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The influence of socio-economic household characteristics on farmer resilience to climate change in Northern Ghana

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Approaches to improved resilience of small-farmers due to the effects of climate change are of critical concern. This study investigates the socio-economic factors that influence small-scale farmers' on-farm resilience in northern Ghana using seven resilient approaches adopted in the study area. Using a multi-stage sampling approach, a total of 300 small-scale farmers were interviewed. A bivariate analysis encompassing Pearson's Chi-square and Cramer's V and multivariate analyses encompassing Ordinary Least Squares regression and Principal Component Analyses to analyse the data, the study found that socio-economic characteristics such as age of a farmer, perception of climate change, educational level of a farmer, access to village savings and loans among others influence farmers resilience to climate change in diverse ways. The level of influence varied across the various resilient approaches and the two analytical models employed in the study. The study concludes that creating enabling environment that enhances socio-economic development improves the level of on-farm resilience of small-scale farmer.

Key words: Climate change, resilience, socio-economic characteristics, small-scale farmer.

INTRODUCTION

Climate change poses a huge challenge with varied diverse effects on sustainable development (IPCC, 2012; UNGA, 2015; Owusu, 2018). The effects adversely affect agriculture productivity in Africa resulting in low output (UNFCCC, 2006; Below et al., 2010; Pelling, 2011; Kangalawe and Lyimo, 2013; Adegbola et al., 2017; Jabik et al., 2022) with consequence on food security globally. The most vulnerable group in any environment is the poorest, especially those who depend most on agriculture for their livelihoods (UNFCCC, 2006; Pelling, 2011; Kangalawe and Lyimo, 2013). The effects and the level of resilience of small-scale farmers are of high concern because they depend on rain-fed small-scale agriculture. In Ghana, the situation is not different as the economy is

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mainly agrarian, with about 44.7% of the active population depending on the agricultural sector (GSS, 2014a).

Small-scale farmers' ability to adapt and cope with the changing climatic conditions depends on some socio-economic factors both at the household and community level. These factors influence farmers' resilience differently. This study investigates the community and socio-economic factors that influence resilience of small-scale farmers in northern Ghana. To build effective adaptive capacity for climate change risk and impacts, it is necessary to have a closer look at these factors and could be useful in designing development initiatives.

According to Kangalawe and Lyimo (2013), farmers' perceptions of weather patterns influence their decisions regarding what to produce, when to plant, what variety to plant, and how to manage the farm. Studies conducted by authors such as Maddison (2006), Uaiene et al. (2009), and Tambo (2016) have demonstrated that while younger farmers are more likely to implement new technologies, elderly farmers have a greater understanding on the perception of climate change and its effects. This assertion therefore implies, age can influence resilience in a positive or negative manner. Understanding climate issues and making decisions about how to adapt to the changing conditions require a level of literacy and education. In accordance with the findings of Madison (2006), Uaiene et al. (2009), and Deressa et al. (2009), higher levels of education and literacy among household heads correlate positively to a number of climate change resilient approaches. The level of significance of the relationship depends on the type of climate change resilient approach adopted.

Also, the number of people in a farmer's household can influence resilience in two ways. Farmers with larger household sizes, of which the majority of the people in the household are within the active labour force group, are more likely to engage in labour-intensive resilient measures (Nyangena, 2007; Deressa et al., 2009), adapt to multiple climate change resilience approaches or divert part of its labour force into non-farm activities (Nyangena, 2007). If majority of the household members are not within the active labour force category, extra efforts must be affected to meet the nutritional and dietary needs of the household. This occurrence could negatively influence the adoption of climate change resilience approaches in such a household.

Again, critical as a determinant of farmer resilience to climate change is the sex of the household head. Male-headed households are more likely to plant economic trees and, change planting dates as a resilient option than female-headed households (Maddison, 2006; Deressa et al., 2009; Uaiene et al., 2009). This is so because poor access to land and inherited property by women in some societies (Yaro et al., 2014) increase the inability of females to engage in long-term rewarding resilience approaches.

Households with higher income levels correlate positively and significantly with various climate change resilience approaches (Deressa et al., 2009; Uaiene et al., 2009; Bryan et al., 2012; Bawakyillenuo et al*.,* 2014). This is because such households are able to acquire farm inputs that can contribute to improve on various resilience options. Also, access to agricultural extension services facilitates diversification and adaptation to climate change (Agrawal and Perrin, 2008; Uaiene et al., 2009; Bryan et al., 2012). Extension officers provide information on agronomic practices such as the introduction of new high-yielding crop varieties, provision of information on climate change and other stressors, facilitation of farmer cooperatives or networks, use of appropriate technology, change in social attitudes and behaviours and the adoption of new crop cultivars (Maddison, 2006; Hassan and Nhemachena, 2008; Bryan et al., 2012; Bawakyillenuo et al., 2014). Furthermore, if the extension service is provided in the form of farmer-to-farmer extension, the likelihood of knowledge transfer, agricultural techniques, and experience from more seasoned farmers increases (Deressa et al., 2009; Laube et al., 2012).

Farmers' ability to improve their resilience level and respond to changing climatic conditions depend on a number of farmers as demonstrated earlier, while the factors vary from farmer to farmer, establishing the bases are very critical.

RESEARCH METHODOLOGY

Description of the study area

The study area is the northern part of Ghana characterised by the uni-modal rain-fall season (Owusu, 2018) from May/June to September/October and the dry season from October/November to April/May (Figure 1). During the dry season, rainfall is absent with low humidity (GTDA, 2015; Owusu, 2018) unlike the rainy season which is often characterised by erratic, torrential, and unpredictable rainfall. The average rainfall volume is between 800 and 1000 mm per annum with about 90% of it occurring between July and September. The lowest mean temperature is 18°C occurring in December/January and the highest mean monthly temperature is 40°C in March/April. The vegetation of the study area is mainly of the Sudan savannah type, characterised by tropical savannah woodland species consisting of scattered drought and fire-tolerant trees and grasses (GSS, 2014b; GTDA, 2015). Agriculture is the dominant occupation of the people engaging about 80% of the active labour force (GSS, 2014b). The farming is rain-fed, making agriculture highly vulnerable in the area (Yaro, 2010).

Research design and data collection approach

The research adopted a quantitative research approach. The approach was adopted because it allowed us to establish the similarities and variances (Mills et al., 2006) of the farmers adopting climate change resilience approaches in the study area. The approach provided the basis for empirical evidence for understanding the dynamics of small-scale farmers' resilience to the

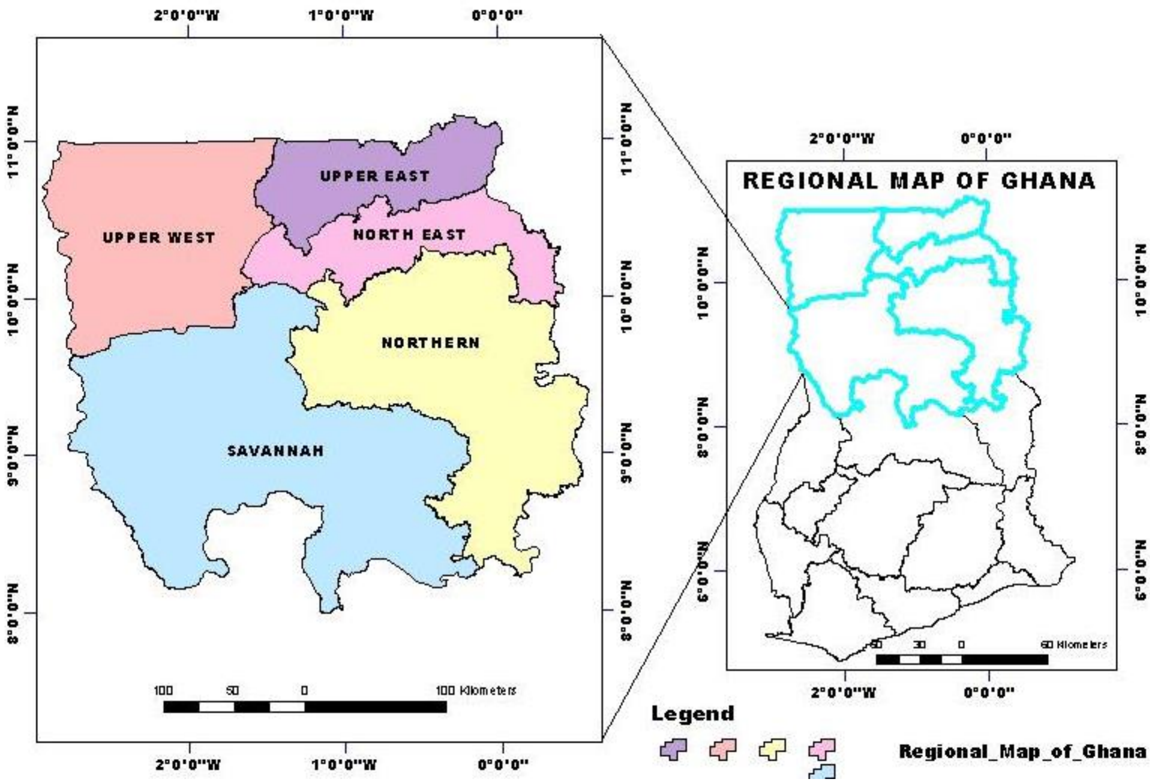

Figure 1. Map of the study area.
Source: Author's Construct

changing climatic environment. Secondary data, through a literature review, was carried out to provide an understanding of the local context and key variables that are relevant for the indicators of climate change resilience.

Sources of data for the research consisted of both desk study and primary data sources. The approach and instruments used for the primary data collection were individual farmer interviews using a structured questionnaire. In addition, key informant interviews were conducted with key persons who have in-depth knowledge of climatic conditions. This approach was useful for achieving construct equivalence in the study since the tools and the methodological processes in the study communities are measured by the same latent traits (Mills et al*.,* 2006). Samples of small-scale farmers were drawn from the study communities. An average of 15 farmers were sampled from twenty communities. The individual farmer-level data was collected from 300 small-scale farmer households.

The secondary data were collected by reviewing relevant literature from sources such as articles, reports, and previous related studies. The information from the secondary source was used to conceptualize the study and triangulate some of the primary data.

Data collection procedure

The study adopted multi-stage sampling approaches to select the communities and individual small-scale farmers in the communities. In each administrative region, the communities were clustered and the sample size was determined purposively, based on the probability proportional to size (PPS). The small-scale farmers in the clusters were sampled randomly using a mathematical approach at a 95% significant level as stated:

$$S = \frac{\chi^2 NP(1-P)}{C^2 (N-1) + \chi^2 P(1-P)}$$

where S = sample size, χ^2 = chi-square value for 1-degree of freedom (at 0.05 = 3.84), N = population size, P = population parameter (with the highest heterogeneity set to 0.5), and C = confidence interval (5%).

Data analyses procedures

The data was managed and analysed using Statistical Package for Social Scientists (SPSS), version 24 and Stata (Basic Editions) data analysis software. The SPSS was used to generate the quantitative variables and clean the data before converting it into STATA for analysis. This was so because, the researcher is more comfortable using SPSS for data entering and cleaning while Stata is more convenient for running the regressions. Principal Component Analysis (PCA) was adopted to construct an index and Ordinary Least Squared (OLS) was used to assess the determinants of resilience among the farmers. Data on rainfall and temperature was accessed through a literature review.

Two categories of variables were used for the analyses, thus the independent variables (the socio-economic variables) and the dependent variables (the climate change resilience approaches. A Chi-square statistic with the assumptions that the dependent variables are binary and the observations are independent of each other was used to test the relationship and correlation between the socio-economic characteristics and resilience approaches adopted by the farmers. This was specified as:

$$X^2=\sum(O-E)^2/E$$

where X^2 = the Chi square test statistic, ∑ = Summation, O = Observed number of households with characteristics, and E = Number of households adopting the approach.

An Ordinary Least Square (OLS) model with the assumptions that, the relationship between the independent and the dependent variables are linear and that there is little or no multi-collinearity in the data, was also used to examine the influence of farmer socio-economic characteristics on the various resilience approaches at the farm level. This model is stated as:

$$A_i = X_i\alpha + \varepsilon_i$$

where A_i indicates farmer i chooses to adapt to climate change (A_i = 1), X denotes the set of explanatory variables or factors that influence the expected benefits of resilience, α is the constant term, and Ɛ is the error term.

FINDINGS AND DISCUSSION

These findings range from evidence of climate change in the study area to socio-economic characteristic of the households that correlate with the various resilient approaches.

Evidence of climate change in the study area

Evidence of climate change in the study area was assessed from two angles; perception from the local farmers and evidence from the Ghana Meteorological Service. Small-scale farmers in the study area perceive there is a huge change in the climatic conditions in the area. About 82% of the households surveyed attested there are changes in the weather pattern prior to 1983.

Indicators used to demonstrate the change in climatic conditions in the area are rainfall, temperature, and wind speed. Majority of the studied participants (82.3%) perceived rainfall volume to have decreased over the period. Using local-level proxy indicators such as the duration of the rainy season, the erratic nature of rainfall, and the much more frequent and longer dry spell of recent times, the participants concluded that there was a decrease in the rainfall volume as compared to the past.

When the perception of rainfall patterns was juxtaposed with the scientific evidence of rainfall data in the area using existing literature, the results showed divergent perspectives. Trend analysis of recorded rainfall volume per annum from the data revealed an average increase in rainfall volume by about 22 per cent between 1983 and 2016 (Jabik et al., 2022).

Comparing local proxy indicators such as coldness after rainfall, the disappearance of hailstorms, daily heat from the sun, and the length of the harmattan season before the 1980s and recently, most farmers (82%) have concluded that the temperature is rising. Comparing the perceived change in temperature to recorded temperature reveals that both maximum and minimum temperatures have increased over the period. The recorded maximum temperature increased by about two degrees between 1983 and 2016 while the minimum temperature increased by about 1.5 degrees over the same period (Jabik et al., 2022).

Analysis of the perception of wind speed of the research participants revealed that the winds are more frequent and stronger than they were before 1983. This was manifested by the frequent storms (dust and rain) and the magnitude of their effects such as the uprooting of economic plants and crops, levelling down of crops, ripping-off buildings, and the extent of wind erosion in the communities. In recent times, storms have become so frequent and their effects so severe that it constantly brings hardship to the small-scale farmer.

Socio-economic household factors and their effects on resilience

Socio-economic characteristics of farmers influence their decision-making on resilience (Deressa et al., 2009; Below et al*.,* 2012). Using the bivariate analysis and Ordinary Least Square (OLS) approach, this section assesses how household characteristics in the study area influenced farmers' decisions on improved resilience among the research participants, using seven resilient approaches adopted by the farmers in the study area. Bivariate analysis was used to establish the relationship between the household characteristics and the various approaches. This was followed by constructing a resilience index and, controlling for multicollinearity, a multiple linear regression model was adopted to establish the relationship as provided in the details subsequently.

Bivariate analysis of socio-economic factors and planting late as a resilient approach

Analysis of the correlation between household socio-economic characteristics and planting late as a resilient approach revealed some socio-economic characteristics correlate with the approach positively in the research communities. The analysis revealed that socio-economic characteristics such as the age of the respondent, the perception of change in weather conditions, ownership of farmland, and access to loans correlate significantly to planting late as a resilient approach. Other factors such as membership of an association, married farmers, household labour used for farming, and male-headed households correlate positively to the resilient approach though not statistically significant.

Farmers of at least 30 years old were statistically significant (p=0.001) to planting late as a resilient approach. This is so because the majority of the respondents were farmers above 30 years, which implies that they are more likely to compare the time crops were planted in the past as compared to recent times. Also, farmers who perceived that there is a change in climatic condition as compared to before the 1980s, correlate significantly to planting late as an approach to improved resilience. This explains that, as farmers perceive that the climatic conditions are changing, they are more likely to change planting dates to suit the changing climatic conditions. Perceived change in weather conditions by farmers also correlates with planting late as a resilient approach with a probability value of p=0.006 and a positive strength of relationship as shown by the Cramer V value of 0.1600 (Table 1). Also, access to loans for farming correlates positively (p=0.101) with planting late as a resilient approach at a 0.10 significant level.

Bivariate analysis of socio-economic factors and planting shorter gestation varieties as a resilient approach

Analyses of the socio-economic characteristics of farmers and how they influence planting shorter gestation varieties as a resilient approach revealed that, the age of respondents, farmers with the perception of a change in climatic conditions, and access to loans correlate positively with planting shorter gestation crop varieties as an approach (Table 2). Age of respondents showed a statistically significant level at p=0.001 for planting shorter gestation varieties. Farmers of at least 30 years old are more likely to explain that they now plant shorter gestation varieties than farmers below the age of 30 years. Using Cramer's V to test the strength of the significance level indicated a very strong association as indicated by 0.5893. Also, as a farmer perceives that the climatic condition has changed over time, the higher the chances of that farmer changing to the shorter gestation varieties. This was proven by the positive correlates of the perceived change in climatic conditions with planting shorter gestation varieties (Table 2). Although other socio-economic factors such as male-headed households and religious affiliation did not prove statistically significant to the resilient approach, they correlate positively with the approach.

Bivariate analysis of socio-economic and farming along riverbanks as a resilient approach

Farming along riverbanks and marshy areas has become one of the effective resilient approaches adopted by small-scale farmers, especially farmers who are closer to rivers and marshy areas. Socio-economic household characteristics such as using family labour for farming, uneducated household heads, male-headed households, ownership of land, and access to loans for farming correlate positively with this resilient approach. Some of the practices along the riverbanks include dry-season irrigation. These variables correlate positively to this approach at a probability value of 0.000. Although ever attended school correlates significantly to riverbanks farming, the relationship is negative (Table 3). This implies that people who have ever attended school are less likely to farm along riverbanks. The analysis also revealed that households that rely on family labour on their farms are more likely to engage in riverbanks farming than others who use hired labour.

Bivariate analysis of socio-economic factors and dry season irrigation as a resilient approach

The relationship between household characteristics and the adoption of dry season irrigation as a resilient approach revealed that, most of the household socio-economic characteristics correlate significantly with that approach. Family labour as a major source of labour for farming plays a significant role in the adoption of this resilient approach. Dry season irrigation is labour-demanding and requires more inputs for farm management. The high demands for labour, therefore, make the use of household labour very relevant as indicated by a probability value of 0.000 and a Cramer's V value of 0.2337 (Table 4). Other household characteristics such as access to loan for farming, membership of associations, crop farming, and age of household heads correlate significantly with the resilient approach.

Bivariate analysis of socio-economic factors and changing crop variety as a resilient approach

Some socio-economic household characteristics correlate significantly with changing of crop variety as a resilient approach in the communities. The use of family labour as a major source of labour for farming, membership of an association, access to loans, ownership of land, male-headed households, and the aged correlate significantly in changing of crop varieties as a resilient approach. This is justified by the statistically significant level of the probability values and the positive relationship of the Cramer V values (Table 5). Changing crop variety is, therefore, a very key on-farm resilient approach in the study area.

Multi linear relationship between socio-economic factors and resilience

Using an Ordinary Least Squared model, the relationship

Table 1. Bivariate analysis of socio-economic factors and planting late as a resilient approach.

Variable	Category	Measure of association			
		Prevalence (%)	Chi^2	P-value	Cramér's V
Age	<30	8.67	105.4608	0.001	0.5929
	30+	91.33			
	Total	100			
Gender	Male	64.33	0.1572	0.692	0.0229
	Female	35.67			
	Total	100			
Education	Yes	23	0.1256	0.723	-0.0205
	No	77			
	Total	100			
Religious Affiliation	Christian	42.7	0.0996	0.951	0.0182
	Others	57.3			
	Total	100			
Ownership of land	Yes	96	1.9746	0.160	0.0811
	No	4			
	Total	100			
Type of farming	Crop	16.7	0.7314	0.392	0.0494
	Mixed	83.3			
	Total	100			
Type of labour	Family labour	63.67	1.5098	0.470	0.0709
	Hired labour	36.33			
	Total	100			
Membership of association	Yes	31.3	0.9681	0.325	0.0568
	No	68.7			
	Total	100			
Access to loan	Yes	27.3	2.6959	0.101	0.0948
	No	72.7			
	Total	100			
Marital status	Never married	4.7	1.6110	0.447	0.0733
	married	84			
	Divorced/widowed	11.3			
	Total	100			
Perception of change in climatic condition	Yes	82.3	7.6788	0.006	0.1600
	No	17.7			
	Total	100			

Source: Author's Construct.

between the various socio-economic household characteristics and resilience was assessed with an index of the various resilient approaches in the study. The standardised coefficient of the socio-economic predictors

Table 2. Bivariate analysis of socio-economic factors and planting shorter gestation varieties as a resilient approach.

Variable	Category	Measure of association			
		Prevalence (%)	Chi^2	P-value	Cramér's V
Age	<30	8.67	104.1911	0.001	0.5893
	30+	91.33			
	Total	100			
Gender	Male	64.33	0.5439	0.461	0.0426
	Female	35.67			
	Total	100			
Education	Yes	18.67	0.6934	0.405	0.0481
	No	81.33			
	Total	100			
Religious Affiliation	Christian	42.7	0.1306	0.937	0.0209
	Others	57.3			
	Total	100			
Ownership of land	Yes	96	3.3898	0.066	0.1063
	No	4			
	Total	100			
Type of farming	Crop	16.7	0.0407	0.840	-0.0116
	Mixed	83.3			
	Total	100			
Type of labour	Family labour	63.67	2.9018	0.234	0.0983
	Hired labour	36.33			
	Total	100			
Marital status	Never married	4.7	3.1477	0.207	0.1024
	married	84			
	Divorced/widowed	11.3			
	Total	100			
Access to loan	Yes	27.3	1.9126	0.167	0.0798
	No	72.7			
	Total	100			
Membership of association	Yes	31.3	0.3036	0.582	0.0318
	No	68.7			
	Total	100			
Perceived change in climatic condition	Yes	82.33	6.2648	0.012	0.1445
	No	17.67			
	Total	100			

Source: Author's Construct.

on resilience using both the index and the various approaches are subsequently shown. The resilient approaches served as the dependent variables and were interacted with the various socio-economic household

Table 3. Bivariate analysis of socio-economic and farming along riverbanks as a resilient approach.

Variable	Category	Measure of association			
		Total (%)	Chi^2	P-value	Cramér's V
Age	<30	8.67			
	30+	91.33	4.3577	0.113	0.1205
	Total	100			
Gender	Male	64.33			
	Female	35.67	5.0990	0.024	-0.1304
	Total	100			
Education	Yes	23			
	No	77	14.5276	0.000	-0.2201
	Total	100			
Religious Affiliation	Christian	42.7			
	Others	57.3	3.0096	0.222	0.1002
	Total	100			
Ownership of land	Yes	96			
	No	4	3.6508	0.056	-0.1103
	Total	100			
Type of farming	Crop	16.7			
	Mixed	83.3	3.4615	0.063	0.1074
	Total	100			
Type of labour	Family labour	63.67			
	Hired labour	36.33	17.1901	0.000	0.2394
	Total	100			
Membership of association	Yes	31.3			
	No	68.7	64.0372	0.000	-0.4620
	Total	100			
Access to loan	Yes	27.3			
	No	72.7	64.6104	0.000	0.4641
	Total	100			
Marital status	Never married	4.7			
	married	84	0.2029	0.904	0.0260
	Divorced/widowed	11.3			
	Total	100			
Perception of change in climatic condition	Yes	82.3			
	No	17.7	0.6017	0.438	0.0448
	Total	100			

Source: Author's Construct.

characteristics.

The regression coefficients of the resilience index revealed that households with higher crop output, membership of Farmer Association such as VSLA,

Table 4. Bivariate Analysis of Socio-Economic Factors and Dry Season Irrigation as a Resilient Approach.

Variable	Category	Measure of association			
		Prevalence (%)	Chi^2	P-value	Cramér's V
Age	<30	8.67	6.7714	0.034	0.1502
	30+	91.33			
	Total	100			
Gender	Male	64.33	2.7579	0.097	-0.0959
	Female	35.67			
	Total	100			
Education	Yes	23	8.3473	0.004	-0.1668
	No	77			
	Total	100			
Religious Affiliation	Christian	42.7	8.5126	0.014	0.1684
	Others	57.3			
	Total	100			
Ownership of land	Yes	96	0.0946	0.758	-0.0178
	No	4			
	Total	100			
Type of farming	Crop	16.7	3.6783	0.055	0.1107
	Mixed	83.3			
	Total	100			
Type of labour	Family labour	63.67	16.3811	0.000	0.2337
	Hired labour	36.33			
	Total	100			
Membership of association	Yes	31.3	55.9213	0.000	0.4317
	No	68.7			
	Total	100			
Access to loan	Yes	27.3	54.7328	0.000	0.4271
	No	72.7			
	Total	100			
Marital status	Never married	4.7	0.5990	0.741	0.0447
	married	84			
	Divorced/widowed	11.3			
	Total	100			
Perception of change in climatic condition	Yes	82.3	0.0586	0.809	0.0140
	No	17.7			
	Total	100			

Source: Author's Construct.

change of crop variety within two years, never attended school and single member (headed) households influence the resilient index positively (Table 6). In other words, households with these characteristics are more likely

Table 5. Bivariate analysis of socio-economic factors and changing crop variety as a resilient approach.

Variable	Category	Measure of association			
		Prevalence (%)	Chi^2	P-value	Cramér's V
Age	<30	8.67			
	30+	91.33	19.3494	0.000	0.2540
	Total	100			
Gender	Male	64.33			
	Female	35.67	21.2880	0.000	0.2664
	Total	100			
Education	Yes	23			
	No	77	6.1244	0.013	0.1429
	Total	100			
Religious Affiliation	Christian	42.7			
	Others	57.3	1.9929	0.369	0.0815
	Total	100			
Ownership of land	Yes	96			
	No	4	14.5888	0.000	0.2205
	Total	100			
Type of farming	Crop	16.7			
	Mixed	83.3	0.7759	0.378	-0.0509
	Total	100			
Type of labour	Family labour	63.67			
	Hired labour	36.33	15.0523	0.001	0.2240
	Total	100			
Membership of association	Yes	31.3			
	No	68.7	24.6481	0.000	0.2866
	Total	100			
Access to loan	Yes	27.3			
	No	72.7	36.2158	0.000	0.3474
	Total	100			
Marital status	Never married	4.7			
	married	84	1.2850	0.526	0.0654
	Divorced/widowed	11.3			
	Total	100			
Perception of change in climatic condition	Yes	82.3			
	No	17.7	2.9414	0.086	0.0990
	Total	100			

Source: Author's Construct.

to adapt to climate change as compared to those households without such characteristics. Change of crop variety within two years, membership of Village Savings and Loans Association (VSLA), and crop value were

Table 6. OLS regression results on resilience.

Variable	Resilient Index	Shorter gestation varieties	Change planting date	Dry season gardening	River banks farming	Refilling	Tree/FMNR	plant in anticipation of rain
Gender (female)								
Male	0.151	-0.011	-0.025	0.093	0.043	0.013	-0.043	0.087
Agecat (less than 30)								
Matured	-0.084	0.033	0.065	-0.055	-0.034	0.01	0.143	0.065
Aged	-0.171	0.022	0.054	-0.118	-0.047	-0.132	0.188*	0.047
Education (no)								
Yes	-0.494***	-0.027	-0.013	-0.145**	-0.202***	0.053	-0.015	0.011
Marital status (single)								
Married	-0.809**	-0.064	-0.051	-0.299**	-0.286**	0.095	0.047	0.039
Divorced/widowed	-0.544	-0.079	-0.043	-0.151	-0.217	0.191	-0.017	0.098
Household size	-0.011	0.001	0.001	-0.004	-0.003	0.002	-0.001	0.002
Religion (Christian)								
Islam	0.232	0.004	-0.001	0.122*	0.059	0.052	-0.096*	-0.064
Traditional	0.050	0.004	0.017	0.022	0.016	0.149*	-0.083	-0.100
Migrant (no)								
Yes	-0.107	-0.021	-0.039	-0.011	-0.067	0.088	0.011	0.018
Crop value/income	0.001***	-4.54e-06	-0.001	0.001***	0.001***	9.89e1	-0.000	-0.000
Village Savings and Loans Ass. (yes)								
No	-0.644***	0.016	0.015	-0.213***	-0.258***	0.061	-0.020	-0.085
Perception (yes)								
No	0.312	-0.059*	-0.093**	0.131*	0.136	0.044	-0.178***	-0.031
Change of crop (yes)								
No	-0.436***	0.040	0.052*	-0.146**	-0.150**	-0.077	-0.064	-0.028
Farming type (crop)								

Table 6. Contd.

Mixed	0.220	0.007	-0.014	0.071	0.066	0.002	0.081	0.020
Cons	-0.119	1.12	1.167	.285	0.573	-0.473	0.381	-0.179
R-squared	0.53	0.068	0.098	0.53	0.49	0.12	0.11	0.10
Number	300	297	291	165	156	32	27	24

Standard errors in parentheses: *p < 0.10, **p < 0.05, ***p < 0.01.
Source: Author's Construct.

statistically significant at p<0.001. This finding is consistent with Deressa et al. (2009), Uaiene et al. (2009), and Bryan et al. (2012) who also established that membership in an association, changing crop variety, and household income influence resilience positively. The explanatory power of the model represented by an R-square value of 0.53, (Table 6) explains the variance of resilience to be 53%, which implies that about 53% of the socio-economic characteristics that influence on-farm resilience are captured in the model. The relatively high value of unexplained variance could imply that several other socio-economic factors influencing residence at the household level are missing in the model. This cannot be avoided with studies of multifactorial social systems, such as farmers' resilience to climate change since all factors influencing farmers' behaviour cannot be captured at once (Below et al., 2012).

Further analysis of the various resilient approaches adopted in the studied communities using the OLS model revealed mixed results. A limited number of the socio-economic characteristics of the households influence planting shorter gestation crops as a resilient approach by the small-scale farmers positively. Perception of change in climatic conditions by the studied farmers is the only variable that was found to correlate significantly with planting shorter gestation varieties. This implies that farmers who perceived a change in climatic conditions are more likely to adapt to the changing condition by planting shorter gestation varieties.

Farmers also adapted to the changing climatic conditions by changing the planting dates of the crops they grow. Changing crop variety within two years and perception of change in climatic conditions were the two socio-economic factors that influence changing the planting date significantly as a resilient approach by the small-scale farmers. This is because as farmers perceive a change in the climatic condition, they change to crop varieties that can survive the change.

A relatively higher number of factors such as changing crop varieties, membership of an association (VSLA), output level, married household heads, and perception about changes in climatic conditions significantly influence dry season gardening as a resilient approach. Membership of associations such as VSLA group members can mobilize financial resources for the acquisition of irrigation equipment and buying of fertilizer and other farm inputs. These factors were not different with regard to river bank farming. However, educated household heads influenced dry season gardening as a resilient approach negatively. This exists because many of the educated participants are engaged in other economic ventures which occupy them throughout the working hours and do not permit them to engage in dry season farming. This finding supports other findings on the relationship between climate change resilience and the educational level of the household head as established by Madison (2006), Uaiene et al. (2009), and Deressa et al. (2009).

Religion showed a mixed influence on the various resilient approaches. While traditional religious beliefs influenced refilling as a resilient approach positively, households with household heads aged at least 60 years and perceived changes in the weather pattern influenced tree planting as a resilient approach. Islam as a religion influenced tree planting as a resilient approach negatively. The varied correlates of the various resilient approaches are not much different from other studies like Bryan et al. (2012) and Tambo (2016).

CONCLUSION AND IMPLICATION FOR DEVELOPMENT

The paper investigated the determinants of on-farm resilient approaches by small-scale farmers in Northern Ghana to the changing climatic conditions. Socio-economic characteristics both at the community level and the individual household levels influence farmers' decisions on on-farm climate change resilient approaches. To respond to changing climatic conditions, small-scale farmers in the studied communities have resorted to engaging in diverse on-farm resilient approaches in the communities. Analyzing the socio-economic characteristics and how such characteristics influence resilience of small-scale farmers revealed that, small-scale farmers in northern Ghana's ability to adapt depend on several factors. Household-level characteristics such as membership of an association, changing crop variety every two years, sex of household head, crop value, and having access to loans for farming proved statistically significant to a number of the resilient approaches.

Socio-economic characteristics such as crop value, membership of a VSLA group and perception of weather amongst others influence resilience positively. This implies that households with these characteristics are more likely to be resilient to climate change than households without such characteristics. Socio-economic characteristics that influence resilience positively should be enhanced through policy initiatives that create the enabling environment for climate change resilience. Some of these policy initiatives could include promoting and improving access to village savings and loans associations, adequate supply of improved inputs, and creation of on-farm employment opportunities that are labour intensive.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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