

Effect of Climate Change on Agricultural Production and Community Response in Daro Lebu & Mieso District, West Hararghe Zone, Oromia Region National State, Ethiopia.

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Abstract

Rain-fed agriculture, which is the backbone of most Ethiopian economies, is seriously under threat due to climate change. Therefore, this study aimed to assess the effect of climate change on agricultural production in Mieso and Daro Lebu districts of West Hararghe zone. A total of Six (6) kebele, three from each district were used for this purpose. The study used Focus Group Discussion to collect data from group of farmers through multidisciplinary group of researcher organized from Mechara Agricultural Research Center. The result of the study revealed that Daro Lebu district was potential in crop production such as maize, sorghum, teff, finger millet, ground nut, sesame, hair coat bean, sweet potato, hot pepper, mango, banana, coffee and chat while Mieso district was potential in livestock production. The study also indicated that due to climate change induced factors the productivity of agriculture was reduced from time to time. The findings revealed that majority of the communities in the study area response to the effect of climate change through practicing planting drought tolerant and early maturing crop variety, shifting from maize production to sorghum and groundnut production, participating on non-farming activities, adjusting cropping time (from April to June), shifting from cattle rearing to shoat and camel production, reducing livestock flock, migration to search feed & water and migration to other area and serve as daily laborer. The research finding also recommended that, provision of drought tolerant improved crop variety and animal breed, create awareness on sustainable means of response to adverse effect of climate change and providing training on climate smart agricultural production methods will be used us option to minimize its effect on community livelihood option of the study areas.

Keywords: Agricultural production, response to climate change, climate change, Focus Group discussion, drought tolerant technology.

INTRODUCTION

Climate change is linked to internal variability of the climatic system and external natural factors but much more to human activities. Climate change has already significantly impacted agriculture and is expected to further impact directly and indirectly food production. Increase of mean temperature; changes in rain patterns; increased variability both in temperature and rain patterns; changes in water availability; the frequency and intensity of 'extreme events'; sea level rise and sanitization ; perturbations in ecosystems, all will have profound impacts on agriculture, forestry and fisheries. Climate change and climate variability that has been experienced in many parts of the world add to the challenges that face the agricultural sector in the Africa. Considerable shifts in long-term averages and variability in rainfall and temperature, sea levels, frequency and intensity of droughts and floods have also been experienced (IPCC, 2007).

Climate change will exacerbate problems related rapid population growth, existing poverty and a heavy reliance on agriculture and the environment. Developing countries have a much more limited capacity to cope with the problems caused by climate change. Africa remains the only region in the developing world where agricultural yields are low and continue to decline. Despite the recent progress in agricultural and land management technologies, agricultural production in most parts of the continent are still at subsistence levels with the small holder producers who dominate the agricultural production landscape barely able to meet their own consumption needs. Agriculture plays a significant role in food security and poverty alleviation, especially in the rural African households. On average, agriculture accounts for 15 percent of the gross domestic product of African countries. (UNECA, 2011).

Most countries in Sub-Saharan Africa (SSA) rely heavily on agriculture for employment and food security for their economies. The sector also has large numbers of smallholder farmers, most of who produce under unfavourable conditions characterized by low and erratic rainfall and poor soils (Mutsvangwa, 2011). Given the importance of agriculture to employment and livelihoods in many developing countries, loss of agricultural productivity due to climate change will affect their entire economies. Many other economic sectors beyond agricultural value chains will likely experience indirect effects on income and consumption.

Agriculture in Ethiopia is heavily dependent on rain and geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate change (Zenebe G., *et.al.*, 2011). In Ethiopia, climate change is expected to intensify the already high hydrological variability and

frequency of extreme events. Droughts impair agricultural productivity and may lock subsistence farmers into poverty traps, whereas recurrent flooding can have long-term negative effects on agricultural GDP by directly damaging crops and destroying roads, thereby exacerbating the inadequacy of transport infrastructure and consequently limiting access to markets. Despite extensive research and increased availability of information, existing knowledge on how to adapt to climate change at the grassroots level is extremely fragmented and dispersed (Reid *et al.*, 2009).

It is believed that 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. Climate change also indirectly affects agriculture by influencing the 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 (McCarthy *et al.* 2001). Climate variability directly affects agricultural production since agriculture is inherently sensitive to climatic conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change. Climate change will affect food security by reducing livelihood productivity and opportunities (Chichongue *et al.*, 2015).

Changing rainfall and temperature patterns due to climate change have different effects on crops and livestock production. The production system of the study area totally depends on rain fed which is highly sensitive to climate change impact. Even though many research studies have been done at the national and international level, there is still an urgent need for communicating climate change issues for communities in appropriate ways. Providing scientific information concerning climate change for society is appropriate to local stakeholder for adoption of sustainable adaptation and response for solutions. Therefore, this study intends to assess the effect of climate change on agricultural production and communities' response during shock in the study area.

METHODOLOGY

Description of the Study Area

Darolebu is located at $8^{\circ}10'N40^{\circ}30'E$ and bordered on the south by the Shebelle River which separates it from the Bale Zone, on the west by the Arsi Zone, on the northwest by Guba Koricha, on the north by Habro, and on the east by Boke districts (Abdi E., *et al.*, 2013). The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 meter above sea level. The minimum and maximum temperature of the district ranges from 14 to $26^{\circ}C$ with average of $16^{\circ}C$ while average annual rainfall is 963 mm/year (District Agricultural Office, 2015). Most part of farming land is meant for production of coffee and chat (*Catha edulis L.*) which are the most cash crops in the district. Income of stallholders households in the district were mainly depends on this crop. Other major food like Maize, sorghum, groundnut and Haricot bean were mostly intercropped in coffee or chat farms in the district.

Meiso is located 300 km east of Addis Ababa at about 200 km east of the Oromia regional state capital of Adam. It is located west of Somali region and is one of district in Oromia where there are pastoralist farming system is practiced. Meiso is located east of Doba, north of Chiro & Guba Koricha, northeast of Anchara district; and northwest of Somali and south and southwest of Afar regions. Geographically, the district is located between $40^{\circ}9'30.1'' W$ and $40^{\circ}56'44'' E$; and: $9^{\circ}19'52'' N$ and $8^{\circ}48'12'' N$. The altitude of the district ranges from 1107 to 3106 m.a.s.l (District Agricultural Office, 2015). The mean annual temperature is around $21^{\circ}C$, while average annual rainfall is between 635 and 945 mm. The district mainly known by livestock raring since it is under one of pastoralist area in the west Hararghe zone. Even though, the community characterized as pastoralist, some of them produce crop like sorghum, maize and Haricot bean for food while sesame for market.

Method of Data Collection and Analyses

Daro Lebu and Mieso district was purposively selected form West Hararghe zone based on working area Climate Smart Initiative project. Accordingly, three kebeles from each district namely Gadullo, Milkaye & Oda Lalaba form Daro Lebu whereas Fayo, Chachole & Oda Bal'a from Mieso were selected. The research employed Focus Group Discussion (FDG) to assess the impact of climate change in the study area. Selections of households for group discussion were based on gender and representativeness of participant from different direction of the kebele. Therefore, 20-35 households were participated from each kebele during the discussion.

Table 2: Participant list on the Focus Group Discussion (FGD)

District	kebele	List of participant		Total
		Male	Female	
Daro Lebu	Gadullo	14	18	32
	Milkaya	21	2	23
	Oda Lalaba	14	9	23
Mieso	Fayo	19	11	30
	Chachole	22	13	35
	Oda Bal' a	18	4	22
Grand total		108	57	165

Source: Own competition

Data collection was conducted through FGD at kebele level and a multidisciplinary team of researchers was organized to collect it. The multidisciplinary teams include researchers of crop, livestock, natural resource, agricultural extension and socio economics from Mechara Agricultural Research Center. Data like crop production, livestock production, natural resource management, climate change impact on household's livelihood, source of information for climate change and households response to climate change in the study area were collected and qualitative method of data analysis was applied to analyze the data.

RESULT AND DISCUSSION

Agricultural Activities in the Study Area

Agricultural activity remains the main source of livelihood for the people of the study area to gate their daily food and income. The farming system of Daro Labu based on Mixed farming (crop with livestock while Meiso district mainly characterized with pastoralist farming system with some of them are agro pastoralists.

Crop Production

Crop production in the study area totally depends on rainfall availability which is highly sensitive to climate change. The major crops produced in the study areas includes maize, sorghum, teff, finger millet, ground nut, sesame, hair coat bean, sweet potato, hot pepper, mango, banana, coffee and chat. Sorghum, maize, teff and finger millet produced for food while chat, coffee, groundnut, sesame, mango, banana and hot pepper are mainly produced for market purpose. Chat and coffee plays vital role to increases the household's income. Sorghum and maize are the crops that play the great role in ensuring households' food security due to their resistance to drought. However, shortage of improved varieties of these crops which adapt climate change impacts reported as main problem by the participants.

Diseases like Anthracnose (*Colletotrichum sublineolum*), rust (*Puccinia spp*), smut (*Ustilago spp*) of sorghum and maize, early and late leaf spot of ground nut, root rot diseases of ground nut and common bean, *Phytophthora spp.* and *Fusarium spp* for hot pepper, Powdery mildew (*Oidium mangiferae*) and Anthracnose (*Colletotrichum gloeosporioides*) of mango were listed by participants. Insect and pest of maize and sorghum include stalk borer, chafer grub, Africa boll worm, aphids and trips are the most listed in the study area. Striga (*striga spp*), *Parthenium spp*, and *Cynodon dactylon* are the most invasive weeds in the study area.

Similarly, there are several factors that hinder the production and productivity of the crop in the study area. The major factors contributed to low production and productivities of crops in the study area such as drought, shortage and erratic rain fall, shortage improved variety, diseases and insect pest, weed, soil infertility, soil and water erosion, lack of training & shortage of agricultural inputs.

Soil infertility problem was visualized by the communities due to different reasons and direct relationship with crop production constraints. Soil fertility decreased from time to time due to it exposed to heavy sunlight and the nutrient loosed easily. The soil is easily taken by wind and water erosion. When the soil flora and fauna are exposed to sunlight the productivity of soil was decreased. Input like improved seed, insecticide and herbicide couldn't available to the farmers at all study area and the cost of those input are high in price and the farmers cannot afford the price.

Shortage of skill and knowledge of farmers on crop production and management are vital constraints in crop production due to lack of training for smallholders farmers on study area. Market problems are observed during the study area, farmers of study are said that they are not selling their product as they need and price of the commodity mainly dependent on the interest of collectors, brokers and retailers.

Livestock Production

Livestock production contributes very important role to ensure households food security and family income in the study area. Cattle, shoa, poultry, donkey are major livestock reared in both districts but camel production was mainly observed in Meiso district. The trend of livestock production reduced from time to time due to various factors like Shortage of grazing land & animal feed, drought, shortage of Veterinary service, lack of

improved animal breeds for all livestock type, grazing land conflict among tribes, low price of livestock and their product and high meddling of broker in livestock marketing

Worldwide reviewers stated that the performances of animals are strongly correlated to environments. Currently climate change is a great challenge in the world. Indirectly climate change has significant impact on feed resources on livestock productivity, carrying capacity of rangelands, and feeds, feeding options and grazing managements (Adisu, 2014). In study area the population pressure and the fixed availability of land resource as well as low attention of farmers toward forage cultivation as compared to food crop cultivation and field forage cropping not feasibly attachable due to land scarce.

Similarly drought, feed shortage, lack of water, disease and lack of veterinary service raised as major constraints for livestock production in the study. The major feed resources in study area include natural pasture, crop residues, crop thinning and weeds and especially during rainy season and browses (trees and shrubs) and cactus. Nutritional stress causes low growth rates, poor fertility and high mortality of livestock's which increases livestock diseases. The major diseases reported in study area are such as *Pastoralists*, *anthrax*, *mastitis*, *rabies*, *newcastile*, and *wax moth*. However, shortage of veterinary clinics and service, cost of drug makes difficulty for livestock production in study area. The participants of the discussion revealed that many farmers didn't brought their livestock's to get veterinary service but they purchased medicine from market then used without considering its quality and expired date. They also indicted that informal marketing of medicine is the main reason that obstruct farmers to benefits from the available veterinary service located at kebele level.

Livestock marketing was traditional system in which price fixation is based on eye ball estimation and determined by the traders or broker rather than producers. High interference of brokers in livestock marketing in the study area reduces the price share of producers. On the other hand due to climate impact (drought and feed shortage) the body weight of livestock reduced which imposed low price especially at sever stage. Other constraints like lack of improved breed, conflict on natural pasture, informal marketing of livestock medicine and lack of training in hindering livestock production and productivity in the study area.

Natural Resource Management

Ethiopia's soil is prone to erosion and loss of soil fertility. Soil and water conservation technologies have been suggested as a key adaptation strategy for developing countries, particularly those in Sub-Saharan Africa, in light of increased water shortages, drought, desertification, and worsening soil conditions (Kato *et al.*, 2009). Natural resource in the study area exhausted from time to time due deforestation, population pressure, expansion of agricultural land and impact of climate change.

Forest coverage in the study area collapsed because of expansion of agricultural land which facilitates climate change and variability in the study area. Similarly, soil fertility status of the study area becomes declined from time to time. In line with government strategy to rehabilitate degraded land, there is huge activity conducted like reforestation and development of different structure to reduce soil and water erosion in the study area for the last years with participation of the community. Even though those conservation practices applied, the participants indicated that poor management of the area was observed. Additionally, the community plant trees on area closure annually but most of seedling didn't survived due to poor management and rainfall shortage.

Effect of Climate Change on Farming Communities' Livelihoods

Climate change directly affects agricultural production since agriculture is highly sensitive to climatic conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change. Climate change affects household's food security by reducing livelihood productivity and opportunities. Farming practice in Daro Lebu and Mieso districts totally depend on the rain fed which highly imposed their livelihoods to climate change. Participants of FGD at all kebele reported that due to climate change they lose their livelihood activities and highly vulnerable to food insecurity and shock.

In the study area crop and livestock productivity reduced from time to time due to severe drought, land degradation, depletion of soil nutrient, diseases, pest and insect, invasive weed and shortage of feed resources for animals. The participants also indicated that rainfall and temperature in study area has been decreasing and increasing, respectively, thus negatively affecting the production and management of crop and livestock in the study area. Crop failure and low harvest is common problem in the study area due to shortage of rainfall and severe drought.



Photo: Impact of drought on Crop & Livestock production, 2015 cropping year

The principal cause of climate change in the study area includes deforestation, expansion of land for agriculture, population pressure, over grazing and poor soil and water conservation practices.

Table 3: Climate change and its effect in the study area

Events	Change observed	Effect
Rainfall availability	Decreased	<ul style="list-style-type: none"> ➤ Crop failure and low yield harvest. ➤ Feed shortage and lose animal flock. ➤ Increase of diseases, pest and insect
Drought	Increased / very Severe	<ul style="list-style-type: none"> ➤ Drying of water sources in villages ➤ Decrease in agricultural productivity ➤ Water insecurity increased
Crop and livestock productivity	Decreased	<ul style="list-style-type: none"> ➤ Increase food insecurity problem in the village
Soil fertility	Decreased	<ul style="list-style-type: none"> ➤ Decrease in agricultural productivity
Forest coverage	Decreased	<ul style="list-style-type: none"> ➤ Decrease rainfall availability

Source: Focus Group Discussion (FDG), 2015

Community Response toward Climate Change

Climate change causes important changes in African agriculture and will continue to do so for the fore-seeable future. The farming community will be required to react to the changes through various means such as making adjustments in farming practices, crop varieties planted, modifying the cropping calendar, and engaging on other risk minimization strategies (Ajayi O.C. *et al.*,2009). Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events (IPCC, 2007). However, the climate impacts threaten the livelihoods of the rural communities of the study area, they have been taken measure through the adoption strategies and risk management measures, which increase community resilience. The On other hand some mitigation strategies practiced by the community (selling of charcoal and wood) imposed climate change in the village. In general, the community practiced different adaptation strategies toward climate change hazard of which the following are the major in the study area.

- Drought tolerant and early maturing crop variety planting
- Shifting from maize production to sorghum and groundnut production
- Pond construction and water harvesting during rainy season
- Migration to other area and serve as daily laborer
- Participating on non-farming activities(petty trading especially women)
- Adjusting cropping time (from April to June)
- Shifting from cattle raring to shoat and camel production
- Migration to search feed and water
- Reducing livestock flock
- Good land preparation and mulching the soil with different plant materials

Though the community practiced the above mention strategies to cope with climate change impact,

access to agricultural technologies and information on climate change were reported as major constraint by the participants for example drought tolerant and early maturing improved crop varieties. Additionally, lack of awareness and training on how to adapt to this shock indicated as constraints hindering their capacity to respond. Limitation of interventions to improve climate change impact on community livelihood also reported as constraints by the communities.

SUMMARY AND RECOMMENDATION

Summary

Climate change imposed food security problem on farming communities by distracting their daily livelihoods. This assessment intended to identify effect of impact of climate change on smallholder farmers concerning agricultural activities. Based on working area of Climate Smart Initiative project, Daro Labu and Mieso districts were selected purposively. A total of six (6) kebeles, three from each were used based on project interest & 30-35 households were involved in the discussion at each kebele.

The major crop produced in the study area includes Cereals (maize, sorghum, teff & finger millet), pulse and oil (haricot bean, sesame & groundnut), horticultural (sweet potato, mango & Hot pepper) and others (coffee & Chat). Maize and sorghum play important role in ensuring households' food security while coffee and chat was the major cash crop in the study area. However, the production and productivity of crops declined due to different environmental factors like drought, shortage and erratic rain fall, shortage of improved variety, diseases and insect pest, invasive weeds, soil infertility, soil and water erosion, weed erosion, lack of training and shortage of input.

Livestock production contributes very important role to ensure households food security and family income in the study area. Cattle, goat, poultry, donkey are major livestock reared in both districts but camel production was mainly observed in Meiso district. Shortage of grazing land and animal feed, drought & water insecurity, shortage of Veterinary service, lack of improved animal breeds for all livestock type, grazing land conflict among tribes, low price of livestock and their product and high meddling of broker in livestock marketing reported as main constraints contribute to reduce livestock production and productivity.

Natural resource of the study area declined from time to time due to deforestation, Population pressure, expansion of agricultural land and impact of climate change. According to FGD participants, due to natural resource degradation problem in the study area climate change happened and impose difficulty on farming community's livelihoods. Climate change exerts pressure on rainfall availability, crop and livestock production & productivity and natural resource of the study area.

However, the communities practiced adaptation & mitigation strategies to cope up with climate change. These practices includes drought tolerant and early maturing crop variety planting, shifting from maize production to sorghum and groundnut production, pond construction and water harvesting during rainy season, migration to other area and serve as daily laborer, participating on non-farming activities (petty trading especially women), adjusting cropping time (from April to June), shifting from cattle rearing to goat and camel production, migration to search feed and water, reducing livestock flock and good land preparation and mulching the soil with different plant materials and good land preparation and mulching the soil with different plant materials.

Recommendation

The study forwards some recommendation to improve smallholder's knowledge on climate smart agricultural activity to adapt toward adverse impact of climate change.

- Drought imposed difficulty on crop and livestock production in the study area. A combination of strategies to adapt this factor; such as proper timing of agricultural operations, crop diversification, use of different crop and diversifying from farm to nonfarm activities should be get attention.
- Shortage of drought tolerant improved seed and livestock breed are the main constraints that limit smallholders' capacity to respond to climate impact. Therefore, to save the livelihoods of farming communities, supply of climate smart technology will be the possible solution in the study area.
- Even though climate change increased from time to time in the study area, lack of awareness on how to adapt to it was observed as constraint. Therefore, training of community on scientific method of respond to climate change and awareness creation on appropriate means of mitigation practices for rural community should get emphasis to maintain their livelihoods.

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