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Full Length Research Paper

Farmers' perception on climate change adaptation strategies: A case study from the irrigation schemes of Central Tigray Regional State, Ethiopia

Kinfe Asayehegn

School of Environment, Gender and development Studies, Awassa College of agriculture, Hawassa University, Ethiopia.
E-mail: kinfe85@gmail.com, mikkinfe@gmail.com.

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Agricultural production and productivity and the vulnerable sector for climate change is growing in most of the agrarian developing countries such as Ethiopia. Application of agricultural technologies and production packages is the reason for the increasing production resisting to climate change. Recently, climate change became a global agenda where scientists, politicians and experts are working towards mitigations and adaptations both in small scale and large scale. This paper therefore, analyzes the farmers' perception in trends of production, productivity in explicit and climate change in general. It also asses the household level adaptation strategies of climate change 542 so as to have a conducive environment for life. To satisfy the predetermined objectives, a two-stage sampling procedure was used to first select peasant associations and then sample respondents. Descriptive statistics was used to analyze the adaptation strategies of climate change taking irrigation user and nonuser households comparatively as a source of primary data. The study found that farming households of the study area use different ways of climate change mitigation and adaptation strategies. Consequently, 76.15% of the sample households perceive change land under cultivation as a good strategy of climate change adaptation a few (57.69 %) practiced it practically for changing their livelihood. The farm families perceives irrigation technology, water harvesting systems, planting short season maturity crops, soil conservation methods such as bunds and terraces and tree planting are good strategies for climate change adaptation at the household level.

Key words: Adaptation strategies, climate change, farmers' perception.

INTRODUCTION

In the last decades it has become increasingly apparent that climate change is already happening, and will continue to happen, bringing with it local impacts on people's livelihoods (Parry et al., 2007). The IPCC's fourth assessment report concludes that it is extremely likely that the rise in global atmospheric temperature that has taken place since the mid-nineteenth century has been caused by human activities (IPCC, 2007). This confirms climate change is a recent phenomenon being caused due to different factors. People will need to change their lifestyles, adapt either because the local impacts of climate change leave them no alternative, or because specific adaptation will reduce the losses associated with those impacts substantially. In many places, climate change will not manifest itself merely as a gradual change in average conditions, but rather a change in the frequency and intensity of extreme events, such as heavy rainfall or drought, or periods of extreme heat or cold (Solomon, 2007).

The threat of global climate change has caused concern among scientists as livelihoods of the smallholders could be severely affected by changes in key climate variable (i.e., rainfall and temperature) and agricultural production and food security could be affected both globally and locally. Evidences are showing that the anticipated effects of climate change are predominantly very large and far-reaching in the tropical zones of the developing countries with precipitation regimes ranging from semi-arid to humid (Cline, 2007).

Climate change could have adverse effect on various

biophysical and economic activities like agriculture, water resources, forestry, human health, biodiversity and wildlife. The consequences of climate change are severe in third World smallholding peasant agriculture because it is rain-fed and relies on the mercy of nature, and still the art of agriculture of the majority of the region (World Bank, 2007).

Variabilities in precipitation are altering water budgets and affecting the amounts and quality of water available for growth and support of life. Increasing temperatures are reducing the ability of ecosystems to retain water for growth. Soils are degrading as they lose water and microbial biodiversity. The spatial extent and intensity of these effects vary geographically from one place to another depending on location in the global atmospheric systems, regional settings on: land cover, land use, topography and weather patterns. The two most important climate stressors are changes in rainfall and temperature (Maitma et al., 2009). Hence, the preference for irrigation schemes is based on the perceived easy adaptability of the systems to local environmental and socioeconomic conditions that mitigates climate change and revealed better livelihoods (Vaishnav, 1994). This is the recent shift in the development paradigm to 'development from below', an approach subsumed under 'sustainable development' (Adams, 1990). Interventions into existing small-scale irrigation systems cannot be done successfully unless the existing farming system is taken into consideration. If small-scale irrigation is to make a substantial and positive contribution for people, it is essential that it fits into their livelihood systems. Experiences of countries that have had successful small-scale irrigation show that such systems have very often developed as part of the indigenous farming system for mitigating the challenges from climate change.

The study area, Tigray regional state is one of the most land-degraded states of Ethiopia (Hurni, 1993). The region is characterized by subsistence farming households raising predominantly cereal and vegetable crops for local consumption and sale. Crop production in the region has failed to keep pace with population growth due to recurrent droughts, environmental degradation and wars, including the most recent conflict with Eritrea which is factors for the cause of climatic changes (Ersado, 2005). In response to severe environmental degradation and population-resource imbalance, the regional government of Tigray has initiated a major rural development program called Sustainable Agricultural and Environmental Rehabilitation of Tigray (SAERT), through which several small-scale dams have been, constructed (Ersado et al., 2004). The commission planned to construct 500 micro-dams over ten years and three of the constructed micro-dams are found in the study area-Laelay Maichew district of the central Tigray.

Generally, there are only a few scientific understanding about climate change adaptations both at local and national levels. Therefore, the study explored the farmers' perception on climate change and the mitigation measures taken by the farming community.

METHODOLOGY OF THE STUDY

Data collection and analysis

Primarily**,** the region is categorized in to administrative Zones and the administrative Zones to Woredas. Secondly, the administrative Woredas categorized to administrative Kebeles and then three administrative Kebeles namely, Dura, Dereka and Mahbere Selam was selected purposively considering the availability of irrigation schemes. A stratified list of household heads by gender and irrigation utilization such as users and nonusers was prepared. The stratum of irrigation user consists of households who own, rented/shared in/out or gifted in land for direct utilization. The second stratum referred to as hereafter as non-users are composed of households who neither owned irrigated land nor involved in irrigation-farming. Finally, data is collected from a total of 130 rural farm households looking separately 65 irrigation user and 65 nonuser households giving equal emphasis for gender difference.

A structured interview schedule supported by personal observations of physical features was used to collect primary data. The structured interview schedule was triangulated using key informant interview of the irrigation and water resource experts and officers, peasant association managers, and development agents. Moreover focus group discussion of farmers taking one focus group from each scheme was the other approach of triangulating of the primary data. In addition to primary data, secondary data were collected from different sources, published and unpublished documents of respective offices and departments such as District Offices of Irrigation Development (DOID), District Offices of Rural and Agricultural development (DORAD), District Offices of Finance and Economic Development (DOFED), Ministry of Agriculture and Rural Development (MOARD), Ministry of Water Resource Development (MWRD) and other related journals and books. Data is inserted and encoded in to Statistical Package for Social Science (SPSS). Applying the SPSS, descriptive statistics (mean, frequency, percentage and standard deviation) is used to analyze the collected data.

RESULTS AND DISCUSSION

Trends of crop and animal production

The trends of crop production have different dimensions with regard to spatial and temporal difference. This temporal and spatial difference depends on different factors. The availability of irrigation schemes and opportunity of rain water is the main cause in addition to

Table 1. Land holding size of irrigation user and nonuser households.

Land holding in ha.	User	Nonuser	Total	t-value
	Mean	Mean	Mean	
Total cultivated land	1.1	0.627	0.856	5.826***
Irrigable land	0.5	0.000	0.247	13.531***
Rain-fed land	0.6	0.627	0.608	0.546
Farm experience in years				
Rain-fed	33.37	29.68	31.52	1.706**
Irrigation	11.86	0.000	5.93	14.757***

*** and** statistically significant at 1% and 5% probability level respectively.

Table 2. Farmers' perception on the trends of crop production (before and after 20 years).

	Crops producing before 20 years but not today	Crops producing today but not before 20 years
Irrigation users		Vegetables Fruits Nuts and tubers
Irrigation nonusers	Sorghum Millet Long season Maize Lenticels	Pea Short season Teff Drought resistance Maize Less valued crops

Source: Own survey result 2010.

other natural resource base for the difference in reference of the spatial disparities. Temporally, the rainwater of the study area is becoming deteriorating and erratic in which at some seasons/years it is heavy that devastates the natural resource base and in the other year/season it is too short that yields drought. Due to this, the trends of the crops such as sorghum, millet and Maize is reduced due to the long season rain water requirement for the crops and replaced by short season crops such as teff, pea, nuts and vegetables for the last twenty years. May and June months were absolutely rainy seasons before the specified time and gradually the starting time for rain becomes from the mid June. However, comparatively the irrigated places improve the production and productivity of crops as a result of double season production and drought prevention for erratic rain falls through supplementing the rain seasons. Even the dry months of May and June are opportunities for soil aeration and drying in the irrigation that leads better production. This supports the irrigators to be net beneficiaries from two dimensions, mitigating the climate change in one hand and extra production in dry seasons in the other hand.

The other factor for the reduction of production of crops per household is the reduction of land size and land resources such as nutrients due to the increase in human population and environmental degradation. Resource ownership and farm experience have a profound effect on the participation decision-making behavior of farm households. The variables experience in rain-fed farming and rain-fed land holding pertain to both users and nonusers of small-scale irrigation while the variables irrigation experience and irrigable land holding pertain to users only. The survey results revealed that 10.8% of the users of irrigation do not own rain-fed land at all. On the other hand, of the total respondents, 4.6% of the users and 7.7% of the nonusers do not own land but cultivated land obtained through sharecropping arrangements. Findings of the survey revealed that 58.5% of the users and 17% of the nonusers shared in land, while 16.9% of the users and 24.6% of the nonusers shared out their own land. This shows that irrigation users are better practice land shared in than nonusers are. The land shortage and searching for additional land is the motivating factor for shared in (Tables 1 and 2).

Wealth ranking of the survey found that rural farm households ranked livestock as a key asset next to land, which indicated 92.3% of the users and 70.8% of the nonusers of small-scale irrigation rear different types of livestock. Livestock, besides its direct role in raising agricultural productivity, it helps households stabilize consumption by absorbing income shocks that might

Table 3. Livestock owned by the farm households in total livestock unit (TLU).

	User	Nonuser	t-value
Mean	4.732	2.338	
St.dev	2.802	1.898	**5.703****
Minimum	0.000	0.000	
Maximum	14.985	8.24	
Oxen (mean)	2	1	**4.742****

Source: survey data, 2010.

arise from crop failures triggered by natural disasters. In the study area, oxen are the sole draught power sources and hence lack of oxen besides its negative effect on land productivity signifies a lower economic status of farm households. Households who do not own oxen either acquire the much needed pair of oxen at a cost or forced to share/ rent out their land, which means a substantial reduction in income. Households with larger number of livestock particularly oxen, therefore, are likely to raise farm income for they can use other farm inputs more efficiently by bringing additional land into cultivation through either cash rent or share cropping basis.

The study also revealed that shortage of feed, recurrent drought, lower market prices and productivity at vulnerable seasons are the common problems of users and nonusers of irrigation in livestock production caused due to the sever problem of climate change. Although both users and nonusers of small-scale irrigation have the problems of livestock production, the severity of the problems is different for the two groups. Severity of the livestock production problems of the users of irrigation is lower than, the nonuser households by nearly half, due to the presence of irrigation by-products, which covered part of the feed expenses and easily availability of water. Practical experience of farm households and experts confirmed that livestock production is comparatively reduced taking a temporal framework before and after twenty years due to the aforementioned factors (Table 3).

Trends in human and other resource changes

Irrigation user and nonuser households have similar response to the changes of some of the resources of the study area while they have different response to some of the resources. Human population is increasing alarmingly as a response of both the users and nonusers of small-scale irrigation. This resulted over splitting of farmlands both in the irrigated and rain-fed areas that reduces the output per individuals. This also results in diminishing of soil and other natural resources due to overutilization and miss utilization. Livestock resources such as cattle, sheep and got of the study area also deteriorates from decade to decade from the sides of the nonusers of irrigation while increasing in the irrigation users. This is due to that irrigation provides feed for the livestock while the nonusers of irrigation are suffering from feed and water for their livestock. Forest resource is the other variable where totally obliterated in the dry mountains distant from the irrigation dams in which the planted seedlings dried out due to water deficiency while re-forested in the wet irrigation scheme bounded plains (Table 4).

Irrigation users and nonusers of Central Tigray have variable responses towards the perception for quality of cultivated land, soil texture, soil depth, soil fertility status and soil erosion (Table 5). This is due to that they have a land of different characteristics as a result of percolation, sedimentation, water logging, water intake, and seasonal rain fall. Consequently, irrigation users perceive a major decrease in the quality of their cultivated land due to lack of aeration and water logging while the nonusers perceive no change in quality of cultivated land before and after, neither benefited nor harmed as a result of construction of the schemes. Irrigators perceive a major decrease in soil texture and depth while the nonusers perceive as a minor decrease (Table 5). Moreover, irrigation users perceive a major increase in quality of common resources (forest, land, wild life) and quality of natural water resource after implementation of irrigation schemes and dams due to easily accessibility of under and above ground water in addition to rain water while quality of grazing land is perceived as a minor increase through compensating the reduced size of grazing land by increased productivity and year round maturity. Beside to the opinions of the users, irrigation nonuser households perceive there is a major and minor decrease in quality of common property resources (forest, land, wild life) and quality of natural water resource respectively due to increasing in temperatures and reduced precipitation(Table 5).

Climate change adaptation strategies

Climate change affects for the livelihood of farm households directly and other intermediaries indirectly. Individuals have different ways of small-scale household mitigation and adaptation strategies. Consequently, 76.15% of the sample households perceive change land under cultivation as a good strategy of climate change adaptation a few (57.69 %) practiced it practically for

Table 4. Farmers' perception in changes of indicators to climate change comparing before and within the last twenty years.

Description	Perceptions									
	major decrease		minor decrease		no change		minor increase		major increase	
	Users	Nonusers	Users	Nonusers	Users	Nonusers	Users	Nonusers	Users	Nonusers
Human population									***	***
cattle		***							***	
sheep		***							***	
goat		***							***	
poultry			***							***
behives										
food crop								***	***	
trees		***							***	
fruits						***			***	
vegetables						***			***	
grass				***					***	

Source: survey data, 2010.

Table 5. Farmers' perception in spatial and temporal trends of natural resources base.

Indicators	Perception of Users -2 = major decrease; -1 = minor decrease; 0 = no change; +1 = minor increase; +2 = major increase.	Perception of nonusers -2 = major decrease; -1 = minor decrease; 0 = no change; +1 = minor increase; +2 = major increase.
Quality of cultivated land	-2	0
Soil texture	-2	-1
Soil depth	-2	-1
Soil fertility status	-2	-2
Soil erosion problem	-1	-2
Qulity of grazing land	1	0
Qulaity of common property resources (forest, land, wild life)	2	-2
Qulity of natural water resources	2	-1

Source: survey data, 2010.

changing their livelihood (Table 6). The farm families perceives irrigation technology, water harvesting systems, planting short season maturity crops, soil conservation methods such as bunds and terraces and tree planting are good strategies for climate change adaptation at the household level (Table 6). Although most of the farm families perceive the adaptation strategies are essential for changing their livelihood in specific and the environment in general, faces different difficulties for application in the reality of their perspectives. This is due to different difficulties in which farm families face due to resource base and other intellectual base differences among households. shortage of land, poor soil fertility , shortage of labour , shortage of farm inputs , diversified crop production, shortage of information , lack of credit/money , lack of water in dry season , lack of farm animals, insecure property right and lack of market access are the main determinants (Table 7).

CONCLUSION AND POLICY IMPLICATIONS

Farmers and experts cumulatively perceive the trend of crop and animal production differs temporally and spatially. With the temporal phenomena both crop and animal production and productivity is reducing quantitatively and qualitatively due to the gradual change in climate. Spatially, areas having access and utilization to irrigation are less susceptible/ vulnerable to climate change. This is due to the reduced drought and replacement of rainwater by irrigation. Moreover, the double season production both in the rainy and dry

Table 6. Household climate adaptation strategies of the study area.

Adaptation strategies	Perceived as a good strategy		Practiced/applied	
	N	%	N	%
Change land under cultivation	99	76.15	75	57.69
Change in planting date	54	41.53	34	26.15
Crop diversification	121	93.07	71	54.61
Irrigation	130	100	65	50
Waterharvesting	130	100	87	66.92
The same crop but shorter maturity period	130	100	0	0
Soil conservation	130	100	130	100
Planting trees	130	100	63	48.46
Find off-farm job	65	50	65	50

Source: Survey Data, 2010.

Table 7. Household level barriers to climate change adaptation strategies.

Barrier to climate change adaptation strategies	Irrigation users		Irrigation nonusers	
	Frequency	Percent	Frequency	Percent
Shortage of land	23	35.38	49	75.38
Poor soil fertility	64	98.46	13	20.00
Shortage of labour	54	83.07	11	16.92
Shortage of farm inputs	6	9.23	54	83.07
Shortage of information	12	18.46	42	64.61
Lack of credit/money	9	13.84	46	70.76
Lack of water in dry season	0	0.00	65	100.00
Lack of farm animals	23	35.38	51	78.46
Insecure property right	5	7.69	23	35.38
Lack of market access	46	70.76	32	49.23

Source: survey data, 2010.

seasons helps to increase production and productivity of crops. Therefore, increasing the coverage of irrigation narrowing the difference using different technologies is crucial a climate change adaptation strategy.

Land is a key asset for making life in the rural area through different crop production and livestock rearing in addition to residence homes. The amount of cultivated land is splitting over time from generation to generation which facilitates gradual climate change through resource- population imbalance. Therefore, family planning is a strategy for climate change adaptations indirectly in addition to the direct mitigation strategies such as forestation, soil-water conservation and crops and animals diversification.

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