We used to 'chase the rains' away in the past: the role of cultural values and beliefs in shaping farmers' perceptions of climate variability and change in North-west Ghana

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Abstract

This paper explores how cultural values and beliefs influence farmers' perceptions of climate variability and change (CVC). Using Doggoh and Tie in North-west Ghana, the study reveals four narratives linked to cultural values and beliefs explaining climate changes: a decline in ritual sacrifices, young people having sex outside homes, traders holding on to rains for business, and indiscriminate murder without necessary sacrifices. The study suggests that more qualitative studies on the role of cultural worldviews in shaping farmers' interpretations of climate changes are needed, as different cultural contexts may have different worldviews about

climate change causes. This will contribute to our holistic understanding of the subject matter of the causes of CVC.

Key words: Farmers' perceptions; climate variability and change, cultural values, cultural beliefs, chase the rains away, North-west Ghana

Introduction

The discourse on farmers' perception of climate variability and change (CVC) has gained wide attention around the globe (see e.g., Behailu et al., 2021; Dapilah et al., 2019; Dapilah and Nielsen, 2019; Kusakari et al., 2014; Lawson et al., 2019; Roy et al., 2020; Salite and Poskitt, 2019; Singh et al., 2018; Talanow et al., 2021; Tessema and Simane, 2021; Woods et al., 2017).

Similarly, the subject matter of farmer perceptions has received different methodological approaches. To start with, most climate perceptions studies have focused on teasing out only farmers' perceptions without comparing with actual climatic data (see e.g., Asante et al., 2017; Derkyi et al., 2018; Elum et al., 2017; Kolleh and Jones, 2015; Salite, 2019; Salite and Poskitt, 2019; Talanow et al., 2021; Tessema and Simane, 2021; Woods et al., 2017). Additionally, the methodology has shifted to comparing farmer perceptions with climatic data (see e.g., Amadou et al., 2015; Ayanlade et al., 2017; Behailu et al., 2021; Dapilah et al., 2019; Dapilah and Nielsen, 2019; Imran et al., 2020; Nyanyakyi-Frimpong and Bezner-Kerr, 2015; Roy et al., 2020; Thomas et al., 2007; Yaro, 2013).

This paper argues that, although there is attention in recent times on understanding how cultural values and beliefs shape farmers' perceptions of climate variability and change (see e.g., Jarawura, 2014; Scoville-Simonds, 2018; Salite, 2019), little is understood within sub-Saharan Africa particularly Ghana on how cultural values and beliefs shape farmers perceptions of the causes of variability and changes in the climate of their local area. Therefore, this paper sets out to bridge this knowledge gap and contribute to our holistic understanding

of how cultural worldviews shape farmers interpretation of their local climate using Doggoh and Tie of North-west Ghana as a case study.

Consequently, this paper is structured into five sections. The first section introduced the gap and contribution of the study to knowledge. The next section reviewed relevant literature on the methodological approaches of previous studies on farmers' perceptions of CVC. Then in the third section, the researchers discussed the research setting and methodology. Section 4 presented the results of the study. Finally, Section 5 focused on conclusion and recommendations.

Farmers' Perceptions of Climate Variability and Change: Current state of knowledge

To have a sense of what has been documented on the subject matter of climate variability and change (CVC), the researchers reviewed relevant literature. It emerged from the review that, farmers' perceptions of CVC have received due attention globally. For example, in West Africa (Amadou et al., 2015; Dapilah et al., 2019; Dapilah and Nielsen, 2019), East Africa (Behailu et al., 2020; Osbahr et al., 2011; Tessema and Simane, 2021), Southern Africa (Elum et al., 2017; Horsefield 2016, Salite, 2019; Salite and Poskitt, 2019; Talanow et al., 2021), South Asia (Roy et al., 2020; Singh, 2014; Singh et al., 2018), and Western Europe (see e.g., Woods et al., 2017). Consequently, the next subsections are organised according to the different methodological pathways that were employed by previous studies to contribute to the discourse on CVC.

Admittedly, it emerged from the review that, most past studies have relied on the methodological approach of only teasing out farmer perceptions without comparing with the pattern of actual climatic data (see e.g., Asante et al., 2017; Derkyi et al., 2018; Elum et al., 2017; Kolleh and Jones, 2015; Salite, 2019; Salite and Poskitt, 2019; Talanow et al., 2021; Tessema and Simane, 2021; Woods et al., 2017). For example, Kolleh and Jones (2015) in a study that focused on farmer perceptions in the Ketu north district of the Volta region of Ghana reported that, farmers perceived decreasing precipitation and increasing temperature. Similarly,

Codjoe and Owusu (2011) reported a shift in the onset of the rainy season from February to March, and a trend of the bi-modal rainfall regime being replaced by a single rainfall pattern which begins later and ends earlier now. There is a limitation from this approach, in that it is then difficult to reflect on the implications of local perception for effective adaptation or potential mal-adaptations because it is not compared with patterns of actual climatic data, nor does it let researcher (s) reflect on what might be driving perception for some farmers when there are differences (Osbahr et al., 2011).

Similarly, some researchers on the subject matter of CVC, have gone beyond only teasing out farmer perceptions to comparing with actual climatic data. Empirically, several studies have used this approach in South Africa (see e.g., Gandure et al., 2013; Thomas et al., 2007), Uganda (see e.g., Osbahr et al., 2011), Nigeria (see e.g., Ayanlade et al., 2017), Zimbabwe (see e.g., Horsefield, 2016; Moyo et al., 2012), Ghana (see e.g., Amadou et al., 2015; Dapilah et al., 2019; Limantol et al., 2016, Yaro, 2013,), Ethiopia (see e.g., Behailu et al., 2021), Bangladesh (see e.g., Roy et al., 2020), Pakistan (see e.g., Imran et al., 2020) and India (see Singh, 2014; Singh et al., 2018). For example, in a study that focused on the Vea catchment in Ghana, Limantol et al. (2016) reported that farmers observed an increase in temperature for the past 30 years, and that the amount of rainfall, duration, intensity and the number of rainy days has decreased. On the analysis of climatic data, Limantol et al. (2016) revealed a rising trend in temperature but no long-term trend changes in annual or monthly rainfall within the Vea catchment area. Similarly, Amadou et al. (2015) reported that farmers observed increased temperatures which matched the analysis of temperature data, but there was also no clear evidence of a statistically significant reduction in the amount of rainfall, but rather high inter-annual variability. This approach is useful as it gives room for the identification of matches and mismatches, and an opportunity to then understand the reasons behind this and where appropriately support farmers with better information and a forum for discussing these differences with farmers (Arbuckle et al., 2013; Dohmen et al., 2009; Menapace et al., 2015).

Additionally, the literature review suggest that, the subject matter of the role of cultural values and beliefs in shaping farmers interpretation of climatic conditions of their local area is gaining attention – see for example: (i) Jarawura, 2014 (Ghana), (ii) Scoville-Simonds, 2018 (Peru), and (iii) Salite, 2019 (Mozambique). For example, Salite (2019) reported among others that, punishment from ancestors for non-frequent realisation of certain rituals which were regularly performed in the past, and abortion from young ladies which is considered unacceptable within the Gaza province of Mozambique as the causes of draught. Similarly, Scoville-Simonds (2018) reported two main narratives associated with the causes of climate change in his study in Peru. He reported that, self-identified Catholic informants observed that, associated climate problems such as sick cattle, hail, frost, poor harvests are due to the abandonment of "pago a la tierra", because of the arrival and influence of Evangelical Protestantism in the area (Scoville-Simonds, 2018). On the second narrative, Scoville-Simonds's study reported that, self-identified Evangelicals have different construction about climate change, and is related problems. Accordingly, they observed that, climate change and its associated problems are specific and already-foretold signs of the end of the world per what has been written in the Bible (Scoville-Simonds, 2018).

Conceptual underpinning of study

To explore the role of culture, the study drew on conceptual ideas of the Theory of drought Perception – (TDP); and cultural worldview and values to make sense of the way that farmers' perceived CVC and judged this information together with other cultural considerations. The TDP is a construct of four elements: memory, experience, definitions and expectations. According to Taylor et al. (1988), memory deals with the drought events that were part of farmers' direct experiences that can be recalled by farmers. Definition is considered as a set of criteria, for example moisture shortage, for classifying a period as "drought" (see Taylor et el. 1988). Then expectation of future drought includes how often farmers expect droughts to occur

and how severe they expect droughts to be (Taylor et al., 1988). On the TDP, the researchers draw specifically on the memory and experiences components to conceptualise this study.

Literature documents worldviews as the general, cultural, political, and social attitudes toward the world that guide individual responses to complex situations, that are mediated by social relations (see e.g., Dake, 1991; Dake, 1992). To Weber (2010), the existence of climate change, the causes, and likely consequences are socially constructed. These constructions are functions of the cultural worldviews of societies. Values on the other hand, are considered as the commonly held standards of what is acceptable or otherwise viz-a-viz important or unimportant within a society or culture (Adger et al., 2009). Hence, literature suggests that, there are socially stratified rules that exist to govern behaviour in every society (Weber, 2010).

In this study, the researchers argue that, farmers' memory and experiences of climatic events in the past and now will guide them in identifying the prevailing climatic events now as compared to that of the past. Similarly, this study argues that, the standards within the Doggoh and Tie that prescribe the practice (s) that is acceptable or otherwise have the potential of shaping their constructions of the causes of CVC. Consequently, once unacceptable practices do happen, without the necessary actions being taken to address them, then potentially, that can lead to unreliable rainfall. On the other hand, acceptable practices potentially can lead to better climatic events happening in Doggoh and Tie.

Research Setting and Methodology

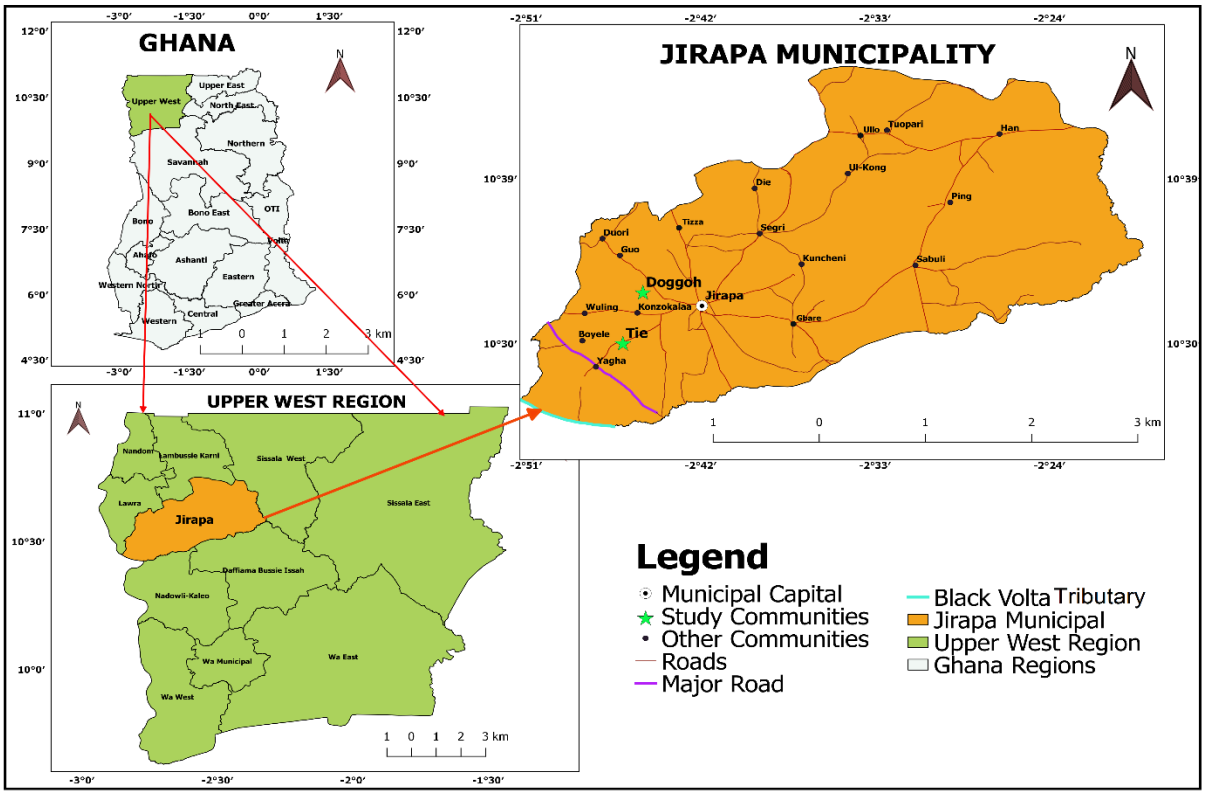
Site description

To understand how cultural values and beliefs construct farmers' perceptions of changes in climate, Doggoh and Tie of the Jirapa Municipality of North-west Ghana were selected[1]. The Jirapa Municipality is one of the 11 Municipal and District Assemblies (MDAs) that

[1] See figure 1 for the map of the Jirapa Municipality showing the study communities

constitute the Upper West Region of Ghana. The villages of Doggoh and Tie are located about 5km North-west of Jirapa (the capital of the Jirapa Municipality). The inhabitants of the two villages are predominantly peasant farmers who are into crop farming and livestock rearing (GSS, 2014). However, few people are into small-scale businesses such as petty trading, operation of beer bars (i.e., pubs) and sale of provision shops.

Figure 1: Map of the Upper West Region of Ghana showing the Jirapa Municipality



Source: Authors' Construct (Geographic Information Systems, 2022)

Method

Primary data: investigation of farmer perceptions. This study employed mixed methods to have a nuanced understanding of climate perceptions. The research methods included: village individual key informant interviews (VIKIs), semi-structured questionnaire (SSQ), focus group discussions (FGDs), and in-depth interviews. The research participants in this study involved 8 key informants (comprising both males and females- 4 in each village), 150 household heads (75 in each village), and 6 focus group discussions involving a combination of male and female farmers, only male farmers, and only female farmers (3 in each village). Also, the study engaged 34 in-depth household case studies (19 households in Doggoh and 15 in Tie). The availability

of respondents explained the difference between the villages of Doggoh and Tie in terms of the number of household case studies.

The data collection period was between January and October 2016. [2]The data collection started with the research team engaging with village key informants to identify people conversant with rainfall patterns in the past and now, and a better understanding of the culture of the communities. Consequently, the village lead persons[3] nominated 4 persons (2 males and 2 females) in each village who were knowledgeable on rainfall patterns in the communities, and cultural values and norms. The study covered themes on: (i) farmers' memory of climatic events in the past[4] and now, (ii) farmers' experiences of climatic events, and (iii) farmers' perceptions of the causes of climate variability and change.

The administration of the SSQ followed key informant interviews. The SSQ had both open-ended and closed coded questions with themes on: farmers' observation of climate events in the past and now. The study administered the SSQ via the face-to-face method. The face-to-face technique permitted the interpretation of the survey questions in the local dialect (i.e., Dagaare) to the research subjects. This was more appropriate as many of the respondents were unlettered, and it helped the research team to ask the questions in the local dialect. This led to a better understanding of the questions, with the respondents addressing the questions appropriately (De Vaus, 2013). Similarly, the face-to-face allowed for high response rates as some respondents could have decided not to answer some questions or could have refused to return the questionnaire in the case of self-administration (De Vaus, 2013). Furthermore, face-to-face allowed for prompting and probing which enabled respondents to understand and answer questions appropriately (De Vaus, 2013).

In-depth interviews with households, and focus groups were organised to have a nuanced understanding of how cultural values and belief systems shape farmers' construction of climate change. Several characteristics including the length of experience and involvement in agriculture and extent of knowledge about the culture of each of the communities were the criteria used for the selection of participants in the focus groups. In moderating the focus group discussions, care was taken in handling participants who wanted to over-dominate the

[2] The results of this paper pertain to farmers' perceptions as shaped by cultural factors as at 2016- this may be same or different now.
[3] Village lead persons were two persons (1 male and 1 female that the Assembly member – i.e., the representative of the Doggoh and Tie villages electoral area at the local government level recommended to lead the research team around the villages and make suggestions on key informants)
[4] Past was used to refer to a period of 25-30 years ago

discussions to enable less vocal participants present their views (Ricthie et al., 2014: 213). Generally, the female farmers were very quiet, and the male farmers were very dominant in all focus group discussions in both villages. Hence, separate focus group discussions were organised solely for individual sexes.

Wealth ranking aided the sampling of households for this study. Consequently, the village leaders (comprising both males and females) in both villages developed criteria for differentiating households into three wealth strata: rich, semi-rich, and poor. The criteria in both Doggoh and Tie included: number of educated persons in a household, ownership of livestock, the nature of building of household, size of farm holding (reference was made to maize-w[5] in Doggoh), number of married wives and number of children of the household head. There existed a bit of differences in terms of the locally developed criteria between the two villages[6]. Additionally, in the context of rich households, the leaders included the ownership of corn mills, stores, and drinking spots.

Simple random sampling was applied in the selection of male-headed households (as the stratification established that many of the households in the two villages were headed by males). This gave every male headed household within each of the wealth strata in the two research villages an equal chance of being selected (Bryman, 2016: 176). With few households being headed by females, care was exercised to include female headed households in all the wealth strata to understand female cropping decisions under CVC. The participants for the focus groups, the in-depth household interviews, and the individual key informant interviews were purposively selected.

The data collected from the SSQ was subjected to statistical analysis using the Statistical Package for the Social Scientist (SPSS). Questions with pre-coded alternatives were entered directly into the SPSS spreadsheet. In the case of open-ended questions, a considerable amount of time was spent in going through all the questionnaires before editing and assigning codes. The results from the SPSS spreadsheet are presented in the form of tables, charts and graphs. Interviews from qualitative data were first transcribed into English. The transcripts were analysed using a NVivo. Consequently, words, phrases, and sentences were labelled (through a process known as coding)- taking into consideration the significant themes and sub-themes of the research objectives (Gibbs, 2002: 57).

[5] Maize- w refers to maize (white colour)
[6] See the detailed criteria for the villages of Doggoh and Tie in Appendix A

Investigation of climate data. To have a sense of the prevailing climatic conditions in North-west, documents from the Ghana Meteorological Agency (GMet) were reviewed to ascertain the availability and quality of climatic data. Consequently, the review revealed that, the Upper West Region had about 13 rainfall stations as at 2016 (see Table 1 for details). Then the next task was to have a picture of the station (s) that was close to the study communities in order to avoid the impact of spatial variability (Osbahr et al., 2011) and then assess the quality of the available data for that station (s).

In terms of proximity to the study communities, Babile, Lawra, and Jirapa stations are the closest. However, on the quality of the available data, Babile climatic station follows that of Wa; that is 85.4% and 100% respectively (see Table 1). On the basis of the two conditions, the researchers settled on data from the Babile station hence daily rainfall data the station from 1960-2016 was obtained from GMet.

Table 1 Percentage distribution of missing and available data for rainfall stations in the upper west region

Station	Start year	End year	Number of years	Percentage missing	Percentage available
Babile	1960	2013	54	14.6	**85.4**
Funsi	1960	2013	54	60.5	39.5
Lawra	1960	2013	54	33.5	66.5
Nandom	1960	2013	54	59.4	40.6
Wa	1960	2012	53	0.00	100
Dafiema	1960	2013	54	66	34
Charipkong	1994	2011	18	53.3	46.7
Han	1960	2004	45	60.5	39.5
Jirapa	1960	1993	34	81.9	18.1
Kaleo	1960	2013	54	67.4	32.6
Nadowli	1960	2004	45	44.3	55.7
Wechaiu	1960	2013	54	74.5	25.5
Tumu	1960	2013	54	35	65

Source: Ghana Meteorological Agency (2016)

On the parameter of temperature, GMet had only monthly minimum and monthly maximum data for the Babile station from 1988 to 2014. The study employed R-Instat (a statistical software application developed by the African Mathematics Initiative) for analysing the rainfall data. Daily rainfall data was first saved in acceptable formats that R-Instat would recognise and was inputted into R-Instat application. The starting point was to summarise the data from 1960-2016 looking out for years with lots of missing data (see table 4.2). Of the years, 42 had very good data and 12 years (i.e., 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971[7], 1990, 2004, 2007, and 2008) were not good. However, R-Instat application is configured to deal with years that had missing data. Statistical analysis for each of the rainfall events for the Babile station were performed in R-Instat. In trying to make meaning from the results, two statistical steps were considered: one was to fit a model for a given rainfall event against year, and two, to generate statistical summaries of the climate events.

Results

Understanding the Climate of North-west Ghana

Evidence from climatic data

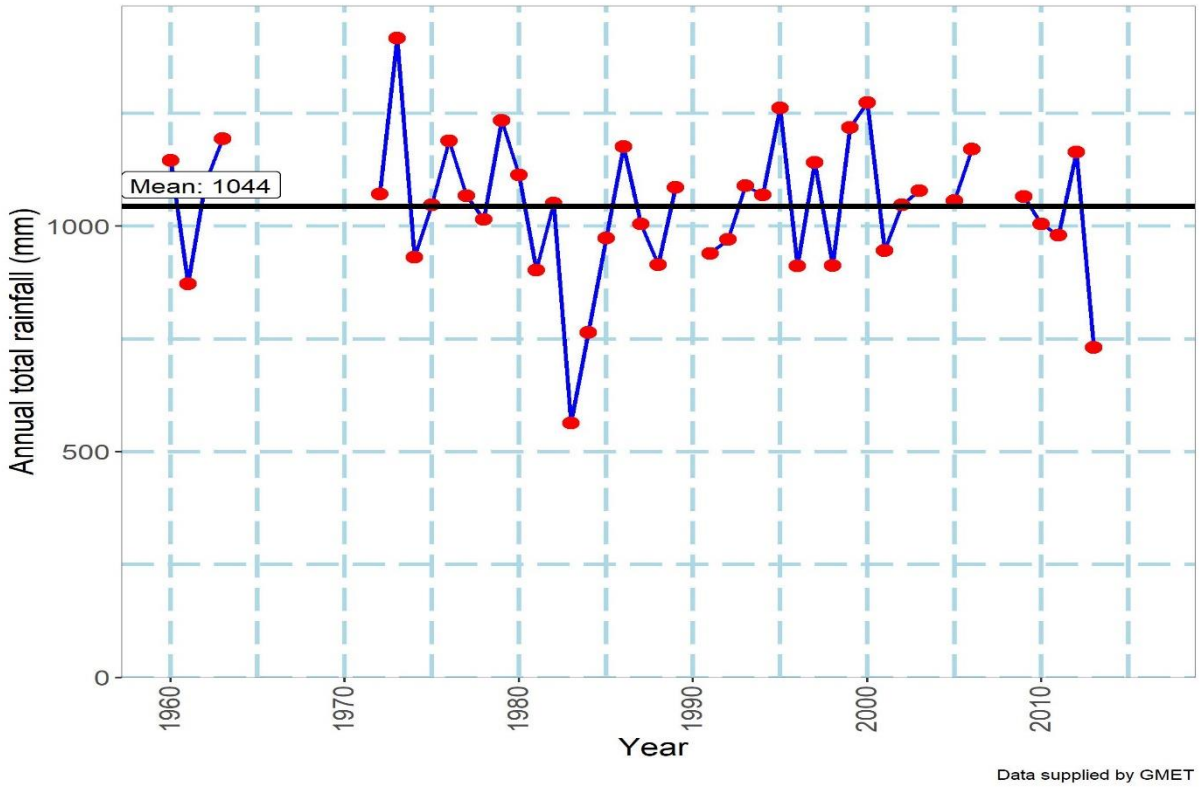
To understand the prevailing climatic conditions of North-west Ghana, several climatic events were computed using R-Instat. These include: (i) total annual rainfall distribution, (ii) the start of the rainy season, (iii) the end of the rainy season, and (iv) the length of the rainy season.

Rainfall

Amount of rainfall: annual averages

[7] Note: 1971 for instance has about 31 missing data but the missing data was for the month of January, which is irrelevant in terms of the definition of the onset of the rainfall.

Rainfall totals for different years are a good starting point to understand rainfall pattern across different years to ascertain trend regarding change or variability. From Fig 2, rainfall distribution from the 1960s was erratic until the maximum was recorded in 1973 (1416.5 mm), then the erratic pattern continued until the lowest annual value of 563.5 mm was recorded in 1983. The literature (see e.g., Codjoe and Owusu, 2011) reports that Ghana was characterised by drought between 1983-1984 hence that explains the low rainfall amount in 1983. Statistically, the results did not depict any vivid pattern as to whether annual rainfall totals have either increased or decreased throughout the period (as a p-value of 0.6 was recorded) but instead high variability of inter-annual rainfall distribution for the 57-year period.



Source: Ghana Meteorological Agency (2016)

Figure 2 Total annual rainfall distribution for Babile, 1960-2016.

The start of the rainy season

In as much as the amount of rainfall is important it is worth recognising that the start of the rain which influences the planting decisions of farmers is equally essential (Antwi-Agyei, 2012; Ingram et al., 2002). Similarly, it is worth acknowledging that, other climatic events like the end of end and length of the rainy season determine the sort of crops or crop varieties that farmers can cultivate in a given agricultural season.

Additionally, literature has documented that, the occurrence of dry spells is also problematic for farmers' cropping decisions as farmers may have to replant in the event of crop failure (see e.g., Horsefield, 2016). In the context of this study however, the researchers computed the start of the rains with the consideration of no occurrence of dry spell conditions as indicated in table 2.

Definition I	The first occasion after April 01st that records more than 20 mm of rainfall in one or two consecutive days without factoring in any dry spell [8]condition
Definition II	Definition two draws on definition I but incorporates the element of no dry spell of more than 9 days in the next 30 days after the first day of recorded rainfall of at least 20 mm as suggested by Stern and Cooper (2011).
Definition III	The first occasion after May 01st that records more than 20 mm of rainfall in one or two consecutive days without factoring in any dry spell condition
Definition IV	Definition two draws on definition III but incorporates the element of no dry spell of more than 9 days in the next 30 days after the first day of recorded rainfall of at least 20 mm as suggested by Stern and Cooper (2011).

Source: Stern et al. (2006)

Table 2 Four definitions of the onset of the rainfall

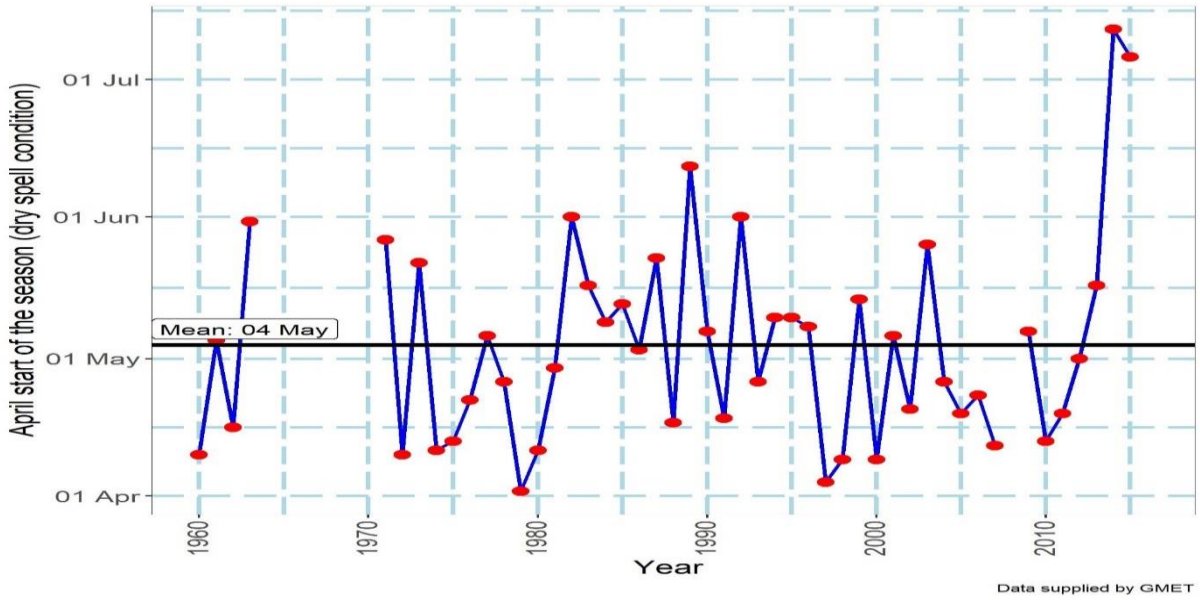
The decision to use the above two definitions is backed by the following reasons. To start with, there are some farmers that may want to plant early in April once the rain begins to fall (i.e., risk tolerant farmers) and some other farmers who would not want to take the risk (i.e., risk averse farmers) hence will wait until May to begin to plant when they can say the rains are now reliable. Similarly, the consideration of whether there will (not) be a dry spell is necessary because a rainfall that is followed by a dry spell is not an effective rainfall as farmers may have to replant and that translates into acquiring farm inputs such as seeds and fertilizer. This will be

[8] A dry spell here is defined as any day with less than 0.85mm of rainfall (Stern et al., 2006).

problematic for smallholder farmers in rural north-west Ghana who are characterised by high poverty levels (GSS, 2014).

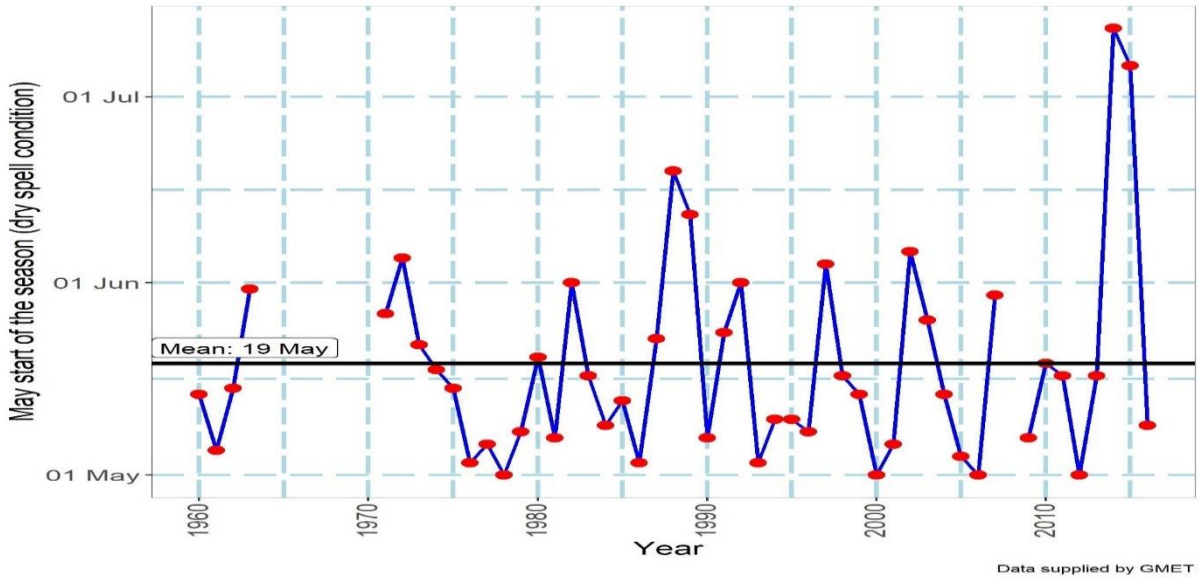
In trying to make meaning from the results, two statistical steps were considered: one was to fit a model for the rainfall events against year, and two, to generate statistical summaries of the climate events.

On the April and May definitions with the consideration of the no occurrence of a dry spell condition, the model showed no significance for both April (i.e., P-value of 0.23) and May (p-value = 0.33) – see Figure 3, Figure 4 and Table 3 for the details.



Source: Ghana Meteorological Agency

Figure 3 First occasion after 01st April that records more than 20 mm of rainfall with no dry spell of more than 9 days in the next 30 days



Source: Ghana Meteorological Agency

Figure 4 First occasion after 01st May that records more than 20mm of rainfall with the consideration of dry spell conditions

Definition	Earliest start date of the rainy season	Latest start date of the rainy season	Mean start date of the rainy season
April (dry spells)	02nd April	12th July	04th May
May (dry spells)	01st May	12th July	19th May

Source: Ghana Meteorological Agency

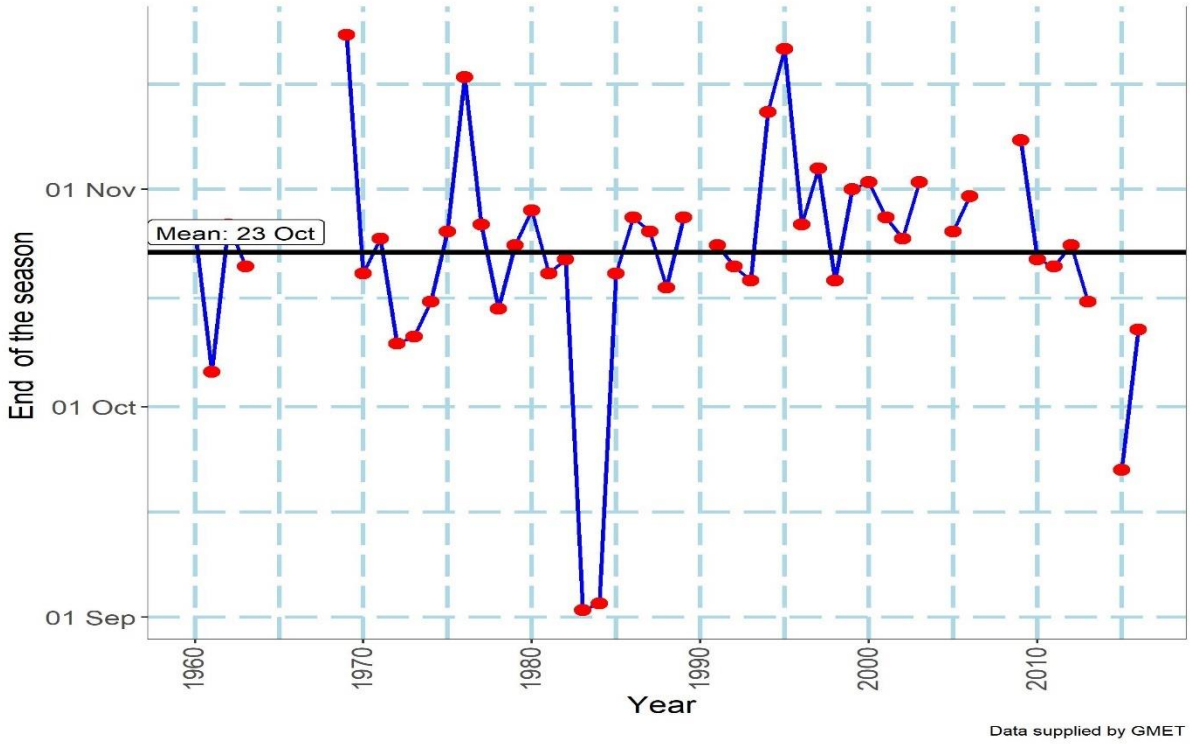
Table 3 Details of the date of start of the April and May definitions of the rainy season in Babile (1960-2016) with factoring in no occurrence of **dry spell conditions**

The end, and length of the rainy season

In as much of the start of a rainy season is important, it is important to acknowledge that, the end of the rainy season is equally critical as the two climatic events will determine how long or short a given agricultural season will be and hence the decisions that farmers can make. In this study, the simple water balance equation as suggested by Stern et al. (2006) was used to define the end of the rainy season.

In this definition, it is assumed that the soil capacity is 100mm, and evaporation is taken as 5mm per day. Based on these assumptions, the end of the rainy season is defined as

the first occasion after the 1st of September when the water balance drops to zero. In R-Instat, descriptive summaries of statistics, and modelling were carried out to understand the nature of the end of the rainy season (i.e., from 1960-2016). The results (see Figure 5) depict no trend (p-value = 0.81) in the end of the rainy season from 1960 to 2016 but rather variability in the end with the earliest end being 02nd September 1983, the mean being 23rd October and the latest 23rd November 1969.

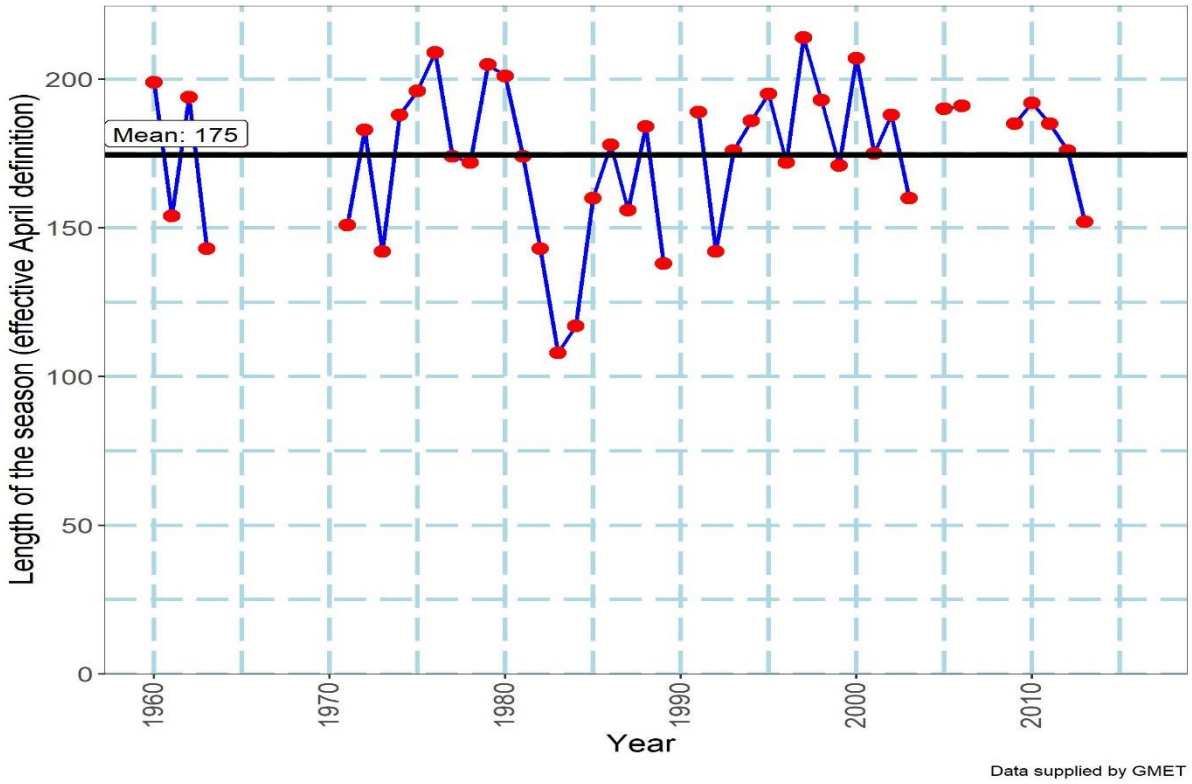


Source: Ghana Meteorological Agency (2016)

Figure 5 The first occasion after the 1st of September when the water balance drops to zero

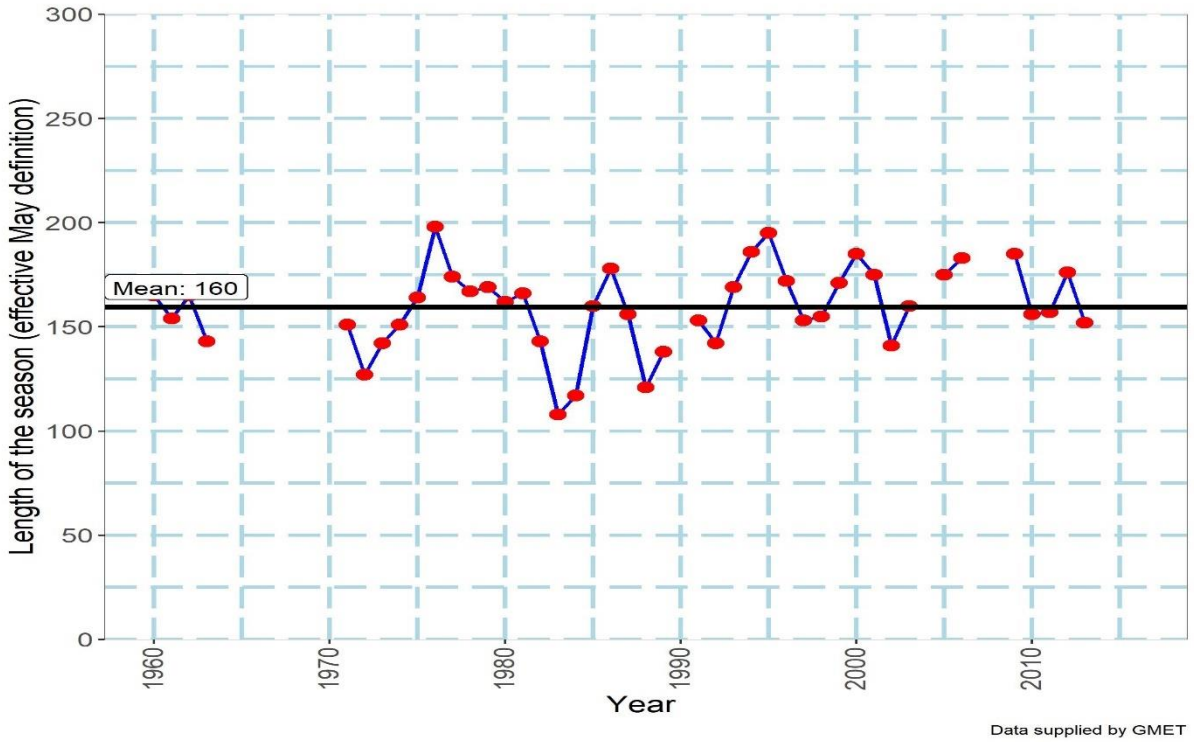
With the start and the end of the rainy season computed, the difference between the two gives the length of the season. Here, the effective start date of the rainy season was used (i.e., with no dry spell of 9 days in the next 30 days). In R-Instat, the dialogue 'calculations' was used to compute the length of the season by subtracting the start of the rainy season from the end of the rainy season as represented in figures 6 and 7 respectively for April and May definitions. With both the April (p-value = 0.35) and May (p -value = 0.13) effective definitions, the statistical analysis showed no significance for the length of the season and years.

For the April effective definition of the start of the season, the shortest season (108 days) of rainfall was recorded in 1983, the longest season (214 days) was recorded in 1997, and the mean length of the season being 175 days (see figure 6). Similarly, for the May effective definition of the length of the season, the shortest length (108 days) was recorded in 1983, the longest (198 days) in 1976 with the mean being 160 days (see figure 7).



Source: Ghana Meteorological Agency (2016)

Figure 6 Length of the season using effective April definition



Source: Ghana Meteorological Agency (2016)

Figure 7 Length of the season using effective May definition

Farmer perceptions of climate of their local area

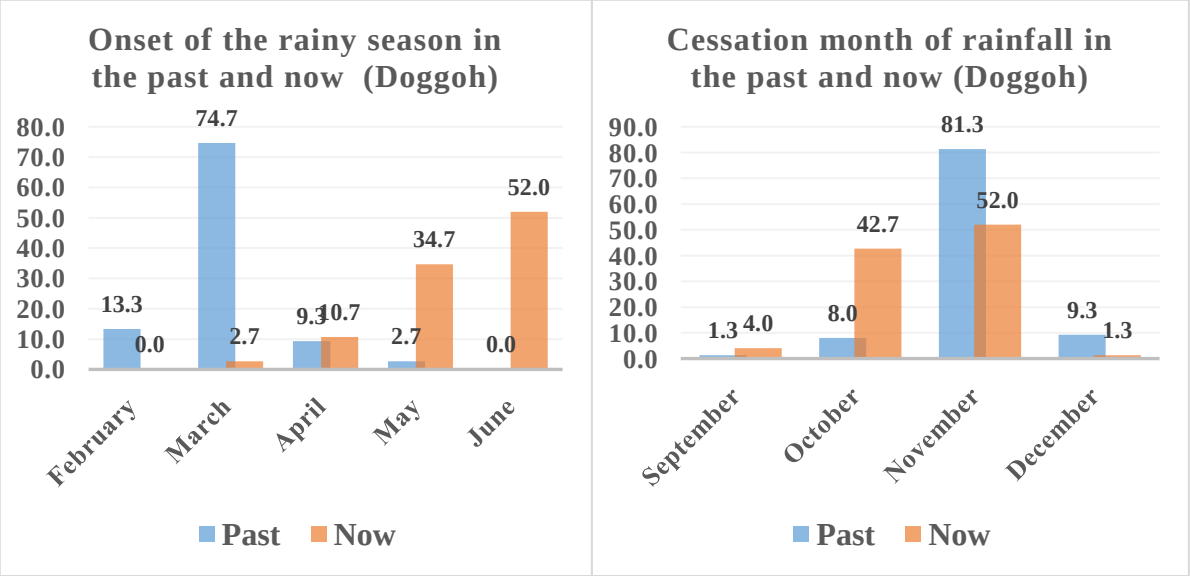
Having looked at the prevailing climatic situation of North-west Ghana using scientific data in the previous section, this section presents results on farmers' perceptions of climate variability and change (CVC). To that end, the section specifically focused on farmers' memory of climatic events, social differentiation of farmers' perceptions of CVC on the element of sex, and how farmers' experiences shape their perceptions of CVC.

a) Farmers' memory of climatic events: Past versus now

The objective was to understand how farmers recall rainfall events in the past and now as memory has been documented as one of the factors that shape farmer perceptions of climate variability and change (CVC) (see Taylor et al., 1988).

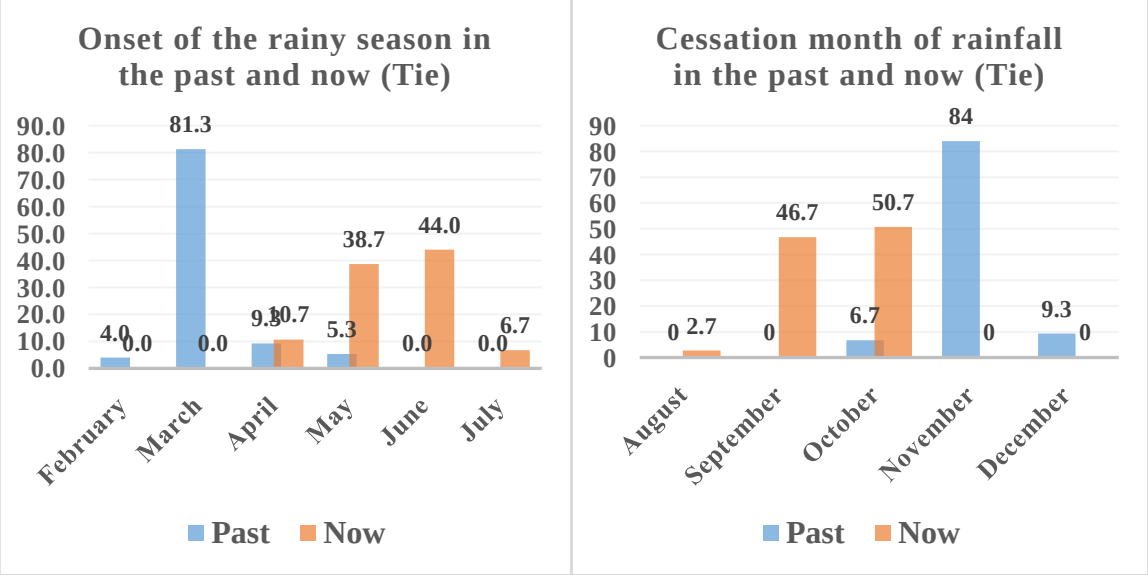
To that end, in the semi-structured questionnaire (SSQ), the researchers asked the respondents relevant questions like *'in which month did the rainfall start?', 'in which month does the rainfall start now?'.* Similarly, questions were posed on the cessation month of rainfall in the past and now.

The results showed that farmers perceived that the onset of the rainy season has shifted from March to June (see figures 8 and 9). In a study in the Afram plains of the Eastern region of Ghana, Codjoe and Owusu (2011) similarly found that farmers' have perceived a shift in the rainy season from February to March. Additionally, the results indicated that there has been a perceived shift in the cessation of rainfall from November to October (see figures 8 and 9).



Source: Fieldwork (Semi-structured Questionnaire, Doggoh, 2016)

Figure 8 Percentage distribution of farmers' perceptions of the onset and cessation months of rainfall in the past and now in Doggoh village (N=75)



Source: Fieldwork (Semi-structured Questionnaire, Tie, 2016)

Figure 9 Percentage distribution of farmers' perceptions of the onset and cessation months of rainfall in the past and now in Tie village (N=75)

Even though the majority of the surveyed respondents opined that there has been a shift in the onset and cessation of rainfall from March to June and November to October respectively, what is clear from the above results is subjectivity in farmers' perceptions of climate variability and change. This finding agrees with previous literature on the discourse of farmer perceptions of CVC (see e.g., Horsefield, 2016; Hulme et al., 2007; Osbahr et al., 2011; Singh, 2014; Singh et al., 2018).

b) Farmer perceptions of climate variability and change by sex

This section is tailored to understanding how male versus female farmer groups in the villages of Doggoh, and Tie perceive climate variability and change (CVC). To achieve that objective, the researchers analysed data from questions that were posed to respondents in the study to understand how farmers recall the onset and cessation months of rainfall in the past and now. Consequently, the SSQ data were analysed using simple cross tabulations. The results are separately presented for the villages of Doggoh, and Tie.

The results under " farmers' memory of climatic events (see Figure 8, and Figure 9) showed subjectivity in farmers' memory of the onset and cessation of rainfall now, and that of the past. It is therefore necessary to tease out who perceives what about farmer climate variability, and change. The analysis here has been restricted to understanding what proportion of the different farmer groups (e.g. male versus females) who perceived that the rainfall started earlier (i.e. March) and ceased later (i.e. November) in the past, and now starts late (i.e. June) and ceases earlier in October. The reason being that those were the responses from the majority of the surveyed respondents in both research villages.

Doggoh village

The results (see figure 8) suggests that farmers recalled February, March, April and May as the onset month of rainfall in the past, and March, April, May, and June as the onset months of the rainfall now. Similarly, the results from the SSQ data revealed that farmers observed September, October, November and December as the cessation months of rainfall in the past, and now[9]. This results clearly showed that different farmers have

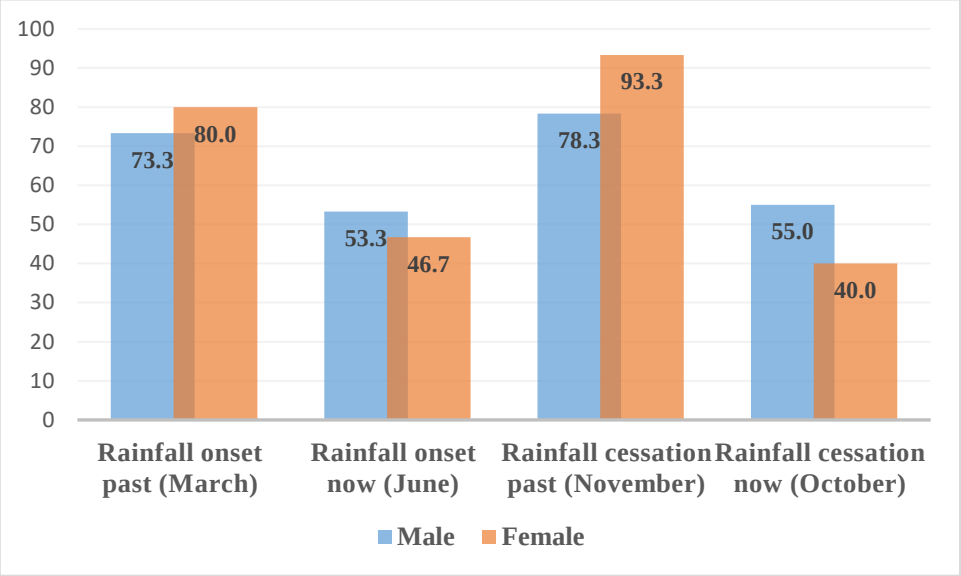
[9] See figure 8

different memory of the onset, and cessations times of rainfall in the past, and now[10]. Therefore, to have a nuanced understanding of the characteristics of who perceives what about rainfall, a cross tabulation was carried out using the questions: *'when did the rainy season start in the past', 'in which month does the rainfall start now', 'when did the rainfall cease in the past', and 'in which month does the rainfall cease now'* against the variable: sex.

Sex, and perceptions differentials

The results **(see figure 10)** showed that more female headed households perceived that the rainfall started earlier and ceased later in the past than their male counterparts. However, the results pointed that more males than females observed the rainfall starts later and ceases earlier now than the past. Statistically, the data revealed the following: (i) more female headed households (80.0%) than the male headed households (73.3%) perceive that the rainfall used to start earlier in March in the past, (ii) more males (53.3%) than females (46.7%) are of the view that the rainfall starts later now in June, (iii) more females (93.3%) than males (78.3%) observed that the rainfall ceased later in the past, (iv) more males (55.0%) than females (40.0%) observe that the rainfall ceases earlier now.

[10] See section on *"farmers' memory of climatic events: Past versus now"*



Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

Figure 10. Percentage comparison of farmers' perceptions of climate variability and change in the past and now by sex in Doggoh village (Males = 60, Females =15)

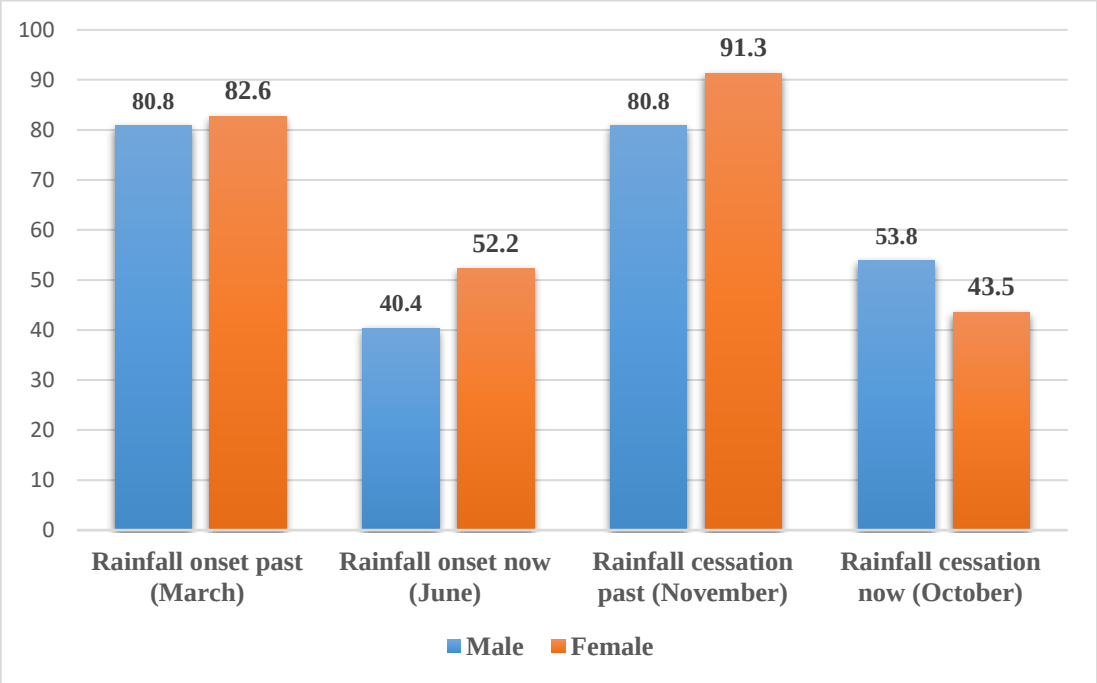
Tie village

For the village of Tie too, a cross-tabulation analysis was carried out using the questions: *'when did the rainy start in the past', 'in which month does the rainfall start now', 'when did the rainfall cease in the past', and 'in which month does the rainfall cease now'* against the variable: sex. A similar approach as applied in the village of Doggoh was used for the interpretation of the results of the cross tabulation focusing on the proportion of the various farmer groups out of the total sample of each farmer group that perceived that the rainfall started earlier in the past (i.e. March) and later now (i.e. June), and the rainfall ceased later in the past (i.e. November) than now (i.e. October).

Sex differentials

On the aspect of sex and farmer perceptions of climate variability and change, the following were the results from the analysis of the data: (i) more female farmers (82.6%) than male farmers (80.8%) perceived the rainfall started earlier in the past (i.e. in March), (ii) more female farmers (52.2%) than male farmers (40.4%) perceived the rainfall now starts later in June, (iii) more female farmers (91.3%) than male farmers (80.8%) perceived the rainfall ceased later in November in the past, and (iv) more male farmers (53.8%) than female farmers (43.3%) perceived the rainfall now ceases earlier in October (see figure 11 for details).

Figure 11. Percentage comparison of farmers' perceptions of climate variability and change in the past and now by sex in Tie village (Males = 52 Females=23)



Source: Fieldwork (Semi-structured questionnaire, Tie village, 2016)

Table 4. Summary of the social differentiation of farmer's perceptions of climate variability and change in Tie

Climate event	Sex	
	Doggoh	Tie
Onset of rainfall past (March	More female farmers than male farmers	More female farmers than male farmers
Onset of rainfall now (June)	More male farmers than female farmers	More female farmers than male farmers
Cessation of rainfall now (October)	More female farmers than male farmers	More male farmers than female farmers
Cessation of rainfall past (November)	More male farmers than female farmers	More female farmers than male farmers

Source: Fieldwork (Semi-structured questionnaire, Tie village, 2016).

Farmers' experiences shaping perceptions of climate variability and change

The results from the household case studies (HCSs) revealed that, farmers' experiences of climatic events in the past and now are shaped by: (i) changes in the return timing of northern farm migrants from the southern belt of Ghana, (ii) communities in the past had to 'chase' the rains away, and (iii) rainfall now is characterised by more wind and less rain drops. The narratives on each of these themes are discussed below.

Example 1: Farm migrants returning later now to the north from the south than in the past

The results from the HCSs showed that migrant farmers from the north to the southern part of Ghana returned to the north around either January, February or latest by March to go about their farming activities. Also, it emerged from the data that migrants that were the only sons in their households returned home immediately after Christmas because of the 'heavy' farm load that one person had to handle. However, those from households with many sons returned later as the farm workload would be shared amongst them (HCS, Doggoh and Tie). In Doggoh, a participant noted "you *see, in the past, our young sons that migrated to the southern part of Ghana, after Christmas, those that were the only males in their households had to start getting back home to prepare the farm fields in anticipation for the rainfall- by March, all our sons would have returned from the southern part of Ghana and plunged straight into farming as it would have rained many times"* (HCS-3-D-Male). On the contrary, many participants in the HCSs indicated that, migrant farmers now begin to come back north around May due largely to late onset of the rainfall now. HCS-12-T-Male expressed his view as follows: "… *but now, it starts raining in the sixth month after Christmas and those who migrate to southern Ghana begin to come back home in May*".

Culturally, males are expected to assist their in-laws in their farming activities (HCSs, Doggoh and Tie). This means multiple farming tasks – of handling their households' farms and that of their in-laws. Consequently, it emerged from the HCSs results that, it is an unacceptable

practice for male farm migrants to return late from the south in the past. A participant in Doggoh observed "*you see, those days we used to seasonally migrate to the southern part of Ghana. Then we returned by January and latest by February, and in March it used to start raining for us to plough our farm fields. If one made a mistake and returned after March, once you get to your father-in-law and greeted him, he would not respond but instead would say you are coming to me after the ploughing of farm fields is over*'' (HCS-13-D-Male).

Example 2: We used to 'chase' the rains away in the past

"Those days it would rain from morning till evening. If you had cattle in the den, you had to take them out in the rain to find some pasture for them to feed otherwise the rain will fall from morning till evening and the cattle would die of hunger or will force their way out" (HCS-9-T-Male)

The results from the data indicated that the amount of rainfall farmers experienced in the past and now are not the same. The main theme that has run throughout many of HCSs is that, the rain used to fall throughout the entire day from morning till evening in the past. This, according to the interviewees translated into several potential hazards. To begin with, the HCS participants noted that, there was a possibility of households going hungry in the past if they were ill prepared for example not having firewood, and flour for food before it started raining. A female participant in Tie explained *"those days, it used to rain throughout the whole day. If you never had firewood, you would go hungry on such rainy days. It used to rain heavily, and water will run over the rivers, then the following day, it will get us indoors due to the torrential nature of the downpour. Similarly, if you did not have beans flour, then you would go hungry. These days, we do not see such kind of rainfall*" (HCS-3-T-Female).

Secondly, it is reported in the HCSs that, farmers felt so cold in the past due to the heavy downpour that characterised rainfall events. Consequently, people carried fire alongside in the early hours of the day on the way to bush farm fields in order to keep themselves warm. In Doggoh, HCS-7-D-Male noted "*you see, those days, once it began raining, it would rain continuously till the end of November, then all the sorghum and millet in the bush farm fields*

were all harvested. You see, before going to the bush farm fields those days in the morning to carry the harvested farm produce, we had to get some fire from wood to warm up ourselves as the whole ground was heavily wet and cold. Then the days we never had any farm work, we had to stay at home to get ourselves warm with fire- but now, the intensity of the rainfall is no longer like that of the past".

Reportedly, the interviewees revealed that, because of the above nature of the rainfall in the past, they had to 'chase' the rains away. In the focus group discussions, participants largely opined that in the past they went on top of their houses, played drums, and pleaded for the rain to cease when it was raining beyond limits (FGDs, Doggoh and Tie).

Example 3: Rainfall now is characterised by more wind and few drain drops

Unlike the narratives in examples 1 and 2, the HCS participants largely agreed that, the current pattern of rainfall does not fall at expected periods even when clouds form and wind blows. In sum, it is observed that the current pattern of rainfall is characterised by more wind and less rain drops. For example, in Tie, a participant observed "*you see, the time we expect the rain to fall, it would not fall. When the clouds form and the wind begin to blow and rise, we expect the rain to fall but it does that without any sign of rainfall. So, by the time we begin to sow, if you do not apply fertiliser, the crops would not do well- these are all farm practices we did not know in the past*" (HCS-3-T-Female). Similarly, many of the respondents opined that the rainfall now is one in which the wind supersedes the rain drops, and it can rain at one section of Doggoh or Tie and sends only wind to the other sections. A female participant expressed her view as follows "*now, once it begins to rain, the wind is usually more than the rain drops. These days, it rains at one section of the same village, but the raindrops do not touch the other areas. But those days, once it began raining, it would rain heavily, touch all sections of the village and the whole ground would be very wet*" (HCS-7-T-Female).

Cultural values and beliefs shaping farmers' perceptions of changes in climate

"…those days the elders used to come together to perform some sacrifices during the beginning of the season. They would say things like we have seen the rain but have not seen the raindrops. When the rain is about to drop too, they would say we have seen the drops, but the amount should increase, the rain should be free of too much wind, it should rain well till the cessation moment for it to stop. The rain used to fall properly but now the early rains are very windy and destroy people's houses and crops".

(HCS-15-D-Male)

In this section, the researchers argue that cultural values and beliefs are important in influencing our understanding of climate, which potentially shapes individual and collective priorities, and responses to climate change (Scoville-Simonds, 2018). It is noteworthy that it is not the scope of this section to compare results of Doggoh with that of Tie as the data revealed the same cultural values are shared by the two villages.

To have a deeper sense of the role of cultural values and norms in shaping farmers' perceptions of CVC, the researchers drew on data from the village key informant interviews (VIKIs), the focus group discussions (FGDs), and the household case studies (HCSs). The analysis revealed that, changes in climatic events is largely a function of decline in the cultural practices/agricultural ritual activities of the forefathers by the current generation of elders. Other factors that emerged from the data included increased in violation of the rules of the gods, and the rains been 'held' by traders as a way of enhancing their marketing activities. Each of the narratives are discussed below.

Good rainfall in the past was a characteristic of sacrifices being offered to the gods and ancestors

The results from the VIKIs data revealed that within Doggoh and Tie, there are expected farm and rain related sacrifices that must be performed in the beginning of every agricultural season, and sometimes in-between the season. The VIKIs identified

tenganmaaloo and *kuuremaaloo* as rain enhancing sacrifices that will translate into a fruitful agricultural season (VIKIs, Doggoh and Tie).

Tenganmaaloo sacrifice

Accordingly, *Tenganmaaloo* starts with contribution of farm produce (i.e., crops e.g., sorghum for brewing *pito*[11], fowls, and livestock) from households within the village. Consequently, upon receipt of these items, the elders of the village make sacrifices to the gods of the land at *Tengan*[12] largely at the beginning of every season to ask for a conducive rainy season that will bring bumper harvest to the people (VIKIs, Doggoh and Tie). In Tie, a VIKI explained the practice of *Tengan-maaloo* at the beginning of the agricultural season as " *once the sazzaba sets in every year in the past, everyone would make contributions (fowls and sorghum etc) – so that the elders will take the lead to the Tengan – so that they ask the gods of the land, and the ancestors to give them a season characterised by high rainfall and high yields – then they will plead that the season should not be characterised by heavy wind and storms – the elders will say things like, if the gods of the land are true gods, then any rainfall that comes with extreme wind should deviate their village and get to another village" (VIKI-1- Tie-Male).*

Similarly, the participants observed that, once the agricultural season was characterised by long periods of dry spells, the elders again had to go to offer sacrifices at the *Tengan* to plead for rainfall. In Doggoh, a participant noted "*once the season was under the influence of long periods of dry spells, the elders would take fowls to the Tengan and make sacrifices and say things like 'if you are true gods, then let there be rainfall for our crops to flourish, then we will after a bumper harvest come back to offer fowls as sacrifices in terms of thanks giving* (VIKI-2-Doggoh-Male). It largely emerged from the

[11] A traditional alcoholic beverage made from sorghum

[12] Throughout the interviews with the village key informants, it emerged that *Tengan* (sacred grove) refers to a grove of trees that is meant for the performance of traditional sacrifices (VIKI1-D-M, VIKI-1-T-Male)

data that, the rationale of the sacrifices at the Tengan is in recognition of the fact that the gods and the ancestors are the true owners of the farm lands hence their permission has to be sought prior to farmers going about their agricultural activities in each season.

Kuuremaaloo ritual sacrifice

Beyond the sacrifices at the group level in the village, the data from the VIKIs revealed that sacrifices were offered at individual household levels involving the use of fowls and livestock to the ancestors (i.e., *kuuremaaloo* ritual). Accordingly, it involved the use of two livestock, and two fowls with one each offered to the farmer's deceased grandfathers, and his fathers (VIKIs, Doggoh and Tie). The respondents reported that, the rationale was to ask for permission from the ancestors even though they are dead, it is believed that, they are still the owners of the farms, and the farm implements. Similarly, those farmers who were soothsayers and as such owned lesser gods sacrificed fowls to their gods and asked for a better rainy season, that would be characterised by better yield. A VIKI in Doggoh detailed "*in the past, once the first rains arrived in the year, there were sacrifices the elders made using fowls and livestock. You know, we do not own the hoe and the farms, they are the properties of our forefathers, so at the beginning of every season, we are expected to make sacrifices and ask our forefathers to permit us to use the hoes and the farms. To that end, we sacrificed like two fowls, one for our grandfathers and one for our fathers. Then for those who are soothsayers, they made sacrifices to their lesser gods. Then, they told the gods that these fowls and the sacrifice are meant to request for a fruitful agricultural season*" (VIKI-2-Doggoh-Male).

Furthermore, the data revealed that the *kuuremaaloo* ritual sacrifice also takes place after the harvest season particularly a season that is characterised by a bumper harvest. Accordingly, four (4) livestock, and four (4) fowls were sacrificed in the past to the ancestors for giving the household a good harvest. A VIKI in Tie detailed the post-harvest *kuuremaaloo* sacrifice as follows: "*Once the season is over, you will offer two black*

livestock and two fouls to your fathers, and two white livestock and two fowls to your grandfathers, this is what we call koure -maaloo" (VIKI-2-Tie, Male).

Ritual sacrifices to appease the gods upon violation of rules of the land

The respondents observed that, other sacrifices were performed in the event of a man sleeping with another man's wife, youngsters having sexual affairs outside of home, and someone killing another person or someone dying in the farm.

In the context of a man sleeping with another man's wife, it emerged from the VIKIs that, the suspect will accordingly contribute a livestock and three fowls for the elders to make sacrifices to the gods of the land to cleanse the land. Similarly, the data revealed that, in recent times, there is this suspicion that youngsters have sex outside of homes, which is also an unacceptable practice in the land of Doggoh and Tie. To that end, the respondents observed that, some farmers at the beginning of every season made sacrifices in their land as a way of asking the ancestors to cleanse their farm fields if some people had sex there. In the FGD in Doggoh, a male participant observed "*If someone has by chance slept with another man's wife, a fowl was used to purify the farmlands by individual farmers in the case of unknown sexual activities. Then the farmer would say things like 'I offer this fowl to cleanse this farmland if someone has slept with another man's wife here so that the land would be cleansed. In the event of those caught in the act, i.e., a man sleeping with another man's wife, the suspect takes a livestock and three fowls so that we use that to offer sacrifices at where the event took place" (FGD, Male Participant, 75 years, Doggoh).*

Additionally, the participants detailed that, when someone died an unnatural death which accordingly manifested in the form of suicide, someone dying outside of home, and when someone killed another person, there were required sacrifices that were made to appease the gods of the land. In Tie, a participant in the FGD noted "*once someone kills another person,*

the elders will gather three fouls, and a white livestock, and then go to the ground where the fellow died to perform sacrifices in order to cleanse the dirt from the ground. The gods of the land taboo such blood hence the sacrifices are meant to purify the land and ask for forgiveness from the gods. Once that is done to the gods of the land, then it can rain. Those who are related to the deceased cannot partake in such food. Even someone that died through suicide, the above sacrifices must be performed. Once someone dies via hanging on a tree, that tree would be cut down" (FGD, Male Participant, Tie).

Unreliable rainfall now– the role of decline in the performance of traditional sacrifices and rituals, violation of the rules of the gods of the land, and traders 'holding' the rains

The participants (i.e., during the VIKIs, the FGDs and HCSs) in this study attributed the causes of the unreliable nature of rainfall in their local area to: (i) a decline in the performance of rain-inducing sacrifices to the gods and ancestors, (ii) the violation of 'rules' of the gods of the land without accompanied sacrifices to appease the gods, and (iii) the rains being 'held' by traders. Each of the above narratives are detailed below with supporting quotes from the respondents.

Decline in the performance of traditional sacrifices and rituals

In the previous section, the respondents reported that elders in Doggoh and Tie were very united in the past hence came together and performed sacrifices to the gods of the land at the beginning of the agricultural season, and at certain 'difficult periods' such as the agricultural season being characterised by a dry spell. That notwithstanding, the participants observed that, the elders of 'today' are no longer united. Hence, they do not perform sacrifices at the *Tengan* and also at their respective households to seek for permission from the ancestors and gods of the land (VIKIs, Doggoh and Tie). Beyond the element of disunity among the elders of this generation, the respondents similarly opined that the advent of Christianity (largely catholic faith) has

translated into many people being converted into Christians hence pay less attention to traditional religion and it associated practices. A VIKI in Doggoh observed "you *see, the coming of Father McCoy and other white fathers to the Jirapa Area has translated into the conversion of many of our people to follow and practice Christianity- hence many people no longer offer sacrifices to the lesser gods as it is considered evil and unacceptable in the Christian faith"* (VIKI-1-D-Male).

To the respondents, the disunity among elders of 'today' and the influence of Christianity translate into less attention being attached to offering sacrifices, and some people staying away from offering sacrifices to the gods of their land and forefathers. Accordingly, these influence the changing pattern of climatic events in their local area now. A HCS participant in Doggoh pointed out that, when it is about to rain now, the wind supersedes the amount of rainfall because the elders no longer make sacrifices to the gods (*HCS-15-D-Male).* The above result of farmers perceiving that the climate has changed because the elders do no longer perform sacrifices to the gods of their land are similarly reported in the literature on cultural values, and farmer perception (see e.g., Jarawura, 2014; Salite, 2019; Scoville-Simonds. 2018).

Violation of the 'rules' of the land

"... You see, it is not like the rain does not want to help us but because we have gone against the rules of our land that is why the rain is no longer regular now as compared to that of the past" (HCS-9-T-Male)

The respondents also opined that, certain unacceptable behaviours such as a man sleeping with another man's wife, youngsters having sex outside of homes, and the deliberate shedding of blood do happen in Doggoh and Tie now and the expected ritual sacrifices are not performed by the elders of the land to appease the gods and the ancestors. To begin with, on the aspect of sex outside home, the respondents detailed that, youngsters are not expected to have sex outside homes as that is against the rules of the land. A HCS in Doggoh detailed "*there are some things the elders say the youth should not involve*

themselves in but they persist to do them. For instance, if people have sex in an open place, all that contributes to the rain not falling properly in recent times" (HCS-2-D-Male, 70). On the element of shedding of blood, it is reported by the participants that it is prohibited to kill someone or when someone died outside of home; maybe in the bush (VIKIs, Doggoh and Tie). Accordingly, sacrifices were made to appease the gods but in recent times, such sacrifices are overlooked. In Tie, a participant explained "*When people were found dead outside of homes, their blood was taken, and contributions were made for the elders and they performed sacrifices which cleansed the land. However, now, people are found dead outside, buried without the needed sacrifices. I think the violation of these ritual norms also contribute to the changing nature of climatic events*" (HCS-14-T-Male- 65).

The rains are 'held' by some people

In the HCSs, the participants pointed out that 'some people' have the 'power' to stop the rains from falling. The respondents observed that traders in particular are not happy when it rains as that is not a good ground for their businesses to flourish (HCS participants, Doggoh and Tie). It was reported by the HCS participants that, traders have the power to 'hold' the rain so that people cannot get good produce from their farms to survive. Accordingly, the demand for food from market sources would increase which will trickle down to induce the prices of food produce to increase, and more profit for traders. In the HCS in Doggoh, a participant reported *"Ok, it is difficult to tell what really accounts for that. I think God and the earth are still in good relation. But I think there are some people who do not want the rain to fall so early, but some need it to fall early. Right now, if it does not rain well and there is no food, those that sell food stuffs can always sell their produce and get enough money. For instance, for all you know, I have bought food stuffs and have filled my room to the brim, if the rain does not fall, the demand for food will increase and I can increase the prices of my food stuff, sell and make a lot of cash. You see that there are points in time some markets are closed and no trader is allowed to go in there because expected rains do not fall at the appointed time…because the*

traders pray that the rain should not fall so that they can make a lot of money from their sales. You see that when markets are closed for long, it then begins to rain…it means we humans that have the power to hold on to the rains" (HCS-18-D-Male).

Discussion, Conclusion and Recommendations

Discussion

This paper sets out to understand how farmers' perceptions of climate variability and change are constructed by cultural values and beliefs. To that end, the paper addressed the following objectives: (i) to understand the scientific version of the climate situation of north-west Ghana, (ii) to understand farmers' memory of climatic events in the past and now, (iii) to understand farmers' experiences of climatic events in the past and now, and (iv) to understand how cultural values and beliefs of an area influence how natives construct changes in climate. To accomplish the above objectives, the researchers relied on secondary data (i.e., daily rainfall data) from GMet and primary data that was collected in the field using mixed methods. Similarly, the researchers drew on the theory of drought perception and ideas of cultural worldviews to conceptualise the study's findings.

The results showed that, farmers' perceptions of rainfall disagreed with analysis of scientific rainfall data. Whereas, farmers observed late start, and early cessation of rainfall now as compared to that of the past, the climate analyses showed no evidence of a change but rather variability in the onset, cessation, and length of the rainy season now as compared to that of the past. The results of this study are consistent with that of Amadou et al. (2015). However, whereas this study reported mismatches between farmers' perceptions of CVC and analysis of climatic data, other studies reported matches – for example in Nigeria (see e.g., Ayanlade et al., 2017) and Pakistan (see e.g., Imran et al., 2020).

On the element of farmers' memory, the respondents in the villages of Doggoh and Tie shared similar perceptions of rainfall. Even though the majority of the surveyed respondents observed a shift in the onset of the rainfall from March to June, and the cessation of the rainfall from November to October, the results clearly showed subjectivity in farmers' perceptions of climatic events. The finding of subjectivity in farmers' perceptions of climate variability and change is in consensus with the broad documentation that farmers memories of climatic events (i.e., past as against the present) are subjective (see e.g. Codjoe and Owusu, 2011; Horsefield, 2016; Hulme et al., 2007; Osbahr et al., 2011; Singh, 2014; Singh et al., 2018). For example, Codjoe and Owusu (2011) reported a shift in the onset of the rainy season from February to March in a study that focused on the Afram Plains of the Eastern region of Ghana. Similarly, Osbahr et al. (2011) observed a similar finding on farmer perceptions in Uganda.

In terms of social differentiation, the results showed negligible difference between male and female farmers' perceptions CVC. In Doggoh, the results demonstrated that, more female farmers than male farmers perceived that the rainfall started earlier and ceased later in the past. However, more male farmers than female farmers perceived that the rainfall starts later now and ceases earlier now. In the village of Tie, more female than male farmers perceived that rainfall started earlier in the past (i.e., March) than now (i.e., June). Similarly, more female farmers than male farmers perceived that ceased earlier in the past (i.e., November). However, more male than female farmers perceived that the rainfall ceases earlier now in October.

On Farmers' personal experiences, farmers argued that in the past, it used to rain torrentially from morning until evening. This type of rainfall pattern led to: (i) some households going hungry because they did not get dry firewood or had not grinded flour at home to cater for their food needs; (iii) cattle escaping from their enclosures to look for pasture because they remain fenced for long periods (iii) some respondents resorted to playing the drums on top of the roof of their houses to request from the gods that the rains cease, (iv) family members that migrated

to the southern part of Ghana started returning by December for them to begin to prepare the farmlands in readiness for the rains. The finding of farmers' perception of their experience of 'chasing the rains away' in the past potentially could be an exaggeration as documented broadly in the literature (see e.g., Slegers, 2008; Singh, 2014).

Unlike scientific notions, findings of this study revealed that changes in climatic events are largely linked to cultural beliefs and values. Specifically, it emerged that non-offering of sacrifices to the gods of the land, the killing of people without accompanied ritual performances to appease the gods, traders 'holding' the rains for their businesses to flourish, and promiscuous behaviour by young people contribute to the associated changes in the rainfall pattern. This finding similarly resonates with other studies. For example, Kumagai et al. (2006) attributed changes in climate are attributable to human actions and inactions. Drawing on Kumagai et al. (2006) ideas, the findings of this study showed that, the inaction of the elders in performing expected ritual sacrifices to the gods of their forefathers at expected time periods of the year have led to changes in climatic events of their local area. Additionally, the finding of the youngsters being blamed as their youthful activities contributing to changes in climate are similarly reported in other studies (see e.g., Boillat and Berkes 2013; Jarawura, 2014).

Conclusion and recommendations

The results of this study have highlighted that climate variability and change (CVC) are real problems for farmers in Northwest Ghana as the climate data revealed variability and farmers claimed changes in their local climate. Consequently, in terms of policy practice implications this study suggests that, farmers in north-west Ghana need to be supported with relevant adaptation measures so they can minimise the negative impacts, and utilise the positive impacts associated with CVC.

Similarly, the results from this paper have highlighted that, cultural worldviews and values play a critical role in shaping farmers' perceptions of CVC. To that end, this study has contributed to our understanding of the role of cultural values in shaping farmers' constructions of CVC.

The above findings have critical implications for climate change adaptation, and research. On the dimension of 'local perceptions of climate variability and change', this study argues that, there should be a shift in just looking at perception as detection (see e.g., Scoville, 2018) to perception as understanding. Specifically, we should look beyond concentrating on what specific climate events have changed, to focusing on how those changes are understood in different cultural milieu (see e.g., Allison, 2015; Paerregaard, 2013; Scoville, 2018). It is worth stating that, such a 'direction' would require deepening the 'human dimension' of climate variability and change by paying attention to worldviews, beliefs, and values in societies.

Appendix A: An illustration of the locally criteria developed by village leaders in stratifying the villages of Doggoh and Tie into different wealth strata

Wealth stratification by village leaders in Doggoh

Criteria		Household type		
		Rich	Semi-rich	Poor
Ownership of livestock	Cattle	≥ 8	5-7	< 5
	Sheep	≥ 30	10- 29	< 10

	Goats	≥ 40	10-29	< 10
Size of maize-w farm holding		≥ 7	3-6	< 3
Number of educated persons in household		≥ 5	3-4	3
Number of wives married by household head		3	2	1
Number of children		≥ 10	3-9	< 3
Nature of household building		Block house with iron roofing	Bricks house with iron roofing	Mud or grass roofing

Source: Fieldwork (participatory exercise, Doggoh, March 2016)

Wealth stratification by village leaders in Tie

Criteria		Household type		
		Rich	Semi-rich	Poor
Ownership of livestock	Cattle	≥ 6	3-5	< 3
	Sheep	≥ 15	10- 14	≤ 9

	Goats	≥ 30	20-29	< 15
	Ducks	≥ 20	15-19	≤ 14
Size of farm holding		≥ 10	5-9	≤ 4
Number of educated persons in household		≥ 7	4-6	≤ 3
Number of wives married by household head		3 or more	2 wives	1 wife
Nature of household building		Block house with iron roofing	Bricks house with iron roofing	Mud or grass roofing

Source: Fieldwork (participatory exercise, Tie, March 2016)

Declaration of Interest Statement

Authors' contribution

This study was part of G. D's PhD thesis. In addition, extra data was picked outside the subject area of his PhD. Conception of research idea, G.D.; formulation of research objectives: G.D. and P.O.A.; methodology: G.D.; fieldwork: G.D.; formal analysis: G.D.; writing -original draft preparation: G.D.; writing- review and editing: P.O.A; H.O; general supervision of the quality of the manuscript writing process, H.O. All authors have read and agreed to the published version of the manuscript.

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Compliance with ethical standards

Conflict of Interest

The authors report no conflict of interest.

Ethical approval

This study was approved by the University of Reading Research ethical clearance committee.

Informed consent

The researchers obtained informed consent from all the participations before collecting data from them.

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