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# Farming Communities Adaptation Strategies to Climate Change in Bibiani-Ahwiaso-Bekwai in the Western North Region of Ghana

**Isaac Verberk Mensah[1], Anthony Bordoh[2, *], Cynthia Anim[3]**

[1]Department of Geography and Rural Development, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[2]Department of Social Studies Education, University of Education, Winneba, Ghana
[3]Department of Social Sceinces, Presbyterian Women's College of Education, Aburi, Ghana

## Abstract

Climate Change (CC) poses threat to food crop production especially in a developing country like Ghana. The study examined the Farming Communities Adaptation Strategies to Climate Change in Bibiani-Ahwiaso-Bekwai in the Western North Region of Ghana. The targeted population consisted of officials from MoFA, GMA and heads of households who are food crop farmers from the study area. Simple random and purposive sampling techniques were used to select the one hundred and fifty-six (156) out of the total of two hundred and thirty-one (231) respondents and six (6) communities (Hwenampori, Wenchi, Tanoso, Awaso-Asempanaye, Kunkumso and Sefwi Bekwai) for the study. The main instruments used for data collection in this study were questionnaire, interview and focus group discussions. Data of the study were analysed using statistical tools such as Pearson Chi-Square and Cross tabulation of the IBM SPSS Version 20. Descriptive statistical tools such as frequencies and bar graphs were also used to present the results. The study concluded that, information on micro-weather conditions in the area that could assist farmers to make informed decisions regarding adaptation measures against climate change from the local meteorological agencies have not been available. It is therefore recommended that the government and other stake holders like NGO's should help provide irrigational facilities to farmers to be able to cultivate in times of dry spells and delayed rains.

## Keywords

Farmers, Adaptation, Climate Change, Bibiani-Ahwiaso-Bekwai, Western North Region, Ghana

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## 1. Introduction and Background

Climate change has attracted global attention than any other recent geographical phenomena. This is evidenced in the number of international committees and organisations about it and their various annual reports as well as its inclusion in academic discipline as a permanent field of study at degree levels of various higher institutions. It is considered the biggest environmental threat in human history and the defining human challenge for the twenty-first century [1, 2]. Global climate has indeed changed and is still changing - an observation and assertion made on the structure of the ecosphere is not eternal and unchanging, rather alteration is the constant rule of the physical environment and would be so even in the absence of human and their distorting impacts [3]. Consequences of such climate change are already felt throughout the Earth system and the effects thereof are observed on every continent and in all sectors. However, adaptation to these changes needs to not only respond to these impacts, but also needs to be integrated into sustainable

* Corresponding author
E-mail address: bordohlity@yahoo.co.uk (A. Bordoh)

development strategies and their implementation.

There is rising anxiety about the effect of CC on human life, as the scientific agreement grows that significant climate change is very likely to occur over the 21st century [4]. As global climate keeps changing, there is need to worry and intensify research focus on it since various earth systems such as agriculture and soil are vulnerable to impacts accompanying such changes. In regards to agriculture, the general agreement is that changes in temperature and rainfall will result in changes in land and water regimes that will then disturb agricultural output [5, 6]. If agriculture becomes affected, then food security also becomes uncertain.

The rapid pace at which climate change is happening, together with the increase in global population and slow income growth, threatens food security globally [7]. Agriculture has proven to be extremely susceptible to climate change as seen by the severe decline in food production over the past two decades, and that the high temperatures that are being experienced in most parts of the globe will eventually reduce yields of desirable crops while encouraging weed and pest proliferation [7]. The changes in precipitation patterns will significantly increase the likelihood of crop failures and production declines [7].

Agriculture in Ghana is a predominant economic activity which determines not only the livelihoods of the farmers but also an indicator of national growth and development since it contributes to employment creation and a source of revenue to the government as well as national food security [8]. Now the threat of climate change to national development in Ghana is officially acknowledged so commitments and efforts are being put in place to address the climate change concerns by agriculturalists and Ghana Trade Unions [9]. A report by Ministry of Food and Agriculture says the crop production sector of agriculture contributes about 66.2% to Ghana's Gross Domestic product (GDP) [10]. Ghana's economy is noted as primary resource-based, dominated by food crop cultivation therefore, extreme weather conditions and other environmental effects associated with climate change portend real danger to agricultural livelihoods and socioeconomic development of the country [9]. Also the study area, Bibiani-Ahwiaso Bekwai (BAB) District is importantly noted for the production of food crops such as plantain, maize, cassava and vegetables as well as cash crops like cocoa and oil palm and is basically rain fed [10, 11]. Since agricultural (food crop production) activities in the area depends largely on rainfall, national food security becomes threatened if the district is adversely affected by uncertainties in rainfall patterns and other extreme weather events like floods, droughts and windstorms.

Matters concerning climate change and agriculture have attracted the attention of a number of researchers and research institutions globally [1, 7]. This therefore affirms the existence of CC as a serious problem of concern for developing countries like Ghana since agricultural activities are dependent largely on climatic variables like rainfall and temperature, hence more research work must be conducted. However, literature on climate change has largely focused on the broad impact of climate change on livelihoods, adaption and mitigation strategies. The purpose of this study was to explore the farmers' adaptation strategies climate change Bibiani-Ahwiaso-Bekwai district from 1984-2014. The study sought to answer this research question - How are farmers adapting to Climate Change and to how effective are the adaptation strategies?

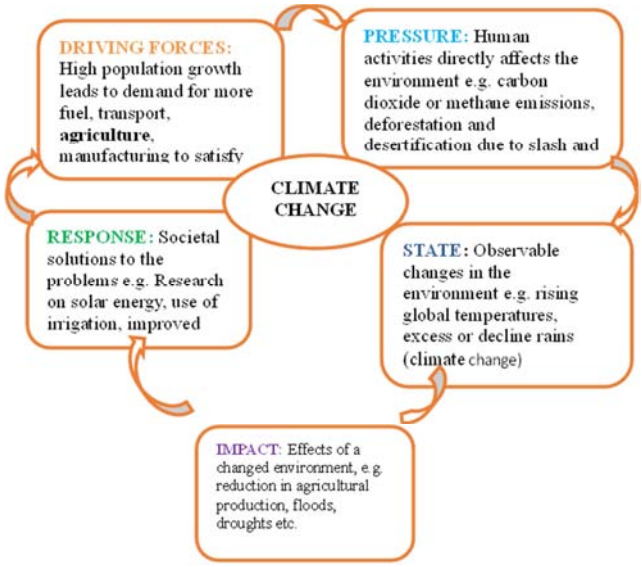
## 2. Conceptual Framework Underpinning the Study

Driving forces are the social, demographic and economic developments in a city. They also include livelihood options, changes in lifestyles, poverty levels and consumption as well as production patterns. These driving forces exert pressure on the environment. For example, the excessive use of natural resources such as forests for firewood or land for urban agriculture. Over-utilization of forests for firewood may lead to deforestation and land degradation, and urban agriculture may contribute to soil erosion and siltation of rivers, depending on how the land is managed. These pressures change the state of the environment and such changes may have environmental, social and economic impacts. These may eventually affect human health as well as economic and social welfare of a society. Society is then forced to intervene to limit the damage or restore degraded areas. This may be in the form of by-laws, as well as budget allocations for monitoring and law enforcement.

The framework helps to design environmental impact assessments, to identify indicators and to communicate results. It can also be used to integrate socio-economic and ecological processes to understand the forces that drive patterns of ecosystem changes, both in scientific studies, and as in policy processes. The Driving Forces-Pressure-State-Impact-Response Framework (DPSIR) framework can be used at any spatial level to address the need for reliable environmental data and information for effecting policy responses for better environmental management. It is also used as a tool by governmental organisations, marine construction companies, scientists, consultants and NGO's to get grip on various aspects of the effects of human activities on the environment. Again, it is possible to use the DPSIR framework within all phases of a project from the initiation phase through planning and design phase, construction phase,

operation and maintenance phase and to decommissioning phase.

The model is very popular in terms of acceptance and its application globally. It has been applied in several instances most especially before the commencement and execution of development projects where Environmental Impact Assessment (EIA) is required in the process. For instance, it has widely been adopted and used in many Integrated Environmental Assessment (IEA) processes for environmental assessment and reporting in Africa [12]. The tool was applied in the Singapore case of the Building with Nature (BwN) programme to structure information on environmental risks and impacts ensuing from various activities in the coastal zone (other than dredging). Here the focus was on water quality aspects, with the emphasis on pressures, state and impacts [12].




Source: Adapted from [12]

**Figure 1.** Driving Forces-Pressure-State-Impact-Response Framework.

## 3. Methodology

The study adopted the mixed research method (qualitative and quantitative methods) to obtain and analyse the data. The targeted population consisted of officials from MoFA, GMA and heads of households who are food crop farmers from the study area. Only community members who have farmed for more than thirty (30) years were presented with questionnaire against the background that they have more experience on climate change and its impacts than younger people. Simple random and purposive sampling techniques were used to select the one hundred and fifty-six (156) respondents and six (6) communities (Hwenampori, Wenchi, Tanoso, Awaso-Asempanaye, Kunkumso and Sefwi Bekwai) for the study. Respondents were selected due to the homogenous nature of households in the various study communities in terms of their occupation. The district has a total household of 27,961 with 74.9% (i.e. 20,938) engaged in agriculture (GSS 2014 cited at www.ghanadistrict.com). Out of the 20,938, who are into agriculture, 98.2% (being 20,552) are food crop farmers that formed the sampling frame from which a total sample size of 231 respondents were selected and contacted for information to aid the final work. In all, 156 respondents out of the total sample size (231) were presented with questionnaires for information to aid quantitative data analysis and 75 respondents were also engaged in Focus Group Discussion (FGD) and or interviewed for information also for qualitative data analysis. The 156 sample size was determined using the formula by Yamane, (1967:886) cited in Israel, (1992:4) as shown in the equation.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n is the desired sample size

N is the target population and

e is the margin of error.

With 92% confidence level, 8% (0.08) margin of error was used to determine the sample size. By using 8% margin of error, the 156 sample size derived was representative enough of the population to draw conclusions. Another reason for choosing 8% margin of error is that the obtained sample size of 156 was only meant for questionnaire administration for quantitative data analysis besides the 75 respondents meant to provide qualitative information through FGD and interviews for qualitative analysis. Again, by reducing the margin of error the sample size was too high for the researcher to get adequate resources to gather data considering the time frame.

The main instruments used for data collection in this study were questionnaire, interview and focus group discussions. In all, a total of 156 farmers were successfully interviewed with questionnaires during the period. Twelve (12) different FGDs were organized within the six communities order to extract valuable much information from the farmers. Data of the study were analysed using statistical tools such as Pearson Chi-Square and Cross tabulation of the IBM SPSS Version 20. Descriptive statistical tools such as frequencies and bar graphs were also used to present the results. A clearer visual impression was achieved when the bar graphs were used to present information. Again, where appropriate, photographs were used to give a visual image of the issues being presented.

## 4. Findings and Discussions Farmers Adaptive Strategies Against Climate Change

This section explores the various adaptation measures employed by farmers in the study area to combat climate change impact on their crops. Adaptation measures to CC which involves the various methods put in place to withstand or reduce the potential impact of climate change, become necessary when the magnitude of the impact of climate change appears significant to man. As highlighted by the "response" component in the DPSIR framework, when poor farming practices such as slash and burn and deforestation compound the problem of CC, the resulting impacts on crops are felt directly by farmers and so they have to devise means to adapt. A cross tabulation of dichotomous "yes and no" questions on the various adaptation measures to climate change were presented to farmers to indicate which amongst the options were mostly adopted. These included mulching, crop diversification, diversification to non-farm activities, and use of agrochemicals, mixed cropping, changing crop variety, changing farm location and the practice of irrigation farming. The results of the field survey revealed that the most preferred adaptation measures against the devastating impact of CC on their crops includes mulching, mixed cropping, change of crop variety, use of agro chemicals and crop diversification.

**Table 1.** Adaptation measures against CC.

| ADAPTATION MEASURES | YES (count) | % | NO (count) | % | Chi-Square |
|---|---|---|---|---|---|
| Mulching | 128 | 83.7% | 25 | 16.3% | 0.439 |
| Crop diversification | 137 | 89.0% | 17 | 11.0% | 0.538 |
| Diversification to non-farm activities | 5 | 3.2% | 149 | 96.8% | 0.749 |
| Use of agrochemicals | 57 | 37.0% | 97 | 63.0% | 0.894 |
| Mixed cropping | 152 | 98.7% | 2 | 1.3% | 0.841 |
| Changing crop variety | 132 | 86.3% | 21 | 13.7% | 0.485 |
| Changing farm location | 32 | 20.8% | 122 | 79.2% | 0.588 |
| Practice of irrigation farming | 18 | 11.7% | 136 | 88.3% | 0.525 |

Source: Authors field data (2015)

Farmers' choice of adaptation measures against CC in order of preference table 1 indicated that 98.7% of the respondents practiced mixed cropping as an adaptation measure, 89.0% diversify their crops in order to cope with the changing climate, 86.3% also adapted by means of changing the varieties of their crops and 83.7% also practiced mulching as adaptation measure. The use of agrochemicals was adopted by only 37.0% of the respondents as means of adapting to climate change. The least measure adopted by farmers to cope with CC was diversification to non-farm activities since only 5 (3.2%) respondents opted for that option. The Chi-Square test results in all cases from Table 1 shows that there is no significant difference ($P>0.05$) among the responses of farmers. This implies that the proportion of farmers who chose the various adaptation measures in the study area does not significantly differs from the proportion of farmers who did not choose the other adaptation measures.

Cross tabulation of specific adaptation measures adopted against climate change to prevent crop failure indicated that mulching, mixed cropping, crop diversification and changing crop variety were mainly used by farmers. The choice of these adaptation measures was informed by farmer's years of farming experience in crop production. The farmers maintained the notion that after exploring a number of possible adaptation measures, they concluded that the above mentioned adaptation measures proved effective hence the choice. The study agreed with the previous studies on "Mulching" which involves the use of dead organic materials to cover the surface of the soil in order to conserve soil moisture content was very popular adaptation strategy which most farmers adopted [13, 14-17]. This serves both as soil and water conservation practice thus improving soil productivity. Mulching as an adaptation measure to cope with the impact of climate change was emphasised in the findings of a study that, farmers in Imo State of Nigeria used mulching as the main measure against CC [14]. Mixed cropping which involves planting of different kinds of crops on the same piece of land was highlighted by 98.7% of farmers as the most preferred adaptation measure against climate change. By mixed cropping, they indicated that the dominant crop combination at a time on a piece of land included cassava, plantain, cocoyam, maize, some vegetables as well as some cash crops like cocoa or oil palm. Again, this finding is consistent with the studies of [13, 14 - 17]. Also from the Focus Group Discussions (FGD), it was discovered that mixed cropping as an adaptation measure provided farmers with crop yield even in situations where there were failures of one kind of crop or the other due to climate change. Quoting directly from a female respondent at Tanoso;

"*We have used mixed cropping for years and have realized that it is the best adaptation measure so far. This is because whenever there is extreme climatic event such dry spells, wind storm or delayed rains, and some of the crops are*

*affected negatively, others still remain unaffected thereby providing yield which mono cropping would not give*."

Comparably, crop diversification and changing crop variety (using different variety or species of the same crop either because of differences in gestation periods or returns) were adopted by majority of respondents as measures to cope with climate change, also crop diversification and changing crop variety as measures adopted by farmers in Bangladesh [17]. Crop diversification involves addition of new crops or substituting new crops for others on the same farm land for different returns from the value-added. Farmers in Northern Ghana use crop diversification as an adaptation measure to combat the impact of climate change on crops [15]. These measures were found to be effective by farmers based on their experience to select an adaptation measure against climate change induced crop failure.

Contrary to the preferred measures adopted by farmers against climate change, diversification to non-farm activity, irrigation practices, use of agrochemicals and changing farm location were least adopted as adaptation strategies. This is also consistent with a study on "an evaluation of farmers' perceptions of and adaptation to the effects of climate change in Kenya", published in *International Journal of Food and Agricultural Economics* but contrary to the findings on "factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh", published *Climate* [15, 17]. Again, it was highlighted by farmers during focus group discussions that they knew the importance of irrigation and use of agrochemicals such as fertilizers, insecticides and herbicides in crop production, but their problem of not adopting such measures was due to the high cost involved which they could not afford.

In a nutshell, the dichotomous "yes and no" responses of farmers on specific adaptation measures against climate change as shown in Figure 2 indicated that most farmers accented to using mixed cropping, crop diversification, changing crop variety and mulching as measures adopted against crop failure. On the other hand, measures such as diversification to non-farm activities, use of agrochemicals, irrigation and changing farm location were least adopted to cope with climate change.

In addition, however, it was also discovered during the focus group discussions that locally, farmers use some other means to cope with the destructive effects of extreme climatic events. It was observed that during situations of windstorm or heavy winds, several acreages of maize, plantain and cassava farms are pulled down but the farmers are able to support their crops with sticks and palm fronds. According to them, they drive palm fronds and such other strong sticks deep into the ground and make it firm after which surrounding maize plants that were pulled down are raised and tied to the sticks. Some also said they do nothing to cope rather they look up to God.

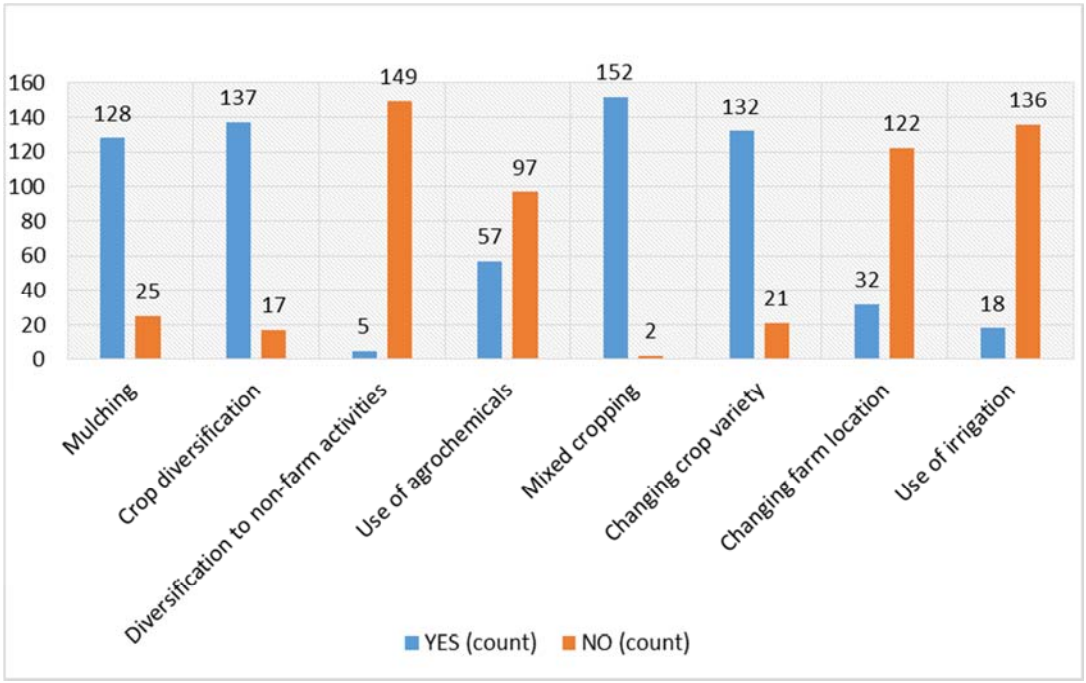



**Figure 2.** Summary on measures adopted by farmers against CC to prevent crop failure.

Source: Authors Field Data (2015).

### 4.1. Determinants of Adaptation to Climate change CC by the Various Communities

This sub-section considers the factors that determine the various adaptation measures adopted by farmers against climate change (CC) within the various communities. As to whether or not factors such as community based governance, availability of resources, education in a form of information on better adaptation choices, years of farming experience, land tenure status and extension service support influence their choice of adaptation measures at their communities. By cross tabulating the study communities (Awaso-Asempanaye, S/Bekwai, Tanoso, Kunkumso, Wenchi and Hwenampori) against specific determinants a more spatial variation regarding what is happening at different communities have been unearth. These have been presented in the tables in this sub-section. In addition, a factor that was most highlighted as determining their choice of adaptation at the various communities was further cross tabulated with the level to education of respondents to elicit the nuances that may explain such factors better.

**Table 2.** Community based governance as a determinant of adaptation against CC in the various communities.

| | | | Communities | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Community based Governance | Yes | Count | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | % of Total | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% |
| | No | Count | 33 | 64 | 15 | 10 | 14 | 17 | 153 |
| | | % of Total | 21.4% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 99.4% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.615 | | | | | | | | | |

Source: Authors field data (2015).

It is observed from Table 2 that only a farmer from Awaso-Asempanaye did adapt to CC based on community based governance. Community based governance involves locally instituted organisation with appointed and trained leaders who offer guidance to farmers on proper farming methods and practices. There was however no significant ($P > 0.05$) relationship between the responses of the famers.

**Table 3.** Resource availability as a determinant of adaptation by communities.

| | | | Community | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Availability of resource | Yes | Count | 4 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | % of Total | 2.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 2.6% |
| | No | Count | 30 | 64 | 15 | 10 | 14 | 17 | 150 |
| | | % of Total | 19.5% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 97.4% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.013 | | | | | | | | | |

Source: Authors field data (2015).

From Table 3, only 4 respondents out of 34 farmers from Awaso-Asempanaye indicated that they adapted to CC based on available resources such as variety of crop seedlings, money to purchase agrochemicals as well other local resources such as strong sticks for supporting crops during rainstorms etc. About 150 respondents from the remaining five communities including 30 out of the 34 respondents from Awaso-Asempanaye did not adapt to CC based on resource availability. There was a significant relationship ($P < 0.05$) among the responses of farmers.

**Table 4.** Education through information acquired as a determinant of adaptation by communities.

| | | | Communities | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Education | Yes | Count | 13 | 10 | 0 | 0 | 0 | 0 | 23 |
| | | % of Total | 8.4% | 6.5% | 0.0% | 0.0% | 0.0% | 0.0% | 14.9% |
| | No | Count | 21 | 54 | 15 | 10 | 14 | 17 | 131 |
| | | % of Total | 13.6% | 35.1% | 9.7% | 6.5% | 9.1% | 11.0% | 85.1% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.000 | | | | | | | | | |

Source: Author's field data (2015).

**Table 5.** Land tenure status as a determinant of adaptation to CC by communities.

| | | | Community | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Land tenure status | Yes | Count | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | % of Total | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% |
| | No | Count | 33 | 64 | 15 | 10 | 14 | 17 | 153 |
| | | % of Total | 21.4% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 99.4% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.615 | | | | | | | | | |

Source: Authors field data (2015).

Majority (85.1%) of the farmers did not adapt to climate change based on any special information given them in a form of education. However, 14.9% of the farmers being (8.4%) and (6.5%) from Awaso-Asempanaye and Sefwi Bekwai respectively indicated that they adapted to CC based on education given to them by either extension officers or any other source (Table 4). The relationship that exist among the responses of farmers was highly significant ($P < 0.05$).

When farmers were asked whether or not ownership of their farmlands was a determining factor to adapt to climate change, only 1 out of 34 respondents from Awaso-Asempanaye said yes. Majority 153(99.4%) from the remaining five communities including those from Awaso-Asempanaye affirmed that they did not adapt to climate change due to land tenure status (Table 5). even though follow-up inquiries discovered that majority were owner occupiers with the minority being tenants (i.e. operating on the basis of share cropping). There was a small association among the responses of farmers which did not also vary significantly ($P > 0.05$). In contrast to this finding is a study on farmers working on rented lands were found to be less likely to adapt to climate change than those who own lands, presumably because owners receive the benefits of land improvements, or at least a larger share of them [18].

**Table 6.** Years of farming experienced as a determinant of adaptation to CC by communities.

| | | | Community | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Experience | Yes | Count | 32 | 63 | 15 | 10 | 14 | 17 | 151 |
| | | % of Total | 20.8% | 40.9% | 9.7% | 6.5% | 9.1% | 11.0% | 98.1% |
| | No | Count | 2 | 1 | 0 | 0 | 0 | 0 | 3 |
| | | % of Total | 1.3% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 1.9% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.561 | | | | | | | | | |

Source: Authors field data (2015).

With regard to experience or years of farming experience as a determining factor to adapt to climate change, majority (98.1%) of the respondents indicated that indeed, whether or not they would adapt to CC depends largely on years of farming experience since to them, the climate keeps changing. This finding is consistent with a study conducted in Kenya where majority (74%) of farmers who adapted to climate change had farming experience of more than 10 years in comparison to 11% of farmers who had low experience of about 10 years and below [15]. At Awaso-Asempanaye community, out of 34 respondents, 32 claimed to have adapted to climate change based on years of farming experience and only 2 respondents did not adapt to CC due to years of farming experience. A similar pattern was observed at S/Bekwai where out of 64 respondents, 63 had adapted to CC based on years of farming experience and only one person indicated that his adaptation to CC was not determined by experience. There was no significant difference among the responses of farmers ($P > 0.05$).

**Table 7.** How respondents' level of education affects their choice of "years of farming experience" as a determinant of adaptation to CC in the area.

| | | | Highest education level | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Primary | Middle school | Secondary school | Tertiary | No formal education | |
| Years of farming Experience | Yes | Count | 38 | 29 | 15 | 16 | 53 | 151 |
| | | % of Total | 24.7% | 18.8% | 9.7% | 10.4% | 34.4% | 98.1% |
| | No | Count | 2 | 1 | 0 | 0 | 0 | 3 |
| | | % of Total | 1.3% | 0.6% | 0.0% | 0.0% | 0.0% | 1.9% |
| Total | | Count | 40 | 30 | 15 | 16 | 53 | 154 |
| | | % of Total | 26.0% | 19.5% | 9.7% | 10.4% | 34.4% | 100.0% |
| Pearson Chi-Square = 0.417 | | | | | | | | |

Source: Author's field data (2015).

Table 7 shows that out of 151(98.1%) respondents who had adapted to CC based on years of farming experience, 53(34.4%) had no formal education, 38(24.7%) had primary education, 29(18.8%) had middle school certificate, 15(9.7%) had secondary education and the remaining 16(10.4%) had tertiary education. On the other hand, the remaining 3 respondents who did not adapt to climate change based on years of farming experience constitute only 2 with primary education and one person with middle school certificate (Table 7). This contrasts the findings of a study conducted in Kenya where majority (63%) of farmers who adapted in various ways to changes in temperature and precipitation had reached post primary education level compared to those who had up to primary level (22%) [15].

By inference, it can be deduced that since respondents with no formal education formed the majority among those whose adaptation strategy against CC was determined by their years of working experience, the role of formal education (highest educational attainment level) in the choice of adaptation measure against CC is not paramount in the study area. Implying that just as those with formal education (from the primary level through to the tertiary level) chose adaptation measure largely based on years of farming experience, so are those with no formal education. This therefore makes it imperative to consider the judgements of farmers with more years of farming experience even without formal education very important in the same way as those with formal education.

**Table 8.** Extension service as a determinant of adaptation to CC by communities.

| | | | Community | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Extension Services | Yes | Count | 3 | 2 | 0 | 0 | 1 | 6 | 12 |
| | | % of Total | 1.9% | 1.3% | 0.0% | 0.0% | 0.6% | 3.9% | 7.8% |
| | No | Count | 31 | 62 | 15 | 10 | 13 | 11 | 142 |
| | | % of Total | 20.1% | 40.3% | 9.7% | 6.5% | 8.4% | 7.1% | 92.2% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.001 | | | | | | | | | |

Source: Authors field data (2015).

Extension services was not seen as a reason for adaptation by majority of the respondents (92.2%). This is because out of the total population, only 12 respondents representing 7.8% from all the study communities adapted to CC based on services provided by agricultural extension agents (Table 8). However, at Awaso-Asempanaye, out of a total of 34 respondents, 3 adapted to CC due to assistance from agricultural extension officers. In like manner, 2 out of a total of 64 respondents from S/Bekwai also adapted to CC by depending on services provided by agricultural extension officers. The relationship between responses of farmers was highly significant ($P < 0.05$).

Judging from the above factors that determine farmers' adaptation measures, it is observed in most cases that few respondents with contradictory views from the views of the majority came from Sefwi Bekwai and or Awaso-Asempanaye. Thus these few respondents did not adapt to climate change based on the determinants which influenced majority of the respondents. By inference and per the characteristics of the study communities, it can be said that, the respondents who did not choose adaptation measure based on farmers' years of farming experience but chose availability of resources may be engaged in other lucrative secondary occupation that afforded them enough resources to adapt to CC. This is so because from the findings (from the focus group discussion), most respondents from Sefwi Bekwai and Awaso-Asempanaye in addition to their primary occupation (farming) also undertake other secondary activities such as trading (during the periodic marketing at Sefwi Bekwai) and mining (at Awaso-Asempanaye bauxite company). This can be substantiated from the viewpoint that so long as other communities (namely Tanoso, Kunkumso and Wenchi) which are predominantly into crop production attributed their adaptation measures largely to years of farming experience and not resource availability or community based governance, then the secondary activities at Sefwi Bekwai and Awaso-Asempanaye have influence on the determinants of adaptation measure by the minority respondents.

Also, the fact that majority of the respondents from all the study communities apparently adapted to climate change based on their years of farming experience perhaps explains the importance of experience in adaptation to CC in the study area. This observation is consistent with a similar study on adaptation to climate change in low-income countries, indicated that farmers with more experience and better-education (well informed) were found to be more likely to undertake adaptation measure against climate change at the individual level, other things being equal [18].

Measures adopted against climate change by farmers in the area was based mainly on years of farming experience as 96.1% accented to choosing an adaptive measure by experience.

Majority of farmers (> 80%) did not depend on community based governance, availability of resource, land tenure system, extension service and education to choose an adaptive measure against climate change. There was no significant difference between the determinants of adaptation and adaptive measure chosen ($p > 0.05$). Figure 3 gives a graphical summary (in counts) of the major determinants of adaptation to and coping strategies chosen against climate change.

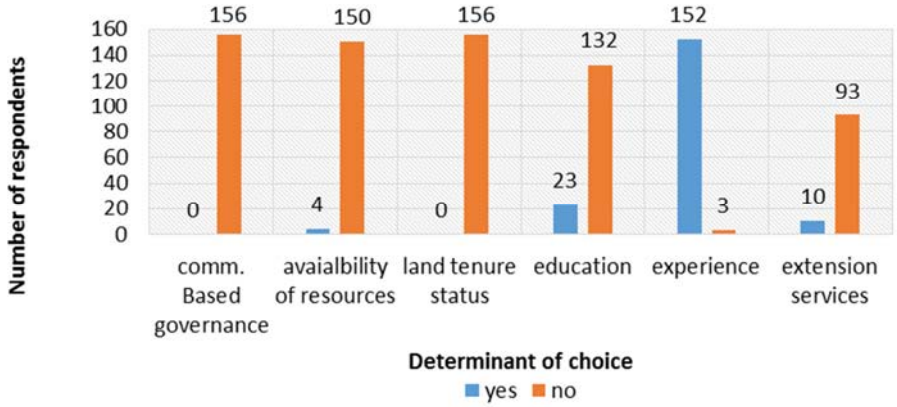



**Figure 3.** Summary of determinants of adaptation measures.

Source: Authors Field Data (2015).

## 4.2. Effectiveness of Adaptation Measures to CC at Various Communities

This sub-section also considers how effective the various adaptation measures farmers adopted against climate change have been at the various communities. Whereas in some communities' adaptation measures were observed to be very effective, other communities observed moderate effectiveness or no effect.

**Table 9.** Effectiveness of adaptation measures by communities.

| | | | Community | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Awaso-Asempanaye | S/Bekwai | Tanoso | Kunkumso | Wenchi | Hwenampori | |
| Effectiveness of Adaptation Measures | Very effective | Count | 30 | 16 | 15 | 7 | 14 | 2 | 84 |
| | | % of Total | 19.5% | 10.4% | 9.7% | 4.5% | 9.1% | 1.3% | 54.5% |
| | Moderate | Count | 4 | 46 | 0 | 3 | 0 | 15 | 68 |
| | | % of Total | 2.6% | 29.9% | 0.0% | 1.9% | 0.0% | 9.7% | 44.2% |
| | No effect | Count | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| | | % of Total | 0.0% | 1.3% | 0.0% | 0.0% | 0.0% | 0.0% | 1.3% |
| Total | | Count | 34 | 64 | 15 | 10 | 14 | 17 | 154 |
| | | % of Total | 22.1% | 41.6% | 9.7% | 6.5% | 9.1% | 11.0% | 100.0% |
| Pearson Chi-Square = 0.000 | | | | | | | | | |

Source: Author's field data (2015).

About 84 (54.5%) farmers affirmed that their adaptation measures against climate change was very effective, 68(44.2%) also affirmed that theirs were moderately effective and only 2(1.3%) indicated that adaptation measures in which ever form was not effective (Table 9). There was high significant difference ($P < 0.05$) between responses of farmers concerning the effectiveness of climate change adaptation strategies. It is observed from Table 9, that to the farmers, the various adaptation measures which included mixed cropping, changing crop variety, crop diversification and mulching were either very effective or moderately effective. When respondents were probed on the basis for considering adaptation measures as very effective or moderately effective, they attributed a discernible increase in output of crops in current year, compared with previous years to effective adaptation measures whereas a slight increase or no change in output was also attributed to a moderately effective adaptation measures. Furthermore, through a comparison of output accrued from cultivation before and after a particular adaptive measure was adopted can determine whether a particular adaptation measure has been effective or not.

If their reasons are justifiable, then output levels of crops at Sefwi Bekwai and Hwenampori have not witnessed any significant improvement. And that can partly be explained from the perspective that even though farming is the primary occupation of all the respondents at Sefwi Bekwai and Hwenampori, however, some of them engaged in secondary occupations such as trading or bauxite mining as in the case of

Awaso-Asempanaye. With this, farmers have divided attention and may sacrifice time meant for proper adaptation strategies for other activities which may render adaptation strategies against CC impacts on crops not to yield the needed effectiveness.

### 4.3. Strengths and Weaknesses of Institutional Mitigation Strategies

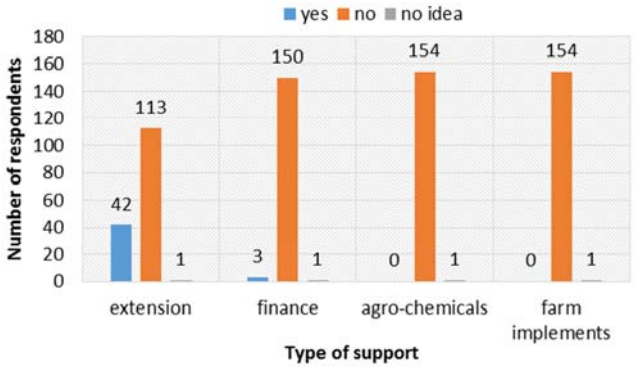
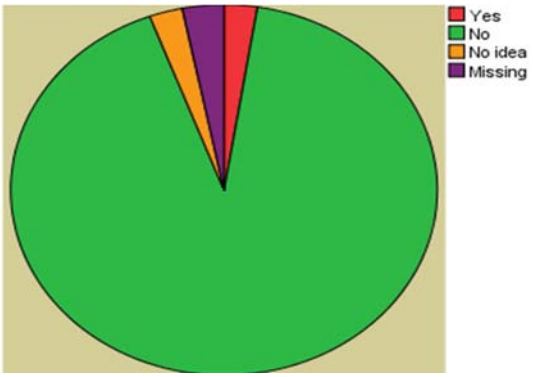



**Figure 4.** Institutional / government support to cope with CC.

Source: Authors Field Data (2015).

From Figure 4, it is observed that institutional mitigation measures or government support to assist farmers to adapt to CC in the form of finance, use of agro chemicals and farm implements were not received by farmers. The presence of extension services in the communities which 42 respondents out of 154 responded yes to, were even non-functional according to them.

From cross tabulation results (Figure 5), majority of farmers affirmed that they do not receive government support in any form against climate change. Extension services, farm implements, agrochemicals and financial assistance were not received as a support by majority of famers (> 90%) from the government. There was no significant difference among the responses of farmers in receiving government support against climate change. There was however a small association among the responses of the farmers. This implies that the responses of the farmers were independent from one another.




Source: Authors Field Data (2015).

**Figure 5.** Government support to adaptation.

During the focus group discussions at the various communities notably, Tanoso, Hwenampori, Awaso and Wenchi, when issues on the presence of agricultural extension officers in the farming communities and visitations by GMA officers (to educate farmers on the periodic expected weather conditions and what farmers should guard against) were raised, they simply gave a unanimous expressions of disappointment in the existence of such institutions in the country. They highlighted the fact that such institutions do not function even though they may exist. They further stressed that for the past 10 or more years, they have not received any form of support (e.g. education, financial aid and or agro chemicals) from any institution and that those officers assigned to visit their communities to educate farmers on measures to adopt against adverse effects of climate change never come.

### 4.4. Constraints to Adaptation

**Table 10.** Constraints to adaptation.

| CONSTRAINTS | YES (Count) | % | NO (Count) | % | Chi- Square |
|---|---|---|---|---|---|
| Lack of knowledge on proper adaptation | 153 | 99.4% | 1 | 0.6% | 0.888 |
| Limited land to expand farm size | 140 | 90.9% | 14 | 9.1% | 0.580 |
| High cost of agricultural inputs | 152 | 98.7% | 2 | 1.3% | 0.841 |
| Lack of access to climate information | 148 | 96.1% | 6 | 3.9% | 0.725 |
| Lack of access to water for irrigation | 151 | 98.1% | 3 | 1.9% | 0.805 |
| Financial constraints | 152 | 98.7% | 2 | 1.3% | 0.000*** |

Source: Authors field data (2015).

From Table 10, majority of the farmers (99.4%) indicated that they don't have much knowledge about deliberate and proper adaptation measures to climate change. This is because they have considered the prevailing adaptation strategies they adopt as just a routine way of carrying out their activities. They could do better and improve tremendously should they know that they have actually been adapting to climate change by virtue of those measures. Again, the cross tabulation results show that majority of farmers (90.9%) have emphasised limited land area to

expand their farm sizes as a major constraint to their ability to adapt to climate change impacts (Table 10). In this regard farmers would wish to expand their land size or relocate to different piece of land for cultivation but the large expanse of land to do so is non-existent. Farmers are most often left with no other option than to continue tilling the same land area over and again even in the case of extreme climatic event such as delayed rains. Whenever there was a delay in rainfall timing, farmers preferred to relocate to other areas close to rivers and other water bodies so that they could manually use the source of water for irrigation but such areas have not been available to them due to limited land sizes. High cost of agricultural inputs was also emphasised by respondents (98.7%) as a constraint to adapt to climate change and its impacts on their activities. Agricultural inputs such as agrochemicals, seedlings of improved crop variety (as in the case of maize and cassava) and other farm implements that could enhance their activities were considered too expensive to acquire to combat climate change.

In addition, most of the farmers (98.1%) observed that lack of access to water was also a serious challenge that hindered adaptation to climate change. This response was again supported unanimously by the farmers during the Focus Group Discussions (FGD) at Awaso-Asempanaye, Tanoso, Kunkumso and Wenchi, that almost all the rivers and streams within the area that could have been used for irrigation manually have dried up due to high temperatures and excessive evaporation. They also emphasised that the illegal mining activities in the area have accelerated the rate of water loss. They said the rivers have all been turned to mud by the artisanal mining activities so they cannot be used for the purpose of irrigation. Farmers therefore rely solely on rainfall for farming activities and this has been very unreliable.

Finally, lack of access to climate information and financial constraints were two other most serious challenges that were emphasised by majority of the respondents (96.1%) and (98.7%) respectively as obstacles to adaptation measures against climate change (Table 10). The study discovered that the ability to choose any adaptation measure against climate change in the area depends largely on finances which was also stressed by farmers during the FGD to be non-existent in whatever form. They had no access to loans or any other credit facilities that can afford them the means to purchase agrochemicals or any improved seed varieties that could withstand harsh climatic conditions. The study also discovered from the FGD that information on micro-weather conditions in the area that could assist farmers to make informed decisions regarding adaptation measures against climate change from the local meteorological agencies have not been available.

## 5. Conclusions and Recommendations

The revealed that, finances were non-existent in whatever form for the farmers. They had no access to loans or any other credit facilities that can afford them the means to purchase agrochemicals or any improved seed varieties that could withstand harsh climatic conditions. The study also discovered from the findings that information on micro-weather conditions in the area that could assist farmers to make informed decisions regarding adaptation measures against climate change from the local meteorological agencies have not been available.

The study also concluded that, the rivers and streams within the area that could have been used for irrigation manually as an adaption strategy have dried up due to high temperatures and excessive evaporation. The findings of the study revealed that, the illegal mining activities in the area have accelerated the rate of water loss and rivers have all been turned to mud by the artisanal mining activities so they cannot be used for the purpose of irrigation. Farmers therefore rely solely on rainfall for farming activities and this has been very unreliable.

One key factor that informed better adaptation measures which was highlighted most by farmers in all the sampled study communities was years of farming experience. It is therefore recommended that since farmers' years of farming experience was pointed out as a major determinant of effective adaptation, appropriate platforms should be made available to such experienced farmers by the extension service providers from MoFA and GMA, so that they can translate their knowledge on climate change impact on crop production to the young and upcoming farmers. This can be done through symposia, holding discussions regularly on the radio and deploying experienced farmers to the various farming communities to help share their experiences.

Additionally, irrigation was least adopted by farmers in the study area. Irrigation was said to be too expensive and water for irrigation was also said to be nonexistent and the available few rivers and streams have also been rendered worthless by illegal mining activities in the area. It is therefore recommended that the government and other stake holders like NGO's should help provide irrigational facilities to farmers to be able to cultivate in times of dry spells and delayed rains. Also the government and local authorities (traditional and modern) should enact and enforce by-laws that would prohibit illegal mining activities near water bodies in the farming communities.

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