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Perceptions and Experiences of Climate Variability by Farmers in Nkwanta North District

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Abstract

The issue of climate change and variability is rapidly taking centre stage in most global discussions in recent times. The study examined farmers' perceptions and experiences of climate variability in northeastern Ghana. A mixed research design comprising questionnaires, focus group discussions, and expert interviews was adopted to gather data from respondents. Using the Jensen & Shumway formula sampling technique, 180 household heads who cultivated food crops were selected from four Nkwanta North District towns to administer the questionnaire. Results of the quantitative data from SPSS and Microsoft Excel were presented in tables and figures. Expert interviews and focus group discussions provided the qualitative data. The data was manually analysed through thematic content analysis and presented through quotations. The results exposed the fact that most farmers have beyond two decades of involvement in the farming business.

This experience made farmers identify variations in the climate system. Again, it led farmers to point out specific events such as increasing temperatures and a decreasing rainfall volume, coupled with prolonged drought, as the common variations that a great number of farmers have observed, which often resulted in low farm produce and many crops getting spoiled in the barns and storage areas. Although the perceptions and experiences of these farmers are limited to their locale, their assertions are certainly consistent with scientific data and reality. Based on this, their experiences should be taken into account when designing interventions needed to avert food insecurity. It is recommended that more extension officers be deployed to educate farmers on adopting improved crop varieties.

Keywords: *Agriculture, Perception, Experience, Climate Variability, Farming*

Introduction

The increase in global temperature resulting from various anthropogenic activities, including excessive release of greenhouse gases into the air, leads to changes in climate, which presents a substantial risk to humankind today. It is estimated that global temperature has risen by 0.6±0.2% on land and sea surface in the middle of the 19th century, indicating a continuous process over the years, and if concerted efforts are not made globally to reduce the emission of carbon dioxide gases, temperatures will further rise by 4.4^{o}C by 2100 (FAO, 2015; IPCC, 2014).

Climate change impact has been so debilitating to the extent that unlike previously, rainfall distribution now is low at places that used to receive higher amounts and vice versa, characterised by a high level of unpredictability in weather patterns (Makuvaro, Walker, Masere, & Dimes, 2018; Kibue et al., 2016). This renders the experience of climate change a local phenomenon as much as it is a global phenomenon. Thus, the experience of change and how people interpret it matter a great deal. The crux of the issue is that how local farmers perceive and experience the impact of the change is key in designing approaches to deal with it in the local environment. These situations meaningfully impact most human livelihood activities that depend heavily on the climate. One such activity, without which survival becomes dire for humanity, is agriculture. This is particularly true in most developing countries,

especially those in sub-Saharan Africa, where many farmers rely on natural rainfall to cultivate their crops. Recent studies indicate that climate change has caused a reduction in agricultural output and, consequently, GDP by 2% to 7% in some African countries. As a result, climate change and variability are perceived as immediate threats to family sustenance in Africa due to their significant contributions to lower crop yields (Asrat & Simane, 2018; Yiran & Stringer, 2017; Porter et al., 2014).

The story in Ghana is similar to what is happening in developing countries of the sub-Saharan region. Studies in Ghana have shown that farmers have experienced a significant reduction in crop yields due to rising temperatures and decreasing rainfall throughout all the agro-ecological zones (Fagariba, Song & Baro, 2018; Ndamani & Watanabe, 2015; Antwi-Agyei, Dougill & Stringer, 2015; Nkrumah et al., 2014). To be specific, numerous concerns have been raised over food insecurity since most agricultural production in Ghana both natural rain and irrigation schemes for cultivation (Ofori, Cobbina, & Obiri, 2021). Whether local farmers are fully aware of and understand this development is a matter of utmost concern because their activities are climate sensitive. While understanding of the climate change phenomenon and its implications on agriculture has gained popularity, majority of the available knowledge is technical; in other words, grounded in scientific studies which concentrate on appraising variables of the biophysical aspect of climate change impacts (Juana, Kahaka, & Okurut, 2012; Yengoh, Armah, Yawson, Odoi, & Afrifa, 2010).

Although perceptions may not automatically be consistent with reality (Azar, G.,2014), they are vital in addressing socioeconomic challenges of man. In other words, they closely relate to people's settings such that there is either a direct or indirect linkage between the people's attitudes, behaviours, and subsequent outcomes (Kuskari et al., 2014). So therefore, in order to design any strategy that appropriately suits local situation and context, it requires that we understand what prevails locally from the point of view of the farmers. By this, there is a higher possibility of dsigning effective policies that will not be alien but rather be embraced by all the local farmers. This work takes a cursory look at the perception and experiences of farmers in the Nkwanta North District of the Oti region of Ghana on climate variability.

Materials and Methods

The study area

Nkwanta North is one of the eight districts that make up the newly carved Oti Region. The region was etched out of the then Volta Region. Nkwanta North District is sandwiched between Nanumba South, Kpandai, Nkwanta South Districts, as well as the Republic of Togo. It is endowed with a landmass of about 1,098.9 square kilometres. It falls between longitudes 0º 10' West and 0º 45' East of the prime meridian, and latitudes 7º 30' North and 8º 45' North of the equator (GSS, 2014). The general relief is comparatively low, and home to few hilly areas which height range between 100m to 200m above sea level. The District has a lot of streams and rivers, with notable ones being Morla, Kpassa, and Oti, which are the primary sources of fish in the District (GSS, 2014).

The type of vegetation is the transitional Savannah Woodland with drought-resistant trees that shed their leaves to reduce evapotranspiration during the harmattan season. The rainfall regime in the District is of the double maxima. The first begin from April to July, and it is the major farming season whereas August to September constitute the second regime which is the minor farming season. Temperature ranges between 11°C and 26°C (GSS, 2014). The soils are mostly of lateritic clay, savannah ochrosols, and oxysols origin (MoFA, 2014). These are very fertile soils, and good for agriculture. It should therefore not be a surprise for the dominance of agricultural activities across the District.

The agriculture sector alone provides jobs for about 80% of the populace in four different sectors of production. They are forestry or tree growing, livestock, food crop, and fishing/fish farming sectors (GSS, 2014). This undoubtedly means that every household in the District is either directly or indirectly involved in agriculture. Common crops produced in in the district are yam, cassava, sorghum, maize, and cowpea, just to mention a few. Animal husbandry is practiced for family sustenance, and the animals reared include cattle, sheep, goat guinea fowl, pig, rabbit, duck and turkey (GSS, 2014).

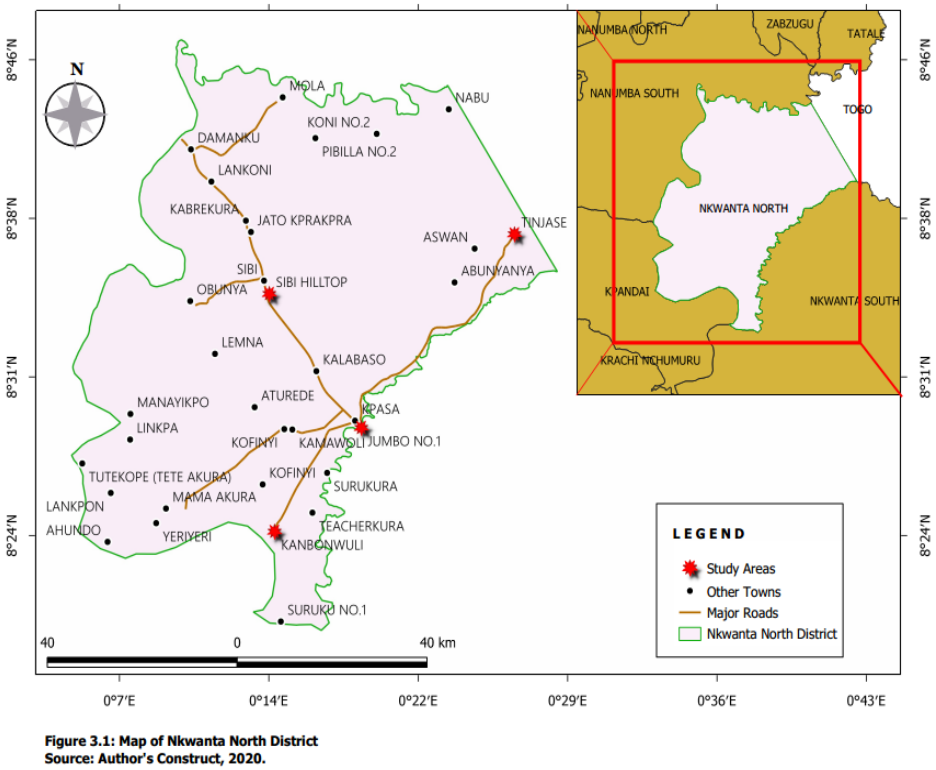

Figure 3.1: Map of Nkwanta North District
Source: Author's Construct, 2020.

Figure 1: Map of Nkwanta North District

Research design

Mixed method design (Creswell, 2017; Teye, 2012) was adopted in the collection of data and results analysis. The mixed-method research combines data from both qualitative and quantitative sources in single research. The qualitative design collected and analysed words (text) in the form of open-ended responses, whose answers to research questions were not predetermined. The data was analysed using themes and pattern interpretation of the data. The quantitative design collected and analysed closed-ended answers, which were mostly prearranged. These data were analysed statistically using SPSS and Excel.

Although the qualitative and quantitative data were analysed separately, they were integrated. The researchers were aware that combining qualitative and quantitative methods was more expensive, it was laborious, and very tedious for a single researcher to conduct (Johnson & Onwuegbuzi, 2004). However, the researchers considered it appropriate, considering the context of the study. This is to say that the mixed method has the ability to offer simpler

understanding of the research problem under consideration. Also, it was preferred because it provided convincing grounds for concluding convergence and validation of findings. Again, it helped to answer a wide range of research questions completely, which otherwise was often not the case in adopting only a single approach (Teye, 2012).

Sampling and data collection techniques

Sample size determination formula: $n = N / (1 + N (e)^2)$

Where n = required sample size

N = Total number of households and

e = level of precision = 0.05

$\therefore n = (1{,}200 / (1 + 1{,}200 (0.05)^2)$
$= (1{,}200 / (1 + 1{,}200 (0.0025))$
$= 1{,}200 / (1 + 3)$
$= 1{,}200 / 4,$
$= 300$

Table 1 gives the breakdown.

Table 1: Sub-Sample Size Determination

Community	**Number of Households (N)**	**Original Sample Size (n)**	**Adjusted Sample size (n)**
Sibi Hilltop	613	153	84
Tinjase	305	76	50
Kabonwuli	154	39	25
Jumbo No. 1	128	32	21
Total	**1,200**	**300**	**180**

Source: Field Survey, 2020

Sampling procedure

The selection of communities for the research was done using a multi-stage sampling technique. Stage one involved putting the district into four different clusters. They are North, South, East, and West, to ensure geographical

representation. The second stage involved a listing of all the main agricultural communities in on pieces of paper as obtained from the district directorate of MoFA. In the third stage, a single piece of paper representing a community was randomly picked from each of the four clusters. This exercise resulted in the selection of Tinjase, Sibi Hilltop, Kabonwule, and Jumbo No. 1 communities, which were used for the study. This fourth stage involved the identification of a major agricultural household in each of the four communities and selecting them to serve as a sample frame. In the fifth stage, 180 household heads who mainly cultivated food crops were randomly selected from each of the four communities. This stage was preceded by assigning numbers to the households in each community. The desired sample size was then selected from among the chosen communities in accordance with the formula above.

Data sources for the study

Primary quantitative and qualitative data were elicited from the heads of chosen households, agricultural extension officers as well as the Director of Agriculture in the district. Secondary data (Flintermann, 2014) obtained comprised census and other reports from the District Assembly, and annual temperature and rainfall distribution figures from the Ghana Meteorological Agency.

Data collection techniques and tools

A cross-sectional survey (Mathers, Fox, & Hun, 2007) was adopted using a self-administered questionnaire to elicit information from one hundred and forty-nine (149) male and thirty-one (31) female household heads. It is observed that there has been a bias against women. Even though this was unplanned, it was expected because most household heads were men and were the major decision makers. In furtherance, ownership of land lay largely in the hands of men, and so smallholder women farmers did not necessarily farm on their land (Ndamani & Watanabe, 2015). The data that was collected employing questionnaires were analysed by coding and entering them into the Statistical Package for Social Sciences (SPSS) version 25. They were all analysed using descriptive statistics in the form of percentages.

In addition, the expert interview was conducted to elicit information from the district director of agriculture as well as the extension officers (Abawi, 2013;

Crow & Pope, 2008; Ho, 2006; Kvale, 1996: 174). Focus group discussion was used to obtain data from individual farmers put into groups across the communities (Sherraden, 2001). The district MoFA director and extension officers served as the experts who took part in the in-depth interview. Expert interview and Focus Group data were analysed through detailed thematic content analysis by subjecting the field notes to intense reading to ensure clarity. Further, the notes were scrutinised for key ideas, consistency of ideas, and categorisation into themes. Respondents were quoted to validate the quantitative data. Field observation (Ciesielska, Bostrom, & Ohlander, 2018) was also employed by the researcher by visiting farms to observe how yams were rotting in the barns. The results, which were obtained in pictures, were also used to support the assertion of farmers.

Results and Discussion

Results of the analysed data on farmers' perception of climate variability, climatic events experienced, as well as perception of rainfall and temperature variability in the study area are presented here.

Farmers' perception of climate variability

Here, the research question sought to find out if farmers perceived variation in the local climate within the district. The results, as shown in Fig. 2, showed that most farmers (98.3%) were aware of variation in climate within the district, and this is in sync with most studies (Hameso, 2018; Clarke, Shackleton, & Powell, 2012). Although most of the farmers in the district belonged to the illiterate group, they were very experienced in their business and were aware of the changes that occurred in their local weather patterns. They might not be in the position to interpret it scientifically, but their perception of expressions was not different from scientific data.

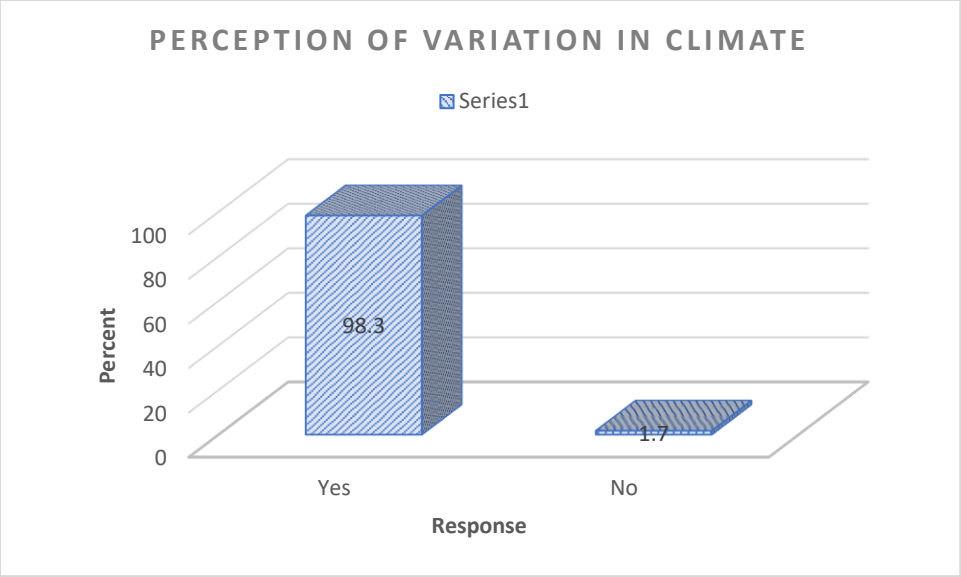

Figure 2: Variation in climate as perceived by farmers
Source: Field Survey, 2020.

A similar opinion was expressed by the district director of Agric as quoted below:

"A lot of agricultural potentials abound in the district, which have not yet been explored. Formerly agriculture in the district was a very lucrative business. Unfortunately, the story is
not the same currently as a result of the continuous variation in the climate regime. Unstable rainfall regime is the major challenge that farmers are battling"
(Interview with district director (MoFA), February 2020).

Climate events experienced by farmers

A study in Swaziland found that a decreasing frequency, intensity, and duration of rainfall was evident (Mamba, Salam, & Peter, 2015). Several other studies also expressed similar opinion on the fact that the activities of farmers were in direct relation with climate and so were better placed to confirm variation in climatic events as experienced. In like manner, the researchers wanted farmers in the study area to point out specific climatic events that they have experienced, if indeed they have perceived variation in the local climate. It was therefore not surprising when the results sanctioned that majority of farmers have experienced delay in the coming of the rain, early truncation of the rain, an increase in rainfall intensity, coupled with high storms, leading to persistent flooding in low-lying areas.

In the same vein, the results, as shown in Fig. 3, show that the majority of the farmers have experienced prolonged periods of drought. Accordingly, a vast majority of the farmers have opined that there was an increase in day and night temperatures. The overwhelming proclamation of farmers (100%) about the appreciation in day and night temperatures confirmed that the prevalence of climate change is no longer a perception but a reality to farmers in the district as it conformed to most studies conducted (Hameso, 2018; Limatol, Keith, Aziabre, & Lennartz, 2016). Perhaps the quotation below would emphasise the severity of prevailing climatic events experienced by farmers in the district:

"*With all due respect, observing from the environment, can you tell any sign of rain on the ground in recent times? Simply put, the dry season has stayed for too long. Some years back at this time, we had received at least one rainfall, but to date, not even a drop. Situations like this open the avenue for the emergence of these worms (army worms) which chew leaves of the crops. Worse of it is when the rains are due to fall, they fall as though all the water in the clouds must get exhausted before it subsides, and after that heavy rainfall it will take a very long time for us to receive another rainfall. My colleagues are here to bare me witness. These heavy rainfalls usually lead to the flooding of people's farms. Those whose farms were not flooded could also not go to the farm due to rivers and streams overflowing their banks" (participant in FGD, February 2020).*

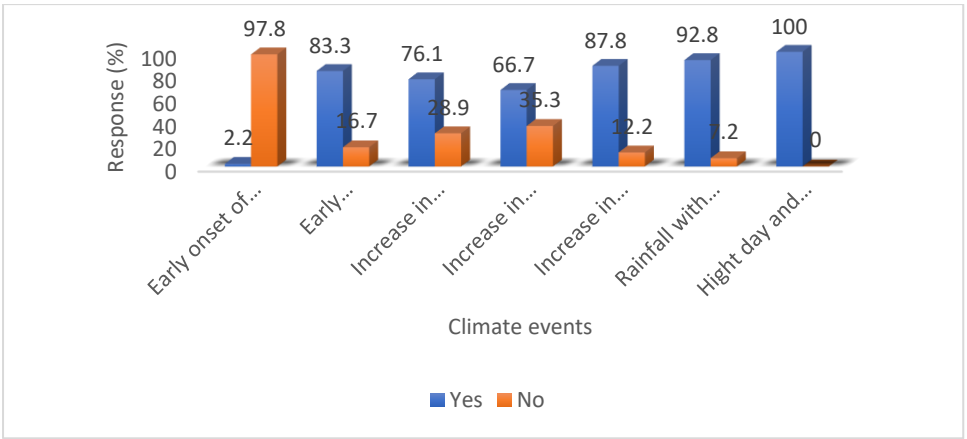

Figure 3: Climate Event as Experienced by Farmers
Source: Field Survey, 2020

Perception of rainfall variability

Farmers were asked questions with relating to their perception on whether there was variation in recent rainfall pattern within their district, almost all (99.4%) respondents concurred that they have been very much aware of the irregular rainfall patterns over the past two decade. The perception about the inconsistency in rainfall could not be underestimated because it was limited to their environment; rather, it provided insight on localized observation as pertained to most geographic settings. Further, the responses were in consonance with recorded data from the Ghana Meteorological Agency as portrayed in Figure 4.

It is apparent from Figure 4 that volume of rainfall reduced from 1854mm to 1422mm between the years 2008 and 2018, such that instability in the average amount is evident. The year 2015 recorded the least rainfall volume, which was 994mm. however, the year 2016 witnessed an increase of up to 1096mm, and since thereafter rainfall volumes kept increasing. On the other hand, although there had been an upward recording, it has always been below the average figure of 2008, which goes to prove that the amount of rainfall received kept varying over the decade under study.

District average annual rainfall patterns

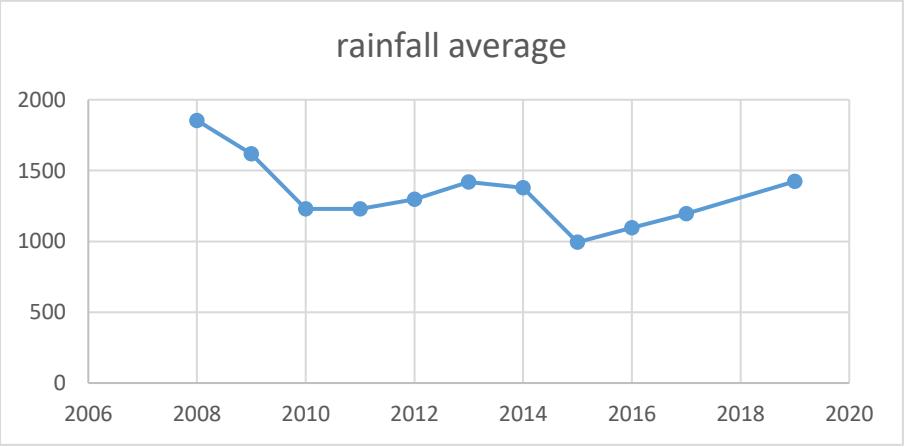

Figure 4: Average rainfall amount between 2008 and 2018

Source: Ghana Meteorological Agency, 2020

The findings added extra credence to the work of Asiedu, Adetola, & Kissi (2017), that rainfall has been irregular for the recent past half decade.

Nevertheless, the unpredictable nature of the rain adversely affected farmers' zeal in preparation towards the farming season. Very low rainfall regime is indicative of looming crises of food insecurity among farming households and by extension, the nation at large. Possibly highlighting this point, one farmer had this to say:

"*The current rainfall regime is not predictable, compared to some decades back where we could easily tell the start of the rains and when it would stop with higher precision" (participant in the FGD, February 2020).*

Form of variation in rainfall as perceived by farmers

Again, farmers were asked to outline specific events indicating why they perceived variation in rainfall within their locality. Although rainfall was seen as a major factor which determined the scarcity or abundancy crop yields, the total volume that was receive usually did not matter as much as the evenly distribution during the cropping season. In view of the fact that the area was located within the transition agroecological zone, the results as shown in Fig. 5 indicates that rainfall has been decreasing in duration was consistent with other studies (Antwi-Agyei et al., 2015; Nkrumah et al., 2014). It was therefore not out of place to conclude that farmers did not get rainfall in the right amount at the beginning of land tillage, and even through the planting period. This situation obviously led to poor yields of crops. In echoing this point, a farmer reiterated that:

"In the days of our youthful stage, the rains came in and left at highly predictable times. At the time, it didn't always fall too heavily or too little, but was uniformly distributed over the planting season. similarly, farmers had ample time to till land, to plant crops, as well as to control weeds, and even some break to relax before harvesting time was due. Currently, the rainfall regime has taken a very unfamiliar and indeterminate dimension" (participant in the FGD, February 2020).

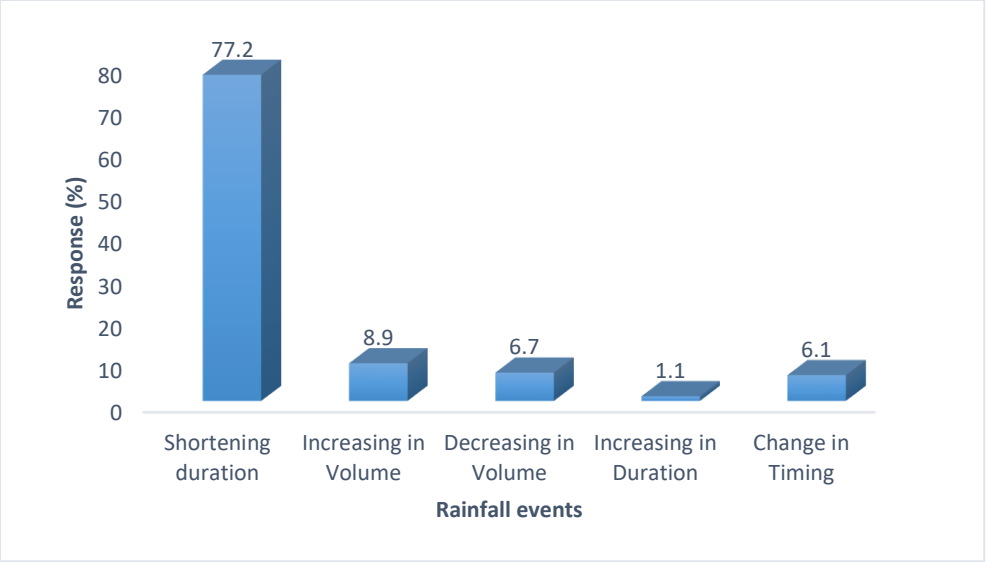

Figure 5: Form of variation in rainfall as perceived by farmers

Source: Field Survey, 2020

Perception of temperature variability

The researchers sought to explore the perception and form of temperature variability from farmers within the study area. In all the communities visited by the researchers, the majority of the men and women were seen seated under shady trees. One would have thought sitting under the trees was enough, but even that, most of the men had shirts or singlets either placed on their shoulders or completely removed. The situation suggested that the people were feeling warm but to confirm the observation, respondents were asked if there was a variation in the temperature and why most of the men had removed their shirts. As shown in Fig. 6, a large proportion of respondents (99.4%) responded in affirmation that there was a change in temperature, and that the change was more of an increase. The quotation below reinforces the researchers' observation.

"*From your observation, we have removed our shirts, right? Let it not appear to you as if we are happy sitting here, or we like to walk bare-chested. It is a result of the excessive heat. The heat these days is too much, and it is not as though it applies only to the diurnal temperatures. You can pay a visit in the night as well to see the number of families sleeping outside their rooms. The least said about the rooms, the better. This is to say that it appears as though the heat from the sun during the day was being stored in the rooms and released at night.*

Clearly, a significant number of us in this community cannot remember the last time we slept in our rooms" (*participant in FGD, February 2020*).

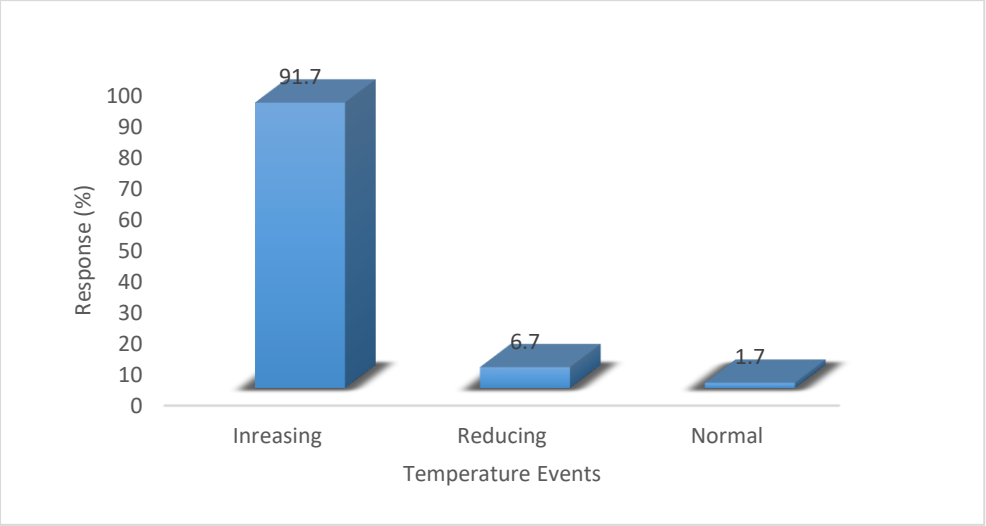

Figure 6: Form of variation in temperature as perceived by farmers

Source: Field Survey, 2020

The results, as shown in Fig. 6, were in sync with the official records between the years 2008 and 2018 as obtained from the Ghana Meteorological Agency. This revelation has dire implications on farming and other related agricultural activities, in the sense that increased temperatures often result in complete loss of soil moisture as well as severe reduction in such some tree species like dawadawa, mahogany, shea and the neem, food crops and livestock (Fagariba et al. 2018; Yiran & Stringer, 2017). Consequently, most farmers would experience high on-field or postharvest losses due to excessive heat, as pointed out by some farmers, that most of their yam species have disappeared. That aside, a greater portion of their yam in the barn appeared nice outside, but as soon as you lifted them, they fell off, signalling rot as shown in Figure 7.

Figure 7: Separation of rotten yams from good ones in the barn as a result of excessive heat.

Source: Field Survey, 2020

Temperature information gathered from 2006 to 2020 from the Ghana meteorological Agency showed that, between 2008 and 2018 average temperature has risen from 270C to 290C. However, in between the years under consideration, temperatures have been oscillating. This however was a great source of worry to farmers and especially crops that were very sensitive to the slightest change in temperature because, a 10C increase in temperature speaks a lot. This fluctuation, coupled with the wide seasonal discrepancies, clearly indicates variability in temperature (IPCC, 2007) as shown in Figure 8.

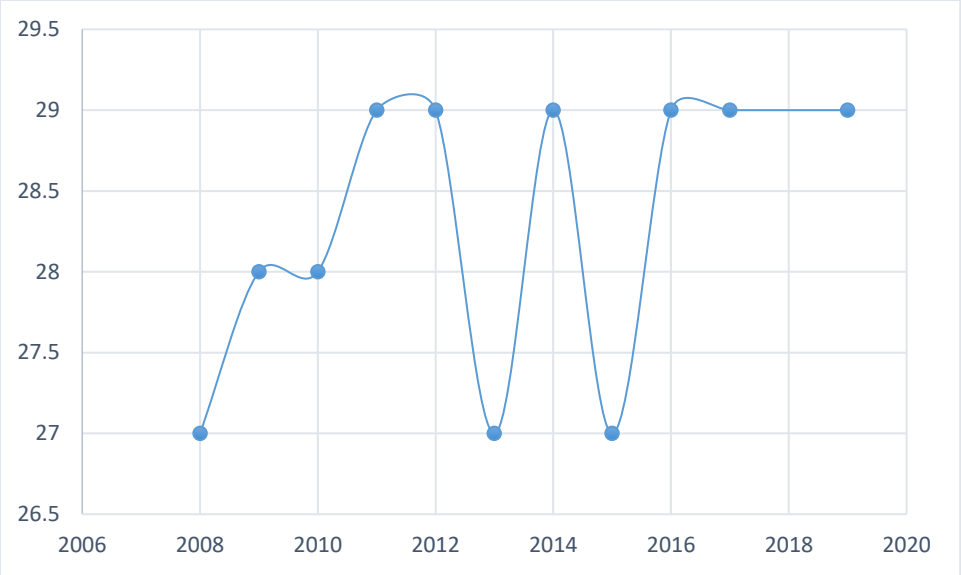

Figure 8: Average temperatures between 2008 and 2018

Source: Ghana Meteorological Agency, 2020

Conclusion

The aim of the study was to assess the perception and experiences of farmers in the Nkwanta North District in north-eastern Ghana on of climate variability. The results revealed that majority of the farm households were aware of the variation in the climate. They were able to identify variation in the elements of climates as well as specific variations that were experienced in the major climatic elements. Some of the variations identified were late onset of rainfall, lengthy drought season and increased day and night temperatures. It is therefore concluded that even though farmers' experience was limited to their local area, there is strong evidence to suggest that it is consistent with the literature and scientific data. Given the fact that most farmers became aware of variation in the climate based on their experiences, it is recommended that more extension officers be deployed to educate farmers on improved ways of farming and to introduce them to high-yielding crop varieties that can cope with drought. This will go a long way to make them risk-averse in times of lengthy drought as well as ensure food security.

Ethnical Statement

The participants expressed their willingness to participate in the study after explaining the essence of the study to them in their local language under the guidance of an assistant. They therefore voluntarily provided their frank opinion to questions in the focus groups and the to the questionnaire. The manuscript has been proofread to improve its language linguistics.

Acknowledgement

The authors express appreciation to residents of the four communities selected, and the district MoFA director who agreed to serve as participants and provided sincere responses that has led to the emergence of this paper.

Conflict of Interest

The authors confirm that there is not any conflict of interest with regards to the publication of this article.

Authorship Contribution Statement

Yeboah: Conceptualisation, Writing, Design, Analysis. Yaro: Editing/ Reviewing, supervision, guidance. Magya: critical revision of manuscript. Oppong-Mensah: critical revision, proofreading and final approval.

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Generative AI Statement

We also wish to state that there was no use of AI tools such as ChatGPT in the course of the work. In view of this, we, as the authors, take full responsibility for the content of our published work.

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