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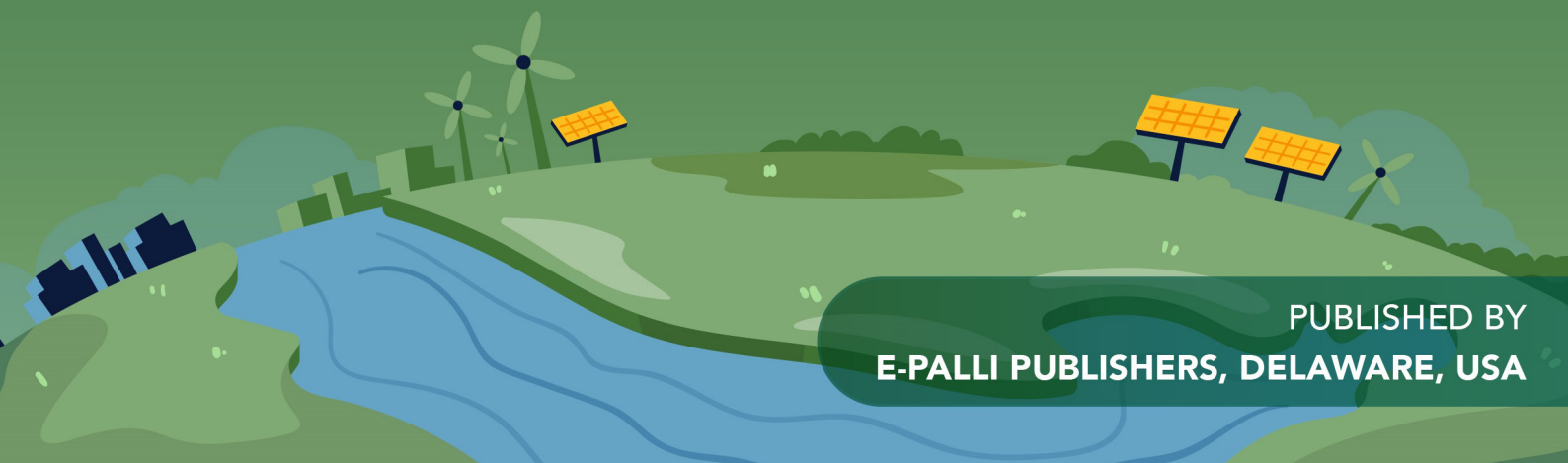

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Assessing Indigenous and Modern Adaptation Strategies to Climate Change Among Legumes Producers in the Bongo District of the Upper East Region, Ghana

Jonah Amosah[1*], Tahiru Lukman[2], Enerst Dabil Nabwomya[3]

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ABSTRACT

Globally, climate change adaptation initiatives have significantly improved recipient farmers' livelihoods by increasing their resilience, production, and overall standard of living. Climate adaptation results in noticeably higher yields from food crops. Climate change events have had a detrimental impact on farmers in Ghana, especially in the Upper East region. This includes producers of legumes in the Bongo District, which is a part of the fragile savanna semi-arid zone. The growing food insecurity and failure of legume crops point to serious losses in climate change adaptation methods. Farmer's adaptation strategies have fallen short over time, necessitating a revision of programs to assist growers of legumes in the Bongo District. The obstacles connected with indigenous and contemporary adaptation techniques to climate change are also examined in this study, along with local and contemporary stakeholders' involvement in adaptation efforts. The primary data was gathered through the use of focus group discussions and interviews. In three communities, 70 farmers who grow legumes were sampled using a simple random sampling technique to select the respondents. The study concludes that farming and mixed cropping are important indigenous adaptation techniques, whereas forecasting and greater variety are important modern adaptation strategies. The MoFA and the Bongo District Assembly are the two important entities in executing adaptation plans, while local farmers were highlighted as key stakeholders. Additionally, it was determined that weak extension services and a lack of integration of indigenous adaptations into contemporary practices could pose serious obstacles to developing climate change adaptation strategies. The study recommends integrating local and contemporary adaptation strategies to combat climate change.

INTRODUCTION

Climate change is the most significant global stressor on food supply and production (Ray *et al*., 2019). Sub-Saharan Africa (SSA) is the most vulnerable region to climate change due to a combination of limited adaptation capacity and distinct socioeconomic and climatic characteristics (IPCC, 2014). The area's population is primarily dependent on agriculture, which is supported by rain (Shimeles *et al*., 2018). As a result, any negative impact of climate change on the water cycle seriously threatens agricultural production, human well-being, and the economy (Food and Agriculture Organization, 2020). West Africa has been designated a significant climate change zone, which is expected to result in lower crop yields and food production, jeopardizing the region's food security (Sultan & Gaetani, 2016). These consequences, which are expected to worsen in the future, will severely harm regional economies and people's quality of life (Sylla *et al*., 2016).

Furthermore, Ghana has been designated a climate change hotspot (Asante & Amuakwa-Mensah, 2015). Numerous studies have documented the effects of climate change in Ghana, the most visible of which is increased rainfall variability, rising temperatures, rising sea levels, and an increased frequency of weather extremes and disasters (Food and Agriculture Organization, 2013). Ghana's economy heavily depends on forestry, agriculture, and other climate-sensitive industries (MoFA, 2007). Agriculture and forestry provide non-timber and timber forest products to approximately 70% of the population (Food and Agriculture Organization, 2013). Climate change has the potential to affect Ghana's economy, particularly the most vulnerable sectors (Asante & Amuakwa-Mensah, 2015).

Northern Ghana is more vulnerable than the rest of the country to the effects of climate change and variability (Klutse *et al*., 2020). This is because the area has a poorer, drier climate and the majority of its residents rely on subsistence farming of staple food including legumes (Darko & Atazona, 2013). The production of food crops including legumes is contributing significantly to Ghana's food export promotion. Ghana is ranked 112th when it comes to the exportation of Legumes in 2020 and the 434th most exported product in the same year. Ghana's main export destinations for Legumes are the United States, the United Kingdom, the United Arab Emirates, Belgium, and Canada. The production of legumes in the Bongo District is estimated to be around 37% of the food harvest (BDA, 2014). Legumes such as groundnuts, soya beans, and beans are the dominant

[1] Department of Development Studies, Faculty of Integrated Development Studies, Simon Diedong Dombo University of Business and Integrated Development Studies, (SDD-UBIDS), Ghana
[2] Department of Environment and Resource Studies (ERS), University for Development Studies, Ghana
[3] Department of Project Management and Community Development, Faculty of Planning and Land Management, Simon Diedong Dombo University of Business and Integrated Development Studies, (SDD-UBIDS), Ghana
[*] Corresponding author's e-mail: jamosah@ubids.edu.gh

crops that are grown (BDA, 2014). In contrast, the people have a low adaptive capacity for adaptation to climate change when compared to the rest of the country because they rely on unimodal rain-fed agriculture and have low socioeconomic development (MoFA, 2016). Communities in northern Ghana are increasingly struggling to cope with harsh weather conditions such as drought and flooding. Coupled with these challenges is the high rate of illiteracy in northern Ghana where Bongo is located (GSS, 2014), making it difficult for the majority of farmers to understand the specifics of weather and climatic forecasts.

According to research, the majority of rural farmers manage their farms using their native expertise, which improves rural livelihoods since they have an understanding of the local environmental conditions (Sullo *et al*., 2020). Few studies have been conducted to examine how indigenous and modern adaptation practices are used to manage climate risks in Ghana (Gyampoh *et al*., 2009; Sullo *et al*., 2020). As a result, this study provides insight into how indigenous and modern adaptation strategies aid legume producers in adjusting to local climatic stressors in the communities of Nyariga, Vea, and Gowrie in Ghana's Upper East Region, where legume producers use both indigenous and modern adaptation strategies to adapt to climate change.

LITERATURE REVIEW

Legumes

Legumes are a crop of crops with the potential to develop a country that invests in them. Legumes are nature's priceless gift to humanity due to their high protein content (16-50%), vital element content, dietary fiber (10-23%), and vitamin content (Maphosa & Jideani, 2017). In addition to protein, legumes are high in carbohydrates, sugars, vitamins, more than 15 essential minerals, and mono- and polyunsaturated fatty acids (Wang *et al*., 2009). These foods also contain a lot of dietary fiber, folic acid, and non-nutritional bioactive substances like polyphenolics, lectins, phytate, and trypsin inhibitors (Burstin *et al*., 2011). Furthermore, grain legumes reduce the risk of obesity (Burstin *et al*., 2011). Legumes are essential for environmental services. Legumes are a preferred crop for the agricultural community in intensive farming because of their biological nitrogen fixation, grain legumes are a preferred crop for the agricultural community in intensive cereal-based cropping systems (Kumar *et al*., 2018).

Long-term cereal-based cropping systems are one input-intensive technique that considerably contributes to GHG emissions, groundwater contamination, and other second-generation problems (Hazra *et al*., 2018). Crop heterogeneity is essential for enhancing crop tolerance to biotic and abiotic stressors and climate change (Newton *et al*., 2011). This, therefore, makes legumes because of their deep roots, symbiotic N-fixation, leaf fall, and carbon-rich soil organisms, legumes are therefore essential for carbon sequestration (Ghosh *et al*., 2012).

Legumes have a higher crop biomass and a slower rate of C-mineralization than cereals, which considerably improve soil C retention in decreased tillage situations. Bayer *et al*. (2016) are of the view that legumes transport a large amount of their photosynthetic carbon as root exudates (amino acids, phenolic acids, and organic acids), along with other lignin-rich substances, which considerably aid in carbon sequestration and the lowering of the plant's carbon footprint (Hazra *et al*., 2018).

Legumes feed the soil with nitrogen (N) for subsequent crops while reducing worldwide CO2 emissions (>300 Tg Yr1) from N-fertilizer (urea) enterprises by up to 50% (Jensen *et al*., 2012). Interestedly, feeds high in legumes can lower the quantity of CH4 released by livestock operations because they include less fiber, digest more quickly, and have condensed tannins and saponins that change rumen methanogenesis and prevent cell wall collapse (Eckerd *et al*., 2010). Also, it was discovered that legumes emit less nitrous oxide (1.02 kg N2O-N ha-1) than cereals fed with nitrogen (2.71 kg N2O-N ha-1) (Jensen *et al*., 2012). The advantages of grain legumes' lower GHG emissions were established by Schwenke *et al* (2015). Legumes occasionally produce more N2O, though.

Faster N-rich residue decomposition and denitrification of symbiotically fixed N within the nodule are two potential causes of higher N2O emission by legumes; however, more extensive, multi-location research is required to obtain conclusive evidence because management practices and local climatic conditions heavily influence it (Bayer *et al*., 2016; Hauggaard-Nielsen *et al*., 2016). However, the enormous contribution that legumes provide to lowering GHGs and storing carbon in the deep soil has to be carefully examined.

Climate Adaptation

The debate about how climate impacts the environment and to reduce climate change predominated in the 1990s and early 2000s. Lately, adaptation has become a topic of increased interest (Adger *et al*., 2009; Dodman & Mitlin, 2011). Changing societal and ecological processes and activities to avoid would be harm or take advantage of new opportunities constitutes adaptation to boost resilience and decrease susceptibility (Adger *et al*., 2007). Rarely does climate change adaptation concentrate solely on climate change problems (IPCC, 2012). Any process or program that increases the resilience of society to the risks that climate change may exacerbate is considered part of adaptation (IPCC, 2012).

Adaptation is an ongoing process that reduces harm or exploits opportunities and is the process of responding to changes in natural or human systems as a result of current or projected climate stimuli or their consequences (IPCC, 2012; Smit & Wandel, 2006). As part of this process, this study distinguishes between incremental and transformative adaptation (Kates *et al*., 2012; Nelson *et al*., 2007). To reduce losses, gradual adaptation to climate change means scaling up or changing current behaviors

and activities, or doing little more of what is already being done (Kates *et al*., 2012; Park *et al*., 2012). On the other hand, transformative adaptation refers to adaptation strategies that are new to a specific location, adopted on a much larger scale, and bring about changes to local resource systems (Adger *et al*., 2011; Cates *et al*., 2012; Nelson *et al*., 2007).

Indigenous Knowledge

Indigenous knowledge is what Aboriginal people have known, understood, and practiced for generations and handed over from generation to generation mostly through oral tradition. Indigenous knowledge evolves through trial and error and is mostly not documented but has a proven ability to adapt to change (Melchias, 2001) since local people have an intimate relationship with their environment. Indigenous knowledge is information gathered over generations in a specific environment (Minja, 2000).

Because the local people have more sensitivity to the effects of their dependence on and close contact with the environment and its resources, local people have gradually acquired local knowledge to combat climate change (IPCC, 2007). Some communities have accumulated knowledge about environmental changes over long periods and have developed methods to detect and manage these changes (Changa *et al*., 2010).

Indigenous and modern Adaptation Strategies to climate change

Individual, family, and community organizational levels (Adger 2000, Berkes & Seixas 2006, Cinner *et al*. 2009c), as well as national assessments (Marshall and Marshall 2007), can be used to assess adaptive practices (Adger and Vincent 2005; Nelson *et al*. 2009a,b). Some systems estimate capacity using inductive, community-driven metrics, whereas others use deductive metrics (Nelson *et al*., 2008). Some adaptive capacity indicators (such as those used by He McClanahan and Cinner in 2009) are better suited for cross-scale comparisons, whereas others are better suited for stand-alone analysis of specific communities or industries. Your objectives, available skills, and available budget determine the best approach for your specific situation. Choosing the most effective approach to adaptation planning necessitates taking into account both opportunities and constraints.

However, these techniques vary from community to community depending on local environmental and climatic conditions (Nindi & Mhando, 2011). Locals use a variety of weather forecasts and indicators to explain the effects of climate change. The appearance of armyworms in theUpper East Region Bongo districtn is a sign of delayed rainfall. Red ant swarms appear in October and November, and the wet season occurs in August and September when swarms appear to fly from the hills to the lowlands. However, large swarms of armyworms in September and October are a sign of drought (Nindi & Mhando, 2011). In addition, smallholder farmers have developed cultivation techniques that are adaptable to climate change. To protect the soil, intercropping or capture crop methods are used in the semi-arid communities south of Bongo.

According to Mafongoya and Ajayi (2017), local communities are implementing culturally distinct strategies to help limit the negative effects of climate change on crop production. Farmers use indigenous knowledge and techniques to mitigate problems associated with natural disasters (Harvey *et al*., 2014). Most legume farmers are aware of and engage in various cultural practices that can help them cope with factors and events that may threaten their production capacity such as mixed cropping (Rankoana, 2016). Examples of these cultural traditions include precautionary measures to respond to early warnings of expected rainfall or shortages due to wind direction, the shape of the crescent, and the behavior of certain animals (Mafongoya & Ajayi, 2017).

According to Berkes (2012), these are reliable rainfall probability forecasts that farmers can use to plan their agricultural activities in order to reduce risk and increase productivity. Other indigenous practices include seed selection, in which the best seeds are carefully selected for the following harvest season because they believe they grow better with less rainfall (Chigavazira, 2012). Morton (2007) asserted that these procedures form a substantial body of knowledge and skill used in methods for managing and enhancing crop production resilience, mitigating the effects of climate change, and reducing the likelihood of crop failure. By fusing several information systems, it is possible to minimize the effect of irregular rainfall on food production.

Berkes, (2012) as part of a community effort to address the effects of climate change on small-scale farming, new and improved technologies, as well as financial resources, may be considered to improve the indigenous techniques used by farmers (Davis & Terblanché, 2016) Utilizing adaptation technology in agriculture entails using organic fertilizers to increase the fertility and moisture content of the soil (Dejene *et al*., 2011). Ponge (2013), using traditional wisdom to increase crop output under irregular rainfall is possible, but it can only be successful when combined with appropriate current scientific technology interventions, like the use of organic fertilizers and pesticides, and meteorological data

Stakeholders' Participation in Adaptation Strategies to Climate Change

Studies from around the world, particularly in the global south, have shown that the costs which comes with the finance of adopting orthodox practices, land tenure rights, educational level, gender, climate, labor shortages, and water scarcity are all factors influencing the level of adoption of new practices among farmers (Wollenberg *et al*., 2012). Modern approaches and techniques in transforming agricultural systems are needed to significantly increase food security, build resilience and adapt to climate change which smallholder

farmers find it difficult to develop. The need for institutional collaboration will therefore be critical to the successful adoption and development of all aspects of climate change adaptation through training and engaging with local communities (Bernier, & Haglund, 2013). According to Hodgson (2006), local and external actors interact as both formal and informal systems that include organizations, social and cultural norms, and conventions that improve adaptation strategies.

Institutions are important for climate change adaptation, especially local institutions that have related and know the peculiarities of their environment. The contributions of these institutions is demonstrated by their ability to develop innovations to adapt to changing climate stressors (Amaru & Chhetri, 2013; Chhetri *et al.*, 2012; Rodima-Taylor, Olwig, & Chhetri, 2012) and invariably provide links to access finance for smallholder farmers (Mccarthy, Lipper, & Branca, 2011). They play pivotal roles in the areas of information gathering and dissemination, resource mobilization, and allocation (Agrawal, 2008).

Challenges of adaptation Strategies to Climate Change

Climate-related adaptation barriers are factors, conditions, or barriers that reduce the effectiveness of adaptation strategies (Bryan, *et al.*, 2009). Financial, sociocultural, institutional, informational, and technological barriers to climate adaptation strategies can be classified into this category (Bryan, *et al.*, 2009). The issues of inadequate financial facilities are significant impediments to farmers' implementation of climate adaptation strategies in Ethiopia. Other research indicates that financial constraints are the primary impediment to smallholder farmers' adaptation to climate shocks in Sub-Saharan Africa (Bryan, *et al.*, 2009).

Individual or group sociocultural beliefs, cultural practices, and worldviews all have a significant impact on how farmers perceive climate change and their subsequent coping strategies (Fosu- Mensah, 2012). Previous studies have found that people's reactions to risk are heavily influenced by their pre-existing beliefs, values, and norms about the event. This means that people from different cultural backgrounds may react differently to the risks associated with the effects of climate change (Fosu- Mensah, 2012). Institutions play an important role in developing communities capacity to respond to climate change, which can help shape social and individual interactions in society (Fosu- Mensah, 2012). According to the existing literature, institutional barriers are the primary constraint for publications on coping strategies (Moser & Ekstrom, 2010). Food security in Ghana and many other Sub-Saharan African communities is jeopardized due to a lack of institutional capacity and food security policies and climate adaptation information (Moser & Ekstrom, 2010).

Access to information about extreme weather events is a powerful tool that can be used to improve household coping strategy adoption and implementation in Ghana. However, due to a lack of suitable climate data, some climate projections in the country have been made. As a result, households rely on agroecological knowledge gained through personal experience (Antwi-Agyei, *et al.*, 2013). This knowledge has enabled farmers to develop complex mental models of climate that may hurt their farming practices (Antwi-Agyei, *et al.*, 2013). Improved technology, improved crop varieties, and irrigation technology development, for example, are critical for farmers' adaptation to climate change. However, due to the limitations of these technologies, farmers are forced to rely on indigenous technology to reduce the impacts of climate change (Antwi-Agyei, *et al.*, 2013).

METHODOLOGY

Study Area

The study was conducted in the Upper East Region of the Republic of Ghana's Bongo District. The Bongo

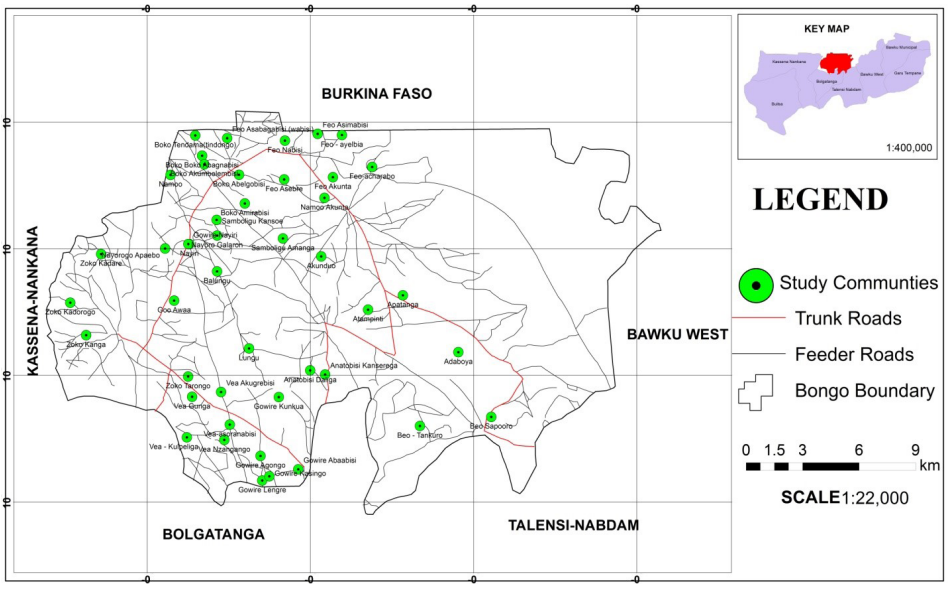

Figure 1: District Map of Bongo
Source: Bongo District Assembly, 2012

District is one of the Upper East Region's 15 districts. It was established in 1988 by Legislative Instrument 1446 (LI 1446), with Bongo as its capital. The district has 459.5 square kilometers of land area and is located between longitudes of 0.45° W and latitudes of 10.50° N and 11.09° N. Burkina Faso borders the Bongo District to the north, Kassena-Nankana East to the west, Bolgatanga Municipal to the south, and Nabdam District to the east. The map of the Bongo District is shown below.

It is located in the Northern Savannah Zone and has one rainy season. The severe drought that comes before the rain and the district's rainfall is canceled out by the extremely high rate of evaporation, which is estimated to be 168 cm per year. The vegetation is similar to that found in the Guinea Savannah. Rivers and streams dry up during the dry season and vegetation withers. Farming operations are halted during this time, and cattle starve to death, significantly reducing their weight and household income.

Study Design

The study adopted the mixed-method approach. The use of both methods aided the study in addressing any weaknesses that either approach might have. The qualitative study focuses on observations and interview content rather than specific details (Zikmund, 2000). Quantitative methods, on the other hand, emphasize objective measurements and statistical, mathematical, or numerical analysis of data gathered through polls, questionnaires, and surveys, as well as by manipulating pre-existing statistical data using computational techniques. Quantitative research focuses on gathering numerical data and generalizing it across groups of people or explaining a particular phenomenon. (Babbie, 2010). To achieve the objectives of the study; the approach helped explore how legume farmers have coped with the effects of climate change threats on the production of legume crops, a mixed method was carried out. Through direct communication with the legume farmers, data were gathered from three farming communities Nyariga, Vea and Gowrie that were randomly chosen for this qualitative study.

Sampling Technique

A sampling technique refers to the method used to select samples from a target population. Examples include simple random sampling, systematic sampling, targeted sampling, and snowball sampling (Creswell, 2011). Multi-level sampling is a sampling strategy (such as collecting participants for a study) used when researching very large populations. The overall population is divided into spontaneous clusters and sub-clusters from which researchers randomly select samples (Karma, 1999). A multistage sampling method was used for data collection. The Bong District as the study area was sampled, because of its semi-arid nature. Again, the Bongo District is one of the most sensitive areas when it comes to climate change in the Savannah Ecological Zone. The Bongo district is one of the districts that actively contribute to food production in the Upper East region, including legumes. The next step in the sample was to classify communities into area councils after obtaining a list of those actively involved in legume production from the Ministry of Agriculture. In addition, simple random sampling technique was used to select the three communities for investigation. A simple random sampling was performed by using the lottery method to select communities under the Bongo District by writing the names of the communities on a piece of paper a draw was made and the three communities selected were Nyariga, Vea and Gowrie.

Sample Size

The study uses a sample size of 70 farmers who have produced legumes for about ten years. A simple random sampling method was used to choose 17 households from Nyariga, 30 from Vea, and 23 households from Gowrie, respectively. Details of the sample size distribution are presented below;

Table 1: Determined Sample Size

Variables	Communities	No. of Respondents
Sample size Determination	Nyariga	17
	Gowrie	23
	Vea	30
Total	**3**	**70**

Source: Field Survey (June 2022)

Data Collection

Data on the socio-demographic characteristics of legume farmers, the effects of climate change, indigenous knowledge, indigenous coping mechanisms, and modern coping strategies were collected. In each community, one focus group discussion was held, as well as five key informant interviews with three farmers, one agriculture extension officer, and one meteorologist from the regional meteorological department. For ten years, the Ghana Meteorological Service collected data on rainfall and temperature in the district. Crop yield data for the district over the last ten years was also obtained from the Ministry of Agriculture (MoFA).

Data Analysis

Thematic content analysis was used to analyze the data. The technique was used to find, examine, and report on data trends. The first step in the data analysis process was to understand the responses and implications from the participants' perspectives. This procedure allowed the data to be coded and scored by counting the number of times a specific subject was mentioned. After coding, themes and sub-themes were created. Finally, contextualizing and interpreting the data determined the extent to which the study problem was addressed. The final phase involved preparing the report and holding a follow-up meeting with the groups to communicate and confirm the study's findings and ensure they accurately reflected the participants' opinions.

RESULTS

Demographic characteristics

Table 2 below revealed that below 40% of farmers in the study community are engaged in farming, while above 40% aged 35 to 60 are actively involved in legume production or farming. The data also revealed that below 25% are involved in farming in the study communities. The data suggest that farming in the study area is labour intensive and this explained why those in the productive age group are involved in farming. In terms of sex distribution, above 60% of farmers were males in the study community, while below 40% were females. Though this does not correspondent with the 2010 population and housing outcomes which revealed there are more females than males in Ghana; it is largely because farming is a male-dominated activity in the study area as men have access to land and patrilineal ownership regimes, as well as farming being a household livelihood security, enjoined men to dominate. Data on household size revealed that below 30% in the study communities are averaging below 5 and between 5 to 10 household sizes, respectively. It was also established that the majority of the households in the study communities are 50% and above. This implies that the household size in the study community is large. This could be a result of the extended family setting that is commonly practiced in the study area.

On education, above 50% of farmers have received formal education in the study communities; while below 50% have received one form of education, thus basic, secondary, post-secondary, and tertiary, respectively. Junior High School education, while 16% received Senior High School education. The data further revealed above 50% of the farmers in the study area are living a married life, while below 30% were single. Besides, below 10% have been widowed or divorced respectively in the study communities.

Table 2: Demographic Characteristics of Respondents

Variables	Nyariga		Gowrie		Vea	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Age						
<35	6	35	9	39	9	30
35 to 60	9	53	11	48	15	50
>60 and above	2	12	3	13	6	20
Sex						
Male	11	65	15	65	21	70
Female	6	35	8	35	9	30
Household Size						
<5	3	18	5	22	5	17
5 to 10 members	5	29	6	26	10	33
>10	9	53	12	52	15	50
Education						
Basic Edu.	4	24	7	30	9	30
Secondary edu.	2	12	5	22	5	17
Post-sec./Tertiary	1	9	2	9	2	7
No formal education	10	59	9	39	14	47
Marital Status						
Single	5	29	5	22	4	13
Married	8	47	15	65	26	87
Divorced	2	12	1	4	0	0
Widowed	2	12	2	9	0	0

Source: Field Survey (June 2022)

Indigenous Adaptation Strategies to Climate Change on Legume Production

To provide an understanding of adaptation strategies to climate change, the study examined the types of legumes crops production in the study area. The data revealed that 41% constituting the majority cultivate groundnuts as their primary legume, while 35% of farmers cultivate soya beans as a primary legume. Also, 12% cultivate Bambara beans, whereas 6% in the Nyariga community cultivate cowpea and beans, respectively. The data on legume crop production in Gowrie revealed that 39% of farmers cultivate groundnuts, while 22% cultivate soya beans as a primary crop. The data also indicates that 17% of farmers cultivate Bambara beans, while 13% of

respondents indicated beans with only 9% of farmers in Gowrie indicating cowpea. More, data on legume crop production in Vea revealed that 43% of farmers cultivate groundnuts, while 33% of farmers in Vea cultivate soya beans. Again, 10% of farmers indicated cultivated beans, whereas 7% of farmers cited Bambara beans with another 7% indicating cowpea. Details on legume production are provided in table 3.

Plate 1: Ground farm in Gowrie Community

Plate 2: Groundnuts have been harvested and dried at the Vea community

Plate 3: Soya beans farm at Nyariga community

In searching for a response on the type of legume production in the local communities, the discussants provided various reasons. A discussant stated;

Groundnuts are a dominant crop majority of farmers cultivate; considering the demand, right now a lot of companies visit our communities in search of groundnuts and market women attract high interest in buying it; it is largely influenced by market availability and also based on the fact that the soil which is sandy support the cultivation of such crop (A participant, Nyagri)

The views of participants in the Focus group discussion in Gowrie also revealed that the majority of farmers cultivate soya beans. A discussant held this view;

In the Gowrie community, most farmers cultivate groundnuts, it has high demand just as soya beans; groundnuts are our traditionally dominant primary legume we cultivate hear; women smallholders farmers, peasants, and other commercial farmers cultivate groundnuts (A discussant, Gowrie).

Data on the indigenous adaptation strategies to climate

Table 3: Legumes Crops Production

Variables	Nyariga		Gowrie		Vea	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Legumes						
Soya Beans	6	35	5	22	10	33
Groundnuts	7	41	9	39	13	43
Bambara Beans	2	12	4	17	2	7
Cowpea	1	6	2	9	2	7
Beans	1	6	3	13	3	10
Total	17	100	23	100	30	100

Source: Field Survey (June 2022)

change on legume production revealed mixed cropping, army warm infestation, crescent moon appearance, and agro-forestry. The communities' indigenous adaptation strategies are learned and transmitted to the younger generation. The study revealed that 88% of farmers in Nyariga practice mixed cropping (such as planting soya beans with beans) as an indigenous adaptation strategy, while 91% of farmers in Gowrie pants groundnuts and beans as mixed cropping with 90% of farmers in Vea plants soya beans and beans as mixed cropping farming as an indigenous adaptation strategy. Furthermore, 59% of farmers in Nyariga, 65% in Gowrie, and 90% in Vea indicated they cultivate legumes such as soya beans, groundnuts, cowpea, and beans, while at the same time keep farm animals such as goats, sheep, pigs and poultry birds including chickens, guinea fowls, ducks and turkeys as livelihood diversification. In addition, the table indicates that 71% (Nyariga) 65% (Gowrie) and 67% Vea believe the appearance of the crescent moon at a particular time is a sign of a good farming season.

The data further revealed that 88% of farmers in Nyariga believe army warm infestation has a trend in production outputs and for that matter, they turned to prepare for the farming season when the infestation is observed. Again, 87% in Gowrie and 50% in Vea also share the same view regarding army worm infestation. The study revealed that 29% 0f the respondent from Nyariga indicated that they practice agro-forestry as an adaptation strategy to climate change, while 24% from Gowrie agreed with the adaptation of agro-forestry, with 30% from Vea also agreeing to agro-forestry. Details are provided in Table 4.

In soliciting participants' views during Focus Group Discussions (FGD) at Gowrie participants indicated that the use of indigenous adaptation strategies is essential to the production of legumes. A participant has this to say;

Over the years, most farmers have been cultivating two or more crops on the same piece of land. We believe that not all crops could do well at the same time and so having a variety of crops planted, one could gain from crops that did not go bad. When one cultivates maize, beans, and soya beans are often introduced to the farm. Our experience in farming also shows that legumes such as beans, soya beans, pepper, etc do not need much of the modern fertilizer to develop and so it is easy and cost-effective to engage in the farming of legumes (A discussant Gowrie)

When asked about the relevance of the indigenous adaptation strategies to climate change on legume production, discussants in Vea indicated the importance cannot be overemphasized. A middle-aged farmer indicated that the experience and test of the indigenous strategies for climate change adaptation have produced results repeatedly . A discussant indicated;

Indigenous adaptation strategies to climate change are a product of local knowledge systems and it is transmitted through daily experience and observation of events. We are happy because, it goes to confirm with modern understanding of climate change scenarios (A participant, Vea)

The views of participants in the Focus group discussion in Nyariga also revealed the same position of their colleague farmer respondents in the other communities. A discussant held this position; For me, it is important to acknowledge the fact that mixed cropping has been one of the best adaptation strategies. It has helped many farmers to have more produce. I have been practicing mixed cropping and it is good, other farmers are equally doing the same (A discussant, Nyariga).

Table 4: Indigenous Adaptation Strategies to Climate Change on Legume Production

Variables	Nyariga		Gowrie		Vea	
	Freq.	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Mixed cropping						
Yes	15	88	21	91	27	90
No	2	12	2	9	3	10
Mixed farming						
Yes	10	59	15	65	25	83
No	7	41	8	35	5	17
Armyworm infestation						
Yes	15	88	20	87	15	50
No	2	12	3	13	15	50
Tree Planting (agro-forestry)						
Yes	5	29	6	26	9	30
No	12	71	17	74	21	70

Source: Field Survey (June 2022)

Modern Adaptation Strategies to Climate Change on legume production

The study also examined the modern adaptation strategies to climate change on legume production. The study revealed that 71% of farmers in Nyariga, 62% in Gowri, and 47% in Vea indicated they rely on the Ghana metrological agency weather forecast for the result. This helped in their effective planning to climate change scenarios. Also, integrated soil fertility management (fertilization application) appears to be the second most common modern adaptation strategy. This view is held by 16% of farmers in Gowri, 21% in Vea, and 28% in Nyariga.

More so, below 20% of farmers, in the study communities indicated the practice of plowing in rolls as a modern adaptation strategy to climate change. Further findings revealed that 10% of farmers in Nyariga used improved seed, with 5% in Gowri and Vea respectively practicing fallowing of land. The data implies that the legume farmers in the Bongo West District used forecasting and fertilizer application as modern adaptation strategies to climate change.

In finding answers to the question of modern adaptation strategies to climate change on legume production during Focus Group Discussions, participants indicated the use of chemical and weather forecasting as information is

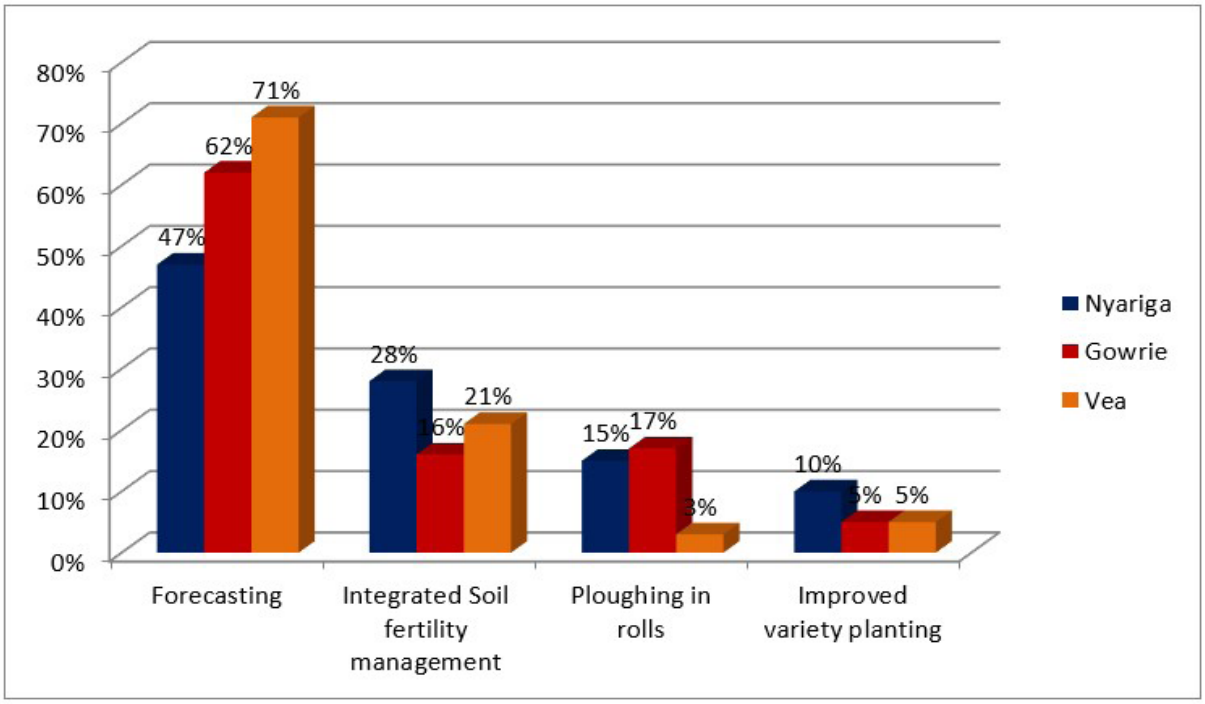

Figure 3: Modern Adaptation Strategy to Climate Change. *Source: Field Survey (June 2022)*

critical to agronomical activities. At Nyariga, a farmer revealed that;

"the continuous farming on the same piece of land has led to low crop yield, so fertilizer application has become a major part of soil nutrient management; again we rely on the weather forecast information to understand rainfall patterns and early warning signs regarding drought or flooding" (Farmer, Nyariga).

Adaptation Strategies to climate change by Local Stakeholders

In the Bong District, many local actors play a critical part in adaptation strategies. Farmers, farmer unions, Tendaanas, households, community volunteers, and diviners are major local players in implementing adaptation strategies at the community level. The data revealed farmer and household responsibilities are rated as highly effective, while the contribution of Tendaana, community volunteers, and diviners was also rated as effective. Details are provided in Table 5.

Discussants indicate that there are local stakeholders in their communities that are immensely contributing to adaptation strategies to climate change on legume production. They indicated that farmers, farmer unions, tendaanas, and household members are local actors who play a crucial role in ensuring climate change adaptation. It was revealed that farmers took charge of major decisions regarding cropping and farmland management. This is what a discussant stated:

"… In terms of key actors in this community, we (farmers) are in charge of all decisions regarding land preparation and cropping; the chiefs and opinion and Tendaanas, and diviners play a part in terms of the indigenous approach to climate change adaptation on legume production; the share experiences on signs and revelations that could influence farmers decision to respond to climate change adaptation strategies (A discussant, Nyariga).

Table 4: Indigenous Adaptation Strategies to Climate Change on Legume Production

S/N	Stakeholders	Duties	Findings	Effectiveness		
				Highly Effective	Effective	Less Effective
1	Farmers	*Preparing farmland	No issue regarding land ownership	√		
		*Decision regarding crops to be cultivated				
		*In charge of securing seed & inputs for crops				
2	Tendaana/ Earth priest	*Link between the living and ancestors	Interceding for rains or averting curse		√	

3	Community volunteers	Participate in implementing community decision	Ability to sustainably implement initiative		√	
4	Households	Support in farming activities	Source of labour	√		
5	Farmer groups	Working together to improve legume production	Collaborating with external stakeholders		√	
6	Diviners	Spiritual verifications of occurrences and events	Giving direction to avert crisis		√	

Source: Field Survey (June 2022)

Modern Stakeholders in Adaptation Strategies to Climate Change

This section examines the role of external stakeholders in contributing to climate change adaptation strategies. These external stakeholders are established by law and are either government establishments or private entities. The Bongo District Assembly, Ghana Metrological Agency, National Disaster Management Organization (NADMO), Water Resources Commission, and Ministry of Food and Agriculture, are government institutions, while non-governmental organizations (NGOs) are formed by private individuals. Modern stakeholders exist to empower or complement local stakeholders in initiating and practicing adaptation strategies to climate change. The study revealed that 65% of farmers in Nyariga rely on agri-extension services for adaptation practices, whereas 71% of farmers in Gowrie also depend on the MoFA extension services, with 69% of respondents in Vea also sharing the same opinion. Again, the Ghana Metrological agency's role in weather forecasting is a major source of information for adaptation practices. This view was held by 15% of respondents from Nyariga, 12% from Gowrie, and 21% in Vea. Further findings also indicate that the Bongo District Assembly, National Association of Disaster Management Organization, and World Vision Internation play a part as stakeholders in adaptation strategies to climate change (Refer Figure. 4).

Discussants also noted that the role of the Department of Food and Agriculture under the Ministry of Food and Agriculture in giving support services to extension officers is significant. A discussant stated;

" We have an extension officer who meets us the farmers, legumes, maize, rice, and other cereal farmers; the officer has been periodically visiting our farms and educating us on best agricultural practices. Through such engagement, we are motivated to adopt best practices to increase crop yield (A discussant, Vea)."

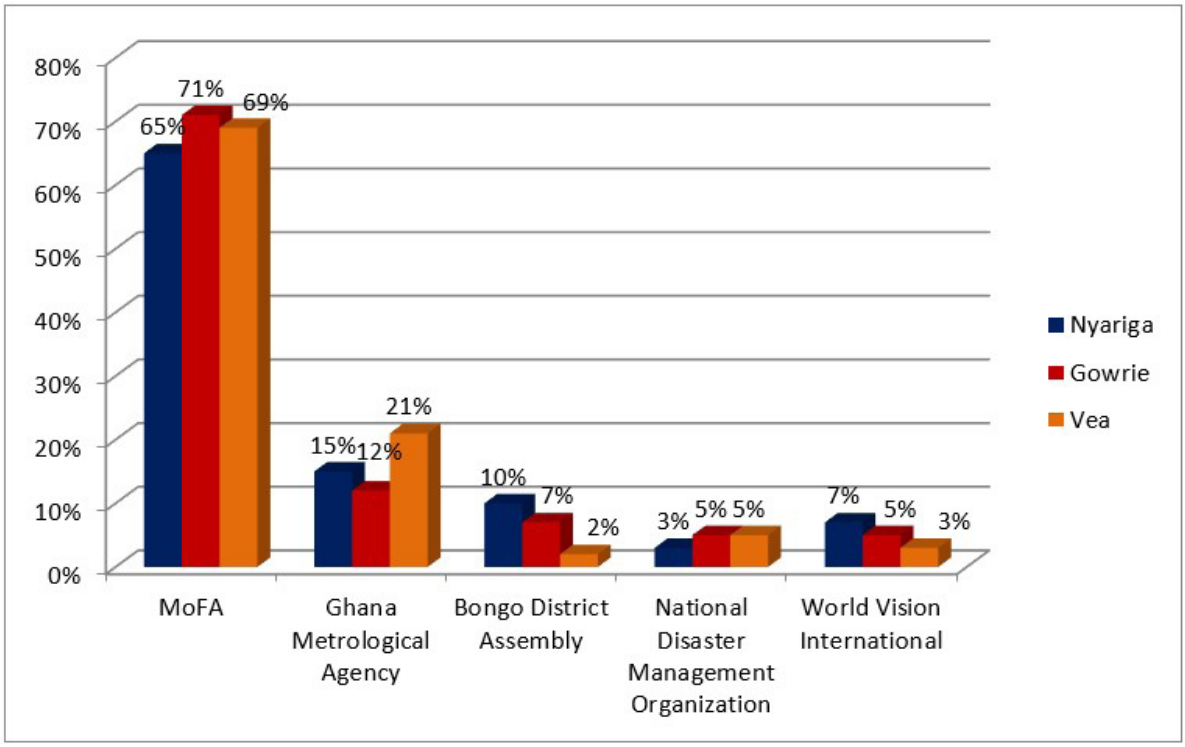

Figure 4: Modern Stakeholders to Adaptation Strategy to Climate Change

Challenges to Indigenous Climate Change Adaptation Strategies

Farmers respond to climate change in different ways. Farmers face a variety of challenges as they develop strategies to deal with the effects of extreme weather events, ranging from personal to institutional constraints. Five constraints were identified based on the literature and focus group interactions with respondents revealed the introduction of new faiths, the uncoordinated nature of indigenous strategies, the mindset of the new generation, the lack of documentation, and limited / no integration of indigenous adaptation strategies to modern practices as challenges to climate change adaptation. The data revealed that 41% of respondents indicated the issue of limited or absence of merger of local adaptation strategies to climate change as a major setback to the indigenous approaches. It was further uncovered that the introduction of new belief systems (Islam and Christianity) have also weakened traditional belief systems including norms, taboos, and superstitions, which adversely affect local adaptation strategies, this view was held by 28% of respondents. Also, 15% of respondents attributed the weakness of indigenous adaptation strategies to the mindset of the new generation of farmers, as they have confidence in modern approaches to adaptation to climate change. In addition, 9% of farmers also cited a lack of documentation of indigenous adaptation strategies as a setback, while 7% expressed worry about the uncoordinated nature of indigenous adaptation strategies to climate change.

The result from the Focus group discussion also revealed that inadequate attention given to indigenous adaptation strategies is one major factor identified. A discussant revealed this; "it is obvious that limited attention is placed on the indigenous adaptation strategies to climate change among legume farmers; We (farmers) are shifting focus to depending on weather forecasting and fertilizer application to the detriment of making good use of indigenous adaptation strategies which are long age practices (A discussant, Gowrie)."

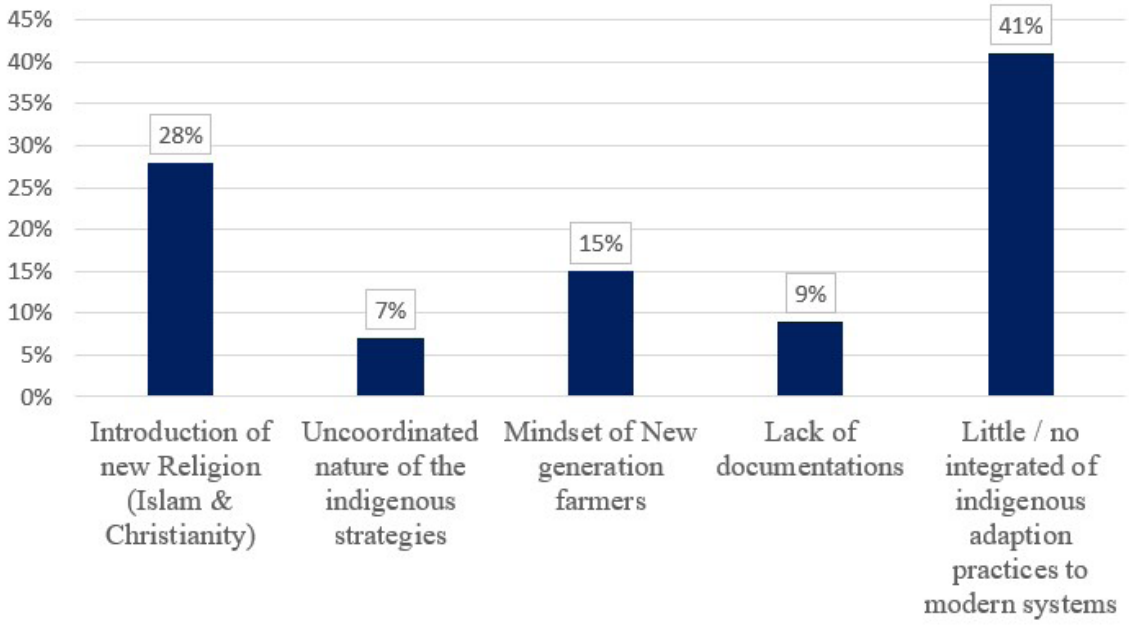

Figure 5: Challenges to Indigenous Climate Change Adaptation Strategies

Challenges to Orthodex/Modern Adaptation Strategies to Climate Change

The table below (Table 5) revealed that poor extension service (39%) is the major challenge associated with modern adaptation strategies to climate change. This was followed by the high cost of agronomical inputs (36%). Also, 11% cited poor access to metrological service, while 7% attributed inadequate access to drought-resistant varieties and the high cost of technological service, respectively.

Probing further in focus group discussions, participants shared similar views with respondents. The issue of poor extension service, high cost of inputs, and inadequate access to metrological information were identified as major challenges. One discussant in Nyariga stated;

Although we have the agriculture officers coming around occasionally, there is too much pressure because he has many communities to cover; it is very difficult to reach out to him at all times. Again, his work is not supported with adequate electronic tools for us to further appreciated extension service and knowledge sharing.

Another discussant added;

The cost of inputs is another issue of concern, the prices of fertilizer are on the high side and the lands have lost their nutrients, so inputs have become a preferred option for soil fertility management, the cost of it is a challenge to farmers (a discussant Gowrie).

Table 5: Challenges of the Modern Adaptation Strategies to Climate Change

Variable	Response	Frequency (N= 70)	Percent (%)
Challenges of modern adaptation strategies to climate change	Poor access to Metrological information	8	11
	High cost of agronomical inputs	25	36
	Poor extension service	27	39
	Inadequate drought-resistant varieties	5	7
	High cost of technological service	5	7
Total		**70**	**100**

Source: Field Survey (June 2022)

DISCUSSIONS

The study established three key issues- adaptation strategies to climate change, stakeholder participation in adaptation strategies, and challenges of adaptation strategies to climate change. This is based on the fact that climate change variability affects legume production in the Bongo District. The study revealed that mixed cropping and mixed farming are predominant adaptation strategies to climate change among legume farmers. These findings are synonymous with the view held by Rankoana (2016) who indicated that legume farmers diversify crops by planting more than one type of crop to reduce the risk of one crop failure. Regarding modern adaptation strategies, forecasting and the use of improved seed variety were identified as contemporary adaptation strategies. These findings also align with Berkes (2012), who expressed the opinion that legume farms depend on weather forecasting as an adaptation measure. Again, the view that improved variety has recently become an appropriate adaptation strategy is also in conformity with Dejene's (2011) work where he stated that fertilizer application contributes to enriching soil fertility as it maintains moisture content. As a result of this, there is a need for the Bongo District Assembly to inculcate already adaptation strategies for climate change action planning.

The study also identified local actors including legume farmers, households, and Priest as some stakeholders in adaptation strategies to climate change, while the Ministry of Food and Agriculture, the Bongo District Assembly, and the Ghana Metrological Agency were also identified as modern actors in climate change adaptation strategies. The findings uncover that legume farmers lead intake decisions regarding cultural farming practices, including land preparation and cropping. The provision of extension service and formation on weather forecasting are equally facilitated by the Ministry of Food and Agriculture and the Ghana Metrological Agency, respectively. These findings agree with Hodgson, (2006) who indicated that local and external actors worked as both formal and informal systems and encompass organizations, and social and cultural norms to ensure effective adaptation strategies.

On challenges to adaptation strategies to climate change, the study identified limited or no integration of indigenous strategies to modern adaptation practices and the introduction of new belief systems (Islam and Christianity) has also weakened farmers' ability to prioritize indigenous adaptation strategies to climate change. These findings support the position of Fosu-Mensah (2012), who held that sociocultural constraints including beliefs, cultural practices, and worldviews of individuals or groups greatly influence how farmers respond to climate change adaptation strategies. Findings also revealed that poor extension service and weak access to weather forecasting information are stumbling blocks to modern adaptation strategies to climate change. This also brings to bear the contribution of Antwi-Agyei, *et al.*, (2013) as they held the position that the lack of suitable climate data has resulted in some climate projections in the country, causing legume farmers to rely on agro-ecological knowledge based on their own experience.

CONCLUSION

The conclusion arrived at from the findings/result from the study is that mixed cropping, mixed farming, and crescent mood prediction are the dominant indigenous adaptation strategies to climate change regarding legume production. More so, weather forecasting, integrated soil fertility management, and the use of improved seed variety were identified as modern adaptation strategies to climate change concerning legume production.

Findings on local stakeholders' participation in indigenous adaptation strategies identified legume farmers, household members as labour sources, and earth priests as major actors, while the Ministry of Food and Agriculture (MoFA), Ghana Metrological Agency, and Bongo District Assembly (BDA) were identified as modern stakeholders participating in adaptation strategies. Further findings revealed that inadequate integration of indigenous adaptation strategies to modern approaches, new belief systems and mindset of the new generation farmers are constraining factors to indigenous adaptation practices to climate change, while poor extension service, cost of chemical inputs, and inadequate access to drought-resistant varieties were identified as challenges to modern adaptation strategies to climate change.

There is a need for stakeholders such as the Environmental Protection Agency (EPA), the Ghana Tourism Authority (GTA), and the District Assembly to engage fringe communities on developing and sustaining the identified natural resources into attractive avenues.

The local and external stakeholders should establish a

strong bond of coordination for effective governance of natural resources in the Wa West District.

The study's findings have brought to light the adaptation strategies to climate change of legume production in the Bongo District. It implies that there is a need to design and implement relevant programs by concerned agencies to minimize climate change's effects on legume production.

RECOMMENDATION

The following recommendations based on the findings as outlined may be relevant in designing programs and policies to ensure adaptation to climate change in the Bongo District.

The Ministry of Food and Agriculture should consider introducing a drought-resistant variety of soya beans and groundnuts to legume farmers in the Bongo District to boast production.

It is also important for the Ministry of Food and Agriculture, Ghana Metrological Agency, and Bongo District Assembly to mainstream indigenous adaptation strategies into climate change actions, plans, and communication.

There is a need for the Ministry of Food and Agriculture, Bongo District Assembly, and World Vision International as a Non-governmental Organization (NGO) to build the capacities of local communities to effectively developed indigenous adaptation strategies to an appreciable level.

The local and external stakeholders should establish a strong bond of coordination for effective adaptation to climate change practices in the Bongo District.

The Bongo District Assembly should engage local communities to develop sustainable adaptation plans for climate change.

There Ministry of Food and Agriculture should consider posting more agriculture extension officers to the Bongo District for effective support services given the adaptation mechanism.

There Ghana Metrological agency should also consider working closely with farmer volunteers to facilitate information dissemination to legume producers.

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