

Private Source of Financing Climate Change Adaptation: A Focus on Small-holder Farmers' Use of Remittances

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By

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Abstract

Emerging discourses on climate change adaptation finance contend that remittances could compliment other sources of adaptation **finance** given its propensity to reach the most vulnerable compared to public expenditure. However, less empirical studies have been done to **verify** this claim. Employing an Order Rank Logit (ORL) structural decomposition model, this study found that remittances significantly influence off-farm jobs and the adoption of micro-irrigation practices, improved crop varieties, compost/animal manure as well as crop rotation. Remittances inversely predicted Indexed-based Insurance (IBI). The study results show that remittances are vital complimentary financial resources for adaptation financing. Thus, if remittances are appropriately yoked into climate intervention policies, it can be strengthened and help farmers fashion out adaptation strategies that present high medium to long-term dividends. The study, therefore, recommends that government take requisite towards making rural people bankable that could facilitate remitting and receiving funds with limited transaction cost. Major mobile network providers should also expand and strengthen network systems for more smooth transactions. At the international level, future Conference of Parties (COPs) should reflect on the potential impact of remittances and other forms of foreign direct investment on climate change adaptation. It also calls on national government to ensure that barriers constraining remittances are removed.

Key Words: Climate Change, Adaptation, Remittances, Financing, Small-holder farmers

1.0 Background to the Study

The intonation that slithers conflicts, dictatorship and poverty as Africa's major developmental antagonist is gradually waning. Perhaps, progress in consolidating the rule of law and good governance, albeit some hitches, account for the changing perspective on Africa. However, at the centre stage of Africa's struggle, today is the destructive effects of the "Anthropocene" (climate variability) (Inter-Governmental Panel on Climate Change, IPCC, 2014). In the foreseeable future, results from the IPCC (2007) show that African economies would be disproportionately affected by climate impacts due to limited adaptive capacity. The cost of climate change to African economies is uncertain, yet series of projections estimates millions of US dollars (IDFC, 2014; Blomberg, 2013; IEA, 2013; AfDB, 2011). Given projected huge financial cost, development experts conclude that Africa is currently and would in the coming years face massive "adaptation finance gap". Adaptation financing gap is the difference between the cost of and the finance required for meeting a given adaptation target and the finance available to do so (UNEP, 2015). Amidst poor commitment from Annex 1 countries, massive resource rent in Africa coupled with poor Gross Domestic Product (GDP) in most African countries, adaptation financing gap is expected to grow exponentially (Watkiss, Downing & Dyszynski, 2010; Stern, 2008). Traditional public financing sources projected by the Kyoto Protocol, United Nations Framework Convention on Climate Change (UNFCCC), Copenhagen 2009 Accord and subsequent Conference of Parties have performed abysmally to support Africa's adaptation needs. Indeed, developed countries seeming poorer commitment to fulfil their pledges makes many scholars and practitioners doubt the new \$100billion pledge made in Paris in 2015 (Musah-Surugu et al., 2017; Bendandi and Pauw, 2016). Describing the failure of international public finance for climate change and pledges Buchner and Wilkinson (2014) had this say:

"Since its emergence, the \$100 billion goal has been both a touchstone of good faith and a hallmark of mistrust "

Identifying new and additional private sources of finance to complement ailing public sources has been a key topic in recent international climate negotiations (Bodansky, 2010; Fridahl & Linnér, 2016). Also, some scholars contend that private sector finance would be more sustainable, predictable, and stable to compliment the weaker public finance (Pauw, 2015). Emerging studies that focus on private sources of financing have indicated that remittances show prominence (Musah-Surugu, 2018; Pauw, 2015). They contend that remittances reach the core of the poor and hence could be a significant source to close the financing gap, specifically at the household level. Given the volumes of remittance flow into developing countries and its potential to reach the poorest of the poor, many recent climate change financing studies have underscore its significance to climate change financing. For example, since 2007 remittances flow to developing countries have outstripped Official Development Assistance (ODA), net export, portfolio equity, tourism receipt and Foreign Direct Investment (FDI) (World Bank, 2015). Similarly, remittances have been tipped as a significant complimentary sources of financing adaptation because it is counter-cyclical, it bypass aid bureaucracies to reach the poor, less volatile, and predictable (Pauw, 2015; OECD, 2016). Nevertheless, a vast body of literature in the emerging field of climate change adaptation has largely ignored remittances role in financing adaptation at the micro level. Indeed, most recent studies have only mentioned remittances in passing as complimentary sources without empirically examining its potential to support rural recipient to adapt to climate change (Musah-Surugu et al, 2018).

As argued by Musah-Surugu *et al* (2018), existing studies have largely focused on central government, donor, FDIs, debt and equity neglecting remittances. This study therefore attempts to make a contribution to literature by examining how remittances are used to finance adaptation to climate change among small holder farmers in Ghana. Previous research in economic and development shows that remittances have been climate shock absorber to many vulnerable households in poorer countries (Couharde & Generoso, 2015; Findley, 1994). Remittances contribute to financing adaptation-related investments ranging from short-term priorities, such as irrigation equipment, to longer-term goals related to health and education (Couharde & Generoso, 2015). Remittances are a form of self-insurance in developing countries. The insurance function is reflected in the tendency of migrants to send more remittances to their countries of origin following downturns in an economy, crises, natural disasters, and/or political/civil conflicts (Ratha, 2007). The specific study objectives are stated below:

1. To examine the **flow pattern of remittances** to smallholder farmers in the Northern Savannah Ecological Zone of Ghana
2. To identify the practices, smallholder farmers use remittances for that can potentially become adaptation practices
3. To identify policy changes that can encourage the use of remittances as a funding source for adaptation finance.

Hypothesis

H₁: access to remittances has a significant influence on the adoption of climate change adaptation practices by smallholder farmers

H₀: access to remittances does not have a significant influence on the adoption of climate change adaptation practices by smallholder farmers

H₂: the amount of remittances received determines the share of income spent on adaptation

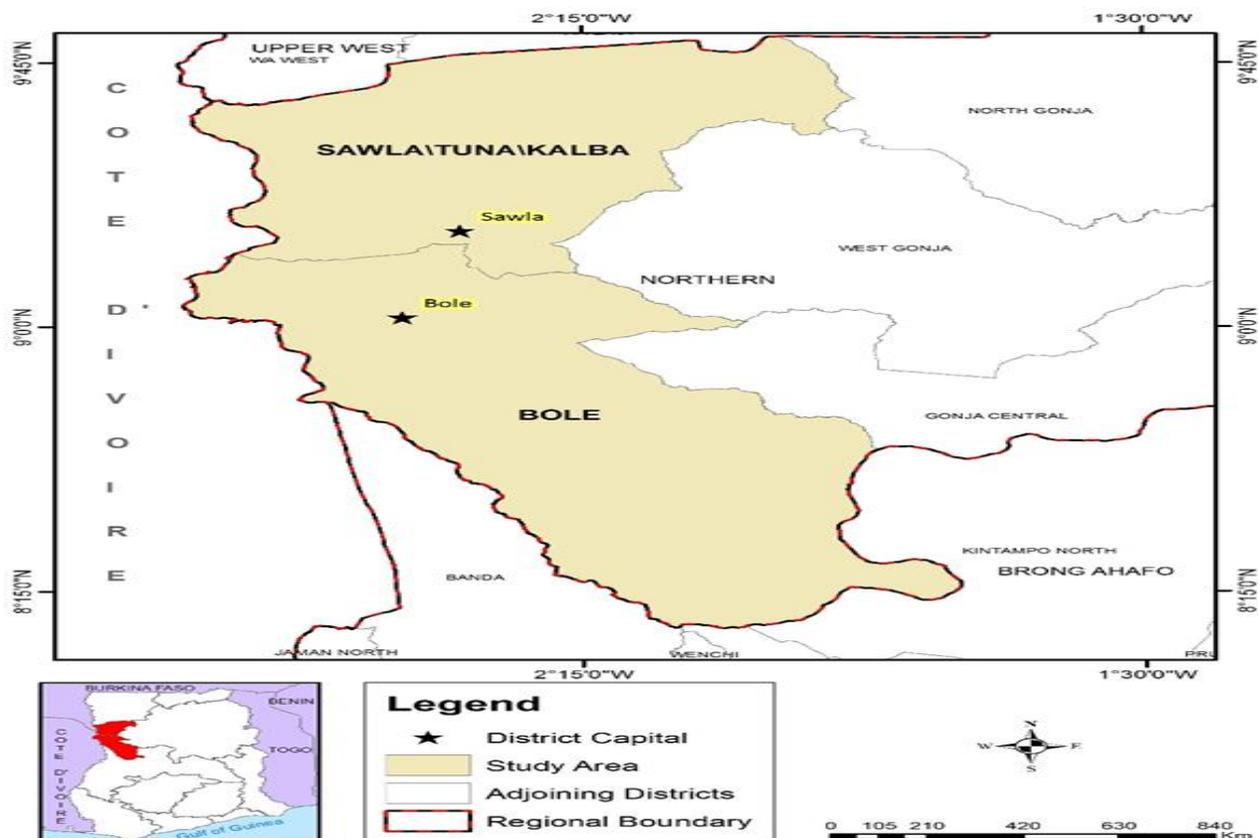
H₀: the amount of remittances received does not determine the share of income spent on adaptation

1.1 Study Significance/Contribution

The Northern Savannah Ecological Zone (NSEZ) of Ghana is facing socio-economic challenges posed by climate change and variability. Future climatic scenarios of NSEZ show that total annual rainfall will decrease by 9–27% by the year 2100, with the range representing spatial variations (Yaro *et al*, 2015). This variability coupled with policy neglect and low public investments in the area would adversely affect local citizens' ability to adapt. Given such policy neglect and low public investment in the area, private adaptation appears to be the most viable adaptation option for the local citizens. The findings of study would, therefore, provide an informed basis for designing strategies that support existing private adaptation measures of local farmers through appropriate public policy, investment and collective actions so as to reduce the adverse impact of predicted changes in future climate. The outcome of this study would, therefore, be useful to public policy makers, NGOs, private sector and philanthropist with interest in climate governance.

2.0 Methodology

The study employed both quantitative and qualitative approaches to data procurement and analysis. Data was sourced from smallholder farmers in the Northern Region of Ghana. Specific communities involved were *Gbogdaa, Nahari, Bali, Mankuma, Bole, Nyanoa, Belma, Jilinkon, Sawla* and *Kalba*. These communities were selected due to their perceived climate change vulnerability and effects (MoFA, 2014). Maize, millet and yam farmers were used as a proxy for smallholder farmers due to the extensive production of these food crops within the areas. For the purpose of this study, the FAO (2010) definition of smallholder farmers is adopted, thus, smallholder farmers are farmers who farm plots of 2 hectares or less and rely exclusively on family labour. The data collection was done by the researcher and assisted by two (2) carefully chosen and well trained field assistants. A convenience sampling technique was used to select 400 farmers, thus, 40 farmers from each community. The convenience sampling approach was appropriate because no lists of farmers (sample frame) in the areas existed hence did not offer opportunity for probability sampling.



Source: University of Ghana Geographic Information Systems Lab (UGGIS), 2017

However, disproportionate allocation was made to the districts to ensure representativeness. A semi-structured questionnaire was used in soliciting quantitative information. Section A of the questionnaire collected information on farmers' perception and knowledge of climate change, Section B was on adaptation strategies, Section C looked at the flow of remittances, Section D was on remittances and climate change adaptation and Section E collected socio-demographic characteristics information. Twenty (20) Focus Group Discussions (FGDs) were conducted, thus, two (2) in each community. These included both male and female farmers and the average number

of participants in a group was nine (9). In-depth interviews were also conducted with six (6) officials of the District Assemblies studied and Ministry of Food and Agricultural with oversight responsibility of climate change. The six officials were purposefully selected based on their role and experiences with climate change adaptation governance within the studied area. The qualitative interview data was analyzed after transcription through thematic analysis strategy. Direct interview quotations have been used throughout the data analysis phase to clearly illustrate inferences and claims that were drawn from either the quantitative data or the theoretical literature. Triangulation of data in this article was meant to improve methodological rigor.

Quantitatively, the Adaptation Strategy Index (ASI) was used to rank the adaptation practices in order of importance on the farm. Questions in that section of the questionnaire provided response options placed on a continuum (Likert scale) has high, medium, low and not at all. Scores assigned to responses were 3, 2, 1 and 0 respectively. Farmers were asked to assess the different strategies by using the four-point rating scale and subsequently ranking was done using the weighted means. This approach as previously used by (Uddin *et al.*, 2014; Devkota *et al.*, 2014; Ndamani & Watanabe, 2016) has been established as efficient in ranking elements. The Order Rank Logit (ORL) as well as multinomial logit structural decomposition models used to examine the effect of remittances on climate change adaptation strategies and the effect of remittances on farmers share of income spent on adaptation respectively. The ORL was employed to examine the influence of remittance on adaptation strategies. Remittance (explanatory variable) data was continuous as respondents were allowed to indicate their average amount of remittance per year. Adaptation strategies (outcome variable) by the ASI provided ranking options (Likert scale), providing ample possibility for ORL analysis (Hill *et al.*, 2014; Stock & Watson, 2012; Dougherty 2011). In this study, adaptation strategies are conceptualized as the responsive mechanism (directly and indirectly) adopted by farmers to offset the effects of climate change and reduce vulnerability (Huang *et al.* 2018; Descheemaeker *et al.* 2017; IPCC, 2015; Doherty & Clayton, 2011). In the testing for **the influence of remittance on the share of income spent on adaptation**, the multinomial logit regression was appropriate. In this case, the independent variable remained the same (remittance as a continuous variable) and the share of income spent on adaptation categorized (100-300, 301-600 and 601-900). According to (Hilbe, 2011; Allison, 2014), the multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables hence making it an appropriate tool for the analysis.

The models enabled the independent testing of the direct paths of the variables involved. The resulted R^2 s for both models indicate that the exogenous variables are significant and fitted predictors of variance in adaptation and share of income. These were further confirmed by all post-estimations tests (such as margins) carried. All estimations were carried out using STATA 15. The major limitations of the study include the study not being able to disaggregate farmers who receive national (internal) and international (external) remittances for the purpose of analysis. This was because the number of recipients of international remittances was insignificant for statistical analysis hence merged with national. The study proposes that future studies with enough financial capacity expand the geographical dispensation in order to attract more international remittances recipients for a disaggregate analysis. Also, the study did not include non-recipients of remittances hence suggest a future comparative analysis between farmers receiving remittances and those not receiving.

3.0 Results of the Study

This section presents the results of the study. The results were arranged in the following order; information about sample of farmers/socio-demographic characteristics, climate change and adaptation to climate change, flow of remittances and use of remittances for adaptation. Subsequently, this was followed by discussion of results.

3.1 Information about the sample of farmers

From table 1, it can be seen that the mean age of respondents was 46 years and more than half (59.0%) were males. 50.0% had no formal education and 89.5% married. Average household size was 7 people, average farm acre 4 and average number of years in farming was 35 years as shown in table 1. 85.0% owned a bicycle and (82.0%) mobile phone. Many (78.8%) and (65.0%) also owned a radio and motor bicycle respectively. Water pump (28.0%), television (33.0%) and Motor king/tricycle (35.0%) were not owned by many. Also, none (0.0%) had a car/tractor (table 2). 82.0% hold the view that the climate has changed over the past 15 years (figure 1). According to the distribution of perception on climate change, all respondents (100.0%) think rainfall has decreased and 98.0% perceived temperature increased. There was also a perceived increased in the occurrence of storm surges (74.0) and a 100.0% increase in the occurrence of prolonged drought (table 3). Exactly half (50.0%) of respondents think the change in climatic conditions in the area is caused by human activities, 20.0% said is a punishment from ancestors, (15.0%) from supernatural God and (15.0%) also think it is a natural cycle (figure 2). Figure 3 shows that the major effect of climate change as stated by respondents is low productivity (97.0%), inadequate feed and water for livestock (84.0%) and stunted growth of crops (76.3%) were also severe effects.

Table 1: Socio-demographic characteristics of respondents (n=400)

Socio-demographic characteristics	Frequency (n)	Marginal (%)	Average	S.D
Sex				
Male	236	59.0		
Female	164	41.0		
Age			46.0	7.9
21-30	3	0.8		
31-40	132	33.0		
41-50	137	34.3		
51-60	70	17.5		
>60	58	14.5		
Religion				
Christianity	181	45.3		
Islam	157	39.3		
Traditional	62	15.5		
Marital status				
Married	358	89.5		
Unmarried	42	10.5		
Educational status				
No formal education	203	50.8		
Basic/primary	169	42.3		
Tertiary	28	7.0		
Household size	-	-	7.0	2.7

Farm size	-	-	4.0	0.7
Farm experience	-	-	35.0	7.7

Table 2: Ownership of properties

Farm properties	Yes (%)	No (%)
Mobile phone	82.0	18.0
Bicycle	85.0	15.0
Car/tractor	0.0	100.0
Motor king/tricycle	35.0	75.0
Motor bicycle	65.0	35.0
Radio	78.0	22.0
Water pump	28.0	72.0
Television	33.0	67.0

Farmers' perception and knowledge on climate change

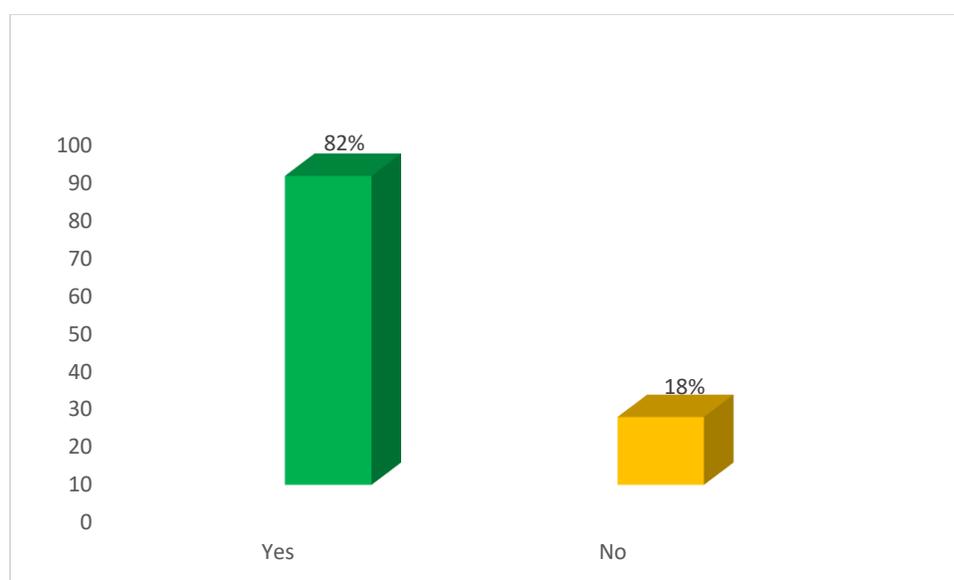


Figure 1: Climate has change over past 15 years

Table 3: Distribution of responses to perceived changes in specific climatic events (n=400)

% of respondents indicating the level of change in climatic events over the past 15 years				
Climatic events	Increased	No change	Decreased	Don't know
Precipitation			100	
Temperature	98.0			2.0
Occurrence of storm surges	74.0	20.0		6.0
Occurrence of drought	100			
Occurrence of floods	40.0	55.0		5.0

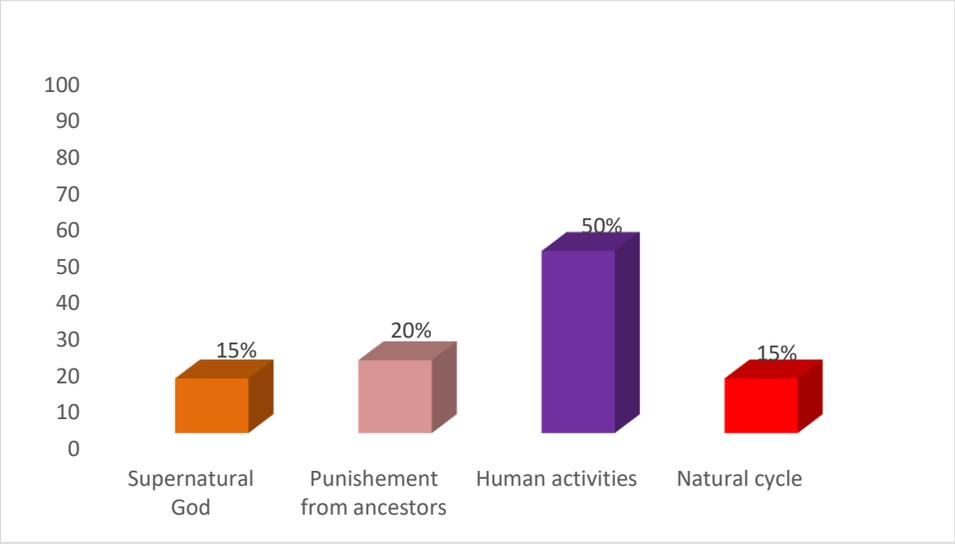


Figure 2: Perceived causes of climate change

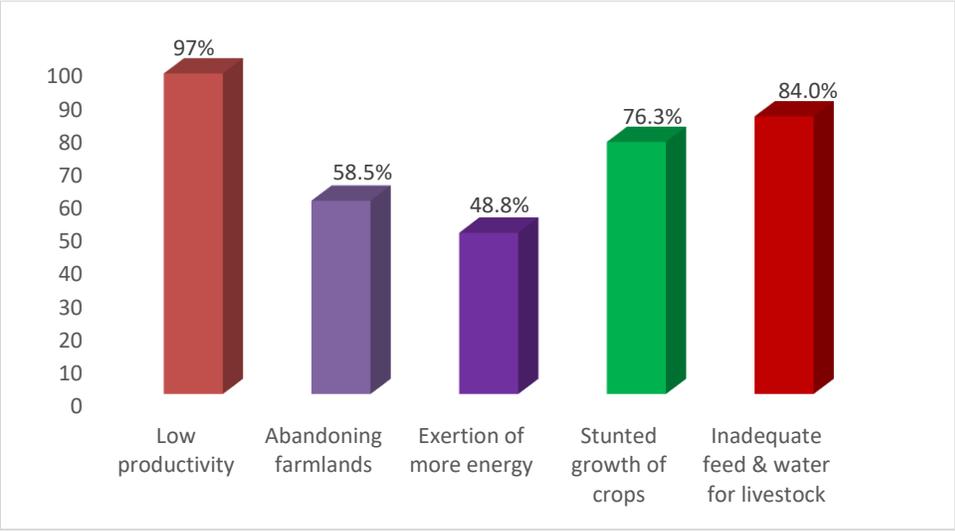


Figure 3: Perceive effects of climate change

3.2 Climate change and adaptation to climate change

Due to the rising effects of climate change, many (85.5%) of the target farmers were implementing various types of adaptation strategies to respond to the effects as seen figure 4. To inform policy towards remittances based adaptation, the study sought to identify the adaptation strategies which held relative importance over the other. Response options for that question were placed on a continuum (Likert scale) has high, medium, low and not at all. Scores assigned to responses were 3, 2, 1 and 0 respectively. Farmers were asked to assess the different strategies by using the four-point rating scale and subsequently ranking was done using the weighted means. This approach as previously used by (Uddin *et al.*, 2014; Devkota *et al.*, 2014; Ndamani & Watanabe, 2016) has been established as efficient in ranking elements. It was observed that backyard gardening was the foremost important adaptation strategy to farmers (ASI, 318.5), cultivation of drought tolerant crops (ASI, 300.0) was ranked second and mixed cropping the third important practice (ASI, 282.5). Off-farm jobs, residue management and altering of planting dates were ranked fourth, fifth and sixth respectively. Indexed-Based Insurance (ASI, 174.9), use of compost/animal manure (ASI, 198.3) and land fallowing (ASI, 192.4) were all given lower rank of importance (table 4).

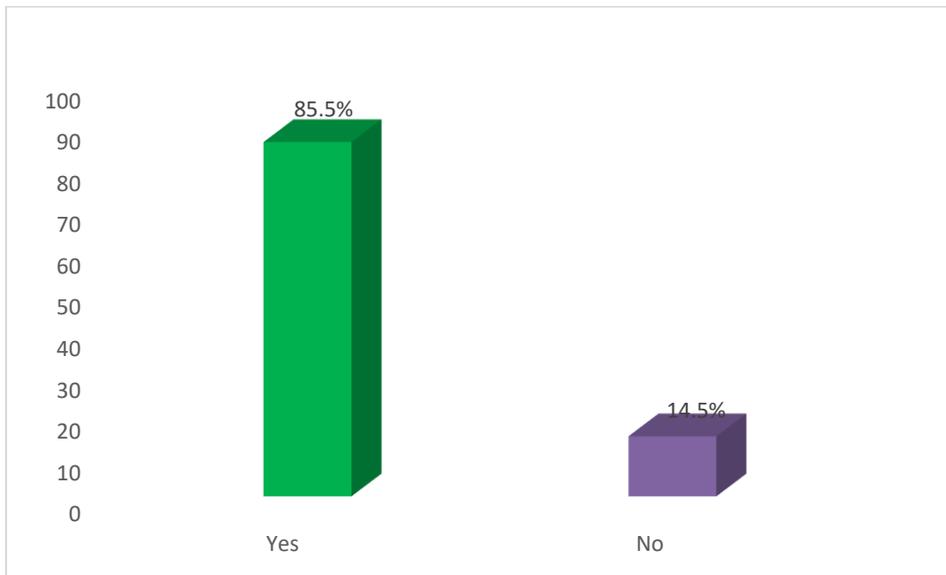


Figure 4: Implemented adaptation practices

$$ASI = AS_n \times 0 + AS_l \times 1 + AS_m \times 2 + AS_h \times 3$$

Where;

- ASI = Adaptation Strategy Index
- AS_n = Frequency of farmers rating adaptation strategy as having no importance
- AS_l = Frequency of farmers rating adaptation strategy as having low importance
- AS_m = Frequency of farmers rating adaptation strategy as having moderate importance
- AS_h = Frequency of farmers rating adaptation strategy as having high importance

Table 4: Ranked order of adaptation strategies to climate change

Adaptation practices	Order of importance on the farm				ASI	Rank
	High	Medium	Low	No		
Backyard gardening	90.3	9.8	-	-	318.5	1
Cultivation of drought tolerant crops	100	-	-	-	300.0	2
Mixed cropping	82.5	17.5	-	-	282.5	3
Off-farm jobs	80.0	20.0	-	-	280.0	4
Residue management	55.5	44.5	-	-	255.5	5
Altering of planting dates	49.3	9.8	41.0	-	252.4	6
Crop rotation	40.0	27.5	32.5	-	207.5	7
Afforestation	25.8	41.3	33.0	-	200.5	8
Irrigation farming	57.8	19.0	23.3	-	199.4	9
Use of compost/animal manure	22.5	54.3	23.3	-	198.3	10
Land fallowing	44.5	17.8	23.3	14.5	192.4	11
Index-Based Insurance (IBI)	25.5	23.8	50.8	-	174.9	12

3.3 Flow of remittances and use of remittances for adaptation

On the average, a respondent receives 369.00\$ of remittance annually. Half (50.0%) receive between 100-500\$ a year, 31.8% between 501-1000\$ and only (18.2%) receive beyond 1000\$. The main medium of receiving remittance was through the remitter sending a friend/relative (72.8%) as shown in table 5. Apart from remittance, all respondents indicated to also be receiving farm crop-based income and some livestock based income. Only (27.0%) receive wage based income. Figure 5 indicates that remittance enabled respondents to engage in some practices that can potentially become adaptation strategies as stated by many (72.0%). Buy chemicals/fertilizer (21.6%), acquire extra food to supplement family needs (17.8%) and buy drought tolerant maize seeds (14.0%) were indicated activities received remittances are used for. Other practices outlined were invest in children education (13.4%), buy an irrigation equipment (10.3%) and put up a storage facility (7.2%) as shown in table 6. However, the major challenges associated receiving remittances were mobile network problems (29.2%), travelling longer distance to redraw remittance (22.5%) and remitters too busy to send money (20.0%). Other challenges were limited financial institutions in the area, poor communication from intermediary and high transaction cost.

Table 5: Amount of remittances received by a respondent per year (GHC)

Amount of remittances (\$)	Frequency (n)	Percentage (%)	Average
100-500	200	50.0	
501-1000	127	31.8	369.0
>1000	73	18.2	
Number times remittance is received in a year			2.0
Medium of receiving remittance			
Sent through a friend/relative	291	72.8	
Mobile money transfer	109	27.2	
Other sources of income	Yes (%)	No (%)	
Farm crop-based income	100.0	-	
Livestock based income	65.0	35.0	

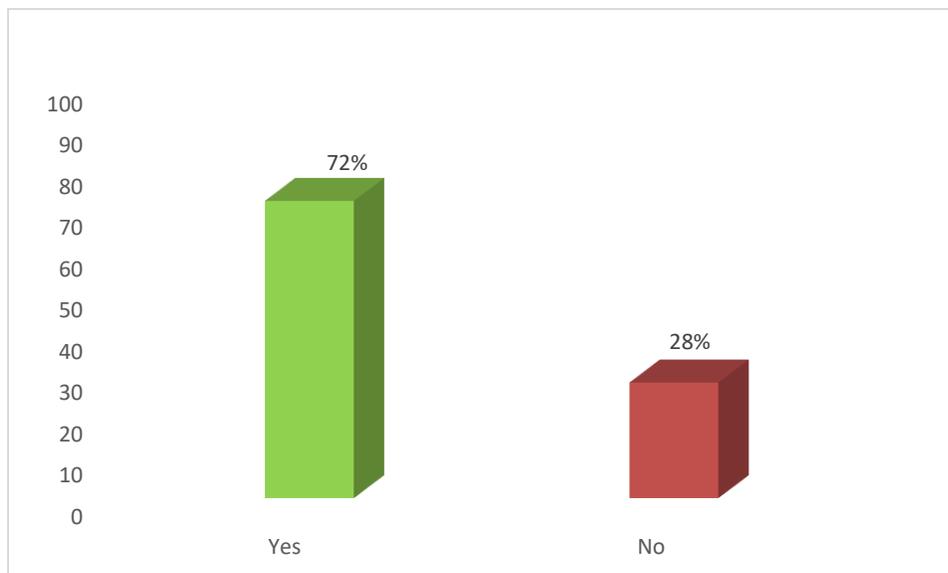


Figure 5: Used remittance for adaptation

Table 6: The practices smallholder farmers use remittances for that can potentially become adaptation practices

Practices	Responses (n)	Percentage (%)
Buy chemicals/fertilizer	382	21.6
Acquire extra food to supplement family needs	320	17.8
Buy drought tolerant maize seeds	247	14.0
Invest in children education	236	13.4
Buy an irrigation equipment	180	10.3
Put up a storage facility	127	7.2
Sponsor relative travel outside the community	98	5.5
Hire labour	94	5.4
Expansion of farmland	85	4.8
Total	1,769	100.0
Challenges of receiving remittances	Responses (n)	Percentage (%)
Mobile networks problem	259	29.2
Travelling longer distance to redraw remittance	200	22.5
Remitters being busy to send to money	179	20.2
Limited financial institutions in the area	178	20.1
Poor communication from intermediary	54	6.1
High transaction cost (for both senders & receivers)	17	1.9
Total	887	100.0

*multiple response

3.4 Influence of remittance on adaptation

From table 4, respondents were asked to indicate the order of importance of adaptation strategies implemented on their farms. This gave a general overview of the adaptation strategies respondents deemed important without remittance. However, the study sought to examine the influence of remittance on adaptation strategies. A Rank Order Logit (ORL) regression employed to examine the influence remittance on adaptation. The ORL model was built on the adaptation practices ranked by the ASI. The ASI offered an opportunity for respondents to rank their most preferred adaptation practices in order of importance. The remittance variable (independent) was measured on a continuous scale whereas the dependent variable (adaptation practices) had ranked outcomes hence allowing for an ORL analyses. It is well known that, in theory, more information can be obtained if respondents are asked to rank the set of alternatives (Dougherty 2011; Stock & Watson, 2012). In statistical terms, the preferences can then be estimated more efficiently. In a situation where respondents are asked to select the most preferred option out of a set of presented alternatives, appropriate estimation choice would have been a standard discrete model, like the multinomial logit model. However, it is empirically established that more information can be obtained from respondent, if asked to give a complete ranking of all presented alternatives. Also, Hill *et al.* (2014) argue that when a dependent variable has more than two categories and the values have meaningful sequential order where a value is indeed 'higher' than the previous one, then an ORL model is the most appropriate. The ORL model was hence the standard tool to analyze the adaptation preferences in order of importance given remittance.

The model predicted 64% of variation of the explanatory variable (remittance) on the outcome variable (adaptation practices). This implies that holding all other things constant, the probability of farmers engaging in climate change adaptation giving remittance is 64.0%. More specifically, remittance had a significant positive relationship with off-farm jobs ($\beta=0.19$), implying that respondents are 19% likely to engage in off-jobs with increased in remittance. Remittance also had a positive relationship with irrigation farming ($\beta=0.18$), cultivation of improved crop varieties ($\beta=0.17$) and use of compost/animal manure ($\beta=0.14$). An inverse relationship was established for Indexed-Based Insurance ($\beta=-0.12$) and no association observed for altering of planting dates and mixed cropping (table 7).

Table 7: Influence of remittance on adaptation practices

Adaptation practices (outcome)	Predictor variable (remittance)		
	Coefficient (β)	P value	S.E
Off-farm jobs	0.19	0.00**	0.02
Irrigation farming	0.18	0.00**	0.03
Cultivation of improved crop varieties	0.17	0.00**	0.05
Use of compost/animal manure	0.14	0.00**	0.02
Crop rotation	0.10	0.02*	0.03
Index-Based Insurance (IBI)	-0.12	0.00*	0.07
Backyard gardening	0.90	0.05*	0.04
Afforestation	0.13	0.04*	0.05
Residue management	0.09	0.04*	0.03
Altering of planting dates	0.16	0.90	0.09
Mixed cropping	-0.16	0.90	0.08

Base category
 Chi square, degree of freedom, p-value
 Log-Likelihood

Land fallowing
 chi square=374.89, df=2, p=0.00, R²=0.64
 5867.30

**p<0.01, *p<0.05

From table 8, using multinomial logit regression, the Nagelkerke R², Cox, Snell and McFadden R-square values show that the multinomial logit model was fitted and remittance significantly predicted respondents share of income spent on adaptation. Multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables (Hilbe, 2011; Allison, 2014). The independent variables can be either dichotomous (i.e., binary) or continuous (i.e., interval or ratio in scale). Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent or outcome variable. Like binary logistic regression, multinomial logistic regression uses maximum likelihood estimation to evaluate the probability of categorical membership (Al-Mudhafer, 2014). In testing for the influence of remittance on the share of income spent on adaptation, the multinomial logit was appropriate as the independent variable (remittance) was continuous whereas share of income spent on adaptation was categorized (100-300, 301-600 and 601-900). The basic assumption was that receiving remittances will be a determinant on the amount of money farmers are willing and ready to spend on adaptation. The model hence showed that respondents are 28.5% likely to spend 100-300\$ of their share of income on adaptation giving increased in remittance ($\beta=2.85$). Similarly, the model predicted 26% and 19% likelihood of spending between 301-600\$ and 601-900\$ respectively of share of income on adaptation giving increase in remittance.

Table 8: Amount of remittance received influence the share of income spent on adaptation

Explanatory variable	Share of income spent on adaptation (\$)								
	100-300			301-600			601-900		
	Exp (β)	Wald	P	Exp (β)	Wald	P	Exp (β)	Wald	P
Remittance	2.85	20.84	0.04*	2.65	18.50	0.03*	1.92	14.4	0.05*
Base category	>901								

*Significant at 5% level; Nagelkerke's R-squared= 0.321; Cox and Snell's R-squared= 0.311 and McFadden's R-squared=0.224

4.0 Discussion

Climate change risks have become profound and evidential rather than perceptual (Hu *et al.* 2017; Luís *et al.* 2018; IPCC, 2015). Recent scholars have established that climate change is associated with negative impacts on the natural environment, human society, physical and psychological health of individuals (Huang *et al.* 2018; Descheemaeker *et al.* 2017; IPCC, 2015; Doherty & Clayton, 2011). A majority of respondents in this study ascribed a changed in climate; manifested in decreased precipitation, increased temperature and prolonged drought. This climate cognition is not strange because as characterized by Sudan Savanna and Guinea Savanna zones, it is obvious farmers have become knowledgeable about the vagaries of weather conditions in the area (Antwi-Etwire *et al.* 2013; Agyei *et al.* 2012). The finding does not depart substantially from Ndamani and Watanabe (2016) who found 87% perceived decrease in rainfall amount and 82% perceived increased in temperature in parts of the study area. Climate change is undoubtedly affecting agriculture and the entire agriculture value chain, smallholder farmers from developing countries are seriously at the core of this extreme change due to weak adaptive capacity (Liu *et al.* 2016; Mulatu Debalke, 2011). The concomitant effect is low productivity and impoverishment of more households. Empirical studies (Descheemaeker *et al.* 2017; IPCC, 2015; Laube *et al.* 2012) further show that high temperatures and less rainfall have resulted in reduced yield in Ghana and other African countries. The findings of this study point to a similar direction as it was established that the major effect of climate change was low productivity. Smallholder farmers were further devastated by inadequate feed and water for livestock and in critical situations abandoning their farms. It has become crystal that climate-induced water stress has caught up with many farmers due to the drying up of rivers, streams and underground aquifers (Kundzewicz *et al.* 2018; Smerdon, 2017). Consequently, livestock which is a valuable household livelihood asset and supplements the needs of many is at a crossing as farmers can no longer engage in this lucrative venture with ardent interest (Descheemaeker *et al.* 2017).

The introduction and integration of sound adaptive strategies has been identified as a more-necessary pathway to mitigating climate change effects (Ndamani & Watanabe, 2016; Agyei *et al.* 2012). Even though, Mulatu Debalke (2011) is of the view that a minority of smallholder farmers are vehement implementers of adaptation strategies, the dividend of these strategies cannot be underestimated. Using ASI to assess the order of importance of adaptation practices implemented by farmers knowingly or unknowingly (autonomous and planned), backyard gardening, cultivation of drought tolerant crops and mixed cropping were ranked the top three most important. Traditionally and historically, backyard gardening has been an aged practice associated with the people of the area (Yiridoe & Anchirinah, 2005). Having larger and flourishing farmlands elsewhere did not disassociate farmers from backyard gardening (Danso *et al.* 2004). Accordingly, this was used to usher farmers into the harvesting season as they start consuming the produce from their backyard gardens before venturing into their main farmlands (Yiridoe & Anchirinah, 2005). In recent times, this has been used more as a risk management strategy as farmers who proclaimed they are confronted with climate change see the need for backyard gardening to support their main farmlands as confirmed in the FGDs. It also came out that minority groups including women and migrants build their livelihood mostly from backyard gardening due to limited access to land. Mixed cropping was also perceived as a risk management strategy as farmers felt that having multiple crops on a piece of land can save them from disappointment. A respondent explains why he adopts a mixed cropping system:

“...when one crop fail us the other will not” hence not putting our “eggs in one basket..”(Farmer 1).

Simply, farmers adopted mixed cropping to reduce overall risk and expanding opportunities for farm profit, acting to boost farmers’ average incomes (Ndamani & Watanabe, 2016; Uddin *et al.* 2014; Mulatu Debalke, 2011). Another respondent thus indicate:

“...this time, when you limit yourself only to the main farmland you will be very disappointed. Many of us now engage in the backyard gardening so that we can we get more yield to feed our families. We get barely nothing from our main farms due to the harsh weather conditions, it is therefore better not to waste your time and walk long distance and bring home nothing. We also mixed the crops together so that if one does not do well the rest can be able to give us some produce...” (Farmer 2).

Justifiably, the pervasive declined in rainfall, prolonged drought effects and increased temperature could be a plausible reason for engaging in cultivation of drought tolerant crops and rating the practice very significant hence corroborates (Uddin *et al.* 2014). IBI was ranked the least important adaptation strategy, most likely due to the significant lack of good management of financial institutions in the country underwriting agriculture and offering farm-based insurance products. Also, poor deployment of technical assistance and low-levels of farmer awareness about the use of agricultural insurance (Ndamani & Watanabe, 2016; Uddin *et al.* 2014).

From above, studies have indicated a certain kind of unanimity on the medium to long-term impacts of climate change (Fosuh-Mensah *et al.* 2012; Apata, 2011; Mertz *et al.* 2009), which has driven a plethora of adaptation strategies to militate against climate-induced effects (Nhemachena & Hassan, 2007), the novelty and nuance related to this study is the integral role of remittance in adaptation. The 21st century has seen remittance represent one of the key issues in economic development (Inoue, 2017; Acosta *et al.* 2007; Adams, 2004); reduced the level, depth and severity of poverty in most developing countries (Vacaflores, 2017; Akobeng, 2016), increased incomes (Oduro & Boakye-Yiadom, 2014; Adams & Cuecuecha, 2013) and smoothed household consumption (Schiantarelli, 2005). A study by Adams and Cuecuecha (2013) using a two-stage multinomial logit model revealed that increased remittance provides available working capital for small-scale entrepreneurs. Similarly, Bang *et al.*, (2016) established rise in remittances increased self-employment and private sector investment in Kanye. Increased in remittance positively predicting engagement in off-farm jobs in this study relates (Inoue, 2017; Bang *et al.*, 2016; Akobeng, 2016; Oduro & Boakye-Yiadom, 2014; Adams & Cuecuecha, 2013). It can be inferred that smallholder farmers are now looking beyond just farming which is touted as mundane due to the extreme effects of climate change to other perceived promising ventures. Therefore, giving available remittances, they are more likely delve into other income generating activities outside the farm, this is contrary to what most of the farmers currently use remittances for (buy chemicals/fertilizer) as seen in table 6. It could insinuate that their current state of remittance is low (369 GHC average per annum) as shown in table 5, thereby they commit some of the remittance money to few agricultural output which could sustain their farms for some time. Nonetheless, the ultimate ambition is to divert into other economic sectors and/or activities should there be an increased in remittances. This was corroborated by the FGDs as a farmer professed:

“...when I get more money from my people outside (remittance), I want to buy a motor-king (tricycle) that will be used to fetch water, carry goods and passengers at a fee. I also

want to open a provision shop which I will sell provisions to make more money. Investing money on the farm is useless these days because the rains will not come and everything will be destroyed..." (Farmer 2).

Along the same line, remittances highly influenced irrigation farming and cultivation of improved crop varieties. Farming cannot be alienated from the livelihood and culture of rural folks. Some hold it at a high esteem and a valuable inheritance passed on by past generations which needs to be protected and enhanced (Al-Hassan & Poulton, 2009; Braimoh, 2009). Despite being challenged by current trends of weather events, motivating farmers to wanting to engage in off-farm jobs, this might be done concurrently as respondents are most likely to buy irrigation equipment and drought tolerant seeds to augment their farms giving increased remittances (tables 6 and 7). Increase in remittances however inversely predicted Indexed-Based Insurance (IBI). IBI is an innovative approach to insurance provision that pays out benefits or compensate clients on the basis of a predetermined index (example, rainfall level or temperature variation) for loss of assets and investments resulting from weather and catastrophic events (Conradt *et al.* 2015).

It is expected that when farmers' income increases they will exhibit high potential to take up IBI (Carter *et al.* 2016; Conradt *et al.* 2015). This was the inverse as it could be rooted on the arguments that remittance itself is a form of insurance against shocks. For instance, Adams and Cuecuecha (2013) argue that remittance from migrants is a strong insurance policy for rural and poorer households who have less access to formal insurance to mitigate weather related risks. Remittances may lessen credit constraints because a stable stream of remittance income may make households more creditworthy in the eyes of formal sector financial institutions (Adams & Cuecuecha, 2013; Schiantarelli, 2005). Lucas and Stark (1985) found that remittances to Botswana increased with the extent of drought in remitters' place of origin, and responsiveness of remittance levels to drought was greater for households with more drought sensitive assets. Remittance also significantly predicted respondents share of income spent on adaptation. It was emphatic that respondents were more likely to spend between 100-300\$ of income on adaptation. The solidity of this issue can traced to the meagre remittances received catapult with over dependence on farm crop-based income which is banned by devastating climate events (seen in table 5).

5.0 Limitations of the study

The study focused mainly on recipients of remittances. In the broader perspective, the inclusion of non-recipients of remittances would have advance the argument and present additional insights into the phenomenon of study. Not including the non-recipients category is thereby a major limitation in the study. Also, a comparison of the northern and southern parts of the country would have presented an intriguing information on remittances and climate change adaptation. Nonetheless, focusing on only the northern part of the country limited the findings of the study due to lack of comparisons based on different economic characteristics, agro-ecological features and culture.

6.0 Conclusions and policy implications

Several studies have point to the potentially valuable complement of remittances to broad-based development and economic growth. In a disaggregate milieu, the study sought to examine the potential of remittances in financing climate change adaptation at the local level. Using ASI analysis to assess general adaptation strategies of smallholder farmers, it was discovered that

farmers rated backyard gardening, cultivation of drought tolerant crops, mixed cropping, off-farm jobs and residue management as the most important adaptation strategies. On the average, a farmer receives 369\$ per-annum of remittance and this is channelled into buying of chemicals/fertilizer to use on farm, acquiring extra food to supplement family needs, buying of drought tolerant maize seeds and invest in children education. Receiving remittances was cropped with challenges including mobile network problems, travelling longer distances to redraw remittance money, limited financial institutions and poor communication from intermediaries. The ORL model predicted that increase remittances is significantly associated with off-farm jobs, irrigation farming, cultivation of improved crop varieties, use of compost/animal manure and crop rotation. It however, inversely predicted IBI. Similarly, a multinomial logit model showed that farmers are highly likely to invest 100-300\$ of their income on adaptation with increase remittances.

The study concludes that remittances are vital in financing climate change adaptation and if appropriately yoked into climate intervention policies, can strengthened and help farmers fashion out adaptation strategies that present high medium to long-term dividends. It therefore recommended that government develop the capacity of financial institutions and private sector for available formal financial institutions to be established in rural areas to hone access to remittances. Major mobile network providers should also expand and strengthened network systems for more smooth transactions. Further, the study calls for advocacy programs that drive interest on the need for migrants to remit and also reduction in the cost associated with sending remittance money. The current double edge levy system where both the remitter and the recipients pay mobile money kiosk operators for both sending and withdrawal potentially affect willingness to use formal mechanisms to remit. The tendency is that many people may remain committed to the use of informal networks for remitting which has many limitations as well. Finally, the study however caution that in motivating action for increase in remittances for adaptation, people have to be skeptical about the fact that increase remittances might exacerbate agricultural shocks. Increase remittances are strongly associated with off-farm jobs which consequently can lead to high leisure activities that provide livelihood satisfaction hence a threat to agriculture labour.

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QUESTIONNAIRE

Section A: Adaptation Conceptualization by Smallholder Farmers

1. Do you think the “climate” has changed so much in the last 15 years?
 - a. Yes []
 - b. No []

2. What kind of changes have you observed in the past 15 years?
 - a. Change in precipitation
 - b. Change in temperature
 - c. Change in both precipitation and temperature
 - d. Change in Wind velocity
 - e. others
3. Kindly describe the nature of the changes

4. Since when did you observe the changes you have indicated in Q2 above?
 - a. About three years ago
 - b. About 7 years ago
 - c. About 10 years ago
 - d. More than 10 years ago

5. What do you think have accounted for the changes?
 - a. Through the art of supernatural God
 - b. It a punishment from our ancestors
 - c. I am not sure of the causes
 - d. Its human activities on the land
 - e. It’s natural cycle/system
 - f. Others
6. Does the changes in anyway affect your farming enterprise?
 - a. Yes []
 - b. No []
7. Describe how it has affected your farming enterprise?

8. Do you undertake some steps to reduce the perceived effect of the changes?
 - a. Yes []
 - b. No [] if no proceed to question Q11
9. If yes to Q7, If yes to Q7, rank the following in order of importance on your farm (1=high importance, 2=moderate importance, 3=low importance and 4= not important at all)

Adaptation Practices	1	2	3	4
Cultivation of improved crops/use of drought resistant seeds				
Mulching				
Use of composite/animal manure on the farm				
Rotating crops seasonally				
Allowing land to fallow				

Altering of planting date				
Irrigation farming				
Mixing crops together				
Engaged in contours and terraces on the farm				
Received education/training about climate change				
Planting trees in and around your farm/house (afforestation)				
Take Index-Based Insurance (IBI) to protect your farm				
Pant cover crops and leguminous crops on the farm				
Harvested and used rainwater for farming				
Use less heavy equipment on the farm (minimum tillage)				
Allowing residue to decompose on the farm				
Engaged in back yard gardening in addition to your farm				

10. List other adaptation practices not listed above
.....
11. Does engaging in adaptation strategies you have indicated above increase your farm investment cost?
a. Yes []
b. No []
12. On the average state how much income that has been invested in these practices you have indicated in Q7 and Q8 above?(GHC)
11. If no to Q6, why haven't you taken any steps or engaged in any adaptation practice?
.....

Section B: Background characteristics of farmers

13. Sex:
a. Male []
b. Female []
14. Age.....
15. Marital Status?

- a. Married []
- b. Unmarried []

16. Highest level of education?

- a. Basic/Primary []
- b. Secondary/High school []
- c. Tertiary []
- d. No formal education []
- e. Other (Please specify).....

17. Religion?

- a. Islam []
- b. Christianity []
- c. Traditional religion []
- d. Others (Please specify).....

18. State how many people live in your household

19. Are you the head of your family?

- a. Yes []
- b. No []

20. What is your average annual income for the past three years?

.....

21. What are the sources of income you have received or have been receiving for the past 5 years?

- a. Farm crop-based income
- b. Livestock-based income
- c. Wage based-income from hired labor
- d. Transfer (government subsidy, lottery prize, insurance, etc.)
- e. Remittances
- f. Others.....

22. What are your annual average remittances for the past 5 years?

.....

Section C: Remittances and Adaptation Practices

23. Have you received any remittances in the last 3-5 years?

- a. Yes []
- b. No [] (if not then move to Q31)

24. If yes to Q12, how much in estimation have you received per year in the last 5 years?
(GHC)

25. State how many times you received remittances in each year?

26. Through what means was the remittances sent?
- a. Financial institution []
 - b. Mobile money transfer []
 - c. Sent through a friend/relative []
 - d. Other (s) please state.....

27. Did remittances enable you to undertake any of the above listed adaptation practices mentioned in Q7?
- a. Yes []
 - b. No []

28. State specifically the adaptation practices you have engaged in using remittances?

29. What is the actual amount of remittances you have spent on adaptation activities per year in the last 5 years

30. Indicate how likely you are to use remittances for the following activities in the future if you continue receiving remittances (1= extremely unlikely, 2= unlikely, 3= neutral, 4=likely & 5=extremely likely).

Activities	1	2	3	4	5
For consumption smoothing (i.e, acquiring extra-farm food supplement for your family)					
For fixing climate induced defective household's infrastructure (i.e, water technologies, storage facilities, etc.)					
Buy improved crop varieties/drought resistant seeds					
Take Index-Based Insurance (IBI) to protect against weather events					
Acquire a rainwater harvesting equipment					
Buy bullocks/cattle					
Invest in children education					
Purchase fertilizer to be used on the farm					
Purchase a tractor/'motor king'					
Pay for capacity building programmes on climate change & farming					

Sponsor a relative to go abroad					
Invest in off-farm trade e.g carpentry, buying & selling etc.					
Acquire more lands to be used for different farming activities					
Purchase low till equipment e.g hoes & cutlasses					
Contribute to a common fund with other farmers					
Hire more labour					

31A. If no to Q23, kindly state why

.....

31B. if you don't have access to remittance do you or would you still take steps/measures to adapt?

a. Yes []

b. No []

31C. if yes to Q19B then what other financing means would you or have you been using to finance your adaptation practice

.....

31D. Do you consider the financial streams listed in 19C to be adequate to finance your adaptation

a. Yes []

b. No []

Section D: Policy Changes for enhancing Remittances Induced Adaptation

32. Which of the following remains an obstacle to adapting to changing climate

- a. Limited access to long-term credit
- b. Limited access to climate information (knowledge)
- c. Limited access to technology
- d. Uncertainty related to amount of remittance to be received
- e. Limited access to land
- f. Others
- g.

33. . What are the enabling environments that can influence the impact of remittances on your adaptation strategies?

.....

34. Will you invest your remittances into adaptation if there is incentive to do so?

.....
35. Will you invest your remittances into adaptation practices if it can be used to acquire government subsidized farm inputs?

a

.....
36. What are the core challenges you face in receiving your remittances?
.....
.....

37. Are there any previous instances where you could not access any remittances?

a

38. What percentage of your money do you spend on receiving transfers?
.....
.....

39. Have your remitters ever reported any challenges that prevent them from sending you money on regular basis?
.....
.....

40. Do you think that the cost for sending and receiving transfers worth it?

41. What are some of the things you feel government can do to reduce the transaction cost for receiving your money?
.....
.....

Section E: Farm characteristics

42. Size of farm currently under cultivation(acres)

43. How many people are employed on the farm in a season.....

44. Do you own the following?

a. Mobile phone []

b. Bicycle []

c. Car/tractor []

d. Radio []

e. Water pump []

45. How many years have you been into farming?.....

46. List the type of crops you cultivate
.....
.....

Thank you

Appendix



