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Original Research Article

Determinants of farmers' perception to invest in soil and water conservation technologies in the North-Western Highlands of Ethiopia☆

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ABSTRACT

Soil erosion by water is a severe and continuous ecological problem in the north-western Highlands of Ethiopia. Limited perception of farmers to practice soil and water conservation (SWC) technologies is one of the major causes that have resulted accelerated soil erosion. Therefore, this paper examines the major determinants of farmers' perception to use and invest in SWC technologies in *Ankasha* District, north-western highlands of Ethiopia. A detailed field survey was carried out among 338 households, randomly selected from two rural sample *kebeles* (called villages here after). Descriptive statistics and logistic regression model were used to analyse the effects of multiple variables on farmers' perception. The results indicate that educational level of the respondents and their access to trainings were found to have a positive and very significant association ($P < 0.01$) with farmers' perception. Likewise, land ownership, plot size, slope type, and extension contact positively and significantly influenced farmers' perception at 5% level of significance. On the other hand, the influence of respondents' age and plot distance from the homestead was found to be negative and significant ($P < 0.05$). The overall results of this study indicate that the perception of farmers to invest in SWC technologies was highly determined by socioeconomic, institutional, attitudinal and biophysical factors. Thus, a better understanding of constrains that influence farmers' perception is very important while designing and implementing SWC technologies. Frequent contacts between farmers and extension agents and continues agricultural trainings are also needed to increase awareness of the impacts of SWC benefits.

1. Introduction

Soil is one of fundamental natural resources to support life on earth. Soil is finite and non-renewable natural resource which takes between 200 and 1000 years for 2.5 cm of topsoil formation under cropland condition (Pimentel et al., 1995). As a core component of land resources, soil is the source of many ecosystem services essential to humans and the environment (Brevik et al., 2015). It is the base to support primary production through organic matter and nutrient cycling, control of pests and diseases; decontamination of the environment, and provision of ecosystem services (UNCCD, 2013). Soil also plays a major role in global climate processes through regulation of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions (FAO & ITPS, 2015). With these and other infinite significances, soil need to be protected in sustainable manner. Global estimates, however, indicate that human pressures on soil resources are reaching critical limits (FAO & ITPS, 2015) and soil is becoming vulnerable to various forms of depletions, such as soil erosion, soil fertility decline, and associated changes in soil physical and chemical properties. Soil erosion by water is the most severe and widespread that occupies 56% (Gelagay & Minale, 2016) or 1094 million hectares of the world's total land area (Walling & Fang, 2003).

Agriculture in Ethiopia is the foundation of the country's economy accounting more than 50% of gross domestic product (GDP), 84% of national export and 80% of total employment. However, recently, there is increasing concern that soil erosion seriously limits agricultural sustainability in Ethiopia (Adimassu, Kessler, Yirga, & Stroosnijder, 2013; Engdawork & Bork, 2014; Gelagay & Minale, 2016; Gessesse, Mansberger, & Klik, 2015; Kidane, Beshah, & Aklilu, 2014; Tesfahunegn, Vlek, & Tamene, 2012; Teshome, de Graaff, & Kassie, 2016). Soil erosion, principally caused by over grazing, continuous cultivation, deforestation and remove of crop residue from the field, highly undermines the role of agriculture to alleviate poverty and food insecurity in whole parts of Ethiopia. The estimated annual soil loss in Ethiopia due to erosion is 1.5 billion tons, of which 50% occurs in cropland (Assefa & Bork, 2015). This is very serious problem

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compared to the estimated soil formation rate of less than 2 t/ha/year (Hurni, 1983). Its severity is being pronounced in the Northern highland areas of the country (Abate, 2011; Balana, Mathijs, & Muys, 2010) which has been characterized by steep slopes, intensive rainfall, sparse vegetation, high population and livestock densities (Kidane, 2016).

There has been great efforts to address the problem of soil erosion in Ethiopia since 1970s (Assefa & Bork, 2015; Tesfahunegn et al., 2012) following the incidence of famine and drought. Since then, the government has given considerable focus on SWC technologies for rehabilitation of land resources. A large number of conservation, rehabilitation and afforestation campaigns were undertaken through Food-For-Work (FFW) programs. Nevertheless, the efforts have not been widespread and didn't bring significant changes as expected (Kidane et al., 2014; Teshome et al., 2016). This is because the farmers were totally ignored from decision making during the selection, planning and implementation processes of SWC measures and the activities were undertaken without interest. Consequently, it forced the farmers to removed SWC structures following the change of FFW program in 1991. Likewise, studies conducted in different parts of Ethiopia (Tesfaye & Brouwer 2012; Aklilu & Jan de, 2007; Azene, 2001; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009; Herweg & Ludi, 1999) reported that the farmers were considered ignorant of SWC technologies and have been given little attention in decisions making processes related to SWC technologies.

Effective protection and conservation of SWC can be realized only when farmers accept and deicide on the benefits of SWC technologies and actively involved in the implementation and maintenance processes. The decisions of farmers to use and manage natural resources highly depend on their perception of the landscape (Assefa & Bork, 2015). Indeed, farmers can modify the technologies to their own real situations (Teshome et al., 2016). Their perception and participation also varies from place to place and from household to household due to different interactive factors. Thus, a better understanding of factors that influence farmers' perception and willingness towards SWC is very important for designing and implementation of efficient, effective and people friendly technologies (Derajew, Bekabil, & Wagayehu, 2013). This study attempts to explore the major determinants of farmers' perception to invest in SWC technologies in Ankasha District, North-Western highlands Ethiopia.

2. Materials and methods

2.1. Study area

The study area is located in Awi Zone, Amhara Regional State of Ethiopia (Fig. 1). Its geographical location extends from 10°31'–10°58'N latitude and 36°37' −36°38'E longitude. A total area of the district is about 1060 square kilometres. The altitude ranges from 1039 to 2896 m above sea level. It is characterized by diversified topography consisting of the rift valley, undulating plains, high plateaus topped by hills and mountains, and river valleys. The major soil types in the study area include vertisols, nitosols, fluvisols and cambisols. fluvisols occupies the gentler slopes and river bank areas and vertisols (locally named as *walka afer*) covers the major lower slope positions.

Rainfall distribution in the study area is bimodal, characterized by heavy rainy season from June to mid-September (*Kiremt*), and small rainy season from March to May (*Belg*). The mean annual rainfall ranges from 770 to 2000 mm and the average annual temperature ranges from 16 to 27 °C. These sympathetic climatic condition and fertile soil have made the district to be one of intensively cultivated areas in the north-western highlands of Ethiopia. Rain-fed agriculture is the only source of livelihood for the majority of population. It is characterized by a smallholder mixed crop-livestock production. Only river-side farms and those found in and around swampy lands use irrigation. The major crops grown in the area include Tef (*Eragrostis tef*), Finger millet (*Eleusine coracana*), maize (*Zea mays*), wheat (*Triticum vulgare*), barley (*Hordeum vulgare),* horse beans (*Vicia fabia*), field pea *(Pisum sativa*), linseed (*Linum usitatissimum*), oats (*Avena sativa*), pepper (*Capsicum annuum*), potato (*Solanum tuberosum*), and onion (*Allium cepa*).(Table 1).

The major land-use and land-cover classes in the district include cultivated land, grassland, forest land, shrubland, built-up areas and water bodies (Fig. 2). Cultivated land is the dominant land use/cover type with 737 square kilometres (69.5% of the total area).

Both primary and ancillary data were utilized in this study. The ancillary data consisting farming history, population, land use types, and soil conservation were collected from different written material. The primary data were collected from the field in two stages. In the first stage, the household survey was conducted to gather the detailed information concerning the farmers' perception of SWC. In the second stage, data were collected through key informant interviews and focus group discussions. These methods were utilized to gather in-depth data on points which were not included in the survey questionnaire and to cross-check the survey results.

One dependent variable (perception of SWC practice) and eleven independent variables (perceived to have influence on dependent variable) were identified based on the field survey results and theoretical framework. The dependent variable is a dichotomous discrete variable that was generated from the questionnaire survey as a binary response, and the independent variables are a mixture of discrete and continuous. Finally, the whole variables were organized, coded, entered into SPSS software and used to analyse the interaction between various independent variables and their responses towards SWC practices. Table 2 summarizes the selected variable and their characteristics.

2.2. Data analysis

Statistical Package for Social Sciences (SPSS) software, version 16.0 was used to analyse the data. Simple descriptive analysis was used to compute the percentages and frequencies for some socioeconomic variables. A logistic regression model was used to analyse the effect of different variables on farmers' perception. Logistic regression allows predicting a discrete outcome from a set of variables that may be continuous, discrete, and dichotomous or a combination.

3. Results and discussion

3.1. Characteristics of the respondents

Table 3 summarizes the major socio-economic characteristics of the respondents. The age of the respondents ranged from 19 to 87 years. The majority of respondents (37%) were under the age group of 26–40 years.

Out of total respondents, 47.9% were literate (able to read and write through informal and formal education) and the remaining 52.1% respondents were illiterate (unable to read and write). The mean land holding size was found to be 1.68 ha with the maximum of 4.50 ha and minimum of 0.25 ha. About 36.1% of the respondents have the land size ranged between 1.0 and 1.5 ha.

3.2. Farmers' perception about soil and water conservation practices

The results of descriptive statistics indicate that 75.4% of the respondents were aware about the effects of soil erosion and perceived erosion could be controlled (Table 4). They willingly expressed that they could control erosion on their farm plots by using traditional and/or introduced SWC measures. The results of focus group discussion with the selected participants indicate that the farmers of the study area have been highly practicing vegetation management methods such as crop cover and conservation tillage to reduce the effects of soil erosion. However, these conservation methods were found to be less