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Small Holder Farmers' Perception on the Impact of Climate Change on Food Production and Revenue Returns in the Semi-Deciduous Zone of Ghana

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Abstract

Climate change is a current threat to crop and livestock production globally. Climate smart agriculture (CSA) is the best way to reduce the negative effect of climate change on crop and livestock production. This study was conducted to investigate small holder farmers' perception on the impact of climate change on food production and revenue returns in the semi-deciduous zone of Ghana. The study was conducted within the Sekyere South district in the Ashanti Region of Ghana. A descriptive research design was used for the study. Questionnaire was the main tool for data collection. Statistical Package for Social Science [SPSS], version 20 was used for data analysis. Pearson Product Correlation was used to determine the correlation between variables and CSA practice sat 0.05 significant level. Results from the study revealed that majority (60 %) of the respondents were males, 40 % were above 51 years, MSCL was the highest academic qualification and the average family size of the respondents was 8. Majority (60 %) of the respondents' farm on a family land with farm size ranging from 1 – 5 acres and mostly practiced mixed cropping in the major rainy season. Hired labour is the highly reliable source of labour (80.0 %) used by farmers. The study revealed that majority (88.0 %) of the respondents do not belong to any farmer association leading to little idea on climate change. The descriptive and correlation analysis revealed that, farmers' major sources of information on climate change and climate-smart agricultural practices comes from extension agents, fellow farmers, friends and relatives. This study concludes that climate change affects crop and livestock production due to decreased rainfall amount and frequency leading to reduction in income and revenue. Again, farmers have little knowledge on climate-smart agricultural practices.

Keywords: Farmers; climate smart; agriculture; adaptation; season; farming systems

1. Introduction

Agriculture in Ghana consists of a variety of agricultural products and is an established economic sector which provides employment on a formal and informal basis. Ghana produces a variety of crops in various climatic zones which range from dry savanna to wet forest and which run in east–west bands across Ghana. The sector contributes about 20 % of the country's GDP, generates about 30 % of the foreign exchange earnings and employs about 50 % of the work force (The World Factbook, 2018). The sector is projected to have the potential growth rate at about 6 % (The World Factbook, 2018),but the vulnerability of the sector to the ongoing climate change phenomenon could inhibit the potential progress in the long run (FOA) (2010). Since 1960, it is estimated that Ghana has experienced a degree rise in temperature and reduction in rainfall in all agro-ecological zones (EPA, 2015). However, future climate projections in West Africa indicate increases in temperature (until 2100) with uncertainties surrounding precipitation (IPCC, 2014). Successful commercialization of farming enterprises and farmer entrepreneurship are thought to embody the key features of structural transformation and provide a pathway out of poverty and subsistence agriculture for the rural farm households.

Smallholders in Ghana, as elsewhere, are widely considered to be the largest as well as the most vulnerable component of the rural sector. Increasing productivity to achieve food security is projected to entail a significant increase in emissions from the agricultural sector in developing countries (IPCC, 2014). Therefore, responding to the challenge of climate change has become a global priority. Climate smart agriculture (CSA) entails the adoption of farming practices and technologies to sustainably increase food production, build resilience to climate change (adaptation), reduces or removes greenhouse gases (mitigation) and enhance the achievement of national food security and development goals, (FAO, 2010).The idea is to promote the notion of addressing multiple goals simultaneously. By aiming to reduce poverty, address climate change, and reduce food insecurity at the same time, it is possible to make more efficient use of resources. Food and Agriculture Organization (FAO) estimates that agricultural production will have to increase by 70% by 2050 to satisfy expected demands of food and feed (FAO, 2013a). These challenges are compounded by the need for farmers to adapt to climate change and at the same time mitigate its contribution to climate change in order to slow the progression of this global challenge (FAO, 2009).

The major challenges faced by smallholders in Ghana are; climate change, drought, poor information dissemination, inadequate extension officers, low soil fertility due to intensive farming over the same area of land, weed competition and poor agronomic practices (Peterson, 2014). However, the challenge lies in the extent to which poor smallholder farmers can successfully adopt CSA practices with current surprises and shocks which climate change presents. Being climate smart therefore calls for adopting practices such as knowledge smartness, nitrogen smartness, energy smartness, water smartness, weather smartness and carbon smartness (Aggarwal *et al*., 2013). This hinges on developing new or enhancing existing institutions to support poor smallholder farmers to successfully adopt these practices. Moreover, considering the fragility of the community's environment and much dependence on rain-fed agriculture, climate variability is further exacerbating existing woes as manifested in increasing temperatures, erratic rainfall patterns encouraging shifts in farming seasons and introducing new pests and diseases. Hence, the need for the adoption of improved practices in agriculture which embraces increased food production and reducing its environmental footprint concomitantly (Beddington*et al.*, 2012).

Sustainable agriculture and now climate smart agriculture have been identified as the way forward in achieving this goal. Strengthening adaptation and resilience to climate change in Ghana seeks to address the factors that constrain small holder farmer's ability to cope with climate change including poverty, weak institutions and under-investment in key sectors. Nonetheless, successful adoption of CSA practices in the study area in future will be dependent on the level of knowledge network among institutions and with farmers, (Agrawal, 2008) as climate change continuously exposes their vulnerability. Climate change adaptation is therefore highly necessary to cope with the inherent challenges which are hampering food productivity. According to FAO (2010), CSA practices are seen as the means to achieve resilience at the same time reducing environmental degradation.

This study aimed to investigate small holder farmers' perception on the impact of climate change on food production and revenue returns in the semi-deciduous zone of Ghana

2. Research Methodology

2.1 Study area

The study was conducted within the Sekyere South district in the Ashanti Region of Ghana. The Sekyere South District is located in the north eastern part of the Ashanti Region. Agona Ashanti being an administrative capital is located 37 kilometers from Kumasi, along the Kumasi-Mampong trunk road. The District shares common borders with Ejura Sekyere dumasi to the north, Mampong Municipal and Sekyere East to the east, Kwabre East to the south and Offinso Municipal to the west. The District has a total land area of 416.8 square kilometers representing about 1.7 % of the total land size of the Region of 24,389 square kilometers. The District is populated with 226 persons per square Km. The District lies between latitude 60 50'N and 70 10'N and Longitude 10 40'W and 10 25' W.

2.2 Research design

Research design is the logical framework upon which the research work is conducted and enables the researcher to gather evidence to address the research question to achieve the objectives stated (Olli-Pekka, 2018). In this study the descriptive research design was used. According to Olli-Pekka (2018) descriptive research is used to describe characteristics of a population or phenomenon being studied. Descriptive research design was used because the study was to investigate small holder farmers' perception on the impact of climate change on food production and revenue returns in the semi-deciduous zone of Ghana, which involves collecting data in order to answer research questions concerning the topic under study. Descriptive analysis and interpretation of the information collected were employed alongside the use of quantitative approach to the study. The aim of using the close and open ended questions was to draw a conclusion about the opinion of respondents. Descriptive research design is also used to validate any existing conditions that may be prevalent in a population(Olli-Pekka, 2018). Descriptive research design is appropriate for this study because it allows the use of both qualitative and quantitative methods which gives a holistic understanding of the research topic.

2.3 Population, sample and sampling technique

The target population for this research work was twenty-five farmers who were citizens living in the Sekyere South District in the Ashanti Region of Ghana. First, a cluster sampling technique was used for the first stage of sampling of this research, considering the heterogeneous nature of the population of the study area. This technique was used in order to obtain adequate representation of the various homogenous subsets within the various units of analysis. Based on this, purposive, snowball and simple random sampling technique were employed to select the number of small holder farmers needed for the study. The snowballing method helped to locate exactly where to find the small holder farmers without going through the whole town in search of them. The use of simple random sampling gave chance to all small holder farmers within theSekyere South District to be selected for the study. For the selection of sample size of small holder farmers to participate in the study, convenience sampling technique was used by the researcher because of the ease of their volunteering and availability. In total, a sample size of twenty-five (25) was used for the study.

2.4 Data collection instrument and process

In order to achieve the purpose of this study, the researcher used questionnaires as the main data collection instrument. Questionnaire is described as a method of gathering information from respondents about attitude, knowledge, perception and feelings (Olli-Pekka, 2018). A total of sixty-seven (67) item questionnaire was designed for small holder farmers within the Sekyere South District. The first part of the questionnaire aimed at recording the general demographic information (such as age, gender, etc.) of small holder farmers, whereas the other sections was questions related to general farm operations, sources of information on climate smart agricultural practices and farmers perception and impact of climate change on food production and revenue returns.In this study questionnaires were used for data collection and the researcher personally administered questionnaires to the farmers. The researcher explained the purpose of the study to the respondents before giving out the questionnaires to them. A total number of twenty-five questionnaires were administered by the researcher. All the questionnaires administered were completed and returned by the farmers which were used for analysis.

2.5 Pre-testing of research instrument

A pre-test was conducted to check for consistency in the responses and to ensure that the instruments would yield fair and reliable results. The purpose of the pre-test was to allow the researcher to make the necessary changes to the test items which were inappropriate and also determine the level of ambiguity of the questions for modification. A total of ten (10) small holder farmers were selected and used for the piloting. Small holder farmers used for the piloting were selected randomly.

2.6 Validity and reliability of research instrument

To enhance validity of the instrument, a pilot study was conducted within the Sekyere South District. This population was not used in the final research. Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda and Mugenda, 2003). In this study, the validity of the research has been considered through the identified approach of Peter Wood that includes a sustained method and respondents' validation of data (Wood, 2006). Small holder farmers were also at liberty to redraw from the study anytime they feel uncomfortable or compromised.

2.7 Data analysis

For this research, the compilation of the field data and analysis was done using Statistical Package for Social Science [SPSS], version 20. Descriptive statistical tools such as dispersion were used in analyzing the closed ended questions. Tables and percentages were employed to display various responses. The data collected on open ended questions were subsequently analyzed using the qualitative technique of content analysis. Significance test was also analysed using Pearson Product Correlation at a significant level of 0.05 (2-tailed).

3. Results

3.1 Socio-demographic characteristics of respondents

Table 1 shows that 60 % of the respondents were males while 40 % were females. Majority of the respondents representing 40 % were above 51 years while, 28 and 20 % of the respondents were between the age categories of 21-30 and 41-50 years respectively. None of the respondents were below 20 years of age. The mean ages of respondents were 25 years. Results on educational background as shown in Table 1 depicted that majority (40 %) of the respondents had MSCL as their highest academic qualification, 28 % had attained tertiary education and 20 % had SSCE/WASCE as their highest qualification, while 12 % of the respondents had no formal education. Analysis on family size (Table 1) revealed that 36 % of the respondents had a family size ranging from 6 – 10 people, 32 % of the respondents had farm size less than 5 people, 28 % of the respondents had a family size of more than 15 people while few(4 %) of the respondents had family size ranging from 11 – 15 people. The average family size of the respondents was 8. Majority (72 %) of the respondents cover less than 4 km to the farm site while, 20 and 8 % had to traveled and cover 4-5 and more than 5 kilometers respectively before reaching the farm site.

Table 1: Socio-demographic characteristics of small holder farmers

Background information	**Variables**	**Percentage** (%)
Gender	Male	60.0
	Female	40 .0
Age	< 20 years	0.0
	21-30 years	28.0
	31-40 years	12.0
	41-50 years	20.0
	> 51 years	40.0
Education	MSLC	40.0
	SSCE/WASCE	20.0

	Tertiary	28.0
	Non-formal education	12.0
Family size	<5	32.0
	6-10	36.0
	11-15	4.0
	> 15	28.0
Distance covered	<3 Kilometers	72.0
	4-5 Kilometers	20.0
	> 5 Kilometers	8.0

3.2 General farm operations/activities

Table2 shows how farmers acquired land to carry out their farming activities within the Sekyere South District. The study revealed that 60 % of the respondents' farm on a family land, 20 % of the respondents purchased the land, 12 % of the respondents were engaged in share cropping while 8 % of the respondents rented lands for their farming activities. Analysis on farm size (Table 2) revealed that 48 % of the respondents had farm size ranging from 1 – 5 acres, 28 % of the respondents had farm size greater than 5 acres while 24 % had farm size less than 1 acre. The study revealed that majority (80 %) of the respondents practiced mixed cropping while few (29 %) practiced sole cropping. None of the respondents engaged in mixed farming. Majority (68 %) of the respondents engaged in farming activities during the major rainy season followed by minor rainy season (24 %) while few (8 %) of the respondents farmed in the dry season. Most (68 %) of the respondents depend on rainfall, 24 % of the respondents practiced irrigation while few (8 %) relied on rainfall and also supplement water under drought conditions.

Table 2: Small holder farmers' general farm operations and activities

Farm operations	Variables	Percentage (%)
Land acquisition	Purchased	20.0
	Rent	8.0
	Family land	60.0
	Share cropping	12.0
	Total	**100.0**
Farm size	<Acre	24.0
	1-5 Acres	48.0
	> 5 Acres	28.0
	Total	**100.0**
Farming System	Sole cropping	20
	Mixed cropping	80
	Mixed farming	0.0

	Total	**100.0**
Farming season	Major rainy season	68.0
	Minor rainy season	24.0
	Dry rainy season	8.0
	Total	**100.0**
Farming system	Rain fed	68.0
	Irrigation	8.0
	Both	24.0
	Total	**100.0**

3.3 Farmers sources of labour, association and Knowledge on climate change

Hired labour is the highly reliable source (80.0 %) used by farmers followed by family members (12.0 %), and group members (8.0 %) been the least sources of labour (Table 3). Majority (88.0 %) of the respondents do not belong to any farmer association except 12 % of the total population. Respondents' knowledge on climate change was very low as 52 % and 28 % had little and no idea at all about climate change respectively. Only few (20 %) of the respondents had fair knowledge about climate change (Table 3).

Table 3: Small holder farmers' general farm operations and activities

General information	Variables	Percentage (%)
Source ofLabour	Hired	80.0
	Family	12.0
	Group	8.0
	Total	**100.0**
Farmer association	Yes	12.0
	No	88.0
	Total	**100.0**
Farmers knowledge on climate change	Fair	20.0
	Little	52.0
	No idea	28
	Total	**100.0**

3.4 Farmers sources of information on climate change and climate-smart agricultural practices

Information to and from agricultural sector to farmers varies and comes in different sources and forms. However, from table 1, majority of the farmers, representing 56 %, 60 % and 68 % never received information from bulletin, NGOs and farmers organizations, respectively. With the exception of radio accounting to 56 % providing substantial information for farmers often, fellow farmers (56 %), friends and relatives (52 %) rarely support farmers with information pertaining to farming activities. Extension agents, traditionally known to disseminate information to farmers was not supported by this data as only 12 % among the respondents could testify to receiving information from extension personnel as against 36 % never getting the required information to support farming activities.

Correlation analysis of farmers' sources of information on climate change and climate-smart agricultural practices (Table 5) shown that extension agents, fellow farmers, friends and relatives were significant ($P<0.05$) positively correlated. However, all the other variables were positively correlated but not significant ($P>0.05$).

Table 4: Descriptive analysis of farmers' source of information

Sources of information	Often	Rarely	Never	Very often
Fellow farmers	8.0 %	56.0 %	32.0 %	4.0 %
Friends and relatives	4.0 %	52.0 %	36.0 %	8.0 %
Radio	56.0 %	32.0 %	12.0 %	0.0 %
Farmer organization	4.0 %	24.0 %	68.0 %	4.0 %
Extension agents	8.0 %	44.0 %	36.0 %	12.0 %
Television	40.0 %	44.0 %	12.0 %	4.0 %
Bulletin	16.0 %	16.0 %	56.0 %	12.0 %
NGOs	12.0 %	16.0 %	60.0 %	12.0 %

Table 5: Correlation analysis of farmers' source of information (N=25)

Sources of information	Std. Deviation	Pearson Correlation	Sig. (2-tailed)
Fellow farmers	20.08	0.972*	0.028
Friends and relatives	22.9	0.982*	0.018
Radio	24.52	0.070	0.930
Farmer organization	30.17	0.490	0.510
Extension agents	17.70	0.960*	0.040
Television	19.96	0.474	0.526
Bulletin	20.75	0.243	0.757
NGOs	23.41	0.272	0.728

** = Correlation is significant at the 0.05 level (2-tailed).*

3.5 Farmers perception and impacts of climate change in food production and revenue returns

The impact of climate change on crop productivity is evidenced and highly supported by this data as 72 % of the responded farmers' depicted higher negative impact on revenue returns (Table 3). Moreover, 56 % were of the view that, climate change has increased the length of drought periods affecting crop survival throughout the season. Table 6 revealed a higher decline on productivity (56 %) as resulting from prolonged dry spells since water is the most limiting plant growth factor. Additionally, 56 % of the farmers reported high levels of pests incidence affecting crop productivity as climate change is favouring their adaptability, breeding and survival.

Table 6: Farmers perception and impacts of climate change in food production and revenue returns

Variable	High	Medium	Low
Production decline	56.0 %	40.0 %	4.0 %
Fertility decline	40.0 %	56.0 %	4.0 %
Revenue decline	72.0 %	28.0 %	0.0 %
Long dry spells	56.0 %	44.0 %	0.0 %
Decreased precipitation	48.0 %	44.0 %	8.0 %
Incidence of pests	56.0 %	32.0 %	12.0 %
Seasonal changes	48.0 %	52.0 %	0.0 %

The Pearson Product Correlation analysis of farmers' perception and impacts of climate change in food production and revenue returns (Table 7) shown that production and revenue decline and incidence of pests were significant ($P<0.05$) positively correlated. However, all the other variables were positively correlated but not significant ($P>0.05$).

Table 7: Correlation analysis of farmers' perception and impacts of climate change in food production and revenue returns

Variable	Std. Deviation	Pearson Correlation	Sig. (2-tailed)
Production decline	26.63	0.931*	0.038
Fertility decline	26.63	0.820	0.388
Revenue decline	36.29	0.941*	0.020*
Long dry spells	29.48	0.995	0.064
Decreased precipitation	22.03	0.977	0.136
Incidence of pests	22.03	0.997*	0.048
Seasonal changes	28.93	0.931	0.238

* = *Correlation is significant at the 0.05 level (2-tailed).*

4. Discussion

4.1 Socio-demographic characteristics of respondents

The higher number of males as compared with their female counterparts observed in this study indicates that men are more likely to adopt innovative practices such as climate smart agriculture. This also indicates that at rural household level more men are into farming activities as compared to their women counterpart. This may be explained by the dominant culture that males still have exclusive rights to make farm decisions regarding both short term and long term adjustments. With this trend, the adoption of climate smart practices implies that households will make a decision to change their practices, such as a modification in farming practices since decision making mostly depends on the men. Thus, there is a need to mainstream gender lenses in designing CSA practices for the successful adoption of all sects of farmers (Peterson, 2014).Below *et al*. (2016) also reported that women are less able to diversify income sources and adapt to climate change because of other domestic responsibilities and less control of financial resources. Similar findings were reported by Adekemi *et al*. (2016).The study revealed that majority of the respondents was above 50 years with MSCL as their highest academic qualification making it less likely to adopt innovative practices such as climate smart agriculture since they are old with lower level of education. This implies that older farmers were less likely to implement many strategies compared to younger ones. This observation is similar to that of Bernier *et al*. (2015) who noted that age was negatively correlated with adoption of climate change adaptation strategies. The explanation was that older farmers were more risk averse and mostly less educated. Shong we *et al*. (2014) noted that old age had a negative relationship to adopting climate change adaptation strategies explaining that agriculture is a labor intensive venture which requires healthy, risk bearing and energetic individuals.

Large family size has high influence on climate change adaptation and successful adoption of CSA. According to the report of Adekemi *et al*. (2016) large family size as observed in this study influence both climate change adaptation and successful adoption of CSA. Results on family size and distance from home to farm sites observed in this study corroborates with the findings of Adekemi *et al*. (2016). Thus, larger household size guaranteed labor availability, particularly for labor intensive CSA practices. Nkonya *et al*. (2008) explained that the bulk of labor for most farm operations in sub-Saharan Africa is provided by family members rather than hired persons. Therefore, lack of adequate family labor accompanied by inability to hire labor constrains adoption of crucial farming technologies. Teklewold *et al*. (2016) observed that larger household size was associated with use of important CSA practices like modern crops seeds combined with water management and efficient use of inorganic fertilizers.

4.2 General farm operations/activities

Family members and hired labour guaranteed labor availability, particularly for labor intensive CSA practices. This makes it possible for farmers to adopt innovative technologies and successful adoption of CSA. Land is an important factor to consider in agricultural production. This study reveals that most farmers farmed on a family land with farm size ranging from 1 – 5 acres. This means that climate change adaptation and successful adoption of CSA will be very high since the farmers had access to the land for a very long time. The results of this study suggested that farmers who had access to land for a very long time are able to practice mixed cropping during the rainy seasons had a higher likelihood of having high demand for CSA. However, farmers' dependant on rainfall highly affects the adoption of CSA (Teklewold *et al*., 2016). According to the report of Johnson *et al*. (2016) availability and easy access to land ensure diversifying farming like mixed cropping and adopting CSA practices, hence reducing the potential risk of total failure making farmers less risk averse in adopting CSA strategies. Similar findings were also reported by Nkonya *et al*. (2008).

4.3 Farmers sources of labour, association and Knowledge on climate change

The results of this study revealed that majority of the farmers do not belong to any farmer association and this was the reason for the little or no idea about climate change and CSA adoption among farmers. Membership provides a link to access such facilities and information extension which are vital to adoption of CSA technologies. This is because through group interactions, members get to exchange ideas, handle farm demonstrations and also get connections to dissemination of important research findings. This result is consistent with Gido *et al*. (2015) who noted that membership in farmer related groups and organizations increases the ease with which extension agents reach members, reduces the cost of service delivery through economies of scale and guarantees a higher number of contacts between members and service providers. Earlier research findings in Nepal and Bangladesh also showed that farmers belonging to cooperative organizations have higher likelihood of using climate change adaptation practices. The reason was that group members could share ideas, discuss problems and take collaborative decisions (Tiwari *et al*., 2014). Extension agents play an important role in creating awareness and demonstration of new CSA technologies (Gbegeh and Akubuilo, 2012).

4.4 Farmers sources of information on climate change and climate-smart agricultural practices

To adapt effectively to climate change, socio-economic and environmental circumstances and the availability of information and technology are key (Gbegeh and Akubuilo, 2012). From the results presented, farmers are unaware and are unable to adapt to climate change since they do not receive the necessary information from institutions and organizations responsible for educating farmers. This according to Demissie and Meaza (2018) is critical since the role of institutions to climate change adaptation and improving the livelihood of smallholder farmers cannot be over-looked. As reported by FAO (2013), institutions are vital to agricultural development, as well as, the realization of resilient livelihoods. Moreover, institutions are not only a tool for farmers and decision-makers, but are also the main conduit through which climate-smart agricultural practices can be scaled up and sustained (FAO, 2013). Additionally, the uncertain projections from climate change are compounded by the paucity and unreliable basic information related to agricultural production, and this eventually affects the most basic data: weather data, land-use data and crop and livestock distribution data, for example, that farmers need in the day-to-day activities (Vermeulen *et al*., 2012;Ajani*et al*., 2013). Several of the losses that farmers incur during the season could have been managed if climate information has been fully exploited by farmers; however, there seems to be gaps in existing climate information services which appears to be widespread globally (Vermeulen *et al*., 2012).Extension agents, fellow farmers and friends and relatives were significant positively associated with adaptation of climate-smart agricultural practices. The positive correlation means there is a positive relationship between extension agents, fellow farmers and friends and relatives and adaptation of climate-smart agricultural practices. This indicates that as extension officers, fellow farmers and friends and relatives continue to feed farmers with a lot of information on climate change the chances of climate-smart agricultural practices adaptation also increases. This also indicates that as farmers' sources of information increases they are more likely shift from their old method of farming to adapt innovative technologies and modern approaches to farming. Similarly as farmers received more information from fellow farmers, friends and relatives they are more likely to adopt climate-smart agricultural practices and innovative way to reduce the negative effect of climate change on crop and livestock production. Similar findings were reported by Beddington *et al.* (2012).

4.5 Farmers perception and impacts of climate change in food production and revenue returns

The reported decrease in precipitation and prolonged dry spells, which lead to decreased crop production as revealed by this survey was in agreement with Amaru and Chhetri (2013) that reduction in crop and livestock production for the past two decades was due to decreased rainfall amount and frequency brought by climate change. There were no doubts that farmers attributed the high decrease in revenue returns from crop production to rainfall variability and increased drought periods to climate change. This observation is similar to the findings of FARA (2015) which suggested decrease in farmers' precipitation and prolonged dry spells lead to decreased crop production. This observation demonstrates the need of most farmers to meet their basic crop production for food generation (FARA, 2015).The Pearson Product Correlation analysis indicate that production decline, fertility decline, revenue decline, long dry spells, decreased precipitation, incidence of pests and seasonal changes were positively correlated with revenue returns. As all these variables increase, revenue returns also increases and as these variables continue to decline revenue returns also decreases. The positive correlation also indicates that as farmers continue to practice the olden system of farming, production and revenue will continue to decline due to the negative effect of climate change on crop and livestock production. On the other hand, farmers' ability to adopt climate-smart agricultural practices and innovative way of farming will boost productivity and increase revenue generated from their farming activities.

Conclusions

1. This study concludes that climate change affects crop and livestock production due to decreased rainfall amount and frequency leading to reduction in income and revenue.
2. Famers low level of awareness affect the adaptation of climate-smart agricultural practices and innovative way of farming
3. Adoption of CSA practices could help improve the standard of living among small holder farmers and reduce poverty and food insecurity.

Recommendations

1. This study recommends that farmers should join agricultural-related associations or groups responsible for educating farmers on climate change and adoption of climate smart agricultural practices.
2. Policy makers should integrate indigenous knowledge into climate change policies and strategy programmes for effective and easy adaption among small holder farmers.

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