



Farm Households' Coping Strategies to Climate Change: A Review

H. Shuaibu^{1*}, J. G. Akpoko¹ and S. Umar¹

¹*Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria.*

Authors' contributions

This work was carried out in collaboration between all authors. Author HS designed the study, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors JGA and SU managed the literature searches. All authors read and approved the final manuscript.

Review Article

Received 4th April 2013
Accepted 13th September 2013
Published 22nd May 2014

ABSTRACT

Natural and Human activities have overtime caused significant shift in the climate state creating climate change. The change in climate state affects all aspects of human life causing mass migration and great loss of human life. It is believed that agriculture is the most susceptible sector to climate change thus becoming the major force challenging the livelihood of farmers. Therefore, in response to these forces, farm households have developed strategies to cope with the aftermath of climate change induced shocks. The paper highlights some of these strategies among farmers in different locations. It was noted that the coping mechanisms adopted by farmers suggest that actions changes with different situations. Furthermore, it was noted that the sustainability of most of the coping strategies is questionable due to over dependence on the use of natural resources. It was thus suggested that for greater sustainability of the strategies, there is an urgent need to find sustainable livelihood strategies of life. This would only be possible through materialization of existing policies and programmes allocation of resources and building capacity of farm households.

Keywords: *Climate change; farm household; coping strategies; agriculture.*

*Corresponding author: E-mail: hskugu@yahoo.com, shuaibuhajara2839@gmail.com;

1. INTRODUCTION

Climate Change is now a reality and its impact on agriculture and other socio-economic activities cannot be under estimated. Global warming due to green house gases can change the variability of climate. Climate variability has attracted much attention in recent decades, not only because of the globally unparalleled persistence of anomalously low rainfall, but also because of the low capacity of society and economical systems to cope with climate change related risks [1]. As a result of this low capacity, extreme climate variability, such as drought, is frequently accompanied by ecological decline, decimation of livestock herds, widespread food scarcity, mass migration and great loss of human life [2].

Many believe agriculture is the most susceptible sector to climate change. This is attributed to the fact that climate change affects the two most important direct agricultural production inputs; precipitation and temperature [3]. Expected long term changes in rainfall patterns and shifting temperature zones are expected to have negative effects on agriculture [4]. Climate change also indirectly affects agriculture by influencing emergence and distribution of crop pests and livestock diseases, exacerbating the frequency and distribution of adverse weather conditions, reducing water supplies and irrigation; and enhancing severity of soil erosion [5,6]. These climatic hazards are becoming the major forces challenging the livelihood of most farmers [1]. The rural population, for whom agriculture is the primary source of food, direct and/or indirect employment and income, will be most affected due to agriculture's vulnerability to climate changes. For instance [7] noted that over 70% of rural populations within sub-Saharan Africa (SSA) rely on rain fed small holder agriculture for subsistence and livelihood. This dependence makes farmers vulnerable to the adverse impacts of climate change implying that any significant change in climate or weather patterns not only has the potential to impact on farming activities [8] but also threatens to increase poverty in the already vulnerable communities. Therefore, climate change and variability in African smallholder farming systems can be considered as an additional threat to pressures of population, poverty, killer diseases (HIV/AIDS and malaria) to development of sustainable livelihoods [9]. Rainfall, in terms of total amount and within season distribution, is the most important climatic element in the predominantly rainfed small holder agricultural systems [10]. In addition, floods and drought spells, extreme weather phenomena such as temperature extremes and unpredictable wind movements, strongly impact on agricultural productivity.

Despite worldwide coverage of climate change impact, there is intra-sectoral and inter-sectoral variation in vulnerability depending on location, adaptive capacity and other socioeconomic and environmental factors. In Europe, for instance, agricultural sector is believed to benefit from gradual climate change due to the carbon effect and the warming climate [11,12]. On the other hand, Africa, continent that has contributed almost nothing to anthropogenic climate change, the impact is believed to be enhanced. This is attributed to the continent's low adaptive capacity, over-dependence on predominantly rain-fed agricultural sector, marginal climate and existence of many other stressors [12,13]. The negative consequences of climate change in Africa are already happening as prevalent in frequent floods, droughts and shift in marginal agricultural systems [13]. The climate change impact on agriculture is believed to be stronger in sub-Saharan Africa [14].

In response to climatic change and variability, farm households over the years have developed different coping strategies in the aftermaths of climate change induced shock. Literature has shown that coping and adaptive capacity of people vary from region to region. They are related to changes in societal aspects such as land use and cultural practices [1].

reveals that coping with climatic changes requires a combination of various individual responses at the farm-level and assumes that farmers have access to alternative practices and technologies available in their locality. The coping capacity is related to environmental changes which take into consideration aspects such as land use and cultural practices.

The paper brings to light the trend of climate change, its impact on household livelihood and the coping strategies households have adopted and how they can be viewed from sustainability point of view.

2. CONCEPT OF CLIMATE CHANGE

To understand climate change, we must first of all understand what climate is. Climate is the synthesis of weather over a given area or location over a period of at least 30 years. Climate is the end product of the workings of the climatic system consisting of the atmosphere, the lithosphere, the hydrosphere, the cryosphere and the biosphere interacting together and powered by solar radiation. The climatic system is an open system that is in dynamic equilibrium or steady state over a given period. If this steady state is disturbed as a result of significant changes in one or more of the components making up the system or the amount of solar energy powering the system, the climatic system will move over to a new state of equilibrium to produce a new climatic state. In such a situation, a change in climate is said to have occurred. Thus, a change in climate represents a significant shift in the climate state. This shift usually occurs over a long period of time and has a permanent effect on the ecosystem and the environment until another change occurs. [15] stated that authorities have variously defined climate change as follows: "A change in climate that is attributable directly or indirectly to human activities that alter the atmospheric composition of the earth leading to global warming, has the potential of affecting all natural and human systems and may be a threat to human development and survival, socially, politically and economically." To the Geographers "climate change is the increase in the average temperature of the earth's near surface air". Some institutions equally describe climate change "as a change of climate (air temperature, windfall, wind speed) which is attributable to human activities that alter the composition of the global atmosphere and which are in addition to natural climate variability, observed over a comparative time period". [15] still went further to say that others see "climate change as a long term shift, alteration, or change in type of climate prevailing over specific location or region". The most widely used definition of climate change is that given by [6] as "statistically significant variations that persist for an extended period, typically decades or longer". It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean temperature.

3. HOUSEHOLD COPING STRATEGIES TO ADVERSE CLIMATIC IMPACTS

Societies are dynamic and they use all possible strategies to reduce the vulnerability to climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual responses to crisis on livelihood systems in the face of unwelcome situations, and are considered as short-term responses [16]. Adaptive strategies are the strategies in which a region or a sector responds to changes in their livelihood through either autonomous or planned adaptation [17]. Coping mechanisms may develop into adaptive strategies through time [16]. However, it is often difficult to make a clear distinction between coping mechanisms and adaptations. This study considers both schemes as coping strategies.

Populations have developed a number of coping mechanisms in order to live with climate variation and uncertainty. Indigenous strategies to cope with climatic variability vary among different geographical locations and between social-religious-cultural settings, as well as between livelihood cores (e.g. between agro-pastoral communities depending on livestock raising compared to sedentary farming communities depending primarily on crop production). It is thus impossible to give a generic overview of indigenous coping mechanisms. Suffice it to state that coping with climatic variability forms an inherent and fundamental part of societies hosted in arid, semi-arid and dry sub-humid temperate and tropical landscapes [18]. Most individuals and households employ a combination of responses to the impacts of climate on their livelihoods [19]. This suggests that actions constantly change with different situations.

In many parts of SSA, households rely on a combination of self-insurance and informal risk sharing arrangements. Many Africans cope with shocks and stresses through informal strategies that rely on family and community structures-gift exchanges, sharing food, migration, remittances, child labour, informal cash or in-kind loans, or sending children to live with relatives- rather than government or market instruments [20]. Though, the coping mechanisms are not sufficient to address the challenges, and all societies are vulnerable to climatic shocks, and vulnerability is more acute on the poor, landless and unemployed, children, women, livestock tenders and large sized households. Wedded with landlessness and unemployment, water scarcity, unaffordability and unavailability of agricultural inputs and other stressors, climate change is more likely to continue to gamble the socio-economic activities and exacerbate the society's vulnerability.

Food secure households often tend to rely on cash loans from relatives, neighbours and money lending organizations. Conversely, food insecure households depend less on informal transfers. This is due to limited networks of relatives and neighbours able to give cash loans [21]. These households often rely on gifts from relatives and neighbours, and providing labour in-kind payment. Where possible, waged labour on other farms, off-farm employment activities, and livelihood diversification are important livelihood coping strategies. Crop diversification and livestock accumulation are also important risk management strategies in many parts of SSA.

The farming industry has a long history of demonstrating its capacity to respond to changing external forces and to implement adaptation and innovations as circumstances change. Research findings have shown that there are a number of actions that individual farmers can implement, some of which are specific to particular enterprises while others have a more general application [4,22]. In general, households do not follow a single coping strategy during those hard times where often different strategies are taken to maximize their positive survival. Some of these coping strategies include taking advantage of a diversified resource base (to minimize the risk due to harvest failure, they grow many different crops and varieties, and they also hunt, fish, and gather wild food plants); change in crop types and varieties; change in the timing of activities (crop harvests, wild plant gathering, hunting and fishing); change of techniques; change of location; changes in resources and/or life style (resorting to wild foods in the case of emergency situations such as droughts and floods); exchange (obtaining food and other necessities from external sources through exchange, reciprocity, barter, or markets in times of crises); and increased natural resource management (enhancing scarce and climate sensitive resources management) [23]. However, some strategies have negative repercussion on the health, productivity of individuals and psychosocial development of children in a family. From the analysis, it can be concluded that significant number of households took up coping mechanisms that can

negatively affect their future livelihood and immediate rehabilitation from the shock. These includes but not limited to sale of farm land, sale of perennial crops, distress sale of farm equipments, sales of household assets and distress migration. However, under normal circumstances, coping mechanisms like seeking additional labour work, borrowing grain, borrowing money and seeking support (from friends, relatives, government and non-government) can be seen as positive coping mechanisms. Coping with climate variability and meeting subsistence needs often means households cannot make productive investments in their farming operation to adapt to climate change or improve long-term productivity. While many households have made minor strategic adjustments to their farming practices in response to climate change (in particular, changing planting decisions), few households can make large investments—in agro-forestry or irrigation, for example—although households want to invest in such measures. Some of the coping strategies have eroded the future hope of the farmers, while others have helped them to easily bear the consequences of environmental shocks.

4. EMPIRICAL STUDIES ON FARM HOUSEHOLD COPING STRATEGIES TO CHANGING CLIMATE

In a study by [24] it was shown that Northern Shewa farmers of Ethiopian peasant farmers, through continuous experiments on their environment, have managed to learn how to control weeds and insects, select crop varieties, classify vegetation types, and cope with climatic and environmental changes. They have developed various strategies to cope with climate changes induced disasters (Table 1). They conserve water resources and avoid unnecessary danger and crisis during dry seasons. They use drought-resistant crops to address problems related to climate variability and drought in particular [25].

Table 1. Distribution of farmers employing climate related coping strategy in North Shewa, Ethiopia

| Strategy | Percentage of farmers employing strategy |
|------------------------------------|---|
| Reduced frequency of meals | 69.7 |
| Decreased quantity of meals | 69 |
| Decreased diversity of meal dishes | 51 |
| Sale of farm land | 33 |
| Sale of perennial crops | 17.9 |
| Distress sale of farm equipments | 27.9 |
| Sales of household assets | 27.9 |
| Distressed migration | 27.7 |

Source: Adopted from [24]

According to [24], one or more different combinations of coping strategies were employed by farmers as presented in the Fig. 1.

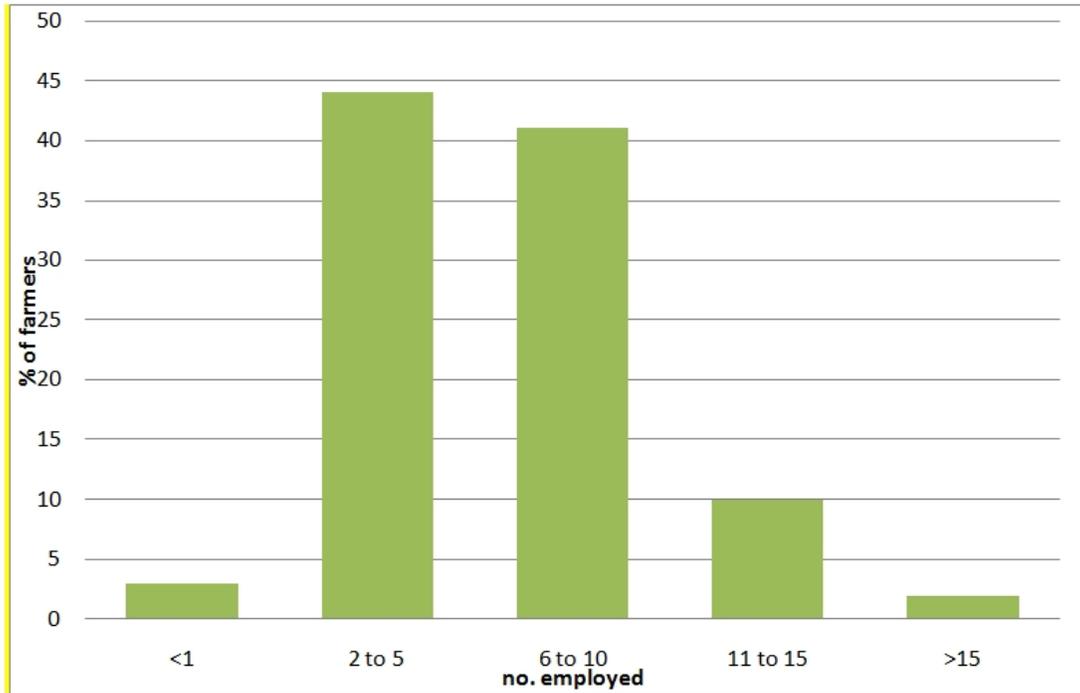


Fig. 1. Number of coping strategy (ies) employed by farmers in North Shewa, Ethiopia
 Source: [24]

Furthermore, [1] conducted another study in Central Tigray, Ethiopia and found that farmers employ various coping strategies against climate risks. In the focus discussion group, the coping strategies to protect against climate related hazards were discussed which include: food for work scheme, credit, petty businesses (such as firewood and charcoal selling), reduction of daily meal in amount and frequency to eat and migration. Similar coping strategies were reported from various studies conducted in different parts of the country [26].

In another study by [10] in two districts in Eastern Zimbabwe, they found that in response to observed changes in weather patterns and absence of previously known local indicators, farmers in both communities confirmed to having shifted their normal agricultural practices to minimise risk and maintain crop productivity. Changes in harvesting dates, crop spacing and crop diversification were also mentioned as measures put in place to cope with climatic variability. The coping strategies used in the two districts are presented in Table 2 below.

Table 2. Percentage Distribution of Coping strategies used by two Districts in Eastern Zimbabwe

| Strategies | Makoni Districts | Wedza Districts |
|------------------------|-------------------------|------------------------|
| Crop Combinations | 22 | 51 |
| Early Planting | 44 | 13 |
| Latest Harvest Dates | 2 | 1 |
| Earliest Harvest Dates | 4 | 6 |
| Crop Types | 3 | 8 |
| Crop Spacing | 25 | 16 |
| Other | - | 5 |

Source: [10]

In Wedza district, the most preferred coping strategy was growing more than one crop type and variety in the same piece of land (51%), followed by increasing inter- and intra-row spacing for maize and legumes to reduce competition for soil moisture, while about 13% confirmed having changed their cropping calendar, while opening new fields was a strategy adopted by about 5% of the farmers. In Makoni district, at least 44% of the farmer had changed their cropping calendars to include dry planting, early and late planting outside the normal planting time. Also of significance were increasing intra- and inter-row spacing for different crops (25%). Other options included shifting harvesting dates to include early harvesting as soon as the crop reaches physiological maturity, and late harvest to minimize post-harvest losses associated with attaining the required moisture content before marketing of produce.

[27] while studying the factors affecting the choices of coping strategies for climate extremes in the Nile Basin of Ethiopia reported that in general, most of the surveyed farmers who reported experiencing shocks over the past five years sold livestock to cope. The other coping strategies included borrowing from relatives, eating less, depending on food aid and food-for-work programs, and looking for off-farm employment. Table 3 describes the types of coping strategies employed under different climatic shocks by percentage of farmers who used the particular coping strategy.

Table 3. Percentage Distribution of Coping strategies for Major Environmental Shocks in Nile Basin of Ethiopia

| Strategies | Drought | Flood | Hailstorm |
|-------------------------------|----------------|--------------|------------------|
| Did Nothing | 27 | 40 | 37 |
| Sold Livestock | 47 | 40 | 40 |
| Borrowed from Livestock | 9 | 6 | 10 |
| Received food Aid | 4 | 1 | 2 |
| Participated in food for work | 5 | 2 | 2 |
| Sort off-farm employment | 2 | 2 | 2 |
| Ate less | 3 | 5 | 4 |
| Applied soil conservation | - | 2 | - |

Source: [27]

In Chicualacuala District of Gaza Province, Mozambique, [28] in a household the following coping strategies are used in different situations: when crops are damaged by drought, they move to other locations where food is available, sell liquid assets, buy limited food, use remittances and eat wild fruits. In Chigubo and Guijá districts (arid and semi-arid zones),

Gaza province, to cope with erratic rains associated with climate variability, the farmers plant whenever the rain comes (even if is not normal time for planting) and grow different crops with the hope that one of the cultures will survive to the weather conditions and succeed until time of harvesting. When there is crop failure or to compensate low harvesting the following strategies are used: Sell livestock, Collect and eat wild fruits, Exchange of labor, Engage in small business, Engage in fishing, Sell firewood and charcoal, Consumption of wild tubers and fruits, Selling of wild fruits and vegetables, Digging deeper wells and walking long distances to fetch water and Migration to other areas looking for employment [28].

In the Great Ruaha River Catchment Area, Tanzania, various ways were reported by the stakeholders consulted to be used in coping with the changing climate, including alterations in the farming activities [29]. In crop production, the use of early maturing crop varieties in rice and maize, and planting drought tolerant varieties for other crops were some of the coping strategies highlighted. Wetland cultivation and migration to other areas were also reported to have become common among household members in the area. Other ways mentioned included in-situ water harvesting using tied ridges and mulching to preserve moisture. Ensuring equitable water allocations for irrigation was also reported as an important attribute of farmers coping with water scarcity particularly in rice fields. Another coping strategy was the planting of drought tolerant crops/varieties like sweet potatoes, cassava, and planting early maturing varieties of maize and beans. Others local coping strategies include engagement in alternative enterprises that are not completely climate dependent such as raising and selling chickens. In some places local people are planting new fruit trees that were not grown in the past, such as mangoes, avocados, and pineapples. It was reported that as a result of increased temperature these fruit trees now flourish well, a situation that would not be possible in due to the cold temperatures of the past. Banana trees are also grown nowadays in places that were not producing such a crop only a few decades ago. To cope with risks related to climate change impacts, some farmers are now relying on planting crops which were in the past considered to be for the warmer and drier areas because they now seem to do fairly well due to the changing climate. Crops such as cashew nuts, onions, sunflowers, and pepper are nowadays commonly produced in the area. Other farmers also reported to practice fallow where they abandon their farms for a while to allow for natural fertility regeneration and to control pests and diseases. However, this is done by those with large land areas. Some practice crop rotation, while others plant their crops e.g. maize very early in the season, soon after they harvest beans, because they normally plant beans three times a year (in March or April, July or August and in September). To assure themselves against crop failure they mix various crops together, such as maize and beans with vegetables and sweet potatoes.

[30] found that farm households in Kenya employed various strategies in order to cope with climate related risks. The main strategies adopted are presented in Fig. 2.

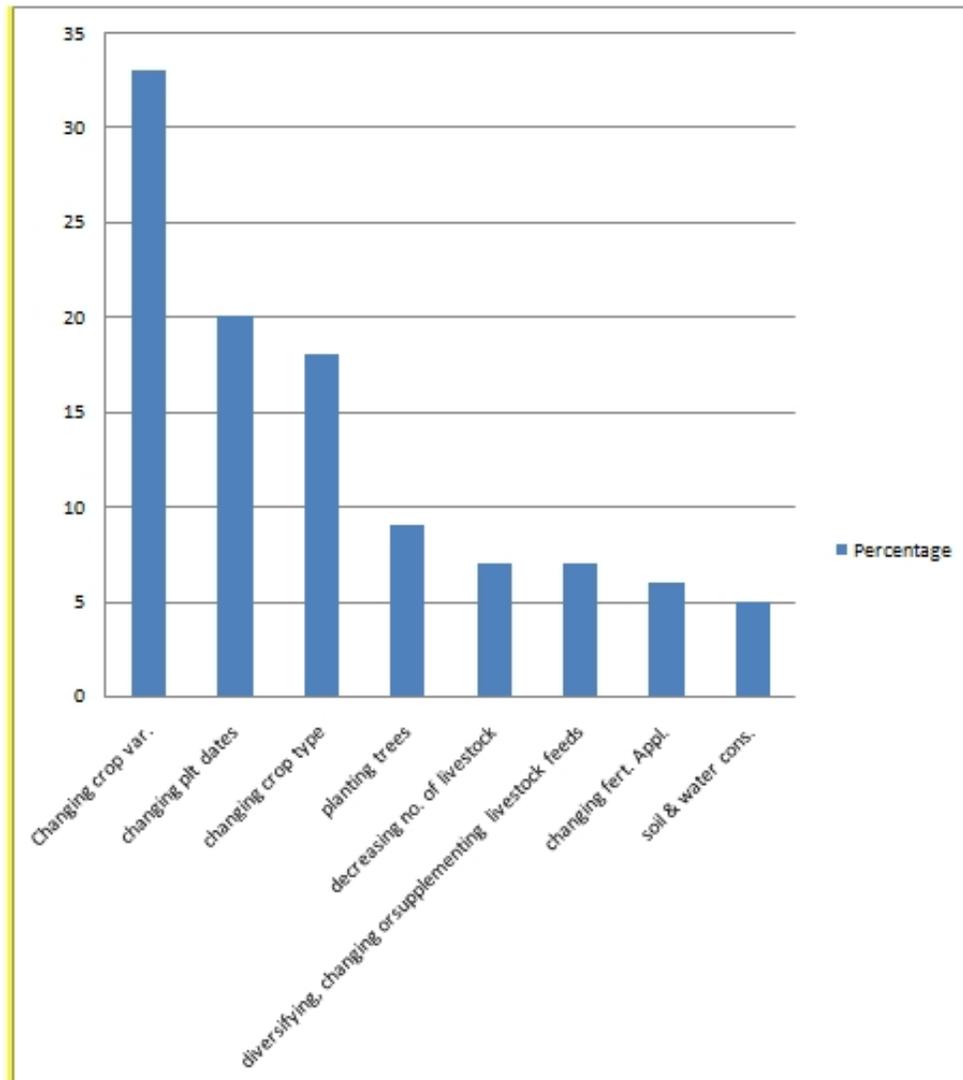


Fig. 2. Changes in agricultural practices reported by farmers in response to perceived climate change

Source: 30

In far Coastal Orissa area of India, rural households have being found to use various coping mechanisms to reduce the impact of climate change induced shocks. However as [31] reported the coping mechanisms vary according to the nature of extreme events. Accordingly, the strategies practiced to reduce climate change vulnerability during calamity year in the study area are presented in Table 4.

Table 4. Coping Strategies during calamity year in Coastal Orissa Area of India

| S/N | Strategy | Percentage of respondents following these strategies | | | |
|-----|--|--|---------|-------|---------|
| | | Common | Drought | Flood | Cyclone |
| 1. | Adjustment in crop varieties | | | | |
| | a. Late(early) sowing of crops | NA | 74 | 30 | NA |
| | b. Use resistant crop variety | NA | 63 | 42 | NA |
| 2. | Adjustment in livestock management | | | | |
| | a. Changing livestock composition | 60 | - | - | - |
| | b. De-stocking of animals | 19 | - | - | - |
| 3. | Water management | | | | |
| | a. Soil moisture control | - | 24 | NA | NA |
| | b. Traditional water harvesting | - | 17 | NA | NA |
| 4. | Seeking alternate employment | - | - | - | - |
| | a. In relief works | 37 | - | - | - |
| | b. Within same locality | 52 | - | - | - |
| | c. Migration | 22 | - | - | - |
| 5. | Drawing down inventories | | | | |
| | a. Stored foodgrains | 56 | - | - | - |
| | b. Sale of cattle | 17 | - | - | - |
| | c. Sale of mortgage of land | 22 | - | - | - |
| | d. Sale of other assets | 08 | - | - | - |
| 6 | Reduced expenditure towards | | | | |
| | a. food consumption | 77 | - | - | - |
| | b. Clothes & festivals | 82 | - | - | - |
| | c. Education | 60 | - | - | - |
| 7. | Cooperative/collective action | | | | |
| | a. Raising high bunds/embankments | - | NA | 44 | NA |
| | b. Joint cultivation of common lands | 19 | NA | - | NA |
| | c. Helping neighbour in reconstruction | 11 | - | - | - |
| 8. | Drawing upon common property resources | | | | |
| | a. Fish/turtle catching | 27 | - | - | - |
| | b. Fuel wood collection | 32 | - | - | - |
| 9 | Other strategies | | | | |
| | a. Cases of non-repayment of dues | 11 | - | - | - |
| | b. Posyponed family festivals | 07 | - | - | - |
| | c. Borrowing | 22 | - | - | - |

In Upper East Region of Ghana, [32] found that farmers responses for crops in bad years are: relying more on legumes than cereals, for immediate food, exchange for food and sale for cash; shifting planting season; refill, transplanting and plant together; using drought tolerant crops and early maturing varieties; eating crops that are premature on the field before harvest is due; going out of production and selling their labour for cash for food. In the case of pastoral farmers, responses were: animals are sent to areas where water and pasture are available; after harvesting beans and groundnut nines are stored for them; animals are allowed to roam in search of feed and water; reduction of herd size through sale; and storing waste water used in the house for the animals. Other measures included multi-cropping, relay-cropping and inter-cropping. Other peripheral responses include the abandonment of farming to engage in other economic activities such as weaving of door mats, car mats, hand bags and baskets owing to unreliability of rainfall and its consequent poor yield of produce. Also, due to drying up of rivers and streams during drought years,

temporary wells are dug within the stream/river bed. Some non-farm coping strategies adopted included petty trading and cottage industries.

In Nigeria, farm households have also been found to use combination of strategies to cope with the effect of climatic change. Studies by [33] in Ondo State revealed that coping strategies to mitigate effect of climate change on food crop production employed by farmers is presented in Table 5.

Table 5. Coping Strategies employed by farm households in Ondo State, Nigeria

| Coping Strategy | Regularly | Occasionally | Never | Mean | Rank |
|---------------------------------|------------------|---------------------|--------------|-------------|-----------------|
| Early planting | 96 (80.0) | 21 (17.5) | 3 (2.5) | 1.78 | 2nd |
| Mixed farming | 88 (73.3) | 32(26.7) | 0.00 | 1.73 | 3rd |
| Early harvesting | 63 (52.5) | 37 (30.8) | 20 16.7 | 1.36 | 6th |
| Mulching | 46 (38.3) | 53(44.2) | 21. 17.5 | 1.24 | 11th |
| Constructing fire track | 39 (32.5) | 27(22.5) | 54.45.0 | 0.88 | 13th |
| Mixed cropping | 96 (80.0) | 24(20.0) | 0.00 | 1.80 | 1st |
| Planting drought resistant crop | 73 (60.8) | 25(20.8) | 22 18.3 | 1.43 | 5th |
| Improved storage facilities | 62 (5.7) | 33(27.5) | 25 20.8 | 1.31 | 8th |
| Soil conservation method | 58(45.8) | 37(30.8) | 25 20.8 | 1.28 | 7th |
| Increase irrigation system | 32(26.7) | 40(33.3) | 48 40.0 | 0.87 | 14th |
| Increase land size cultured | 54(45.0) | 38(31.7) | 28 23.3 | 1.22 | 10th |
| Reduce land size cultured | 36 (30.0) | 30(25.0) | 54 23.3 | 0.85 | 15th |
| Move to different location | 43(35.8) | 39(32.5) | 38 31.7 | 1.04 | 12th |
| Off farm activities | 93(77.5) | 19(14.2) | 10 (8.3) | 1.69 | 4th |
| Delay planting | 55(45.8) | 37(30.8) | 28 (23.3) | 1.23 | 9 th |

Source: [33]

Figures in parenthesis are percentages

5. CONCLUDING REMARKS AND POLICY IMPLICATIONS

The coping strategies adopted by farm households suggest that actions constantly change with different situations. It is important to note that not all strategies to cope with hazards are efficient or appropriate for long term adaptation. Some strategies are based on short-term considerations, survival needs, lack of information or foresight and these may impact negatively on the environment, thereby reducing future adaptive capacity [34]. The sustainability of different coping strategies also depends on the intensity, duration and frequency of the hazard. The major threat to most of the coping strategies is their lack of sustainability in the face of current and projected climate change impacts which would lead to ecosystem degradation and loss of goods and services from the natural resource pool on which community depends on.

Also, most of the coping strategies are mostly based on the use of natural resources and their sustainability under a changing environment is questionable. Hence, there is an urgent need to find sustainable alternative livelihood strategies of life that would only be possible through materialization of existing policies and programmes, allocation of resources and capacity building. This further emphasizes the need for greater investments in rural and agricultural development to support households' ability to make strategic long-term decisions that affect their future well-being. Investments in infrastructure (such as roads and irrigation), extension services, credit schemes, and climate information systems would help create the

enabling environment for adaptation. Farmers also need access to essential inputs such as better seeds and fertilizer, as well as other rural services supporting adaptation, such as education and health services.

COMPETING INTERESTS

Authors declare that there are no competing interests.

REFERENCES

1. Mengistu DK. Farmers' perception and knowledge of climate change and their coping strategies to the related hazards: case study from Adiha, Central Tigray, Ethiopia. *Agricultural Sciences*. 2011;2(2):138-145. Doi: 10.4236/as.2011.22020.
2. Tarhule A, Lamb P. Climate research and seasonal forecasting for West Africans: Perceptions, disseminations, and use? *Bulletin of the American Meteorological Society*. 2003;84:1741-1759. doi:10.1175/BAMS-84-12-1741
3. Deschenes O, Greenstone M. The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. *American Economic Review*. 2006;97(1):354-385.
4. Charles N, Rashid H. Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI Discussion Paper 00714. 2007; Washington DC, USA.
5. Watson RT, Zinyoera MC, Moss RH. *The regional impacts of climate change: An assessment of Vulnerability*, Cambridge University Press Cambridge; 1998.
6. Intercontinental Panel on Climate Change. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Report edited by McCarthy J.J. et al., Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK; 2001.
7. Food and Agricultural Organisation, FAO. *The state of food insecurity in the world: Eradicating hunger-Taking stock ten years after the World Food Summit*. 2006; FAO, Rome. Accessed on 23/10/2012.
Available: <http://www.fao.org/docrep/009/a0750e/a0750e00.htm>
8. Schlenker W, Lobell DB. Robust negative impacts of climate change on African agriculture. *Environmental Research Letters* 5. 2010; Doi 10.1088/1748/1/01410.
9. Mapfumo P, Chikowo R, Mtambanengwe F, Adjei-Nsiah S, Baijukya F, Maria R, Mvula A, Giller K. Farmer's perceptions leads to experimentation and learning. *LEISA*. 2008;24(4):30-31.
10. Mtambanengwe F, Mapfumo P, Chikowo R, Chamboko T. Climate change and variability: Small holder farming communities in Zimbabwe portray a varied understanding. *African Crop Science Journal*. 2012;20(2):227-241. ISSN 1021-9730/2012.
11. Tol RS, Fankhauser S, Richel RG, Smith JB. How much damage will climate change do? Recent estimates. *World Economics-Henley on Thames*. 2000;1(4):179-206.
12. McCarthy JJ. *Climate change: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change*, Cambridge University Press; 2002.
13. Collier P, Conway G, Venables T. *Climate change and Africa*. *Oxford Review of Economic Policy*. 2008;24(2):337-352.
14. Kurukulasuriya P, Mendelsohn R. A Ricardian analysis of the impact of climate change on African cropland, The World Bank. 2007; Accessed on 5th January, 2013.
Available: <http://ssrn.com/abstract=1005544>.

15. Leadership Newspaper. Climate Change and Agriculture in Nigeria, January 16, 2013.
16. Berkes F, Jolly D. Adapting to climate change: socio-ecological resilience in a Canadian Western Arctic Community. *Conserv. Ecol.* 2001;5(2):18-27.
17. Campbell A. Managing Australian Landscapes in a Changing Climate. A Climate Change Primer for Regional Natural Resource Management Bodies. Department of Climate Change; 2008.
18. Falkenmark M, Rockström J. Curbing Rural Exodus from Tropical Drylands. *Ambio.* 1993;22(7):427-437.
19. Thomas D, Osbahr H, Twyman C, Adger N, Hewitson B. Adaptive: Adaptations to climate change amongst natural resource-dependant societies in the developing world: across the Southern Africa climate gradient. Tyndall Centre for Climate Change Research. Technical Report. 2005;35.
20. Heltberg R, Siegel PB. Climate Change: Challenges for Social Protection in Africa. Paper for conference on social protection for the poorest in Africa. Washington DC, World Bank; 2008.
21. Freeman HA, Kaitibie S, Moyo S, Perry BD. Livestock, livelihoods and Vulnerability in Lesotho, Malawi and Zambia: Designing livestock interventions for emergency situations. ILRI Research report 8. ILRI (International livestock Research Institute). 2006; Nairobi, Kenya: pp 62.
22. Maddison D. The perception of and adaptation to climate change in Africa. CEEPA Discussion Paper No. 10. 2006; Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.
23. Salick B, Anja B. Indigenous peoples and climate change. Oxford, UK, Tyndall Centre for Climate Change Research. 2007. Accessed on 24/08/2012.
Available: <http://tyndall.webapp.uea.ac.uk/publications/Indigenouspeoples.pdf>.
24. Tesso G, Emanu B, Mengistu K. Econometric analysis of local level perception, adaptation and coping strategies to climate change induced shocks in North Shewa, Ethiopia. *International Research Journal of Agricultural Science and Soil Science.* 2012;2(8):347-363. (ISSN: 2251-0044).
25. Workineh K. Traditional Oromo Attitudes towards the Environment: An Argument for Environmentally Sound Development. OSSREA Social Science Research Report Series, No. 19. 2001; Addis Ababa: Commercial Printing Enterprise. Accessed on 24/12/2012. Available: <http://www.ossrea.net/ssrr/workneh/toc.htm>
26. DPPC. Vulnerability profile: Strengthening emergency response abilities. Addis Ababa, Ethiopia; 2000.
27. Deressa TT, Ringler C, Hassan RM. Factors Affecting the Choices of Coping Strategies for Climate Extremes: The Case of Farmers in the Nile Basin of Ethiopia. IFPRI Discussion Paper 01032. 2010.
28. Sacramento A, Matavel A, Basilio M, Bila. Climate Change Impacts and Coping Strategies in Chicualacualla District, Gaza Province, Mozambique. Joint Programme on Environmental Mainstreaming and Adaptation to Climate change in Mozambique. MDG Achievement Fund. n.d.
29. Kangalawe R, Mwakalila S, Masolwa P. Climate Change Impacts, Local Knowledge and Coping Strategies in the Great Ruaha River Catchment Area, Tanzania. *Natural Resources.* 2011;2:212-223. Doi:10.4236/nr.2011.24027
30. Bryan E, Ringler C, Okoba B, Roncoli C, Silvestri S, Herrero M. Coping with Climate Variability and Adapting to Climate Change in Kenya: Household and Community Strategies and Determinants IFPRI. 2011; Washington, DC.

31. Roy BC, Mruthyunjaya T, Selvarajan S. Vulnerability to Climate Induced Natural Disasters with Special Emphasis on Coping Strategies of the Rural Poor in Coastal Orissa, India¹. Paper prepared for the UNFCCC COP8 Conference organised by the Government of India, United Nations Environment Programmes, and FICCI during October 23-November 1, 2002, Vigyan Bhavan, New Delhi, India.
32. Ofori-Sarpong E. Impact of climate change on agriculture and farmers coping strategies in the Upper East Region of Ghana. *West African Journal of Applied Ecology*. 2001;2:21-35.
33. Olayemi AO. Determinants of climate change and coping strategies among crop farmers in Ondo state, Nigeria *Agricultural Research and Reviews*. 2012;1(4):127–131.
34. Eriksen S. Linkages between climate change and desertification in East Africa. Part 1: Physical and social linkages. *Arid Lands Newsletter*. 2001;49.

© 2014 Shuaibu et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<http://www.sciencedomain.org/review-history.php?iid=537&id=5&aid=4653>