International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

# Impact of Climate Change: Views and Perceptions of Policy Makers on Smallholder Agriculture in Ghana

Emmanuel Kodjo Tetteh[a]*, Nelson Obirih Opareh[b], Richard Ampadu[c], Kwabena Barimah Antwi[d]

[a]* *Research Scientist, Science and Technology Policy Research Institute, Box CT. 519 Accra +233 Ghana*

[b]*Principal Research Scientist, Science and Technology Policy Research Institute, Box CT. 519 Accra +233 Ghana*

[c]*Research Scientist, Science and Technology Policy Research Institute, Box CT. 519 Accra +233 Ghana*

[d]*Senior Lecturer, Faculty of Social Science, University of Cape Coast, Private Mail Bag, +233 University of Cape Coast, Ghana*

[a]* *ekotetteh@yahoo.co.uk*

[b]*nobirih_opareh@yahoo.com*

[c]*r.ampadu@yaho.com*

[d]*k_bantwi@yahoo.co.uk*

**Abstract**

The threat of global climate change has caused intense debate among policy makers as agricultural productivity and food security risks considerable decline due to changes in rainfallpatterns and temperature. Although the impact of climate change on crop yields vary greatly from region to region, smallholder farmers in developing countries who depend solely on rain-fed agriculture are among the most disadvantaged and vulnerable groups. While the successes in agricultural production in Africa and Ghana over the last decades are heralded, the inequitable distribution of benefits and unsustainable impacts on natural resources are becoming more evident. Many authors have blamed global warming and climate change on the emission of greenhouse gasses however, farming methods and other human activities are also to blame for the emerging change in the climate. Therefore, bringing farming practices and ecosystem services into decision-making in order to make full use of the potential gains from working with the natural environment and the underpinning biophysical processes is imperative. This paper assesses the views and perceptions of Ghanaian policy makers on the impact of climate change on smallholder agricultural productivity in order to sustain agricultural productivity in Ghana. The study used data from a case study conducted by the Environment Policy Action Node Project with sponsorship from the Alliance for a Green Revolution in Africa (AGRA) in Ghana between 2012 and 2013. An interview guide was used to collect qualitatively data from 35 key policy making institutions/organization in Ghana. One important finding of the paper is that even though Ghana has a climate change policy, most of the policy makers were not aware of the policy document and its contents.

---

* Corresponding author.
E-mail address: ekotetteh@yahoo.co.uk.

The paper however argues that to improve smallholder agricultural productivity in Ghana, a national debate on climate change mitigation and adaptation policies are needed to ensure coherence agricultural production strategies driven by empirical scientific and technological data.

***KEY WORDS***: Climate change; Smallholder; Agriculture; Policy makers; Adaptation.

## 1 Introduction

Globally, food production has been rising steadily, yet, the accelerating pace of climate change combined with increasing global population and income growth, threatens the world with persistent food security challenge [27]. By 2050 the world will need to increase crop production to feed a projected nine billion people, in the face of changing consumption patterns, the impacts of climate change and growing scarcity of water and land [4]. While it is still considered a global canker, climate change is projected to adversely affect most people in developing countries, particularly in sub-Saharan Africa (SSA) which maintains the highest proportion of malnourished populations in the world [28, 5].

In many SSA countries including Ghana, agriculture remains the main engine for economic growth, contributing around 34 percent to gross domestic product and employing more than half of the total labour force [10]. Despite its economic importance, the agricultural sector in SSA has performed poorly relative to other developing countries. Studies such as [7, 12, 13] that tend to address the issue of low agricultural productivity in SSA have pinpointed to poor policies and institutional failures as the primary culprits.

Farming techniques are primitive, and the smallholder farming systems that dominate the agricultural landscape have very limited capacity to adapt agricultural innovations [20]. Besides, most of the smallholder farmers are poor rural dwellers that use family labour and depend on rain-fed agriculture for their livelihoods [23].

In Ghana, agriculture is often referred to as the backbone of the economy and economic growth strategies [30]. The sector contributes the biggest share to GDP at 39%, compared to about 26% for industry and 31% for the service sector [17]. Agricultural activities also provide livelihoods for 60% of the population [21, 22]. In effect, successive plans for poverty reduction and growth have been based on the agriculture sector and the country's current medium term development plan, the Ghana Shared Growth and Development Agenda of 2010, based the social and economic transformation of the country on a modernized agriculture [22]. However, the sector is plagued by low productivity as a result of inadequacy of modern technology, small-sized land holdings, reliance on rainfall and an aging farmer population. Agricultural productivity in Ghana is further threatened by the effects of climate change to the extent that the yield per hectare of staple foods such as maize, cassava, yam, cocoyam and plantain are increasingly declining [15].

The impacts of climate change in Ghana is on-going and is expected to worsen in the near future if the trend continues and no serious efforts are made to address the problem. According to the Environmental Protection Agency (EPA), there had been an increase in both the minimum and maximum temperatures for all ecological zones in Ghana. The EPA study shows that in 2006, the mean base year temperature ranged from 26.4$^{o}$C (Forest) to 28.6$^{o}$C (Sudan savanna) with a possible mean temperature change from 0.6, 2.0 and 4.0 for 2020, 2050 and 2080 respectively. The EPA had also estimated that the rate of change in total rainfall in the various ecological zones will decrease from 1.1% to 20.5% for 2020 to 2080 and this will reduce agricultural productivity, especially yields in root and tuber crops by about 40 percent by 2080 [8]. Other studies have shown that in 2007, several communities in Northern Ghana experienced severe flooding which affected 317,000 people and destroyed 1,000 km of roads. More than 210 schools and 45 health facilities were damaged, and 630 drinking water sources and facilities were damaged or contaminated and more than 30 people lost their lives through the flooding [14].

Given that climate change is causing considerable damage to the natural environment and agricultural productivity, it is important for decision makers to bring farming practices and ecosystem services into decision-making in order to make full use of the potential gains from working with the natural environment and the underpinning biophysical

processes. Policies, strategies and programs that can mitigate the impact of climate change are not only important but necessary. Such policies notwithstanding, must emanate from people who have concrete knowledge of the concept and its underlying factors. This, however, is embedded with practical challenges such as the mechanics of securing the participation of farmers in delivering land-use changes and the use of modern technologies to increase productivity [25, 29].

Increased understanding of policy makers about climate change challenges and agricultural productivity is crucial for enhancing smallholder farmers' activities in Ghana. However, little is known about how the Ghanaian policy makers understand and perceive the impact of climate change on smallholder agricultural productivity. The important questions to ask therefore are: What are the perceptions of policy makers about the reality of climate change in Ghana? Does Ghana have a climate change policy and what critical issues do the policy seeks to address? How has the climate change policy affected smallholder farming activities and what are the outcomes. Policy makers' full understanding of climate change impact and its underlying factors will certainly translate into strategies, actions and achievement goals for agricultural development. This is important because knowledge about climate change impact and agricultural policies – both mitigation and adaptation – could have major implications on Ghana's agricultural sector over the coming years. The aim of this paper therefore is to assess Ghanaian policy makers understanding of climate change and adaptive strategies to increase smallholder agricultural productivity in Ghana. The rest of the paper is structured in sub-sections as follows: Section two provides an overview of climate change policies in Ghanain the context of climate change and agricultural modernization. Section three presents the methodology while section four provides and discussed the results of the study. Section five concludes the paper with the summary and recommendations.

### *1.1 Overview of climate change policies in Ghana*

Successive governments of Ghana have realized that changes in rainfall patterns and increased temperatures are causing considerable risk to agriculture and have formulated policies to mitigate the impact of climate change on agricultural productivity [32]. In order to ensure natural resource sustainability as well as dealing with issues relating to climate change, Ghana adopted her first Environmental and Climate Change Policy in 1991 [8] and in1992, Ghana signed the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro, which the government of Ghana ratified on 5$^{th}$ December, 1995. The first National Communication was also published in 2000 and the second National Communication which provided an inventory of the sources and channels for the removal of greenhouse gas emissions; as well as an assessment of the vulnerability of different sectors (including agriculture, water, energy and industry) to climate change; and a detailed climate change mitigation strategies the country intended to pursue was published in 2010 [1, 18].

The issue of climate change has however, been the focus of environmental actors in Ghana. For example, in 1994, Ghana enacted the Environmental Protection Agency Act (Act 490) which established the Environmental Protection Agency (EPA) as a regulatory and enforcement agency under the Ministry of Environment, Science and Technology (MEST). The EPA played a leading role in the climate change assessment reports required under the UNFCCC. Until recently, the EPA was the UNFCCC focal point for Ghana, mandated to oversee the Clean Development Mechanism (CDM) under the Kyoto Protocol [11, 31]. The focal point of UNFCCC has currently shifted to MEST due to international negotiation requirement on climate change policy which requires a Ministry and cabinet minister to lead the process. The overall contribution of agriculture to GDP has declined in recent years [33], [26] and questions have been raised about the sustainability of the sector in the face of an aging rural population [15, 22].

### *1.2 Ghana Goes for Green Growth Policy*

The Ghana Goes for Green policy was produced under the guidance of the National Climate Change Committee (NCCC) headed by the Ministry of Environment, Science and Technology. Members include: Ministry of Finance and Economic Planning; National Development Planning Commission; Ministry of Food and Agriculture; Ministry of Foreign Affairs; Ministry of Energy; Energy Commission; Ministry of Health; Environmental Protection Agency; Forestry Commission; the Council for Scientific and Industrial Research and Ghana Meteorological Services. The document is a National Climate Change Policy Framework (NCCPF) developed as part of the work plan of the cross-sectoral National Climate Change Committee, headed by MEST. The aim of NCCPF was to ensure a climate resilient and climate compatible economy while achieving sustainable development and equitable low carbon

economic growth for Ghana [11]. It was designed to ensure full integration into Ghana's main planning processes at national, regional and district levels. It sought to address the multiple challenges of climate change and ensure a multi-sectoral response across all stakeholders. The NCCPF is linked to the key strategic objective of the Ghana Shared Growth Development Agenda (GSGDA) in that it is meantto help foster high and equitable levels of growth towards a middle-income status [19].

The NCCPF had contributed significantly to the strategic objective of the Ghana Shared Growth Development Agenda which among other things aim to foster high and equitable levels of growth towards a middle income status. It also echoes the need to increase policy coherence on climate change by ensuring low carbon growth, effective adaptation to climate change and social development strategies.

### *1.3 Materials and Methods*

The study used data from a case study conducted between 2012 and 2013 by the Environment and Climate Change Policy Action Node (GECCPAN) with sponsorship from the Alliance for a Green Revolution in Africa (AGRA) in Ghana.AGRA is an Africa based organization working in partnership with governments, agricultural research organizations, farmers the private sector and other rural development stakeholders to significantly and sustainably improve the productivity and incomes of resource poor famers in Africa. The GECCPAN study has the aim of modernizing and increasing smallholder agricultural productivity in Ghana. An interview guide was used to collect qualitatively data through in-depth interviews with individuals who were either part of or knowledgeable about policy processes on climate change and agriculture in Ghana. The respondents who were purposively selected include Parliamentarians, and representatives of government institutions and organizations such as the Ministry of Environment, Science, Technology and Innovation; Ministry of Agriculture; Ministry of Health; Ministry of Energy; Council for Scientific Research (CSIR); National Development Planning Commission; Ghana Metrological Service; Metropolitan and District Assemblies which are the key climate change policy formulation institutions in Ghana. The data was processed with the SPSS software and analysed thematically.

## 2. Results and Discussion

The study covered a total of 35 respondents who were either part of or knowledgeable about policy processes on climate change and agriculture in Ghana. The study defined the respondents as policy makers because they were representatives of government institutions, structures and organizations where key government policies emanate. The main issues discussed include evidence and causes of climate change; farmers' awareness of climate change; perceptions about decline in agricultural productivity as a result of climate change; and early warning systems of climate change in Ghana.

### *2.1 Signs of Climate Change in Ghana*

In response to a question of whether climate change is real in Ghana, 97% of the policy makers answered in the affirmative while 3% answered in the negative (see Figure 1). The respondents were unanimous in pointing out that climate change is a shift in the climatic conditions and patterns of weather which usually impact adversely on agricultural productivity in particular and the environment as a whole. To majority of them, these changes are usually evident in the intensity of rainfall, flooding, high temperatures and drought which are not consistent with weather patterns during the past two or three decades.The responses from the policy makers suggest that they are not oblivious of the global debate of climate change and its consequences. However, only 45% of the policy makers mentioned that climate change is a global phenomenon. The rest attributed it to negative human activities on the environment.

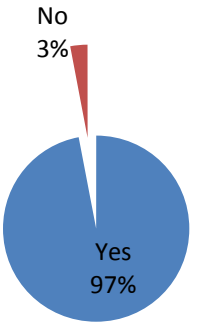


Figure 1: Reality of climate change in Ghana
Source: Field data, 2013

### *2.2 Policy Makers Perception of Farmers Awareness of Climate Change*

The study explored the policy makers' perception of climate change awareness among smallholder farmers. Figure 2 shows that 74% of the policy makers were of the view that smallholder farmers in Ghana were aware of the change in climate while 20% claimed the farmers were not aware of such phenomena. It is important to inform farmers of the change in climate and to educate them on adaptive farming methods and technologies.

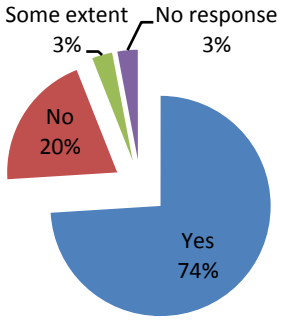


Figure 2: Policy makers' perception of farmers' awareness of climate change
Source: Field data, 2013

### *2.3 Causes of Climate Change in Ghana*

Asked about the causes of climate change in Ghana, 94% of the policy makers said that climate change in Ghana was the consequences of fossil burning, deforestation, indiscriminate small-scale mining, water pollution, urbanization and other human activities, while the rest (6%) attributed the phenomena to ozone layer depletion through emission of greenhouse gasses and global warming.The policy makers were optimistic that human activities are central to the causes of climate change in Ghana. They were in support of policies to control some of these human activities in order to lessen the occurrence and impact of climate change in Ghana.Many authors have blamed global warming and climate change on the emission of greenhouse gasses which Africa produces a minimal amount, however, Ghanaian policy makers were quick to point out that other human activities such as farming methods are could also be blamed for the emerging weather variation phenomenon in Ghana.

### *2.4 Effects of Climate Change on Agricultural Productivity*

The study solicited from the policy makers the effect of climate change on agricultural productivity in Ghana and found the reduction in yields of root and tuber crops like yam, cocoyam and plantain as the major effects. According to the policy makers, the alarming rate at which yields of these crops continue to decline as a result of climate change requires that immediate steps are taken to ensure food security as well as reducing poverty among

smallholder farmers in the country. Buttressing the impact of climate change on food insecurity in Ghana, [24, 25] have stated in their studies that rapid loss of forest, soil erosion, and reduction in soil fertility, heavy rainfall, drought and high temperatures are causing low yields of major staples foods in Ghana. Other studies have also documented that climate variability in Ghana have caused widespread land degradation, extinction of valuable forest products and loss of ecosystems and biodiversity [2]

### *2.5 Effects of climate change on Ghana's economic growth*

Agriculture-climate change issues are closely related to economic growth. For instance vulnerability and adaptation assessments have demonstrated that the economy of Ghana is at risk from the effects of climate change since it depends largely on the agricultural sector which is strongly susceptible to the impacts of climate change [14, 22]. Putting agricultural yields and outputs at risk, climate change threatens the vital foundations of Ghana's social and economic transformation.

In terms of economic growth, the policy makers acknowledged that climate change has impacted negatively on Ghana's gross domestic product (GDP). They were unanimous in stating that the impact of climate change on the economy and on smallholder farmers is already substantial in that it has become one of the major obstacles to reducing rural poverty. They maintained also that crop failures, pest infestation, loss of ecosystems and valuable wood species have reduced incomes to individuals and that of the state.Indeed, they acknowledged the differentiated impacts of climate change among gender and various social groups, with the more vulnerable being the poor, women, children, and rural residents especially those of the northern part of the country. The solutions they proposed to improve the robustness of the agricultural sector were the generation and availability of drought tolerant crop varieties, and a transformation from rain-fed to irrigated and modernized agriculture. The concerns of the policy makers over climate change demonstrates clearly that climate change and agricultural issues in Ghana have broadened over the years into a development concern from an earlier focus on climate change as a largely environmental issue. However, some of the policy makers pointed out that while agriculture-climate change issues are now covered in key government documents, they are still not part of agricultural sector documents.

### *2.6 Policy Makers Awareness of the Climate Change Policy*

On the question of whether Ghana has a climate change policy, 45% of the policy makers answered in the affirmative while the rest (55%) answered in the negative. Of those who were aware of the policy document, the majority has only heard of the document but have not seen or read it. Asked about what a climate change policy in Ghana should address, most the policy makers said that, agriculture-human related issues such as farming along rivers, tree cutting and bush burning, indiscriminate small-scale gold mining, overgrazing, and deforestation should be the critical focus of the policy. This suggests that the policy makers did not view climate change as a global phenomenon but rather a result of human activities.

A study conducted by the BBC World Service Trust [3] noted that awareness of climate change among Ghanaians are the effects that directly impinge on their lives and their ability to carry out livelihood activities, particularly those related to agriculture. Among these impacts are changes in rainfall patterns; flooding; decline in cocoa production; depletion of water and forests and long periods of drought. The study stated further that many Ghanaians do not understand the climate change challenges as a global phenomenon, and as a result tend to blame their own actions as the causes of climate change. Incidentally, because of this perspective, the emphasis in public discussions on climate change is neither on climate change mitigation or adaptation, but on ceasing human actions that are thought to cause climate change [6]. This brings to mind the concerns raised by international organisations that the international focus on climate change and agriculture which is "climate smart agriculture" may be dominated by interests promoting mitigation projects which do not necessarily have the interests of the poorest and most vulnerable in mind [9]. Therefore, for Ghana to achieve "climate smart agriculture" it is important to align the country's development strategies, to smallholder farmer vulnerability, and effectiveness as well as the vulnerability and opportunity of other stakeholders in the agricultural sector. In particular, Ghana needs to be more proactive by paying a greater attention to adaptation strategies, as has been recommended by international organizations.

### *2.7 Climate Change Policy Focus for Ghana*

The study enquired from the policy makers their opinion on the nature of a climate change policy for Ghana with regard to content and practicability. In their response, about 86% of the policy makers maintained that such a policy should address the negative impact of human activities on the environment such as indiscriminate logging, illegal small-scale gold mining, farming along rivers, bush burning overgrazing and indiscriminate cutting of trees for fuel and charcoal. Some of the policy makers were also of the view that Ghana's climate change policy should also address human health issues due the consequences of changes in weather and precipitation. The policy makers strongly supported afforestation activities and called on the government to set up an afforestation fund to promote and facilitate afforestation and tree planting throughout the country. The introduction of modern agriculture technologies, drought resistant and early maturing crops, according to the policy makers is the way forward for sustaining and or improving smallholder agricultural productivity in Ghana. As a national priority, they proposed massive campaign, sensitization and advocacy on the adverse effects of climate change on smallholder agricultural in Ghana. To them, government programs towards climate change should aim at addressing issues of mitigating the challenges rather than adapting to the impacts.

### *2.8 Mitigating Climate Change Impact on Smallholder Agriculture in Ghana*

In response to the strategies and measures that could reduce the impact of climate change on smallholder agriculture, the policy makers mentioned the use of small-scale irrigation schemes but were also quick to add that irrigation facilities are capital intensive and not affordable to the resource poor smallholder farmers. Some of the policy makers were of the view that ensuring sound environmental management practices and the use of research and extension services could reduce effects on agricultural productivity. The onus, they said is for the Ministry of Food and Agriculture and its extension services as well as agricultural research organizations to introduce resistant crop varieties, early maturing crops, and to educate farmers to adapt new technologies, and better farming practices. In view of this, the focus, they said should be on awareness creation and building the capacity of smallholder farmers. According to them, the agricultural and the water sectors are the critical sectors of immediate government intervention.

With regard to adaptation strategies been discussed at the government level in order to reduce climate change impact on smallholder agriculture, the policy makers indicated reduction in carbon growth, proper land management, and controlling environmental destructive human activities which were mentioned above. Asked if they have made any individual statement on climate change and smallholder agricultural in their capacity as government officials that can be found in the media or any workshop proceedings in Ghana, the respondents from MESTI and EPA answered in the affirmative while the rest answered in the negative. This was expected because; the two institutions were responsible for the country's climate change policy framework. The specific issue that was published by the media or discussed at a workshop by the EPA was "The Effect of Climate Change on Crop Production". The EPA had also published an article in the media entitled "Ghana Climate Change Impacts: Vulnerability and Adaptation Assessments". The study noted that the effect of this publications lead to field visits and informal interviews between smallholder farmers on one hand and Agricultural Research Scientists, Environmental Experts and Agricultural Extension Officers on the other hand. MESTI on its part have organize several training programmes for the "Youth in Agriculture as well as collaborating with the Forum for Agricultural Research in Africa (FARA) and leading agricultural experts and scientists to hold a number of forums to discuss solutions for food security in Africa and Ghana.

### *2.9 Early Warning Systems of Climate Change in Ghana*

As to whether Ghana can boast of any early warning systems, 56% of the policy makers said that the countryhas adequate early warning systems while 44% claimed the country has no such systems. The Ghana Metrological Service and the National Disaster Management Organization (NADMO) were mentioned as Ghana's climate change early warning systems. The study revealed that through the African Adaptation Program (ADP), Ghana has Automated Weather Stations that provide accurate weather reports in order to enable farmers make informed decisions. Besides, the Agricultural Extension Service of the Ministry of Food and Agriculture has programs and projects which are aimed at sensitizing farmers on best practices. However, the policy makers unanimously agreed that indigenous knowledge such as rainwater harvesting, backward gardening, not farming close to river belts and avoidance of indiscriminate tree cutting and bush burning are effective ways of combating climate change effects. They called for the involvement of the custodians of indigenous knowledge during climate change policy discussions.

### *2.10 Policy Makers Perception of Trends in Agricultural Productivity*

The perception of the policy makers about the trends of agricultural productivityis shown in Figure 3. The Figure shows that 48% of the policy makers' perceived that agricultural production in the country is decreasing while about 26% perceived agricultural productivity as increasing but about 23% had no idea about the trends in agricultural production in the country (see Figure 3). Even though total agricultural productivity in Ghana is increasing, production trends among smallholder farmers is declining.

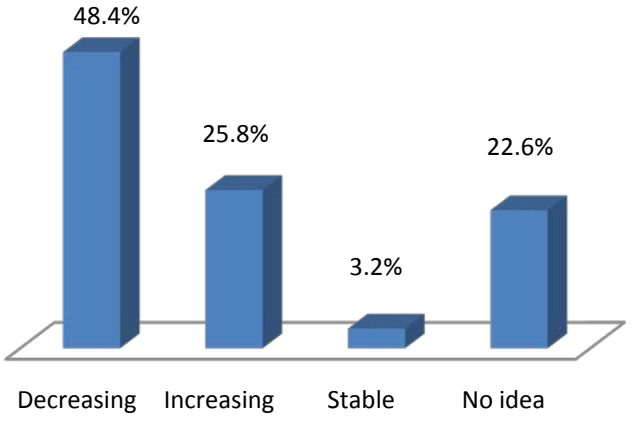


Figure 3: Level of policy makers' knowledge about agricultural productivity in Ghana

Source: Field data, 2013

About 65% of those who claimed that agricultural productivity was decreasing attributed the decline to climate change related issues while 58%thought the decline was due to disease outbreak and 42% attributed it to decreasing fertility of farm lands (see Figure 4). The respondents' choose multiple answers.

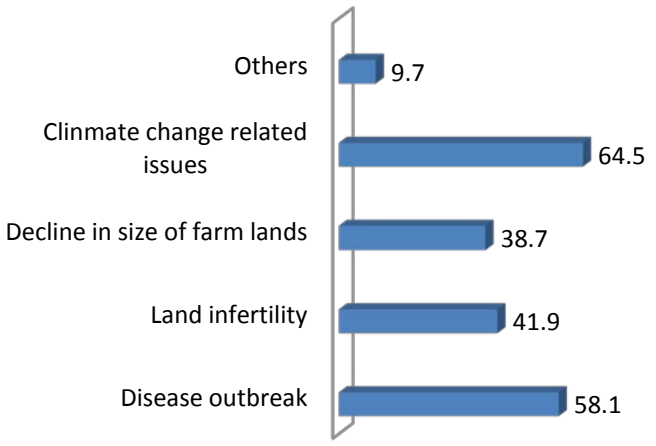


Figure 4: Policy makers' perception of decline in agricultural productivity

Source: Field data, 2013

## 3. Conclusions

Economic growth in many developing countries including Ghana is based on a well-functioning agricultural sector. However, climate change is posing a threat to agricultural productivity and sustainability. Concerns about the agricultural sector are heightened by recent studies on climate change impacts that highlight the risk to global food production. Agriculture, within the last two decades, has only become a significant part of the climate change policy debates in Ghana. Previously, climate change discussions were centered on environment, energy and forestry. Changes in rainfall patterns and increased temperatures are likely to bring considerable additional challenges to the agricultural sector that is already at risk from traditional farming methods and aging farmers. In Ghana agriculture is vulnerable to climate change, but is also contributing to climate change effects as a result of other human activities.

This study has revealed that majority of the policy makers in Ghana were not oblivious of the concept of climate change and its negative impact on smallholder agricultural productivity. Increasing flooding, erratic rainfall patterns, incidences of pests and diseases, decline in soil fertility, low crop yield, water scarcity and high temperatures were mentioned as some of the signs of climate change in Ghana. The paper demonstrates that most of the policy makers had little knowledge of Ghana's climate change policy document. They however reiterated that a climate change policy for Ghana should address human activities that impact adversely on the environment.

There is evidence of increased risk of low yields, crop pests and diseases of crops under climate change. Climate change resilient strategies include promotion of technology transfer, "climate proofing agriculture" and vulnerability reduction among poor smallholder farmers through resistant crops as well as controlling human activities that impinge on the natural environment. The paper recommends that to achieve climate change and agriculture policy goals, policy makers should fully acquit themselves with the dos and don'ts of the climate change policy document for Ghana. Smallholder farmers should also be educated on the impact and adaptive measures of climate change. The paper however argues that to improve smallholder agricultural productivity in Ghana, a national debate on climate change mitigation and adaptation policies are needed toensure coherent agricultural production strategies driven by solid empirical data.

**Acknowledgements**

The author wishes to express special thanks to the Environment and Climate Change Policy Action Node (GECCPAN) of Ghana for providing the necessary data for this paper. The authors also acknowledge the Alliance for a Green Revolution in Africa (AGRA) for sponsoring climate change studies to improve the productivity and incomes of resource poor famers in Ghana. Finally, we acknowledge the Parliamentary select committee on environment and climate change and representatives of government institutions and organizations for availing themselves for interview during the data collection process for this manuscript.

## References

[1] Agyeman-Bonsu, WK. National Climate Change Adaptation Strategy (Unpublished paper), Accra, 2010d.

[2] Armah FA, Odoio JO, Yengoh GT, Obiri S, Yawson DO, Afrifa EKA. Food security and climate change in drought-sensitive savanna zones of Ghana. *Mitigation and Adaptation Strategies for Global Change,* **16(3)**: 291-306, 2010.

[3] BBC World Service Trust. Ghana Talks ClimateResearch Report, 2010.

[4] Beddington J. *Food security: Contributions from science to a new and greener revolution, Phil. Trans. R. Soc. B* ***365:*** *61–71, 2010.*

[5] *Benhin J K A. South African crop farming and climate change: an economic assessment of impacts, Glob. Environ. Change* ***18:*** *666–782, 2008.*

[6] Cameron C. Climate Change Financing and Aid Effectiveness, Ghana Case Study. Agulhas, Applied Knowledge, 2011.

[7] Douglas G, Williams C. Agriculture as an Engine of Growth and Poverty Reduction:What We Know and What We Need to Know? African Economic Research Consortium, 2009

[8] Environmental Protection Agency (EPA). The Clean Development Mechanism in Ghana. A Guide. Developed under the Capacity Development for the Clean Development Mechanism (CD4CDM) by KITE and SSNAFRICA. Accra, Ghana: Environmental Protection Agency of the Ministry of Environment, Science and Technology, 2007.

[9] Food and Agriculture Organization (FAO). "Climate Smart" Agriculture: Policies, Practice, and Financing for Food Security, Adaptation and Mitigation. Food and Agricultural Organisation of the United Nations, 2010.

[10] Government of Ghana. Budget Statement and Economic Policy. Available online at ghana.gov.gh/index.php/.../3854-finance-minister-presents-2014-budget. 12/12/13, November, 2014.

[11] Government of Ghana (2011). *Ghana's Second National Communication to the UNFCCC,* 2011. Available athttp://unfccc.int.resource/docs/natc/ghana_second_nationalcommunication_final_version.pdf. 2/12/13, November, 2013.

[12] Guy B N, Jim G, Harounan K. "Explaining the Failure of Agricultural Production in Sub-Saharan Africa", Jupiter, 2003.

[13] Jhon LG, Jeffery DS. Agricultural, climate and technology: Why are the Tropics Falling Behind. *Americans Agricultural Economics Association*, 731-737, 2000.

[14] IPCC **(**2012): Summary for Policymakers. In: Field, C.B., V. et. al. (eds.) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation:* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press,. 1-19. http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-SPM_FINAL.pdf 20/9/2013)

[15] Ministry of Food and Agriculture (MoFA). Food and Agriculture Sector Policy (FASDEP II). Accra: Ministry of Food and Agriculture, 2007.

[16] Ministry of Food and Agriculture. Facts and figures (2010). Report produced by the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture. Accra: Ministry of Food and agriculture, 2011.

[17] Ministry of Food and Agriculture. Medium Term Agricultural sector Investment Plan, (METASIP), 2011-2015.

[18] Ministry of Science, Environment and Technology [MEST] (2003). Ghana's Climate Change Technology Needs and Needs Assessment Report, version 1. Accra: Ministry of Environment, Science and Technology.

[19] Ministry of Science, Environment and Technology (MEST). Ghana Goes for Green Growth: National Engagement on Climate Change Discussion Document. Accra: Ministry of Environment, Science and Technology. [online: http://prod-http-80-800498448.us-east-1.elb. amazonaws.com/w/images/2/29/GhanaGreen.pdf]12/12/13, 2010

[20] *Müller C, Cramer W, Hare WL, Lotze-Campen H. Climate change risks for African agriculture, Proc. Natl Acad. Sci. USA* ***108 43:*** *3–5, 2011.*

[21] National Development Planning Commission [NDPC] (2011, August). The Implementation of the Ghana Shared Growth and Development Agenda – 2010 Progress Report. Accra: National Development Planning Commission, 2011.

[22] National Development Planning Commission (NDPC). Development Agenda 2010-2013, Vol. 1 – Policy Framework (final draft). Accra: National Development Planning Commission, 2010.

[23] *World Bank. Agriculture and rural sector South Asia: Shared Views on Development and Climate Change (Washington, DC: World Bank) chapter 7 pp 97–107, 2009*

[24] Obiri S, Dodoo DK, Essumang FA, Armah. Cancer and non-cancer risk assessment from exposure to arsenic, copper and cadmium in borehole, tap and surface water in the Obuasimunicipality, *Ghana Ecological Risk. Assessement,* **16(3):** 651-665, 2010.

[25] Paruchuri Y, Siuniak A, Johnson N, Levin E, Mitchell K *et al*. Occupational and environmental mercury exposure among small-scale gold miners in the Talensi-Nabdam District of Ghana's Upper East region. *Sci. Total Environment*, **408**: 6079-6085, 2010.

[26] Republic of Ghana (GoG). *Ghana's Second National Communication to the UNFCC*, Accra, 2011.

[27] Rosenzweig C, Iglesias A, Potential impacts of climate change on world food supply: data sets from a major crop modeling study, http://sedac.ciesin.columbia.edu/giss crop study, 5/11/13, 2003a.

[28] *SchlenkerW, Lobell DB (2010). Robust negative impacts of climate change on African agriculture, Environ. Res. Lett. **5** 014010, 2010*

[29] UnaiPascual (2013) Bringing Ecosystem Services into Economic Decision-Making: Land Use in the United Kingdom**.***Science*, 2013; 341 (6141): 45 DOI, 2013.10.1126/science.1234379

[30] Wiggins S,Leturque H. Ghana's sustained agricultural growth: Putting underused resources to work. Overseas Development Institute, London, UK, 2011.

[31] *World Bank. Agriculture and rural sector South Asia: Shared Views on Development and Climate Change (Washington, DC: World Bank) chapter 7 pp 97–107, 2009*

[32] Yaro JA. The Social Dimensions of Adaptation to Climate Change in Ghana. The World Bank Discussion paper no.15. Washington: The World Bank, 2010.

[33] GOG 2014 Budget Statement and Economic Policy, read by the Minister of Finance Seth Tekper on 19th November 2013 on the floor of Parliament.