Farmers' perception on climate change, their vulnerability to the adverse effects of climate change, and their adaptation strategies

Reducing Land Degradation and Farmers' Vulnerability to Climate Change in the Highland Dry Areas of North-Western Ethiopia

TECHNICAL REPORT OF EXPERIMENTAL ACTIVITIES

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Dr. Claudio Zucca

Partners

Dept. of Water, Atmosphere and Environment, Institute of Hydraulics and Rural Water Management, BOKU - University of Natural Resources and Applied Life Sciences, Vienna Austria

Amhara Region Agricultural Research Institute (ARARI), Bahir Dar, Ethiopia

Ethiopia Institute of Agriculture Research (EIAR), Ministry of Agriculture and Rural Development, Addis Ababa, Ethiopia

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International Center for Agricultural Research in the Dry Areas (ICARDA)
PO Box 950764,
Amman 11195,
JORDAN
www.icarda.org

Synthesis

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Report submitted by: Yigezu A. Yigezu, Bezaiet Dessalegn, and Simegnew T. Endalew (PhD student at BOKU University under the supervision of Prof. E. Schmid)

Summary Report

The effects of climate change vary across regions, households, individuals and farming systems, and so do farmers' adaptation strategies. In the Amhara region, little is known about how climate change affects rainfed farmers' livelihood and what strategies households are using to adapt. Furthermore, factors governing farmers' decisions to adapt to climate change and the impact of those decisions on livelihoods are little known. Thus, farmers' perception on climate change, their vulnerability to the adverse consequences of climate change, and the availability of adaptation efforts need to be better understood, so that resilience to current climate variability as well as to the risks associated with longer-term climate change can be gauged and appropriate actions taken to increase or restore resilience.

This research was conducted to achieve that aim. The objective was to assess farmers' perceptions on climate change and analyze the biophysical and socio-economic factors determining their exposure and adaptive capacity and adaptation to climate change.

In Ethiopia, the agricultural sector is dominated by small-scale mixed crop livestock production with very low productivity and high vulnerability to climate change. Drought, which is frequent in Ethiopia, can shrink household farm production by up to 90% of a normal years output and could lead to the death of livestock and human beings. In response to the recurrent droughts and related environmental calamities, farmers in Ethiopia have developed different coping strategies. In the Ethiopian smallholder farmers mixed crop-livestock production system the farmers use a combinations of wide ranges of adaptation and coping strategies. Thus, this study tried to systematically combine those adaptation strategies. Moreover, the previous studies failed to differentiate between the long and short-term responses of farmers for the weather extremes. Therefore, this study differentiated coping and adaptation strategies as adaptation comes from experience through generations and is well planned long-term strategy to overcome any weather extreme, while coping indicates the immediate reaction to any of the weather extremes to reduce its effects in the short run only.

Hence, this study analyzed farmers' perceptions of climate change in Gumara Maksegnit watershed, their adaptation strategies and factors that govern their choices of adaptations towards climate change and its impacts. The following research questions were addressed:

- Do farmers notice that there is climate change?
- If they do, how do they understand it? Do they consider it as being man made?
- Do they consider that it can be mitigated?
- What adaptation strategies they are using?
- What factors affect their perceptions of climate change and their choice of adaptation strategies?

1 Materials and methods

Data: sampling design and procedure

A number of households in the watershed were designated as either "treated" (located in areas, or sub-watershed, treated with soil and water conservation interventions) or as "untreated". Household within the larger watershed which are far away from the treated and the adjacent untreated ones were also included. Such sampling design was used in order to study the learning effects (spillover effects) of being close or far from the intervention site. For the treated and nearby untreated (control) households within the two sub-watersheds (treated and untreated) the study used a census which enumerated all the households that are. In the far away parts of the watershed however, the study used random sampling methods using research randomizer to select sample households. The sample size were determined by power analysis considering at least 95% and 4% confidence and precision levels respectively of the estimates from the households outside the treated and immediate control areas. Moreover, 15% more random households were considered to account for missing values and other data errors.

Empirical model

The analytical methods that are commonly used in studies involving multiple choices are the multinomial logit (MNL) and multinomial probit (MNP) models. Both the MNL and MNP are important for analyzing farmers' decisions and extent of adaptation as these decisions are are often made jointly with possible interdependence. These approaches are also appropriate for evaluating alternative combinations of adaptation strategies, including individual strategies. This study used the multinomial logit (MNL) to analyze the determinants of farmers' choice of adaptation strategies in the Gumara Maksegnit watershed of Ethiopia. The method can be used to analyze both crop and livestock choices as methods to adapt to the negative impacts of climate change.

The typical characteristics of the MNL is that it allows the analysis of decisions across more than two categories even if they are not ordered, allowing the determination of choice probabilities for different categories. It is also preferred due to its computational simplicity in calculating the choice probabilities that are expressible in analytical form. MNL model provides a convenient closed form for underlying choice probabilities, with no need of multivariate integration, making it simple to compute choice situations characterized by many alternatives. The model makes the strong assumption of irrelevance of independent alternatives (IIA), which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set. While true in many cases, the IIA assumption may not hold in some cases. The degree of complementarity/substitution between the two alternatives under consideration and the other alternatives in the choice set determines the validity of the IIA assumption.

In this study, we set out with the IIA assumption and used the multinomial logit (MNL) model to investigate the factors affecting household choices of climate change adaptation methods. In the model, the dependent variables include different adaptation methods and the explanatory variables include different household, institutional, and social factors. Statistical tests were then carried on the fitted MNL model where the test results confirmed that the IIA assumption holds true, and that there are no multicollinearity and endogeneity problems in the fitted model.

2 Results and Discussions

Farmers' perceptions of climate change

In the study area most (95.9%) of the respondent farmers perceive the presence of climate change or weather extremes through time in the area. They noticed climate change in terms of erratic nature of rainfall, late onset and early offset, untimely rain (e.g. harvesting and dry season rain), shortage of rainfall amount and time period (previously up to 6 months of rain but in recent years only 3 months), increase in frequency of drought, increased temperature, flooding and increased coldness.

However, only 61.8% of the farmers believe that climate change is manmade and it can be amended through sustainable land management such as afforestation of the bare land areas and mountains, stopping free grazing, area closure and establishing soil and water conservation structures. The remaining believes that climate change is from God and do not see amendment mechanism other than praying.

Occurrences and effect of weather extremes on household livelihoods

As indicated in the table 1 below, the most frequently occurring risk factor with the greatest impact on household's livelihood is drought followed by hail storm. Risk factors such as theft of assets and conflict occurred in very few households in the area. However, if they occur they have a significant impact on livelihood aspects. More over there is huge disparity in perception of risk factor occurrences explained by high standard deviation.

Table 1. Weather occurrences for the last ten years and its impact on farm households

Weather extremes	Occurrence in the last 10 years (Mean ± Std. Dev)	Rank: importance in affecting household livelihood (score-(rank), 1 most important)	Effect on production of main crop (% reduction)	Effect on household income (% reduction)
1. Drought	2.02 (0.85)	1.68 (1)	34.04	25.70
2. Too much rain or floods	1.17 (1.09)	2.53(13)	19.73	14.86
3. Hail storm	0.78 (0.91)	2.38(2)	38.37	31.13
4. Irregular weather	10			
5. Temperature increase	10			
6. Untimely rain	2.51 (1.46)			

Adaptation and Coping Strategies

This study separated coping and adaptation strategies in the sense that coping refers to immediate response while adaptation refers well planned long-term response. The study indicated that households adopt wide ranges of combinations of adaptation and coping strategies for different risk factors. The coping strategies ranges from none/praying, selling of livestock, relay on credit, aid, off-farm work, eat less to temporary migration for off/non-farm work. Households used different coping and adaptation strategies for different weather extremes and risk factors in order to reduce its effect on their livelihood status.

Most of the farmers have the habit of saving in the form of money and crop from the good year through squeezing current consumption and utility for the worst year yet to come. Farmers also commonly save asset in the form of livestock as livestock's can be quick source of income in the worst condition. Young farmers have the habit of temporary migration for non/off-farm employment to the potential areas as well as cities. Farmers responded that in the crop choices they mainly stick on local crop varieties especially for sorghum and barley as the land races are very tolerant to any weather extremes.

The focus group discussion revealed that the occurrence of any weather extremes causing some part of or the majority of crop failure can cause deforestation at least in short run. This is due to the fact that the farmers coping strategies include off-farm work and this may consist in harvesting fire wood from the mountain forest and selling it the market to earn income. Despite all the efforts by the government to stop deforestation 40% of the farmers are engaged in fire wood collection and selling to cope with bad conditions. One of the reasons for this is the shortage of the availability of cash in time as the existing financial institutions cannot provide credit in short period of time due to the rules and bureaucratic procedures. In the households of Gumara-Maksegnit watershed Livestock are source of security: when the household is exposed to any weather extreme the immediate action is to sell livestock, mainly goats, and sustain household's livelihood. Through time the farmers developed other adaptation strategies such as crop livestock diversification. Praying God remains the common response to the weather extremes faced in the area.

According to farmers, the probability of occurrence of most of the weather extremes occurred in the previous 10 years is expected to increase during the coming 10 years, and with increased intensity and effect. The prediction of the future occurrence of risk factor is shown below (table 2).

Table 2. Important risk factors for the coming years

Risk factor	Do you think the factor become more important in future due to climate change (%)		Frequency of occurrence for the coming 10 years (Mean ± Std. Dev)
	Yes	no	
1. Drought	98.34	1.66	2.20 (0.84)
2. Too much rain or floods	74.44	25.56	1.61 (1.17)
3. Hail storm	59.67	40.33	1.18 (1.19)

The effects of risk factors on crops and livestock species

As indicated in the table 3 below, the vulnerability of crops and livestock species is dependent on the risk factor considered. According to the study teff is the most vulnerable crop to drought and cattle's are also most vulnerable to this risk factor. The susceptibility of different species of crops and livestock for the different risk factors are shown below.

According to the responds perception the average crop yield for three different extreme cases were shown in (table 4) below. For the last 10 years the number of normal, bad and good years was 4.73, 2.47 and 2.8 respectively.

Table 3. Susceptibility of different species of crops and livestock for the different risk factors

Risk factor	Most susceptible crops (Rank)			Most susceptible livestock (Rank)		
	1st	2nd	3rd	1st	2nd	3rd
1. Drought	Teff	Wheat	Barley	Cattle	Small ruminants	Equines
2. Too much rain or floods	Sorghum	Chickpea/beans	Wheat	Small ruminants		
3. Crop pests or diseases	Beans	Chick pea	Wheat	-	-	-
4. Hail storm	Beans	Teff	-	Small ruminants	-	-

Table 4. Average Crop yield for selected crops under different extreme cases

Crops	Extreme cases average crop yield (Kg/ha)		
	Normal year	Bad year	Best year
Wheat	1099.23	583.50	1724.88
Barley	1031.85	536.09	1582.31
Lentil	443.611	252.00	775.11
Chick pea	838.983	451.99	1371.91
Faba bean	848.837	434.39	1347.97
Teff	960.437	506.44	1532.28
Finger millet	455.56	233.33	1488.89
Sorghum	1262.44	720.42	1874.09
Niger seed	300.00	200.00	400.00

Barriers to adaptation

Different studies indicate many factors which affect farmers' capacity to adapt to climate change. These determinant factors include the policy and institutional environment, climate information, and the socio-economic characteristics of the household, among others. In the group discussion in Gumara maksegnit watershed, the following were mentioned as significant barriers: shortage of land, lack of awareness and training, lack of climate information, lack of credit/money, shortage of labor, lack of access to extension and improved technologies, infrastructure problem and lack of access to water for irrigation.

Model results

The multinomial logit model results indicated that household characteristics such as sex, family size, education, land and farm incomes which could be enhanced through policy intervention have significant impact on adaptation to climate change. Thus, investment in education systems, sufficient input supply which increases production and farm income

and introduction of technologies which are less labor intensive in the rural areas can be underlined as a policy option in the reduction of the negative impacts of climate change.

The model also revealed that institutional factors, such as extension on crop and livestock production and access to information on climate change through radio, enhanced adaptation to climate change. Consequently, policies aiming at promoting adaptation to climate change need to emphasize the crucial role of providing information on better production techniques and on climate change (through extension) to enable farmers adapt to climate change.

Social capital which was represented by number of relatives, number of farmers using SWC and improved technologies also affected adaptation to climate change positively. Policy interventions which encourage informal social networks (information, financially or materially) can promote group discussions and better information flows and enhance adaptation to climate change.

***NOTE**: The data presented in this report are currently being elaborated for scientific publication, thus some of them are not final. The aim of this report is to summarize the nature and quality of the activities conducted and of the dataset generated, and to illustrate the main results obtained.*

Project Manager

Claudio Zucca
Soil Conservation/Land Management Specialist
CGIAR Research Program on Dryland Systems
ICARDA
Marrakesh, Morocco
C.Zucca@cgiar.org