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Adaptation of Farmers to Climate Variability in Tubah Sub-Division, North West Region of Cameroon

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ABSTRACT

The impact of climate variability on agriculture has significant consequences on livelihoods, food production, and the overall economy of countries, particularly those with agriculture-based economies in the developing world. The study, aims at examining the adaptation strategies put forth by farmers to overcome climate variability in Tubah Sub-Division. The main objective of the study is to investigate how farmers adapt to climate variability impacts in order to improve on agricultural productivity in Tubah Sub-Division. Both primary and secondary data obtained were employed for the study. Data for this study were collected through random sampling. Generated data were presented using frequency tables, percentages and charts. The results showed that agricultural activities in Tubah Sub-Division are predominantly subsistence. Secondly, climate change is not the only challenge to farmers but a combination of factors tends to impact negatively farming activities in Tubah Sub-Division.The study recommends the diversification of agricultural activities as a major response to impacts of climate variability within Tubah Sub-Division.

INTRODUCTION

Adapting to climate variability entails taking the right measures to reduce the negative effects of climate variability by making the appropriate adjustments and changes. The Intergovernmental Panel on Climate Change (2007) defines adaptation as adjustments in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities. It also refers to actions that people, countries, and societies take to adjust to climate variability that has occurred. Adaptation has three possible objectives: to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages and to take advantage of new opportunities. Adaptation to change refers to adjustments of physical, ecological and human systems that increase societies' abilities to cope with the change. Agriculture is particularly sensitive, because it is significantly affected by climate variability through effects on water availability, temperatures, soil processes, pests, pathogens and competitors, which in turn will influence crop productivity at farm level (Turral *et al.,* 2011).

The Food and Agriculture Organization (FAO, 2008) warns that an increase in average global temperatures of just two to four degrees Celsius above pre-industrial levels could reduce crop yields by 15-35% in Africa and western Asia, and by 25-35% in the Middle East . The Intergovernmental Panel on Climate Change says that agriculture contributes 13.5% of global greenhouse gas emissions (IPCC, 2004). According to Greenpeace (2010) if calculating both direct and indirect emissions from the food system, agriculture's contribution could be as high as 32%. (Greenpeace includes all related activities; in addition to agricultural production, they add land use, transportation, packaging and processing.) The future of agricultural production relies on both designing new ways to adapt to the likely consequences of climate variability, as well as changing agricultural practices to mitigate the climate damage that current practices cause, all without undermining food security, rural development and livelihoods.

Agriculture is central to the survival of millions of people in many countries of sub-Saharan Africa. It is the number one provider of employment and livelihood in developing countries. Climate variability is a serious threat to agriculture and food security. Extreme weather conditions and changing patterns of precipitation lead to a decrease in the crop productivity. High temperatures and uncertain rainfall decrease the grain yield of crops by reducing the length of the growing period. Future projections show that temperature would be increased by 2.5°C up to 2050 . The projected rise in temperature would cause the high frequent and prolong heat waves that can decline the crop production. The rise in temperature results in huge reduction in yield of agronomic crops. Sustaining the crop production under changing climate is a key challenge.

Tubah Sub-Division is located between latitude 5° 07'N and 5° 10'N of the Equator and between longitude 10°13'E and 10°20'E of the Greenwich Meridian.It is bounded to the north by Belo Sub-Division, to the west by Bamenda III and Bafut Sub-Divisions, to the south by Ndop Central Sub-Division and to the East by Balikumbat Sub-Division. This sub-division is located about 12 km north-east of Bamenda town, the Regional Capital of the North-West Region of Cameroon (Figure 1). It is made up of four

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main villages; Kejom Keku, Kejom Ketinguh, Bambui and Bambili and covers a surface area of 460.25km[2] with Bambui as the administrative head-quarter The sub-division lies within the sub-equatorial climatic region. As part of the Bamenda Highlands, the relief disposition of Tubah Sub-Division is mountainous. The lowest altitudes in the sub-division is found around 'Fenvang' Valley, which is a stream that separates Bambui and Kejom keku as well as the rice fields of Kejom Ketinguh which lies in the Ndop Plains. The plateau area lies above 1900m and covers half of the study area. Waterfalls are equally common in this area. The soils in Tubah Sub-Division owe their formation from basaltic rock disintegration. The soils range from humid ferruginous soils on the high plateau to alluvial soils in stream valleys. The climate of Tubah Sub-Division is wet and dry savannah type of climate. Rainfall and temperatures vary with altitude. In the highlands and where the mountain forest is still largely intact, rainfall is greatly enforced. This is mainly on highlands where annual rainfall is about 2500-3000mm. The lowland records 1500-2000mm of rainfall a year with peak periods between the months of July and October.

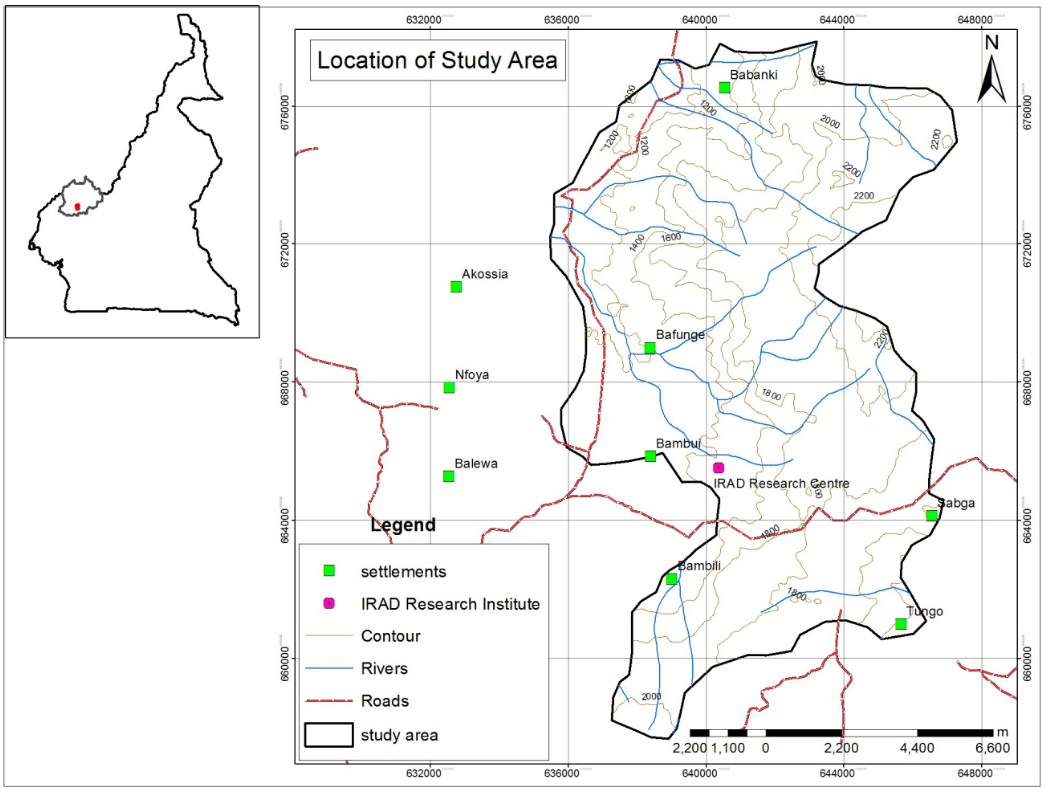

Figure 1: Location of study area
Source: Adapted from Helvetas, (2010)

Problem Statement

Agriculture in Tubah Sub-Division is confronted with the major challenge of increasing production to feed a growing and increasingly prosperous population in a situation of decreasing availability of natural resources and modifications in the climatic patterns. Tubah Sub-Division is an agricultural area with a very important agricultural potential that is linked to favourable natural conditions and diverse farming and pastoral activities. This sub-division is endowed with research and information centres such as IRAD-Bambui, created by Presidential Decree No.56/LF on the 15th of May 1965, the Agricultural School of Bambili and the Presbyterian Rural Training Centre-PRTC Fonta created in 1969 by the Presbyterian Church in Cameroon. These centres are expected to contribute to high agricultural production because of the improved production techniques. There are equally a good number of NGOs that intervene in agricultural activities. This is the case of MIDENO created by Presidential Decree no. 81/350 of 13 Augustin 1981 charged with integrated rural development projects, INADES formation, Swiss Association of International Cooperation, HELVETAS, International Institute of Tropical Agriculture-ITTA, Support Service to Grass Root Initiative for Development-SAILD amongst others. There is high demand for land to meet the dire residential needs, commercial needs, social amenities and socio-economic infrastructures in Tubah Sub-division due to the creation of the University of Bamenda in Bambili. This has exerted pressure on the land resources and created a variety of complex land cover and land use dilemmas and if not controlled can degenerate to environmental crisis coupled with the sporadic floods, droughts and landslides. These potentials were supposed to make Tubah, a

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production basin of the region but it seems not to be the case. The research is therefore interested in examining the adaptation strategies of farmers to overcome climate variability impacts in Tubah sub-Division.It is again this backdrop that this research is carried out and to achieve the following objectives; The main objective of the study is to investigate how farmers can adapt to impacts of climate variability in order to improve on agricultural productivity in Tubah Sub-Division.

Theoretical Framework
The different theories that are closely related to the study are discussed here.

Protection Motivation Theory
Protection motivation theory was founded by R.W. Rogers in 1975 in order to better understand fear appeals and how people cope with them. However, Rogers would later expand on the theory in 1983 where he extended the theory to a more general theory of persuasive communication.

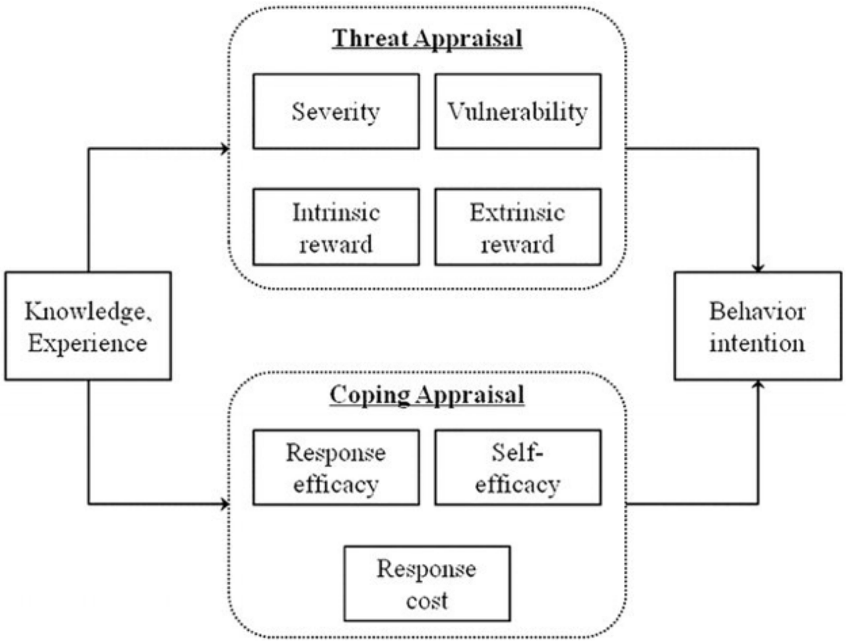

Figure 2: Protection motivation theory
Source: Rogers, R. W. (1975)

The theory consists of three main aspects as indicated on the diagram. These include the Threat-Appraisal Process, Coping-Appraisal Process and the Response Efficacy.

Threat-Appraisal Process
The threat appraisal process consists of both the severity and vulnerability of situation. It focuses on the source of the threat and factors that increase or decrease likelihood of maladaptive behaviours. Severity refers to the degree of harm from the unhealthy behavior. Vulnerability is the probability that one will experience harm. Another aspect of the threat appraisal is rewards. Rewards refer to the positive aspects of starting or continuing the unhealthy behaviour. To calculate the amount of threat experienced take the combination of both the severity and vulnerability, and then subtract the rewards.

Coping-Appraisal Process
The coping appraisal consists of the response efficacy, self-efficacy, and the response costs. Response efficacy is the effectiveness of the recommended behaviour in removing or preventing possible harm. Self-efficacy is the belief that one can successfully enact the recommended behaviour. The response costs are the costs associated with the recommended behaviour. The amount of coping ability that one experiences is the combination of response efficacy and self-efficacy, minus the response costs. The coping appraisal process focuses on the adaptive responses and one's ability to cope with and avert the threat. The coping appraisal is the sum of the appraisals of the response efficacy and self-efficacy, minus any physical or psychological "costs" of adopting the recommended preventive response. Coping Appraisal involves the individual's assessment of the response efficacy of the recommended behaviour (that is, perceived effectiveness of sunscreen in preventing premature aging) as well as one's perceived self-efficacy in carrying out the recommended actions.(that is, confidence that one can use sunscreen consistently). The Threat and coping appraisal variables combine in a fairly straightforward way, although the relative emphasis may vary from topic to topic and with target population.

Response Efficacy
Response efficacy concerns beliefs that adopting a

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particular behavioral response will be effective in reducing the diseases' threat, and self-efficacy is the belief that one can successfully perform the coping response. In line with the traditional way of measuring the consequences of behaviour, response efficacy was operationalized by linking consequences to the recommended behaviour as well as to whether the subject regarded the consequences as likely outcomes of the recommended behaviour.

More recently the Protection motivation theory, appeared in research on environmental risks, natural hazards, and climate change addressing four core elements of the cognitive mediating processes: threat appraisal, coping appraisal, maladaptive coping, and protection motivation Regarding climate variability, these elements are climate variability risk appraisal, adaptation appraisal, and avoidant maladaptation risk perception of climate change, adaptation assessment, maladaptation, and adaptation intention. Other concepts, as belief in climate variability, adaptation incentives/disincentives habit, and subjective norm, are hypothesized to affect the adaptation intention of farmers in response to climate change are analysed in this work. It guided us in determining some constructs in surveying the behaviour of farmers in the study area.

Empirical Literature

Waren (2012) holds that the human impacts on the environment associated with economic growth and development is believed to be the primary cause of global warming. In an illustration by Tsalefac (1999) climate variability and precipitation analysing the inter-annual variation of different rainfall regimes in the western parts of Cameroon, bring out the positive and negative impacts of this on agriculture. Edwin (2011) states that temperature rise enrichment of ambient carbondioxide and variation of total pattern of rainfall distribution change crop environment, thus affecting crop growth and yields of non-irrigated farms. Changaya. (2000) reports that over the past 50 years, temperatures have risen by 0.44oC. Hoffmann U (2013) holds that Climate change is also likely to affect the livestock sector both by affecting the quantity and quality of feed and by affecting the frequency and severity of extreme climate events.

IAASTD (2008); Greenpeace (2008); ITC (2007); OECD (2002); IPCC (2007); IFAD (2008); Pretty (2007); Cline (2007); University of Michigan (2007); Danish Foreign Office (2008); holds that, there is considerable support for organic farming as the best way to mitigate greenhouse gas emissions. Organic agriculture's emissions are generally lower than those of industrial agricultural methods. Although some modes of organic agriculture do not produce yields as high as industrial orchemical agriculture, it is a more sustainable means of cultivating the land. It builds soil quality and uses more diverse cropping systems, which in turn reduces the number of greenhouse gases emitted.The Intergovernmental Panel on Climate Change (IPCC) (2007) states that Agriculture is one of the world's largest industries. Agricultural land alone covers 40-50 percent ofthe world's land surface. The IPCC calls for better cropland, fertilizer and livestock management, as well as enhanced crop diversification, a reduction/elimination of fossil fuel-based fertilizers, a reduction in livestock and the use of better livestock feeds. The IPCC also proposes an increase in agricultural research and development of modes of agriculture, and increased knowledge and technology transfers.United Nations Conference on Trade and Development and United Nations EnvironmentProgramme (2008)notes that Organic farming is not only a more environmentally sustainable alternative to conventional farming but can provide economic, social and cultural advantages as well. This report by the United Nations Conference on Trade and Development (UNCTAD) and the United Nations Environment Programme (UNEP) focuses on organic agriculture in Africa but suggests that its findings could be applied to other countries throughout the world as well.

ECOSOC (2000); Shrybman (2000); World Bank (2008); ICTSD (2008); ICTSD (2008); Earth Policy Institute (2005); Pretty, Ball, Lang & Morisson (2005); ODI (2007); (2007); Shah (2008); Rubin & Tal (2008) reports that Developing Countries, particularly in Africa, are predicted to be the hardest hit by climate change. The World Bank, WTO and other organizations argue that these countries will have to increasingly rely on international trade to secure enough food as their own production levels fall. They ignore the contribution of trading agricultural commodities to increased greenhouse gas emissions. Both trade and industrialized agricultural production are heavily dependent on fossil fuels and therefore increase greenhouse gas emissions and exacerbate climate change. Shrybman, Steven (2000). argues that the ways in which we assess the impacts of agricultural production on climate change need to be changed. Current climate change literature overlooks the combined impacts of trade and agriculture. In the climate change context, mitigation means limiting global climate change by reducing the emissions of greenhouse gases and enhancing their sinks Smit (2002). Adaptation means actions targeted at the vulnerable system in response to actual or expected climate stimuli with the objective of moderating harm from climate change and exploiting opportunities brought about by climate change Fussel HM, Klein R.J (2005).

Adaptation is an essential component of climate impact and vulnerability assessment, and is one of the policy options in response to climate change impacts (Smit B, 1999). Indeed, the important role of adaptation as a policy response by governments has been recognized internationally. Article 4.1b of the United Nations Framework Convention on Climate Change (UNFCCC) states that parties are committed to formulate and implement national and, where appropriate, regional programs containing measures to mitigate climate change and to facilitate adequate adaptation to climate change. The Kyoto Protocol (Article 10) further commits parties to promote and facilitate adaptation, and deploy

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adaptation technologies to address climate change IPPC (2007).

Many potential adaptation options have been suggested for the agrarian community to alleviate expected adverse impacts of climate change. They encompass a wide range of forms (technical, financial, managerial), scales (global, regional, local) and participants (governments, industries, farmers) . Most of these represent possible or potential adaptation measures, rather than ones actually adopted. Climate change impact analyses often assume certain adaptations, although the adaptation process itself remains unclear (Smit B, 1999). There is a need to understand what types and forms of adaptation are possible, feasible and likely; who would be involved in their implementation; and what is required to facilitate or encourage their development or adoption. A necessary first step in addressing these concerns is the identification and characterization of adaptation options in the agrarian community. Effective adaptation to climate change is contingent on the availability of two important prerequisites: information on what to adapt to and how to adapt, and resources to implement the adaptation measures (Fussel, 2005). The collection of information about the vulnerable system and the stressors that it is exposed to, and the transfer of resources to vulnerable societies in order to help them to prepare for and cope with un avoided impacts of climate change are thus necessary elements of a comprehensive climate policy.

METHODOLOGY

Our research is defined by qualitative analysis, interpretivism epistemology and subjectivism ontology. This implies that the researchers depend on the study because in the course of interviewing people and writing their response, it is possible that he influences either in the questions he asks or in the way he interprets their responses.

Given the fact that the study seeks to assess the adaptation strategies put forward by the farmers of Tubah Sub-Division to overcome effects of climate variability in this locality, it is necessary for us to focus on both quantitative and qualitative analysis as research methods of study.

The research sampled 150 farmers from the study area. The sample design appropriate for this study is the non-probability sampling where inclusion criteria consists of only farmers operating within the sub-division. To this effect, Tubah Sub-Division is stratified into Villages. Fifty famers from the villages of kejom Ketinguh, kejom Keku, Bambui and Bambili each were purposively chosen to represent the population of the farmers of the sub-division The choice of these villages is influenced by the accessibility of the target population and equally the huge practice of farming in the different villages.

Primary data collection was acquired directly from participants or respondents in a study or any event through surveys, observations, questionnaires, interviews; whereas, secondary data were acquired from others sources including government publications, websites, internet, newspaper, books, journals articles, internal records, academics journals.

Data were obtained through the admission of a structured self-complete or closed-ended and open-ended research questionnaire to farmers. To ensure the confidentiality of the survey, closed ended questionnaires were distributed among farmers and were collected immediately after completion and placed in secured document in their presence.

The Chi-square test of goodness of fit, Cochran's Q test and the Mac Neymar test were used to analyse data and test the hypotheses.

RESULTS AND DISCUSSION

State of Agriculture in Tubah Sub-Division

Tubah Sub-Division is characterized by the practice of mixed form of agriculture. This includes the cultivation of crops and the rearing of animals. According to the results from the field, 57.37% of the respondent were farmers involved in crop cultivation while 29.08% were involved in animal or livestock rearing. However, 13.55% were involved in mixed farming. The wastes from animal are used in this case for manuring the soil for crops.

The state of agricultural activities in Tubah Sub-Division was observed through a certain number of questions whose results are summarized on the following paragraphs. The field investigation showed that subsistence agriculture is the most common form of farming practiced within the sub-division. 44% of the respondents affirmed to be involved essentially in this form of agriculture where only the excesses are taking to the market. 30 % is engaged in market gardening and 25% only is engaged in commercial farming.

Three categories of crops are distinguished; seasonal, annual and perennial crops with different agricultural calendars. Seasonal crops are crops with a brief vegetation cycle from planting through weeding to harvesting. They include maize, beans, soya beans, groundnuts, Irish potatoes, vegetable and tomatoes. These crops highly follow seasonal variation. Planting begins in March with the beginning of the rains and harvesting takes place after 4-6 months. Land preparation starts immediately for dry season cultivation and the process continues yearly

The second category of crop is the annual crops with a vegetative cycle that ranges from 6-12 months. They include cocoyams, colocasia yams, sweet potatoes, cassava. These crops do not highly follow seasonal variation. But most at times, planting begins in March and last for about 6 months before harvest except Irish potatoes which lasts only for four months. A second planting equally takes place immediately after harvest.

The last series of crops are perennial crop. Their vegetative cycle exceeds one year and include coffee, raffia palm and plantain. Agricultural activities for these crops are spread almost throughout the year as planting and harvesting takes place anytime except coffee whose planting usually takes place between March and April.

The study equally analyses the different methods of

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Table 1: Different Methods of Cultivation in Tubah

Methods of Cultivation	Number of responses per village				Total	Percentage (%)
	Kejom Ketinguh	Kejom Keku	Bambui	Bambili		
Slash and burn	05	05	09	05	24	16
Slash and mulch	09	09	13	12	43	28.66
Market gardening	15	10	12	15	52	34.66
Irrigation farming	10	05	06	10	31	20.6
Total	39	29	40	42	150	100

Source: Field work 2023

cultivation in Tubah Sub-Division. This was basically on how the farmers use the land for his or her livelihood as presented in Table 1.

It was observed that market gardening is taking the lead constituting about 34.66% of methods of cultivation practiced in Tubah today. Irrigation agriculture in Tubah today has made the cultivation of certain crops to be possible throughout the year. Irrigation is also at 20% in rice farms and for cultivation of tomatoes and huckleberry amongst others during the dry season especially in the Uplands of Tubah Sub-Division. These diverse methods of cultivation are also in a way a response to climate variability and helps farmers to maintain production over the years.

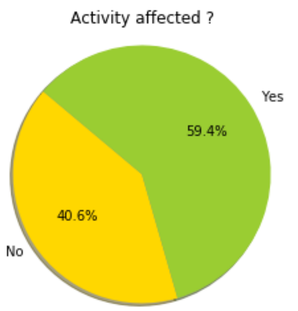

Figure. 3: Activity affected by climate changes
Source : Field Data 2022

Problems Affecting Farmers in Tubah Sub-Division

Before diving into the problems, we were interested to know if the farmers have noticed any change in temperature and rainfall patterns over the years. The responses showed that 63% of farmers have noticed shifts in temperature and rainfall patterns over the years such as rainy season starting late and ending early, relatively increase in temperature amongst others. 36 % claimed they have not noticed changes. This was especially common with young farmers who have not been into the activity for a long time. It was now important for us to find out if the change in the rainfall and temperature patterns have affected the agricultural activity? The results are summarised in Figure 3.

The results indicated that 59% of the farmers' activity is affected by this change in pattern while 40 % is not significantly affected. We sort again to find out the problems faced by farmers of this sub-division in the section that follows.

Problems faced by famers

The study sets out to identify the problems hindering agricultural production in Tubah Sub-Division. The

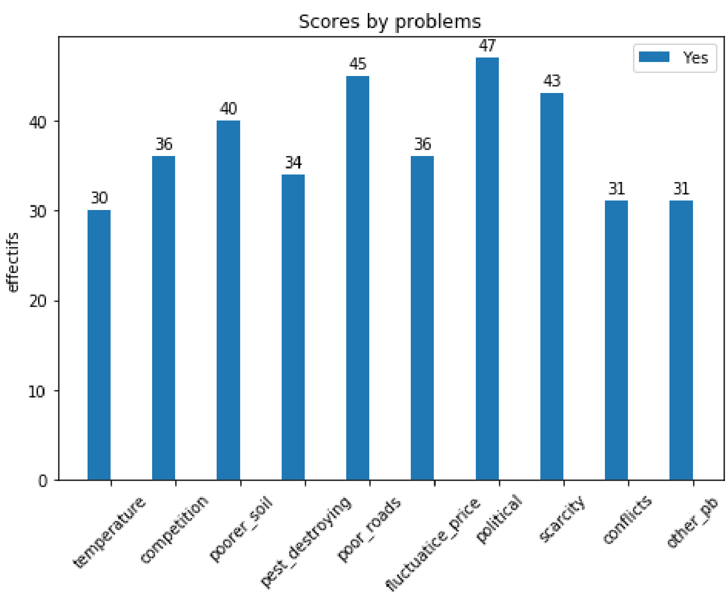

Figure 4: Problems faced by farmers in Tubah Sub-Division
Source:Field data, 2022

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following results were discovered as summarized in the Figure 4.

The problems range from competition, pests, fluctuating prices in the market and political instability amongst others. Political instability is noted as one of the problems due to the anglophone crises that started in 2016 and has disrupted farming calendar and marketing of farming products in the study area. Fluctuation of prices in the market and climate change here noted by temperatures also hinders productivity of the sector.

Climatic challenges

Tubah Sub-Division has a varied climate within its geographic area, given its topography of hills and plains. The highest temperature is registered in the lower parts of Kejom Ketinguh, which lies in the Ndop Plain and Bambui which lies in the plain that extends to Bafut. Bambili and Kejom Keku generally have colder climates including Sabga and the upper parts of Kejom Ketinguh. These climatic variations fit into two distinct seasons- the rainy season that stretches from mid-March to October

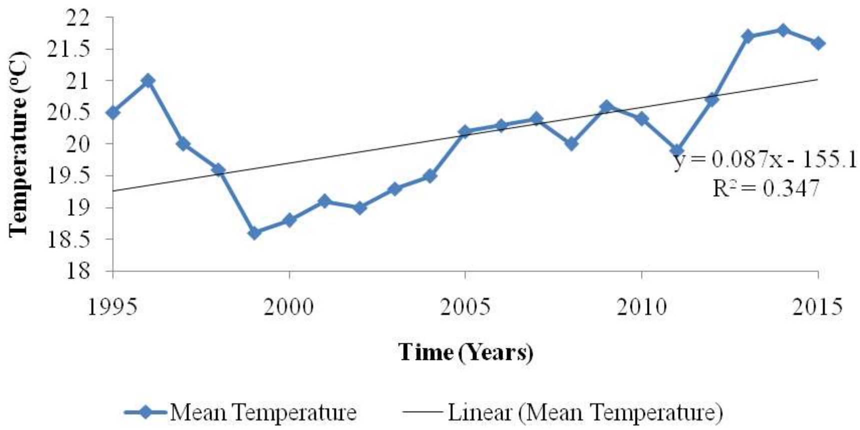

Figure 5: Total mean temperatures Trend in Tubah Sub-Division (1995 – 2015)
Source: Bamenda Airport Meteorological Data 1995-2015

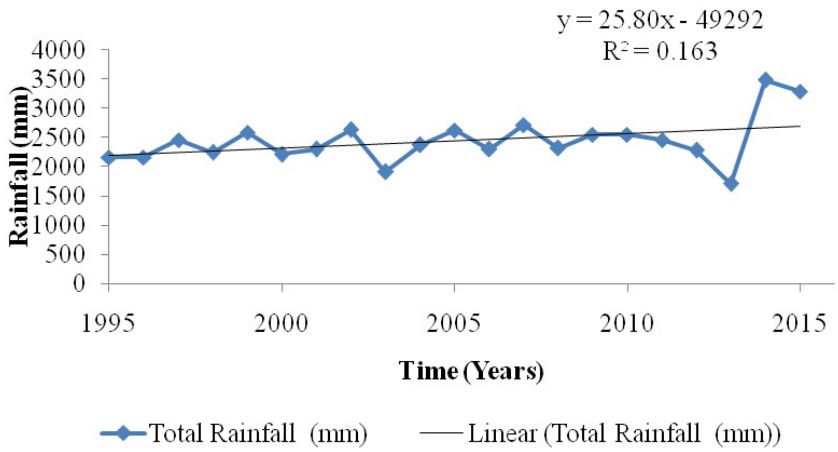

Figure 6: Total Annual Rainfall Trend in Tubah Sub Division (1995 – 2015)
Source: Bamenda Airport Meteorological Data 1995-2015

and is characterized by heavy rains ushered in by the south west monsoon winds. Although places are generally wet during this period, temperatures are relatively warmer (figure 6).The dry season starts from November to mid-March and is marked by the harmattan.Taking into considerationthese two aspects of climate, it was discovered that climate variability is effective in the study area.

Trend analyses of mean annual temperature and total annual rainfall between 1995 and 2015, are presented in Figures 5 and 6 respectively. Mean annual temperature showed an increasing warming trend of about 0.09 0C per year (Figure 5) while total annual rainfall showed an increasing trend of about 25.80 mm per year (Figure 6).

Some of the effects of this variability in climatic conditions are Some of the effects of this variability in climatic conditions are;

Increased Temperatures

Nearly all land areas are seeing more hot days and heat waves. Temperatures in the highland areas of the sub-division such as in the kwighe areas of kejom ketinguh are warmer than before.

Increased Drought

Climate change is changing water availability, making it scarcer in more areas. Global warming exacerbates water shortages in already water-stressed areas and is leading to

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an increased risk of agricultural droughts affecting crops, and ecological droughts increasing the vulnerability of ecosystems. This has affected availability of pasture land and stresses livestock rearing which ids one of the main activities of those in the highland areas of the sub-division.

Not Enough Food

Changes in the climate and increases in extreme weather events are among the reasons behind a global rise in hunger and poor nutrition. Fisheries, crops, and livestock may be destroyed or become less productive. Heat stress has diminished water and grasslands for grazing, causing declining crop yields and affecting livestock within the sub-division.

Adaptation Strategies of Farmers

The figure indicates a number of strategies that farmers of Tubah put in place to combat climate variability.
It was discovered that a number of strategies are used by farmers here. It ranges from diversification of crops and activity, to irrigation, use of organic manure

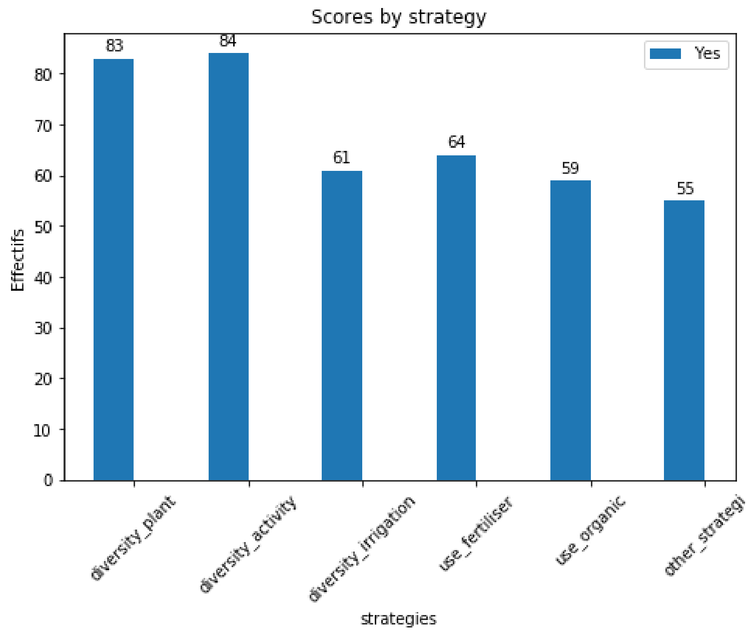

Figure 7: Different adaptation strategies used by farmers against climate variability
Source: Field data 2022

and fertilizers amongst others.These actions are very evident within the sub-division with a gradual shift from cultivation of cereals to market gardening crops such as the babanki njama njama, carrots, onion, tomatoes and so on. Climate change poses a real threat to farmers around the world. Agriculture is highly dependent on good weather, including high and low temperatures, rainfall, wind intensity, and many other variables. Estimates show that climate change might reduce global agricultural productivity by 17% by 2050. For countries highly dependent on agricultural exports, like Cameroon and Tubah Sub-Division in particular, this poses a real problem.Farmers in Tubah Sub-Division are not left out in the diversification race. The farmers here are involved in crop production and livestock amongst others.

CONCLUSION

This section of the work concentrates on the verification of hypotheses and presentation of the findings of the work in a general conclusion.

Verification of Hypotheses

The work started up with three hypotheses. The hypotheses will be tested and confirmed using the statistical techniques Let us start from the first through to the fourth hypotheses.

First Hypothesis

Agricultural activities in Tubah Sub-Division are predominantly subsistence

H_0: Agricultural activities in Tubah Sub-Division are not predominantly subsistence.

H_1: Agricultural activities in Tubah Sub-Division are predominantly subsistence

Agricultural activities is a nominal variable with 3 values (subsistence, market gardening, commercial farming) under the null hypothesis the occurrence of farming of each category is equal to a probability value of 1/3. The expected number of subject in each class is 50, this number is greater than 5. We can use chisquare test for goodness of fit.
To achieve this we use the function scipy.stats.chisquare of python, we choose the risqué $\alpha = 0.05$:
The P-value= $0.015 < 0.05$, we reject the null hypothesis so that the occurrence of subject in each categories is not equal.
We can conclude that Agricultural activities in Tubah Sub-Division are predominantly subsistence.

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importscipy.stats
importscipy
x = (d['type_activity'].value_counts(sort=False))

observed_values = scipy.array([x[1],x[2],x[3]]) # [subsistence, marketgardening, commercial farming]
expected_values = scipy.array([50,50,50]) # [subsistence, market gardening, commercial farming]
scipy.stats.chisquare(observed_values, f_exp=expected_values)

```
Power_divergenceResult(statistic=8.32, pvalue=0.015607557919982827)
```

```
In [8]: import scipy.stats
        import scipy
        x = (d['type_activity'].value_counts(sort=False))

        observed_values = scipy.array([x[1],x[2],x[3]]) # [subsistence, market
        expected_values = scipy.array([50,50,50]) # [subsistence, market garde

        scipy.stats.chisquare(observed_values, f_exp=expected_values)
Out[8]: Power_divergenceResult(statistic=8.32, pvalue=0.015607557919982827)
```

Figure 8: First Hypothesis

Second Hypothesis

The major challenge faced by farmers in Tubah Sub-Division is climate variability

H_0:The major challenge faced by farmers in Tubah Sub-Division is not climate variability

H_1: The major challenge faced by farmers in Tubah Sub-Division is climate variability

Each farmer faced k challenged, and his answer during interviews is binary (yes/no), we want to know if the different challengeshave the same impact or different. We can conduct the Cochran's Q test

H_0 : the problems are equally impacts

H_1: the problems are the different impacts

The subjects are randomly selected we can conduct Cochran's Q test, we select a risq α = 0.05. we use cochrans_.

p-value = 0.02 < 0.05, we reject the null hypothesis so that the problems has different impact. lets consider only 2 problems faced by farmer , climate variability and conflict between farmer.

We have on pairednominal data., so that we can apply Mcnemar test

we apply Mcnemar using contingency_tables.mcnemar of python

The p-value = 1. > 0.05 we fall to reject the hypothesis null, so that climate variability and conflict between

```
from statsmodels.stats.contingency_tables import cochrans_q
d_no = d[d['satisfaction_proceeds']==0]
da = d_no[['temperature_change','competition','poorer_soil','pest_destroying',
      'poor_roads', 'fluctuatice_price', 'political', 'scarcity',
     'conflicts','other_pb']]

print(cochrans_q(da))
```

```
df           9
pvalue       0.0236201998227
statistic    19.1905956113
```

```
In [8]: from statsmodels.stats.contingency_tables import cochrans_q
        d_no = d[d['satisfaction_proceeds']==0]
        da = d_no[['temperature_change','competition','poorer_soil','pest_dest
               'poor_roads', 'fluctuatice_price', 'political', 'scarcity',
               'conflicts','other_pb']]
        #da = d_no[['temperature_change', 'other_pb']]
        print(cochrans_q(da))
        #da.head()

        df           9
        pvalue       0.0236201998227
        statistic    19.1905956113
```

Figure 8: Second Hypothesis

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farmers have equally impact amongst others
We conclude that The major challenge faced by farmers in Tubah Sub-Division is not climate variability.

```
In [11]: from statsmodels.stats import contingency_tables
         group = d_no.groupby(['temperature_change','conflicts'])
         gs = group.size()
         l = [[np.float64(gs[1][1]),gs[1][0]],[gs[0][1],gs[0][0]]]# [yes,yes] [
                                                                  #[no,yes],
         ar=np.array(l)
         ar
         contingency_tables.mcnemar(ar,exact=True).pvalue
Out[11]: 1.0
```

Figure 9: Second Hypothesis

Third Hypothesis

Diversification of agricultural activities is a major response to impacts of climate variability within Tubah Sub-Division.

H_0: Diversification of agricultural activities is not a major response to impacts of climate variability within Tubah Sub-Division.

H_1: Diversification of agricultural activities is a major response to impacts of climate variability within Tubah Sub-Division.

Each farmer can give a binary answer on k strategies to cope of climate change, we want to know if the different strategy is the equal response or different. We can conduct the Cochran's Q test

H_0: the strategies are equal response to impacts of climate variability

H_1: the strategies are unequal response to impacts of climate variability

The subjects are randomly selected we can be conducting Cochran's Q test; we select a risq $\alpha = 0.05$. we use cochrans_q of python.

p-value = 0.0005 < 0.05, we reject the null hypothesis so

```
In [15]: from statsmodels.stats.contingency_tables import cochrans_q
         da = d[['diversity_plant','diversity_activity','diversity_irrigation',
                 'use_fertiliser', 'use_organic', 'other_strategi' ]]
         print(cochrans_q(da))

         df          5
         pvalue      0.000539851317305
         statistic   21.9301470588
```

Figure 10: Third Hypothesis

that the strategies don't have the same impact. considering only 2 strategies used by farmer , diversity of plant and other strategies among (diversification irrigation, use fertilizers, organic manure). In each case, We have on pairednominal data., so that we can apply Mcnemar test we apply Mcnemar using contingency_tables between

```
In [6]: from statsmodels.stats import contingency_tables
        dict1 = {}
        liste =['diversity_irrigation','use_fertiliser', 'use_organic', 'other_
        for elt in liste:
            group = d.groupby(['diversity_plant', elt])
            gs = group.size()
            l = [[np.float64(gs[1][1]),gs[1][0]],[gs[0][1],gs[0][0]]]# [yes,ye
                                                                      #[no,yes],
            ar=np.array(l)
            dict1[elt] = contingency_tables.mcnemar(ar,exact=True).pvalue
            contingency_tables.mcnemar(ar,exact=True).pvalue
        print(dict1)

        {'other_strategi': 0.0033532746580679064, 'use_organic': 0.009682849
        923057575, 'diversity_irrigation': 0.018316097516916346, 'use_fertil
        iser': 0.03953953287797777}
```

Figure 11: Third Hypothesis

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diversifying the number of crops and another,
all the p-value <0.05, we reject the null hypothersis, so that diversity plant is the most response to impacts of climate change. So we can conclude that diversification of agricultural activities is a major response to impacts of climate variability within Tubah Sub-Division.
Summarily we can conclude that:

• Agricultural activities in Tubah Sub-Division are predominantly subsistence.

• Climate variability is not the only challenge to farmers but a combination of factors tends to impact negatively farming activities in Tubah Sub-division.

• Diversification of agricultural activities is a major response to impacts of climate variability within Tubah Sub-Division.

Perspectives and policy implication of the study

Integrated systems can also provide adaptation benefits. Research has showed integrated systems can make farms more resilient for every component analyzed: they can improve the local micro-climate by reducing local temperature and increasing precipitation and water availability; reduce the impact of extreme weather events on crops, livestock and other products; reduce soil erosion; improve productivity; and provide additional socio-economic benefits by increasing the number of products farmers can produce for subsistence or to sell.

Rehabilitation of degraded pastures also provides climate adaptation benefits, including reduced local temperatures, increased air humidity, better resistance against heatwaves and drought and more resilience against natural disasters. It also has a positive effect on soil erosion and water availability.

Agroforestry systems are an important tool for climate change adaptation in agriculture. The working paper finds that agroforestry produces adaptation benefits for local climate, including reducing the impact of five types of extreme weather events evaluated by the study (drought, heatwaves, cold waves, heavy rain and floods), improving soil and water availability, attracting pollinators and improving biodiversity.

Trees planted sustainably offer environmental benefits---such as capturing greenhouse gases and protecting the soil---as well as the potential for economic gain through the commercialization of timber and non-timber forest products

Sustainable agricultural production requires the full participation of rural female farmers, and therefore mechanisms need to be in place to facilitate the communication process and allow the voices of rural farmers to be heard. The challenges in rural areas will be to improve the accessibility of information especially concerning climatic data and to increase the quality and quantity of information to be exchanged.

To ensure the relevance of research centres of Tubah, information on climatic data and its effects on new agricultural technologies and market information should be repackaged in a format and language appropriate for rural women and affordable.

REFERENCES

Ajadi, B. S., Adeniyi, A., & Afolabi, M. T. (2011). Impact of climate on urban agriculture: case study of Ilorin City, Nigeria. *Global Journal of Human Social Science, 11*(1), 12.

Bellarby, J., Foereid, B., Hastings, A. F. S. J., & Smith, P. (2008). *Cool Farming: Climate impacts of agriculture and mitigation potential.*

Cline, W. R. (2007). Global warming and agriculture: Impact estimates by country. *Peterson Institute.*

Cochran, W. G. (1950). *The comparison of percentages in matched samples. Biometrika, 37*(3/4), 256-266.

Edwin P. (2011), Human activity, the main driving force behind climate variability and change. *The New York Time Magazine,* 12

Field, C. B. (Ed.). (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change.* Cambridge University Press.

From Climate Change (2007). *Chapter 8 "Agriculture." Intergovernmental Panel on Climate Change (2007):* www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf (accessed June 11,2023).

Hoffmann, U. (2013). Section B: Agriculture: a key driver and a major victim of global warming. *Lead article, in,* 3-5.

Molua, E. L. (2007). The economic impact of climate change on agriculture in Cameroon. *World Bank Policy Research Working Paper,* (4364).

Ndenecho, E. N. (2006). Sustaining Mountain Environments and Rural Livelihoods in Bamenda Highlands, Cameroon: *Mountain Geography and Resource Conservation.* Unique Printers.

Organic Agriculture Can Feed the World. University of Michigan (2007): http://www.i- sis.org.uk/organicagriculturefeedtheworld.php (accessed June 20, 2023).

Scales, L. T. (2013). Analyzing and interpreting data from. *Journal of graduate medical education,* 541.

Stevens, S. S. (1946). *On the theory of scales of measurement. Science, 103*(2684), 677-680.

Tsalefac M (1999), *Climate variability, economic crisis, a dynamics in the agrarian structure on western highland of Cameroon. thesis for award of a doctorate degree.*

Turral, H., Burke, J., & Faurès, J. M. (2011). *Climate change, water and food security* (No. 36, pp. xv+-174).

Urama, K., & Ozor, N. (2011). Agricultural innovations for climate change adaptation and food security in Western and Central Africa. A*gro-Science, 10*(1).

Warren G. (2012). Drop in temperatures hindering photosynthesis thereby reducing crop yields. *A book published in Kenya during the Cultivators Summit,* 7.

World Bank (2008). *Development outreach: making agriculture a development priority.* Washington D.C, 120p

Zumbo, B. D., & Zimmerman, D. W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology, 34,* 390-400.

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