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Vulnerability of Women Crop Farmers' Sensitivity and Exposure to Climate Change Impacts in the Agona West Municipality in Ghana

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Abstract

Exposure and sensitivity together describe the potential impact that climate change can have on a farming system. Women farmers are said to be most vulnerable to climate change due to their multifaceted roles in the society. The Agona West Municipal Assembly in the Central Region of Ghana is selected as a case for study. The research approach employed for this study was survey method. The target population for the study was 291 which were sampled based on Krejcie and Morgan's (1970) table for determining sample size out of 1200 women crop farmers in the Agona municipality. The main tools used for data collection were the Global Positioning System (GPS) points and questionnaires, through open and closed ended questions from women farmers in the Agona Swedru, Nkum, Abodom, Bobikuma, Nyakrom and Ostenkorang communities. This research applied statistical analysis to the data collected from the field through the use of the Global Positioning System (GPS) and vulnerability index. the Global Positioning System (GPS) was used to depict the exact location of some farms questionnaire. A vulnerability index was developed using indicators from the Human Development Index (HDI). Construction of vulnerability index for the women farmers Sensitivity indicators include age, education, marital status, residence status and household size. The study concluded that women crop farmers' exposure to climate change was unevenly distributed across the municipality with farmlands falling within high, medium and low risk zones. The findings of the also concluded that, the sensitivity of the respondents were analysed based on indicators such as age, educational status, number of dependents and residence status. It was recommended that, Extension agents should also be trained on climate change science to enable them pass adequate information to farmers on appropriate adaptation measures or strategies. The study also recommended that, the government should identify means of managing climate change stresses such as droughts and floods to ensure food safety through the provision of dams to collect surface runoff in times of floods and also as a form of water supply in times of drought.

Keywords

Vulnerability, Women Crop Farmers, Sensitivity, Exposure, Climate Change, Agona West Municipality

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1. Introduction and Background

This paper presents an assessment on the vulnerability of women crop farmers' sensitivity and exposure to climate change impacts in the Agona West Municipality in Ghana. The paper is structured into five (5) main sections namely; the Introduction and Background, Review of the Literature, Methodology, Findings and Discussion and the Conclusion. The first section introduces the structure of the paper, the context and aims and objectives of the paper. The literature review section reviews the relevant literature on vulnerability of women crop farmers' sensitivity and exposure to climate change impacts. The methodology section presents a wide description of the methodology and procedures adopted in the conduct of the study. Findings resulting from the study are presented and discussed in the section following the methodology, conclusion and recommendations.

The international development community has recognized that agriculture is an engine of growth and poverty reduction in countries where it is the main occupation of the poor (THE WORLD DEV, 2008). But the agricultural sector in many developing countries is underperforming, in part because women, who represent a crucial resource in agriculture and the rural economy through their roles as farmers, labourers and entrepreneurs, almost everywhere face more severe constraints than men in access to productive resources. Efforts by national governments and the international community to achieve their goals for agricultural development, economic growth and food security will be strengthened and accelerated if they build on the contributions that women make and take steps to alleviate these constraints [2].

Agriculture can be an important engine of growth and poverty reduction. But the sector is underperforming in many countries in part because women, who are often a crucial resource in agriculture and the rural economy, face constraints that reduce their productivity [2]. Overall the labour burden of rural women exceeds that of men, and includes a higher proportion of unpaid household responsibilities related to preparing food and collecting fuel and water. The contribution of women to agricultural and food production is significant but it is impossible to verify empirically the share produced by women. Women's participation in rural labour markets varies considerably across regions, but invariably women are over represented in unpaid, seasonal and part-time work, and the available evidence suggests that women are often paid less than men, for the same work [2]. This implies that, women make essential contributions to agriculture and rural enterprises across the developing world.

Agriculture being the mainstay of Ghana's economy plays a critical role in ensuring food security, as well as socio-economic development. Provisional Gross Domestic Product estimates for 2014 showed a growth of 4.6 percent over the 2013 revised estimates. The Agriculture sector recorded the highest growth of 5.6 percent, followed by Industry (3.7%) and the Services sector with a growth of 4.9%. Though the estimates show an improvement in the growth of the Agriculture sector, its share of the structure of the economy continues to decline, with its share reducing from 22.3% of GDP in 2013 to 21.4%. Crops however remain the largest activity in the economy with a share of 15.9% of GDP [3]. Though Ghana's agricultural potential is high, climate change keeps agricultural production below its potential.

Basically, subsistence farms make up the majority of both male and female-held total farms, 78% and 73% respectively [4]. This leaves the percentage of market-oriented farms at 22% for male-held farms and 27% for female-held farms. Female-led farms, especially those that are medium or large, appear to be more market-oriented than those held by men. It is estimated that about 80 percent of rural land in Ghana is regulated under customary law. It is the responsibility of lineage chiefs to lead community decision-making with regards to the distribution of land plots [5]. In practice, however, male heads of families are in charge of setting up land tenure arrangements, sometimes even in matrilineal societies. The result is that women's access to and use of land is through their male counterparts [4]. Moreover, there are differences in crop diversity depending on the gender of the holder and type of farming activity. Among subsistence farms held by women, there is less diversity in crop type as most harvest maize (50% compared to 35% in male-led farms). Gender disparities in agriculture emerge as less female farmers adopt improved crop varieties, compared with more male farmers, because they have less access to land, family labour and extension services [6].

Ghanaian women also own less livestock, use less fertilizers, own less mechanical equipment, have less years of education and school attendance rates than men [4]. Even though the contribution of women in agriculture is immense, they are still susceptible to the impacts of climate change as a result of a combination of a number of factors including gender-based cultural norms, inheritance structures and household responsibilities [7]. Farmers of the Agona West Municipality, the case study for this research share similar characteristics as that of farmers in other parts of the country in terms of cultural or gender disparities, environmental and climatic conditions. Agriculture, the major economic activity in Agona West engages more than 64% of the municipal

population and is heavily impacted upon by climate change [8]. Flooding resulting from intense rainfall is another factor impeding the efforts of farmers with the worst flooding scenario occurring in 2011. Women farmers should be provided with irrigational facilities to enable them practice all year round farming. Reservoirs and dams should also be built to collect and retain water when it rains to be used on the farms when the rains cease [9].

For this reason, the municipality has begun incorporating measures that would build the resilience of sensitive sectors including agriculture, water and health. However, government through the extension services is to ensure improvement in the mass education of farmers to enlighten them on new technologies employed in farming and new crop varieties that are resistant either to floods or droughts since these two extremes are the most prevalent in the Agona West Municipality and Ghana as a whole [9]. In an attempt to assess the vulnerability of the women crop farmers in the Agona West Municipality, a semi-quantitative approach is used to determine the level of two components of the exposure and sensitivity in order to ascertain the overall vulnerability. The women crop farmers, extension officers, the District office of the Ministry of Food and Agriculture and the Agona West Municipal Assembly are the stakeholders of this research. This research examines women crop farmers' in Agona West Municipality's vulnerability to climate change by measuring their level of exposure and sensitivity capacities. The study was guided by two research questions- 1. How exposed are the women crop farmers of the Agona West Municipality to floods? 2. To what extent are women crop farmers in the Agona West Municipality sensitive to climate change impacts?

2. Review of the Literature

Exposure and sensitivity are specific determinants for farming system [9]. Exposure is defined as the degree of climate stress upon a particular unit of analysis; it may be represented as long term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events [10]. Two main elements can be considered in exposure. These include things that can be affected by climate change (populations, resources, property etc.) and change in climate itself (precipitation, temperature changes etc.). In the climate change context, exposure relates to "the nature and degree to which a system is exposed to significant climatic variations" [10].

Exposure represents the background to climate conditions and stimuli against which a system operates, and any changes in those conditions. Thus, exposure as a component of vulnerability is not only the extent to which a system is subjected to significant climatic variations, but also the degree and duration of these variations [11]. For vulnerability assessments, the climatic variations can be aggregated as climate variability or specific changes in the climate system (e.g. temperature increases, variability and change in rainfall, etc). It has to be noted that systems are often exposed to natural climate variability, independent of future climate changes; however, climate change can alter and increase the future exposure [12]. With regard to exposure, it is also important to define the exposure unit, i.e. the activity, group, region or resource that is subjected to climate change [10].

Exposure is the assessment component that compares local or regional projections of climate impacts with a specific inventory of physical assets or communities. Both climate projections and asset inventories are conducive to quantitative analysis. Exposure, then, is the component most commonly undertaken through "desktop" analysis, such as Geographic Information System (GIS) mapping, review of historic extreme weather events, regional hazard response plans, flood plain maps and reports on the exposure of specific economic sectors and populations to certain climate impacts.

In this study, exposure is represented by one element:

Floods: one of the key constraints to women crop farmers in the Agona West Municipality is the nearness of their farms to water bodies. Increased rainfall usually leads to a rise in the level of water which affects farms. A major incident of flooding occurred in 2010 which destroyed several farmlands.

Sensitivity is the degree to which a system will be affected by or responsive to climate stimuli [13]. The sensitivity of a system to climate change also reflects the "degree to which a system is affected, either adversely or beneficially, by climate variability or change. Sensitivity is basically the biophysical effect of climate change, but sensitivity can be altered by socio economic changes. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)" [10]. Additionally, sensitivity reflects the responsiveness of a system to climatic influences, and the degree to which changes in climate might affect it in its current form. Thus, a sensitive system is highly responsive to climate and can be significantly affected by small climate changes.

Sensitivity describes the human–environmental conditions that can worsen the hazard, ameliorate the hazard, or trigger an impact. This measure, which herein reflects the responsiveness of a system to climatic influences, is shaped by both socio-economic and ecological conditions and

determines the degree to which a group will be affected by environmental stress [14]. The sensitivity of agro-ecosystems to climate change, as determined by the FAO/IIASA Agro-ecological Zones (AEZ) model, was assessed within the socio-economic scenarios defined by the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions (SRES) [15].

This research examines four factors that may influence the sensitivity of a farming region:

Age: Age extremes of the age spectrum affect the response of farmers to climate stimuli. Older farmers may lose time and money due to mobility constraints or mobility concerns increasing the burden of climate impacts or lack of resilience [16, 17].

Educational status: Education of the head of household is also hypothesized to positively affect response to climate change. Access to information on climate change through extension agents or other sources creates awareness and favourable condition for adoption of farming practices that are suitable under climate change [18]. Also, education is linked to socio-economic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information [19].

Residential status: This study focused on migrants and indigenes and their responses to climate stimuli. Migrants are regarded as renters who are either transient or do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford [19].

House hold size: Families with large numbers of dependents or single-parent households often have limited finances to outsource care for dependents, and thus must manipulate work responsibilities and care for family members. All these affect the resilience to and recovery from hazards [19].

Exposure and sensitivity together describe the potential impact that climate change can have on a farming system. However, it has to be noted that even though a system may be considered as being highly exposed and/or sensitive to climate change, it does not necessarily mean that it is vulnerable. This is because neither exposure nor sensitivity account for the capacity of a system to adapt to climate change (i.e. its adaptive capacity), whereas vulnerability is the net impact that remains after adaptation is taken into account. Thus, the adaptive capacity of a system affects its vulnerability to climate change by modulating exposure and sensitivity [20].

3. Methodology

The research approach employed for this study was survey method. The population for the study was all women farmers in the Agona West Municipal Assembly in the Central Region of Ghana. The target population for the study was 291 which were sampled based on Krejcie and Morgan's table for determining sample size out of 1200 women crop farmers in the Agona municipality [21]. The main tools used for data collection were the Global Positioning System (GPS) points and questionnaires, through open and closed ended questions from women farmers in the Agona Swedru, Nkum, Abodom, Bobikuma, Nyakrom and Ostenkorang communities. The questions were translated to women crop farmers in their local language to help in accuracy in the data collection, because not all of them can read and write.

This research applied statistical analysis to the data collected from the field through the use of the Global Positioning System (GPS) and vulnerability index. the Global Positioning System (GPS) was used to depict the exact location of some farms questionnaire. A vulnerability index was developed using indicators from the Human Development Index (HDI). Construction of vulnerability index for the women farmers Sensitivity indicators include age, education, marital status, residence status and household size.

4. Findings and Discussions

4.1. Women Crop Farmers' Exposure to Climate Change Impacts

The data used in the determination of flood exposure in the Agona West Municipality are listed Landsat 8 data (30 m resolution) captured on 22nd March 2014, Digital Elevation Model (DEM) of 90m resolution and the Global Positioning System (GPS). Erdas Imagine software was used to classify the raster image obtained from Landsat 8 into a cover map. The map contains five (5) different classes, which are palm plantation, shrub, built up, forest and farm. The image has some few clouds, which were masked before the classification. An unsupervised classification was performed. The map composition was done using the ArcMap software.

A Digital Elevation Model (DEM) of 60 m resolution generated from contour maps was used to map the flood risk of the study area using ArcGIS model builder and ground truth was applied to validate the output map. The two main parameters used were elevation and nearness to river bodies. The DEM was used to produce elevation values which range from 147 m to 772 m above mean sea level. This was reclassified into nine (9) levels using natural breaks (Jenks) classification method. The lowest elevation range is taken as the most vulnerable and vice versa. Ground truthing was

done by picking Global Positioning System (GPS) points of some farmlands to ensure they fall within the areas demarcated on the satellite image for farmlands shown Figure 1 below.

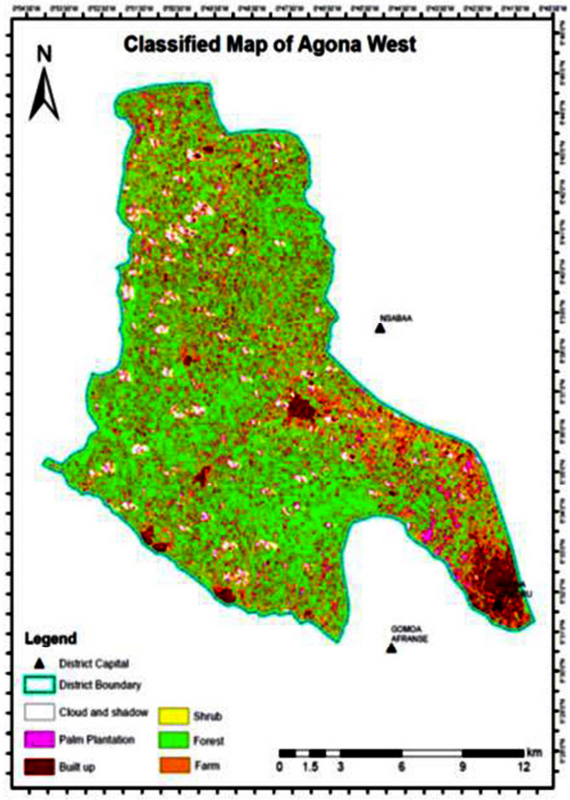


Figure 1. Classified Map of Agona West Municipality.

The rivers depicted by lines were used to calculate line density for the whole study area. The line density values decrease away from the line, thus, depicting the fact that the further an area is from a river, the less likely it is to be flooded. These two factors were weighted using ArcGIS "weighted overlay" to give the resultant model depicting flood vulnerability. The flood vulnerability model output was reclassified from a range of 2-9 vulnerability levels (2 = worst case) to three levels as (i.e. high, medium and low risks). The output was a flood risk map indicating high, medium and low flood risk zones in the figure 2 below.

Data generated from the map displayed in figure 2 shows that all farmlands in the municipality occupy an area of 65,807,100 km^2. Farmlands in high risk zones occupy about 7,812,900 km^2, farmlands in the medium risk zone also occupy about 32,781,600 km2 whiles 25,212,600 km^2 of farmlands lie in the low risk zone. The largest river draining through the municipality is the "Akora" river which increases sharply any time it rains intensely flooding farmlands closer to it. Other smaller rivers include "Abena" and "Enchiwi" which does flood intermittently when it rains heavily. However, in January 2015, the "Ankora" and "Yaa Fitaa" streams located in Ahamadonko in the Nkum area council overflowed its banks causing flooding on nearby farmlands.

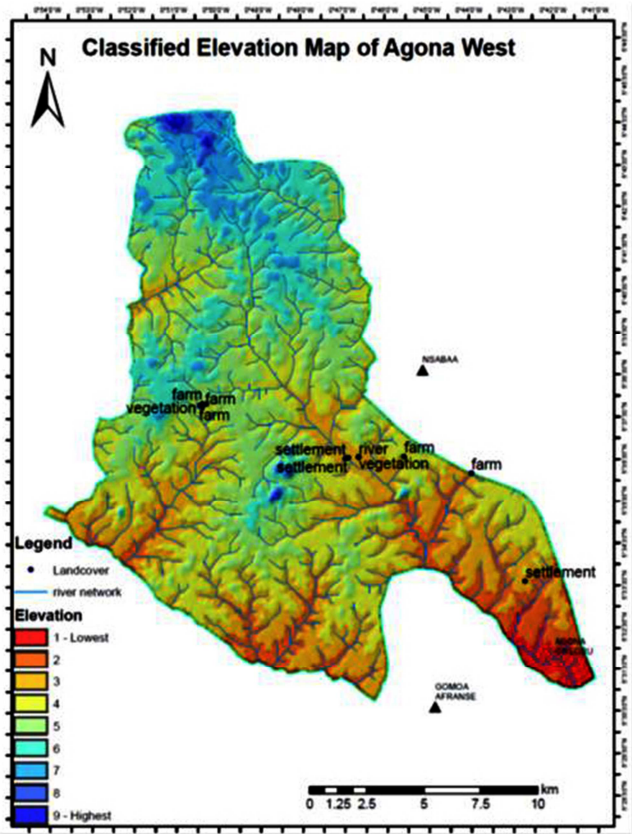
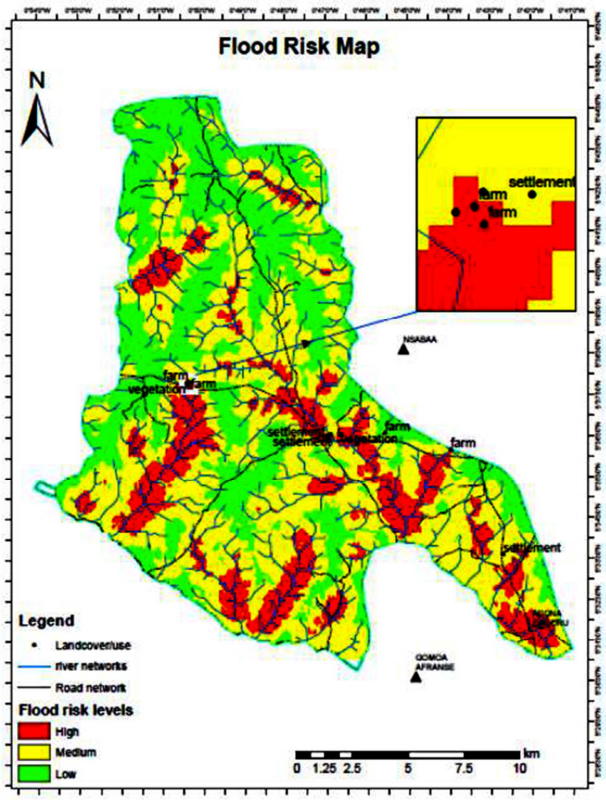


Figure 2. Classified Elevation Map of Agona West Municipality.

The farmlands of the surveyed women crop farmers are the unit of analysis of exposure to climate change impacts. It is important to define the exposure unit, i.e. the activity, group, region or resource that is subjected to climate change [10]. The Global Positioning System (GPS) was used to depict the exact location of some farms on the map shown in Figure 3.

The location of the farmlands of the respondents extended across various flood risk zones indicating their degree of exposure. Most of the farmlands are located near water bodies which increases their degree of exposure in relation to farmlands that are located far from the water bodies. Moreover, the women farmers explained that in times of intense rainfall, farmlands closer to water bodies or farmlands located in the high flood risk zones experience flooding over longer periods of time while those in the medium and low risk zones experience shorter durations of flooding. This can be attributed to the fact that runoff water easily drains away from farms located in the medium and low risk zones. Similar studies stipulate that exposure as a component of vulnerability is not only the extent to which a system is subjected to significant climatic variations, but also the degree and duration of these variations [11]. In spite of the consequences that the women crop farmers face as a

result of their farms' location, they explained that per the nature of their jobs they can only identify and intensify effective modes of adaptive mechanisms to enable them face future exposure to climate change impacts. This findings was supported by similar study on "*Climate Change and Food Security: An overview about the issue"* which explains that systems are often exposed to natural climate variability, independent of future climate changes; however, climate change can alter and increase the future exposure [12].



Source: Author, 2015.

Figure 3. Flood risk Map of Agona West Municipality.

Assessment of the farmlands reveals that any form of climate stress such as floods would have a devastating effect considering the stretch of farmlands in the municipality. However, large magnitude changes in climate in the region do not necessarily imply an elevated destruction of farmlands (high exposure). Throughout the municipality, several farmlands are found close to water bodies and though this is expected to help farmers enjoy adequate provision of water for their crops, it also poses an initial risk of the farmlands to flooding even before the floods occur. Such areas where high exposure to climate change occurs is expected to have a high level of crop loss. It is important to note however that risk also depends on variation in crop species' intrinsic capabilities to tolerate changes in climate.

It can be concluded from the results of the study that most of the women crop farmers are moderately vulnerable to climate change. From analysis made on sensitivity, about 138 out of 291 farmers are within the medium range with similar results recorded for adaptive capacity. In the case of exposure, a critical study of the map makes it obvious that the farmland size of the areas demarcated as medium risk areas are larger than both the high and low risk areas. This implies that more farms are located in the medium risk areas and hence the women crop farmers' level of exposure to climate change is moderate.

In summary, the level of vulnerability of the women crop farmers in the Agona West Municipality is categorized into three with 20.62%, 47.42% and 31.96% of the respondents having low, medium and high vulnerability to climate change respectively. With agriculture being the breadbasket of Ghana's economy, the conditions of service and the elements of agriculture must be of great concern to the nation. Assessing the impact of one of the greatest dictators of agricultural production that is climate can therefore not be overemphasized. To ensure constant increment in agricultural produce, farmers must be equipped and provided with accessible human and non- human resources to enable them adapt efficiently to climate change impacts. Their exposure as well as sensitivity to climate change impacts should also be reduced to the barest minimum.

4.2. Women Crop Farmers' Sensitivity to Climate Change Impacts

The significant variables or indicators in the prediction of sensitivity were age, education, number of dependents and residence status. The age distribution of the respondents presented in Table 1 reveals that both young and old women are involved in crop farming.

Table 1. Age range of women crop farmers in Agona West Municipality.

Age Group	Frequency	Valid Percent	Cumulative Percent
56-70	85	29.2	29.2
46-55	66	22.7	51.9
36-45	79	27.1	79.0
20-35	61	21.0	100.0
Total	291		

Source: Field data, 2015.

From table 1 above distribution shows that about 51.9 % of the respondents are above the age of 45 whereas about 49.1% are between the ages of 20-45. This implies that most of the respondents were relatively old and almost retiring from their active farming. It can also be inferred that the able bodied ones prefer off farm jobs and income which can affect the food security of the municipality. This is contrary to the findings that more young people are involved in farming than old people [22].

However, education of the farmer reduces her sensitivity to

climate and also positively affects her awareness to climate change impacts as shown in table 2 below.

Table 2. Educational status of respondents in Agona West Municipality.

Educational Status	Frequency	Percent	Cumulative Percent
secondary	63	21.6	21.6
primary	117	40.2	61.9
none	111	38.1	100.0
Total	291	100.0	

Source: Field data, 2015.

From table 2 With about 40.2% of the respondents attaining only basic education and 38.1% with no education, it will be difficult for most farmers to easily come across information on climate change to help them respond positively to climate change impacts. A previous research by Bayard *et al.,* 2007 indicated similar results whereby education significantly but negatively affected awareness to climate change. This is contrary to a study which indicated that education influenced adaptation positively [23]. Besides, similar study indicates that, education of the head of household increased the probability of adapting to climate change [24].

In congruence with the Heinz Center for Science, Economics, and the Environment, migrants can also be described as "renters" who mostly lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford [19]. As such any time disasters occur they will not hesitate to seek shelter somewhere else as depicted by table 3 below.

Table 3. Respondents' residence status.

Residence Status	Frequency	Percent	Cumulative Percent
Migrants	190	65.3	65.3
Indigenes	101	34.7	100.0
Total	291	100.0	

Source: Field data, 2015.

Table 3 above indicates that about 65.3% of the women farmers surveyed were migrants from surrounding villages whereas about 34.7% were indigenes of the towns and villages where they were interviewed. Migrants are settlers who would seek shelter elsewhere when any climate stress occurs. This implies that the food security of the municipality would be at risk when migrants seek greener pastures elsewhere after a disaster has occurred. Among the 291 women farmers surveyed, 3 of them had a household size of 10, 16 of the respondents had 8, 21 respondents had 7 household members, 40 had 6 household members with 38, 81, 60, and 32 recording 5, 4, 3, and 2 respectively. On the whole, mode of 4 dependents was recorded for all the respondents with a minimum value of 2 and a maximum value of 10.

In this study, the least number of dependents and the highest number of dependents were 2 and 10 respectively. Overall, an average of 4 dependents was recorded. However, families with large numbers of dependents or single-parent households often have limited finances to outsource care for dependents, and thus must manipulate work responsibilities and care for family members [25]. Contrary to adaptive capacity, sensitivity increases with increased number of dependents. This finding is in harmony with the argument which assumes that a large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks, especially during peak seasons [26].

On the whole, it can be inferred from the vulnerable groups as shown in Table 4 below that those in the low sensitivity column are relatively young, that is, between 20 to 35 years, have less than 4 dependents, are indigenous people and also have a relatively high educational status that is, secondary education. On the contrary, respondents who are highly sensitive to climate change are old, that is, between 55 to 70 years, have above 4 dependents, are migrants and have no education. Respondents who were placed in the medium range however were between the ages of 36 to 46 years, have at most 4 dependents, have primary education and are indigenes.

Table 4. Statistics on women crop farmers' sensitivity to vulnerability.

Sensitivity	Frequency	Percentage (%)	Mean	Standard deviation	Minimum value	Maximum value
Low	60	20.62	0.2964468	0.6003545	0.159028	0.159028
Medium	138	47.42	0.5412389	0.842892	0.4	0.695139
High	93	31.96	0.8243802	0.918873	0.706944	1

Source: Field data, 2015.

ANOVA analysis was used to determine whether differences exist between the mean sensitivity scores of low, medium and high vulnerable groups. The results suggested that a statistically significant difference exist between the mean sensitivity scores of the three vulnerability groups at 95 percent confidence intervals ($F=775.69$, $df=290$, $p<0.05$). Table 5 presents the Bonferroni pairwise comparison of the vulnerability groups in terms of the difference between their mean vulnerability scores.

Table 5. Bonferroni pairwise comparison between sensitivity groups.

Row mean-Column mean	Low	Medium
Medium	0.244792 (0.000)	
High	0.527933 (0.000)	0.283141 (0.000)

Source: Computations from field data, 2015.

The results indicate that a significant difference exist between all the vulnerability groups. It however can be concluded that most of the women crop farmers in the locality are in the medium vulnerability group.

5. Conclusion and Recommendations

The study concluded that women crop farmers' exposure to climate change was unevenly distributed across the municipality with farmlands falling within high, medium and low risk zones. Farmlands very close to water bodies are likely to be flooded earlier and more intensely than those far from the water bodies. The findings of the also concluded that, the sensitivity of the respondents were analysed based on indicators such as age, educational status, number of dependents and residence status. About 51.9% of respondents were above 45years which implied that most respondents were old and about retiring from farming. Only 21.6% had undergone secondary education signifying low rate of education amongst respondents. Moreover, about 65% of respondents were migrants which also meant that if such respondents secure more lucrative jobs, farming would be abandoned. These findings increased the level of sensitivity of these women farmers in the municipality. In effect most households showed signs of increased sensitivity to climate change.

It is recommended that, Extension agents should also be trained on climate change science to enable them pass adequate information to farmers on appropriate adaptation measures or strategies. The study is also recommended that, the government should identify means of managing climate change stresses such as droughts and floods to ensure food safety through the provision of dams to collect surface runoff in times of floods and also as a form of water supply in times of drought.

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