



# Farmers' perception on causes, indicators and determinants of climate change in northern Ethiopia: Implication for developing adaptation strategies



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## ABSTRACT

Even though climate change is recognized as a major challenge for the economic growth of developing countries such as Ethiopia, little information has been documented about climate change from local people perspectives. The objectives of this study are to describe socio-economic, biophysical and institutional characteristics of farmers, and assess the causes, indicators and determinant factors of climate change based on farmers' perception in northern Ethiopia. Systematic sampling technique was used to select 60 sample household head farmers. The sample farmers were interviewed using semi-structured questionnaire. Data were analyzed using descriptive, chi-square ( $\chi^2$ ) and logistic regression analysis. This study revealed that farmers' socioeconomic, farm and institutional attributes influence their perception on climate change. Significantly higher proportions of farmer respondents perceived that deforestation (93%) followed by soil degradation (88%) are the main causes of climate change. Higher proportions of the respondents also identified that the most commonly used indicators of climate change are variability in rainfall (92%), erosion rate (90%), temperature (85%) and agricultural outputs (85%). The success of logistic regression model overall prediction is described by model  $\chi^2 = 81$ ,  $p = 0.003$ , indicating that the independent variables significantly explained the dependent variable. The success of the regression model prediction level is also described by a strong association between the perception of farmers on climate change and the group of the explanatory variables by coefficient of determination of 83%. Among the explanatory variables, access to rain-fed agriculture, experience on soil management and water harvesting structures were significantly important determinants of farmers' perception on climate change. It is thus suggested that introduction of comprehensive activities tailored to show in-depth examples of local and global causes and indicators of climate change, considering the determinant variables can enable farmers to design suitable adaptation strategies to climate change (e.g., land-use based on its suitability, intensifying moisture and water harvesting practices, introducing high yield but short season variety, drought, pest and diseases tolerant crop varieties).

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## 1. Introduction

Climate change refers to long-term changes and statistical variability persisting for an extended period (typically decades) in weather conditions (Gbetibouo, 2008; IPCC, 2007; Mustapha, Sanda, & Shehu, 2012). Globally, climate change is becoming a major challenge to agricultural development efforts and human welfare. However, agricultural production activities in Africa are generally more vulnerable to climate change than other

socioeconomic sectors (Hassan & Nhemachena, 2008; Kurukulasuriya et al., 2006). Reports by IPCC (2001a, b); Agbo (2013) and van Wesenbeeck, Sonneveld, and Voortman (2016) revealed that agriculture in Sub-Saharan Africa is extremely influenced by climate change and variability. For instance, the crop yield projection for Africa may fall by 10–20% by 2050 or even up-to 50% due to climate change (Jones & Thornton, 2003). The effects of climate change vary by region and are more severe in developing countries such as Ethiopia in which about 85% of the population economy is dependent on rain-fed agriculture (Mengistu, 2011; World Bank, 2007). Other researchers (e.g., Agwu et al., 2011; Karthikeyan & Tadesse, 2014; Mertz, Mbow, Reenberg, & Diouf,

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2009; World Bank, 2007) also added that climate change challenges agricultural production due to an expected heavy rainfall or an extended extreme frequent droughts. It is thus highly demanding to examine farmers perception on causes, indicators and effects of climate change in order to formulate community based efficient policy interventions and adaptation strategies (van Wesenbeeck et al., 2016).

Farmers' perception on climate change plays a key role for appropriate adaptation and mitigation strategies related to land-use and agricultural practices decision making (Adger, Hug, Brown, Conway, & Hume, 2003; Kemausuor, Dwamena, Bart-Plange, & Nicholas Kyei-Baffour, 2011). Despite of this, few farmers in developing countries could have adapted strategies to mitigate climate change effects successfully. Some of such measures may include: crop rotation, early planting, crop diversification and proper tillage and weeding schedules (DelPHE, 2010). Besides to this, local farmers have learned effects of climate change which is evidenced by late arrival of rain, drying-up of streams and rivers but they have not perceived its direct and deeper implications on their economy (Apatha, Samuel, & Adeola, 2009). Substantial reports have also indicated that previous adaptive measures by farmers against the effects of climate change become ineffective due to the pace at which adverse climate events taken-place has not at least equivalent to the measures undertaken by the farmers (Enete & Thornton, 2011). The report by Shrotriya, & Prakash (2011) and Agbo (2013) indicated that agriculture sector accounts for 33% of the annual total emissions; the livestock sector accounts for about 18% of global green house gas emissions and deforestation also accounts for 18% of carbon dioxide emissions. However, many farmers do not understand how such farming activities can aggravate or not on climate change and its effects. Hence, having comprehensive scientific information about farmers perception on climate change and variability could help to bridge any knowledge gaps by farmers and policy makers.

Many types of indicators of climate change are reported in literature at global-scale even though there are variability with location and time of study. Erratic rainfall often combined with intermittent dry spells, drought, flood and change in temperature have commonly shown indicators in most reports (e.g., Adger et al., 2003; Agbo, 2013; Okonya, Syndikus, & Kroschel, 2013; Tripathi, Sengupta, Patra, Chang, & Jung, 2014). Farmers may thus be aware about climate change, but the level of awareness on its short, medium and long-terms causes and consequences may vary among the farmers. Conversely, some farmers may not perceive climate change and its effects at all or others may not care on this issue for various reasons (Deressa, Hassan, Ringler, Alemu, & Yusuf, 2009; Okonya et al., 2013). For example, low level of education, ignorance, age, and entirely involving at off-farm activities could be the causes for farmers' low level of perception on climate change in Australia (Conacher, 1995; Deressa, Hassan, & Ringler, 2011). Despite such reports elsewhere, the determinant factors for farmers' for being perceived on climate change in the condition of northern Ethiopia in particular and many developing countries in general are not scientifically well documented.

Many researchers reported that most people's understanding on the underlying causes and indicators of climate change varies, as some are taking a more scientific approach and others a more religious one (e.g., Chaplin, 2007; Kemausuor et al., 2011). Farmers' perception on climate change is determined by a number of factors such as access to information, extension services, education, experience, resource availability. In practice, farmers take decisions in the context of their own environment, and differences may exist between perceived and real environments (Kemausuor et al., 2011; Mather, 1992).

Farmers who work closely with agricultural fields have better

perception on climate change. Consequently, many studies (e.g., Gbetibouo, 2009; Kemausuor et al., 2011; Negatu & Parikh, 1999) reported that identifying and analyzing factors that influence farmers' perception on climate change is a key step to develop, transfer and adopt appropriate technologies. Having well documented information of farmers' perception on climate change is thus generally needed to develop policies and strategies that promote successful adaptation strategies (Bryan, Deressa, Gbetibouo, & Ringler, 2009; Kemausuor et al., 2011). In addition, farmers' perception on climate change is suggested to be documented as this can influence more the success of adaptation strategies and management practices as compared to other factors. Such documentation can also help to identify gaps in farmers' perception and knowledge and areas where policy-makers, decision-makers, scientists and other stakeholders including extension agents could contribute vital inputs to improve their climate change adaptation strategies (Tolobonse et al., 2010). Scientific information about farmers' perception on climate change can also support to know the extent of the impacts of government policy and interventions related to climate change. This is crucial to document whether local farmers are consciously addressing the perceived threat of climate change in accordance to the intended government adaptation policy and strategies (Penaranda, Elizabeth, & Barreras, 2012).

Examining problems associated with farmers' perception on climate change and adaptations of appropriate technologies are considered as two distinct stages used for decision processes (Gould, Soupe, & Klemme, 1989; Shiferaw & Holden, 1998). Perception on climate change and understanding its consequence is a first stage before adaptation (Gbetibouo, 2009). Other scholars reported that perception of climate change by farmers is important step to shape the preparedness to adapt relevant strategic practices (Nzeadibe, Egbule, Chukwuone, & Agu, 2011; Speranza, 2010). The success of technology adaptation strategy for effects of climate change is depend mainly on influencing factors such as farmers perception about climate change and practicality of adaptation policy (Adger et al., 2003; IFAD, 2008). Climate change adaptation policy which is developed considering the knowledge and perception of farmers can bring effective and sustainable adaptation response to effects of climate change (Nyanga, Johnsen, & Aune, 2011).

Despite the fact that the northern Ethiopia is highly vulnerable to climate change related problems, investigation on scientific information with regard to farmers' perception on causes, indicators and responsible factors for climate change is limited. In addition, there is variability in the methodologies used in the existing reports related to farmers' perception on climate change. Some researchers have used quantitative analysis (e.g., Mustapha et al., 2012), and others qualitative and/or quantitative analysis (e.g., Agbo, 2013; Karthikeyan & Tadesse, 2014; Kemausuor et al., 2011). Such discrepancies are demanding to test for their appropriateness in different research scopes and conditions in the northern Ethiopia. Hence, the objectives of this study are to assess socio-economic, farm, biophysical and institutional characteristics of farmers; assess the causes and indicators of climate change based on farmers view; and analyse the determinant factors for farmers' perception on climate change in the condition of northern Ethiopia.

## 2. Materials and methods

### 2.1. Study area

This study was executed from February to June 2014 in Dura catchment of Tigray region, northern Ethiopia (Fig. 1). The study catchment area is 5000 ha, with altitude ranges between 2060 and 2650 m above sea level (Ethiopian Mapping Agency, EMA, 1997). In

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