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Social Differences in the Vulnerability and Adaptation Patterns among Smallholder Farmers: Evidence from Lawra District in the Upper West Region of Ghana.

Adam Yidana, Abass[1*]; Adelina Mensah[2]; Mubarik Salifu[3]; Kwadwo Owusu[4]

[1]Climate Change and Sustainable Development Programme, College of Humanities, University of Ghana, P. O. Box LG59, Legon, Accra, Ghana.

[2]Institute of Environment and Sanitation Studies, College of Basic and Applied Sciences, University of Ghana, P. O. Box LG59, Legon, Accra, Ghana.

[3]Institute for Interdisciplinary Research and Consultancy Services

University for Development Studies, P. O. Box TL1350, Tamale, Ghana.

[4]Department of Geography and Resource Development, College of Humanities, University of Ghana, P. O. Box LG59, Legon, Accra, Ghana.

*Email of the corresponding author: abassadamyidana@yahoo.com

Abstract

There is growing attention on socially differentiated stakeholder groups in understanding vulnerability and adaptation to climate change. However, empirical research on smallholder farmers in Ghana has not paid adequate attention to social differentiation among smallholder farmers. This study sought to assess the perception of vulnerability and adaptation strategies of socially differentiated groups of smallholder farmers to climate change in Lawra district, north-western Ghana. Gender and age axis of social differentiation are the major focus of this work. The study employed a mix method study design involving 8 FGDs and 160 questionnaire surveys among smallholder farmers. Kendell's W rank correlation was used to rank constrains identified, descriptive statistics and chi-square was used to determine adaptation patterns among different social groups. Results suggest that, smallholder farmers are not homogenous. Rather, males and females and youth and older folks differ in their perception of vulnerability and subsequent adaptation strategies. The results highlight the need for adaptation interventions that pay attention to different stakeholder needs in reducing smallholder farmers' vulnerability.

Key words: social differentiation, smallholders, adaptation, vulnerability, age, gender.

1.0 Introduction

Some of the worst impact of climate change will be experienced by the world's 500 million smallholder farms who produce up to 80% of food, provide livelihood for 2.5 billion people and manage about 80% of farmlands in developing countries (IFAD, 2012; IFPRI, 2015). Smallholder farmers generally refers to rural producers, predominantly in developing countries who farm using mainly family labour and for whom the farm provides the principal source of income (Barnett, 2007). The definition of smallholder farmers by scale varies depending on countries and regions (Calcaterra, 2013). Generally, farm size of not more than two hectares is used to define smallholder farms in Sub-Saharan Africa. Beyond farm size, smallholders are defined to include low market participation, low inputs use, location in rural areas, dependent on family labour and largely labour intensive (Kay, 2001; Chamberlin, 2008; Vermeulen & Cotula, 2010).

The smallholder farm production system is generally complex, diverse and risk prone. They constitutes the most vulnerable and marginalised people in rural society, inhabits some of the most marginal landscape and lack land tenure and resource rights (IFAD, 2012). The exposure to climatic stresses contributes to their vulnerability in addition to non-climatic stressors such as small farm size and unfavourable land tenure, low technology, low capitalization, low market participation, high food prices, and poor infrastructure (Nielsen & Reenberg, 2010; Jayne et al., 2010; Holler, 2014; Nyantakyi-Frimpong & Bezner-Kerr, 2015). Especially for Sub-Saharan Africa (SSA) smallholder farmers, increase droughts/dry spells, more unpredictable rain, floods, and increase temperature resulting in low soil moisture and water stress are the climatic stressors that poses significant threats to their livelihoods (Below et al., 2010).

However, smallholders are not a homogeneous group that should be supported at all costs, but are rather a diverse set of households living in different types of economies (IFPRI, 2015). As such vulnerability to climate change is not uniform but differs according to social groups. Social differentiation enabled by both formal and informal institutions accounts for the different vulnerability that people face in their communities (World Bank, 2010). The nature of the inheritance system, governance system and land tenure arrangements are critical factors mediating vulnerability and resulting in adaptation that reinforces social exclusion (World Bank, 2010).

Among smallholder farmers in Ghana, gender is an important determiner of social differences (Carr, 2008; Padmanabhan, 2007). It plays a fundamental role in the livelihoods of rural people and provides a clear basis of social differentiation with the gendering of crop production. Males dominate the cultivation of staple and cash crops while females focus on vegetables and other subsistence crops. What is noticeable between male and female smallholder farmers regarding production, is the relegation of females to the production of subsistence base crops relative to the staple crops and cash crops cultivation by their male counterparts (Rodima-Taylor, 2012). This culminates into substantial marginalization of females enabled by the patriarchal social structure where men are in authority over women in all aspects society. Similarly, Nyantakyi-Frimpong & Bezner-Kerr (2015), studying vulnerability and adaptation patterns among rural people in semi-arid Ghana noted a striking generational and gender differentiation among rural people. The youth's perception of the vulnerability context and subsequent adaptation response varied significantly from the elderly, likewise between males and females. In a related study, Trang (2010), discovered that older household heads who established their households before the 1990s were wealthier and less vulnerable to social and environmental changes compared to younger ones who only recently established their households, as such were generally poor.

Despite the complexity of smallholder farmers' social fiber, existing work on climate change adaptation target them as a homogeneous group, masking significant heterogeneity emanating from socio-cultural norms (Padmanabhan, 2007; Carr, 2008), and differences in access to resources, poverty levels and adaptive capacity (Wossen & Berger, 2015). The inherent aggregate nature of these studies makes it difficult to provide insight in terms of effective adaptation strategies at the household level. In view of this, it is unlikely that interventions to improve household food security and general wellbeing of the most vulnerable groups will be met. This study therefore, investigates the gender and generational axis of vulnerability and adaptation among smallholder farmers to climate variability and change in semi-arid rural Ghana. It focuses on examining the perception of vulnerability and patterns of adaptation.

2.0 Data Sources and Methods

2.1 Study Area

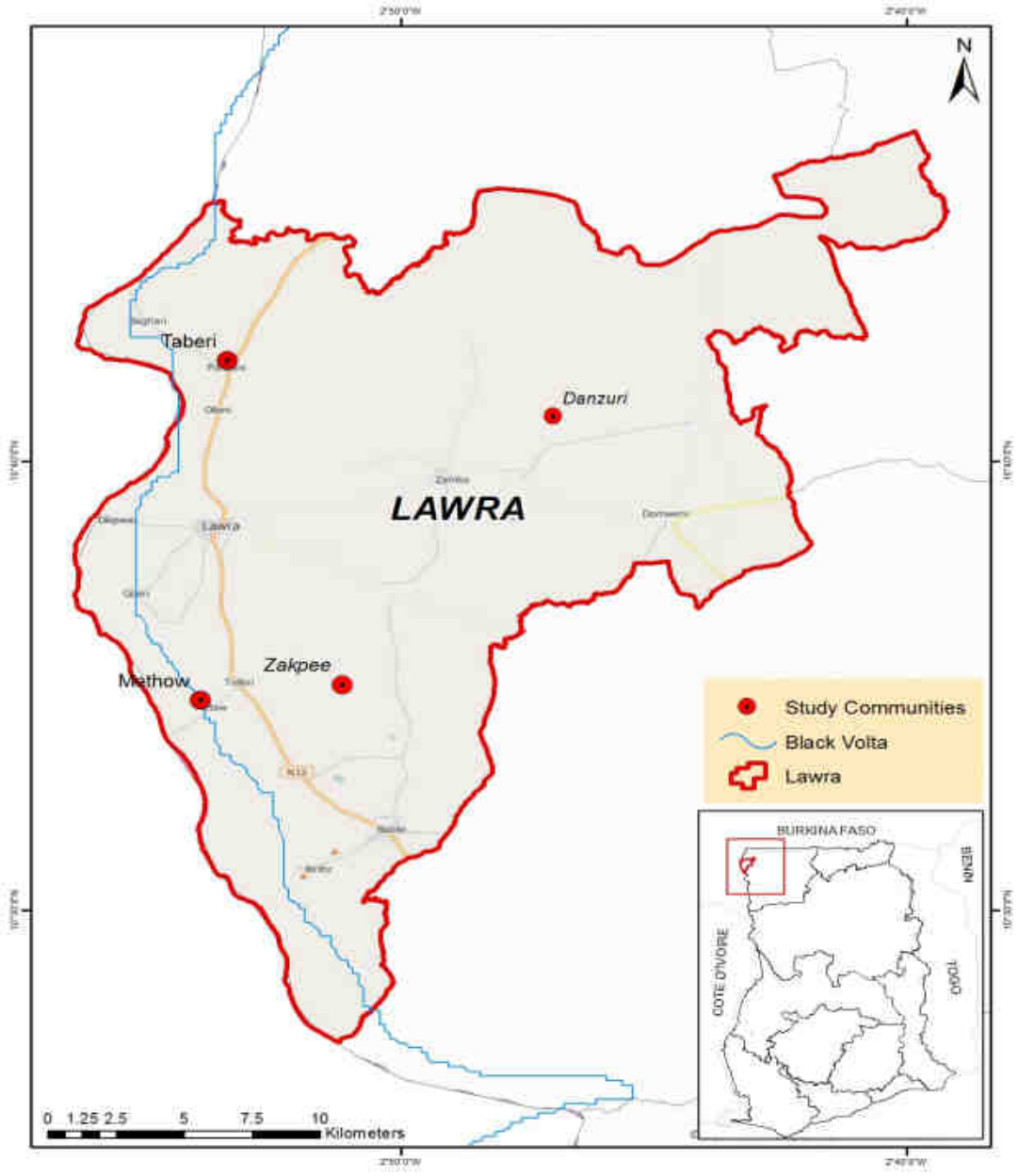
The Lawra district, which is the focus of the study, is one of the eleven districts that make up the Upper West Region of Ghana. It lies in the north-western corner of the region. It is bounded to the north by Nandom district, to the east by Lambussie-Karni district and to the south and west by the Republic of Burkina Faso (Figure 3.1). The total area of the district is 1,051.2 square km. This constitutes about 5.7% of the Region's total land area, estimated at 18,476 square km.The district is estimated to have 157 communities with 95% of the inhabitants in the rural areas (GSS, 2013). The population density is about 89 per square km, making it the most densely populated district in the region. The population of Lawra district, according to the 2010 Population and Housing Census, was 54,889 representing 7.8 percent of the region's total population. Males constitute 48 percent and females represent 52 percent. The district is comprised predominantly of the Dagaaba ethnic group with dialectical variations. There are other minor tribes such as Akans, Hausas and Dagombas (GSS, 2013).

The District is mainly drained by the Black Volta to the west which lies very close to the boundary between the District and the Republic of Burkina Faso. The Black Volta has several tributaries in the District; notable amongst them are the Kamba/Dangbang, Nawer, Duodaa. The Lawra district lies within the Guinea Savannah agro ecological zone which is characterized by short grasses and few woody plan. Common trees in the District consist of drought and fire resistant trees such as baobab, dawadawa, Shea trees and acacia. The greatest influence on the vegetation is the prolonged dry season. The mean annual rainfall ranges between 1016mm and 1270mm and is concentrated in one season - April to October (Lawra District Assembly, 2014). The mean annual temperature range between 27° C to 36° C. The period between February and April is the hottest (Lawra District Assembly, 2014).

The majority (78%) of people in the Lawra district are farmers producing small quantities of maize, millet, groundnuts, soya beans and cowpea. Animal rearing is also undertaken by most farmers to supplement crop production. The local agricultural sector is confronted with depleting soil fertility, unreliable rainfall pattern, limited capital investment and skills, pests and disease, inadequate access to extension services and low access to market (Lawra District Assembly). Food insecurity is a major challenge to many households within the district especially during the lean season (WFP, 2012). The harvest season is usually characterized by abundance,

particularly to crop farming households. However, due to low income levels, farmers usually sell their produce to provide their non-food needs leaving them with insufficient food for the rest of the year (Lawra District Assembly, 2014).

Four rural communities including Methow-Yipala, Zagkpee, Tabier and Erimon-Dazuuri were chosen as the study locations in the district (Figure 3.1).



Source: Remote Sensing/GIS Laboratory, Department of Geography, University of Ghana, 2016

Figure 3. 1 Map of study area showing study location

2.2 Study Design and Method

The mixed method study design was used for this study. The findings of the study seek to achieve both nomothetic (generalization) and ideographic (sympathetic understanding) objectives. Primary data was collected through Focus Group Discussions (FGDs) and semi-structured questionnaire survey. FGDs preceded the questionnaire survey.

The FGDs were conducted to understand livelihood strategies of farmers and hazards confronting smallholder farmers. Eight FGDs were conducted; gender disaggregated FGDs were conducted in Methow-Yipalla and Erimon-Dazuuri while age disaggregated FGD was conducted in Zakpee and Tabier. Disaggregation of FGDs discussants according to gender and age was informed by socio-cultural consideration in the study area which constrained females and younger people from expressing themselves in the midst of their male and elderly counterparts (Yiridoe, 1995). The focus of the work on this axis of social differentiation also accounted for the disaggregation for the community FGDs. Particular attention was paid to other social factors including marital status, migratory status, disability and social class in ensuring inclusiveness in the discussions. The composition of groups ranged between 9 and 12 people. Additionally, FGDs were used to validate adaptation practices of smallholder farmers that were identified from literature. The results from the FGDs were incorporated in the questionnaire for the survey.

A total of 160 farmers, 40 each from the four communities randomly selected, were interviewed for the questionnaire survey. With emphasis of the work on social differentiation, deliberate efforts were made to maintain a balance in gender and age. To achieve a balance among the social groups of interest (males, females, youth and older generation), stratified sampling procedure was used to create four strata of the population based on the social groups. Selection of respondents in the field was very challenging as a result of lack of comprehensive list of farmers disaggregated by age and gender. An improvised list was developed and used in the field. This involved the division of communities into four blocks and a vantage point identified. People within each block were asked to provide names of farmers within that block. The lottery method was then used to randomly select respondents.

2.3 Data Analysis

Focus group discussion data and field notes were transcribed, summarise and grouped into major themes.

The chi-square ($\chi 2$) was used to estimate the statistical difference among the social groups (males, females, youth and older generation) in the adoption of adaptation strategies. Data from FGDs were grouped into major themes (hazards) and complemented with hazards identified from existing literature. The hazards were then presented to respondents for ranking from the most pressing constraint to the least pressing one using numeric scales 1, 2, 3….12. The total rank score of each constraint was calculated and the constraint with the least score ranked the most pressing one while the constraint with the highest score was ranked the least.

The Kendall's Coefficient of Concordance (W) was used to determine the level or degree of agreement among the rankings of the constraints by the respondents using the rank scores (Legendre, 2010). The coefficient of concordance (W) is a positive value ranging between zero (0) and one (1). A Kendall's concordance coefficient of one suggests maximum agreement among rankers while zero coefficient means maximum disagreements among rankers on the rankings of the constraints.

Given that T = the sum of ranks of each constraint being ranked, the variance of the sum is given by;

$$Var_T = \frac{\sum T^2 - (\sum T^2)/n}{n} \quad (1)$$

And the maximum variance of T is then given by

$$\frac{m^2(n^2-1)}{12} \quad (2)$$

Where, m = Number of sets of ranking by the farmers and n = the number of specific constraints being ranked.

The Kendall's coefficient of concordance (W) is therefore given as,

$$W = \frac{[\sum T^2 - (\sum T^2)/n]/n}{m^2(n^2-1)/12} \quad (3)$$

Equation (3) is further simplified to the computational formula as;

$$W = \frac{12[\sum T^2 - (\sum T^2)/n]/n}{nm^2(n^2-1)} \quad (4)$$

The coefficient of concordance (W) may be tested for significance using the F-statistic. This is given by,

$$F = \frac{[(m-1)w_c]}{(1-w_c)} \quad (5)$$

The F-statistics has $V_i = \frac{(n-1)-2}{m}$ Degree of freedom for the numerator

$V_2 = (m-1)[(n-1)-2/m]$ Degree of freedom for the denominator.

Decision rule: If $F_{cal} > F_{cri}$ from Fisher's F-statistics distribution, the null hypothesis is rejected; otherwise, it is not rejected.

3.0 Results

3.1 Perception of Vulnerability of Socially Differentiated Groups of Smallholder Farmers

In responding to the question," what are the major challenges confronting you in undertaking your livelihood activity (farming)?'' participants identified a wide range of issues that broadly categorizes into climatic and non-climatic stressors. Below is a summary of the hazards identified by the different social groups in all four participating communities.

Table 1. Hazards faced by smallholder farmers: response from FGDs

Community	Males	Females
Methow-Yipalla	• Drought • Poor soil quality. • Lack of credit to invest in farming. • Inadequate access to improved seeds. • No labor in the farm especially for women. • High mortality of livestock • Poverty • Floods • Conflicts over land along the Black Volta. • Inadequate tractor services especially during ploughing season.	• Inadequate water • Inadequate access to fertilizer • Inadequate tractor service • Difficulty in transporting compost to fields. • Dry spells. • No grinding mill in the community. • No alternative livelihoods especially for the women • Poor road network • Difficulty transporting farm produce to the major market centre • Poverty
Erimon-Dazuuri	• Dry spells • Loss of soil fertility • Inadequate tractor services especially during ploughing season. • Inadequate capital for farm inputs i.e fertilizer and tractor service. • Inadequate veterinary services. • Inadequate extension service. • No knowledge on new agricultural technology and practices. • Poor response to outbreak of diseases and epidemics from disease control office	• Inadequate tractor service. • Inadequate water • No access to capital to invest in farm inputs eg fertilizer. • No knowledge in modern farm practices and technology. • No market for farm produce • High prices of grains during lean season

Field survey, 2016

Table 2. Hazards faced by smallholder farmers: response from FGDs

Community	Youth	Older folks
Zakpee	• Dry spells • Insufficient tractor services. • Lack of knowledge on modern farming technology and practices • Water problems • Animal theft. • Outbreak of swine fever • Lack of access to credit • No veterinary service • Conflicts • No work to compliment farming especially during off-farm season. • Heat	• Poverty • Dry spells • Lack of credit access to invest in farms. • Inadequate tractor services especially during ploughing period. • Loss of soil fertility • Lack of knowledge in modern compost preparation. • Inadequate tractor service. • Lack of storage facility for farm produce.
Tabier	• Loss of soil fertility. • Inadequate tractor service. • Insects' infestation. • Lack of credit to invest in farms. • Unpredictable rainfall. • Menace of nomadic herdsmen. • Bush fires • Loss of soil fertility. • Insects' infestation. • No market for farm produce/exploitation from market queens	• Inadequate tractor service especially ploughing period. • Lack of access to improved seeds. • Outbreak of animal disease with no veterinary service. • Lack of capital for fertilizer purchase/ difficulty acquiring fertilizer. ` • Bush burning. • Inability to leave land to fallow • Excessive temperature.

Field survey, 2016

Constrains that have similar effects were grouped under one theme. The major themes identified include; drought/dry spells, water stress, floods, extreme temperature, human disease and crop pests and diseases. Others include animals' disease and theft, decrease soil fertility, and problems with inputs purchase. The rest are problems with output sales, high food prices and conflicts.

The hazards were presented to all respondents in the survey, to rank them in other of importance from the most pressing to the least pressing one. The Kendall's Concordance Coefficient was used to test for the level of agreements of the rankings among smallholder farmers. Results of the Kendall's Test showed that the Chi Square value for the pooled sample ($\chi 2$=487.563) was significant at 1 percent with a Kendall's concordance coefficient of 0.277 as presented in Table 4.3. This means there is a 27% agreement level among smallholder farmers on the ranking of hazards faced by smallholder farmers. With the exception of conflicts, there is an overwhelming consensus among farmers that threats posed by hazards have increased over time.

Drought/dry spells

Drought/dry spells hazard was ranked by respondents as the most pressing hazard confronting farmers in the Lawra district. The different social groups of males, females, youth and older generation do not differ in ranking dry spells/drought as the most pressing problem.

Water stress

The females and youth social groups both ranked water stress second with a mean rank of 4.18 and 5.16 respectively. However, the males' social group ranked water stress as the seventh most pressing hazard whiles the older generation ranked it third.

Decrease soil fertility

Males ranked decrease soil fertility hazard second most pressing hazard whereas females ranked it fourth. Similarly, youth ranked decrease soil fertility fourth most pressing hazard whiles older people ranked it second.

Problems with inputs purchase

The males group ranked it third whereas females ranked it fifth. The youth ranked it fourth and the older generation ranked it sixth.

Table 3. Ranking of hazards by smallholder farmers.

No	Hazards	Kendell W Mean Rank				Rank			
		Male	Female	Youth	Older generation	Male	Female	Youth	Older generation
1	Dry spells	3.61	2.69	2.98	3.39	1	1	1	1
2	Water stress	6.25	4.18	5.16	5.40	7	2	2	3
3	Floods	7.42	9.05	7.90	8.33	11	11	11	11
4	Extreme temperature	6.85	8.27	7.46	7.59	9	10	10	10
5	Human disease	5.97	6.77	6.41	6.19	5	8	6	7
6	Crop pests and disease	6.23	7.26	7.15	6.39	6	9	9	8
7	Animal pests and disease	5.94	6.41	6.54	5.81	4	7	7	4
8	Decrease soil fertility	5.32	5.53	5.51	5.37	2	4	3	2
9	Problems with inputs purchase	5.70	5.82	5.55	6.02	3	5	4	6
10	Problems with output sales	7.09	5.91	6.69	6.41	10	6	8	9
11	High food prices	6.80	4.66	5.70	5.88	8	3	5	5
12	Conflicts	10.82	11.45	10.95	11.22	12	12	12	12

Kendall's Test Statistics

N	Male	Female	Youth	Older generation
	86	74	70	90
Kendall's W[a]	0.2162	0.414	0.279	0.282
Chi-square	204.253	337.283	214.903	278.806
Df	11	11	11	11
Asymp. Sig.	0.000	0.000	0.000	0.000

Source: computed from field survey data, 2016

High food prices

Males ranked high food prices as the eighth most pressing hazard whiles females ranked it third. Both youth and older generation ranked high food prices as the fifth most pressing hazard.

Animal pests and disease

To the males, this hazard is ranked fourth while females ranked it seventh. Similarly, the youth ranked it seventh whereas the older generation ranked it fourth.

Human disease

Human disease was ranked fifth and eighth respectively by males and females whereas the youth and older generation ranked it sixth and seventh.

Problem with output sales

Males ranked problems with output sales as the tenth most pressing hazard, females ranked it sixth. Youth on their part ranked it eighth whiles older people ranked it ninth.

Crop pests and disease

Males ranked this hazard as sixth and females ranked it ninth most pressing hazard facing smallholder farmers. The youth equally ranked it ninth while the older people ranked it eighth.

Extreme temperatures

Males ranked extreme temperatures ninth and females ranked it tenth most pressing hazard faced by smallholder farmers. Both the youth and the older people ranked extreme temperature hazards tenth.

Floods

There is absolute agreement among all social groups that floods are the eleventh ranked hazards faced by farmers.

Conflicts

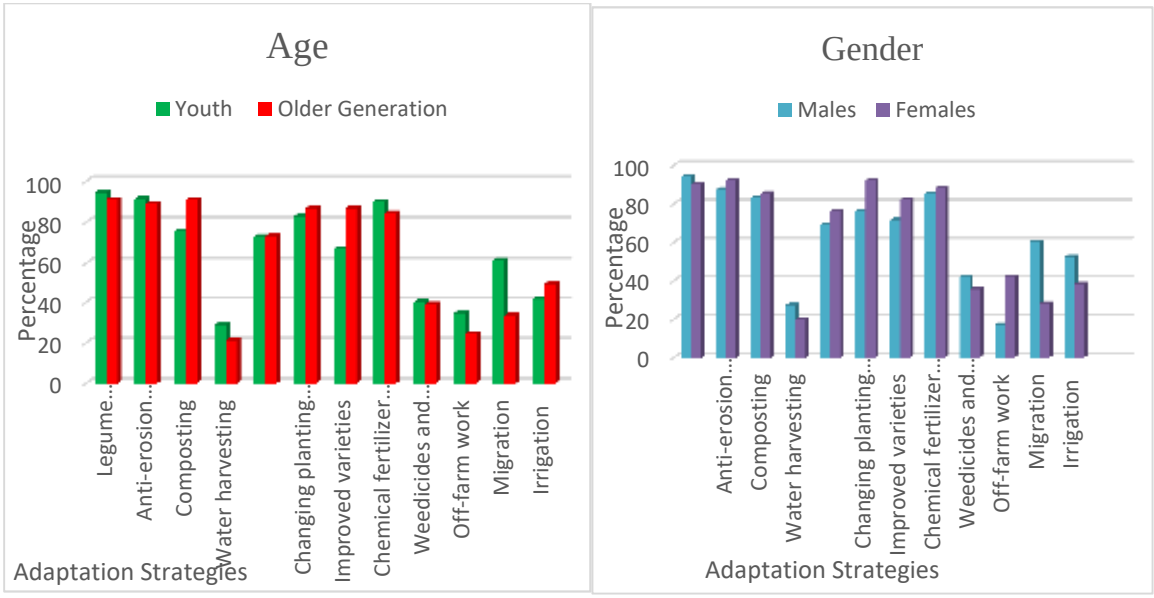
Similarly, all social groups strongly agree to conflicts as the least ranked hazard.

3.2 Patterns of Adaptation

Figure 1 shows the results on adaptation strategies of smallholder farmers in the study area. Generally, there is overwhelmingly high adoption of adaptation strategies related to SLM practices including mix cropping/legume intercropping (92.5%), anti-erosion measures (90%), composting (84.4%), changing planting dates (85%) and CA practices (73.1%). The only SLM strategy which was found not to be used by majority of farmers was water harvesting which was adopted by 24.4 percent of respondents.

Further, Table 4.5 indicates the patterns of adaptation of the differentiated groups (both by age and gender). With regards to sustainable land management adaptation strategies, compost use and changing planting dates have a 1 percent statistically significant difference in terms of gender and age group respectively. This implies, a significant difference exists between the youth and the older generation in their use of compost. Also, significant difference exists between males and females in the use of changing planting dates as an adaptation strategy. The other adaptation strategies related to sustainable land management practices including mix cropping/legume intercropping, anti-erosion measures and water harvesting do not have a statistically significant difference between them either by age or by gender.

Figure 1. Patterns of Adaptation of Differentiated Groups of Smallholder Farmers.



Source: Constructed from field survey, 2016.

Adaptation practices related to modern inputs use including improved seed varieties and chemical fertilizer use were equally adopted by majority of respondents (78.1% and 86.9% respectively) as shown in fig. 1. Weedicides and pesticides use were found to be relatively low (39.4%) among respondents.

Table 4. Patterns of adaptation

Adaptation Strategy	Social Group	P. Value
Mix cropping/Legume intercropping	Gender	0.451
	Age	0.500
Anti-erosion measures	Gender	0.205
	Age	0.595
Composting	Gender	0.806
	Age	0.008***
Water harvesting	Gender	0.262
	Age	0.279
Conservation Agriculture	Gender	0.500
	Age	0.946
Changing planting dates	Gender	0.007***
	Age	0.503
Improved varieties use	Gender	0.108
	Age	0.003***
Chemical fertilizer use	Gender	0.421
	Age	0.302
Weedicides and pesticides use	Gender	0.488
	Age	0.887
Off-farm employment	Gender	0.001***
	Age	0.172
Migration	Gender	0.000***
	Age	0.000***
Irrigation	Gender	0.129
	Age	0.347

Source: computed from field survey data, 2016

Note: *** =1% significant level.

Table 2 reveals that the difference between males and females in their use of improved varieties is statistically significant at 1 percent. The difference between males and females and between youth and the older generation in chemical fertilizer application and weedicides and pesticides use are not statistically significant.

The use of diversification strategies including off-farm work, migration, and irrigation is relatively low with less than half of respondents adopting any one of these strategies (Figure 1).

The social groups, both by age and gender, differ in their use of off-farm employment and migration as adaptation strategies (Table 2). With regard to off-farm employment activities, there is a statistically significant difference between males and females at 1 percent significance level (Table 2). In the case of migration, males and females as well as youth and the older generation differ at a 1 percent significance level (Table 2). This implies a significant difference between males and females as well as between youth and the older generation in their use of migration.

Irrigation is adopted by 45 percent of respondents. However, there is no statistically significant difference between males and females and also between the youth and the older generation in the adoption of irrigation.

4.0 Discussion

4.1 Vulnerability and Adaptation Patterns of Differentiated Groups of Smallholder Farmers

Even though non-climatic stressors are argued to pose worse challenges to smallholder farmers (Nyantakyi-Frimpong & Bezner-Kerr, 2015; Holler, 2014; WFP, 2012; Jayne et al., 2010; Nielsen & Reenberg, 2010a), the study identified drought and dry spells as the most pressing hazard faced by smallholder farmers. Unsurprisingly, men and women and youth and older folks do not differ in their perception that drought and dry spells as the most pressing hazard faced by smallholder farmers in Lawra district. Nyantakyi-Frimpong & Bezner-Kerr (2015) revealed that the unpredictable occurrence of dry spells and Optimum Growth Period (OGP) during planting season in Lawra district amplifies the predicaments of rural farmers and makes their livelihoods more precarious. This is because an overwhelming majority of farmers in the area depends solely on rainfall for productivity (GSS, 2013). Consistent with this finding, Westengen and Brysting (2014) found that farm

households ranked drought as the worse stress factor plaguing farmers followed by water stress and unreliable onset of rainfall. Similarly, no generational and gender differentiation is found in the least ranked hazards; extreme temperature, floods and conflicts respectively.

Drought and dry spells apart, males recognized decrease soil fertility as second most pressing hazard whiles females noted water stress as second. Analysis of qualitative data revealed that women and youth has the burden of providing water for the household in the dagaaba social set up, as such these groups perceive the problem of water stress to be more threatening than males and older folks. It further revealed that, the patriarchal nature of the society restricts inheritance, the prime source of land acquisition, to males. This system of land acquisition also favours older folks compared to the youth. Consequently, males and older folks perceive challenges associated with land as more pressing relative to females and youth.

In Africa smallholder farmers in rural areas constitute net buyers of grains, as such are directly hurt by increase in food prices (Jayne et al., 2010). In this study, females consider high food prices as the third important pressing hazard. Generally, farm households in the upper west region witness household food shortages in the lean season averaging five months (Quaye, 2008) which often leads to migration, especially among men, to southern Ghana (Rademacher-Schulz et al., 2014). This leaves the females with the burden of providing food for the households during this most difficult period of the year. For males, problems with inputs purchase including high price of inputs, lack of funds to acquire farm inputs, unavailability of traction livestock (donkeys) and tractor services during planting period was ranked as third. FGDs revealed that farming is perceived to be a male economic activity with men and youth regarded as not actively engaged in farming in their own right but regarded as "helpers" of their spouses and parents. The burden of farm inputs provisioning therefore lies with the males.

Males perceive animal pests and diseases to be more a threat than females while older folks consider it more a threat than the youth evidence by the fourth and seventh rank respectively in both instances. Qualitative data showed that, livestock, especially cattle, sheep, pigs and goats are predominantly owned by males. Recent outbreak of swine fever which resulted in high mortality among pigs coupled with increased incidence of animal theft in the area likely influence the higher rank of males and older folks.

4.2 Patterns of Adaptation

Figure 4.5 indicates high adoption of strategies related to sustainable land management practices. Only water harvesting was found to be relatively unpopular with farmers. This holds a huge potential for climate change mitigation and adaptation in the area. The finding however contradicts Ndamani & Watanabe (2015) who suggest that, the use of sustainable land management practices including mulching, mix cropping, and changing planting dates is low among farmers in the Lawra district. Response from focus group discussions revealed that most of the sustainable land management strategies conform to the traditional farming practices of the Dagaaba people. Besides, the upfront financial cost involve in the use of these strategies is relatively less compared to other strategies. It was further revealed that these strategies were vigorously pursued by the district office of the MoFA as part of their strategies to promote climate smart agricultural practices in the district.

The results show a statistically significant difference between the youth and the older generation in the use of compost (Table 4.5). The difference in terms of compost use is explained by the fact that livestock are mostly owned by the older generation, as such they have access to manure compared to the youth. Also the construction of compost pits is done at the household level, and since the older generation are invariably heads of the households, they reserve ownership of these compost pits. Males and females also differ significantly in the use of changing planting dates. This could be explained by the fact that most females do not own separate farmlands but rather intercrop their plants on their husbands' field thereby constraining their ability to take independent decisions relative to the crop field. This results corroborate studies suggesting that males and females significantly differ in the use of conservation agricultural practice (Ekboire et al., 2002). Conversely, Etwire et al., (2013) found no significant difference between males and females in the use of recommended agricultural practices strategies including changing planting dates, composting, row planting and conservation agriculture among smallholder farmers in northern Ghana.

Modern inputs including improved varieties and chemical fertilizer application are used by majority (78.1% and 86.9% respectively) of farmers whiles relatively fewer (39.4%) farmers use weedicides and pesticides (Figure 4.5). However, Nyantakyi-Frimpong & Bezner Kerr (2014) in a similar study in the Upper West region indicated that majority (76%) of farmers did not use improved varieties because they perceived it to be weak, sensitive and required extra care. It also needed stricter timing of cultural practices especially weeding and fertilizer application. This buttresses the claim that farmers' seed use is more complex than a simple choice between different varieties (Issahaku & Maharjan, 2014). Westengen & Brysting (2014) reported a high uptake of improved maize variety and a low uptake of improved sorghum variety among smallholder farmers in Tanzania.

In terms of modern inputs use, there is a statistically significant difference between males and female in the use of improved varieties (Table 4.5). The difference in the use of improved seeds is probably explained by the activities of some NGOs in the area (Result project and PRUDA) supporting female farmers through the distribution of improved seed varieties. The study results showed no significant difference by age and gender in relation to chemical fertilizer application and weedicides and insecticides use (Table 4.5). In Malawi, Chirwa (2005), found no significant difference between males and females in the use of chemical fertilizer and improved varieties but noted a significant difference in age with respect to improve variety use with older farmers less likely to adopt improved varieties. Contrasting results were found in other studies in Upper West region and elsewhere in Africa where males and female farmers have a statistically significant difference in the use of modern technological inputs, with males having more access than females (Ragasa et al., 2012; Anaglo et al., 2014; Mukasa et al., 2015). FAO (2011), identified a number of constraints that lead to male dominance in modern inputs use: financial capital requirements, risk taking behavior, and human capital requirement.

With rainfall becoming progressively less predictable whiles droughts and dry spells become more frequent, exclusive dependence on rain-fed agriculture is becoming risky (Van Aelst & Holvoet, 2016). A common adaptation strategy among smallholder farmers is diversifying one's income stream through off-farm activities and migration (Below et al., 2010). Following from this, smallholder farmers in northern Ghana participate in livelihood diversification including off-farm jobs and migration. The study indicate a relatively low participation in diversification activities including off-farm economic activities (28.8%), and migration (45.6%) (Figure 4.5). However, Dumenu & Obeng (2015) observed that though the range of diversification portfolio available to smallholder farmers in the Guinea and Sudan savanna zones is limited, the use of the strategy as an adaptation is relatively high. Similarly, Yilma et al., (2008) noted that 68% of agricultural households in the Upper East region have at least a family member engaged in off-farm income generating activities.

Further, the study reported significant difference in gender and age relative to off-farm employment and migration. In particular, significant difference was found between males and females in engagement in off-farm economic activities with more females than males participating in non-farm income activities. In keeping with this finding Owusu et al., (2011), reported a statistical significant difference between males and females, with more females than males participating in non-farm work in northern Ghana. Also, Van Aelst & Holvoet (2016) identified significant difference between men and women in terms of participation in non-farm economic activities with more males undertaking off-farm income activities and also marked difference between the youth and the older generation with the youth 60% more likely to engage in non-farm work. Owusu et al., (2011) suggests that participation of males in off farm work increases the probability at which a farm household becomes food secure in northern region.

In terms of migration, both gender and the age show manifest difference at 1 percent significance level (Table 4.5). By gender, migration is essentially a male affair whiles in terms of age, the youth dominates. Consistent with this finding, Rademacher-Schulz et al., (2014) reported a similar results in the Nadowli district where migration is usually a male undertaking and predominantly a youth affair. In Burkina Faso, Nielsen & Reenberg (2010a), made similar observation of migration embarked on by men and most especially the youth below 35 years.

Declining and unpredictable rainfall pattern coupled with emphasis of development projects on irrigation, have made irrigation more popular among smallholder farmers in semi-arid areas (Nielsen & Reenberg, 2010a). Results from the current study, however revealed low (45.6%) participation of respondents in irrigation (Tale 4.5). Dumenu & Obeng (2015) reported that 34.6% and 61.5% of farmers in the Guinea and Sudan savanna agro-ecological zones of Ghana engage in irrigation as an adaptation. Qualitative interviews noted inadequate capital to invest in high mechanized irrigation and tedious nature of traditional irrigation methods as the major constrains affecting respondents' participation in irrigation. The result further illustrates no significant difference between farmers both by age and gender in the use of irrigation (Table 4.5). Consistent with this results, Yilma et al., (2008) reported that gender of household head was not statistical significant in using irrigation in the Upper West region, but the sign of the coefficient indicated a higher probability of irrigation in female headed households. However, away in Tanzania Van Aelst & Holvoet (2016), reported that significantly more men than women use irrigation. Irrigation significantly improves income of the most marginalised groups including female headed households, youth and poor in society (Nkhata et al., 2014).

The significant differences showed between the differentiated groups of smallholder farmers with respect to the use some of the adaptation strategies imply that the null hypothesis is rejected.

5.0 Conclusion

Existing studies have targeted smallholder farmers as a homogenous group that should be supported as a composite unit (Morton, 2007; Jayne, T. S., Mather, D., & Mghenyi, E., 2010; WFP, 2012; Holler, 2014;

Wossen & Berger 2015). We sought to interrogate this assertion to ascertain whether smallholder farmers are indeed homogenous in their configuration. We therefore set out to investigate gender and generational differentiation in perception of vulnerability and subsequent adaptation response among smallholder farmers. The study concluded that smallholder farmers are not homogenous, rather, males and females and youth and older folks differ in their perception of vulnerability and subsequent adaptation strategies.

Males ranked drought/dry spells, decrease soil fertility and problems with inputs purchase whiles females ranked drought/dry spells, water stress and high food prices as the top three worse stress factors faced by smallholder farmers. The youth on their part ranked drought/dry spells, water stress and decrease soil fertility whereas older folks ranked drought/dry spells, decrease soil fertility and water stress as the top three worse stress factors facing farmers. This means that efforts to reduce vulnerability and improve the wellbeing of smallholder farmers should be targeted at the individual socially disaggregated group.

In relation to adaptation choices, we found a statistically significant difference in the adoption of sustainable land management practices including compost use and changing planting dates. Regarding modern inputs use, there is a significant difference between males and females in the use of improve varieties with more females than males adopting improved varieties. In terms of diversification, there is significant difference between males and females in undertaking off-farm income activities. Males vary significantly from females whiles the youth also vary significantly from the older folks in the use of migration as an adaptation strategy by smallholder farmers. Interestingly, no statistical significant difference could be established between the social groups in the use of irrigation as an adaptation.

Therefore, development interventions should focus on reducing vulnerability to drought and dry spells through the provision of accurate and timely rainfall information. Also the Savannah Agricultural Research Institute should develop drought resistant crop varieties that is suitable to local conditions and also addresses the socio-cultural aspirations of farmers.

To reduce vulnerability of male farmers to hazards, MoFA and development organizations should prioritize, in addition to drought/dry spells measures, soil fertility enhancement strategies including precise application of agro-chemicals. Also, these organizations should improve access to credit to eliminate or reduce problems associated with inputs purchase.

The Community Water and Sanitation Agency and NGOs working in the water and sanitation sector should provide potable water in the study area. This will reduce vulnerability of both the females and the youth.

In line with Ghana's Intended Nationally Determined Contribution (INDC) to the UNFCCC, to promote CSA in the northern savannah agro-ecological zone, policy measures should be targeted at improving the efficiency and effectiveness of the sustainable land management strategies so as to sustain and improve adoption. Specific interventions should be targeted at improving water harvesting techniques among smallholder farmers in the Lawra district. This will reduce vulnerability to drought/dry spells identified by all social groups as the most pressing hazard faced by farmers. With findings showing low adoption of compost and manure use among the youth relative to older folks, focus should be placed on the youth to increase its adoption.

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