Journal of Earth Science & Climatic Change

Ansah and Siaw, J Earth Sci Clim Change 2017, 8:12
DOI: 10.4172/2157-7617.1000431

Research Article Open Access

Indigenous Knowledge: Sources, Potency and Practices to Climate Adaptation in the Small-Scale Farming Sector

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Received: Nov 07, 2017; **Accepted:** Dec 07, 2017; **Published:** Dec 12, 2017

Abstract

Due to the socio-cultural distinctiveness of indigenous communities from mainstream societies, decisions, policies and actions other than their own on climate adaptation may prove insufficient, inappropriate and ill-adapted even if well-intended. A lucid understanding of indigenous adaptation practices, sources and potencies for climate change and its antecedents allow small holder farmers to manipulate current knowledge to adequately optimize general efforts and improve climate adaptation interventions. The study utilized a sampled size of 218 (N=218) smallholder farmers in randomly selected communities in the Sekyere South district. The mixed method approach to data analysis were utilized in the analysis of data from the study respondents.

The study revealed that the sources of knowledge about changes in the environment were centered on observed changes in weather phenomena, physical changes on trees (flowering, shedding of leaves, etc.) and behaviors of certain animal species (birds, amphibians, insects, and arthropods) The study again revealed specific indigenous adaptation strategies applied by smallholder farmers in coping with climate change including ending farming or building in waterways or lowlands areas, planting resistant crop or early yielding varieties, planting more trees of cover crops, irrigations practices among others.

The findings underscore the need for farmers' education, awareness creation, poverty alleviation and increased access to more efficient inputs as powerful tools for climate change adaptation in Sekyere South District.

Keywords: Climate change; Indigenous adaptation practices; Smallholder farmers; Sekyere South District

Introduction

Nations in Africa are among the most defenseless the world over when it comes to the impacts of climate change due to the reliance of a significant number of the populace on agriculture, especially rain-dependent agriculture and far reaching incidence of poverty that renders them incapable to withstand the stresses of climate change. Intermittent drought in numerous nations has exhibited the impacts of climate variability on food sources for people [1]. Agriculture is regarded as the mainstay of most African countries. It is the highest contributor to Gross Domestic Product (GDP); the greatest cradle of foreign exchange, representing around 40 percent of the region's overseas currency remunerations; and the primary generator of investment funds and tax returns. Likewise, around 66% of agricultural raw materials make up the manufacturing sector, and agriculture employs about 56% of the continent's workforce [2].

Over the last forty years, Ghana has recorded temperature rise of about 1 degree Celsius as well as reductions in rainfall and runoff of approximately 20 percent and 30 percent respectively [3]. In 2009, for example, property lost from floods in the southern part of Ghana in June and July alone, was about US$ 5,813,954.7 and the deaths were 23 [4]. Increase in temperature, decrease in rainfall, and its unpredictability, are likely to jeopardize the employment of about 60 percent of the active population of Ghana, majority of whom are small scale rural farmers.

Accelerated and sustainable livelihoods for the farmers depend on their potential and adaptability when it comes to practices and belief systems. Farmers' perceptions about and knowledge of management/coping strategies relating to climate change have to be documented to determine strengths and weaknesses as a first stage in amelioration interventions. Gaps exist in farmers' indigenous knowledge about climate change and once these have been identified it might be possible to carve adaptation interventions (for instance from scientists and the agricultural extension agents) more adequately.

Due to the socio-cultural distinctiveness of indigenous communities from mainstream societies, decisions, policies and actions by the majority may prove insufficient, inappropriate and ill-adapted even if well-intended. Existing literature show that indigenous societies/local communities have elaborated coping strategies to deal with variabilities in the environment and have even cited instances of adaptation measures to early impacts triggered by climate change [5-7]. Thus, terse understanding of their specific susceptibilities, concerns and adaptive capacities to climate change can engender valuable insights to climate-induced changes and buttress broad-scale scientific research with local precision and nuance [8].

Grenier [9] and McGregor [10] present indigenous/traditional knowledge (IK) as a collective memory that is conveyed with speech from generation to generation through songs or tales and also through actions and observations. Indigenous or traditional knowledge; the knowledge and know-how accumulated across generations, and

renewed by each new generation, which guide human societies in their innumerable interactions with their surrounding environment. Traditional ecological knowledge; a cumulative body of knowledge, practices and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including human) with one another and the environment [11-14]. Although, each term may have somewhat different connotations and reference groups, they often share sufficient meaning to be utilized interchangeably in many contexts [11,12].

In recent years, there has been a growing awareness that scientific knowledge alone is inadequate for solving the climate crisis [15] which has led to growing recognition of local, indigenous, traditional knowledge as an important source of climate knowledge and adaptation strategies. After Harold Conklin's documentation on indigenous ways of understanding and knowing the plant world of the Hanunoo society in the Philippines [16], a lot of questions sprung over the supposedly superior intellect and training of scientist; scientific knowledge by explicating the complexity, detail and accuracy of indigenous knowledge and its value for the scientific community [17]. Indigenous knowledge is first and foremost an intellectual pursuit, debunking prevailing stereotypes of traditional thought as limited to the functional [18]. Although current studies purport indigenous communities to be among those who suffer the most from changing climates, they rarely represent themselves as helpless or unable to cope in the face of climate change [19,20].

Despite recognition of its importance by the Intergovernmental Panel on Climate Change [6] and other international forums, governments all through Africa continue to belittle the role of indigenous knowledge in national climate change adaptation policies. Instead, policy makers are relying on international financial institutions (IFIs) and donors to transmute farming by introducing large-scale industrial agriculture practices as the key to adaptation [21]. Paradoxically, this method of production relies on hybrid seeds, synthetic fertilizers and machinery run with large carbon inputs, further jeopardizing the climatic stability on which all types of agriculture rely [22,23]. Scanty data exist on the various indigenous indicators utilized by smallholder farmers in predicting and coping with environmental changes occasioned by climate change. For instance, Gyampoh et al., [24] enumerated a number of traditional indicators used by a section of Ghanaian societies in predicting variations in the environment and as such are able to respond by making adjustments in their livelihoods to ensure the protection of their main source of livelihood; agrarian-based agriculture. Specifically, the movement or appearance or disappearance of birds, leafy conditions of trees, cloud cover on mountain tops, rainbow positioning, croaking of frogs, appearance of crawling insects/ants, degree of hotness of the ground, direction of the wind, appearance of grasshoppers. According to Gyampoh et al., [25] indigenous people often observe the activities around them and are the first to identify and adapt to any changes.

This gives reason to investigate the sources, potency and practices of indigenous knowledge to climate adaptation in the small-scale farming sector of Ghana. This drive is ably summed by Fars-Borda who opined that 'People cannot be liberated by a consciousness and knowledge other than their own'.

Data and Methods

The qualitative and quantitative data for this paper was hauled from a broader, original study that explored CCM in the Ashanti region of Ghana. The study design utilized the mixed method' approach; encompassing the analysis of solicited quantitative and qualitative data from the study participants. The study employs a cross sectional analysis of quantitative data from smallholder farmers (farmers operating on small scale or farmlands less than 2 hectares) from SSD. SSD was selected due to its classification among the forest fringes communities in Ghana and have more than two thirds of its population employed in the agricultural sector for development and livelihood sustenance by SSD in 2015.

The study involved respondents' of 18 years or more who were engrossed in agrarian-based activities in the selected farming communities. This age limit was a set standard for respondents' level of maturity [26] and their ability to observe, analyze and make inferences about indigenous knowledge in their farming communities, *ceteris paribus*.

Sampling and study participants

The Ashanti Region was purposively selected for the study based on the dominance of the agricultural sector (65% of total employment) in the region's economic activities, 77% of total farmers' populace's operating farmland sizes less than 1.2 hectares (smallholder farmers) and the abundance of arable lands for cultivation (Ministry of Food and Agriculture [27]. We further selected SSD of the Ashanti Region purposively using simple random sampling techniques from among the 30 political and administrative districts in the region [27]. A total of 5 communities were sampled for the study (Table 1).

A total sample of 218 study participants shared their views during the data gathering stage of the study. A proportionate sample distribution was done based on population size of the respective communities so as to reduce bias and encourage full representation. During participant selection, we first provided a list of farming households from the study communities and a random selection of the required number of the study participants was carried out by blindfolded field officers from each community. Finally, all selected farming household respondents were contacted personally for a brief discussion about the study objectives. In a situation of absence or a decline in participation, the espoused procedures were diligently followed to get a suitable replacement.

Community	Population	Sample size
Akrofonso	1,600	40
Bedomase	1492	37
Boanim	3,800	42
Bepoase	3,875	46
Domeabra	5,162	53
Total		218
Source; Sekyere South District, 2014		

Table 1: Sample size selection from communities.

Data collection

Data was entirely primary but was supported with secondary information such as journal articles, reports and books on IK in the study area. IKs in Ghana, Ashanti region and the study communities were solicited by means of interviewer administered questionnaires. The distribution of questionnaires was achieved through trained field officers recruited from a pool of teaching and research assistants under the Culture and Tourism Programme, Department of Geography and Rural Development, KNUST. To rid call back challenges, distribution and completion of questionnaires were carried out in the morning and completed at sun set for five consecutive days. Mid-day breaks were observed to compile and also refresh field officers. The data collection process was supervised by researchers to ensure relevant data acquisition. The severity and varied dimensions of IK were analyzed based on the views of the study participants.

The study participants were assured of confidentiality and anonymity concerning responses provided. Participation was purely based on voluntary and convenience of respondents.

Data analysis

Data were aptly organized, coded, and cross-checked for inconsistencies and entered into the PASW (version 17) database. Descriptive statistics were first performed to describe the socio-demographic characteristics of the respondents. The results were presented in frequency distribution tables, figures and charts.

Profile of the district

The Sekyere South District, established in 2008 by Legislative Instrument 1898, is one of the thirty administrative Districts in the Ashanti Region of Ghana. Before 2008, the District was known as Afigya Sekyere District. As a result, re-demarcation of Districts in 2008 however, Afigya was carved out and the District boundary redefined and named Sekyere South District (SSD). The population of Sekyere South District, according to the 2010 Population and Housing Census, is 94,009 representing 2 percent of the Ashanti Regional population. Close to 47 percent of the population live in rural communities. The district has a household population of 91,819 with a total number of 19,445 households. The average household size in the district is 4.7 persons per household. As high as 67.3 percent of households in the district are engage in agriculture. In the rural localities, seven out of ten households (77.8%) are agricultural households while in the urban localities, 58.8 percent of households are into agriculture. Most households in the district (96.7%) are involved in crop farming. Poultry (chicken) is the dominant animal reared in the district.

A greater part of the District falls within a dissected plateau with heights between 800m and 1200m above sea level. The only high land can be found in the northern portion which happens to be the Mampong Escarpment stretching from Jamasi to Boanim. Major rivers in the District include the Offin, Oyon and Abankro. These rivers serve as source of water for most settlements in the District (Sekyere South District Profile, 2010. Human activities such as farming along the banks have negatively impacted on their flows. The District experiences equatorial climate type with double rainfall maxima regime. The major rainy seasons occur between March and July with the minor rainfall season occurring between September and November. Mean annual rainfall ranges between 855mm and 1,500mm. Temperatures are very high especially during the dry periods with mean monthly temperature hovering around 27oC (Sekyere South District Profile, 2010).

The vegetation of the District can be best described as moist-semi-deciduous. The rain forest abounds in different species of tropical woods of high economic value which includes Wawa, Odum, Sapele, and Mahogany. The vegetative cover is dictated by the soil type and human activities. Some trees shed their leaves during the dry season. The vegetation supports crops such as cocoa, coffee, plantain, banana, citrus, cassava, cocoyam and maize as reported in Sekyere South District Profile in 2010.

The soil profile of the district is characterized by the forest ochrosols. Forest Ochrosols are by far the most extensive and the most important soils within the Forest belts for both food and tree cash crop cultivation. Such soils, under natural conditions contain adequate nutrients that are tied-up with the organic layers in their topsoil. They can, therefore, sustain good crop growth by CEPA in 2000.

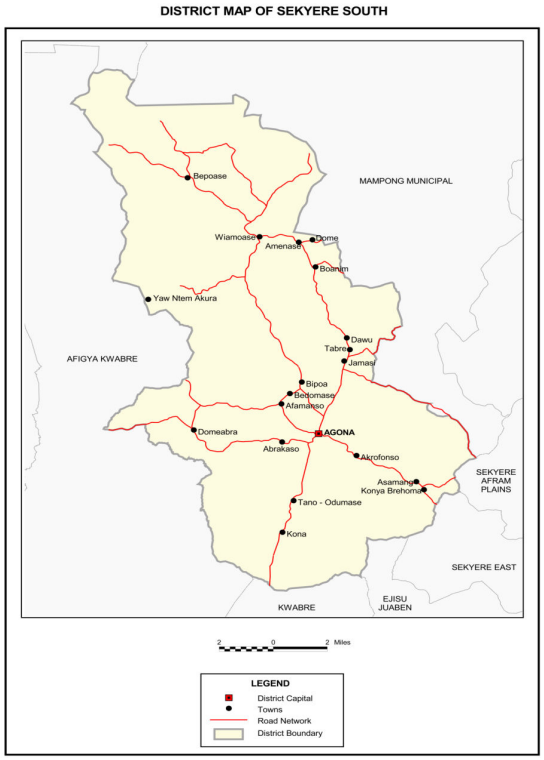

Figure 1: Ghana statistical service in 2010 [28,29] population and housing census.

Results and Discussion

This section of the study explored by discussing responses on the sources, potency and practices utilized by smallholder farmers in climate adaptation efforts in selected communities in the Sekyere South District of Ghana.

Demographic physiognomies of respondents

The researchers begun administering questionnaire by establishing background characteristics of respondents. This section of the questionnaire gathered the socio-demographic characteristics of respondents based on gender distribution, age distribution, marital status, and educational attainments of respondents.

Socioeconomic characteristics of households are theorized to have substantial impact on adaptation choices of local farmers. The study revealed that male household heads amounted to 78 percent of the total sampled participants. The study again illuminated that 86% of respondents were married/cohabitants. Out of this, 93% were engaged in monogamous marriages whiles the outstanding 7% were highly polygamous with the number of wives ranging from 2-6. As revealed in Table 2, the age distribution of participants revealed that 49% of household heads fell within the age group of 40 to 69 years, 33 percent were between the ages of 19 to 39 years, and 18 percent were 70 years and above.

The literacy level of the study participants is marginally greater than the regional average, with 32 percent capable of reading, speaking (conversations) and writing. Abangale et al. [30] stated that there is a positive relationship between formal education and productivity of labour. Productivity of a farmer is likely to increase since they are able to acquire and possibly apply scientific knowledge in their farming activities. However, for those who had no formal educational background, the germaneness of indigenous knowledge could not be over emphasized.

With regards to the sex of respondents, Table 2 shows that more males (78%) are into farming than females (22%). Majority of our female participants claimed that they are into other non-agricultural activities aside small-scale farming. Many of them reported that agricultural activities require brute force which they do not have. Examined literature posits that the selection of an adaptation approach is a gender-sensitive phenomenon is different settings. It is argued that male household heads are relatively risk averse and have more access to information, land and other resources relative to female-headed households [31,32] mostly in the third world countries and therefore are more inclined to adopt practices than female household heads [33]. From an opposing view point, studies have indicated a relatively advanced inclination to adopt coping measures by female-headed households [34-38]. This study dwells on the notion that no substantial discrepancy exists in the gender of household heads in selecting or utilizing a certain adaptation strategy.

The soil types of the district make it ideal for the cultivation of Cocoa, citrus, coffee and oil palm especially in the Kumasi-Offin compound soil. Food crop farming is primarily the source of livelihood for more than 92% of the study households. Cassava, Plantain, Cocoyam, Maize etc. are among the popular food crops cultivated in the selected communities. They support crops such as maize, yams, legumes, cassava, plantain and groundnuts [39]. These findings uphold the statement that agriculture remains the principal economic activity in the district.

Adapting to climate change: role of indigenous knowledge

Farmers have a far-reaching history of responding to climate change and its unpredictability. According to Boven and Morohashi [40], indigenous knowledge is a potent resource of rural dwellers and therefore a crucial ingredient in the fight against poverty and social exclusion for many rural communities worldwide. Indigenous adaptation practices can help farmers to cope with both current climate variability and future climate change [41]. However, the debate about the adaptation of small-scale farmers to climate change has occurred in the absence of knowledge about existing and potential adaptation practices.

Because prevailing ideas about adaptation are vague, conducting focused research on indigenous adaptation practices and formulating appropriate advice for implementing new practices is difficult. The study unraveled the following indigenous coping strategies to climate change in various dimensions. With the study's objective of identifying indigenous sources, potency and adaptation/coping measures specific to the Sekyere-Dumase district, this section espoused the indigenous sources and adaptation practices employed by smallholder farmers to predict changes in the environment.

Characteristics	Dominant response
Males	78%
Married/Cohabitation	93%
Age	
70+ years	18%
40-69 years	49%
19-39 years	33%
Literacy level	32%
Land size ownership	Ranges between 0.5-50 acres with an average of 8.76 acres
Yearly expenditure	Average of GH ¢ 3009.00
Source: Author's construct, 2015	

Table 2: Summary of socio-demographic characteristics.

Sources of indigenous knowledge on climate change: One of the major rationales for the study was aimed at unravelling the indigenous sources of knowledge relied upon by small scale farmers to better understand and adequately react to changes in the environment. The study revealed that the sources of knowledge about changes in the environment were centered on three important phenomena in the local ecosystems; observed changes in weather phenomena, physical changes on trees (flowering, shedding of leaves, etc.) and behaviors of certain animal species (birds, amphibians, insects, arthropods, etc.) as seen in Figure 1. From the table, the sources of indigenous knowledge generally were dominated by those that dwelt on observations of changes in weather phenomena. This was followed by physical changes respondents examined on trees and animal species respectively. Specific details under each are provided in Table 3 and Figures 2 and 3.

The potency of adaptation practices: The study ascertained the potency of adaptation practices by comparing previous and currents results from their utilization. Under this, the qualitative views of respondents were analyzed to arrive at a conclusion that best described the efficacy of the indigenous adaptation practices then and now. Further probing into the practices revealed that even though most of the indigenous practices have existed and been passed down from generation to generation, most of them are still relevant and being used in most of the study communities. Their utilization and efficacies

remained unquestionable for decades but owing to a more recent complications in the observed changes in the environment, coupled with the fast increasing susceptibilities of communities to climate change, absolute reliance on the sources of indigenous indicators for correctly predicting environmental changes has become more difficult and obsolete for farmers. Also, the potencies of the identified adaptation practices for yielding perfect responses to changes in the environment has become riskier and challenging as time goes by. The quotations below are some of the statements opined by the study participants.

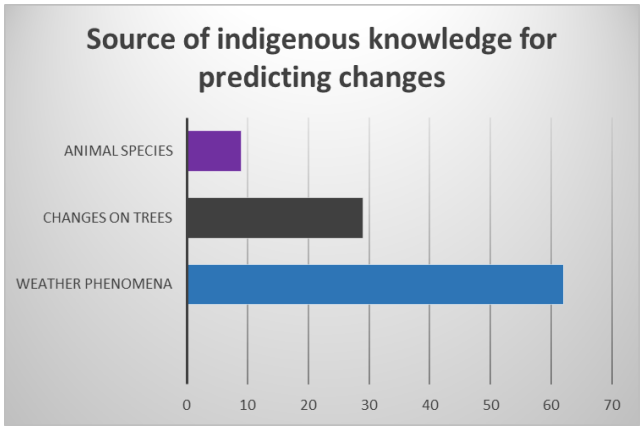

Figure 2: Sources of indigenous knowledge: Source; Field data, 2015

"At first it was very easy to say it is going to rain or determine when it is time to start farming seasons but these days, it rains when least expected so it is difficult to rely solely on what we have always known." (Agya Appau, Akrofonso).

"All the water bodies we relied on for irrigating farmlands have all dried up completely. These days getting water for watering crops in more tedious and labour-intensive for us. A cost we are not well placed to foot." (Akua Afriyie, Boanim).

"Times have changed and so things are not the same anymore. Merely observing physical changes on trees were very helpful in making predictions about rainfall but these days, such observations have proven to be misleading on numerous occasions."(Opanyin Ansah, Domeabra).

The above quotes from respondents indicate that although the role of indigenous knowledge in climate adaptation practices have been critical, solely relying on their sources in modern times could be very costly and eventually could render the livelihoods of countless farming households vulnerable.

Classification of indigenous adaptation strategies: Based on Below et al., [41] classification of adaptation practices, farm management and technology emerged the most prominent category. Thus, most indigenous practices cited by famers dwelt on farm management and technology (57%), followed by knowledge management, networks, and governance (18%); diversification (13%); government interventions (8%); and farm financial management (4%). It is worthy of note that, the qualitative nature of analyzed responses imply that all numbers are for demonstrative purposes only and should not be mistaken as an indicator of the relative significance of the categorized practices.

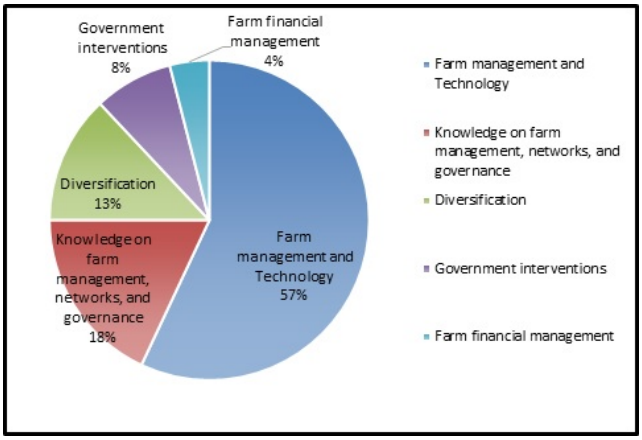

Figure 3: Field data, 2015.

Weather Phenomena	Trees/Plants	Animal Species
1. "Eb)"- Fog The presence of dense fog on nearby highlands during April indicated less rainfall and no incidence of flooding for farms close to river banks or in low lying areas.	"Onyina"- Ceiba pentandra This is a big forest tree that sheds its leaves between January and March. The sprouting of its leaves correspond to the rainy season which begins in the month of June and July in Ghana. This assisted farmers to predict rainfall patterns.	"Atwer 3"- Frog When the loud croaking sound of the frogs is heard very often in the dry season and also in May to June, it signifies an end to the dry season and a sign to prepare for the rainy season. It also believed to be a cry to the heavens for rains to fall for the frogs.
2. "Mununkum"-Clouds When the cloud cover become very dark in the east, it is an indication of an imminent rainfall in the communities	"framo"- Terminalia superba and "Emire" – Terminalia ivorensis These forest trees shed their old dried leaves as soon as the rainy season is about commencing.	"Kankabi" – Millipede "Nkrane" – Black ants When millipedes and centipedes are seen climbing higher grounds, it is an indication of an impending rains as they are seen to be taking shelter on higher grounds to escape the flow of fallen rains.
3. "Agradaa ne Ayerem"-Thunder and lightening When these two weather phenomena become very loud and pronounced in the farmer's immediate location, it means heavy rainfall is inescapable.	"Kakapenpen" – Rauvolfia vomitaria When the tree bears fleshy and red colored fruits, it is an indication of the nearness of the rainy season.	"Akyenkyena" – Pied Hornbill When these birds move to the farming communities in large groups, it means rainfall is near.

"Nyankot)n" – Rainbow The presence of this multi-colored arc in the sky signifies and end or near end to the rainy season.	Boabab tree The flowering stage of the tree before turning into fruits marks the onset of the rainy season. If the rain will not be good for the farming season, the tree will not flower well.	"Ab3b3" – Grasshopper The presence of grasshoppers are associated with limited rains when they appear in their numbers in the communities especially in the month of April
"Mframa" – direction of the wind Blowing winds from West to East in the communities was seen as rain bearing winds. This is seen by falling leaves of trees and leaping directions of plants and tree branches.		"Dabodabo" – Duck When the duck is seen flipping its long flat tail in a wet place, it a sign that rainfall is in the horizon. When it does same in a dry place, it is seen as a sign for drought.
Source, Field data, 2015		

Table 3: Indigenous ways of predicting changes in the environment.

These adaptation practices by smallholder farmers are buttressed by Benneh [42], who opined that the flowering of the shea nut tree, migratory patterns of birds and position of the constellation Pleiades all help farmers determine when the rainy season is due. Also, according to Ofori-Sarpong, smallholder farmers select diverse intercropping procedures based on variations of soil moisture and the onset, character and duration of rainfall. Typical combinations include cowpea, cowpea-sorghum, millet, and groundnut in years with poor rainfall, and maize-beans, maize-groundnut and maize-millet combinations during years with moderate rainfall [43] (Table 4).

Climatic Event	Coping/Adaptation Strategy
Flooding	Cease farming or building in lowlands/waterways Construction of improved drainage system (dependent of credit facilities available to farmer) Building embankments
Drought	Planting drought resistant or early yielding crops Planting cover crops or more trees Food storage for unfavorable conditions Expanded use of traditional rainwater harvesting and water conserving techniques Building shelter banks and windbreaks to improve resilience Monitoring of the number of grazing animals and deforestation Set-up of revolving funds to purchase rainwater tanks Use of shallow tube wells/dugouts Rotation method of irrigation during water shortages Construction of water impounding basins Adoption of organic agriculture Adjustment to planting dates and crop variety
Bushfires	Improve farm maintenance techniques Fire prevention education Construction of fire lines/belts and controlled burning
Source: Authors' construct 2015.	

Table 4: Indigenous adaptation practices employed by smallholder farmers to cope under extreme climatic situations.

Knowing that crop success is subject to the variability and unpredictability of weather events, and the occurrence of pests, indigenous communities have traditionally favored the cultivation of a diversity of traditional crop varieties over a single high-yield but also high-risk, mono-cropping system [44]. Through their investigation of three agricultural systems in Kenya, China and Bolivia, Swiderska et al. [45] established that the maintenance of varied traditional crop varieties and access to seeds have been significant for adaptation and survival by subsistent farmers.

Factors that constrain adaptation to climate change

A number of renowned researchers have explored the various factors that constrain successful adaptation to climate change by smallholder farmers. These studies revealed that adaptation strategies utilized by smallholder farmers are constrained by numerous factors including inadequate knowledge about climate change; impacts, causes and vulnerability, lack of awareness about potential risks, insufficient human capacity, land tenure, labour constraints, financial resources and under-resourced institutions. The findings accentuate the need for farmers' education, awareness creation, poverty alleviation and improved access to more proficient inputs as powerful tools for climate change adaptation in the district.

Though these factors evidently constrain all global economies alike, their adverse impact is very dreadful in poor or third world countries where there is very weak or non-existent knowledge generation and apt communication system to buttress efforts to positively deal with climate change. The study gathered the following to be major factors that constrain adaptation measures aimed at adapting and managing the climate menace in local communities.

1. Inadequate knowledge about current and future impacts and vulnerability of climate change in rural communities. This is buttressed by findings of Barros [46], who concluded that the effectiveness of weather forecasts and early warning systems in the region is characteristically limited by these factors as well as by the lack of resources to implement and operate them.
2. Insufficient human capacity and financial resources. The usefulness of shared efforts to adapt to climate change depends largely on the human capital who primarily acts as change agents in social settings. Latest literature continues to establish monetary constraints related to adaptation. Nevertheless, such constraints generally involve the financing of discrete adaptation choices [47].

3. Lack of awareness about potential risks. Adaptation can also be limited by social and cultural motives which might be linked to societal values, world views, and cultural norms and behaviors [48].
4. Under-resourced institutions. Numerous climate literatures present large evidence that institutional potential is a key factor that may possibly constrain the variation system (Very high confidence; Berkhout, 2012) [49].

Mitigating climate change impact on smallholder agriculture in Ghana

The impacts of climate change on the livelihood of smallholder farmers demand responsive actions that could adequately lessen the impacts of climate change on agricultural productivity. Based on qualitative inputs of respondents, the following actions were suggested to be some of the effective ways of mitigating the climate menace in the selected communities.

1. Use of small-scale irrigation schemes and also the provision of irrigation facilities should be provided during on-farm operations. Though respondents were of the belief that this particular initiative can help mitigate climate related challenges of farmers, they quickly opined that, the initiative is capital intensive and therefore not readily affordable to the smallholder farmers. According to AQUASTAT, 2000, only 0.5% of the cultivated area in Ghana was irrigated (AQUASTAT, cited in Dazé, 2007) [50] but climate change has increased the demand for irrigation schemes. The use of hand-dug wells, dugouts and small reservoirs, and run-off river diversions were the main sources of water for farm irrigations. These sources were manually constructed by smallholder farmers within the same farming area. These sources according to respondents have been very reliable due to the presence of rivers such as Offin, Oyon and Abankro which are mostly the reference points for the run-of river diversions.
2. It was also suggested that safeguarding thorough environmental management practices and further assistance from research-based experiences and farm extension services possibly can lead to the reduction of climate change on agricultural productivity the communities. Extension service Officers were to constantly educate farmers to adapt new technologies and also buttress farmer's indigenous farming practices with improved farming practices.
3. Also, for cereal crops, strategies that could be employed to mitigate climate change comprise the acquisition and use of drought resistant crop varieties in planting. Cropping can be maximized, such that millet, groundnuts and cowpeas are planted; water conservation methods are introduced for rice production.
4. Another suggestion considered shifting of planting season by farmers. Under this strategy, respondents indicated that, instead of farmers waiting to begin planting in March which has been the norm since time past, smallholder farmers should delay and begin planting in April or early May. According to respondent, this was the most conscious way of adapting to changes and therefore acknowledged by every smallholder farmer in the local communities.
5. Finally, it was suggested that, the unfailing services of the Ghana Meteorological service would be of immense help to smallholder farmers. This would be highly appropriate in the event where the agency is able to make future predictions of climatic phenomena. This will prove to become an important tool for smallholder farmers to know when to plant and what to plant based on weather reports being made easily accessible and understandable by farmers.

Aside from the suggestions revealed by the study, Gloria et al., [51] opined that farmers in the Offinso districts have added cropping around streams, the use of dug out wells for farming and tree planting as measures to adapt to climate change. These are germane suggestions which when implemented will help smallholder farmers to adapt to climate change in a more effective way especially, in the advent of failing indigenous adaptation practices.

Conclusion

In general summation, we conclude that even though the relevance of indigenous knowledge sources and practices remain indispensable in the struggle to adapt to climate change, efforts will be more promising should there be a co-production of other knowledge sets (science based) to buttress established positive practices. The findings posit that a fall in agriculture may render the livelihood of many of the locals at ransom. It is therefore imperative to make agricultural activities lucrative and sustainable to protect the livelihoods of farmers and protect the youth from migrating out from the municipality for better lives elsewhere. The major factors constraining them from adapting to climate change were poverty; farmland and land tenure issues, inadequate access to more efficient inputs, lack of information and poor skills, and labor constraints. The environmental complications conveyed by global climate change are beyond the lived experience of all knowledge holders, whether scientific or indigenous and therefore require a holistic approach encompassing varied knowledge sources to adequately tackle the resultant challenges. Operational adaptation planning necessitates access to the best available knowledge, be it indigenous or scientifically sourced.

We therefore suggest that, in the face of climate change risks and impacts that remain uncertain and unpredictable, there is an increasing need for procedures and measures that nurture the co-production of new knowledge sets, grounded on collaborative energies encompassing community-based knowledge holders and natural and social scientists. The findings underscore the need for farmers' education, awareness creation, poverty alleviation and increased access to more efficient inputs as powerful tools for climate change adaptation in the area.

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