate variation". Because, climate has been in a constant state of change throughout the earth's 4.5 billion-year history, but most of these changes occur on astronomical or geological time scales and are too slow to be observed on a human scale. Natural climate variation on these scales is sometimes referred to as "climate variation", as distinct from human-induced climate change.

The term is often used to denote deviations of climatic statistics over a given period such as a month, season, or year when compared to long-term statistics for the same calendar period. Climate variation measures these deviations, which are usually termed anomalies. These anomalies often manifest themselves through prolong dry season, reduction of the number of rainy days, early start of rains, and erratic rains thus, making crop production to become a problem in Tubah Sub-division. This makes farmers to be unable to respect or prepare a fixed agricultural calendar, therefore, affecting agricultural yields. Even if they do, it is inevitable to overcome the challenges (pest and disease, strong winds) brought about by seasonal variation. Also, it is grasped as variation in climate on all temporal and spatial scales beyond individual weather events. These variabilities may be due to natural internal processes within the climate system called internal variation, or variations in natural or anthropogenic external factors called external variation. Climate variation in the context of this study refers to a persistent change or variations in climatic elements (rainfall and temperature) over time which is observed seasonally, annually, and decadal. Triggered mainly by human activities and physical drivers to some extent.

As seasonal variation sets in, the growing season gets longer due to prolonged dry seasons. Even though, a longer and hotter growing season turns to increase yields of many crops which have a shorter growing season and different farming seasons such as maize, solanum potato, beans, and market gardening crops. But they are also harmful to plant growth as they turn to provide breathing grounds for weeds, pests, diseases, and fungi which strive under warmer temperatures. While higher carbon dioxide (Co_2) levels, causes problems to farmers' crops especially to smallholder farmers in Tubah as increased carbon dioxide reduces the nutritional value of most food crops such as vegetables as observed during field survey. Extreme temperatures prevent crops from growing successfully, particularly if the temperature exceeds a crop's optimal level such as Solanum potato, corn, and sweet potatoes (Muh *et al.*, 2018). Farmers are, therefore, forced to adapt by cultivating other crops or other varieties that can cope with the new climate conditions. Also make use of improved varieties seeds, genetically modified crops, and irrigation systems to adapt. Despite technological

advancements, climate is still a key factor in agricultural productivity, as this continues to make food crop cultivation very costly for farmers. Thus, affecting the quantity and quality of food made available which are elements of food security in Tubah Sub-division. Climate variation is of concern given that extreme events, such as prolonged dry seasons, erratic rains, and intensive rains can disproportionately impact plant growth, reduce resilience and leave a lasting impact on the staple food of the people Tubah

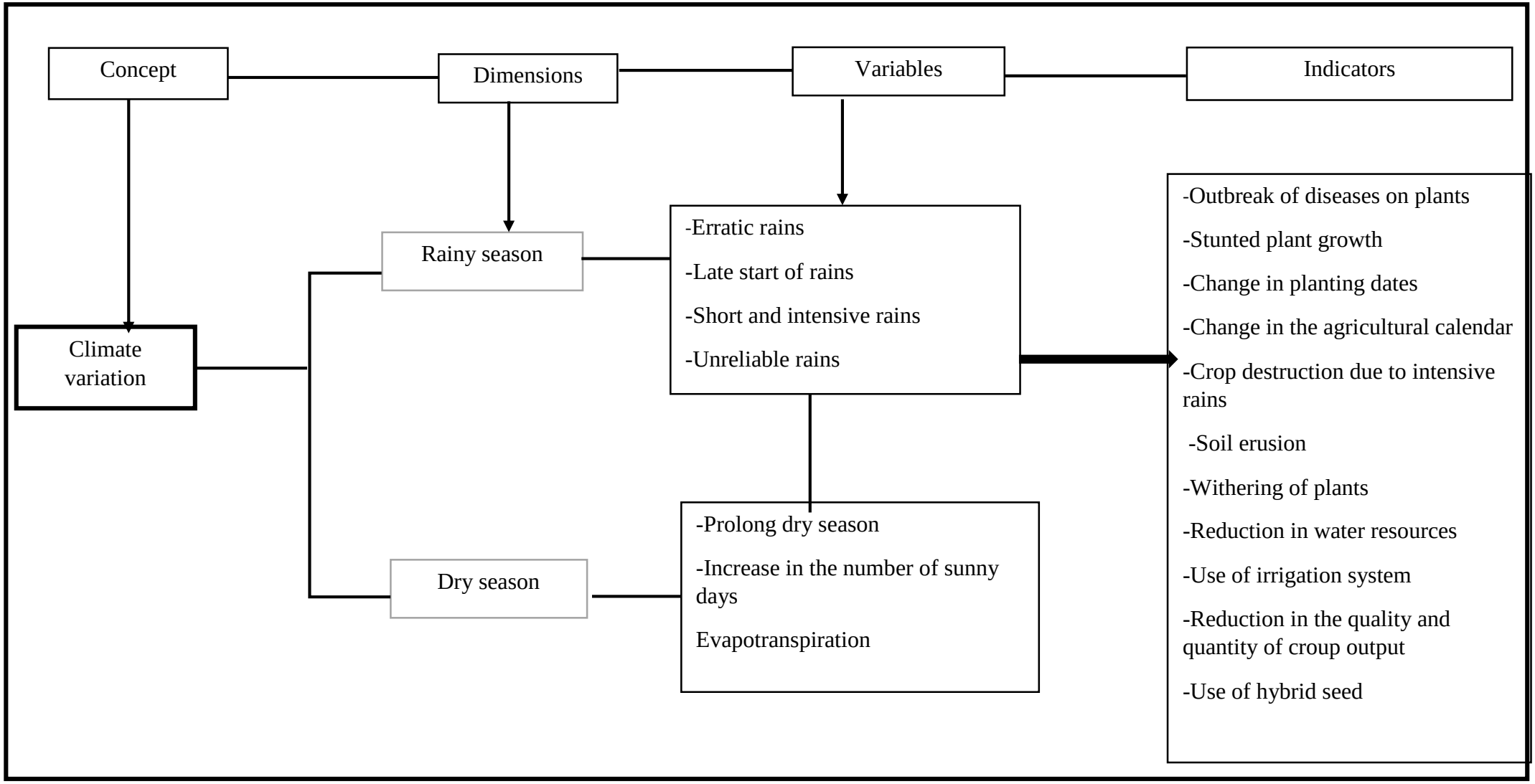


Figure 2: The conceptualization of climate variation

Source: Conceived by the author, inspired by master II course

0.8.6 The concept of food security

Food security is a complex and flexible concept which gained prominence since the World Food Conference in 1974. Many definitions have been put forward by several authors and international organizations including the FAO and the WFF. So, it is necessary to first apprehend the twig of this term and circumscribe it into the perspective of the study, since food security is a complex and multidimensional concept. Thus, identifying and defining the various dimensions of food security which are; accessibility, stability, availability, and utilization cannot be compromised. As it is said that, a single word does not have a particular meaning until it is being defined for the purpose for which the word is intended to be used. All these terms boil down to form the concept of food security.

0.8.6.1 Food availability

Food security refers to the supply of food through production, distribution, and exchange or simply, the supply of foodstuffs in a country from production to imports (Tweeten, 1997). FAO sees food availability as the physical existence of food. At the national level, food availability is a combination of domestic food production, commercial food imports, and exports, food aid, and domestic food stocks. At the household level, food could be from farm production or bought from the local markets. In this work, food availability is defined as the all-around existence of food at the household level which meets the social and cultural preferences of the people while regarding food production as the main source of food supply.

0.8.6.2. Food accessibility

Food access is a state in which, all households have enough resources to obtain food in sufficient quantity and diversity for a nutritious diet. This depends mainly on the amount of household resources and prices. In addition, accessibility is also a question of the physical, social, policies, and environment (FAO,2013). Access focuses on the demand side (Barrett 2010). It considers the loss of livelihood producing assets, the incomes of households, the prices of goods, and the preferences of households. This write-up defines food accessibility as, the affordability and allocation of food, as well as the preferences which meet the cultural needs of individuals and households at all times. Drastic changes in the physical and social dimensions have seriously disrupted production strategies and threaten food access to households in this study area. As Tubah Sub-division is being affected by environmental

changes such as; prolong dry season and uncertainties in rainfall patterns which are becoming much more frequent. This causes the harvest volumes to shrink and the prices of food to increase. This has affected the availability and accessibility of food for households. In this work, food accessibility is perceived as the affordability, allocation of food in terms of its social, religious, and cultural norms and values that influence households' demand for certain types of food.

0.8.6.3. Food Stability

Stability refers to the environmental and economic conditions which ensure the sustainability of food production which gives room to reasonable supply prices of food on a temporal and long-term dimension. Therefore, it is the ability for a given population, household, or individual to have access to adequate food at all times. Without risk of losing access to food as a consequence of sudden shocks such as; an economic or climatic crisis or cyclical events such as; seasonal food insecurity (FAO 2007). Stability is given when the supply on household level remains constant during the year and in the long term. This includes food, income, and economic resources. In this light, food stability in this study refers to the ability for households to access or acquire food daily in its right proportion which meets the cultural values of a given people. Which is not altered negatively by a sudden shock be it environmental, economic, or political shocks. Food stability remains a challenge in this zone as during farming periods food becomes limited and the prices of food do increases coupled with the ongoing sociopolitical crisis, Tubah Sub-division is facing. This has caused prices of food to be fluctuating at any given point in time as many activities are being halted including farming activities. Thereby, creating problems of food insecurity in this area.

Food security could be defined as securing access by vulnerable people to available supplies, (FAO, 1983) implying that attention should be balanced between the demand and supply side of the food security equation. Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (GPO, 2001; GPO, 2003; FAO, 2009; WHO, 2014). According to Demirba ve Atis, (2005) food security is the ability to assure an adequate amount of food made available while, ensuring stability in supply and obtaining ability of food. While, WFP defines food security as “A condition that exists when all people, at all times, are free from hunger”. (WFP, 2009) as to them, food should be made available all through the farming period and during times of crisis.

The United Nations Development Program (UNDP, 1994) brings out another aspect to food security by defining it as, “a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. This requires not just enough food to go round but necessitates that people have ready access to food, that they have an “entitlement” to food by growing it for themselves, buying it or by taking advantage of a public food distribution system. Even though, they have shifted from food production and importing capabilities at the macro-level towards focusing on individuals and their ability to avoid hunger and malnutrition (Foster, 2003). Food Climate Research Network (FCRN, 2018) defines food security as that aspect of food, which goes far beyond its nutritional lips and adequacy to encompass enjoyment, as well as the various social, religious, and cultural functions that food plays in peoples’ lives. This study looks at food security as the availability of food in both quantity and quality which is socio-culturally adaptable to a people. Thus, it is a condition where people at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary and cultural needs for an active and healthy life at the various household level.

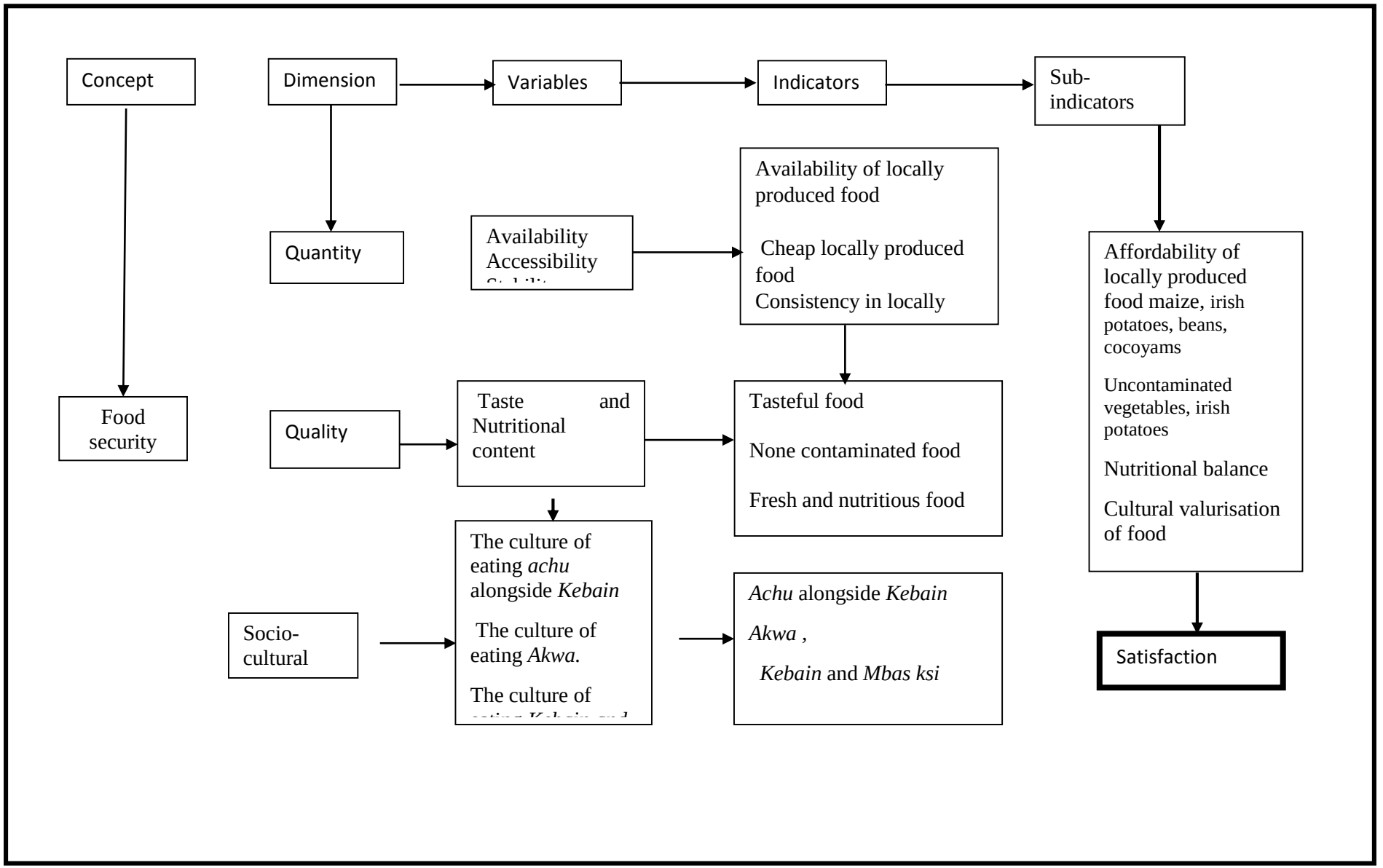


Figure 3: Conceptualization of food security

Source: Authors conception 2020

0.8. Theoretical framework of the study

A theory is a well substantiated explanation of phenomenon of a natural world that can incorporate laws, hypotheses, and facts or scientifically acceptable general principles or body of principles offered to explain phenomena (American Museum of Natural History, 2000). Series of theories have been used to delineate this work within the scientific base or foundation.

0.8.1 The Neo-Malthusian theory

Neo-Malthusian theory argues that food security and sustainable development are intrinsically linked (Scanlon,2003). As the theory resets on the opinion that resources are limited, and the growing population could rapidly outstrip the provision of resources including land and food as food production increased in arithmetic progression. Malthus one of the main proponent of the Neo-Malthusian theory clearly stated that, 'the power in population is greater than the power in the earth to subsistence for man'. Judging from their point of view, increasing number of people will drive up the demand for food, which would result to additional use of arable land. This is especially true in areas lagging in adequate food production technology and integrated programs which simultaneously address community needs for food to ensure food security

Although there has been a green revolution in the world, millions of people are still food insecure in SSA. FAO projects that by 2050 population and economic growth will result in doubling the demand for food globally which is not different from the projections made by the proponents of the Neo-Malthusian. It is typically true that innovational changes have certainly increased food production in Tubah Sub-division through the use of fertilizers, hybrid seeds, and irrigational schemes. Peasant farmers still face challenges of meeting up with resources to produce in large quantities to feed their fast-growing population coupled with the issue of climate variation which handicap most farmers. This makes it very difficult for net income buyers to feed their households in terms of good quality and quantity of food. Moreover, urbanization and the ongoing sociopolitical crisis is making matters worse. As most of the arable lands are gradually converted to residential area especially in Bambili and Bambui which are the main urban towns in this community thus reducing the quantity of food made available. In addition, it reduces productivity and increases the cost of production while downplaying the sociocultural adaptability of the people of Tubah.

0.8.2 Availability decline theory

This theory holds that people are insecure because of insufficient food supply. The proponents of food availability decline theory assume that food insecurity is caused by sudden reduction of per-capital for food supply. According to these scholars this is usually triggered by natural disasters (drought, floods, pest infections) wars and epidemics that leads to contraction of food supply. As a consequent, food prices goes up and people, who are unable to bear such an increase, consume less. Thereby making some vulnerable individuals to start reducing their food consumption because of rising prices. Therefore, one can say that human activities are controlled by the environment (Johnston *et al.*, 1994) including their feeding habits.

It is therefore for this reason that this theory was used in the study to show how food availability has become a challenge over time as the area evolves. Through urbanization Tubah Sub division has witness variation in food prices making availability of food a challenge to low income earners. Moreover, the ongoing crises has weakened the strength of food production in the zoon as farmers cultivate most at times but are unable to harvest their produce from the farm for the market. While sellers are unable to access food for the market for sell because of unforeseen circumstances so everyone tries to take precautions. This however hinders the availability of food as it causes a reduction in the quantity of food made available. This however directly influences the prices of food made available and people, who are unable to bear such an increase, consume less food.

0.8.3 Climate theory

One of the major theory develop in 1970s and 1980 to address the issue of food security which identified climatic phenomena as the main cause of food insecurity was the climate theory. As the author directly linked climatic conditions to food insecurity to make it easy Cox, related the theory with the concept of famine belt. The scholar further justified this by pointing out that at the national or local level, climate linked phenomena such as drought, floods and others are major factors causing food insecurity in an area. Environmental conditions of Tubah Sub-division have largely influenced food security. This is seen through the manifestation of the dry season and the rainy season which the people take advantage of, to cultivate their foodstuffs. But at times, this area is characterized by climatic extremes which at times end up destroying crops and reducing the quantity of food made available. Thus, hindering food security as it influences stability and consistency of most staple food crops in this area.

0.9. Research methodology

The methodology adopted in this work is a hypothetico-deductive approach with hypotheses as the point of departure which was subjected to verification. This approach made use of various research methods and techniques that were largely concerned with data collection, treatment or processing, and analysis. Libraries were consulted to collect secondary data on the effect of climate variation on food security. Among them were; libraries of the University of Yaounde 1, the University of Bamenda, the achieves of the Bambui council, and the Sub-Divisional delegation for agriculture and rural development Tubah Bambui. The ministry of agriculture, Ministry of scientific research, NGOs, and other related offices and institutions were visited in other to get more data related to the agricultural system and the various strategies they adopt toward climate variation. This gave way for the fieldwork to carefully observe and identify how climate variation (unreliable rainfall patterns) affects crop yields in Tubah Sub-division which is the major parameter of food security. Here farmers, *buyam-sellams*, some stakeholders, council authorities, and resource persons in Tubah Sub-division were contacted and the facts collected were either through, field observation, administration of questionnaires, focus group discussion, and granting of interviews.

0.9.1 Sources of data collection

The data collected for this research work came from two main sources which were primary and secondary sources.

0.9.2 Secondary sources of data

Many documents were consulted to obtain secondary data. The data obtained was largely qualitative data and was gotten mostly through literature review. By consultation and systematically exploiting the following documents; annual reports, registers, theses, dissertations, articles, textbooks, topographic maps, aerial photographs, and satellite images published and unpublished documents on climate variation and food security while making use of some related websites on food security. Internet materials were downloaded in a flash disk and exploitation. All documents were exploited by analysing ideas of existing authors and researchers' works on the topic while making some modifications. These consultations were realized from libraries, research institutions, and internet exploration. Libraries of the University of Yaoundé 1 particularly those of the Faculty of Arts, Letters and Social Sciences (FALSS) and the Regional School of Agriculture Bambili were visited. The intention was to

find out what has already been done in the domain of climate variation with food security so as to know the gaps to be filled by our study and equally to gather more relevant data.

Tubah Council Development Plan (TCDP) was also consulted to get data patterning to agriculture and economic activities of Tubah Sub-division. Specialized research centers of; IRAD in Nkolbison, Bambui, and specialized administrative service center of Tubah Council Bambui alongside the Sub-divisional services for Agricultural Statistic and Survey were visited to obtain demographic data relating to agricultural output while gathering data on some adaptation strategies put in place to cope with climate variation. The Ministry of agriculture and rural development (MINDER) was not left out where an authorisation was issued by the minister to permit access to important agricultural documents and for internship. Lastly, organisations were also visited such as the food and Agriculture Organization of the United Nations to see what has been done to ensure food security in other areas of the world. All this was done to get information on climate variation in Tubah Sub-division to see the extent to which it has affected the agricultural sector, the main determinant of food security.

a) Climatic data

The main climatic data obtained was rainfall. It was gotten from two stations; IRAD Bambui and the Regional Delegation of Meteorology for the North West Region, where we obtained rainfall data from 1963 to 2018. This was to ensure that the climatic data were consistent and coherent. It consisted of monthly and annual rainfall and was used to show the relationship existing between crop production and rainfall. The main climatic parameter that determines crop production in communities practicing rain-fed agriculture such as Tubah. Furthermore, the data were subdivided into decadal data and annual to show the pattern of rainfall, the abnormalities which are observed over time, and their influence on crop production. While making use of standardized precipitation index to show the unreliable nature of rainfall in Tubah Sub-division to show how it affects food security.

b) Crop production data

This mainly consisted of food crops data which was obtained from the Sub-divisional Delegation of Agriculture and Rural Development, Tubah (SDDARD). It was made up of annual yields of maize, cocoyam, solanum potatoes, vegetables, beans, groundnuts, tomatoes, and some spices which are mostly cultivated seasonally and annually in Tubah Sub-division. The data obtained helped to better orientate the scope of the study as it helps to throw more light on existing between crop cultivation and climatic variation. This was equally used to

assess how the crops cultivated coincide with the feeding habits of the people and to verify the extent to which climate variation affects the staple food of the local people.

0.9.3. Primary data collection

Primary data for the study was gotten through fieldwork and was largely quantitative in character. It equally comprised of data obtained from direct contact with resource persons of the Tubah Council, IRAD Bambui, and direct observation on the field through visits to the study area. From these visits, data were obtained through interviews, focused group discussions, distribution of questionnaire to farmers and households through convenient random sampling alongside direct field observations. Trips were organized to the field, the first was for familiarization with the study area. This pilot field study helped to initiate the process of data collection. The second tour continued with data assortment which took quite a long because of the sociopolitical condition of the region. However, data was collected from the field in two phases, which were the early planting periods, and the harvesting periods (March, September to December). The first coincided with the beginning of the rainy season when planting takes place, while the second corresponded with the harvesting period in September and the second farming season. Some respondents from Tubah Sub-division were also contacted from Bamenda such as the agric post coordinator for Kejum Kekum. This data played a key role in the attainment of the results of the study.

0.9.2.2 Field observations

An appraisal of agricultural activities in the study area was made through participant and passive observations. During the observation phase, pictures were taken to visually present the findings. Participant observation gave a deeper understanding of certain practices. This was to give way for issues linked directly or indirectly to climate variation while going through the field to be able to back up information generated from secondary data to verify the various hypotheses. With regards to field observation, areas were selected with a high rate of agricultural activity such as Bambui, Bambili, Sabga, and Kejuk Kekum to observe the extent to which climate variation affects the quantity and quality of food crops produced. This was done because of the spatial distribution of agricultural activities in Tubah Sub-division and agric posts. Farmers caring out home base gardening were visited to observe the farming techniques applied, the method of preserving the product, and transporting them to the various markets and homes for consumption. Some photos were taken on aspects that illustrated those issues at stake. For example, blight on crops and other crop diseases while taking into

consideration common techniques of farming. All these indirectly influence the prices of food in the market and help to explain the effect of climate variation on food security in Tubah. Participant observation was equally carried out with some resource persons from the field (the field coordinator for agric post-Bambili). Thereby enabling us to observe and examine the magnitude of climate variation on crop production during the two seasons and how they influence food supply and food prices in the market.

During fieldwork, two local markets were equally visited so as to know how food prices vary during various seasons. This enabled us to verify hypothesis 3 of the research work. That is: seasonal variation influences the prices of food in Tubah Sub-division.

0.9.3.0 Interviews

Five interviews were done which targeted resource persons and related officials who could give an insight on crop production, climate variation, and how this variation affects food security. This involved the Divisional Delegate of Agriculture and Rural Development, Mayor of Tubah Sub-Division, Director of IRAD Bambui, and some major farmers of the community not forgetting local authorities in this area such as the Fon of Bambili. Who gave an inside on climate variation and how it affects food production, the culture of the people, and their various feeding habits. Hence giving a wilder knowledge and concrete information on how food security has been affected due to variation of agricultural output caused by climatic variation patterning to the study area.

The Director of IRAD

The Director of IRAD Bambui was interviewed to have in-depth information on the effect of climate variation and how it affects food production in Tubah Sub-division. This interview equally draws information concerning the measures IRAD has put in place to adapt to climate variation so as to boost agricultural output while ensuring food consistency and availability in the community of Tubah. There by solving some of the problems faced by farmers during crop cultivation or during the farming periods among them were; the late start of the rain, diseases, and paste affecting plant growth as a result of climate variation. This was in line with hypothesis one on the relationship that exists between rainfall uncertainties and food production.

Farmers

In line with hypothesis two, five farmers within this Sub-Division were interviewed on how seasonal variation influenced crop cultivation and feeding habits in Tubah Sub-division. This permitted us to appraise the relationship between crop cultivation and feeding habits. Also, it equally helped in accessing how the culture of the people has changed over time due to climate variation which affects most of their staple food. While gathering data on how the local population preserves their food items at the level of the various households in Tubah.

Restaurant operators and *buyer-sellams*

To enable us get information on how seasonal variation influences the prices of food in Tubah Sub-Division, one restaurant operator and one *buyer-sellam* were interviewed. Thu helped the study to get facts on the prices of most crops cultivated and the demand of the people. Which aided in evaluating, the relationship existing between seasonal changes, and the prices of food within specific periods of the year which goes a long way to affect the affordability of food in Tubah Sub-division.

0.9.3.1 Focus group discussions

Focus group discussion was done to collect primary data in the field. This was carried out in two villages and was mostly during gatherings such as *njangi,* cultural, and in churches. This process of data collection was used during the second fieldwork and was made up of mostly farmers, and those who sell foodstuff in the various local markets. It had a minimum of seven persons and a maximum of ten persons. During group discussion, issues discussed were mostly based on the patterns of rainfall, and how it affects crop cultivation which intern affects food security. While, identifying strategies used to fight against extreme climatic conditions 0such as prolonged dry season. At the same time, looking at how such negative effects, influences crop cultivation methods used in Tubah. However, some aspects patterning to food preservation and the affordability of food at the house whole level were equally discussed. A checklist was developed in order to keep track of the topics for the discussion and exploration with the groups.

0.9.4. Population for the study

The population for this study was made up of all the households in the 6 villages in Tubah Sub-division. These 6 villages had a total human population of 65250 inhabitants and

4276 households following the population and household census of BUCREP in 2010 (Table1).

Table 1: The population of the study area

N	Villages	Village population	HH (villages)
1	Bambui	15808	1279
2	Bambili	14323	938
3	Sabga	2000	568
4	Big Babanki	16383	671
5	Small Babanki	14286	520
6	Finge	2450	300
Totals		**65250**	**4276**

Source: BUCREP,2010 Population and Housing census. HH= households

0.9.4.1. The sample size

The sample size for the population of the study was drawn from 4276 households in the study area following the 2010 population and household census. The rationale for using households was that, it is much easier to administer questionnaire in households than individuals in streets and this approach equally reduces cost and facilitates the work. In effect, 5% of the households made up the sampled population for this study. The sample size of 5% for the study was chosen in accordance with the roles set by Nwana (1982), which stipulates that:

-If the population of a study is in a few hundreds, a 40% or more sample, will do,

-If the population is in many hundreds, a 20% will do,

-If the population is in a few thousands, a 10% will do and,

-If the population is in several thousands, a 5% or fewer samples, will do (Nwana, 1982).

0.9.4.2. Sampling technique

The 5% sample size for this study was selected from the total number of households in each village using the formula:

X*5/100

X= number of households

5= sample size chosen

Computing a 5% sample size from 4276 households, 214 households was selected to whom copies of questionnaire were administered (Table 2).

Table 2: Selected sample size for the study

N°	Village	Number of households	5% Sample size
1	Bambui	1279	64
2	Bambili	938	47
3	Sabga	568	28
4	Big Babanki	671	34
5	Small Babanki	520	26
6	Fingi	300	15
	Total	**4276**	**214**

Source: BUCREP,2010 Population and Housing census

From table 2, the researcher was able to know the total number of copies of the questionnaire to be taken to the field for administration. This aided to easily calculate the number of effective respondents.

0.9.4.3. Administration of questionnaire

The administration of questionnaire followed a systematic random sampling approach and a convenient sampling method where copies of questionnaire were attributed to those who were available and ready to work. This was applicable in areas such as Small Banki and Big Babanki which were areas seriously affected by the ongoing Anglophone crisis. Even though the area is a hotspot for agricultural activates it was observed that many people had evacuated the area for safety while some were very skeptical on matters related to studies. Furthermore, the systematic random sampling was easily applicable in areas still having a stable population (Bambili, Bambui,Fingi and Sabga).As the area was stratified into agricultural zones with respect to areas covered by agricultural post. However, this approach facilitated the application of the sampling frame determined (table 2). Where by, a copy of questionnaire was distributed to the 20^{th} household after each 1-20 household count during field survey in those areas. Survey instrument was designed to collect data on the perception of respondents on rainfall variation, impact of climate variation on crop production and adaptation strategies. Questions equally centered on how agricultural output influences the prices of food stuff in the market as this determines affordability and how climate variation affects their feeding habits which are culturally bound. The questionnaire comprised of both closed and open-ended questions. In order to avoid biases, the data instrument took into consideration all gender derivatives so as to obtain a suitable representation. After administering the questionnaire, the number of effective respondents was determined.

Table 3: Number of effective respondents

No	Villages	HH (villages)	5% size	Eff Resp.	% Eff Resp
1	Bambui	1279	64	63	98.43
2	Bambili	938	47	45	95.8
3	Sabga	568	28	27	71
4	Big Babanki	671	34	13	38.2
5	Small Babanki	520	26	10	38.4
6	Finge	300	15	12	80
Totals		**4276**	**214**	**170**	**79.4**

HH: household, Eff. Resp: effective respondents

Source: BUCRE, 2010(2005 projections) population and housing census

In the field we distributed some copies of the questionnaire to any one we met and who were available to fill the data instrument in areas seriously affected by the ongoing crisis while, taking into consideration the sampling frame of the area. However, some copies were self-administered in order to gain time due to the reigning insecurity in the study area. Out of the 214 copies that were distributed only 190 were collected after processing,20 copies were not filled up to quarter. These ones were superfluous and we were left with 170, effective respondent (Table 3).

From a spatial point of view, 63 copies were administered in Bambui, 45 Bambili, Fingie 12, Sabga 27, 13 and 10 respectively to Big and Small Babanki (Figure 4)

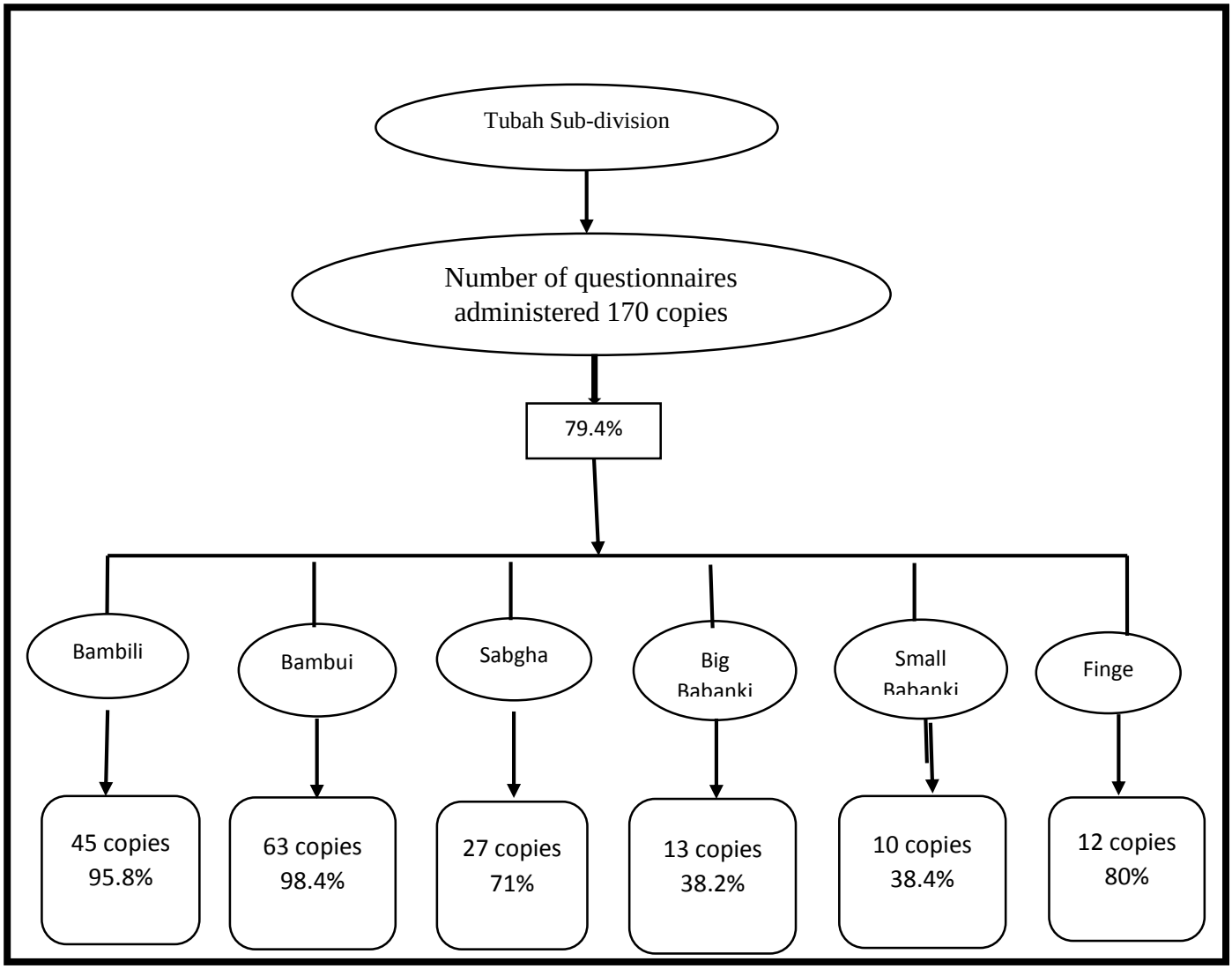


Figure 4: Spatial distribution of effective respondent in the various villages of Tubah Sub-division
Source: Adopted and modified from Tufoin,K.(2020 : page 38)

The research design has been conceived in a tabular form and presented here below. It captures the research questions, objectives, hypothesis methodology, concepts, theories and the chapter layout (figure 5).

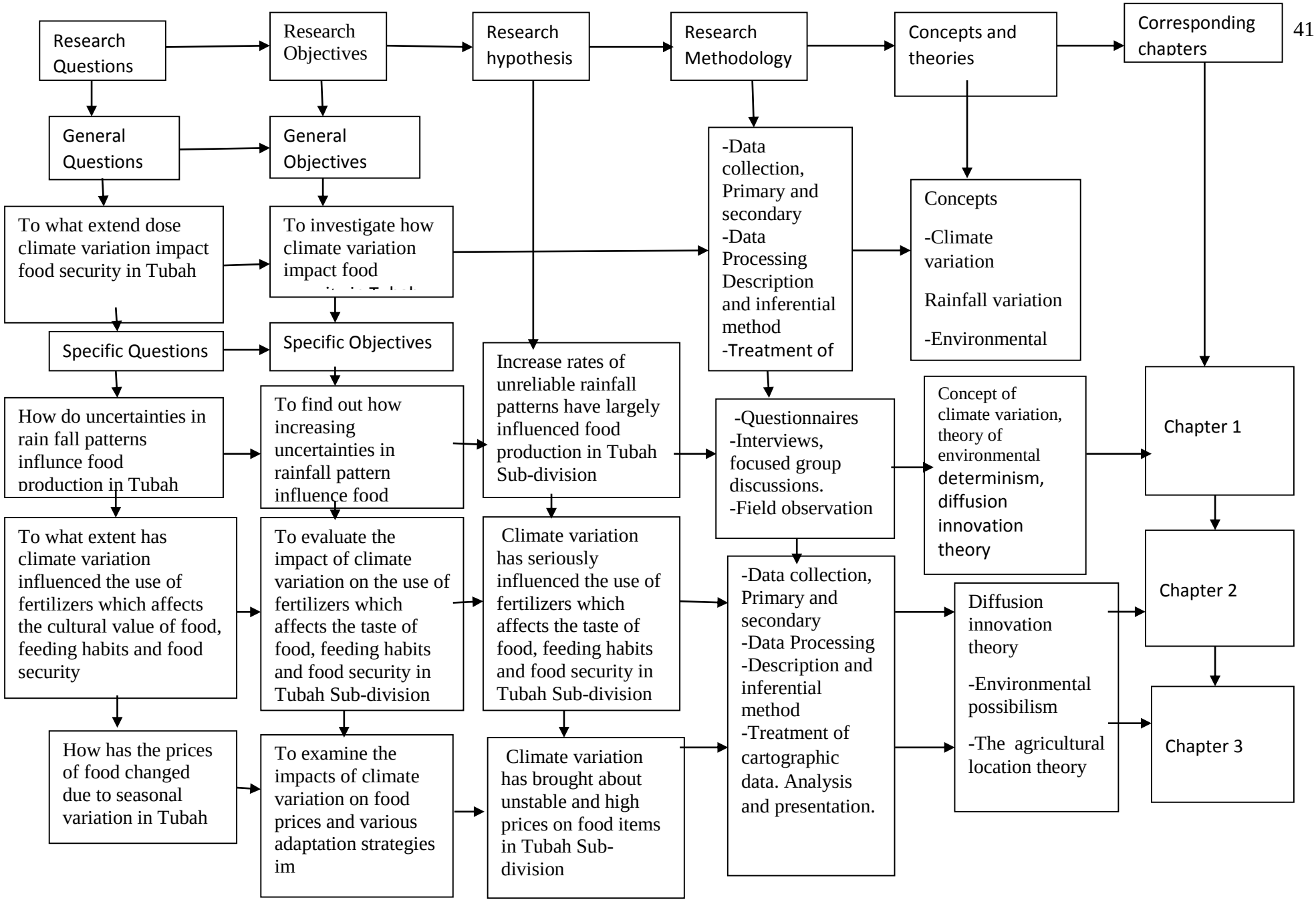


Figure 5: Synthetic table

Source: Conceived by the author

Operationalization of variables

A critical look at the research questions, objectives and hypotheses shows that we have dependent and independent variables which needs to be operationalized to help build the questionnaire and equally the type of data to be collected.

Hypothesis 1: 1. Increase rates of unreliable rainfall patterns have largely influenced food production in Tubah Sub-division**.**

Independent variable: Unreliable rainfall patterns

Dependent variable: food production

Table 4:The operationalization of the variable of hypothesis 1

Independent variable	**Indicators**	**Dependent variable**	**Indicators**
Unreliable rainfall patterns	-Early start of rain -Prolong dry seasons -Reduction in the number of rainy days. -Reduction in rain frequency and the intensity of rains. - Late onset and early cessation of the rainy season. -High rates of evapotranspiration. -Reduction in water bodies.	Food production.	-Change in planting dates -Crop destruction due to heavy wind on farm lands which leads to low output and reduction in the quantity. -outbreak of diseases and past on crops. -Use of chemicals on crops such as insecticide and fungicides. -Stunted plant growth -Deterioration of crops -Irrigational practices.

Hypothesis 2: 2. Seasonal variations have seriously influenced the use of fertilizers which affects the taste of food, feeding habits and food security in Tubah Sub-division.

Independent variable: Seasonal variation

Dependent variable: Influenced the use of fertilizes and change in feeding habits and food security

Table 5: The operationalization of variables of hypothesis 2

Independent variable	**Indicators**	**Dependent variable**	**Indicators**
Seasonal Variations	-Prolong dry seasons -short rainy season -Early start of the rainy season -Extreme weather events -Reduction in the number of rainy days	Fertilizers, feeding habits and food security	-More of cereals cultivate -Introduction of new species of crops and the use of high variety seeds and fertilizers -More of intensive market gardening and home gardens -Alteration in planting and harvesting dates of crops -Changing consumption patterns and food preparation practices. -Changes in the nutritional patterns of food. -Cultural diversity of food -Changes in the taste of food -Poor nutritional intake -Hunger and Importation of food items -Change in cultural values. -Adaptation to new storage methods for food.

Hypothesis 3: Climate variation has brought about high prices on food items and adaptation strategies in Tubah Sub-division

Independent variable: Climate variation

Dependent variable: High prices of food and adaptation strategies

Table 6: The operationalization of variables of hypothesis 3

Independent variable	**Indicators**	**Dependent variable**	**Indicators**
Climate variation	-Prolong dry seasons -short rainy season -Early start of rain -Unpredictable nature of rain -Extreme weather events -Warmer temperature	Food prices And adaptation	-Poor harvest -Destruction of crops due to strong winds and rain -Higher prices on food farm produce. -Limited labour force -Low and moderate prices on farm produce during harvesting periods -Higher prices due to the outbreak of past and diseases on plants, animal. -Urbanization Small parcels of land cultivated -Rise in the cost of transportation -Mechanization of agriculture -High rate of irrigation -High usage of fertilizers and other inputs. -Change in dietary intake. -Increasing population. -Poor health on humans

0.10. Data treatment, presentation and analysis

Several types of data were collected and were accorded different types of treatment before presentation, analysis and interpretation. The various types of data principally consisted of quantitative and qualitative data which embodied interview data, focus group discussion data, questionnaire data, cartographic data, rainfall data and observation data. In order to better analyze the data collected from the field, descriptive and inferential statistical tools were used. Data obtained were treated differently and presented in the form of graphics, figures and tables.

0.10.1 Interview, focus group discussion and observation data, treatment, presentation and analysis

The treatment of qualitative data began with data coding where the Strauss method of open system data coding was used. In this case, categories of responses from respondents and the major themes were identified, assigned, and classified. These categories were manually recorded on a prepared notebook as per the objectives of the study that enabled the formulation *of constructive codes from in vivo* codes obtained during interviews and focus group discussions. The *in vivo code* emphasized the participants' actual spoken words. This type of data coding method championed because of its usefulness in highlighting the voices of the participants themselves during interviews and focused group discussion. The *in vivo* coding method was also used because it was thought to be very reliant to pass across the message using the direct words of the participants. The codes obtained as per the objective of the study include:
Objective 1: Climate has changed we do not know when the rainy season starts and ends again, rainy season starts and stops, when plant crops when rain start but soon after it is dry season and the seedlings die all, if you have the means you can replant.
Objective 2: We now use fertilizers to increase agricultural output not because we love to do so but due to the declining nature in soil fertility and changing climatic conditions which we are witnessing over time. Although, we equally advice farmers on the effects of the wrong usage of fertilizers, we still face challenges on how farmers should properly apply these agrochemicals on crops so as to have quantitative and qualitative food which meets up with the social, religious and cultural values of the people.
Objective 3: Over the years, we have witnessed fluctuation in food prices making it at times very difficult for some people to afford especially during farming seasons, periods of poor harvest and crisis talk les of this influx of students yearly. At times, we step up our budget for food this is usually not easy.

These codes were presented and analyzed in the three chapters of the study using both inferential and descriptive statistics and the results were interpreted where meaningful conclusions were drawn. Observed phenomena were captured with the use of a digital camera. These data were inputted in Photoshop software where the photos were enhanced through enlightening and clearing off impurities found in the photos to make them very clear and visible.

0.10.2. Cartographic data treatment presentation and analysis

This category of data was obtained with the help of an ASTER image downloaded from the United States Geologic Survey of Earth Explorer (USGS). It helped to capture and extract the areas of interest which were treated to get relief and hydrography maps. In order to carry out land cover analysis, Landsat mages for 1988, 2003, and 2020 downloaded from USGS were exploited. These images were later processed using ERDAS imagine software where a supervised classification technique was used. This was followed by a conversion of the data from raster to shape file using ArcGIS software. This was later superimposed on cartographic shape file of Tubah Sub-division where they were spatialised and the information presented on maps. As concerns the location and soil maps realised, the data was obtained from the National Institute for Cartography (NIC) and superimposed into cartographic shape files of Tubah Sub-division from which the maps were realized for spatial analysis to show the location of the study area and the various soil types which have influenced agricultural activity.

In order to get the various farming systems, a field survey was done where the areas with the different farming systems were identified. This was also accompanied by the use of a Global Positioning System (GPS) mark Garmin 62, which was used to collect the geographic coordinates of Longitudes and Latitudes in degree. Google Earth Image, dated December 2019 was used to digitize and generate the different farming areas. This data was downloaded from GPS and superimposed on a cartographic shape file of Tubah Sub-division to show the various crops.

0.10.3 Questionnaire and climatic data treatment, presentation, and analysis

The data that was collected using a questionnaire was largely quantitative and required a concise method of treatment and presentation. The options chosen by the respondents from a range provided were weighted one point for easy quantification. This method made good use of micro soft excel and SPSS (Statistical Package for Social Sciences). The weighted options of the respondents were input in the software where cross-tabulations of data and frequencies were generated to show the degree of correlation between variables which are climate variation and food security. This software did the summation of responses according to the villages automatically and the tables generated carry the statistics, totals and percentages for analysis. While micro soft office excel was used to do the climatic analysis where graphs were generated to show the correlation. Many tools and instruments were used in this study that assisted in the collection of data (Table7).

Table 7: Tools instruments and uses

Tools and instrument	Uses
Microsoft word and excel	To treat qualitative data and to obtain graphs
Adobe Photoshop	To change photos and clear impurities
AreGis(shape files) and Adobe illustrator	To realize maps
Digital camera	To capture phenomena
Google maps	To collect spatial information on space and to verify land use, farming systems and relief maps realized
GPS	To collect waypoints
The eye	It was used to observe phenomena
Appendices	For the clarification of assertion made in the study
Questionnaire	To collect quantitative data

Source: Ngwangunu, (2020)

0.10.3. Plan of work

The general introduction of this work covers the background of the study, delimitation of the study, the problem statement, research questions, objectives, and hypotheses of the study. The literature review, concepts as well as theories related to the topic are equally examined in the general introduction. This section of work ends with the research methodology of the study.

Dissertation chapter layout

This study comprises three chapters which are further subdivided into sections. These sections comprise the introduction, discussions of the data presented in the chapter, and finally conclusion which crowns the chapter. The conclusion principally summarizes the main issues raised and discussed and introduces the next chapter.

Chapter one investigates the variation of rainfall patterns and their impact on crop cultivation. The chapter analyses the causes of climate variation, the people's perception of the changing environmental conditions while looking at the physical background of the area. Also, analysis was done on rainfall trends and temperature trends of this area. In addition, the standardized precipitation index was done to measure precipitation anomalies to detect periods of meteorological droughts. It equally looks at the regularities in rainfall events and their implications on agricultural productivity. The main goal of all this is to validate hypothesis 1 which states that, increase rates of unreliable rainfall patterns have largely influenced food production in Tubah Sub-division.

Chapter two sets out to assess how seasonal variations have influenced the use of fertilizers which affects the taste of food, feeding habits, and food security in Tubah Sub-division. While showing how the trend of agricultural production dropped due to climate variation resulting in the high use of fertilizers which is affecting the taste of staple food. This has contributed to some perturbation in the staple food even though food is readily available.

The chapter equally measures the degree and magnitude of food insecurity and the various drivers responsible. The principal reason for doing this is to validate hypothesis two which states that; seasonal variations have seriously influenced the use of fertilizers which affects the taste of food, feeding habits, and food security in Tubah Sub-division.

Chapter three elaborates on the influence of seasonal variation on food prices. The chapter also aims at verifying the relationship which exists between food prices and seasonal variation in Tubah Sub-division. The data collected, presented, analyzed, and interpreted helped in the validation of hypothesis three which states that there is a relationship that exists between food prices and seasonal variation in Tubah Sub-division. This chapter as so brings out other factors responsible for the variation in food prices and concludes with various adaptation strategies. To both increase in food prices and climate variation. While the general conclusion focuses on the summaries on findings, verification of hypothesis, conclusions and suggestions, and finally references.

CHAPTER 1

THE INFLUENCE OF RAINFAL AND TEMPERATURE VARIATION ON FOOD PRODUCTION IN TUBAH SUB-DIVISION

Introduction

Rainfall and temperature variations in contemporary times has become a major challenge to food production (food security) around the world particularly in SSA. Recent modifications in the length of the rainy, `dry season and the number of days of rainfall and those of no rainfall have seriously influenced the agricultural calendar and the quantity of crop cultivated as well crop yields. This chapter seeks to find out how uncertainties in rainfall and temperature patterns influence the quantity of food production in Tubah Sub-division which is the main determinant of food security. Also this chapters shows how other physical factors have influenced food production0

In order to achieve this objective, the following hypothesis served as a guide ‘unreliable rainfall patterns and temperature variations have largely influenced food production in Tubah Sub-division’. The data used to verify this hypothesis was mainly gathered from secondary sources, questionnaire, focus group discussions, interviews, and field observation. These data have been grouped into seven main sections which are 1.1,1.2, 1.3, and 1.4 Section 1.1 focuses on the influence of climate on crop production and indicators of a changing climatic conditions in Tubah Sub division. Section 1.2 lays emphasis on the perception of farmers in the Sub-division on the changing climatic conditions. A close look was also taken in this section to investigate the causes of the changing environmental conditions. Section 1.3 dwells on the rainfall pattern of this area as it uses statistics of rainfall from 1963 – 2018 to show changing trend in rainfall. This section further shows the monthly pattern of rainfall and how it influences the agricultural calendar, inter-annual variation in rainfall, and the inter-annual anomaly which provide a better illustration of the general trend and fluctuations in rainfall. Section1.4 examines the impact of rainfall variation on agricultural output. By first showing the regularities in rainfall events and how the local people of Tubah perceive its impact on agriculture. the physical background of Tubah which seeks to show how relief, hydrography, and soil have influenced the evolution of agricultural activities the engine of food security. While the last section brings out the magnitude in temperature and rainfall variations in Tubah Sub Division

1.1 Climate and its influence on food production in Tubah Subdivision

Tubah Sub-division has varied climates within its geographic area, due to its topography of hills, valleys, and plains which has influenced food security. These different climatic conditions have also influenced the cultivation of a variety of crops across this Sub-division. Kedjom Ketinguh with temperatures of about 23.1°C is one of the warmest places in Tubah Sub-division. Tihkhebeng, one of the quarters in Ketinguh which lies in the Ndop plain has witnessed the highest temperatures ever as compared to other areas (IRAD, 2017). Next to this is Bambui which lies in the plain that stretches to Bafut. Bambili and Kedjom Keku generally have colder climates, includi000ng Sabga and the upper plateaus of Kedjom Ketinguh with temperatures ranging from 15.1-20.4 °C (Figure 6). This explains why Tubah Sub-division has agricultural activity as its mainstay due to its climatic dynamics which fit into two seasons (Dry Season and Rainy Season) of the area; and experience the tropical highland climate in general. These two seasons have influenced the cultivation of food crops of both warm and cold climates while determining the agricultural calendar of this area. Therefore, influencing the quantity of food made available which is socio-culturally adaptable to the people of Tubah.

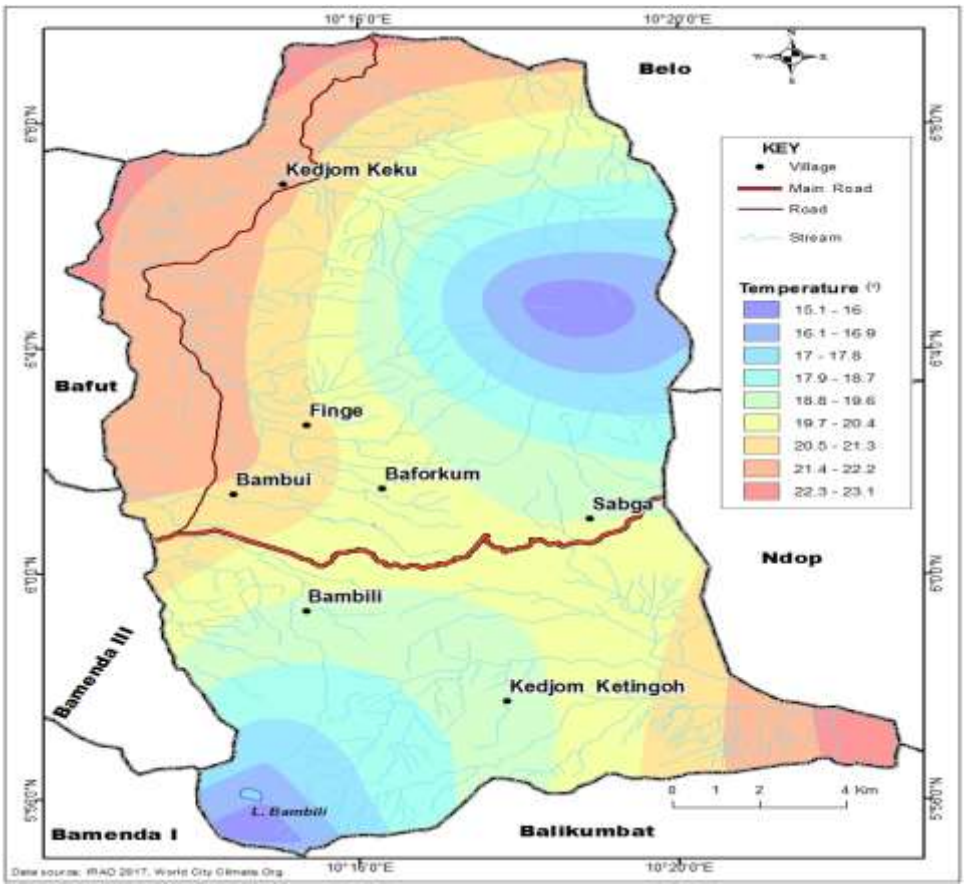


Figure 6: Temperature map of Tubah-Sub division
Source: World City Climate. Org and IRAD 2017

1.1.2 Indicators of changing climatic conditions and its influence on food security in Tubah Sub-division

Although people have different points of view on the changing climatic conditions, several climate change indicators around the world as pointed out by IPCC and confirmed in Tubah Sub-division indicate climatic dynamics. Indicators such as changes in seasons, prolong periods of dryness, reduction in volumes of water bodies and other anthropological indicators such as degradation of totemic sites, cultural and religious sites are clear indicators of changing environmental conditions as observed in the field.

1.1.3. Changes in seasons

Tubah Sub-division like other Sub-divisions in the NWR is experiencing some degree of changes in the behavior of its two main seasons (rainy and the dry season). Besides it is also influenced by the monsoon wind which brings the rains. Tubah receives mean monthly rainfall higher than 100mm. Although there is a tendency towards an increase in rainfall from February onwards in all parts of Cameroon, except the Northern Regions (Molua and Lambi, 2006). Rainfall is highly seasonal on which farmers depend for their agricultural activities. Rainfall and temperature data obtained from IRAD Bambui reveal a gradual increase in mean monthly rainfall from the beginning of the wet season (March/April) towards the peak (August) and a steep decline from August towards the beginning of the dry season (figure 7). Statistics of precipitation and temperature in Tubah Sub-division from 1995 to 2015 indicated an increasing mean annual temperature rate of 0.09 °C per year and a slight increasing annual rainfall rate of 25.8 mm per year (Naintboh *et al.,* 2018). While Ojuku, Enchaw and Tsalefac (2010) in a study revealed that rainfall is the most conspicuous indicator of climate change in the Western Cameroon High Plateau. Historical data analysis shows that rainfall has been on the decline over the years. This is in line with what farmers are experiencing in the various communities in Tubah as rain tends to start earlier and also stop after some few weeks or days only to restart after about two weeks with severe effects on farmers who plant during the first rains.

Table 8: Mean monthly rainfall (mm) and temperature (°C) of Tubah Sub-Division

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (mm_	10.62	34.05	122.72	177.16	182.94	271.44	386.27	374.14	368.07	211.68	40.06	11.08
Temperature (°C)	20.13	22.36	21.17	20.74	20.31	19.33	18.22	18.26	18.63	19.67	19.75	19.77

Source: IRAD Bambui, 2018

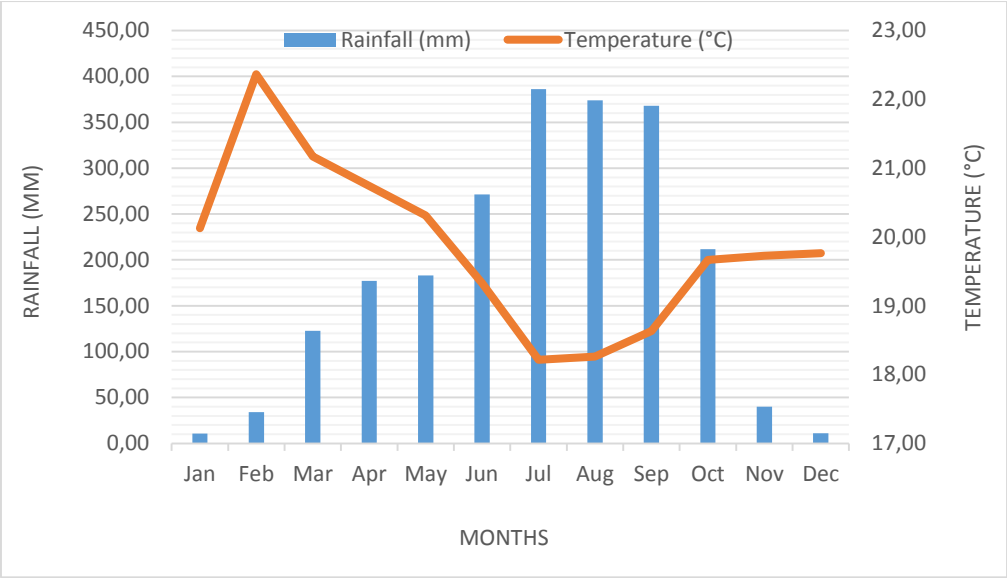


Figure 7: Mean monthly rainfall and temperature

Source: IRAD Bambui, 2018

High rainfall deficits are experienced during the months of February, March, October and November (Ojuku *et al.,* 2010). Judging from Figure 7, February has the highest mean monthly temperature. From March, the temperature starts falling and rises again from September. This explains why on the agricultural calendar, tomatoes, Solanum potatoes, and vegetables are cultivated during this period of the year. While, from the month of March, there is a steady increase in rainfall to September with July recording the highest amount of rainfall within the year. It is generally believed that planting starts from March which is the starting period of the rain as shown on the chart. Generally, Tubah is a community that practices rain-fed agriculture, as its agriculture activities depend on these two seasons based on the data generated in the field during the main face of the field survey (Table 9).

Table 9: Agricultural calendar of food crop production in Tubah Sub-division

Farming methods	Food Crops cultivated	Planting	Weeding	Harvest	Approximate
Extensive farming	Maize, beans, Peanuts,	March-April	May-July	July-Oct	5months
Subsistence Intensive farming	Maize, beans, Peanuts,	March-April	May-July	July-Oct	5months
	Dry season beans and maize	Sept-Oct	Oct-Nov	Jan-Feb	5months
	Yams	Jan-Feb	April-May	Nov-Dec	11months
	Coco yams	April-May	July-Aug	Nov-De	7months
	Arish potatoes, sweet potatoes	July-Aug	Sept-Oct	Dec-Jan	5months
Intensive farming	Arish potatoes, sweet potatoes	July-Aug	Sept-Oct	Dec-Jan	5months
	Dry season Arish	Sept-Oct	Oct-Nov	Jan-Feb	5months
	Cucumber, Tomatoes,	March-April	May-June	June-July	3months
	Okro and pepper	March-April	May-June	June-July	3months
	Huckleberry	March-April	May-June	June-July	3months

Source: Divisional Delegation for Agriculture and Rural Development Tubah and field work, 2020

Table 9 demonstrates the agricultural calendar with the farming season starting from March –April and the various farming methods practiced in Tubah Sub-division. Judging from the above data set obtained from the SDDAR Tubah, a majority of farmers do cultivate mainly seasonal crops and do carry out rotational crop farming. For instance, farmers attested to the study that after harvesting maize from July to August, dry season bean is planted from September to October to maintain soil fertility. Intensive farming is also practiced with the cultivation of food crops such as root crops and tubers as well as fruits and vegetables from January to December so as to ensure consistency in food production and to stay food secured. Vegetable farmers in Big Babanki during focus group discussion made known to the study that they are constrained in the cultivation of vegetables because they no longer understand the climatic situations these days but try to follow the agricultural calendar. "*The rains are becoming scarce and the dry season is getting much longer than before making the streams around dry up. This has made it very difficult to cultivate on a normal regular basis"*. Interviewed person further stressed that; variation in weather conditions has made it impossible for farmers to have a mastery of its occurrence, thus perturbed their agricultural calendar because they plant crops and it does not rain and the crop dry out due to prolonged dry season.

During an interview with the Director of IRAD Bambui on the changing climatic conditions of Tubah and how it has influenced food production in this area, strained on the fact that there has been a change in the behavioral pattern of rainfall. The Director equally reviled to the study that these changes in season affect the agricultural calendar of the 6 communities of Tubah. As in recent years, the length of the rainy season has reduced while the length of the dry season is increasing and now it is very difficult to say when exactly the dry season starts and ends. "*These changes in the season have seriously affected the agricultural calendar as it makes it difficult for farmers to actually know when to start their farming activities"*. Therefore, it can be inferred that uncertainties in rainfall patterns upset the agricultural system of this area which is largely rain-fed thus reducing crop yields which affect food security.

1.2. Perceptions of local communities on changing environmental conditions in Tubah Sub-division

The changing environmental conditions of Tubah Sub-division are becoming preoccupying to the local population due to variation in climatic element such as temperature (Figure 6). According to the data collected during field survey as presented on Table 10 and interviews, the population of Tubah Sub-division is aware that their climate has changed and this was affirmed by a response score of 90%. From their perceptions, there is a significant

change in the climate of this area over the past decades with severe impacts on the crops they cultivate. That notwithstanding, 1.8% of the respondents were still ignorant of the changes in their climate. This category of respondents was made up of those who had nothing to do with farming.

Table 10: Respondents perception on the changing climatic conditions

No	Villages	No of respondents	Have you witnessed signs of a changing climate in recent years?		
			Yes	No	No idea
1	Bambili	45	44	0	1
2	Bambui	63	59	4	0
3	Finge	12	10	2	0
4	Sabga	27	22	4	1
5	Kejukekum	13	10	2	1
6	Kejume ketinguh	10	8	2	0
	Total	170	153	14	3
	10%	100	90	8.2	1.8

Source: Fieldwork, 2020

The 90% of respondents as depicted by Table 10 are of the view that the climatic conditions have changed over time as opposed to 8.2% who did not notice any changes. Based on data collected during field investigation, the climate of Tubah has become very unreliable in recent years. This is justified based on the fact that during one of the focus group discussion, with some farmers in Bambili, they made mention of seasonal distortions as the rainy season appears to start and stop early than expected while the dry season gets longer. Also, they have noticed a reduction in the number of rainy days and an increase in the number of days with no rain during the rainy season. Such distortions made it difficult to predict and clearly state the actual date for the rains to fall although announcements are generally passed in churches to inform farmers on when to start planting. According to interviewees, in the past, they were conscious that the first rain will fall by mid-March, which marked the commencement of the planting period. But it is contrary today as farmers complained of huge losses whenever they plant after the first rains because the plants easily wither due to the early stop of rain. They provided some indicators of the changing climatic conditions such as recurrent heat waves characterized by high temperatures, prolonged dry seasons, erratic rains which affect the farming colander and the quantity of food crops cultivated. This however, goes a long way to influence food security negatively by reducing the quantity of food made available in this area.

The no-respondents which represent 8.2% denied the fact that there have been changing climatic patterns probably because they are not farmers or are not directly involved in farming.

According to these skeptics, the climate is still the same it is just undergoing some variation. The no-respondents further attest that they are still able to cultivate their usual crops in large quantities even though the rain may not permit them to start their farming activities on time. Some informants made it clear to the study that those who complain of changing climate conditions are those who are very lazy to carry on with farming activities. As they will farm only when the rain becomes constant instead of preparing their farms while waiting for the rain to fall. Below is a skeptic perception in a sequestrated interview;

> *"Everywhere today people are talking about climate change as the main reason for a reduction in the length of the rainy season and an increase in the number of sunny days. To me I do not believe in this because I still go on with my agricultural activities all I try to do is just to operate with what I see which God has made available. Rain or no rain I still work because I must eat".*

Despite the different perceptions of the respondents on the changing climatic conditions, a large proportion of the respondents affirmed that these changes are real. The difference in perception may be due to the fact that poor farmers who depend solely on natural rain for farming are more vulnerable to climatic distortions than big farmers who are used to applying irrigation techniques to cultivate all year round.

1.2.1. Comparative decadal analysis on perceived temperature and rainfall to show the degree of climate variation from 1980-2020 in Tubah Sub-division

Comparative decadal analysis on perceived changes in temperature and rainfall is an approached used in the study to determine the degree of climate variation as perceived by the sample population. Temperature and rainfall are the two key determinacy of food production which determines food security in Tubah Sub-division. As they determine when to plant, the growth rate of crops, when to harvest crops and the availability of food in the local market.

1.2.2 Perceived change in temperature from 1980-2020

According to the United Nation Environment Program, the current path, global average temperatures are likely to climb to more than 1.5^{o}C above pre-industrial levels before midcentury, and would exceed 3 ^{o}C by the end of the century (United Nation Environmental Program and Emission Gap Report 2018). The evidences are very clear for Tubah figure 8 gives a vivid view of perceived temperature change with the period 2001-2011 and 2011- 2020 being the two decades of significant shift in temperatures as perceived by the sampled population of Tubah.

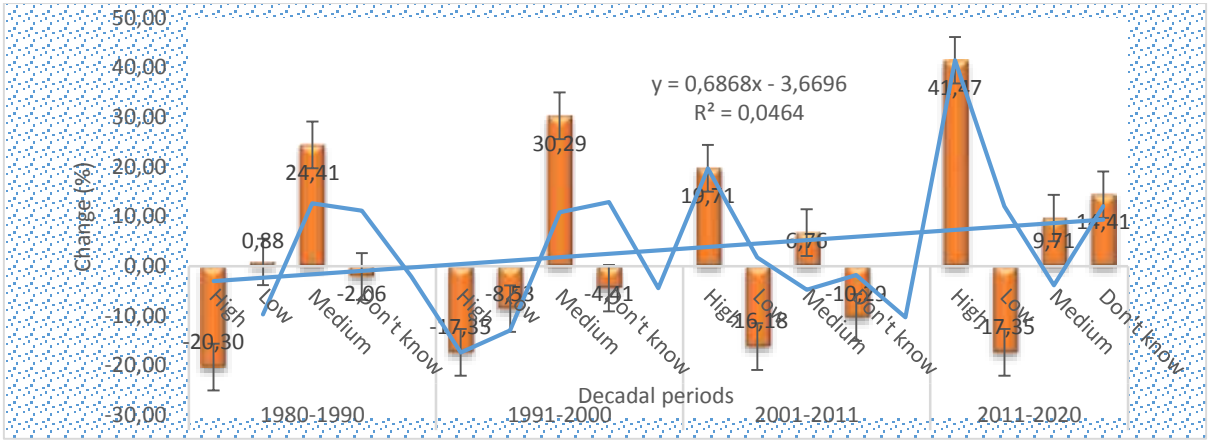


Figure 8: Perceived change in temperature (1980-2020)

Source: Fieldwork, November 2020

From figure 8, it shows that the period 2011-2020 respondent perceived a very high change in temperature in Tubah Sub-division the degree of perceived change in temperature is indicated by the coefficient. The inter-decadal perceived change in temperature is indicated by the coefficient of determination (R^2). The general perceived decadal temperature trend for Tubah Sub-division from 1980 – 2020 was a slight increase by a factor of (R^2 =0.0464), implying that, the ingenious people of Tubah have witness or is perceiving an increase in temperature over the past 4 decades vies- a- vies their day-to-day life. These respondents father underline that, this high temperature is as a result of climate change which is creating soil moisture deficit due to high rate of evapotranspiration making plants to be stunted. Even before they attain maturity making agricultural output to be low this indirectly causes high prices on food in the market. The question is, do the people of Tubah also perceive changes in rainfall.

1.2.3. Perceived changes in rainfall in Tubah Sub-division from 1980-2020

Generally, agriculture in SSA is mostly rain feet meaning that, the farmers depends on the rain for farming activities. It was therefore very important to investigate if the people of Tubah have perceived any changes in rainfall from the year 1980-2020.As rainfall is the main climatic parameter in Tubah Sub-division which influences agricultural productivity. The0 analysis shows the degree of perceived change in rainfall which is indicated by the coefficient. The inter- decadal perceived change in rainfall is indicated by the coefficient of determination (R^2). The general perceived decadal rainfall trend for Tubah Sub-division from 1980–2020 was a slight fall by a factor of (R^2 =0.0561) (Figure 9).

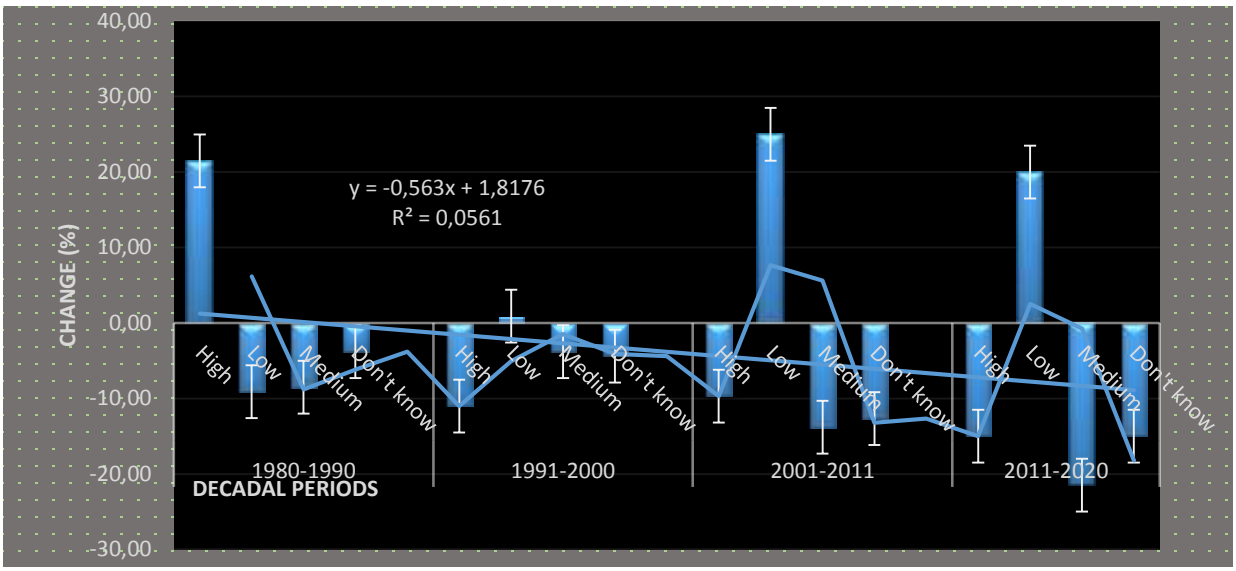


Figure 9: Perceived change in rainfall (1980-2020)

Source: Fieldwork, November 2020

Figure 9 illustrates that, the period 1980-1990 the respondents perceived a slight fall in rainfall but the period 1991-2000 they perceive a drastically fall in rainfall. While the period 2000-2011 and2011- 2020 where periods marked by very low amount of rainfall and very dry conditions. It is therefore of interest to look at the actual degree of climate variation from a scientifically point of so as to confirm to what the people of Tubah are experiencing.

1.3 Actual climatic variation in Tubah Sub-division

It is widely recognized that climate variation and the occurrence of extreme weather conditions are among the major risk factors affecting agricultural production and food security in SSA. Information from the archive of IRAD Bambui shows that rainfall is one of the most important elements of climate change scenario and its impact could be measured by 0its effect on crop growth and yields. As rainfall accounts for close to 70% of the physical inputs in the agricultural system, data obtained from field survey instruments show that farmers attest to have experience variation in climatic conditions such as a reductibon in the length of the rainy season, reduction in the number of rainy days and increasing length of the dry season which affects the quantity of food produced. The term “climate variation” is often used to denote variations of climatic statistics over a given period (for example a month, season, or year) when compared to long-term statistics for the same calendar period. Climate variation is measured by these deviations which are termed anomalies. This variation may be due to natural internal processes within the climate system (internal variation) or to variations in natural or anthropogenic external factors (external variation), (IPCC, 2007; 2014).

1.3.1 Inter-annual variation in rainfall and temperature

Inter-annual variation is that variation that occurs between years or from one year to another which helps to provide current and past dynamics of the climate system (Vuille *et al.*, 2012). Climate change and variation are indicated by climatic variables such as temperature, rainfall, wind, and sunshine. Furthermore, climate change and variation in Tubah Sub-division has been indicated by variations in rainfall and temperature as seen from the analysis of secondary descriptive data (Figure 10 and 11) which negatively affect crop production and the food security of the various communities in Tubah.

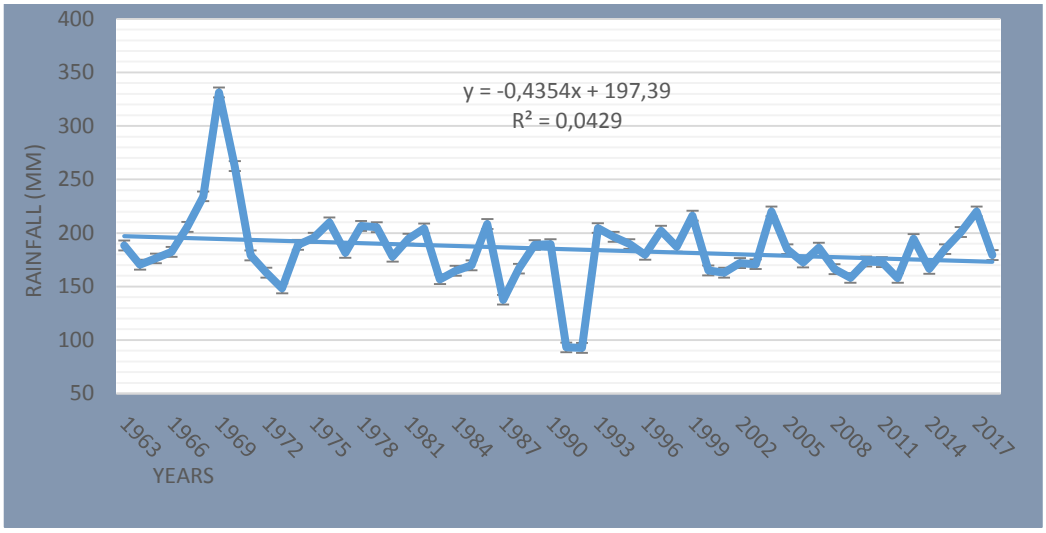


Figure 10: Inter-annual rainfall for Tubah (1963-2018)

Data source: IRAD Bambui, 2018

In line with figure 10, the inter-annual variation of rainfall in the study area was examined from 1963-2018. The variations from year to year are indicated by the coefficient of determinate. The inter-annual variation in rainfall indicates variations in rainfall from 1963-2018. The degree of variation in rainfall is indicated by the coefficient of determination (R2). Also, the general rainfall trend for Tubah Sub-division from 1963 to 2018 was a slight decrease by a factor of (R2 =0.0429). During an interview with the director of IRAD Bambui, who reviled to the study that this area has witnessed a great variation in rainfall with the dry season dominating the wet season with increasing length of the dry season over a reduction in the number of rainy days. Although, Tubah has a mean annual rainfall of 184.98 mm, with a Coefficient of Variation of 18.54% (still reliable as it falls below the threshold of 20%). So, implying years of rainfall below the threshold were years of drought and also indicative of years of reduction in agricultural yields although the rains are still reliable and can help to boost agricultural productivity. In order to ensure food security in this area with a seasonality index

of rainfall this is markedly seasonal with long-term drier conditions base on climatic analysis. According to field observation by the study, this directly influence the quantity and the quality of food produced in the long run thereby, affecting the socio-cultural adaptability of the people in this community. According to Von Braun (1991), a 10% decline in the amount of rainfall below the long-run average leads to a 4.4 % reduction in a country's national food production. This is common in this community with rising temperatures Figure 12.

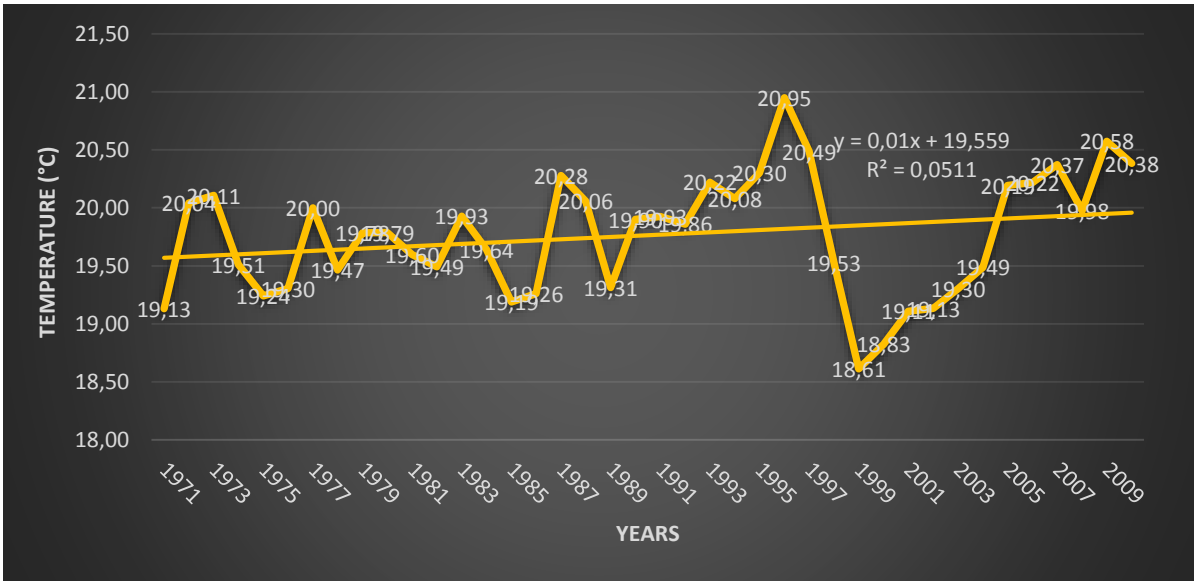


Figure 11: Inter-annual temperature for Tubah (1971-2010)

Data source: IRAD Bambui, 2018

The inter-annual temperature for Tubah Sub-division ranges between 18.61 to 20.95°C base on figure 11 and is believed to have influenced food security. As it has influenced, the cultivation of crops which are socio-culturally adaptable to the people of Tubah. However, the general trend line for temperature in Tubah Sub-division from 1971 to 2010 was a slight increase by a factor of (R2 =0.0511). It can be inferred that this area has witnessed some period of dryness over the years which has negatively affected the quantity of food produced caused by variations in seasons. A hotter climate will increase the rate of evaporation and transpiration meaning crops will require more water to grow well (Ojuku *et al.,* 2010). This has equally exacerbated water demand and put farmers under pressure especially peasant farmers also, rising temperatures have altered the patterns of migration for many pests and diseases which affects the quantity and quality of food made available. Such as blight which affects tubers (solanum potato, sweet potato, and yams).

Rainfall in Tubah Sub-division is seasonal with the rainy season from April to October and the dry season from November to March. During the dry season, water resources shrink drastically and become inaccessible for farmers (peasant farmers who are net producers) as evaporation exceeds precipitation while, plants tend to wither as well. This poses a serious

problem on food production as it tends to affect plant growth and agricultural yields by distressing soil moisture. Thereby affecting the quantity of food made available during the dry season due to soil moisture deficiency. However, rainfall anomalies provide a better illustration of the general trends and fluctuations in rainfall. It is evident that rainfall has been decreasing over time in Tubah Sub-division. Positive anomalies show that the rainfall values were more than the average, while negative anomalies reveal that the amount of rainfall was below the average (Figure 12).

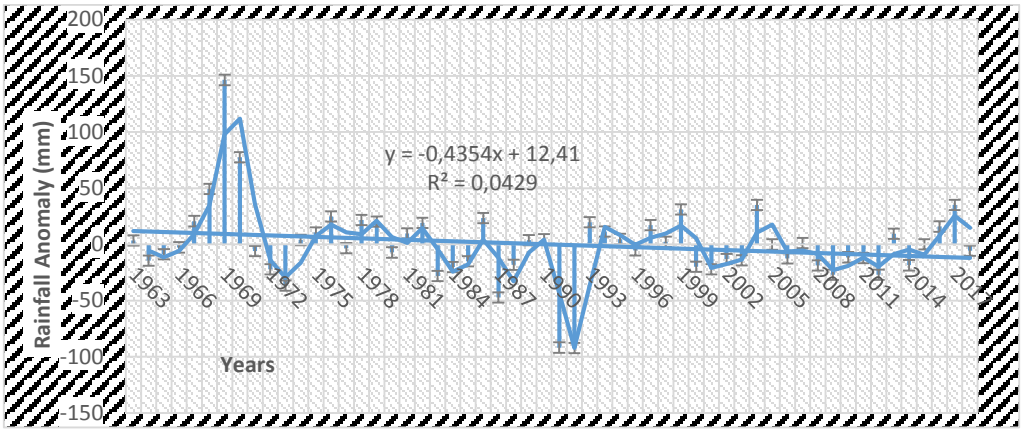


Figure 12: Inter-annual rainfall anomaly (1963-2018)

Data source: IRAD Bambui, 2018

From the analysis in figure 12, the period 1964 to 1966 was marked by decreasing rainfall trend after which there was a general increase till 1970. The period 1971 to 1974 was another period of decreasing rainfall trend followed by a slight increase from 1975 to 1982. Another decrease was experienced from 1983 to 1992 with a sharp decrease in 1990 and 1991. Which was followed by a slight increase from 1993 to 1999, 2000 to 2003 was another episode of decreasing amount of rainfall with an increase in 2004/2005. From 2006 to 2015, another decreasing trend was experienced in this area and a slight increase in rainfall amounts from 2016 to 2018. These periods of decreasing rainfall trends can be attributed to years of prolonged dry season. Judging from the result, this phenomenon happens almost every 10 years that is, occurred in the early 1960s, early 1970s, early to mid-1980s, and the early 1990s. In addition, it equally revealed periods of water stress as prolonged dry seasons cause the shrinking of the water table and the drying out of intermittent surface water sources. This could also be called years of agricultural drought as it results to soil moisture deficit which leads to poor agricultural output. As the general rainfall trend for Tubah Sub-division between 1963–2018 was a slight decrease by a factor of (R2=0.0429) as indicated on the graph. This implies that rainfall is below

the average and affects agricultural output as agriculture in this community is rain-fed therefore, indicating a negative implication on food security.

1.4 Regularity in rainfall events and food production in Tubah Sub-division

Statistic of rainfall for Tubah Sub-division reveals a decreasing trend in rainfall (table 8 and figure 10-12) creating a distortion in agricultural activities either by pushing farmers to plant late or too early (figure13). This reduces croup yield there by limiting the quantity of food produced and made available for the people. Regularity in rainfall events can be measure in terms of how often it rains when it starts and cessation or how predictable the rain is. This has affected productivity as farmers in this area depend on the rain for their farming activities. Even though, some crop has witnessed an increase in output, others continued to decline over the years due to changing environmental conditions and reduction in the number of farmers as a result of high cost of production. According to Von (1991) a 10% decline in the amount of rainfall below the long-run average leads to a 4.4% reduction in a country's national production. Hence, it is important to examine respondents' views on the changing patterns of rainfall events (figure 13) in other to carefully analysis its impact on crop production and food security in this zone.

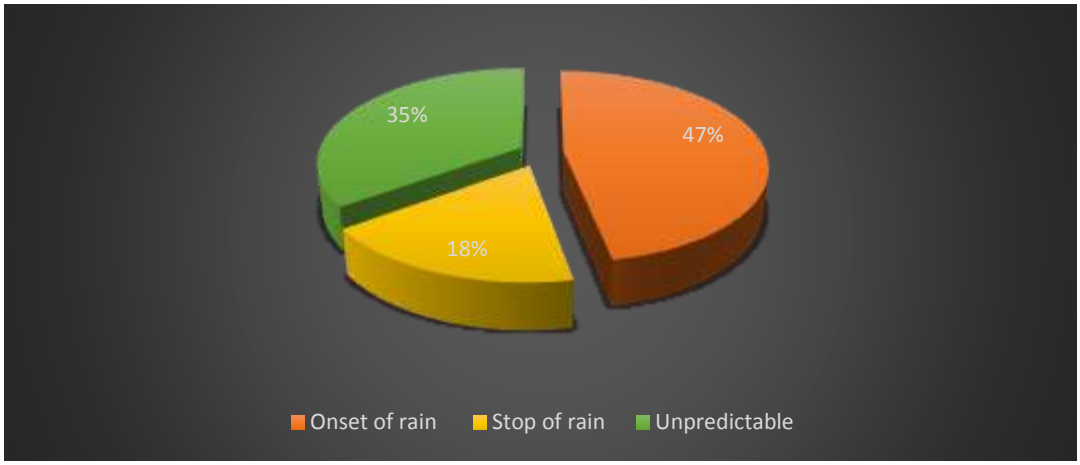


Figure 13: Regularity in rainfall events

Source: Fieldwork, November 2020

1.4.1 Early start of rain

During field investigation, some key respondents made it known to the study that the onset of rains is earlier than before. This was confirmed by, 47% of the sampled population who acknowledged that most often the rain starts early than expected. They equally reported that early onset of rain has made it difficult for farmers to know when exactly to start preparing their farms for planting. According to respondents, rain usually starts as early as February instead of March then stop and resurfaces around ending march and is usually very intensive and consistent causing farmers to start planting. It was observed that most at times, it will rain

consistently and later on stop destroying the farmlands of those who planted early following the start of the rain causing them to replant again. While the August rain starts to show its face around July when the first harvesting is ongoing which at times destroy most crop during the harvesting season creating a reduction in the quantity of food. During one of the focus group discussions, carried out with farmers during the regional agriculture show, farmers reported to the study that, for the past three years, they have been losing crops and money because of the unpredictable pattern of rainfall. *Sometimes the rains start and then stop within some few weeks, causing crops which have germinated to wither or fail to attain maturity. Sometimes the dry season lasts for more than six months*. This inconsistency in rainfall patterns affects productivity and reduces yields (Naintoh et al., 2018) creating a negative feedback on food security. Furthermore, it is usually accompanied by strange diseases which affect plant growth if not properly handle may end up destroying the crops. According to field findings, it was equally noted that some years had very intensive and short rain during its second face of fall which usually ends up destroying the little crops cultivated. As farmers reported during one of the group discussions that "*after we planted our crops last year, the rains stopped and our crops languished. When we replanted, a hailstorm destroyed our crops this however reduces the quantity of food made available"*.

1.4.2 Cessation of rains

Studies shows that the climatic conditions of Tubah Sub-division have being alternating over time as prolonged periods of sunshine, and rising temperatures are some of the indicators of the early cessation of rains (figure14-19) which affects plant growth and the quantity of food produced. Cessation of rain in March and September is very common, causing farmers to lose their resources due to the early stop of rain. As farmers end up double planting because plants planted during this period tend to wither due to the high rate of evapotranspiration and moisture deficit. Figure 1 9 illustrates that 18% of the sample affirm the early seizure of rain in Tubah Sub-division for the past decades while 35% of this population asserted that, rains are very unreliable and common in this area of interest. Weather variation emanating from changes in climatic conditions affect food security (Rosenzweig *et al.,* 1995). During an interview with one of the farmers carrying out mixed cropping, explained to the study that drought effects were becoming very severe with the changing climatic conditions where rains are becoming scarcer coupled with the early cessation and erratic nature of rain. While making mention of the fact that, increasing length of the dry season and reducing length of rainfall negatively affects agricultural productivity as the rains tends to stop early than expected hindering plant growth. This therefor, can be attributed to seasonal variation which affects even the harvesting period

making food deteriorate in the farmers because rain sometimes fall till July which is the heart of the harvest period as earlier seen on Figure 9 and table 10 above.

1.4.3Variation in seasons

Generally, variation in seasons brings about distortion in rainfall patterns which negatively affects agriculture and food security in Tubah Sub-division. As the mean temperature and precipitation has been changing (NMSA, 2001) and figure 9 above. According to MINADER and IRAD field workers, this has made it difficult for farmers to situate the right time for planting and lose their time and money in buying seeds for replanting when the first planting fails thereby changing planting dates. For instance, shifting of planting dates of potatoes from March to April due to climate variation has resulted in more diseases prevalence as the cropping cycle extends to the period of heavy rains. This has seriously affected agriculture and food security in Tubah in terms of the quantity of food made available. According to Christensen *et al.,* (2007) rainfall variation and extreme climatic events are expected to adversely affect agricultural production and food security. This is in line with this study as it was observed by the study that climate variation continues to bring about numerous effects on crop production, as crop yields turn to reduce, making food to become insecure, and inaccessible.

1.4.4. Increasing length of the dry season

Boko *et al.,* (2007) in a study revealed that in the year 2020 Africa's rain-fed farm production will decline by 50% as a result of changing climatic patterns. Some scholars equally noted that there is a general tendency towards decrease in the number of days of rainfall, with average deficits of about 25 days per year experienced in Douala. The monthly distribution of this deficit also shows a general decline in Douala, except in the months of April and August. January and February have −4 to −5 days, July and November −3 to −4 days of rainfall (Ojuku *et al.,* 2010). This has directly affected the soil moisture gradient which stresses plant growth since the amount of water needed for plant growth is reduced due to the high rate of evapotranspiration. Prolong periods of dryness has led to meteorological drought as observed in figure 15-20 below. Causing plants to wither and dry off as plant roots are unable to draw sufficient nutrients from the soil needed for growth. In addition, it was attested by 4.7% of the sampled and interviewees testified to this by saying that during the dry season, water needed for irrigation is less as prolong period of dryness reduces the volume of water in streams and rivers where they get water for irrigation. Thereby reducing the volume of water needed for irrigation while making off-season production very difficult in some localities in Bambili and

Kejum Keku. This has led to poor crop growth in this study area resulting in low yields as climate variation tends to hinder agriculture. Also, they reported to the study that it has made farming costly for less privileged farmers while making food availability during this period a problem. As many farmers tend to stop cultivation due to its demanding and costly natu0re thus, seriously affects food security as a result in the reduction in the quantity of food made available.

1.4.5 How rainfall variation is perceived to affect food production in Tubah Sub-division

Agriculture in Cameroon and Tubah Sub-division, in particular, is rain-fed so, will ultimately influence crop yields because there is a direct relationship between rainfall and agricultural output. As, a variation in rainfall patterns will imply a droop or an increase in agricultural yields (Ndo *et al.,* 2016). Statistics from the field survey revealed that Tubah Sub-division has been experiencing a decreasing trend in rainfall (figure 9) and is perceived as one of the factors responsible for a plunge in agricultural output in Tubah Sub-division. According to data collected during field investigations, on the variation of rainfall and its impact on agricultural yields, the unreliable patterns in rainfall has brought about a reduction in crop yields as acknowledged by 58.2% against 42% of the respondents (table 11) this has gone a long way to affect the availability of food. An adequate supply in rainfall will boost crop yields while a lapse in rainfall or water supply causes a plunging shift in plants and increase incidence of diseases on crop (Adejuwon, 2005). Since, plants are very sensitive to rainfall variation (Table 11).

Table 11: Respondents' perceptions on rainfall variation and agricultural output

Villages	No of respondents	Have you noticed any changes in rainfall patterns in your area?		If Yes, what is the impact on agricultural production in your area?	
		No	Yes	A drop in production	An increase in production
Bambili	45	10	35	28	16
Bambui	63	23	40	33	29
Finge	12	4	8	10	2
Sabga	27	10	17	15	16
Kejukekum	13	4	9	7	5
Kejume ketinguh	10	2	8	6	4
Total	170	53	117	99	71
%	100	31.2	69	58.2	42

Source: Fieldwork, November 2020

Table 11 illustrates the perceptions of respondents on the unreliable nature of rainfall and its impact on crop productivity. The table depicts that 69% of the local population in Tubah are of the view that rainfall is unreliable as compared to the 32.1% who denied the fact that they have witness any variation in the rainfall patterns. From the table, the high level of no–responds in the six villages is justified by the fact that most of the farmers do depend on the traditional method of rainfall predictions. These respondents advanced reasons that, they do more of mixed crop farming and do apply fertilizers to boost productivity therefore, do not feel the impact of rainfall on agricultural output.

While the yes-respondents which represented 69% admitted that rainfall has been unreliable in Tubah Sub-division as such, it has contributed to a drop in agricultural output. According to the IPCC (2004) changes in yield will occur when rainfall and moisture supply stretch its critical minimum. The yes respondents further attested that most often rains do come early or even if it starts on time, it will cease early than they expected causing the plants to wither. According to key informants in the field, who explained to the study that most at times, farmers end up not planting because they are waiting for the rains this causes a fall in output as asserted by 58.2% of the respondents. This unreliable pattern in rainfall has resulted to changing planting dates which have brought about a fall in output and a reduction in the quantity of food made available as farmers eventually end up planting late than before and cultivate smaller portions of land.

1.4.6. The effects of the late start of rainfall on agriculture

The late onset of the rainy season has been a serious challenge to farmers in Tubah Sub-division of the NWR of Cameroon posing a threat to food security. Over time, there has been a shift in the rainy seasons as rainfall becomes very unreliable due to variation in climatic elements leading to the late onset of the wet season in this area of interest. This has seriously affected food security as food productivity tends to reduce annually due to perturbation in agricultural activities due to the late onset of rains. Kipkoech et al., (2012) in a study pointed out that there exists a direct relationship between climate change and food security by identifying climatic variables which influence food production such as precipitation. Some of the effects of the late onset of rain on crop cultivation (Figure 21) include; late planting, poor yields and withering of plants and the outbreak of diseases on crops.

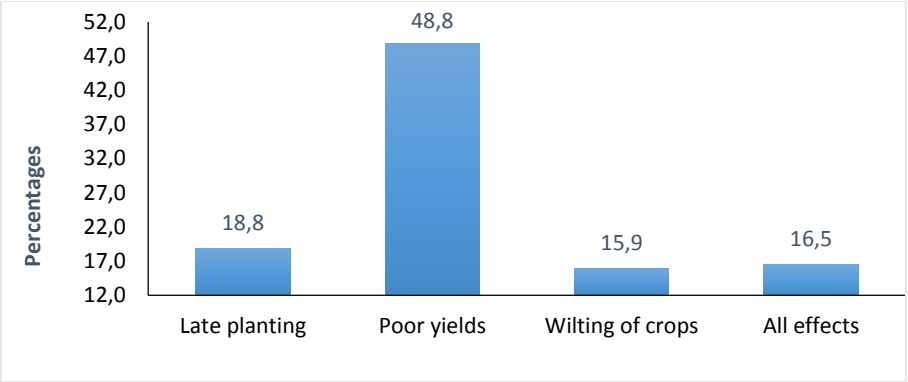


Figure 14: Effects of the late onset of the wet season on crop cultivation

Source: Fieldwork, 2020

Figure 21 shows the effects of the late onset of the wet seasons on crop cultivation. As it has led to the late start of the farming season putting farmers in a dilemma on when exactly they are to start planting and tilling their farms. This was asserted by 18.8% of the sampled population, who further explained that even if they do plant early while waiting for the rains or after the first rains, the crops will wither as the rate of evaporation exceeds precipitation. Thereby, reducing soil moisture which leads to low agricultural yields as acknowledged by 48.8% of the sampled population. During an interview with the leaders of one of the farming groups in Tubah Sub-division, Ngeifi Mixed Farming Group (NMFG of Bambili), who is a person of age and has been in the agricultural sector for long, stated it clearly that:

> *"Rainfall is becoming very unreliable even when it rains, it is just a light drizzle that lasts just for few hours. This type of rain we the farmers cannot totally rely on it since when we plant following our normal farming calendar the crops turns to get bad. This is because even if the rains do come in March, it will just rain just for a few days then resurface back the following month very lightly. Even when it is intensive the few crops which survived the drought period often at times get damaged by the rains. Moreover, when we try to follow instructions given by IRAD on the various planting dates and the timing periods of rains, it still fails us. For example, the farmers were informed this year that on the 21st of April there will be rains that will favour plant growth. But here we are in May still experiencing dry skies …".*

In line with figure 14, the tell end effect of the late onset of the rainy season is poor yield 48.8% of the respondents asserted to this. Respondents justified by advancing reasons such as; the rain is our own calendar and so when it fails to come on time it disrupts our activities making the cost of labour to be very high. Also, it will make us invest more in hybrid seeds since our local traditional seeds are less resistant to these climatic changes thus, causing farmers to farm less because not everyone can afford these hybrid seeds. Thereby reducing productivity and increasing the prices of food in the local markets.

1.5 Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is the most commonly used indicator worldwide for detecting and characterising meteorological droughts which occurs when dry weather patterns dominate an area. The SPI indicator measures precipitation anomalies at a given location based on a comparison of observed total precipitation amounts for an accumulation period of interest (1, 3, 12, 48 months) with the long-term historic rainfall record for that period (McKee *et al.*,1993). The SPI is used to define drought intensities and criteria for a drought event for different timescales. This helps to better show how unreliable patterns in rainfall affect crop cultivation as prolong periods of dryness will mean a reduction in the quantity of crops produced.

1.5.1 Decadal Standardized Precipitation Index

Episodes of prolonged dryness have been experienced in Tubah Sub-division over time (Figure 15 to 20). A detailed scenario is presented, where the incidence of droughts has been assessed on a decadal time scale. The drought season is considered to be a situation where water resources and other components of the natural and human environments are most vulnerable to weather conditions due to water scarcity. This, therefore, means that periods where the dry season is at the peak (December, January, and February), are not used in assessing SPI because they are normal periods of droughts (Figure15).

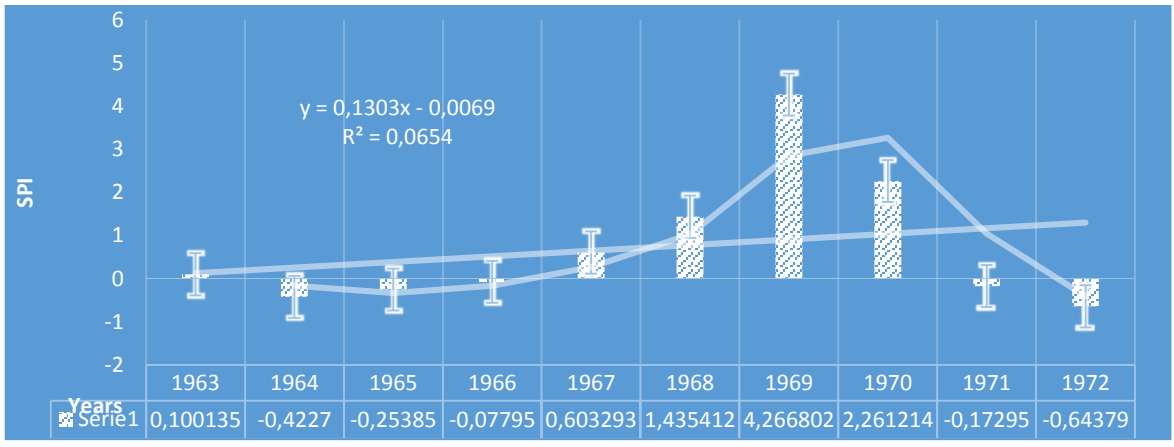


Figure 15: SPI trend, 1963-1972

Data source: IRAD Bambui, 2018

Figure 15 shows that, the decade 1963-1972 had SPI values that ranged from -0.3 to 2.9. There were 5 episodes of mild dryness (1964, 1965, 1966, 1971, 1972), 2 episodes of mildly wet (1963 and 1967), 1 episode of moderately wet (1968) and 2 episodes of extreme wet (1969 and 1970). The SPI trend for the year 1972 to 1982 is illustrated in (Figure 16).

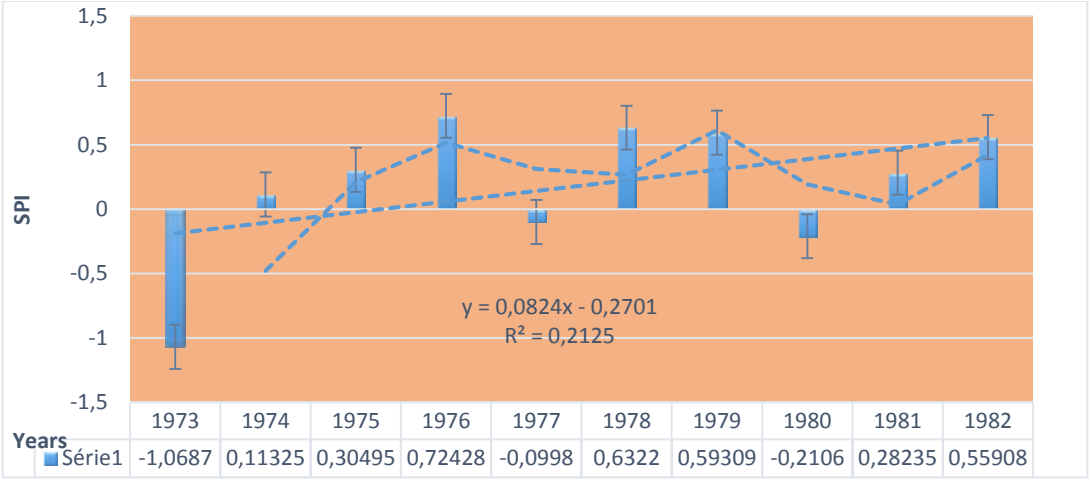


Figure 16: SPI trend, 1972-1982

Data source: IRAD Bambui, 2018

The SPI value ranges from -1 to 0.5. There were 9 episodes of mildly wet and 1 episode of moderate dryness. In this decade, there was a considerable increase in the rainfall of this area. During the 1983-1992-decade, SPI value ranged from -3 to 0.1 (Figure 16). This was characterised by 5 episodes of mild dryness, 1 episode of moderate dryness, 2 episodes of extreme dryness and 2 episodes of mildly wet.

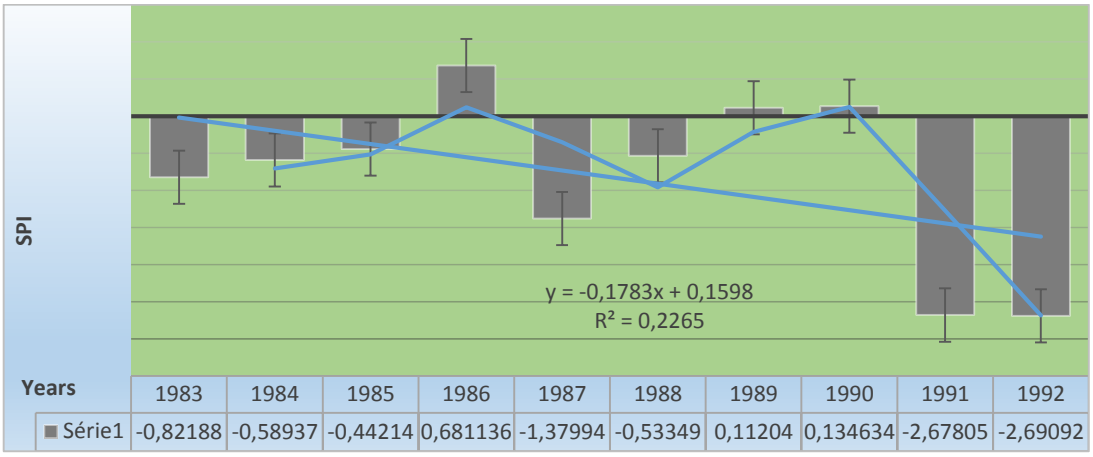


Figure 17: SPI trend, 1983-1992

Data source: IRAD Bambui, 2018

Figure 17 illustrates that, the decade 1983-1992 was characterised by a decrease in rainfall and an increase in temperatures leading to dryness with 2 episode of extreme dryness in 1991 and 1992. From 1993- 2002, SPI values were -0.7 to 0.4 (Figure 18) showing a change in rainfall.

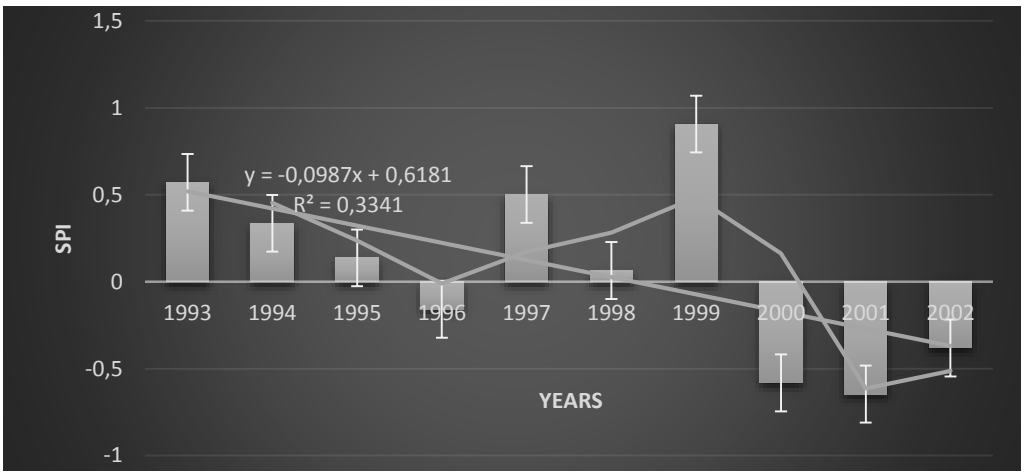


Figure 18: SPI trend, 1993-2002

Data source: IRAD Bambui, 2018

From figure 18 it can be inferred that, there were 6 episodes of mildly wet and 4 episodes of mild dryness. Implying that, rainfall is fluctuating in every given year. Even though, this decade did not witness much degree of dryness as compared to the previous decades. While critically looking at the period 2003 -2012, it shows a great degree of dryness with a SPI values of 0.8 to 0.5 (Figure 19).

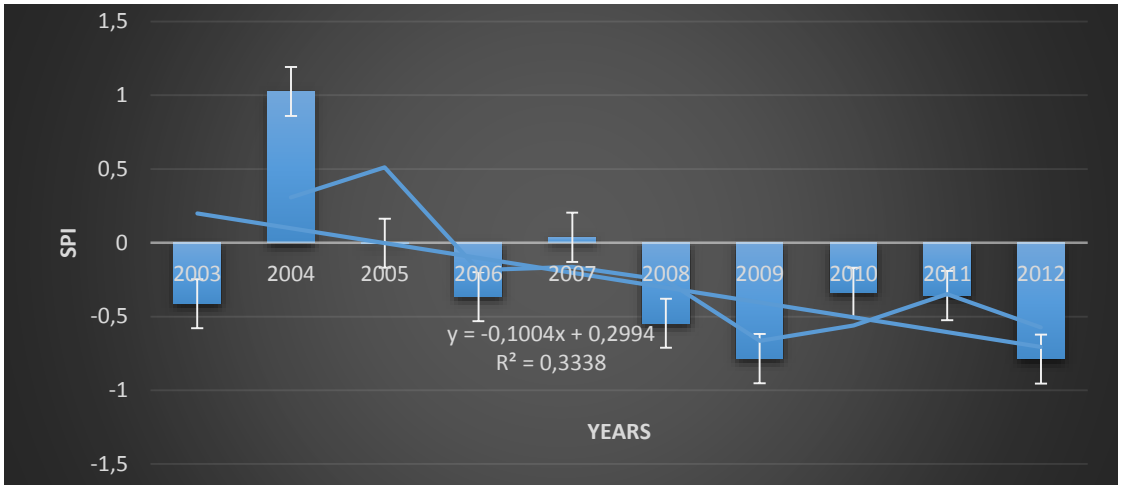


Figure 19: SPI trend, 2003-2012

Data source: IRAD Bambui, 2018

The year 2003-2012 was marked by 8 episodes of mild dryness meaning agricultural output was indirectly affected and 2 episodes of mildly wet in 2004 and 2005. During this decade, there was a decrease in rainfall amounts. It was only in 2004 that this area experienced a relative increase in the amount of rainfall. The next episode of rainfall was only experienced after two years followed by years of dryness. The question here is how did farmers survived and how did crops strive in the face of dryness for 5 conservative good years? While from 2013 to 2018, SPI values were -0.8 to 0.7, there were 3 episodes of mild dryness and 3 episodes of mildly wet (Figure 20).

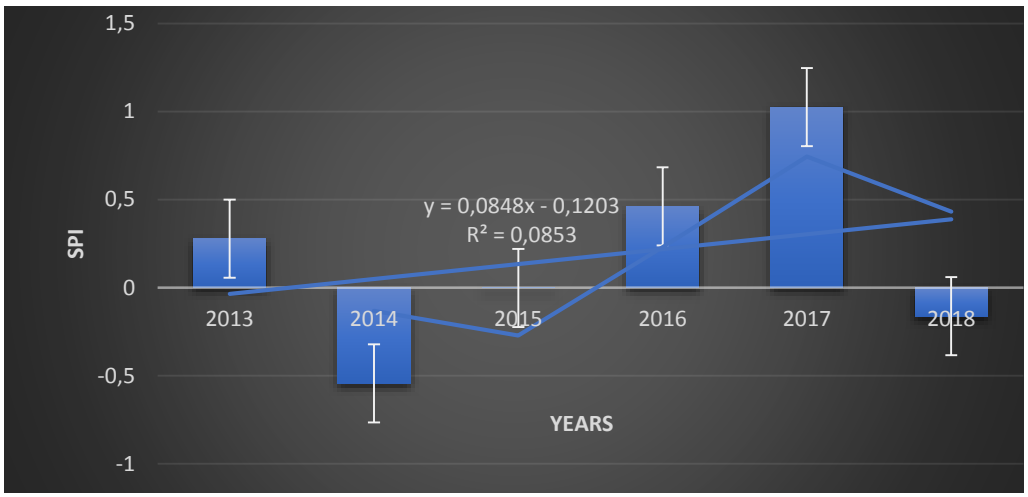


Figure 20: SPI trend, 2013-2018

Data source: IRAD Bambui, 2018

The SPI trend shows a decreasing trend in the precipitation of Tubah Sub-division. The mean standardized precipitation index has been calculated to show the trend of rainfall in the various decades (Table 12).

Table 12: SPI trends from 1963-2018 in Tubah Sub-division

Period	Mean SPI	R^2	Trends
1963-1972	0.71	0.0654	Increasing
1973-1982	0.18	0.2125	Increasing
1983-1992	-0.82	0.2265	Decreasing
1993-2002	0.08	0.3341	Decreasing
2003-2012	-0.25	0.3338	Decreasing
2013-2018	0.18	0.0853	Decreasing
Average	0.013	0.02096	

Source: Computed from figure 14-19

Table 12, illustrates that there has been a varying trend in rainfall patterns from 1963 to 2018. The period 1963 -1972 with the mean SPI value of 0.71 shows an increasing trend of rainfall with a coefficient of determination (R2=0.0654). The decade 1973 -1982 also witnessed an increasing trend of precipitation with the mean SPI value of 0.18 showing a slight increase in precipitation with a coefficient of variation (0.2125).It can therefore be asserted that from 1983 -2018, there has been a decreasing trend in the precipitation of this area due to human activities such as deforestation, burning of fossil fuels, urbanization, bush burning among others besides the concentration of carbon dioxide in the atmosphere has led to an increase in global temperatures(IPCC, 2004). This may further warm the planet thereby leading to high temperatures and at times an increase in dry months (Haile,2005). Nonetheless, this analysis is not different from what the people perceived to be happening with the climate of Tubah Sub-division. As most of the interviewee asserted that, they have witnessed an increase in

temperature and a reduction in precipitation patterns within the previous decades. There by justifying the reason for a reduction in most products from the farm which affects food security since it has influenced agricultural production in Tubah Sub-division. However apart from temperature and rainfall variations the physical milieu equally influences food production in this area.

1.6 Physical background as a constituting factor to climatic variation and food production Tubah Sub-division

The physical milieu of Tubah Sub-division constitutes; relief, hydrology, soil, and climate which are key elements influencing agricultural activities in a given area. This has gone a long way to influence food availability through agricultural yields. Consequently, the effect of climate variation on food security in Tubah Sub-division cannot be studied without understanding the physical background of the study area. Mindful of the fact that it is the physical milieu of an area that gives rise to its prevailing climatic conditions which either, determine the cultivation of some specific crops or hinder their growth. Therefore, it is very important to examine the physical environment of Tubah. Even though, they are being modified over time by man to suit their taste and needs, causing environmental changes which affect food security in Tubah Sub-division through the quantity of food produced in the 6 communities of Tubah.

1.6.1. Relief and hydrology

Tubah Sub-division is characterized by undulating hills and plains as observed in the field. According to the Tubah council developmental plan (TCDP (2012), this zone is naturally endowed with two plains; one in Bambui, which stretches to Bafut, and another plain is found where the lower part of Kedjom Ketinguh lies, and forms part of the Ndop Plain. While the hills are dented with woody valleys and interlocking spurs. The main hills in Tubah are; Ngu'bi, Nguh Mbonyam and Nguh Aseh in Kedjom Ketinguh; Munduba in Bambui; Vumih and Mbi in Kedjom Keku, Bambili hills in Bambili. From the relief presented by TCDP, the undulating nature of the land gives rise to the various agricultural activities adapted to plains and adapted to the hills (figure 21).

The hydrolology of Tubah Sub-division is made up of Streams, rivers, waterfalls, and lakes. This Sub-division has one main Lake found in Bambili and it is a source of many streams which drain a large part of Bambili. Streams from lake Bambili include; the *Ntse-Ni, the Ntse-Legel, Ntse-Nkwa, and the Ntse- Nta*. Most of the farmers in this area exploit these streams for their agricultural activities during the dry season while Ntse which is a neighbourhood of

Bambili relies on Ntse- Nta stream for irrigational purposes during the dry season. Kedjom Ketinguh has 14 waterfalls and two main streams that are fed by feeder brooks from the upland plateau. It can be inferred that; the existence of good a drainage (Figure 21) influences agricultural activities even in times of changing climatic conditions.

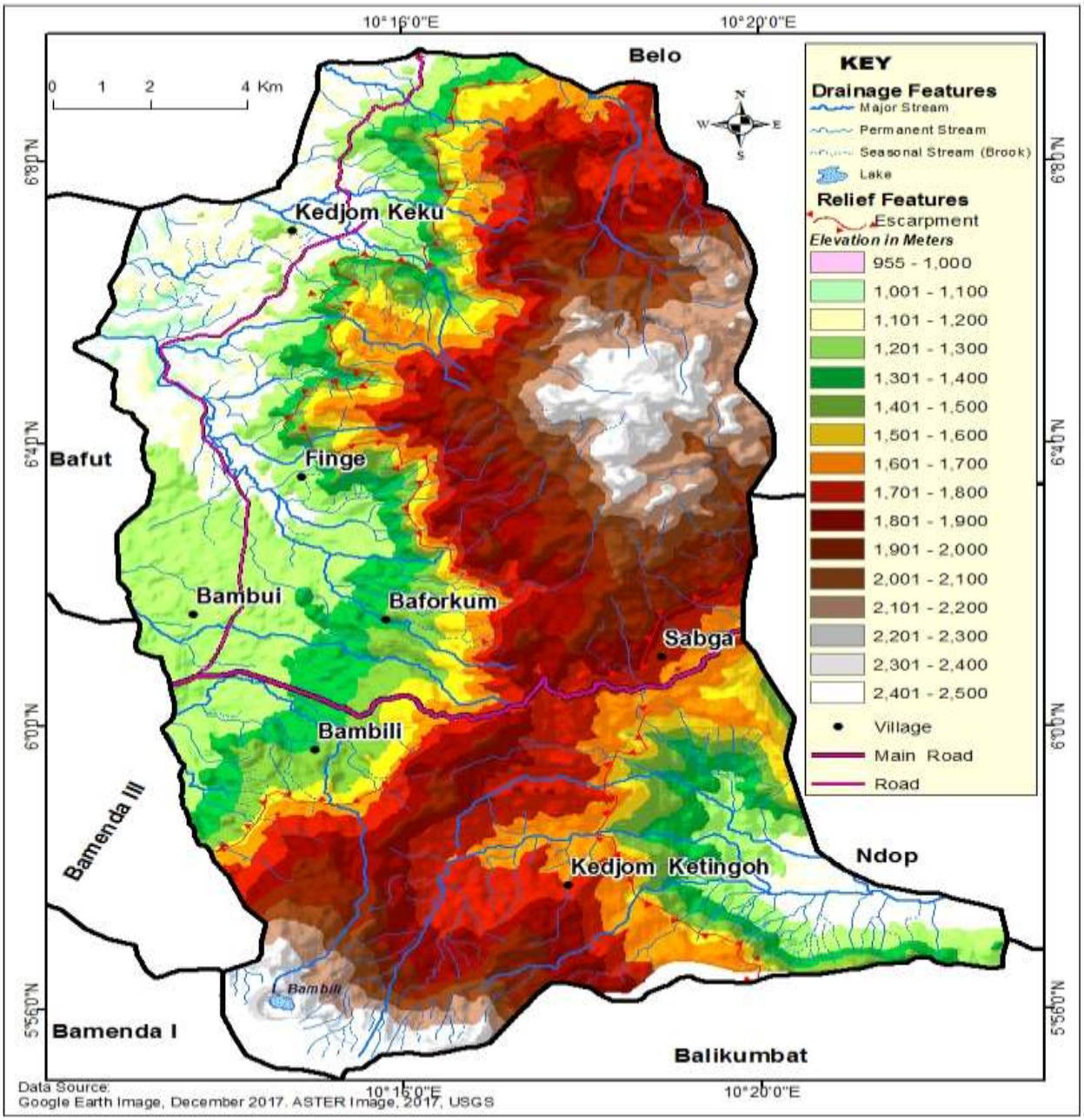


Figure 21: The drainage and relief map of Tubah Sub-division

Source: NIC Yaounde and ASTEK, 2020

From figure 21, it is seen that the relief is made up of highlands ranging from about 1000 to about 2500 meters. Although the relief is rugged and undulating, there are also gentle plains which favour agricultural activities, and for this reason, the Sub-division had been

commonly referred to as one of the food baskets of the North West Region (NWR). Statistics from the 0archives of the Sub-divisional Delegation for Agriculture Tubah reveal that this Sub-division produced 1024 tons of maize in 2009 and 497.5 tons of *Solanum potatoes* on 46.5 hectares. During field survey, it was observed that farms were in the gentile areas while few farms were observed on the sloppy areas such as at the foot of Sabga hills. Examples of such areas include Bambui, Bambili, and Kejume Ketighor where intensive farming ng was practiced. According to key informants, crop cultivation was mainly at the foot of the hills because of the presence of volcanic soils and the availability of water. These streams and brooks are canalized by farmers for the cultivation of vegetables and other market gardening crops during the dry season. It can therefore be inferred that the gentile undulating hills and plains have provided a suitable ground for the cultivation of food crops adapted to both low and high altitudes. Hence ensuring food security through the availability of food cultivated.

1.2.2. Soils

Tubah Sub-division is characterized by a diverse variety of soil ranging from alluvial, volcanic to sandy soil which is considered fertile, corresponding to the agronomic activities of the people. Soil is the primary input for agriculture and constitutes the main resource for croup cultivation for any given area (AFDB, 2019). The existence of fertile soil is due to the abundance of humus, in the form of dark volcanic soil found up the hills of Kedjom Keku, Kedjom Ketinguh, Bambili, and Bambui as observed during field survey. While the lower parts of Kedjom Ketinguh have mainly alluvial soil formed from the annual deposits of sediments from the upper plateaus. Also, there is a little bit of sandy soil washed down from the hills and deposited on riverbeds or banks of streams. However, the sand is exploited for construction during the off-farming season to generate income so as to increase livelihood. Although this area is blessed with very rich soils, prolong dry season and progressive increase in temperatures has favoured unsustainable practices which deplete soil fertility such as the slash and burning method of farming. As it helps to increase soil moisture deficit and kill micro-organisms in the soil which are very necessary for plant growth resulting, in the use of fertilizers to boost productivity. Moreover, these practices at times kill micro-organisms in the soil making the soil infertile after a period of time (TCDP,2012). Nonetheless, the presence of dives variety of soils has given rise to the cultivation of different food crops as observed in the field (Figure 22).

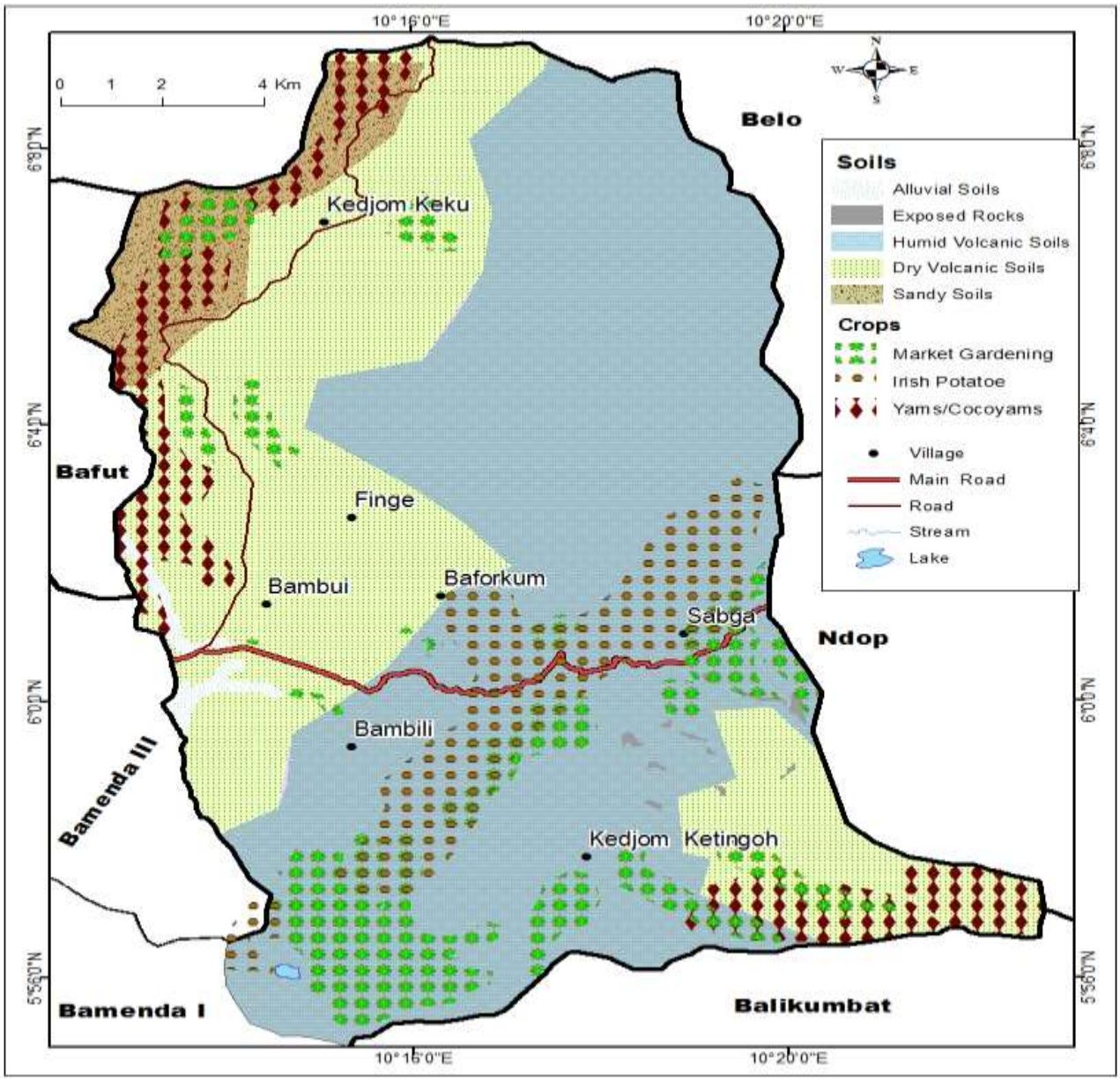


Figure22: Soil map of Tubah Sub-division

***Source**: Adapted from the Administrative shapefile of Tubah Sub-division and filed work, 2020*

Figure 22 illustrates the various soil types and crops cultivated in Tubah Sub-division which has favoured the staple food of the people. During field observation, it was realized that crops such as solanum potatoes are largely cultivated in Bambili, Sabga, and Baforkum due to the availability of humid volcanic soils. While the dry volcanic soil alluvial soil paved the way for the cultivation of cocoyam and yams in Kedjom Ketingho and Bambui. Evan though the people of Kedjom Kekum do cultivate theirs on sandy soil. Key informants in the field informed the study that, these crops are being cultivated on very largescale because of the availability of unexploited land as compared to other areas such as; Bambili which is highly populated. While during group discussions with farmers, it was revealed that, the main aim for the cultivation of these crops on a large scale is for the market and also to suit their cultural preferences. This

clearly explains the theory of environmental determinism as man makes use of the natural resources provided by nature to ensure food security in this study area. Therefore, to yield abundant crops, farmers in Tubah Sub-division have to seed the right plant at the right place. The right place is not only determined by the geographic location but also by soil types and climatic peculiarities as well.

1.7. Causes of Variations in both Temperature and Rainfall in Tubah Sub-Division

". . . there is new and stronger evidence that most of the warming observed over the last 50 years is likely to be attributable to human activities" (IPCC, 2001).

Drivers of climate variability are the factors responsible for the changes in climatic conditions of an area they consist of both physical and human factors as indicated by the IPCC which budges down food production and food security. Human activities, including those related to production, processing, packaging, distributing, retailing, and consuming food, are partially responsible for climate variability through the emission of greenhouse gases and changes in land use (Ingram *et al.,* 2010*).* According to data collected during field survey as presented on Figure 23 and interviews, illustrates that human activities are the main drivers of climate variability in Tubah Sub-division. Besides, respondents were able to identify the causes of climate variability by clearly differentiating between human and physical factors.

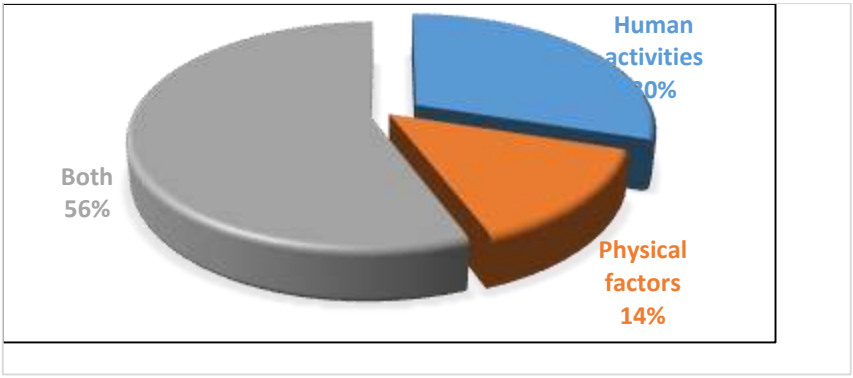


Figure 23: Causes of variations in temperature and rainfall
Source: Fieldwork, November 2020

According to field investigations and interviews carried out with the Sub-divisional delegate for agriculture and rural development Tubah and the Mayor of Tubah Sub-division, it was established that the changing climatic condition of this area is as a result of human activities such as the burning of bushes for agriculture, high rate of deforestation (cutting down of tries for the settlement of its fast grow growing population thus, reducing the carbon snick hold) for the construction of houses, the need to expand farmland and the high rate of development coupled with poor farming practices. Furthermore, 80% of farmers affirmed to this accession

during group discussion as they explained to the study that, in the past, climatic conditions were very reliable farmers could farm at any time and harvest bountifully while respecting the agricultural calendar. However, today, the train has changed, they do not know exactly when to start their farming activities. Based on their perceptions, farm outputs are poor since the rain is not very reliable again (figure 8). According to field survey,30% of the respondent were of the view that human activities are the main causes of these climatic changes. While 14% believe that, the climate has changed due to physical factors. Nonetheless, respondents pointed out that both human and physical factor are responsible for the recent changes in the climatic condition of Tubah Sub-division as indicated by 56% of the sample population. Field investigation and findings revealed that, the magnitude of climate variability drivers are slightly high with an average of 38.1%. It should be noted that,30% of the respondent are of the view that human activities are responsible for these variations while 56% are for the view that, both human and physical activities are responsible. Implying that climate variability cannot just be attributed to one activity in this area thus, the need to analyses the magnitude of both human and physical drivers which has led to an increase in the magnitude of variation in temperature and rainfall.

1.7.1 Magnitude of rainfall and temperature variations in Tubah

It is impossible to carry out this research work without analyzing the magnitude of rainfall and temperature variations in Tubah. As they appear to be the main factors responsible for the reduction in agricultural output which negatively affect food security in Tubah Sub-division. The magnitude of climate variability is the degree to which climate variability is being amplified in this area as a result of both human and physical drivers (Figure 24).

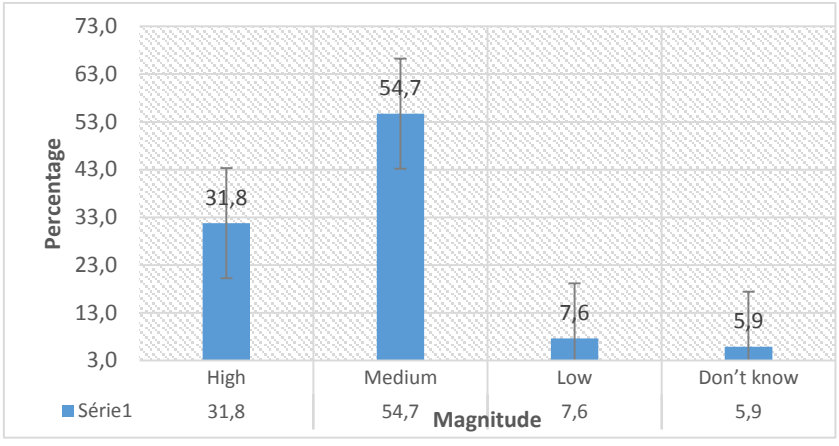


Figure 24: Magnitude of temperature and rainfall variations in Tubah

Source: Fieldwork, November 2020

Figure 24 shows that, the magnitude of climate variability drivers in Tubah Sub-division is moderate but need to be monitored and controlled with a percentage of 53.0. 54.7% of the sample population indicated that the magnitude of these drivers is at a medium rate even though,

others indicated that the rate is low with 7.5 % some were still ignorant of the fact that, there exist drivers of climate variability while 31.8% acknowledged that, the magnitude is high. This high percentage of moderate and high magnitude of climate variability drivers is an eloquent testimony to affirm that, the environmental conditions of Tubah Sub-division are gradually changing bringing about climatic variation. At this point it is very important to critically look at the magnitude of various climatic drivers contributing to climate variability in this area.

Field investigation and findings revealed that, the magnitude of climate variability drivers are slightly high with an average of 38.1%. It should be noted that,30% of the respondent are of the view that human activities are responsible for this climatic variations while 56% are for the view that, both human and physical activities are responsible. Implying that climate variability cannot just be attributed to one activity in this area thus, the need to analyses the magnitude of both human and physical drivers. Table 9 shows the magnitude of the various driver's base on respondent view

Conclusion

Human and physical activities are responsible for the changing climatic conditions of Tubah Sub-division (figure 23). Several indicators account for these variations such as changes in seasons as the length of rainfall reduces while the length of the dry season keeps increasing as a result of seasonal variation. This directly affects food security by distorting the agricultural calendar of the People of Tubah bringing about a reduction in the quantity of crop yield (table 10 and figure 21).

Statistics on the inter-annual variation of rainfall from1963-2018 for Tubah Sub-division show a slight decrease by a factor of (R2 =0.0429) with a Coefficient of Variation of 18.54% (still reliable as it falls below the threshold of 20%). The Standardised Precipitation Index (SPI) was equally used. Which is the most commonly used indicator worldwide for detecting and characterising meteorological droughts which occurs when dry weather patterns dominate in an area. The decadal standardized precipitation index for Tubah shows that drought episodes have been experienced in Tubah Sub-division over time. Statistics shows that there has been a varying trend in the precipitation of Tubah from 1963 to 2018. While the period 1963 -1972 the mean SPI value was 0.71 and reveals increasing trend precipitation with a coefficient of determination (R2=0.0654). The decade 1973 -1982 also witnessed an increasing trend of precipitation with the mean SPI value of 0.18 showing a slight increase in precipitation with a coefficient of variation (0.2125). From 1983 -2018, there have been decreasing trends in the precipitation of this area revealing periods of meteorological drought. It can be inferred at

this point that, during this period Tubah Sub-division has witness agricultural drought which has seriously affected food production and food security.

This is as a result of variations in season as the rains either comes early or ceases early putting farmers on a dilemma as to when to start their planting activities. This has resulted to low agricultural yield which ultimately reduces the amount of food made available in this area of study. Moreover, rainfall variation equally affects farming system practices as it affects yield and makes the cultivation of some crops very difficult over time while, indirectly affecting the sociocultural values of the people of Tubah. Also, climate variation influences the type of crops to be cultivated and the feeding habits of the people since it determines the type of food made available and accessible for the people. This will be examined in chapter 2 so as to show the degree at which the people of Tubah are food secured.

CHAPTER 2

THE INFLUENS OF TEMPERATURE AND RAINFALL VARIATIONS ON FOOD AVAILABILITY AND FOOD ACCESSIBILITY IN TUBAH SUB-DIVISION

Introduction

The role of temperature and rainfall variation on crop cultivation, feeding habits and the cultural value of food is a double edge sword as it affects food availability and accessibility. As variations in temperature and rainfall has led to the spread of diseases which affects crop cultivation and the nutritional patterns of the people of Tubah. This has brought about a change in feeding habits (staple food) of the people as most of the crops cultivated such as; cocoyam, banana, corn, irish, vegetables, sweet potatoes which the people mostly consume are affected by diseases. Thereby, creating the problem of availability and accessibility of these crops for consumption due to increased extreme climatic events such as prolong dry seasons and scanty rains which are great threats to food stability and security. The impact of this phenomenon is been felt at the domestic level and in the local food market where the people are unable to have a consistency in their staple food.

This chapter attempts an answer to the second specific question of the study, which is in line with hypothesis 2 of the study and states that ‘‘to what extend has rainfall and temperature variations influenced food availability and accessibility in Tubah Sub division’’. The chapter further opens with an introduction followed by three main parts which are subdivided into sections which dwells on food security and its dimensions in Tubah Sub division while laying more emphases on the dimension of food availability and accessibility. The chapter equally shows the various crops cultivated to ensure availability and consistency of food. While the last part of this chapter shows the level of food accessibility in this area.

2.1 Food security in Tubah Sub-division

Food security is the outcome of multiple factors, operating at various household and international levels which help to ensure adequate access to food in both quantity and quality (FAO, 2019). It depends not only, on availability from production, but a suite of entitlements that enable (or protect) economic and social (cultural preferences) access to food. To help analyse the factors underpinning food security in Tubah Sub-division the food security situation

of a given unit of analysis (dimensions) has been explained based on interviews and focused group discussions.

2.1.1 Dimensions of food security in Tubah

The United Nations Development Program (UNDP 1994) brings out the various dimensions of food security by defining it as, "a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". This helps to better explain the dimension of food which are; availability, accessibility, utilization and consistency (stability) of food. Thus, food security requires not just enough food to go around, but necessitates that, people have ready access to food on a daily basis. This was not different from what was observed in Tubah Sub division as the people did not only have an "entitlement" to food by growing it for themselves, buying the food or by taking advantage of a public food distribution systems. Such as the USAID. Which distribute foodstuffs such as oil, rice and beans to the people of Tubah Sub-division. By so doing ensuring that food is available and accessible as affirmed by 61.8 and 48.8 % of the respondents respectively. Although the dimension of food utilization and food stability still remains a great challenge to the people of Tubah Sub division as indicated by 23.5% and 59.4% of the respondents (table13) This means food production and importing capabilities of food should be shifted from a macro-level towards a micro-level which will be more focus on individuals and their ability to avoid hunger and under nutrition. Table 13brings out the various dimensions of food security in Tubah Sub-division to show to what extend the people are food.

Table 13: Dimensions of food security in Tubah

Dimensions	Responses					
	Yes		No		No idea	
	Frequency	%	Frequency	%	Frequency	%
Food availability	105	61.8	29	17.1	36	21.2
Food accessibility	83	48.8	51	30.0	36	21.2
Food utilization	65	38.2	40	23.5	65	38.2
Food stability	42	24.7	101	59.4	27	15.9

Source: Fieldwork, November 2020

2.1.2. Food availability in Tubah

Farming in Tubah Sub division is the predominant activity carried out in other to ensure the all-round existence of food (food availability) at the household level. According to data generated from field instrument, 64.1% of the sampled population indicated that food is available (table 13) as they had enough food for household each day. This is justified by the

fact that, during harvesting there is plenty of food and food is usually very affordable for everyone to buy in as much as most of them are farmers who do cultivate their own food and take the excess to the market. They equally pointed out that after the harvest and pre-harvesting period food is not relatively available on a daily basis. Key informants justified this by saying that, during this period (planting season) food is very expensive since people are trying to plant what they stored from the previous harvest availability a challenge. Thus, posing the problem of food stability and consistency as seen on table 13 above. In addition, during the rainy season, the roads are not accessible due to the po1or nature of the earth road there by contributing to the issue of food stability and availability. In other to understand or show the dimension of food availability in this area of research, household-level of food security was determined by, looking at food cultivated by individual household and food items bought from the local markets. There by helping to show the all-around existence of food at the household level in quantity while regarding crop production, as the main source of food.

Food accessibility and stability in Tubah Sub division

Judging from table 13 Food is accessible in Tubah Sub division as affirmed by 48.8% of the respondent despite the irregularities in temperature and rainfall patterns. Which according to the respondents' food is always accessible since farmers constantly cultivate moreover most of them practice home gardening. This makes it easy for them to easily access food at any time or season of the year. Although, key informants indicated that drastic changes in the physical and social dimensions have seriously disrupted production strategies and threaten food access to households in this study area. Tubah Sub-division is being affected by prolonged dry season and erratic rains which are becoming more and more frequent. Thus causing the harvest volume to shrink and food prices to increase, affecting the stability and accessibility of food for households. Coupled with the ongoing socio-political crisis which is creating a serious problem whereby most farmers cultivate but are unable to harvest their crops during the harvesting season. Even though Tubah Sub-division is highly characterized by farming activity, food stability is still a big problem to them.

From an interview with the Mayor of Tubah Sub-division who disclosed to the study that; *"food stability has become a problem, as income and economic resources are affected due to changing environmental conditions and the ongoing crisis which ultimately hinders the ability to obtain food over time".* This is mainly because most of the farmers are practicing peasant agriculture and depend on the climate and the available natural resources for a sustainable livelihood so as to stay food secured. Interviewees equally made it known to the

study that it is difficult for farmers to farm intensively during this period of the crisis besides even if they do, they do not have the capital to follow up the farms and their crops are usually destroyed in the farm due to the crisis. It can thus be inferred that crisis plus lack of capital may crate the issue of stability over time as it indirectly reduces the quantity of crops cultivated which is made available and accessible.

2.2 Crops cultivated in Tubah Sub-division to ensure food availability and accessibility

According to field survey and investigation different varieties of crops are been cultivated in Tubah Sub-division to ensure food availability and accessibility. Although they are mostly crops which generate income, they constitute the staple food of the people of this zone such crops include; cocoyam used for *achu*, solanum potato potatoes (*Solanum tuberosum*) used for *akwa* maize (*Zea mays)*, and vegetables used for *kebain* and *mbas ksi* and other crops such as; beans (*Phaseolus vulgaris*) and cassava. Bananas and plantains equally grow spotted in farms or around the compounds as observed in the field. Coffee which was formally one of the main cash crops in this area has drastically diminished in production due to fall in prices, and many coffee farmers have transformed their coffee farms to the production of food crops. Few farmers mainly in Kedjom Ketinguh are involved in the cultivation of rice as a source of income(TCDP,2012). While most of the food crops nurtured is to gratify their cultural values and the nutritional patterns of the people of Tubah. However, most farmers generate income from them as most of them cultivate crops and export some to neighbouring towns and villages such as Bamenda town, Foumbot, Douala, Yaoundé the list continues. These products are equally exported to neighboring countries, such as; Garbon, Central Africa, and Equatorial Guinea. Since these markets fetched the population of Tubah money to enable them sustain themselves as well as boosting the livelihood of the people. Table 14 shows the crops cultivated in Tubah Sub-division and their values.

Table 14: Main crops cultivated in Tubah Sub-division and their values

Crop category	Crop types	Scientific names	Value
Cereals and legumes	Maize	*Zea mays*	#
	Beans	*Phaseolus vulgaris*	+
	Groundnuts	*Arachis hypogea*	#
	Rice	*Oryza sativa*	~
	Pumpkin	*Cocurbita spp*	~
Ubers	Cassava	*Manihot utilissima*	+
	Yams	*Dioscorea spp*	~
	Solanum potato Potatoes	*Solanum tuberosum*	*
	Sweet potatoes	*Ipomeoma batatas*	*
	Cocoyams	*Xanthosima sagiffitolium*	*
	Colocassia	*Colocasia esculenta*	#
Vegetables	Tomatoes	*Lycopersicon esculentum*	+
	Cabbage	*Brassica oleracea*	+
	Carrot	*Daucus carota*	+
	Huckleberry	*Solanum nigerum*	#
Perennial tree crops	Plantain	*Musa spp*	~
	Banana	*Musa spp*	#
	Arabical Coffee	*Cofea Arabica*	+
	Raffia palm	*Raphia vinifera-*	*

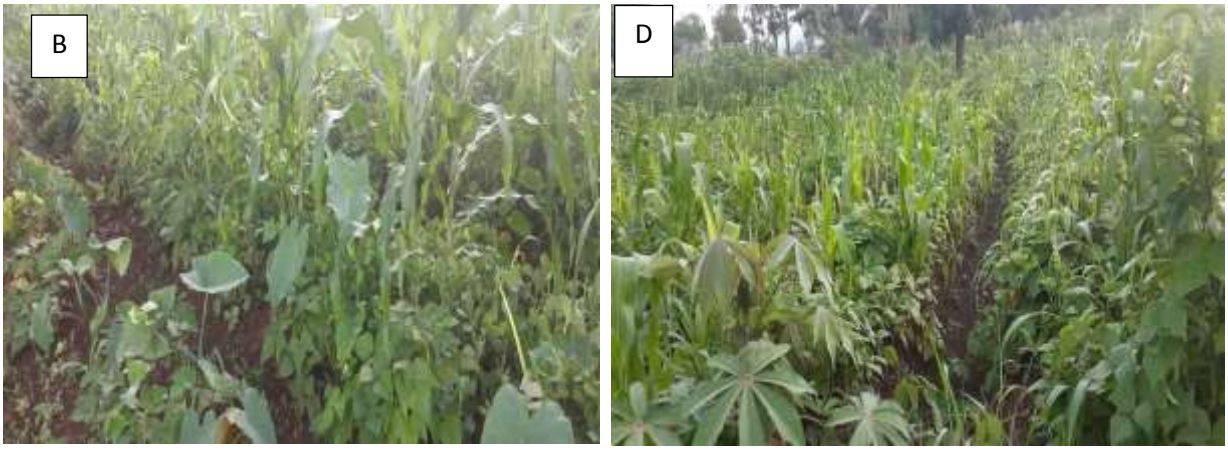
Ngwega (2010, page 83) and field work, 2020

+: Income generating crops
+: Income generating and staple crops
~: Mostly for income generating and lesser for consumption
#: Mostly staple crops than for income generation

Table 14 depicts the various crops cultivated in Tubah Sub-division and their values. The first categories of crops commonly cultivated in this zone are cereals and legume and are largely influenced by the climatic conditions. Also the availability of fertile soils equally influences the growth of these crops, for example, maize is grown in large quantities because of the good volcanic and humus-rich soil found in this area. Maize is a major staple food crop grown in diverse agro-ecological zones, farming systems, and consumed by people with varying food preferences and socio-economic backgrounds (UNECA, 2015). This was not different from what was observed by the study as maize constituted the staple food of the people and the reason for its cultivation. It is generally grown in all the villages in this Sub-division but in greater quantities in Bambili because of the available market and in the two Kedjoms (Big and Small Babanki) because it is the main staple. Next to it, is beans which is generally cultivated by everyone and are usually integrated as a mixed crop on the same ridge with corn. Even though it is mostly for household consumption, the excess is often taken to the market during off-farming seasons.

Plate 1: Different crop types cultivated in Tubah Sub-division

Ngwangunu, 11/12/2020



Source;Photo by Ngwangunu,15/04/2020

Photo (A) cultivation of vegetables on a very small scale for home consumption.
Photo (B) tuber cultivation a mixture of sweet potatoes and cocoyam
Photo (C) beans, groundnut, cocoyam and maize cultivation
Photo (D) cultivation of a large piece of land with a mixture of tuber and cereals

2.2 .1. Variation in crop yields due to temperature and rainfall variations

Seasonal variability has influenced crop yields both positively and negatively across the country especially in Tubah Sub-division. Judging from the field survey instruments,74.7% of farmers have witnessed an increase in maize cultivation even with the changing climatic condition. Thereby influencing the availability of this product across Tubah Sub division. While crops such as; beans, groundnuts, cassava, cocoyam, solanum potato, vegetable, and other food crops have been negatively affected due to the changing environmental conditions in Tubah leading to a reduction in yields (Table 15). This however is based on the fact that this area has witnessed a fall in the rainfall pattern (Figure 8) also; the local populations complain of the early start of rains and prolong dry seasons which is seriously affecting food availability and to greater extend food accessibility. Changes in rainfall distribution, intersessional fluctuations,

and erratic rainfall patterns have been reported by key informant to be one of the major reasons for the reductions in crop production which has become a major issue to farmers and policy-makers as it poses a threats to food security (11, 13, 24). According to agric field coordinators, it very difficult; for farmers to cultivate on time due to these distortions which mostly result in the cultivation of small parcels of land causing a reduction in crop yields in this area. Furthermore, the early cessation of rains and the outbreak of diseases which mostly affect roots, tubers, cereals, and other crops are equally contributing factors (IRAD Bambui, 2018). All this turned to reduce the quantity of food made available and accessible in this zoon.

Table 15: Respondents perceptions on the influence of temperature and rainfall variation on food availability

Crops	Changes							
	Increase		Decrease		No change		Not applicable	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Maize	127	74.7	41	24.1	2	1.2	0	0
Beans	66	38.8	89	52.4	15	8.8	0	0
Groundnuts	59	34.7	85	50.0	13	7.6	13	7.6
Cassava	48	28.2	102	60.0	19	11.2	1	.6
Cocoyam	40	23.5	112	65.9	17	10.0	1	.6
Solanum potato potato	40	23.5	100	58.8	27	15.9	3	1.8
Vegetables	76	44.7	78	45.9	15	8.8	1	.6
Other crops	63	37.1	59	34.7	33	19.4	15	8.8

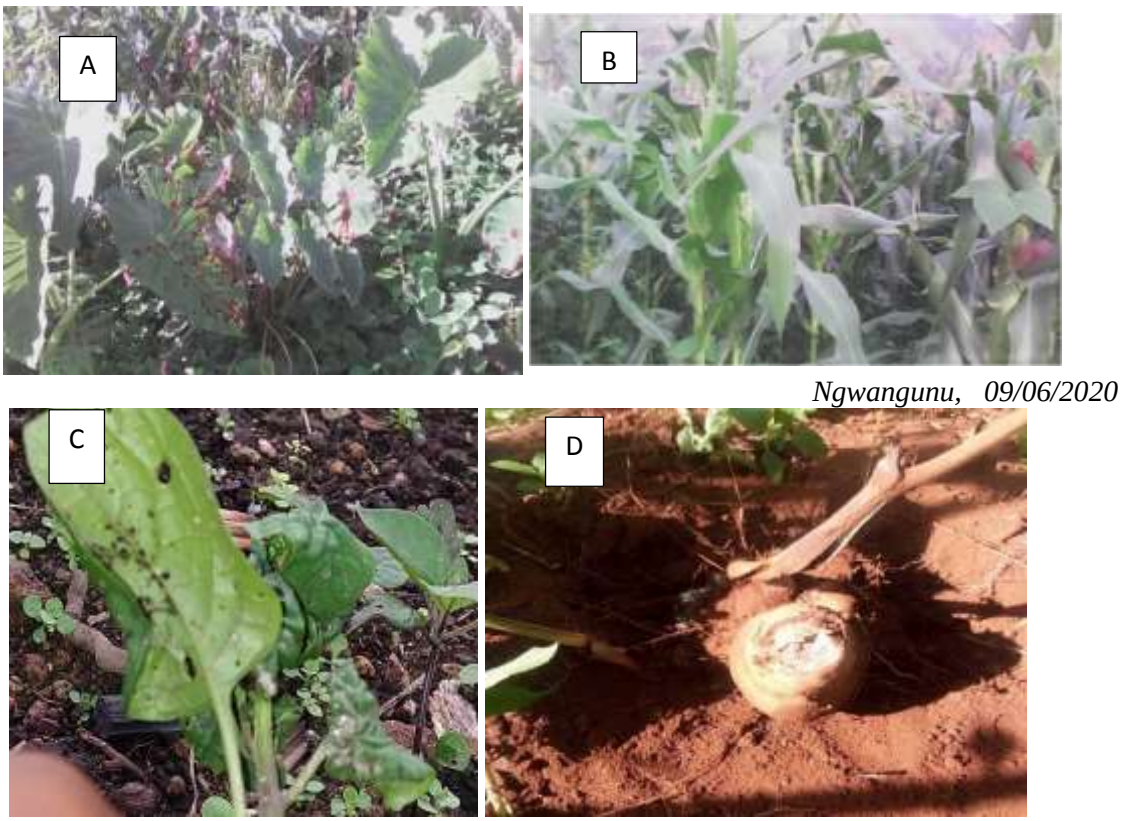
Source: Fieldwork, November 2020

Table 15 illustrates the perceptions of farmers on the effects of climate variability on crop yields which affects the quantity of food made available in Tubah Sub-division. From table 13 it can be inferred that maize is the only crop in which climate variability has brought about a significant increase in its output as 74.7% of respondents testified to this. According to the eloquent testimonies of respondents, it was found that maize is one of the staple foods of the people and it is generally cultivated by people both within and far off areas from Tubah town. Moreover, it is a seasonal crop that can be grown at any point in time provided there is the availability of water and from which people can generate income. In addition, it is can be cultivated within the two-farming season and thrive well despite the advent effects of climate variability in Tubah Sub-division coupled with the fact that the Kejum people in Tubah mostly depends on meals made from maize. So they do cultivate on a larger scale unlike the other communities in Tubah. It should be noted that there exist other commonly grown crops in this area and they include; yams, cow pieces, onion, and tomatoes, which has witnessed only 37.1% of increase base on the different views of farmers from their previous harvest. This means about 70% of farmers either maintained their previous production or had a decrease in yield due to the effect of climate variability on crop productivity.

On the other hand, cocoyam and solanum potatoes witness a decrease in yield according to the data collected during field survey as presented on table 13 and interviews, the population of Tubah Sub-division is aware that yields have reduced as their climate has changed and this was affirmed by a response score of 65.9% and 58.8%. Based on information from SDDARD, these crops are highly affected by blight (photo 2A and 2D) and require a lot of care to have a good harvest with the recent climatic alterations. The low percentage of no respondents can be justified based on the fact that solanum potatoes and cocoyam are not cultivated on a large scale by most of the farmers as it requires a lot of capital and does not flourish well in every part of this Sub-division (figure6). Unlike maize which is cultivated by almost every household even though it is equally affected by insects (photo 2B) however, its cost-effectiveness is not high as compared to solanum potato. Solanum potato and cocoyam are mostly cultivated as a cash crop from which people generate income base on fieldwork investigations. During the fieldwork survey, some farmers advanced reasons why they do not cultivate these two food items particularly solanum potato potatoes. According to them, it is due to the untimely nature of the rain, which accelerates the deterioration process during the harvesting period since they need to be harvested under dry conditions. This creates a high probability for most of it to get bad before reaching the market as they become moist due to the rains.

Moreover, they cannot be stored for long when harvested under such poor conditions. *So I mostly cultivate just in small quantities for my house because they are often very expensive.* However, it constitutes one of the staple food of the people of Bambili and Bambui this explains why they are mostly cultivated on a larger scale in this area. Although it is highly affected by climate variability (higher temperatures and unpredictable rainfall) can destroy solanum potato within a twinkle of an eye as reported by some key farmers to the study.

Plate 2: Some crops affected by temperature and rainfall variations in Tubah Sub-division



Ngwangunu, 09/06/2020

Source; Photo by Ngwangunu, 11/11/2020

Photo A; Cocoyam affected by blight due to climate variability.
Photo B; Maize affected by insects brought about by rain.
Photo C; Vegetables affected by insect due to varying climatic conditions.
Photo D; Blight on tuber due to prolong periods of sunshine.

In line with the table above, beans, groundnut, and vegetable are perceived to have experienced a decrease in output due to the effect of climate variability. For instance, it has been reported that rainfall variability affects the production of traditional crops, increases crop diseases incidents, and causes drastic reductions in soil (Kashaigili et al.,2014) .This is not different from what was reported by farmers during focus group discussions, as close to 80% of farmers complained of the unreliable nature of rains (table 7 and 9) usually accompanied by some strange diseases and insects which affect vegetables in particular (photo 2C) this was asserted by 45.9% of the respondents. Moreover, respondents made it clear that this has seriously reduced the output of these crops since these crops depend on rainfall for a good yield while, the other two crops had a slight decrease by 50 and52.4% respectively. This is because, these crops occupy a reasonable piece of land and are often intercropped to maximize land size, coupled with low or no use of chemical fertilizers and manures, leading to low crop yield. This

implies that not only clim ate variability is responsible for the decrease or increase in croup output but other non-climatic elements.

2.2.2 Perceived trend in food crop production in Tubah

Over the past decade food crop production in Tubah has witness a negative trend. Field survey show that, maize is the main crop which has seriously benefited from climate variability while crops such as coco yam, cassava vegetables are seriously threatened. This explain the reason for a high increase in maize production as perceived by the sampled population (25).

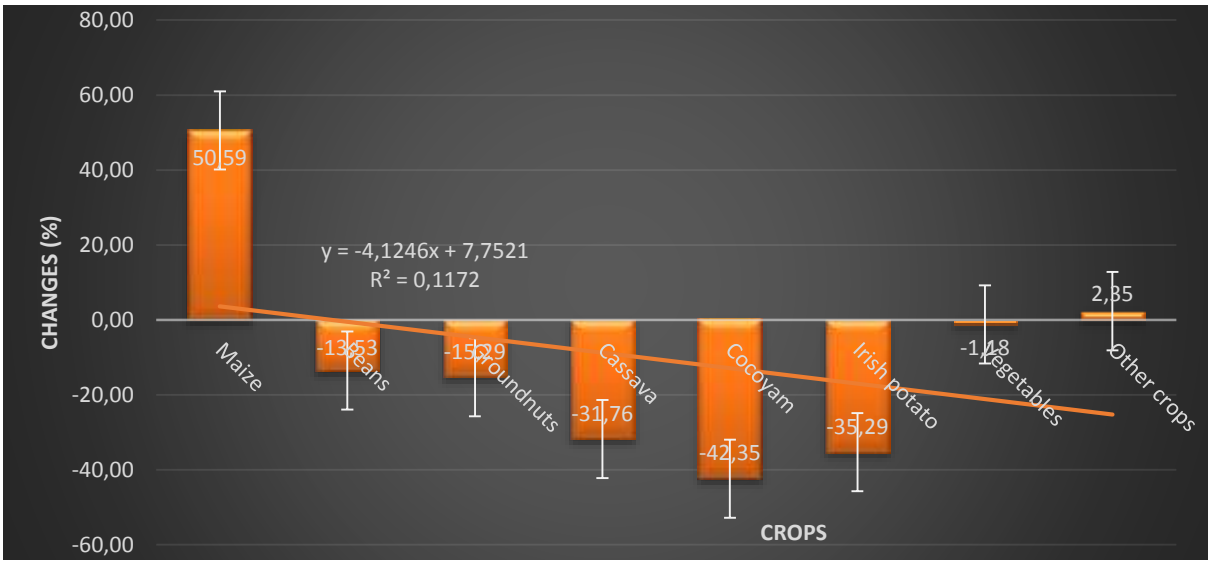


Figure 25: Perceived trend in food crop production

Source: Fieldwork, November 2020

As demonstrated on figure 25, the perceived trend of crop production is determined by the coefficient R^2= 0.1172 which shows a downward shift in food crop production. From the analysis, there have been a perceived increase in maize production and a slight increase in the production of other crops. While cassava, coco yams and irish potatoes has undergone a drastic shift in production. Beans grandaunts and vegetables have witnessed a slight decrease in production. The degree of perceived change in food crop production is indicated by the coefficient of determination (R^2). The general perceived trend for Tubah Sub-division for crop production was a slight decrease by a factor of (R^2 =0.1172). This implies that food availability is a great challenge to the people since they perceive a reduction in the trend of crop production.

According to Naintoh et al., (2018), the continuous increase in temperature (0.09 ^{0}Cper year) and rainfall (25.80 mm per year) between 1995 and 2015 have led to slight increases in yields (1.26 t/ha/yr), though accompanied with disease infestations. But experienced one of its

greatest decline in yields (-20.5 t/ha) in 2014.These authors further correlated Solanum potato yields with climatic elements and found out that it had different relationships. For instance, yields had been increasing with temperature, even though the relationship was a very weak positive one (R= 0. 02). While, potatoes yields increased with a slight increase in rainfall trend and the regression analysis shows that rainfall had a week positive correlation. Although, climate variability has influenced the production of some crops positively while, others negatively as perceived by respondent. Other parameter also influences crop production Such as; crisis which however affects the quantity, and sociocultural adaptability of the people of Tubah to food throughout the annual harvest. This explains why most of the crops recorded were not mainly the food staple of the area (Table 16).

Table 16: Annual crop harvest for Tubah Sub-division for 2019/2020

Crops produced	Production in Tonnes 2019			Production in Tonnes 2020		
	Dry season	Rainy season	Total	Dry season	Rainy season	Total
Maize	26	614	640	87	609	696
Cassava	880	874,5	1754,5	992,28	1212,75	2205
Yam	58,5	273	331,5	64,8	1512	1576,8
Colocassia	1848,5	326,3	2174,8	1912,5	337,5	2250
Potatoes	187,5	563	750,5	195	582	777
Beans	191,85	63,95	255,8	206,25	68,75	275

Source: Fieldwork, November 2020

Table 16 shows that crop production is increasing which contrasts what was observed in the field as vast lands were left uncultivated. Also, even if they are cultivated, they are easily being destroyed as they are highly seasonal and perishable crops such as; Solanum potatoes, vegetables, and maize. In addition, it was very difficult for Agric-technicians to take records on harvest consistently because of the crisis. But for crops such as; cassava, colocassia, yam,and potatoes which are mostly produced for the market, it was easy to get their records from famers in the market. According to one of the Agric-technicians, more income is invested in the cultivation of such crops so as to generate income, and also they are mostly cultivated annually not seasonally unlike the main stipple. Moreover, they do not need constant follow-up even if they are destroyed in the farms, they are not totally damaged since they can still grow again and be harvested in due time. This explains why the annual output for maize is far less than that of cassava, yam, and others even though maize is virtually cultivated by almost everyone.

2.3. Fertilizers and crop production in Tubah Sub-division to ensure food availability

The green revolution exposed the world to technics and ways to boost agricultural yields so as to stay food secured (food availability) through the use of hybrid seeds, and agro-chemicals such as fertilizer. Famers made it known to the study that foreign chemicals are

highly used by farmers in Tubah Sub-division as, everyone tries to look for ways to enhance agricultural productivity in this area while adapting to the effect of climate variability. Moreover, soil rarely has sufficient nutrients available for crops to reach their potential yields because of the unsustainable methods of cultivation practiced in this zone. Although, soil nutrients are very essential for plant growth farmers are unaware of the effects of unfriendly farming practices which reduces the productive nature as reported to the study. Farmers tend to apply soil amendments technics that are rich in nutrients to enhance soil fertility and increase crop productivity (Amjad et al., 2016). This is coupled or aggravated by the effects of climate variability on crop production in this area. Subsequently, leading to the high demands for fertilizers and other agrochemicals used by farmers to adapt to the negative effect of climate variability on crop production. Following the Second World War, agriculture underwent many changes with the increased use of inputs, such as fertilizers, pesticides, and other agrochemicals leading to an increase in crop production and food security in many areas (FAO, 2008). The table below accounts for some of the reasons why farmers use fertilizers (Table17).

Table 17: Respondents' perception on variation in temperature and rainfall influenced food availability and accessibility of food and the use of fertilizers in Tubah Sub-division

No	Villages	No of responders	Has variations in temperature and rainfall influenced food availability and accessibility of food which has led to the use of fertilizers ?			What are some other reasons why people use fertilizers?		
			Yes	No	No idea	Increase output	Soil deficiency	All of the above
1	Bambili	45	39	2	4	39	4	2
2	Bambui	63	48	5	9	31	30	2
3	Finge	12	9	0	3	5	4	3
4	Sabga	27	19	2	6	10	13	4
5	Kejukekum	13	10	0	3	12	6	2
6	Kejume ketinguh	10	7	1	2	10	2	2
	Total	**170**	**133**	**10**	**27**	**96**	**59**	**15**
	%	**100**	**78.2**	**5.9**	**15.9**	**56.5**	**34.7**	**8.8**

Source: Fieldwork, November 2020

Judging from Table 17, 78.2% of respondents acknowledged that many famers have resulted to the use of fertilizers due to seasonal changes which is affecting agricultural yield and food security. The table also indicates that only 6 and 16% do not use or have any idea on the usage of fertilizers due to climate variability while justifying that they mostly cultivate mainly for their household consumption rather they use manure instead of fertilizers which are usually expensive to purchase and need to have a good mastery on its application. However, 56.5% of farmers in this Sub-division use fertilizer to boost agricultural output especially

farmers producing purposely for the market. In one of the five interviews conducted with farmers, on the use of fertilizers in line with climate variability, 90% of them said, they use fertilizers to improve their yields which often increase their chances of making more profit in the market. They further underline that they have no choice but to continue using fertilizers and other inputs to increase the nutrient of the soil as they say;

> "T*he soil used to be very fertile we even use to cultivate without fertilizers and agrochemicals in the past but now, if you try to work that way, you will lose all your resource and time. Because the soils are no longer fertile as before added to the challenges we face due to changes in season".*

This was also admitted by 34.7% of the sample who acknowledged that they tend to increase soil fertility with the help of fertilizers because the soil has become less productive.

Despite the diverse views of respondents, on their rationale for the usage of fertilizers, 9% are of the view that they use fertilizers due to seasonal variation, and to increase outputs due to soil infertility. It can be inferred from table 14 that different reasons account for the usage of fertilizers on crop production in Tubah Sub-division apart from seasonal variation with the main aim of increasing output thereby ensuring food security and the accessibility of food in this area. Even though the usage of fertilizers has some negative repercussions on the socio-cultural adaptability of food which some households advanced reasons for during the field survey and interviews.

2.2.3 The negative effect of fertilizer on food availability and acceptability

Farmers in the NW Region of Cameroon and Tubah Sub-division in particular use fertilizers to increase crop yield especially market-oriented farmers however, its wrong application downplay on the quality of food produced. As it often changes the taste of most staple food in the study area and affects not only feeding habits of Tubah people but their food security as well. Studies revealed that farming with foreign chemicals such as; metalaxyl and inorganic fertilizers contaminates crops and predisposes consumers to cancer and other diseases (Enchaw and Fombe, 2020). Besides, too much application of fertilizers affects the soil, environment, and crop by changing the taste of food. The eloquent testimonies of key informants attested to this by justifying that, in the past, the *ankara* system of farming was very much applicable where farmers would burn the soil and use the ash as fertilizer before cultivating crops such as cocoyam and sweet potatoes. Moreover, they cultivate these crops long side maize and other crops too to boost productivity. But with the adverse effect of climate variability, this is not 100% applicable as farmers *say the changing climatic conditions do not understand the native system of farming anymore but do understand the language of fertilizers and agric -chemicals.* Agric field coordinators made it known to the study that farmers engage

in the usage of fertilizers such as NPK5 20:10;10 and 14:24;24) for maize, urea (46%) for maize and vegetables, (11:11:22) for solanum potatoes without having a good mastery of its application since they are not very educated (table 18)

Table 18: Respondents levels of education for farmers in Tubah Sub-division

No	Villages	No of respondents	What is your level of education?				
			No formal education	FSLC	O/L	A/L	BSC/BA
1	Bambui	45	0	32	9	1	3
2	Bambui	63	2	26	11	13	11
3	Finge	12	5	4	3	0	0
4	Sabga	27	5	17	1	2	2
5	Kejukekum	13	2	6	1	3	1
6	Kejume ketinguh	10	2	2	1	2	3
	Total	**170**	**16**	**87**	**26**	**21**	**25**
	%	**100**	**9.4**	**51.2**	**15.3**	**12.4**	**14.7**

Source: Field work, 2020

Table 18 illustrates the level of education of respondents who are farmers. The table depicts that 9.4% of farmers have not attended any formal education and a majority of them have just First School Leaving Certificate (FSLC) 51.2%. This high percentage is justified based on the fact that farming does not require any level of education before operating a farm. The average percentages of farmers with GCE O/L and A/L 15.4 and 12.4% respectively because most youths in Tubah Sub-division abandon school after obtaining the GCE O/L and A/L to engage in farming to enable them to raise money to enable them get back into school. While only 15% of them are Degree holders and are well educated implying that only these few educ ated farmers may have a good mastery of the usage of fertilizers on crops. Unlike the uneducated farmers, who engage in farming as a means to generate income and improve their livelihood, generally face problems in applying the right amount of fertilizer on crops. It was disclosed to the study during an interview with the program coordinator for the regional delegation of agriculture and rural development that *most farmers who are market-oriented cannot do without fertilizers because they believe that it increases yields despite the after effect when it is not applied in its right quantity.* Table 19 shows the perception of respondents on the effect of fertilizers on staple food.

Table 19: Respondents perceptions on food acceptability due the use of fertilizers as a result of rainfall and temperature variation in Tubah Sub-division.

No	Villages	No of respondents	What is the effect of fertilizer on the quality of food and you feeding habits?		
			Change in taste	Increases the rate of decay	Too soft
1	Bambili	45	30	12	3
2	Bambui	63	42	20	1
3	Finge	12	10	2	0
4	Sabga	27	15	10	2
5	Kejukekum	13	7	4	2
6	Kejume ketinguh	10	6	2	0
	Total	**170**	**110**	**50**	**8**
	%	**100**	**64.7**	**29.4**	**4.7**

Source: Field work, 2020

From field inquires it was observed as depicted in table 19 above that, the high usage of fertilizer on crops has some effects which playback on staple food, 64.7% of sampled households perceived a change in the test of food. Some sampled households affirmed a change in the taste of food over time which tends to hinder the availability and the utilization of food in these communities. For example, key informants pointed out that the people of Bambili love to eat pounded solanum potato and cocoyam (*akwa*) but over time, they were unable to do so because of the improved seeds which most farmers use. Based on their opinions, these improved seeds are often very watery and do not give the unique taste the food deserves particularly when fertilizer is used on it. But for the case of vegetables, fertilizer either changes their taste or causes them to easily get rotten as indicated by 29.4%who testified that food easily gets decay. Thus, affecting the cultural value of food as respondents complain of not getting total satisfaction after consuming some local meals like *Akwa*, *kebain*, and *mbas ksi* which are products of some food crop such as solanum potato and vegetables.

The director of IRAD during an interview explained to the study that, most crops in the field are affected by bacterial before their harvesting period of which if not properly treated will affect the crop after the post-harvesting period. For crops such as cassava, cocoyam, and solanum potato, fertilizers make them easily get rotten or too soft. This has created conservation problems as it is difficult to store these products for a long time. In as much as the local population tries to adapt to the advent effect of climate variability, it still affects the cultural value of food and the feeding habits of the people. For it is said, *food tastes best when it is cultivated naturally without the use of fertilizers*. But environmental dynamics has pushed many farmers to resort to using fertilizers, which often change the taste of most staple food in the study area and affect not only feeding habits of Tubah people but their food security as well as observed by the study. This affect food preservation as fertilizers make it easily get rotten

especially tubers making it difficult for farmers to store food for a long time creating the issue of consistency. Besides, the inability to preserve produce affects its availability in the market after the harvest season thereby creating the problem of consistency on these staple foods and change in consumer intake. The question is, are the people of Tubah food secured if they cannot store food for long.

2.3.2 Comparative analysis of food accessibility in Tubah Sub-division

It is worth noting that there are many different ways through which particular groups of people become food insecure in Africa over time and can be easily examined through a comparative analysis of food accessibility in such areas (FAO, 2018). For instance, subsistence producers do lose access to productive land or the vulnerability of their crops and livestock to climate, land degradation, and pests which are the main threat to food production Tubah Sub-division. When this phenomenon manifests, they become susceptible to food insecurity. For farmers producing for the market, their incomes and food security depend on commodity, input prices as well as environmental conditions, and at times, they are vulnerable to shifts in government policies and default on debts if or when their harvests fail (WFP and World bank,2010). This might lead to a scenario of food insecurity in households thus the need for a comparative analysis on food accessibility in Tubah Sub-division for the past five years (figure26).

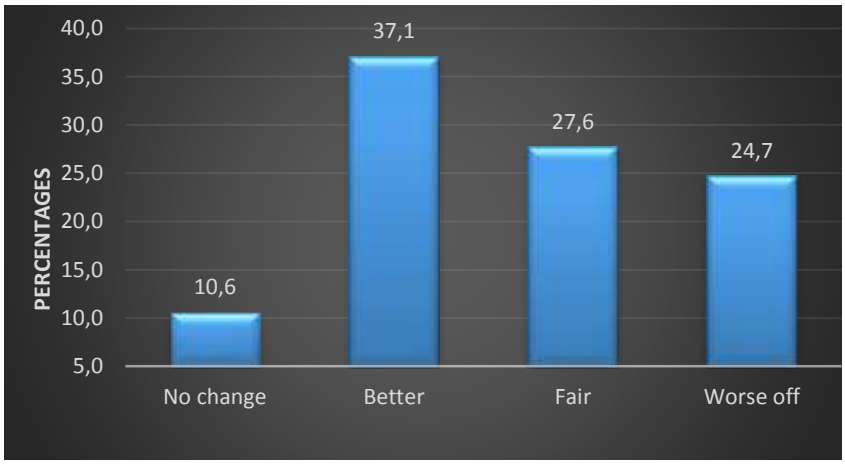


Figure 26: Level of access to food today as compared to five years ago
Source: Fieldwork, November 2020

Figure 26 shows that the level of household access to food is better today as compared to five years ago 37.1% of respondents asserted to this while 27.6% affirmed that the level of food access is fair, 24.7% indicated that it is worse off compared to five years ago. This means that in as much as most of the people of Tubah are farmers there are still some households which have been food insecure for the past 5 years. This can be justified based on the fact that productivity is declining as climate variability takes its cause. Also the effect of the ongoing

crisis has not been favourable on famers figure 18 portray a clear picture of this scenario in Tubah Sub-division. If 27.6% indicts that the condition is fairly better and 24.7% talks of worst condition, it means some set of people are already moderately food insecure as compared to 37.1% who have adequate access to food. This implies that the 24.7% and 27.6% of respondents may have experienced uncertainties in obtaining food. So were compiled to reduce the quantity and quality of food they take at a given period of time within the year due to lake of money.

Although this area is considered as one of the bread baskets of the NW Region, this Sub-division still experience complex issues emanating from rapid population growth, and socio-political crisis. This has made life more difficult as the people thrive to make ends needs so as to overcome the complex issues which have adversely affected food security. The coming of the University of Bamenda in 2010 by a presidential degree nailed the last nail to the coffin as it tends to speed up the rate of urbanization. While the real income of the people remains fixed, in as much as the prices of food items keeps rising, making net buyers food insecure in Tubah Sub-division. Equally has made it very difficult for most household to acquire adequate food for home consumption. Key informants informed the study that things have become more difficult due to the effects of climate variability which causes poor harvest as a result of prolong dryness, unreliable rainfall and outbreak of pests and diseases making food availability and accessibility a problem. They further explained to the study that some of them who are workers their salaries are not increasing but their family sizes keep on increasing they say; *it is difficult to feed plenty mouths today with the inflation in food prices with a good quality of food since food is becoming difficult to access in the market.*

Conclusion

It is evidently clear that climate variation is affecting crop cultivation as it has influenced the use of fertilizers. Although fertilizers increase crop yields it equally alters the taste of food which indirectly influences the cultural value of the people and food security in Tubah Sub-division. Field inquiry showed a reduction in the trend of agricultural production which has made the people of Tubah result in the usage of fertilizers to boost agricultural productivity and to ensure availability and consistency of food. Even though these fertilizers have increased productivity, it is still having some negative repercussions on crops when applied wrongly as it makes crops to be too soft, get rotten too fast, and changes the taste of their staple food. Especially when the wrong dosage is applied on crops as a majority of farmers are uneducated so, lack a good mastery of the usage and application of fertilizers. Because, they are market oriented so obviously use fertilizers to increase yield and earn profit so as to improve livelihood.

According to a study, SSA's agricultural system is grounded on an economic than a household basis, evident in the shift from subsistence farming towards greater intensification

(Nfor and Enchaw, 2019). This has pushed most people to change their feeding habits while consuming less of their staple food therefore, giving room for the scaling of their level of food security. Although food is readily available, Tubah Sub-division still faces the problem of; food accessibility, stability, utilization, and consistency. Data obtained from the field revealed that the situation is getting worst as compared to the past 5 years (Figure 26). Meanwhile, there is no specific timing for food security it can occur at any time pushing households to make some adjustments to avoid food shortages. This will be discussed in the subsequent chapter which focuses on food insecurity which is as a result of the problem of food stability and consistency.

CHAPTER 3

FOOD INSECURITY AND ADAPTATION STRATAGIES IN TUBAH SUB-DIVISION

Introduction

Local agriculture is the key element to food security in many agricultural countries in Africa although the sector faces climatic constraints creating an impact on food leaving many food insecure. This is highly due to the problem to food stability in many areas. Besides studies have proven that if one aspect of food security is distorted in an area, there is a high possibility for them to become food insecure. Variation in climatic elements such as rainfall and temperature has render food availability and accessibility to be a major challenge making food stability an issue in most homes particularly in Tubah Sub division. Furthermore, climate variation has brought about high food prices making food not affordable for all, particularly in the present context of socio-political crisis where food supply from rural areas is difficult and farmlands are reducing due to urbanisation. Thus resulting to changes in the land uses of this area as well as causing a reduction on agricultural land use and the quantity of food crops cultivated. Coupled to the low yields recorded on farm produce caused by the unpredictable nature of rain and prolong dryness damaging food items in farms there by, creating the problem of food accessibility and consistency over time. In order to guarantee food security in Tubah Sub-division climate change mitigation and adaptation strategies has been adopted. Such as; agroforestry and more of intensive farming which demands the high application of foreign chemicals for a good output thereby, increasing the prices of food in the market.

This chapter however, treats and appraises the third specific hypothetical assumption and corresponding objective which is to find out to what extent seasonal variation has contributed to food insecurity and adaptation strategies in Tubah Sub-division.

Also, this chapter examines the variation in food prices as a result of seasonality to show the degree of affordably of foodstuffs in Tubah Sub-division the study aims at examining the extent to which climate variation has influenced the prices of food and adaptation strategies in Tubah Sub-division. In an attempt to provide an answer to the third research question, and to verify hypothesis 3 which states that “climate variation has brought about high food prices and adaptation strategies in Tubah Sub-division”. Furthermore, this chapter is sub-divided into three parts which are 3.1, 3.2 and 3.3.

3.1 Drivers of food insecurity in Tubah

Tubah Sub-division in the North West Region is experiencing complex issues emanating from rapid population growth, prolong dryness during the dry season coupled with the ongoing socio-political crisis. This has made life more difficult as the people thrive to make ends needs so as to overcome the complex issues which have adversely affected food security. The coming of the University of Bamenda in 2010 by a presidential degree nailed the last nail to the coffin as it tends to speed up the rate of urbanization. While the real income of the people remains fixed, in as much as the prices of food items keeps rising, making net buyers food insecure in Tubah Sub-division. Thus, making it very difficult for household to acquire adequate food for home consumption. Besides things have become more difficult due to the effects of climatic dynamics which causes poor harvest as a result of prolong drought, unreliable rainfall and outbreak of pests and diseases making food availability a problem (Table 20).

Table 20: Worsening level of food insecurity in Tubah

Options	Ratings of security (%)					
	<5%	**6-10%**	**11-15%**	**16-20%**	**21-25%**	**26%+**
Income not increasing at the rate of inflation	38.2	30.6	11.2	10.6	8.2	1.2
Poor harvest due to drought	50.0	19.4	26.5	2.4	.6	1.2
Poor harvest due to low temperatures	31.8	32.9	22.4	10.6	2.4	0.0
Poor harvest due to pests and diseases	30.0	24.1	11.2	23.5	2.9	8.2
Lack of agricultural inputs	35.9	17.6	13.5	12.9	17.1	2.9
Low salaries	25.3	17.6	7.6	11.2	11.2	27.1
High rate of urbanization	30.0	11.2	12.9	15.9	10.6	19.4
Retirement of main provider	41.2	10.6	9.4	17.1	8.8	12.9
High cost on food transportation due to poor roads	32.9	17.6	23.5	11.2	1.2	13.5
Reduced government support	20.6	13.5	17.6	4.1	15.9	28.2
Increased household size	23.5	27.6	9.4	15.9	15.3	8.2
Death of the main food provider	37.1	30.0	16.5	10.0	3.5	2.9
Others	45.3	28.2	1.8	10.0	11.2	3.5

Source: Fieldwork, November 2020

Table 20 gives statistical values on factors responsible for the worsening levels of food insecurity in Tubah Sub-division. One of the main drivers of food insecurity is the increase of household sizes as most family sizes ranges from 1 to 3 and 4to 6 ,retirement of main providers makes food availability a challenge .Although most of the population are farmers they still lake the means to get agricultural inputs so as to boost production which will go a long way to increase food security .From the food the scaling on table 21 it shows that things are getting

worse as day passes and the people are food insecure with a scale of <5% which has contributed to several effects on households.

3.2 The magnitude and the effects of food insecurity in Tubah

When one of the determinants of food security is affected in an area, it creates the problem of food insecurity in that area (table 22) Tubah Sub–division has witness some scenarios of food insecurity over time as the magnitude and the effects of food insecurity can be measured on a scale of Rarely, Sometimes and Often. This parameter makes it easy to evaluate the degree of food insecurity in Tubah. Since this has left the people of Tubah Sub-division on variety of options so as to sustain themselves over time. Table 21 brings out the magnitude and the effect of food insecurity in Tubah.

Table 21: The magnitude and effects of food insecurity at household levels in Tubah Sub-division

Options	Scale (%)					
	Rarely		Sometimes		Often	
	F	%	F	%	F	%
Worried that household would not have enough food	45	26.5	101	59.4	24	14.1
Household not able to eat the kinds of foods you preferred because of lack of resources	42	24.7	112	65.9	16	9.4
Household members have to eat a limited variety of foods due to lack of resources	56	32.9	112	65.9	2	1.2
Household members have to eat some foods you really did not want because of lack of resources to obtain other types of food	72	42.4	67	39.4	31	18.2
Household members have to eat a smaller meal than you felt you needed because there was not enough food	73	42.9	62	36.5	35	20.6
Household members have to eat fewer meals in a day because there was not enough food	69	40.6	51	30.0	50	29.4
No food to eat of any kind in your household because of lack of resources to get food	111	65.3	46	27.1	13	7.6
Household members go to sleep at night hungry because there was not enough food	113	66.5	45	26.5	12	7.1
Household members go a whole day and night without eating because there was not enough food	117	68.8	41	24.1	12	7.1

Source: Fieldwork, November 2020

According to table 21, it shows that 59.4% of the sampled households in Tubah pointed out the fact that, they do worry of not having enough food while at times, some households are unable to eat the kind of food they preferred because of lack of resources (65.9%) also they do

eat limited varieties of food over time. The magnitude of food security gets worst on average household income or net income earners in this study area as often at times, families have to eat fewer meals on a daily basis because there was not enough food (50%).While a total of 40.6%of sampled households ascertained to the study that, they do eat smaller meals often than they felt they needed because they did not have enough food. Although, it's rare for members of households to go the whole day and night without eating because there was not enough food nor for members to go to bed hungry or talk less of not having food to eat of different kind at home as 68.8%, 66.5% of the sample population affirmed to these options. This means that in as much as the people do cultivate food, they still have an issue of accessibility and affordability due to lack of resources. This makes it very difficult for utilization of food to be effective as climate variability comes along with its own constrains in Tubah Sub-division.

3.3 Household food insecurity access scale

Household Food Insecurity Access Scale (HFIAS) is a method based on the idea that the experience of food insecurity (access) causes predictable reactions and responses of people in a given area. To achieve this, facts were captured and quantified during field survey carried out on households and summarized on a scale (Table 21). This helped to evaluate the level of food security in Tubah Sub-division by identifying their various sources of food. In as much as various households obtain food from different sources ranging from producing their food through the farming system which is the most common in the area, households equally purchase food from the various local market just to ensure food security as indicated by 63.5% of the sampled population (table 22).

Table 22: Sources of food in Tubah Sub-division

Sources	Responses					
	Yes		No		Not applicable	
	F	%	F	%	F	%
Own crop production	116	68.2	53	31.2	1	.6
Barter	88	51.8	68	40.0	14	8.2
Own livestock products	104	61.2	63	37.1	3	1.8
Purchase	108	63.5	49	28.8	13	7.6
Wild food collection	85	50.0	47	27.6	38	22.4
Exchange labour for food	82	48.2	73	42.9	15	8.8
Hunting	85	50.0	59	34.7	26	15.3
Steal	45	26.5	83	48.8	42	24.7
Friends/relatives	56	32.9	76	44.7	38	22.4
Food at school	72	42.4	48	28.2	50	29.4
Food at work	65	38.2	34	20.0	71	41.8
Other food sources	57	33.5	66	38.8	47	27.6

Source: Fieldwork, November 2020

From table 23 is observed that 68.2% of the sampled households in Tubah Sub-division get their food from the farm. This is basically because a majority of the people in this Sub-division are farmers who essentially produce for home consumption and the excesses are been taken to the market. Meanwhile, 63.5% asserted that they purchase food from the market and gave reasons such as; *no one can ever cultivate all that they need, there will always be the need to buy one or two items to complement with what we have at home*. Data from survey instrument revealed that most households do keep livestock as confirmed by 61.2% of the respondents. Base on their opinions, they do this activity just to generate income and at times use these products as a source of protein. They further made mentioned that it is a method of adapting to climate variability as it gives them no option but to adapt by doing such activities. Hunting and wild food collection still remains sources of food of the people of Tubah as 50% of the sampled households agree to this. While others get food from schools, relatives, or friends especially students, and others exchange labour for food (48. 2%). Looking at table 17 there is a need to critically examine the state of food security in Tubah Sub-division by doing a comparative analysis.

3.3.1 Timing of food insecurity

About 2.7 million Cameroonians are forecast to be in food crisis or worse on Cadre Harmonisé (CH Phase 3 or above) levels of acute food insecurity from January–March 2020 before reducing to 2.1 million in June–August 2020 as timed by Permanent Interstate Committee for Drought Control (CILSS FAO, 2020). According to this organ, the drop in this level of food insecurity is because, January – March are often characterized by farming

activities (food becomes very expensive) while June- August are mostly pigeonholed with harvesting activities. In Tubah Sub-division a similar situation was observed in the field as food becomes more affordable during harvesting periods. As time passes, seasons do change and the climates undergo some modifications caused by man while nature takes its cause. This has made it very difficult to pinpoint periods of food insecurity in Tubah Sub-division as it can occur at any given time of the year (Figure 27) depending on the sector people operate.

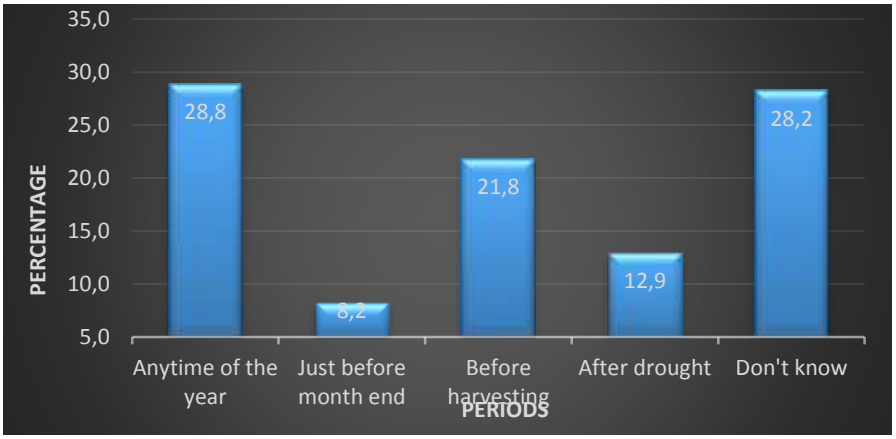


Figure 27: Timing of food insecurity
Source: Fieldwork, November 2020

Fieldwork observation and statistics generated from survey instrument publicized that, there is no specific timing for food insecurity in Tubah Sub-division as indicated by 28% of respondents. It can occur just before harvesting periods when food becomes expensive to afford 21.8% for net income buyers**.** While for salary earners, it could be just before the end of the month 8.2%. During an interview with the leader of Ngeifi Mixed Farming Group NMFG of Bambili it was revealed to the study that, during periods of prolonged dry seasons, crop yields are often very low and expensive in the market due to moisture deficits making plant growth a major problem. This gave a percentage of 12.9 respondents who indicated that there is food insecurity during periods of drought (prolong dry season) which affects plant productivity (figure 14 above) a good example is a prolonged period of dryness in the year 2017 in Tubah Sub-division according to key informants (Fieldwork, 2020).

3.4. Adaptations made to avoid food shortages in households

Generally, the human race is faced with lots of challenges daily including the challenge of putting food on the table and looking for ways to ensure consistency. This however, can be affirmative in Tubah Sub-division where most of the people are farmers and practice subsistent farming alongside market gardening in the urban (Bambili) and peri-urban areas of Tubah Sub-division. The intention had been to increase food production and to ensure a steady supply and

access to food for the fast-growing population. Climate change is projected to negatively impact the four pillars of food security availability, access, utilization, stability and their interactions (FAO et al. 2018). However, different strategies are used to either adapt or mitigate to it. Various households in Tubah over time have adopted various measured to avoid food shortages (Table 23).

Table 23: Adjustments made to avoid food shortage in Tubah Sub-division

No	Villages	No of respondents	What adjustments do you make to avoid food shortages in your house?		
			Reduce the number of meals	Improve on storage systems	Do petti trading
1	Bambili	45	10	23	12
2	Bambui	63	18	27	18
3	Finge	12	2	8	2
4	Sabga	27	11	8	8
5	Kejukekum	13	5	4	4
6	Kejume ketinguh	10	3	5	2
	Total	170	49	75	46
	%	100	29	44.1	27

Source: Fieldwork, November 2020

Table 23, testify that households in Tubah Sub-division do some adjustments to avoid food shortages 29% of the sampled households acknowledged they reduce the number of meals intake per day,44.1% improve on storage systems while 27% do other trading activities. They advance reasons that changes in seasons have brought a reduction in output moreover the soil is not still as productive as before and in other to stay food secured they do some trading businesses to raise income and food adjustments. As they affirmed that at times they will have to reduce the number of meals they eat per day so as not to run out of food the next day. It was also observed during field investigation that; households equally try to store food in different ways so that they do not run out of food by drying the food or storing them in containers. An interview conducted with one of the farmers on what adjustment they make to avoid food shortage stated that;

> "I *engage in the trading business because I cannot cultivate all the food I need to feed my household. I equally need money to be able to buy what I cannot cultivate so that my family does not run out of food. Even though I try as much as possible to properly dry the corn and beans which I cultivate so that I should not run short of them after the harvesting period".*

3.5 Rising food prices as a contributing factor to food insecurity in Tubah Sub-division

High food prices are driving millions of people into food insecurity, worsening conditions for many who were already food-insecure, and threatening long-term global food security (FAO, 2008). According, to key respondents this was not different from situation of Tubah where, prices of food were relatively cheap it was only until the mid-2000s when the advent effect of climate variation was so pronounced added to developmental issues which came up in Tubah Sub-division. Since the 19th Century, Tubah Sub-division has transcended from being a traditional monoculture society to a complex heterogeneous area, offering many services to its inhabitants as well as its hinterlands. It attracts a lot of people due to its economic, social, and administrative functions (Balgah and Nformi, 2017). Consequently, increasing the influx of people giving room for more mouths to be fed while agricultural production remains mainly for the external market this directly create a hike on food prices. Since local producers want to make profit and only a few of these food stuffs are made available in the local market (warfare department national institute of research NWR).

3.5.1. Seasonal variation and food Prices in Tubah Sub-division

During the field survey, it was observed that the prices of food in the market largely depended of the actual season (raining or dry season). This however helped to determine the quantity and the type of food made available for the local population of Tubah. Moreover, it goes a long way to influence the prices of food since they mostly produce seasonal crops because the agricultural system is rain-fed just like in any other part of Cameroon. Farmers largely depend on the rain for most of their farming activities and to a greater extent; it influences agricultural output (table 11). Most of the products sold in the various markets were mostly what farmers cultivate such as maize, beans, vegetables, cocoyam table 10 above and constitute most of their food staples. They equally import some foodstuffs from various Divisions and Sub-divisions across the country to add with what is been cultivated such as rice and even some of the same food crops cultivated in Tubah Sub-division. This is in order to have a large quantity of food that meets up with the demand of the people of Tubah at affordable prices. The effect of climate variation on crop production has brought about changes in food prices as asserted by 76.5% against 23.5% of the sample respectively (Table24)

Table 24: Respondent perceptions on seasonal variations and food insecurity

No	Villages	No of respondents	Have seasonal variations brought about instability in food which is influencing food insecurity ?		If yes what is the general trend of prices of food stuffs in Tubah Sub-Division?		
			Yes	No	High	Medium	Low
1	Bambui	45	39	6	27	11	7
2	Bambui	63	47	16	31	17	15
3	Finge	12	9	3	7	4	1
4	Sabga	27	18	9	10	10	7
5	Kejukekum	13	10	3	4	5	4
6	Kejume ketinguh	10	7	3	3	3	4
	Total	170	130	40	82	50	38
	%	100	76.5	23.5	48.2	28.2	23.6

Source: Fieldwork, November 2020

From table 24, it is observed that 76.5% against 23.5% of respondents affirmed that seasonal changes have brought about an increase in food prices. According to interviews conducted with *Bayam-sellam* and restaurant operators' prices of food crops greatly vary across seasons as what they do sell are largely seasonal food crops. They further explained that a bad harvest from farmers during the harvesting period will cause prices of food to inflate since they will buy from farmers at a higher price. Although, prices of foodstuff are generally high during the off-farming season and low during the farming season too. As agricultural prices vary across seasons, typically speaking just before the harvest, and dropping substantially immediately thereafter (Luc et al., (2016). Households made know to the study that prices of food (vegetables, cocoyam and solanum potato) are generally high during the dry season since farming during this period requires a lot of resources to have a good yield which sellers hope to make profits. *Food production in the NW region has dropped by about 20%, causing an increase in consumer food prices* (Laban a restaurant operator). While the World Bank (2014) reported that Countrywide, food prices have risen by 2.2 %, due to seasonal changes as at times, demand may exceed supply thus inflating prices while making food affordability an issue to net buyers. As the local population perceived an increase in food prices (table 24).

3.5.2 Affordability food in Tubah Sub-division

Results obtained from data collected with research instrument shows that food stuffs are still affordable (54%) even though there is a perceived increase in the trend of food prices, the food items are still very affordable to some people or household 29%. Although it is still very difficult for some households to afford food as 17% of the sampled households indicated. This

situation is very common with very low-income earner and those with very large family sizes of about 4-9 members. Figure 28 gives the various proportions of the sampled population.

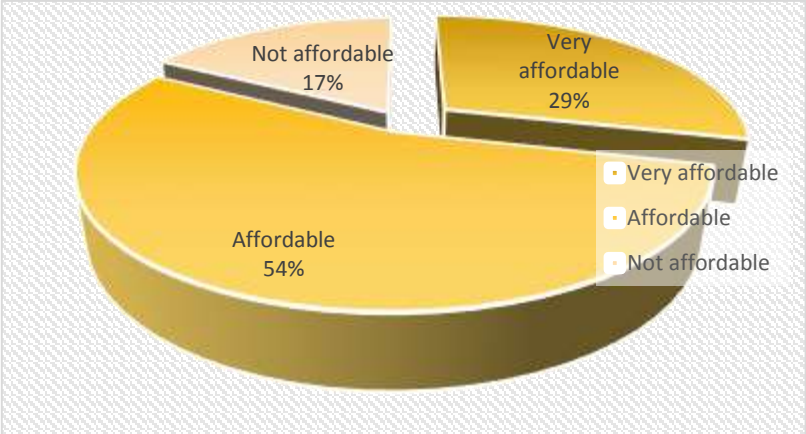


Figure 28: Affordability of food stuff in local markets
Source: Fieldwork, November 2020

As demonstrated by figure 28 food is affordable in Tubah Sub-division (54%) even though it is not very affordable for all 29% and not affordable (17%) for some sampled households implying that some people are still food insecure in this area. This can be justified based on the fact that the perceived increase in prices and a fall in the trend of agricultural production are linked to climate variation (Table 11 and Figure 20) hence directly making the affordability of food at the household level a major challenge in Tubah Sub-division. As agriculture remains the main breadbasket in this area. Informants explained to this study that increased frequency and intensity of extreme events such as prolong dry seasons and scanty rains have affected soil quality and crop yields with locally cultivated food stuffs becoming scarce in local food market making them expensive. Though, farmers in Tubah try to adapt to this situation through small-scale irrigation, fertilizer application, the use of hybrid and drought resistant seeds, and the use of pesticides and fungicides on crops provided by IRAD Bambui, emerged and re-emerged pests and diseases brought about by seasonal variations have continued to keep yields of most cultivated crops such as corn for corn fufu, cocoyam for *achu* and solanum potetoes for *akwa* low to ensure consistency and availability. This however leads to hike in food prices because these inputs are often very expensive for farmers to buy, use and increase output.

3.5. 3Comparative analysis of prices of food in Tubah Sub division

Food price increases have exacerbated the situation for many countries already in need of emergency interventions and food assistance due to factors such as severe weather and other factors such as urbanization and conflict (Jacques Diouf FAO Director-General). It is therefore

clear that apart from climatic factors other factors are equally responsible for soaring food prices. To get a concrete analysis on food prices in this area, the researcher segmented the area into different evolutional phases. Which either contributes to a fall or a rise in food prices in Tubah Sub-division. While linking productivity to the 2 main farming periods or seasons as they either led to an increase or a fall in the food prices in the market (Table 25, Figure 29Aand29B).

Table 25: Prices of food crops as a result of developmental evolution in Tubah Sub-division

Food items	**Prices before the coming of the university of Bamenda. Farming/off farming periods**	**Prices after the coming of the university of Bamenda. Farming/off farming periods**	**Prices within the ongoing crises. Farming/off farming periods**	**Units of measurement bucket/bag**
Potatoes	500/800	1800/2000	2500/2700	15 litters
Cocoyam	1000/1200	1800/2000	2500	15 litters
Solanum potato	1200/1700	2500/3000	4000/5000	15 litters
Banana	250	500	1000/1500	15 litters
Sweet yam	2500	4000	4000	15 litters
Corn	1800	2000/3000	4000/5000	15 litters
Beans	3500	6000/5000	8000/10000	15 lit ters
Vegetables	4000	7000	9000	1 (50kg)
Tomatoes	1500/2500	3500/5000	7000/8500/10000	1 Basket

Source: Fieldwork, November 2020

From table 25 above and Figure 29AandB, food prices tend to change as years pass. This is caused by several factors such as climate variation, development, and socio-political crisis. Field respondents explained to the study that, seasonality also contributes to the increase in food prices as agricultural prices vary across seasons, typically speaking just before the harvest, and dropping substantially immediately thereafter. For example, crops such as beans, corn, and vegetables are very cheap during harvesting season but become expensive thereof (Figure29A and B).

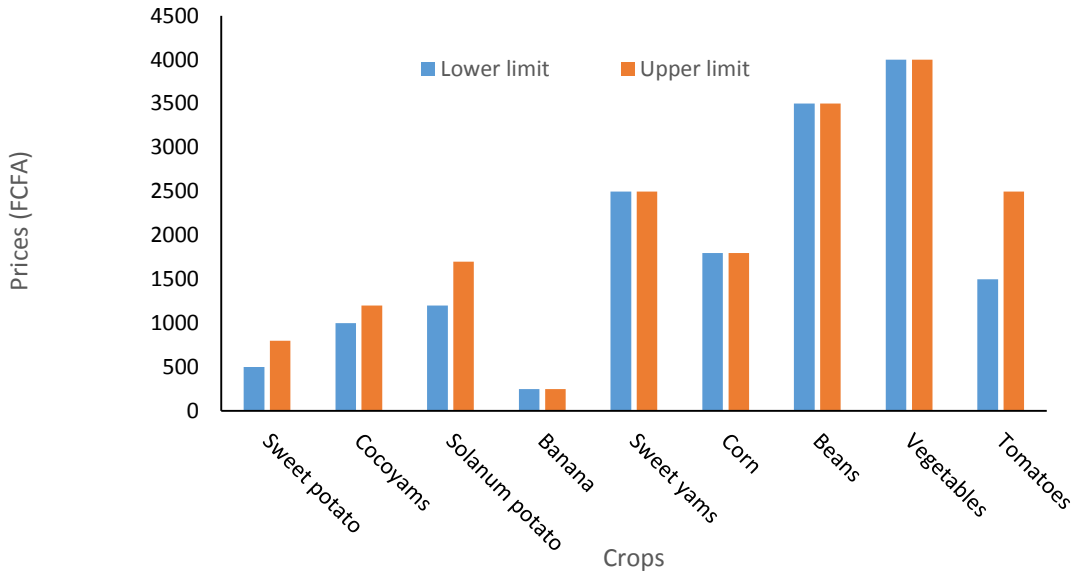


Figure 29A: Prices of food before the creation of UBa

Source: Adopted from Table 20

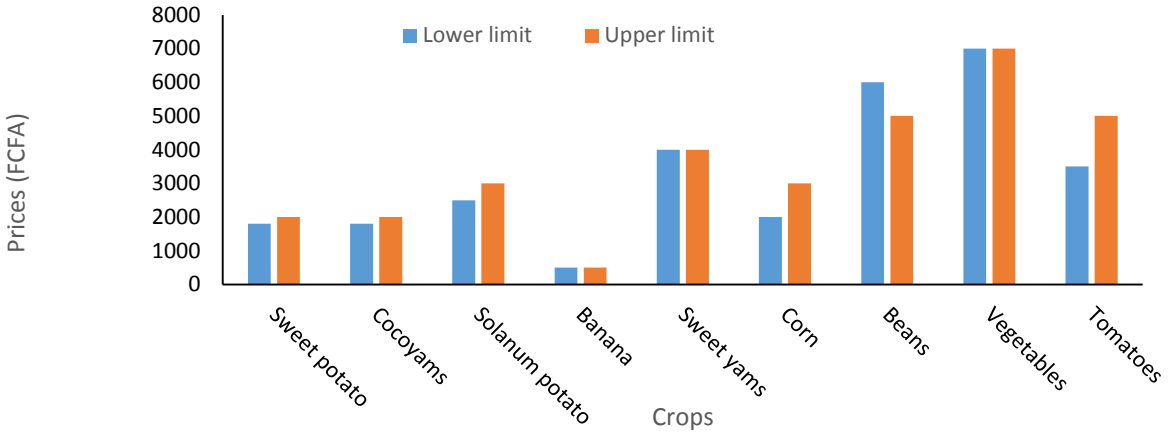


Figure 29B: Prices of food before the creation of UBa

Source: Adopted from Table 25

Furthermore, based on statistics collected in the field, food prices were very affordable before the coming of the University of Bamenda. But as developmental issues came up in 2010 it brought about a push in food prices while using the same units of measurement. While the ongoing crisis has equally brought about periodic changes in food prices in Tubah causing the prices of food to either remain fixed, increase or fall as compared to the periods before and after the coming of the University of Bamenda. Therefore, it can be inferred that food prices in Tubah are on a hike as indicated above where the local population perceives an increase in the trend of food prices. It is therefore important to examine the level of price variation over the years (Table 26)

Table 26: Rate of food prices increase in Tubah Sub-division from 2000 -2018

Food items	Prices of food in 2000 in FCFA	Prices of food in 2014 in FCFA	% increase (2000 -2014)	Price of food in 2018 in FCFA	% increase (2014 -2018)
15 litters of Potatoes	500	1800	**57**	2500	**38**
15 litters of Cocoyam	1000	1800	**80**	2500	**38**
I5 litters of solanum potato	1200	2500	**52**	4000	**60**
1 bong of Banana	250	500	**100**	1000	**100**
15 litters of Sweet yams	2500	4000	**60**	4000	**100**
15 litters of Corn	1800	2000	**11**	4000	**100**
15 litters of Beans	3500	5000	**43**	8000	**50**
1 bag (50kg) of Vegetables	4000	7000	**75**	9000	**28.6**
1 basket of Tomatoes	1500	3500	**57**	7000	**100**

Source: Field work, November2020

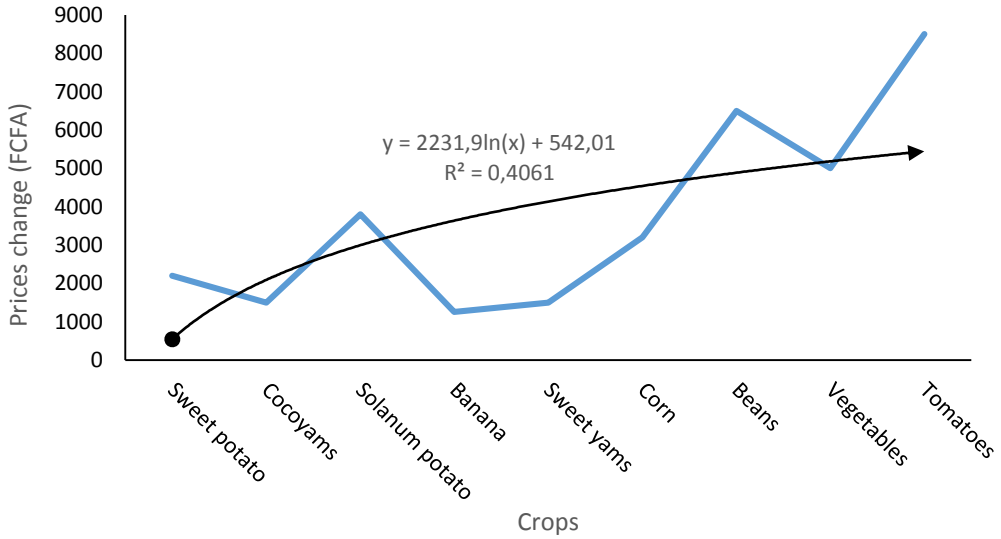


Figure 30: General trend in food prices

Source: Table 25 and 26based on food price statistics

Considering table 26 and figure 30, it is seen that the period spanning from the year 2000 -2014, the prices of agricultural products have witnessed an average increase in agricultural outputs in Tubah Sub-division. This can be justified based on the fact that production is reducing as earlier seen on Table 8 and Figure 14 while the population is increasing due to the existence of many functions especially educational functions. The year 2014 -2018 witnessed a drastic increase in food prices as some food items increased at an

arithmetic progression such as corn and banana whereas items such as beans, solanum potato, cocoyam, and vegetables increased at a progressive rate. According to *bayam-sellam*, this increase is due to the ongoing sociopolitical crisis which started in 2016.Areas in conflict suffer disruptions in livelihoods, nutrition, roads and land even suffer more from disruption in markets and destruction in crops (Barnett,2003). This stands true for this zone as most of the roads are often blocked by separatist fighters making it difficult for the items to reach the market in a good state. Added with the challenges, characterized by food supply from the farm, prices tend to inflate during the rainy season due to bad roads. While during the dry season due to scarcity of water resources and the outbreak of disease which affects crop yields, making food security a problem in Tubah Sub-division as urbanization seems to be on a rise in this area. Therefore, it can be inferred that this has also contributed to a hike in prices (Figure 29 and 30) display an increasing trend in food prices. So, it is however, necessary to examine household income spent on food in order to clearly sho w how a change in prices can contribute to food security or insecurity.

3.5.4 Percentage of income spent on food at the household level

A vast majority of urban and rural households in the developing world rely on food purchases for most of their food items and stand to lose from high food prices as an unfavorable shift in exchange conditions may lead to food insecurity (Son, 2003). High food prices reduce real income and worsen the prevalence of food insecurity and malnutrition among the poor by reducing the quantity and quality of food consumed (FAO, 2018). This phenomenon was equally observed in Tubah Sub-division as households tend to increase their income spent on food (Table 27) just to ensure food security. Although most of them are peasant farmers and cultivate mostly commonly consumed crops, they are still affected by high food prices in one way or another because farmers cannot cultivate all that they need.

Table 27: Percentage of income spent on food at household level

Period	Scale	Frequency	Percent
Last month end	5-10%	50	29.4
	11-20%	46	27.1
	21%+	46	27.1
	Don't know	28	16.5
Last year	5-10%	13	7.6
	11-20%	77	45.3
	21%+	29	17.1
	Don't know	51	30.0
Past five years	5-10%	50	29.4
	11-20%	36	21.2
	21%+	28	16.5
	Don't know	56	32.9
Past ten years	5-10%	25	14.7
	11-20%	27	15.9
	21%+	15	8.8
	Don't know	103	60.6

Source: Fieldwork, November 2020

The results of the data collected, processed, analysed and interpreted revealed that response scores of 29.5% indicated they spent an income of 5-10% last month compared to 27.1% who spent an income of 21%+ on food that same month. While 29.4% affirmed they spent an income of 5-10% of their income scale on food for the past five years whereas ,60.6% of the respondent indicated that they don't know the actual amount of income spent on food for the past ten years in Tubah Sub-division. Compared to response score of 15% who acknowledged they spent an income scale of 11-20% on food. Therefore, the percentage of income spent on food in this area, at the household level is slightly on a rise as the proportion of income spent ranges between 5-10% and 11-20%. According to key informants in the field, this rise in prices is due to several factors such; as the ongoing sociopolitical crises and development which is a contributing factor to food insecurity in the community of Tubah.

3.6 The effect of price on the cultural value of food in Tubah Sub-division

L'econmie Quotidien (2021) reported on the increasing prices of foodstuffs in the towns of Yaoundé and Douala has made food affordability a major challenge. Price hike on food has seriously affected the cultural value of food in Tubah Sub-division. Although climate variation has an upper hand on crop productivity and food availability, affordability remains a key determinant of food security as affordability and accessibility determines the amount of food made ready for consumption in households. During field investigation, it was observed that food can be made available but not accessible or affordable because of the increase in food prices. This has gone a long way to gradually replace local food items with other meals which

are more affordable as compared to the local meals of this area. For instance, during an interview with some local food sellers in Bambili and Bambui, they made mention of the fact that the main cocoyam used for *Achu* is very expensive due to the effect of climate change on this crop so they rather import from the East Region which is usually very expensive. According to them, *the essence of buying is to sell and make profit this explains why prices do fluctuate in the market. Moreover, this crop is highly perishable if we do not sell on time we make huge losses.* The hike in the price of cocoyam has pushed the indigenous people to subsidize it with *yellow country coco* which does well in the area but is not consumed by all. Informants revealed that it is because it has a way in which it has to be cooked for you to better enjoy the meal so they prefer other food like *eru* which is affordable.

Plate 3: Some foodstuff sold in the market and how they are sold

Source: Photos by Ngwangunu ,20/12/20

Photo A: Shows the availability of cocoyam for achu in the market but mainly for external buyers.
Photo (B)*: The substitute for the cocoyam on plate 3A commonly used by households which is more affordable*.
Photo (C): *The quantity of vegetables sold for 500FCFA.*
Photo (D): *Shows how cocoyam and solanum potato potatoes is retailed.*

Also, vegetable is a delicacy usually accompanied with corn-fufu the cultural meal of the people of Kejom (Babanki), and part of the people of Sabga but was observed to have witnessed some degree of price perturbation (photo C). However, this is highly attributed to climate change which is affecting productivity making the cost of production to be high but

farmers still produced mainly for the market with the help of fertilizers. This traditional meal is gradually losing its value in the system as people do cultivate vegetables in this area mainly for the external market to generate income for households. It can therefore, be inferred that money has value over the cultural value of the people. More to that vegetable, which was sold in the 90s and early 2000s for 100 FCFA, is today sold for 500FCFA upward making affordability a challenge. While a complete plate of *Acho* and a complete plate of *vegetable and fufu* sold for a 100 FCFA in the past is today sold as from 1000 FCFA in restaurants. The eloquent testimonies of key informants clearly indicate signs of increasing food prices as they acknowledged that putting a single meal on the table today is very costly for an average income earner. Talk less of constantly preparing a complete cultural meal and even when cooked it does not satisfy everyone as it ends up not going round for everyone. Respondents made it known to the study that, they prefer to replace their cultural meals with other foods which are very affordable and can satisfy their needs at the moment. Further made mentioned that instead of buying food that will not satisfy everyone in the house they rather go for what is cheaper and more affordable. Consequently, resulting in a reduction in the quantity, quality, and a change in food preference. A household is defined as a net food buyer when the value of food staples it produces is more than the value of food staples it consumes (FAO, 2008). It was observed during field investigation that poor households tend to be net buyers of food, although agriculture and staple food production is the principal livelihood for many in this community.

3.7. Other factors contributing to high food insecurity in Tubah Sub division

Apart from the effect of temperature and rainfall variations on food production, availability, accessibility and stability in Tubah Sub-division, other factors are equally responsible for food insecurity in this area such as urban densification and sociopolitical crisis. Before the 1960s the physical environment and the environs of Tubah knew little or no modifications in its land cover and land uses compared to what we have today. Although the main economic activity of the people is principally agriculture but many scholars believe that it has caused some modification in some land cover like a forest, in search of more arable land. It is with all certainty to say that, the presidential decree of 2010 brought a lot of landmarked changes in this Sub-division which gradually reduced arable land particularly in the community of Bambili and Bambui (figure 31). Therefore, it can be inferred that this degree brought about urbanization which has reduced agricultural land and increased food prices due to its fast-growing population.

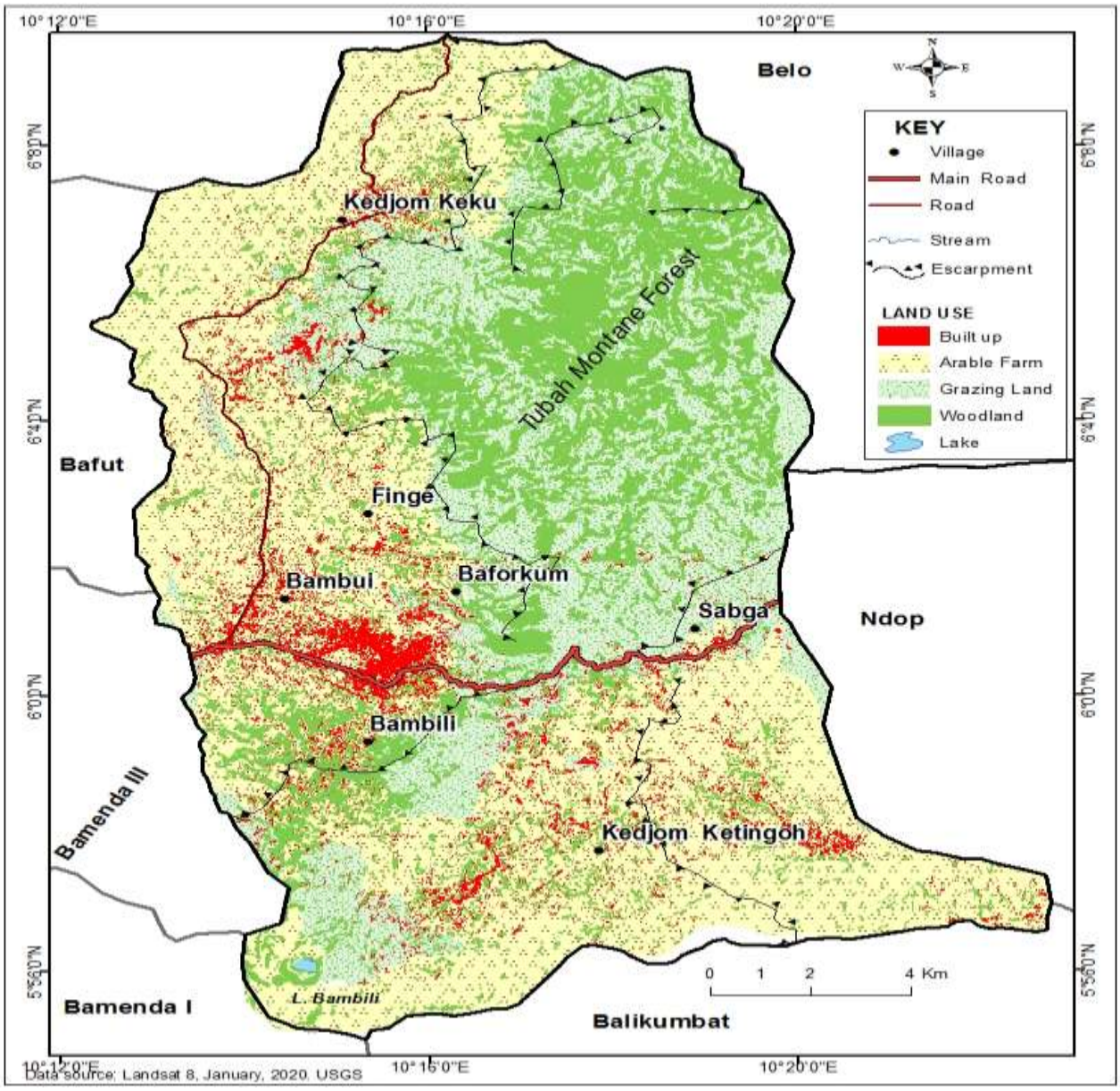


Figure 31: Land use map of Tubah Sub-division 2020

Source: Landsat 8, January,2020 USGS

As shown in figure 29 built-up area is gradually taking over arable land. For instance, areas such as Bambili, Baforkum, Finge, and Bambui the main urban towns of the zone, the proportion of farmland are small as compared to settlements. While Kedjom keku is characterized by more farmlands than built-up areas it was observed during fieldwork that this area is furthest away from the urban part of Tubah and so does not have functions that could attract people. Rather, it served as a market center where people come and buy food crops at very affordable prices and re-sell in other communities.

Urbanisation

Urbanization renders people more vulnerable to rising food prices especially the poor (net buyers) who are often susceptible to high food prices United Nation Population Fund

(UNFPA, 2011). Key informants in the field informed the study that the coming of the University of Bamenda as a means to promote development in the area has resulted in to an increase in food prices while making part of Tubah an urban town. This has made net buyers more vulnerable to food insecurity as food affordability becomes a major challenge to them due to urban densification. Unlike Stage *et al.*, (2009) in a study viewed urbanization as one of the long-term drivers of food prices while, pointing out the fact that urbanization is been conflicted with other long-term processes such as; economic growth and environmental degradation. Which are strongly responsible for high food prices and are some of the major causes of food insecurity to low-income earners. This is very contrary to what was observed on the field during field investigations. The coming of the University of Bamenda and other institutions has led to urban densification just within a short period which has caused an increase in the demand of land. This increase in population has equally led to the high demand for goods and services in Tubah Sub-division although they are often very limited in supply. Due to a reduction in agricultural land for other urban activities thus, reducing the quantity of crop production coupled with variation in seasons (Table 13). Key informants confirmed that urbanization has brought about an increase in prices as sellers particularly in Bambili and Bambui are conscious of the fact that students will always buy even if they increase the prices of foodstuffs. They equally made mention of the fact that food items are no longer as affordable as they were, before the coming of the university.

Judging from field survey and investigations the land cover of Tubah Sub-division has changed over time to suit the peoples' needs. According to Balgah & Nformi (2017), the population which was about 54,000 in the year 2000 has increased as compared to the present population. This increase meant an increase in land uses and functions with existing land uses being intensified and new land uses cropping up. Settlements increased rapidly to meet the needs of the rising population coupled with the fact that part of the study area has been considered as urban (Bambili and Bambui). These changes have resulted in an increase in urban functions like schools, hospitals, banks, among other services. Due to these high demands for land to meet the desire residential needs, commercial needs, social amenities, and socio-economic infrastructures. This has exerted pressure on the lean resources and created a variety of complex land cover and land use dilemmas leading to a progressive reduction of agricultural land and forest cover due to urbanization (Table 28).

Table 28: Analysis on the land cover of Tubah Sub-division 1988-2018

Land cover	1988		2003		2018	
	Area in km^2	Area in%	Area in km^2	Area in %	Area in km^2	Area in %
Settlements	5.66	1.8	9.63	3.2	17.36	6
Arable land	100.69	33	131.4	43	129.88	42
Wood land	107.28	35.1	65.43	21.4	59.74	19.5
Water bodies	0.25	0.08	0.201	0.06	0.18	0.05
Range land	91:19	30	98.62	32.3	97.91	32

Source: Landsat 4,5 and 8

Table 28 depicts that in the year 1988 1.8% of the land was covered by settlement while 33% of the land was made up of arable land and 35.1% was covered by woodland. In the year 2003 arable land witnessed a steady increase by 10 %(43%) meaning that more lands were cleared and exploited for agricultural purposes and residential purposes while the woodland reduced by 11.3%. Looking at the year 2018 it is seen that settlements are increasing at a faster rate while arable land slightly decreases. It can thus, be inferred from Table 29 that, there is a great modification in the land cover of Tubah Sub-division due to the increase in population which has brought about a change in its land uses over time. Figure 28,29 and 30 shows the visual transformative view of the land cover of this area from 1988-2018 which this study attributes to urban densification one of the drivers of increasing food prices. Moreover, it implies more urban functions, the influx of more people attracted by these functions consequently more mouths to feed with reducing natural resources as resources will be substituted to suit their needs. It was observed during field survey that some areas which use to be intensively cultivated in past are now built-up areas used for different purposes particularly in areas such as Bambui, Bambili, and Baforkum . Many respondents attributed this to the quest for income to meet some of their needs and moreover, the soil is not more as productive as before.

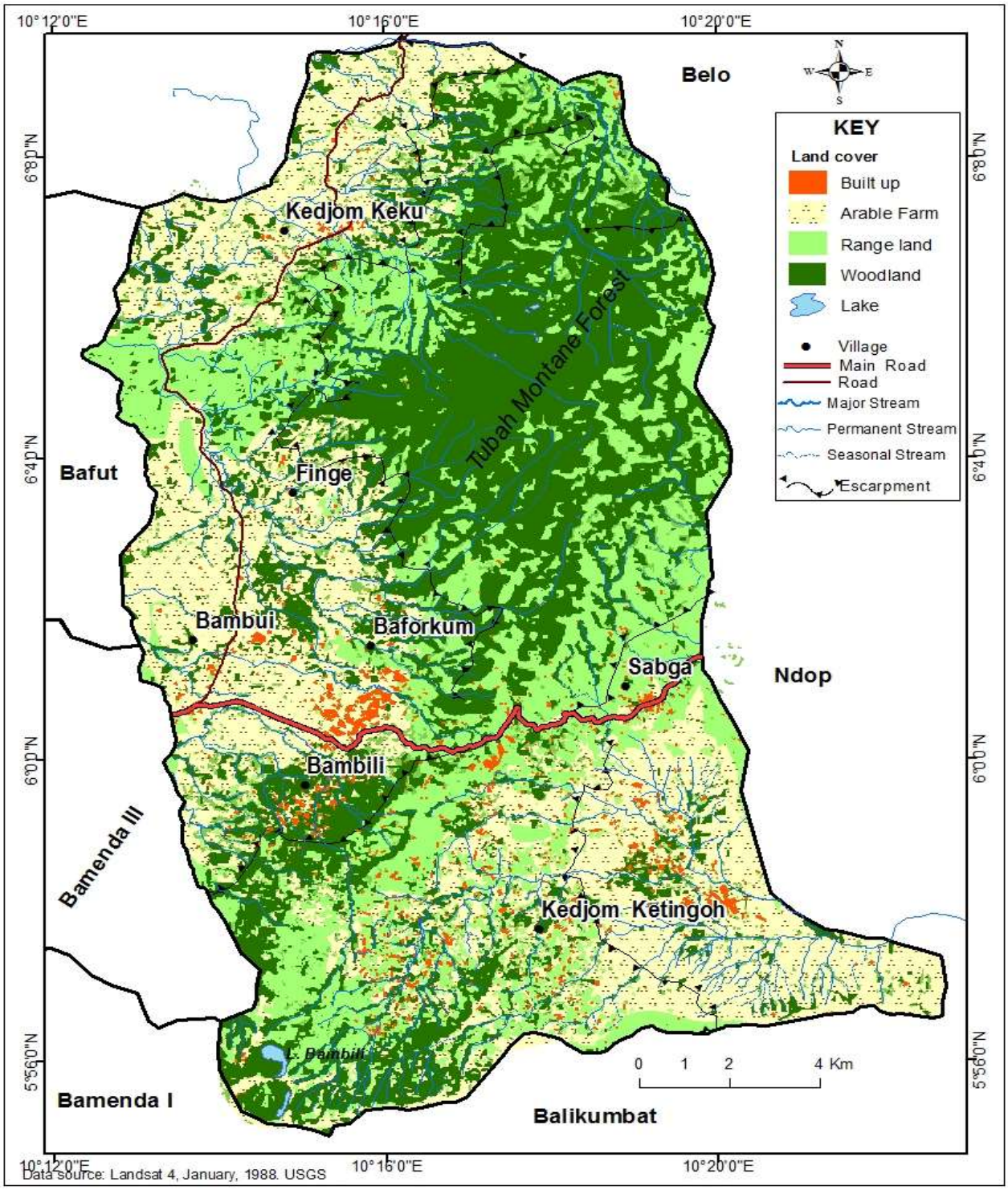


Figure 32: Land cover for Tubah Sub-Division 1988

Source: Landsat 4,January 1988 USGS

Figure 32 shows more of areable land and less of settlemnt impling agricultural productivity is high thus prices of food are affordable.

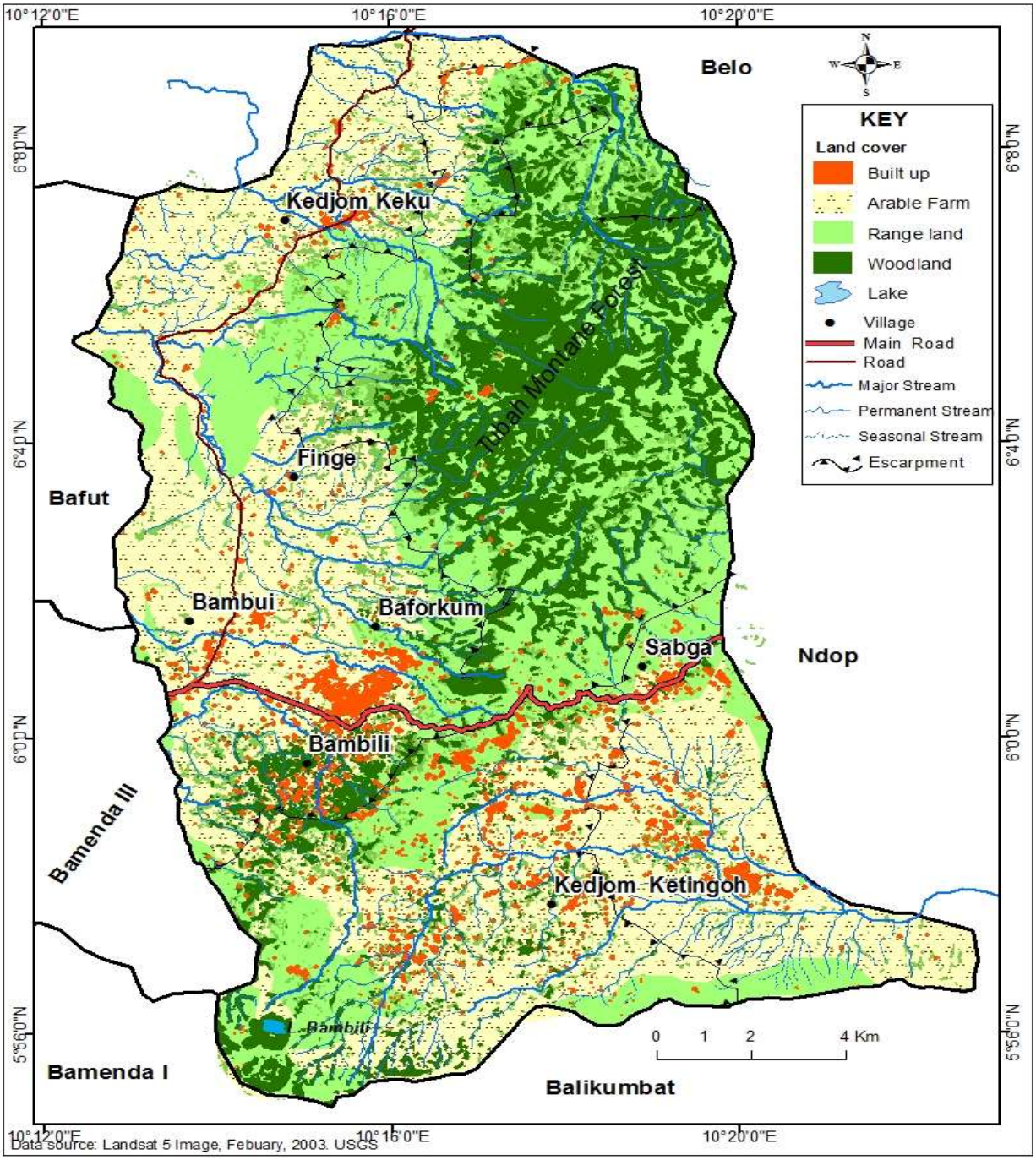


Figure 33: Land cover for Tubah Sub-Division 2003

Source: Landsat 4, Febuary 2003 USGS

Figure 33 reveal an increase in settlement pattern due to increase in population impling a slight decrease in areable and wood land.

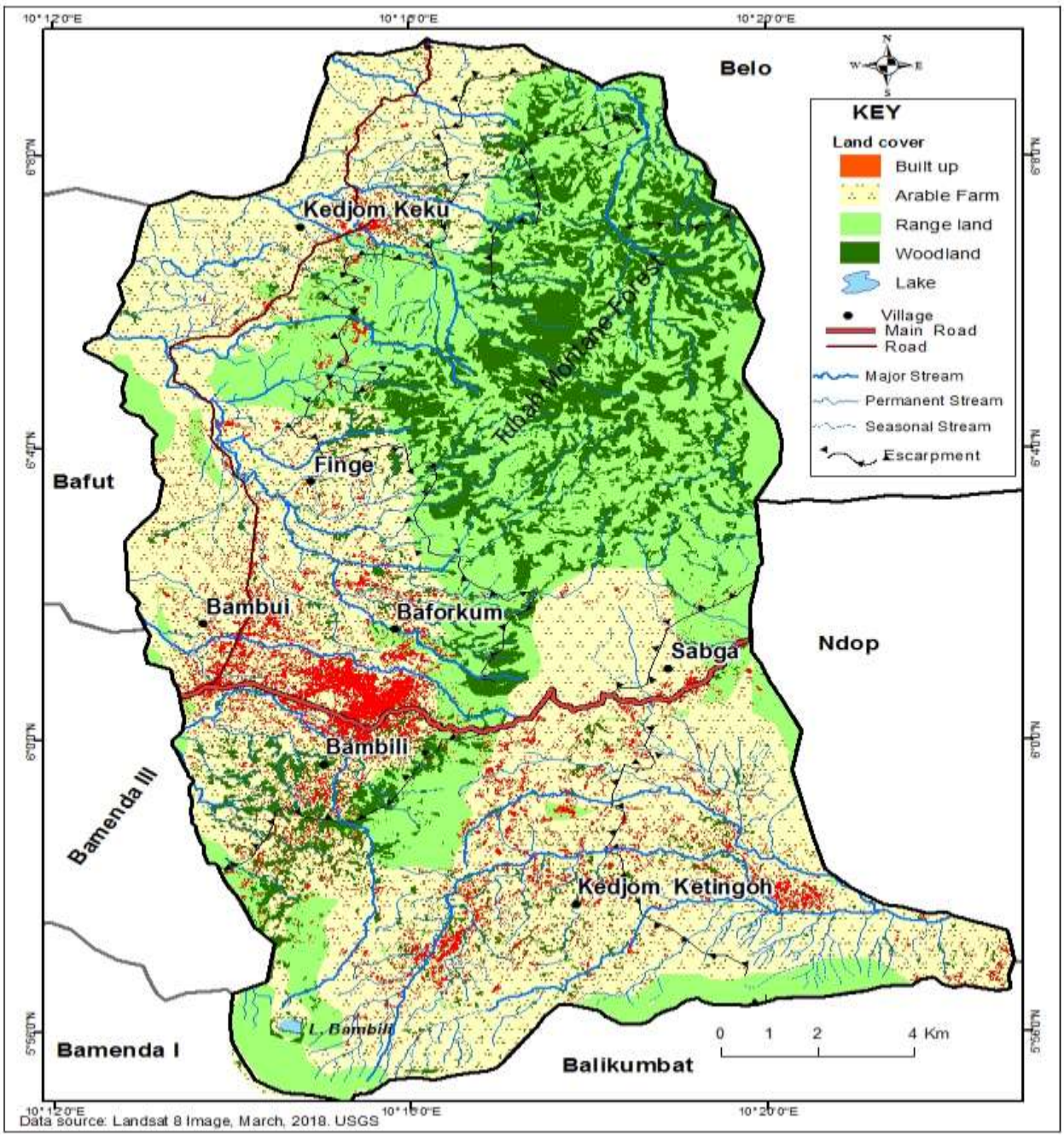


Figure 34: Land cover for Tubah Sub-division 2018

Source : Landsat 8, March 2018 USGS

Socio-political crisis

Continuous violence and instability will continue to drive high levels of acute food insecurity (fourth annual Global Report on Food Crises (GRFC 2020). While the Guardian Post (2021) reports that, 4.9 million Cameroonians are facing acute food insecurity and a majority of those affected are in the crisis-hit Northwest and South West Region. The ongoing crisis in Cameroon has caused food insecurity levels to rise sharply in the NW Region and particularly in Tubah Sub-division. This is based on the fact that clashes between the separatist fighters and the military has pushed a huge number of persons to abandon their homes, farmlands, and

livelihoods in search of safety as reported by the Fon of Bambili during an interview. It can be inferred that due to these clashes farmers are unable to access agricultural lands thus, reducing productivity which increases food prices (photo A and B). Some farmers testified to the study that their farms are now battle lands *even if we manage to cultivate, the crops will all be destroyed by these two parties. So we rather abandon the farms.* Moreover, it was observed in the field that some farmlands were not cultivated so contributed to a reduction in agricultural output reduction and the quantity of food made available. (Plate 4).

Plate 4: Farmlands abandoned in Bambili and Baforkum

Source: Photos by Ngwangunu *11/08/2020*

Photo (A): *Abandoned farmland due to the ongoing crisis.*

Photo (B): *Uncultivated farm land in Bambili with unharvested yams.*

World Bank (2019) revealed that violence and insecurity curtailed trade and contributed to high food prices and staple shortages. Insecurity and conflict have limited agricultural activities in this area causing a soar in food prices. Interviewees explained that most displaced people in Tubah Sub-division are unable to work as insecurity has prevented them from returning to their homes, putting pressure on the resources of host communities. More so, this crisis has displaced the young people and men who could provide a good labour force for agricultural activities leaving mostly the women and the old. This implies that productivity ultimately reduces whereas the cost of labour increases making prices of food staples available to rise.

Also couple with what are generally called ghost town days which according to respondents reduces the number of working days as it could last for days, weeks and months. Informants made it known to the study that during this period prices of food become very high as movements are restricted. This however creates issues of food system and market disruptions, pushing up food prices and sometimes leading to scarcities of water and some food items. It has equally prevented businesses from operating and weakened the national economy, reducing employment opportunities, increasing poverty levels, and diverting government

spending towards the war effort. Despite the governments' effort, there are still high rates of insecurity and roadblock which has prevented the inflow of goods particularly food items. Moreover, it was also noticed in the field during an interview with buyer sellers that, numerous checkpoints along the roads of Tubah Sub-division which are been pirated by policemen and separatist fighters have automatically increased the prices of food since these two parties demand settlement.

3.8 Adaptation to climate variation to ensure food security

Unprecedented climate anomalies in the world, the NWR and Tubah Sub-division inclusive, do not coincide with the socio-cultural and economic units of the local population that are based on traditional methods of agriculture. So developing an integrated strategy to combat climate change impacts is indispensable to help farmers come out of this externality which affects food security. This has pushed both stakeholders and the local population to adopt new strategies and techniques by employing methods such as; introducing agroforestry in to the system, improved seeds, changing planting dates, use of irrigation schemes, and planting of trees (Table 29).

Table 29: Adaptation to climate variation to ensure food security

Adaptations	Responses					
	Yes		No		Not applicable	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Planting trees	119	70.0	49	28.8	2	1.2
Irrigation schemes	114	67.1	51	30.0	5	2.9
Soil and water conservation	134	78.8	21	12.4	15	8.8
Changing planting dates	110	64.7	45	26.5	15	8.8
Improved seeds	120	70.6	45	26.5	5	2.9
New technologies	88	51.8	73	42.9	9	5.3
Others	139	81.8	20	11.8	11	6.5

Source: Fieldwork, November 2020

Table 29 shows the various adaptations strategies adopted by farmers to better mitigate and adapt to climate variation in Tubah Sub-division to ensure food security. Analysing from the table, 70% of farmers' plant trees (agro-silviculture) in this area although most of these trees are fruit trees alongside none-fruit trees and crops to help increase soil fertility. The use of agroforestry system ensures that farmlands remain productive throughout. As most of the trees integrated in the farm fix nitrogen through root nodules as well as recycle nutrients and prevent

wind and water erosion by means of their canopies and roots (photo B). While their green foliage from trimming/pruning or pollarding serves as green manure and improves soil nutrients conditions. The high annual production of litter comprising of leaves, twigs and flowers is a crucial contributor to nutrient cycling (Abobaka *et al.*, 2020) This can be justified base on the fact that the evidence of climate variation is visible in this area so farmers tend to look for information on how to better cope with this variation from the various institution. During one of the focus group discussions with most of the farmers, it was revealed to the study that, most farmers do attend seminars on climate change organized by IRAD Bambui and the ministry of agriculture where farmers are been educated on climate variation and how they can overcome the economic effects.

Equally, some farmers say *they would rather prefer to plant fruit trees such as; pears, mango, and plum trees since they can sell and generate income from them to improve their standard of living.* The adoption of agro trees producing products would help intensify the agroforestry system which would lead to marketable food and tree products, increasing business opportunity which would help improve farmers' livelihood (SDDA Tubah,2020). This boils down to the fact that the people are conscious of the changing environmental condition which needs precautions. They rather prefer to take precautions like planting of trees which will sustain them in the long run.

Improved seeds

Concerning improved seeds, 70.6% of farmers do make use of new improved seeds. Tchawa (2009) pointed out innovation and adaptation options which could offset climate variation such as; investment in improved technology and the use of improved variety seeds which are more tolerant to these climatic changes. Its crystal clear this strategy is equally adopted in the various communities in Tubah by famers as, seeds are usually obtained from IRAD, and other agricultural institutions in and around Tubah with the main aim of boosting agricultural yields to ensure food security (photo A). Based on information obtained from the library of IRAD, farmers tend to use new improved seeds such as ciperia, Tuperia (solanum potatoes) which are high yielding, disease-free, and early maturing which produces bulbs that are almost the size of sweet potatoes. Maize composite and hybrid seeds, ATP, coca, kasai, early white which are short growing, hybrid, and early maturing. Beans they mostly cultivate the MIDENO beans which are early maturing and hybrids. Each year, there is the production of foundation and commercial maize seeds by IRAD demonstration farm in Fonta.In 2008, 4 hectares were planted with CHC202. But farmers mostly grow ATP because it grows healthier and sells higher. Improved seeds today have been so widespread in Tubah Sub-division to the

extent that the indigenous species can hardly be traced. Improved beans species mostly grown is the MIDENO beans. Improved cassava is produced by IRAD under the root and tubers section. Demonstrated farm for cassava is found at Nfonta planted both by IRAD and PRTC Nfonta.

Farmers in Tubah Sub-division have not only been severely affected by climate change, but they have equally been mapping out strategies to adapt to the change. Some communities in this geographic space are responding to issues of climate change by reviving their drainage systems so as to easily access water during the dry season. As earlier discussed in chapter 2 concerning the effect of climate variation on food production in Tubah Sub-division, respondents were able to identify the early cessation of rains as one of the contributing factors to a fall in agricultural production. In other to better adapt to this,67.1% of respondents do make use of irrigation systems of farming especially during the dry season when soil moisture is relatively low. Even though, it is generally the traditional irrigation system which is commonly practiced in this area.

Furthermore, a good number of farmers acknowledge that they practice soil and water conservation technique 78.8% (plate 5B), 64.7% do change planting dates as a result of the changing climatic conditions because increasing temperature and decreasing precipitation are detrimental to agricultural productivity (Yong, 2013) although26.5% still stick to their normal planting dates. As changing sowing dates is ineffective in counteracting adverse climatic effect because of the narrow rainfall band that strictly determines the timing of farm operations in Cameroon (Tchawa, 2000 and Tingem, 2009). According to this group of farmers, it is better to replant when the rains become constant instead of waiting for the rains which may never come again and in the end, one may have nothing to eat. Soil and water conservation is still on a lead in this area as farmers are conscious of the high rate of evapotranspiration as places become warmer than before, farmers incorporate creeping crops such as sweet potatoes to help cover the tope soil plate 5 while crowning it with agroforestry technique (rotational tree fallow and shrub fallow).Adopting and implementing agroforestry techniques will help improve the productivity of staple food crops by improving soil fertility and promoting agro-ecosystem functions.

Plate 5: Different adaptation strategies adopted by farmers

Source: Photos by Ngwangunu

20/12/2020

Photo (A)*: Demonstration of hydride seeds of irrish potatoes during the regional agric show 2020.*

Photo (B)*: Sweet potatoes farm in Bambili planted to reduce soil erosion and reduce soil moisture deficiency.*

New technology and other adaptation strategies are also used by various individual farmers. Even though, the use of new technology is not very common like the use of tractors to do the tilling so as to gain time. This is because tractors are very expensive to get they are generally rented from IRAD or at the school of Agriculture Bambili at relatively high prices, however,51.8% of farmers still make use of this adaptation strategy especially small farming groups who can contribute and raise the money to enable them to rent the tractors. Equally, other adaptation strategies include mixed cropping, use of organic manure, fertilizers pesticides, and insecticides. It can be inferred that mixed farming is commonly done so as to reduce losses brought about as a result of the negative effects of climate variation 81.8% admitted to this. According to farmers, they prefer this adaptation strategy because it is very cheap and flexible. This explains the reason for the high percentage on the table above since it contributes to an increase in agricultural production. Nevertheless, the people of Tubah still face some constraints in adapting to climate variation to ensure food security such as; limited information on climate variation and lack of capital.

Conclusion

Mindful of the fact that climate variation is bringing about a reduction in crop cultivation it is clear that, this automatically affects the prices of food in Tubah Sub-division. As prices of food tend to fluctuate during off and post farming periods even though other factors are equally responsible such as; urbanization and political unrest making food to be affordable, very affordable, and less affordable especially to the net income earners. Therefore, resulting to an increase in income spent on food by households. However, the people of Tubah still try to cope with these variations in food prices by adopting several measures while adapting to climate variation. Although, they encounter several challenges in adapting to climate variation.

GENERAL CONCLUSION

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This study muses on the effect of climate variation on food security in Tubah Sub-division. In an attempt to appropriately analyze the problem stated which is based on climate variation, crop cultivation, feeding, habits, the effect of fertilizers on staple food, available, accessibility and affordability of food in Tubah Sub-division, a general objective and three specific objectives were set; These objectives had as the main goal to investigate how the effect of climate variation has influenced food security; through the effects of uncertainties in rainfall patterns on crop cultivation, feeding habits as it affects staple food and to evaluate its impact on food prices not living out strategies put in place to adapt to these environmental change in Tubah Sub-division. Data on the degree to which the objectives of the study have been attained is presented in the three chapters of this study. This same data is used for the testing and validation of the stated hypotheses.

Testing of hypotheses, analysis, and discussions of the results

The testing of each hypothesis was based on the theory of perception in action that was drawn from the respondent's views and quantified through the survey instrument administered. The conception that perception, is an indispensable property of animate actions; that without perception research would be unguided, and without taking any action on the perception, it would serve no purpose constituting the departure point for a series of verification and validations of the stated hypotheses. To verify these hypotheses a statistical tool was used notably the Chi-square to analyse the data obtained in the field through direct observation, interviews, focus group discussions, and the administration of the questionnaire. After testing each hypothesis, some analyses and discussions of the results of the test exercise were made. Research hypothesis 1 is first tested, followed by hypotheses 2 and 3.

Research hypothesis 1

Research hypothesis one channeled the study to collect relevant data in other to establish the link between uncertainties in rainfall patterns and food production in Tubah Sub-division. The high magnitude of climate variation drivers justifies the evidence of a tell-tale fingerprint of climate variation which is increasingly seen everywhere as time goes by; with increasing temperatures during the dry seasons while the rainy season gets shorter than before. Coupled with the unpredictable nature of weather events. Making it very difficult for farmers to carry out their daily farm work or farming activities in the various villages. The inconsistency in rainy

season patterns from 1963-2018 means rainfall is not regular which has resulted in low yields. Moreover, this Sub-division is witnessing the early cessation of rains and the late onset of rain which is affecting farming systems in Tubah Sub-division. Resulting in low yield on crop production as a result of seasonal variation, soil erosion, and decrease in soil moisture. This has gone a long way creating a drop in agricultural output even though this area is considered as one of the breadbaskets of the NWR. To verify the validity of this assertion, the responses of the respondents were exploited (Table 30).

Table 30: Respondents' perception on temperature variation, rainfall variation and food production

Villages	No of respondents	Have you noticed variations in temperature and rainfall patterns in Tubah Sub-division		If Yes, have these variations affected food production?	
		No	Yes	A drop in production	An increase in production
Bambili	45	10	35	28	16
Bambui	63	23	40	33	29
Finge	12	4	8	10	2
Sabgha	27	10	17	15	16
Kejukekum	13	4	9	7	5
Kejume ketinguh	10	2	8	6	4
Total	170	53	117	99	71
%	**100**	**31**	**69**	**58**	**42**

Source: Field work, November 2020

In a bit to establish the degree of relationship between variables, the unreliable pattern of rainfall and temperature, crop cultivation as portrayed by table 30, a contingency table was developed and the null and alternative form of the hypothesis were equally stated.

Table 31: The contingency table for hypothesis one will thus be

Observed values(O)	Expected values(E)	O-E	O-E²	$\frac{(O-E)^2}{E}$
10	14	-4	16	1.14
35	14	21	441	31.5
28	14	14	196	14
16	14	2	4	0.28
23	14	9	81	5.8
40	14	26	676	48.2
33	14	19	361	25.8
29	14	5	25	1.8
4	14	-10	100	7.14
8	14	-6	36	2.6
10	14	-4	16	1.14
2	14	-12	144	31.5
10	14	-4	16	1.14
17	14	3	9	0.64
15	14	1	1	0.07
16	14	2	4	0.28
4.	14	-10	100	7.14
9	14	-5	25	1.8
7	14	-6	36	2.6
5	14	-9	81	5.8
2	14	-12	144	31.5
8	14	6	36	2.6
6	14	-8	64	4.57
4	14	-10	100	7.14
				∑ **225.6**

Source: Table 26 based on Chi Square statistics

$$x^2 = \frac{(\mathrm{O} - E)^2}{\mathrm{E}}$$

Chi square value = 225.6

Degree of freedom (df)= (c-1) (r-1) = (6-1) (4-1) =5×3 = 15

Null Hypothesis (Ho): Uncertainties in temperature and rainfall patterns has not influenced food productivity in Tubah Sub-division.

Alternative hypothesis (Ha): Uncertainties in temperature and rainfall patterns has largely influenced food productivity in Tubah Sub-division.

We now have our Chi Square statistic (χ^2 = 225.6), which is the calculated value, our predetermined alpha level of significance (0.05), and our degrees of freedom (df =15). Situating the Chi square distribution table at 15 degrees of freedom and reading along the row we find that the value of χ^2 (225.6) is above the critical value 24.996. Since our calculated value of χ^2 = (225.6), is far above the critical value of 24.996, we can then discard the null hypothesis that; i uncertainties in temperature and rainfall patterns has not influenced food productivity in Tubah Sub-division and retain the alternative which states that; uncertainties in temperature and rainfall patterns has largely influenced food productivity in Tubah Sub-division.

The first specific objective was aimed to find out how uuncertainties in temperature and rainfall patterns influences food production in Tubah Sub-division. Rainfall is becoming very unreliable while food crop production is drastically affected as crop production in this area is rain-fed. This has seriously led to a fall in agricultural output. During field survey and investigations, it was revealed that variations in temperature and rainfall has led to uncertainties in rain fall as farmers are witnessing the late on set and early cessation of rains. Therefore, implying climate variation affects the agricultural calendar, land quality, farming activities, food production and yields. Changes in the quantity and quality of food due climate variation impact on cultural values of food in Tubah, making people stay hungry even when some other food stuffs are available.

Research hypothesis 2

This hypothesis attempts to establish a link between temperature and rainfall variation on food availability and food accessibility in Tubah Sub-division. The responses of the respondents paved the way for the verification and validation of the hypothesis. Its crystal clear that variation in temperature and rainfall is affecting food production which has pushed the people of Tubah to use fertilizers in other to boost productivity. Although the use of fertilizers has bogged down the quality of food. As observed by this study that the taste of food is changing which is affecting the people of Tubah's feeding habits and their level of food security as a result of seasonal variation. In order to verify this assertion, the responses of the respondents were exploited (Table 32).

Table 32: Respondents' perceptions on food available due to temperature and rainfall variation and its influence on the use of fertilizers on staple food

Number of villages	**Number of respondents**	**Has variations in temperature and rainfall influenced food availability and accessibility of food which has led to the use of fertilizers ?**			**What is the effect of fertilizer on the quality of food and your feeding habits?**		
		YES	NO	No Idea	**Change in taste**	**Increases the rate of decay**	**Too soft**
Bambui	63	39	2	4	30	12	3
Bambili	45	48	5	9	42	20	1
Big-	27	9	0	3	10	2	0
Small	13	19	2	6	15	10	2
Sabga	10	10	0	3	7	4	2
Fingi	12	7	1	2	6	2	0
Total	170	**133**	**10**	**27**	**110**	**50**	**8**
%	100	**78.2**	**5.9**	**15.9**	**64.7**	**29.4**	**4.7**

Source: Field work, November, 2020

Contingency table

Observed values(O)	Expected values(E)	O-E	O-E²	$\frac{(O-E)^2}{E}$
39	9.3	28	784	84.3
2	9.3	-7.3	53.3	6
4	9.3	-5.3	28	3
30	9.3	21	441	47.4
12	9.3	3.3	11	1.2
3	9.3	-6.3	40	4.2
48	9.3	39	1521	163.5
5	9.3	4.3	18.5	2
9	9.3	-0.3	0.09	0.01
42	9.3	33	1089	117
20	9.3	11	121	13
1	9.3	-8.3	69	7.4
9	9.3	-0.3	0.09	0.01
0	9.3	-9.3	86.5	9.3
3	9.3	-6.3	40	4.2
10	9.3	1.3	2	0.2
2	9.3	-7.3	53.3	6
0	9.3	-9 .3	86.5	9.3
19	9.3	10.3	106	11.4
2	9.3	-7.3	53.3	6
6	9.3	-3.3	11	1.2
15	9.3	6.3	40	4.2
10	9.3	1.3	2	0.2
2	9.3	-7.3	53.3	6
10	9.3	1.3	2	0.2
0	9.3	-9.3	86.5	9.3
3	9.3	-6.3	40	4.2
7	9.3	-2.3	5.6	0.6
4	9.3	-5.3	28	3
2	9.3	-7.3	53.3	6
7	9.3	-7.3	53.3	6
4	9.3	-5.3	28	3
2	9.3	-7.3	52.3	6
7	9.3	-2.3	5.3	0.6
1	9.3	-8.3	69	7.4
2	9.3	-7.3	86.5	9.3
6	9.3	-3.3	11	1.2
2	9.3	-7.3	53.3	6
0	9.3	-9.3	86.5	9.3
				∑ 556.42

Source: Table 28 based on Chi Square statistics

$$x^2 = \frac{(O-E)^2}{E}$$

Chi square value = 556.42

Degree of freedom (df)= (c-1) (r-1) = (6-1) (6-1) =5×5 = 25

Null Hypothesis (Ho): Temperature and rainfall variations has not influenced the availability and accessibility of food in Tubah Sub-division.

Alternative hypothesis (Ha): Temperature and rainfall variations has influenced the availability and accessibility of food in Tubah Sub-division.

Considering our chi square statistic (x^2 = 556.42), which is the calculated value, our predetermined alpha level of significance (0.05), and our degrees of freedom (df =25). Situating the Chi square distribution table at 25 degrees of freedom and reading along the row we find that the value of x^2 (556.42) is above the critical value 37.652. Since our calculated value of x^2 = (556.42), is far above the critical value of 37.652, we can then reject the null hypothesis that; Temperature and rainfall variations has not influenced the availability and accessibility of food

in Tubah Sub-division. Since this has influenced the use of fertilizers which affects the taste of food, feeding habits and food security in Tubah Sub-division. and retain the alternative which states that; Temperature and rainfall variations has not influenced the availability and accessibility of food in Tubah Sub-division.

The second specific objectives had as the main goal to evaluate the impact of temperature and rainfall variations which has influenced the availability and accessibility of food in Tubah Sub-division. During field investigation and survey, it was reviled that climate variation has hindered the constant availability and accessibility of food. This has however influenced the use of fertilizers on crop production which is affecting the taste of staple food. This has given room to a diverts variety of food and creating a shift in in cultural meal of the people (changes in food preference) creating the problem of food insecurity. Although, this is as a result of the non-availability and accessibility of quality food which satisfy their cultural values due to the effect of climate variation. There by making some people to go food insecure at any time of the year while the magnitude and effect of food security is getting worst.

Hypothesis 3

This hypothesis sets out to assess the relationship which exist between seasonal variation in Tubah Sub-division and food insecurity (the problem of food instability). The responses of the respondents on the affordability of food paved the way for the verification and validation of the hypothesis. In a society where agricultural production is characterized by the use of fertilizers to boost productivity, rise in food prices is inevitable due to seasonal variations which often results to low yields. Even though, other factors do account for food insecurity in Tubah Sub-division. In order to verify this assertion, the responses of the respondents were exploited (Table 33).

Table 33: Respondents' view on seasonal variations and food insecurity in Tubah Sub-division

No	Villages	No of respondents	Have seasonal variations brought about instability in food which is influencing food insecurity ?		If yes what is the general trend of prices of food stuffs in Tubah Sub-Division?		
			Yes	No	High	Medium	Low
1	Bambui	45	39	6	27	11	7
2	Bambui	63	47	16	31	17	15
3	Finge	12	9	3	7	4	1
4	Sabga	27	18	9	10	10	7
5	Kejukekum	13	10	3	4	5	4
6	Kejume ketinguh	10	7	3	3	3	4
	Total	170	130	40	82	50	38
	%	100	76.5	23.5	48.2	28.2	23.6

Observed values(O)	Expected values(E)	O-E	O-E²	$\frac{(O-E)^2}{E}$
39	11	28	784	71.3
6	11	-5	25	2.3
27	11	16	256	23.3
11	11	0	0	0
7	11	-4	16	1.5
47	11	36	1296	118
16	11	5	25	2.3
31	11	20	400	36.4
17	11	6	36	3.3
15	11	4	16	1.5
9	11	-2	4	0.4
3	11	-8	64	6
7	11	-4	16	1.5
1	11	-10	100	9.1
18	11	7	49	4.5
9	11	2	4	0.4
10	11	-1	1	0.09
10	11	-1	1	0.09
7	11	-4	16	1.5
10	11	-1	1	0.09
3	11	-8	64	6
4	11	-7	49	4.5
5	11	-6	36	3.3
4	11	-7	49	4.5
7	11	-4	16	1.5
3	11	-8	64	6
3	11	-8	64	6
3	11	-8	64	6
7	11	-4	16	1.5
				$\sum$ 238

Source: Table 30 based on Chi Square statistics

$$x^2 = \frac{(\mathrm{O} - E)^2}{\mathrm{E}}$$

Chi square value = 238

Degree of freedom (df)= (c-1) (r-1) = (5-1) (6-1) =4×5 = 20

Null Hypothesis (Ho): There exist no direct relationship between food insecurity and seasonal variation in Tubah Sub-division.

Alternative hypothesis (Ha): There exist no direct relationship between food insecurity and seasonal variation in Tubah Sub-division.

Our chi-square statistic (x2 = 143.03), which is the calculated value, our predetermined alpha level of significance (0.05), and our degrees of freedom (df =10). Situating the Chi-square distribution table at 10 degrees of freedom and reading along the row, we find that our calculated value of x2 (238) is above the critical value of 31.410. Since our calculated value of x2 = (238), is far above the critical value of 31.410, we can then reject the null hypothesis that: There exists no direct relationship between food insecurity and seasonal variation in Tubah Sub-division and retain the alternative which states that: There exists no direct relationship between food insecurity and seasonal variation in Tubah Sub-division.

The third specific objective was to examine how seasonal variation has influenced food insecurity in Tubah Sub-division. So as to also identify other factors which are contributing to an increase in income spent on food by households. While examining the effects of an increase in food prices and its implications on the cultural value of food in Tubah Sub-division.

Conclusion

Statistics show that both human and physical drivers are responsible for the changing climatic conditions in Tubah Sub-division. Some indicators such as shorter rainy seasons, unpredictable weather events are some of the evidences of varying climatic conditions responsible for these changes. A comparative analysis on perceived rainfall and temperature trend reveals that in the period 1980-2020 this Sub-Division has witnessed a certain degree of climate variation. Because this period has been marked by increasing temperature and a fall in rainfall patterns as perceived by the sampled population. While the analysis on the actual climatic variation shows an increase in monthly rainfall. Even though there has been a slight fall in the inter-annual rainfall by a factor of R2 =0.0464 from the period 1963-2018. Also, the inter-annual anomaly for Tubah Sub-division indicates a decline in rainfall pattern by a factor of R2 =0.0429 which the study attributes it to prolong dry season. Furthermore, a standardized precipitation index for this area was established to measure the precipitation anomaly and, it was further divided into decades to get the decadal SPI trend. The treatment shows that the first two decades witnessed an increase in precipitation followed by, 5 decades characterised by decreasing precipitation trends. This, therefore, indicates an uncertainty in rainfall pattern in Tubah Sub-division which seriously affects agricultural systems and food security. Declining rainfall trend negatively affects crop production trends, which tends to affect all aspects of food security (Tume et al.,2020). Knowledge from the study through the unanimous responses of respondents revels farmers make use of fertilizers to boost productivity so as to ensure food availability in other to stay food secured.

The tail end of these fertilizers is that it affects the taste of most staple food and its costly. This however gives room for the study to closely examine the degree of food security in the community of Tubah. As they still face the issue of consistency in production over time. In addition, there is no specific timing for food insecurity as many tend to run food insecure at any time of the year creating room for adjustment by household to avoid food shortages. Though to an extent, climate variation has brought about a boost in agricultural output through the use of fertilizers, it has also increased food prices making food not very affordable for all. Making matters worse is the fact that the net income of most people remains constant while food prices inflate as attested by respondents. Although, other factors equally contribute to food insecurity

such as; urbanisation and political unrest. Making households change the amount of income spent on food however, several adaptation strategies have been adopted by farmers in the various communities in Tubah to cope with the impact of climate variation on food security.

SUGGESTIONS AND RECOMMENDATIONS OR WAY FORWARD

There is need to properly address the issue of climate variation which affects the various aspects of food security in Tubah Sub-division. By, distressing consistency, production, availability, and affordability of staple food, leading to perturbation in the cultural value of food. While development takes its cause through changes in land uses and land cover as the study shows that agricultural land use has reduced. Whereas settlements have increased implying a reduction in agricultural output with increase in population making many changes in the percentage of income spent on food. Due to an increase in food prices owing to a decline in agricultural output making the timing of food insecurity unpredictable, it can occur at any time of the year. This is highly influenced by the unreliable patterns in rainfall which have created a drop in the trend of food cultivation. While influencing the use of foreign chemicals with the intention of increasing food production and to ensure a steady supply and access to food for the fast-growing population on crop production. However, data collected analysed and prosed revealed these chemicals affects the taste of staple food worsening conditions of food insecurity in the community of Tubah. Moreover, the ongoing crisis in the NWR is seen to be a contributing factor to food insecurity in Tubah Sub-division. The field coordinator of WFP for central Africa during a visit in Bamenda, reported to the CRTV news on the 23rd of October that the NWR is suffering from food insecurity. It is therefore for this reason that; a plethora of suggestions are necessary to all stakeholders involved in the agricultural sector and traditional rulers of Tubah Sub-division.

Local-level

Creating a good synergy by strengthening relationships with agricultural technicians, NGOs, and other associations or stakeholders concerned with agriculture is very vital to overcoming issues of climate variation. This may help bring several heads to reason, view from the same spectrum and come up with adaptation measures which takes into account unintended negative consequences and explicitly look at the cross-scalar, and long-term impacts of adaptation actions. This will however help to come up with strategies that are very much applicable to the area of interest both in the short term and in the long term. Because, the problem of climate variation cannot be solved by one person but multiple actors ranging from the national level right down to the local population. When relationships are strengthened, it makes it easy for information to easily spread across the zone. Through the establishment of a

good communication and feedback mechanism making it easy for measures to be easily spread across to famers and it return makes it easy for actors to get feedbacks from farmers. Also, it makes it very easy for each stakeholder to benefit from technical, materials, and financial support to cope with climate variation in Tubah Sub–division. By so doing building resilience for poor famers and those in vulnerable situations by reducing their exposure and vulnerability to climate related extreme events and other economic, social and environmental shocks preventing the people from attaining food security.

This study equally suggests that capacity building and skills should be encouraged among farmers. It will help ensure sustainable food production systems and implement resilient agricultural practices which increases productivity and production, help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters which may arise in the long term and that progressively improve land and soil quality. Thereby helping to end hunger, achieve food security and improved nutrition and promote sustainable agriculture which is in line with the 2030 Agenda for Sustainable Development (2015) For instance, encouraging farmers to regroup themselves into common initiative groups and other farm associations would help reduce cost of production and losses enquired by individual farmers. Particularly during poor harvest, and might go a long way to promote large-scale farming instead of peasant farming. Thereby ensuring food consistency because of the availability of resources as most farmers complained of lack of resources to cope with climate change.

Creating room for more education to understand the dynamics of climate change and reinforcing climatic stations will go a long way to reduce the dilemmas associated with uncertainties in rainfall patterns. According to what this study obtained from the field on the sources of information on climate variation and the level of education of farmers, it is suggested that more advantages should be added to educated farmers to follow short training on the science of climate variation. This will help to easily educate the other farmers on the notion of climate variation and the use of agrochemicals on crops as education is a powerful strategy to accelerate changes in the way we produce and consume food.

Also integrating and design new education modules from primary, secondary to tertiary education could help overcome the challenge of climate variation, food security and the use of foreign chemicals on food. By so doing, knowledge gaps can be filled and greater trust established in shifting behavior of individuals to be more sustainable right from the base. While institutions in charge of collecting climatic data should be well equipped with the necessary equipment needed to collect daily climatic data and qualified staves. Who will be able to treat the data properly and deliver it to farmers on time via their common initiative leader. This will

go a long way to keep farmers on track and help avoid the dilemma of when to actually carry-on farming activities while reducing losses and the issue of double planting by peasant farmers caused by environmental changes.

Although the use of fertilizers in crop production has brought about a bountiful harvest, analysis from survey instruments shows that it negatively affects food base on the perceptions of respondents. Therefore, there is a need for the sensitization of farmers on the proper usage of fertilizers as majority of those involved in the farming sector are uneducated. If farmers are well educated on the use of fertilizers and their effect on food more room will be given to adaptability to preserve their cultural values. Also, the SD-DARD for Tubah should encourage farmers to carry on organic farming thereby limiting the use of fertilizers in crop cultivation.

Furthermore, the issue of conservation of food staples as identified by respondents due to the effect of fertilizer could be overcome by upgrading post-harvest processing facilities such as that of IRRAD and opening new ones at the disposal of farmers. This will be of vital importance to ensure and enhance food security by limiting wastage and increasing the supply of food while reducing income spent on food staples. For example, what is observed in Yaoundé and Douala with the construction of warehouses and conservation rooms for perishable agricultural products such as cassava, cocoyam, and solanum potato. Local authorities in each of the 6 communities in Tubah can equally crate their own warehoused in line with their various staple food where locally cultivated crops corresponding to those food staples can be harvested and preserved there by ensuring consistency and availability.

In other to overcome the issue of rising food prices due to climate change and urbanization, the council could own large farms lands just like the experimental farms of IRRAD where crops can be cultivated on a large scale and sold to the local population at relative prices. This will go a long way to ensure consistency in food, the availability of food for all and increase the livelihood of the people. Moreover, the government should give subsidies to farmers as they often do. This could help reduce the cost of production and help them better adapt to changing environmental conditions and their effect on crop yields.

To help overcome the issue of cultural diversity and to better promote the local meals of Tubah Sub-division, the council can step in through the help of various local authorities in the community of Tubah to come up with local food shows. This will serve as a means to sensitize the local population on the importance of their cultural roots and to educate the young people on their cultural values. Also, the creation of local food restaurant should be encouraged and supported by the council where all those involved in this type of business are identified and registered under a common platform.

Urbanization brought about an increase in population and rising food prices in other to address this challenge observed in the field, the council should come up with a plan for the area. Whereby each land cover is defined according to it functions and more priority should be given to agricultural functions.

BIBLIOGRAPHY

Adejuwon, J.O. (2005). Food crop production in Nigeria: Present effect of climate variation. *Climate Research, inter-Research*, Germany. pp 481-492.

Aeberhard, A. and Risto, S. (2008). Trans disciplinary co-production of knowledge in the development of organic agriculture in Switzerland, Ecological Economics, doi:10.1016/j.ecolecon.

Agba, D. Z., Adewara, S. O., Adama, J. I., Adzer, K. T., Atoyebi, G. O. (2017). Analysis of the effects of climate change on crop output in Nigeria. *American Journal of Climate Change*, Vol6, pp 554–571.

Amawa, S.K. (2001). Variations on the Spring Discharge on the Mbum Plateau (North West Provence of Cameroon). *Reading in Geography*. Unique printer Bamenda. pp 127-141.

Amawa, G., Kimengsi, J., Sunjo, E., Awambeng, T., Azieh, E. (2015). The Implications of Climate Variation on Market Gardening in Santa Sub-Division, North West Region of Cameroon. *Environmental and Natural Resource Research*.v5n2p14.

Anuforom, A.C. (2004). Rainfall Variation and its Impact on Yield of Millet and Yam in Nigeria. *Presented at the 30th International Post Graduate course at the WMO Regional Training Center*, Best-Dagan, Israel

Ayanlade, E. (2009). Inter –annual Climate Variation and Crop Yield Anomalies in Middle Belt of Nigeria. Presented at the 30th International Post Graduate course at the WMO Regional Training Nigeria,*Geeo Journal* pp 452-465. Nigeria.

Ayansina and Ogunbo, S. (2009). "GIS approach in assessing seasonal rainfall variation in Guinea Savanna part of Nigeria." In *Proceedings of the In 7th FIG regional conference*, vol. 16, pp 282-296 Vietnam, DOI:10.1108

Badolo, F and Somlanaré, R. (2019). Climatic Variation and Food Security in Developing Countries. *Journal of food security*, Vol 7 Pp109-114DOI10.12691/jfs-7-4-2.

Boko, M., Niang.I., Nyong, A., Vogel, A., Githeko, A. (2007). Africa Climate Change 2007: Impacts, adaptation and vulnerability: Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. *Cambridge University Press*

Boxster, J. and Eyes, J. (1997) Evaluating Qualitative Research in Social Geography: establishing rigour in interview analysis and transactions. Institute of British Geography.pp;505-525

Chabejong,E. (2016). Food Security and Malnutrition in the Sahel Region of Cameroon. *A Review on the Impact of Climate Change* ,chapter9 Pringer International publishing ,DOI: 10.1007/978-3-319-24660-4_9

Christensen, J.H., Heswitson, B, T., and Alley, R. (2007). The physical science basis: Working group I contribution to the fourth assessment report of the IPCC. *Cambridge University press* vol 4

Clifford, N., Shaun, F., Gill, V. (2010). Key Methods in Geography. SAGE Publications Ltd, 1 Oliver's Yard.55 City Road, London. Second Edition.Pub.554pp

Crany, M. (2001). Making Sense of Group Interviews. In M. Limb and Dwyer C.(eds). Qualitative Methodology for Geographers. London: Oxford University press, PP.215-233

Demirba, N.and Atis, E. (2005). "Evaluation of food security problem for wheat case in Turkey's agriculture." *Ege University Journal of Agriculture Faculty*. No 42: pp179-190

Downing, T. (1992). Climate Change and Vulnerable Places: Global Food Security and Country Studies in Zimbabwe, Kenya, Senegal, and Chile. *Environmental Change Unit, University of Oxford,* United Kingdom pp. 54

Ehrlich, A., and Ehrlich. P. (2009). "The Population Bomb: Revisited". *The Electronic Journal of Sustainable Development* 1(3) 63-71.

Enchaw, G. B., and Tchawa, P. (2020). Cultivating gender insensitive land tenure reforms and harvesting food insecurity in Cameroon, Sub-Saharan Africa. *African Journal of Land policy and Geospatial Sciences.* (AJLP & GS). Special Issue-Conference on Land Policy in Africa. Vol 3, No 1. pp 67-79, ISSN: 2657-2664.

Enchaw, G. B., and Fombe, L. F. (2020). Women at The Interface of Urban Food Systems in Sub-Saharan Africa:Case Study Of Yaounde-Cameroon. In *Annals of the Faculty Arts, Letters and Social Sciences of the University of Yaounde I*. N°21, *Nouvelle série* 2020. pp 231-253. ISBN 978-9966-450-26-8.

Enchaw, G. B. and Nfor, D. M. (2020). The small farmer infrastructural incentive imbroglio in rural Cameroon. In ASRIC Journal on Agricultural Sciences, Vol.1 No 1. Pp 43-57. African Scientific Research and Innovation Council (ASRIC) Plot 114 Yakubu Gowon Crescent Asokoro Abuja, Nigeria

Fox, L. and James, H. (1958). Criteria of Good Research. Phi. *Delta Kappa International*.Vol.39, No6.Pp284-286

Funk, C., Harrison.l., Catherine.P., Galu.G., Korecha.D.(2009). Examining the role of unusually warmIndo-pacific sea-surface temperatures in recent African droughts. Quarterly Journal of Royal Meteorological Society. DOI: 10.1002/qj.3266

Fraser, D., Legwengoh, F., Bahadur.K.O.(2015). Dietary Changes Increase the Propensity of Food Riots? *An Exploratory Study of Changing Consumption Patterns and the Inclination to Engage in Food-Related Protests Sustainability* ,Academic Open Access Publishing Vol 7(10), 1411214132; https://www.doi.org/10.3390/su71014112

Freedman, P. (1960). The Principles of Scientific Research. (2nd edi) New York. Pergaman pres. 113-221

FAO (2002) Measurement and assessment of food deprivation and under nutrition. *International Scientific Symposium.* 26-28 June, Rome.

Food and Agriculture Organization (FAO), (2006). Policy Brief Food Security. Issue 2. June 2006.

Food and Agriculture Organization (FAO), (2009). The State of Food Insecurity in The World, Economic Crises-impacts and Lessons Learned.

Food and Agriculture Organization (FAO). 2014. www.fao.org, Accessed: 07.08.2020.

https://hdl.handle.net/20.500.12478/1984//June 8//2020

https://doi.org/10.1108/17568691211248739 //July 11//2020

Gerald, N., Rosegrant, M., Jawoo, K., Sulser, T., Tingju, Z., Ringler, C., and Siwa, M. (2009). Climate Change. Impact on Agriculture and Costs of Adaptation. IFPRI, Washington D.C. retrieved from http://www.fao.org/3/w0078e/w0078e05.htm

Glock, S.and Charles, Y. (1961). Survey Research in Social Sciences. New York: *Russel Sage Foundation*.pp543

Government Planning Organization (GPO).(2003). Working Group of National Food and Nutrition Strategy Reports. Ankara.

Government Planning Organization (GPO). (2001) Working Group of National Food and Nutrition Strategy Reports. Ankara.

GopaL, M.H. (1964). An Introduction to Research Procedure in Social Sciences. Bombay: Asia publishing house. ISBN 978-0210270134.pp303.

Haile, M. (2005). Weather patterns, food security and humanitarian response in sub-Saharan Africa. Philosophical Transactions of the Rural Society B: Biological Sciences,360,22169-2182 http://dx.dio.org/10.1098/rstb.2005.1746

Hay, I. (1999). Writing Research Reports in Geography and Environmental Sciences. *Journal of Geography in Higher Education.*pp125-135

Kashaigili, J. J., Levira, P., Liwenga,E., and M. V., Mdemu,E.V.(2014) "Analysis of climate variation, perceptions and coping strategies of tanzanian coastal forest dependent communities," *American Journal of Climate Change*, vol. 03, no. 02, pp. 212–222.

Kurukulasuriya, P., and Rosenthal, S. (2013). *Climate Change and Agriculture: A Review of Impacts and Adaptations*. Environment development paper; No 91. Climate change series. World Bank. https://www.openknowledge.worldbank.org/ handle/10986/16616

Kwarteng, A., Dorvlo, A., and Kumar, G. (2009). "Analysis of a 27-year rainfall data (1977–2003) in the Sultanate of Oman," *International Journal of Climatology*, vol. 29, no. 4, pp. 605–617.

L'economie quotidien (31 March 2021) N°02154. Hausse de prix des denrées alimentaires à Yaoundé et Douala pp3-4

Malthus, T. R. (1826). An essay on the principle of population. John Murray. London, UK.

LobelL, D., Bänziger, M; Magorokosho, C., Vivek, B. (2011). Nonlinear heat effects on African Maize as evidenced by historical yield trials. Article; *Nature Climate Change* 1: pp 42–45.

Lobell, D.B., Schlenker W., Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. *Journal of Environmental Science*.Vol.333, Issue, pp;616-620 DOI:10.1126/science.1204531

Lobell, D.B, Bänziger, M., Magorokosho, C., Vivek, B. (2011) Nonlinear heat effects on African Maize as evidenced by historical yield trials. *Journal of Nature Climate Change* Vol, 1: pp 42–45.

Lobell D.B., Schlenker W., Costa-Roberts J. (2011). Climate trends and global crop production since 1980.*Jornal of Environmental Science.* DOI :10.1126/science.1204531.`

Luc, C., Christopher, L. G, and Kaminski. (2017). Food price seasonality in Africa: Measurement and extent. *Journal Elsevier* DOI: 10.1016/j.foodpol.2016.09.016 67: 119–132.

Mary, A.L, and Majule A.E. (200). Impacts of Climate Change, Variation and Adaptation Strategies on Agriculture in Semi-Arid Areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania Africa. *Journal of Environmental Science and Technology* Vol.3(8), pp 206-218.

Mckee, B.T., Doesken, J.N., kleist.J. (1993). The relationship of drought frequency and duration to time scales. Eighth conference on Applied Climatology 17-22 January, Aneheim, California. Department of Atmospheric Science Colorado State University

Molua, E. L. (2012). "Gendered response and risk- coping capacity to climate variation for sustained food security in Northern Cameroon", *International Journal of Climate Change Strategies and Management*, Vol. 4 No. 3, pp. 277-307.

Molua, E., L. (2002). Climate variability, vulnerability and effectiveness of farm-level adaptation options: the challenges and implications for food security in South western Cameroon. *Journal of Environment and Development Economics* Vol. 7, No. 3 (July 2002), pp. 529-545. Cambridge University Press.

Munang, T., Rivington, M., Gianni, B. (2009). Adaptation assessments for crop production in re-sponse to climate change in Cameroon. *Agron. Sustain. Dev*, 29 (2), pp.247-256.

Murdock, G. (1960). Staple Subsistence Crops of Africa. *Geographical Review, 50*(4), 523-540. doi:10.2307/212308y

Naintoh, B.M., Wantim. M., and Ayonghe, S. (2018). Assessing the impact of climate change and variation on solanum potato potatoes production from 1995-2015 in Tubah Sub-Division, North West Region Cameroon in *Journal of Cameroon Academy of Sciences* 14(2) Pp105.DOI: 10.4314/jcas.v14i2.2

Nakinti . N. (2014). Erratic rains, dry spells destroy crops in Cameroon forcing farmers to replant and pushing up food prices. *Global press journal spatial report*

Njumbe, G., Bidogeza, J., Kamga, R., Fleissner, K., Tenkouano, A., Afari-sefa, V., Rosine, F. (2018). Household perceptions with respect to food security: evidence from the rural-urban continuum in Cameroon ISHS Actaèu Horticulturae 1225: section III. Horticultural Congress. DOI10.17660

Ndoh, I.M. and Bitondo, D. (2019). Crop Yield Response and Community Resilience to Climate Change in the Bamenda Highlands. *American Journal of Biological and Environmental Statistics.* Vol. 5, No. 3, 2019, pp. 31-41.doi: 10.11648/j.ajbes.20190503.11

Nfor, D. M. and Enchaw, G. B. (2019). Embracing Innovative Agricultural Systems and Harvesting Food Insecurity in Rural North West Region of Cameroon. In East African Scholars Journal of Agriculture and Life Sciences, Vol. 2, Issue-12. Pp 557-566.

Ngwega, D.A. (2010). *Farmers' Adaptation to Innovative Strategies in Agriculture: The case study of rural areas of Mezam Division, Cameroon*. An unpublished master 2 dissertation. Geography, FALSS, University of Yaoundé.pp83

Nkengla-Asi, L., Babu, S.C., Kirscht, H., Apfelbacher, S., Hanna, R., Tegbaru, A. (2017). Gender, climate change, and resilient food systems: lessons from strategic adaptation by smallholder farmers in Cameroon. International Food Policy Research Institute Pp01658

Ojuku, T., Enchaw, G.B.and Tsalefac, M. (2010). Climate Change, Impacts and Peasant Farmers Adaptation Strategies In The Western Cameroon High Plateau. Annals of the Faculty Arts, Letters and Social Sciences of the University of Yaounde I. vol. 1, N°11 New series 2010 2nd semester. pp 341-362.

Olesen, E., Trnka .M, Kersebaum ,E.(2011), "Impacts and adaptation of European crop production systems to climate change," *European Journal of Agronomy*, vol. 34, no. 2, pp. 96–112, View at: Publisher Site | Google Scholar

Olimar, M. (2011). Food Security and Population Growth in the 21st Century. E-International Relations

Rashid, K. and Rasul, G. (2010). Rainfall variation and Maize Production over the Potohar Plateou of Pakistand *Journal of Meteorology*,63.74.

Schlenker, W. and Lobell, D.B. (2010). Robust negative impacts of climate change on African agriculture. Environ. Res. Lett. 5 014010 doi: 10.1088/1748---9326/5/1/014010.

Seck, P.A., Toure, A. A., Coulibaly, J. Y., Diagne. A. And Wopereis, M. C. S. (2013). Impact of rice research on income, poverty and food security in Africa: an ex-ante analysis.

Sneyd, Q. (2013).Wild Food, Prices, Diets and Development: *Sustainability and Food Security in Urban Cameroon Sustainability*,5 (11), pp 4728-4759; https://doi.org/10.3390/su5114728

Somlanare, R., Badolo, F., Tajani, F. (2019**).**Does rainfall variation matter for food security in developing countries ?, *Reviewing editor Cogent Economics & Finance*,v7(1), DOI: 10.1080/23322039.2019.1640098

Tchawa, P. (2000). Chains of Innovations by Farmers in Cameroon. ILEEEEIA News Letter, Vol.16 No2, 14-15.

The Guardian Post (25 Febuary2021) Nº 20804 4.9 million Cameroonians facing acute food insecurity. pp8

Thornmton, P. K., Polly. J.E., JchallinoR, M. A. (2014). Global Change Biology, Climate variation and vulnerability to climate change: viewed online at https:// www.doi.org/10.1111/gcb.12581

Tingem, M., Rivington, M., & Bellocchi, G. (2009). Adaptation assessments for crop production in response to climate change in Cameroon. Agronomy for Sustainable(pp.133-148)

Tufoin, K.D. (2020). *The contribution of the motorbike sector to the socio-economic development of the Fundong Sub-Division (North West Region, Cameroon)* An unpublished master 2 dissertation. Geography, FALSS, University of Yaoundé 1. pp38

Tume S.J.P., Squires, V., Gaur, M. (2020). Climate Change and Food Security in the Bamenda Highlands of Cameroon. In: (eds) Food Security and Land Use Change under Conditions of Climatic Variation .

UNFCCC (2015). Physical and socio-Economic Trends in Climate-related Risks and Extreme Event, and their Implications for Sustainable Development, United Nations Framework Convention on climate change, Technical Paper No.3

Von, B. J**.** (1991). Change and commercialization in agriculture: The effect on the poor. The 'world bank research observer. Vol 6 Pp 57-8, https://www.doi.org/10.1093/wbro/6/1/57

Wayne, W. (2019). Behavioral Change Model. Diffusion of innovation theory - SPH - BOSTON UNIVERSITY sphweb.bumc.bu.edu.

Wopereis, M. C. S., Johnson, D. E., Ahmadi, N., Tollens, E., and Jalloh, A. (EDS.), Realizing Africa's Rice Promise. CAB International, Wallingford, UK. pp. 24-33.

Yengoh, G. T., Tchuinte, A., Armah, F. A., and Odoi, J. O. (2010). Impact of prolonged rainy seasons on food crop production in Cameroon. Mitigation and Adaptation Strategies for Global Change, 15, 825–841. doi:10.1007/s11027-010-9241-2

Yong, D. N .(2013) Agriculture and Climate Change in Cameroon: An Assessment of Impacts and Adaptation Options, *African Journal of Science, Technology, Innovation and Development*, 5:1, 85-94, DOI: 10.1080/20421338.2013.782151

What economic theory tells us about the impacts of reducing_Malthusian Theory of Population Intelligent Economist.htm Accessed: 07.08.2021.

Word Health Organization (WHO, 2014), http://www.who.int/trade/glossary/story028/en/, Accessed: 07.08.2021.

https://WWW.doi.org/10.3390/su71014112

https://www.esrl.noaa.gov/gmd/education/info_activities/pdfs/TBI accessed on 07/03/2021 8pm.

APPENDICES

Appendix 1

The Chi Square Statistics

There are basically two types of random variables and they yield two types of data: numerical and categorical. A chi square (X^2) statistic is used to investigate whether distributions of categorical variables differ from one another. Basically categorical variable yield data in the categories and numerical variables yield da0.ta in numerical form. Responses to such questions as "What is your major?" or Do you own a car?" are categorical because they yield data such as "biology" or "no." In contrast, responses to such questions as "How tall are you?" or "What is your G.P.A.?" are numerical. Numerical data can be either discrete or continuous. The table below may help you see the differences between these two variables.

Data Type	Question Type	Possible Responses
Categorical	What is your sex?	male or female
Numerical	Disrete- How many cars do you own?	two or three
Numerical	Continuous - How tall are you?	72 inches

Notice that discrete data arise fom a counting process, while continuous data arise from a measuring process.

The Chi Square statistic compares the tallies or counts of categorical responses between two (or more) independent groups. (note: Chi square tests can only be used on actual numbers and not on percentages, proportions, means, etc.)

2 x 2 Contingency Table

There are several types of chi square tests depending on the way the data was collected and the hypothesis being tested. We'll begin with the simplest case: a 2 x 2 contingency table. If we set the 2 x 2 table to the general notation shown below in Table 1, using the letters a, b, c, and d to denote the contents of the cells, then we would have the following table:

Table 1. General notation for a 2 x 2 contingency table.

Variable 1

Variable 2	Data type 1	Data type 2	Totals
Category 1	A	B	a + b
Category 2	C	D	c + d
Total	a + c	b + d	a + b + c + d = N

Note: notice that the four components of the denominator are the four totals from the table columns and rows.

Suppose you conducted a drug trial on a group of animals and you hypothesized that the animals receiving the drug would survive better than those that did not receive the drug. You conduct the study and collect the following data:

Ho: The survival of the animals is independent of drug treatment.

Ha: The survival of the animals is associated with drug treatment.

Table 2. Number of animals that survived a treatment.

	Dead	Alive	Total
Treated	36	14	50
Not treated	30	25	55
Total	66	39	105

Applying the formula above we get:
Chi square = $105[(36)(25) - (14)(30)]^2 / (50)(55)(39)(66) = 3.418$
Before we can proceed we need to know how many degrees of freedom we have. When a comparison is made between one sample and another, a simple rule is that the degrees of freedom equal (number of columns minus one) x (number of rows minus one) not counting the totals for rows or columns. For our data this gives (2-1) x (2-1) = 1.
We now have our chi square statistic ($x^2 = 3.418$), our predetermined alpha level of significance (0.05), and our degrees of freedom (df =1). Entering the Chi square distribution table with 1 degree of freedom and reading along the row we find our value of x^2 (3.418) lies between 2.706 and 3.841. The corresponding probability is $0.10<P<0.05$. This is below the conventionally accepted significance level of 0.05 or 5%, so the null hypothesis that the two distributions are the same is verified. In other words, when the computed x^2 statistic exceeds the critical value in the table for a 0.05 probability level, then we can reject the null hypothesis of equal distributions. Since our x^2 statistic (3.418) did not exceed the critical value for 0.05 probability level (3.841) we can accept the null hypothesis that the survival of the animals is independent of drug treatment (i.e. the drug had no effect on survival).

Table 3. Chi Square distribution table.

	probability level (alpha)					
Df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

Chi Square Test of Independence

For a contingency table that has *r* rows and *c* columns, the chi square test can be thought of as a test of independence. In a test of independence the null and alternative hypotheses are:
Ho: The two categorical variables are independent.
Ha: The two categorical variables are related.
We can use the equation Chi Square = the sum of all the $(f_o - f_e)^2 / f_e$
Here f_o denotes the frequency of the observed data and f_e is the frequency of the expected values. The general table would look something like the one below:

	Category I	Category II	Category III	Row Totals
Sample A	A	B	C	a+b+c
Sample B	D	E	F	d+e+f
Sample C	G	H	I	g+h+i
Column Totals	a+d+g	b+e+h	c+f+i	a+b+c+d+e+f+g+h+i=N

Now we need to calculate the expected values for each cell in the table and we can do that using the row total times the column total divided by the grand total (N). For example, for cell a the expected value would be (a+b+c) (a+d+g)/N.
Once the expected values have been calculated for each cell, we can use the same procedure are before for a simple 2 x 2 table.

Observed	Expected	|O - E|	$(O - E)^2$	$(O - E)^2 / E$

Suppose you have the following categorical data set.

Table . Incidence of three types of malaria in three tropical regions.

	Asia	Africa	South America	Totals
Malaria A	31	14	45	90
Malaria B	2	5	53	60
Malaria C	53	45	2	100
Totals	86	64	100	250

We could now set up the following table:

Observed	Expected	|O -E|	$(O - E)^2$	$(O - E)^2 / E$
31	30.96	0.04	0.0016	0.0000516
14	23.04	9.04	81.72	3.546
45	36.00	9.00	81.00	2.25
2	20.64	18.64	347.45	16.83
5	15.36	10.36	107.33	6.99
53	24.00	29.00	841.00	35.04
53	34.40	18.60	345.96	10.06
45	25.60	19.40	376.36	14.70
2	40.00	38.00	1444.00	36.10

Chi Square = 125.516

Degrees of Freedom = (c - 1) (r - 1) = 2(2) = 4

Table 3. Chi Square distribution table.

probability level (alpha)

Df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

Reject Ho because 125.516 is greater than 9.488 (for alpha □□□□□□

Thus, we would reject the null hypothesis that there is no relationship between location and type of malaria. Our data tell us there is a relationship between type of malaria and location, but that's all it says.

Appendix 1: Chi square statistical table

DF	0.995	0.975	0.20	0.10	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	0.0000393	0.000982	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.550	10.828
2	0.0100	0.0506	3.219	4.605	5.991	7.378	7.824	9.210	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.860	16.924	18.467
5	0.412	0.831	7.289	9.236	11.070	12.833	13.388	15.086	16.750	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.690	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.180	11.030	13.362	15.507	17.535	18.168	20.090	21.955	24.352	26.124
9	1.735	2.700	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.920	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.300	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32.000	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.790
18	6.265	8.231	22.760	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.900	27.204	30.144	32.852	33.687	36.191	38.582	41.610	43.820
20	7.434	9.591	25.038	28.412	31.410	34.170	35.020	37.566	39.997	43.072	45.315
21	8.034	10.283	26.171	29.615	32.671	35.479	36.343	38.932	41.401	44.522	46.797
22	8.643	10.982	27.301	30.813	33.924	36.781	37.659	40.289	42.796	45.962	48.268
23	9.260	11.689	28.429	32.007	35.172	38.076	38.968	41.638	44.181	47.391	49.728
24	9.886	12.401	29.553	33.196	36.415	39.364	40.270	42.980	45.559	48.812	51.179
25	10.520	13.120	30.675	34.382	37.652	40.646	41.566	44.314	46.928	50.223	52.620
26	11.160	13.844	31.795	35.563	38.885	41.923	42.856	45.642	48.290	51.627	54.052
27	11.808	14.573	32.912	36.741	40.113	43.195	44.140	46.963	49.645	53.023	55.476
28	12.461	15.308	34.027	37.916	41.337	44.461	45.419	48.278	50.993	54.411	56.892
29	13.121	16.047	35.139	39.087	42.557	45.722	46.693	49.588	52.336	55.792	58.301
30	13.787	16.791	36.250	40.256	43.773	46.979	47.962	50.892	53.672	57.167	59.703
31	14.458	17.539	37.359	41.422	44.985	48.232	49.226	52.191	55.003	58.536	61.098
32	15.134	18.291	38.466	42.585	46.194	49.480	50.487	53.486	56.328	59.899	62.487
33	15.815	19.047	39.572	43.745	47.400	50.725	51.743	54.776	57.648	61.256	63.870
34	16.501	19.806	40.676	44.903	48.602	51.966	52.995	56.061	58.964	62.608	65.247
35	17.192	20.569	41.778	46.059	49.802	53.203	54.244	57.342	60.275	63.955	66.619
36	17.887	21.336	42.879	47.212	50.998	54.437	55.489	58.619	61.581	65.296	67.985
37	18.586	22.106	43.978	48.363	52.192	55.668	56.730	59.893	62.883	66.633	69.346
38	19.289	22.878	45.076	49.513	53.384	56.896	57.969	61.162	64.181	67.966	70.703
39	19.996	23.654	46.173	50.660	54.572	58.120	59.204	62.428	65.476	69.294	72.055
40	20.707	24.433	47.269	51.805	55.758	59.342	60.436	63.691	66.766	70.618	73.402
41	21.421	25.215	48.363	52.949	56.942	60.561	61.665	64.950	68.053	71.938	74.745
42	22.138	25.999	49.456	54.090	58.124	61.777	62.892	66.206	69.336	73.254	76.084
43	22.859	26.785	50.548	55.230	59.304	62.990	64.116	67.459	70.616	74.566	77.419
44	23.584	27.575	51.639	56.369	60.481	64.201	65.337	68.710	71.893	75.874	78.750
45	24.311	28.366	52.729	57.505	61.656	65.410	66.555	69.957	73.166	77.179	80.077
46	25.041	29.160	53.818	58.641	62.830	66.617	67.771	71.201	74.437	78.481	81.400
47	25.775	29.956	54.906	59.774	64.001	67.821	68.985	72.443	75.704	79.780	82.720
48	26.511	30.755	55.993	60.907	65.171	69.023	70.197	73.683	76.969	81.075	84.037
49	27.249	31.555	57.079	62.038	66.339	70.222	71.406	74.919	78.231	82.367	85.351
50	27.991	32.357	58.164	63.167	67.505	71.420	72.613	76.154	79.490	83.657	86.661

QUESTIONNAIRE

Dear Respondent,
I am a Master's student in the Department of Geography of the University of Yaoundé I. I am carrying out research on 'The Impact of Climatic variation on Food Security in Tubah Sub-Division'. I assure you of the confidentiality of information provided to be used for academic purposes.

Kindly place a tick (✓) in the appropriate box and provide brief answers where necessary.

Section A: Respondents identification

Identification	Options
Sex	☐Male(1), ☐Female(2)
Marital status	☐Single(1), ☐Married(2), ☐Widowed(3), ☐Divorced(4)
Age group	☐<25(1), ☐26-34(2), ☐36-45(3), ☐46-55(4), ☐55+(5)
Family size	☐1-3(1), ☐4-6(2), ☐7-9(3), ☐10^{+}(4)
Educational level	☐No formal education(1), ☐FSLC(2), ☐GCE O/L(3), ☐GCE A/L(4), ☐University(5)
Village	☐Bambui(1), ☐Bambili(2), ☐Sabga(3), ☐Big Babanki(4), ☐Small Babanki(5)
Occupation	☐Farming(1), ☐Business(2), ☐Teaching(3), ☐Student(4), ☐Bike rider(5), ☐Driver(6), ☐Technician(7), ☐Health personnel(8)

Hypothesis 1: "Unreliable rainfall have largely influenced food production in Tubah Sub-Division''

1. Have you witnessed signs of a changing climate in recent years? ☐Yes(1), ☐No(2), idea(3)
2. Have you noticed any change in rainfall patters in your area? ☐Yes(1), ☐No(2
3. If yes, have these changes affected food production? ☐ Yes(1), ☐No(2
4. If yes, in what ways? ☐ Increase ☐ Reduce
5. Has the period of rainfall change overtime? ☐Yes(1), ☐No(2)
6. If yes, how has it changed? ☐Starts early ☐Starts late ☐ it has become unpredictable
7. In your opinion how is the behavior of the rainy season and dry season as compared to the previous years

Indicators	Yes	No	Don't know
Length of rainy season is reducing			
Length of the dry season is increasing			
Short and intensive periods of rainfall			
We don't know when the rainy season starts			
We don't know when the dry season starts and ends			

7. Does these changes in season affect your agricultural activities? ☐Yes(1), ☐No(2)
8. If yes how do they affect your agricultural activities? ☐late planting (1)☐ Poor yields(2) ☐Wilting of crops(3) ☐ All(4) .

Hypothesis 2: Climate variation have seriously influenced the use of fertilizers which affects the taste of food, feeding habits and food security in Tubah Sub-Division.

9. What are some of the crops you mainly cultivate and why.....

……
…..

10. Have you noticed any changes in crop yields due to changes in seasons?

Crops	Changes (✓)			
	Increase in yield	Decrease in yields	No changes in yields	Not Applicable
Maize				
Beans				
Groundnuts				
Cassava				
Cocoyam				
Solanum potato				
Vegetables				
Other crops				

11.Appert from seasonal variations are other factors contributing to a reduction in crop yields? ☐Yes(1), ☐No(2)

12.Has 10 and 11 above resulted to the use of fertilizers now than before? ☐Yes(1), ☐No(2)

13.What are some of the other reason why people use fertilizers in your area? ☐ To increase output (1)☐ Soils are becoming infertile(2) ☐ All of the above(3)

14.What are some of the food you mostly consume…….

……
….

15.Are these foods contaminated by fertilizers ☐ Yes(1), ☐No(2)

16.If yes have they changed the taste of food? ☐ Yes(1), ☐No(2)

17.If yes in what way? ☐ (1)Change the taste of most crops ☐(2) Increase the rate of decay of most crops (3) ☐Makes crops to be too soft

19. What are your sources of food which helps you to stay food secure?

Source	No	Yes	Not Applicable
Own crop production			
Barter			
Own livestock products			
Purchase			
Wild food collection			
Exchange labour for food			
Hunting			
Steal			
Friends/relatives			
Food at school			
Food at work			
Other food sources			

20.Do you at any time worry that your household will not have enough food or the kind of food you preferred because of seasonal variation ? ☐ Yes(1), ☐No(2)

21.How often do the above problem occur ?

Period	Anytime of the year	Just before month end	Before harvesting	After drought	Any time of the year
Tick (✓)					

21.How do you rate the level of access to food today as compared to five years ago?

Rate	No change (1)	Better (2)	Fair (3)	Worse off (4)
Tick (✓)				

22. What adjustments or possible solutions have you made to avoid food shortages if any or to improve your diet? ☐Reduce the number of meals(1), ☐Do petty trading(2) ☐Receive food grants(3)

Hypothesis3: Climate variation has brought about unstable and high prices on food items in Tubah Sub-Division.

23Have seasonal changes brought about an increase in food price? ☐ Yes(1), ☐No(2)

24.If yes what is the general trend of prices of food stuffs in local markets in Tubah Sub-Division? ☐High(1), ☐Medium(2), ☐ Low(3), ☐No idea(4)
25.How affordable is food in local markets? ☐Very affordable(1), ☐Affordable(2), ☐Not affordable(3)
26. On average, what percentage of your income did you spend on food?

Period	Last month end	Last year	Past five years	Past 10 years
Tick one (✓)	☐5-10% (1) ☐11-☐20% (2) ☐21%+ (3) ☐Don't know (4)	☐5-10% (1) ☐11-☐20% (2) ☐21%+ (3) ☐Don't know (4)	☐5-10% (1) ☐11-☐20% (2) ☐21%+ (3) ☐Don't know (4)	☐5-10% (1) ☐11-☐20% (2) ☐21%+ (3) ☐Don't know (4)

27. What might have contributed to the changes?

Changes	Food price increase(1)	Poor harvests (2)	Low income (3)	High income (4)
Tick one (✓)				

28.Which are some of the activity you do so as to generate income so as to be able to afford food
?.....
.....
.....
29.What are the adaptation measures you use to cope with the effect of climate variation on agriculture? Name 3……

30.What are the major barriers you encounter to implement adaptation strategies? ☐ Inadequate knowledge on adaptation ☐ Lack of information about long-term climate change ☐ Insufficient credit services ☐ All of the above.

31.In your own opinion what could be done to reduce the prices of food crops in your local market ☐Price stabilization(1), ☐Government subsidies(2), ☐Council should produce and sale at low cost(3), ☐All strategies(4)
32.What do you think the authorities of your area can do to ensure food security? ☐Create a council farm(1), ☐Support farmers with inputs(2), ☐Open farm-to-market roads(3), ☐Annual agric shows(4), ☐Provision of subsidies to farmers(5), ☐Encourage crop-specific cooperatives(6), ☐All strategies(7)

THANKS FOR YOUR COOPERATION

Appendix 2: Research Attestation

UNIVERSITE DE YAOUNDE I
UNIVERSITY OF YAOUNDE I

FACULTE DES ARTS, LETTRES ET SCIENCES HUMAINES

DEPARTEMENT DE GEOGRAPHIE
B.P 755 Yaoundé
Tél. 22 22 24 05

FACULTY OF ARTS, LETTERS AND SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY
P.O BOX 755 Yaoundé
Tel. 22 22 24 05

ATTESTATION DE RECHERCHE

Je soussigné, **Pr. PAUL TCHAWA**

Chef du Département de Géographie, atteste que

Mademoiselle: **TAMBIE NGWANGUNU BERTHA**

Matricule: **18Z802**

Est inscrit(e) au cycle de : MASTER II (2018-2019)

Spécialité :Environmental Dynamics and Risks

ET prépare une thèse sur le sujet: **The effects of climate variability on food security in Tubah .**

A cet égard, je prie toutes les ressources et tous les organismes sollicités de lui réserver un bon accueil et de lui apporter toute l'aide nécessaire à la réussite de cette recherche dont la contribution à l'appui au développement ne fait pas de doute.

Fait à Yaoundé le 12 AOUT 2020

LE CHEF DE DEPARTEMENT

Le Chef de Département de Géograp
Université de Bordeaux

Appendix 3: Authorisation from the Regional Delegation of Agriculture

REPUBLIQUE DU CAMEROUN
Paix–Travail–Patrie

MINISTRERE DE L'AGRICULTURE
ET DU DEVELOPPEMENT RURAL

DELEGATION REGIONALE
DU NORD-OUEST

DELEGATION DEPARTEMENTALE
DE LA MEZAM

DELEGATION D'ARONDISSEMENT
DE TUBAH

REPUBLIC OF CAMEROON
Peace-Work-Fatherland

MINISTRY OF AGRICULTURE
AND RURAL DEVELOPMENT

REGIONAL DELEGATION
FOR THE NORTH WEST

DIVISIONAL DELEGATION
FOR MEZAM

SUB DIVISIONAL DELEGATION
FOR TUBAH

Date: 16/12/2020

Ref. No ____SDDARD/T/43

This is to prove that Mrs TAMBIE NGWANGUNU BERTHIE metrical 18Z802 a student from the university of Yaounde 1 has completed her internship at the Regional Delegation of Agriculture and Rural Development, North West Region Bamenda under the supervision of the Sub Divisional Delegate of Agriculture and Rural Development Tubah which started on the 24th of November 2020 and ended on the 14th of December

THE SUB-DIVISIONAL DELEGATE
TUBAH
Bubidi Hilda Limaya
SENIOR AGRICULTURAL TECHNICIAN

REPUBLIQUE DU CAMEROUN
PAIX – TRAVAIL – PATRIE

MINISTERE DE L'AGRICULTURE
ET DU DEVELOPPEMENT RURALE

DELEGATION REGIONALE
DU NORD-OUEST

SERVICE OF ADM. AFFAIRS AND FINANCE

REPUBLIC OF CAMEROON
PEACE – WORK – FATHERLAND

MINISTRY OF AGRICULTURE
AND RURAL DEVELOPMENT

REGIONAL DELEGATION FOR
THE NORTH WEST

Tel. 233363107
P.O.Box 4083

Bamenda, the 24 NOV 2020

The Regional Delegate
Le Délégué Regional

Service Note No 653/86/RDARD/NW/653
Bearing on the posting of **Mrs. TAMBIE NGWANGUNU Bertha, Mle. No 18Z802** a student on internship at the Regional Delegation of Agriculture and Rural Development, North West Region, Bamenda.

Article 1: With effect from the date of signature of this Service Note, **Mrs. TAMBIE NGWANGUNU Bertha, Mle. No 18Z802,** a student from the University of Yaounde I on internship at the Regional Delegation of Agriculture and Rural Development, North West Region, Bamenda is posted to the Sub Divisional Delegation of Agriculture and Rural Development, Tubah for two weeks starting from 24th November, 2020 to 14th December, 2020.

Article 2: The Sub Divisional Delegate for Agriculture and Rural Development, Tubah, shall keep the Regional Delegate of Agriculture and Rural Development informed when the student assume duty.

Article 3: Please ensure that you give her the necessary assistance for the success of the internship.

The Regional Delegate

Fuchi Thomas Tong
Ingénieur d'Agriculture
(Hors - Echelle)

CC

- **DDARD, MEZAM**
- **SDDARD, TUBAH**
- **Student Concerned**
- **File/Chrono**