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Modeling Smallholder Farmers' Preferences for Soil Management Measures: A Case Study From South Ethiopia

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ABSTRACT

Land degradation is a major environmental problem in Ethiopia posing serious threats to agricultural productivity and livelihoods. The interactions of numerous socio-economic, demographic, natural, and institutional factors constitute the underlying causes of soil degradation in Ethiopia. However, there exist evidence gaps on the contextual factors that hinder investments on soil conservation among smallholders. Using primary data generated through a stated preference survey among 359 sample smallholder farm households in Southern Ethiopia, this study investigates investment constraints on soil management technologies among smallholders. A random parameter logit model was implemented to estimate the model. Results indicate that smallholders are willing to invest in soil management technologies if appropriate incentive mechanisms, primarily, secured land tenure rights and access to finance are in place. Unfortunately, the prevailing land tenure regime in the country does not allow private property rights on land and smallholders have very limited access to credit. Thus, instituting secure land rights and improving credit access to smallholders should be considered as key interventions to enhance adoption of soil management technologies. The study highlights that policy interventions that incentivize adoption of soil management measures provide not only on-site private benefits but wider societal off-site benefits through the provision of multiple ecosystem services.

1. Introduction

Soils underpin terrestrial-based provisions of ecosystem services such as food and biomass production, climate regulation, and biodiversity maintenance. Soil is the primary resource-base on which a significant proportion of the world's poorest people directly depend for their livelihoods and subsistence (FAO, 2011; IAASTD, 2009). This important resource base, however, has been under the threat of degradation and the livelihoods of many subsistence farmers in developing countries still depend on this degraded soils with established links to persistent poverty (Sanchez, 2002). Historical changes to land use and management, reflecting multiple societal and economic drivers, compounded by contemporary unsustainable soil management practices have led to the degradation of soil resources with the consequent negative impacts on multiple ecosystem services such as decrease in biomass production including crop yields, water quality, and loss of biodiversity (IAASTD, 2009; MA, 2005).

Studies indicate that soil degradation is a serious problem in Ethiopia (FAO, 1986; Sutcliffe, 1993; Bojo and Cassells, 1995; Nyssen et al., 2004). These studies show that the physical gross annual soil loss ranges from 42 to 103 t/ha/year. According to the Ethiopian Highland Reclamation Study (EHRS) (FAO, 1986), by the mid-1980s, about half of the Ethiopian highlands[1] (about 27 million ha) was 'significantly eroded', over 2 million ha of which are described as 'beyond the point of no return'. Based on the field measurements of 202 plots in 12 sites of Tigray highlands of Northern Ethiopia, Gebremichael et al. (2005) have found that the rate of mean annual soil loss from crop land in the absence of soil and water conservation measure is 57 t/ha/year. On the basis of the premise that soil losses reduce land productivity, primarily through the loss of plant-available nutrients and soil water holding capacity, various studies derived quantitative economic estimates of the impacts of physical soil losses in Ethiopia. The EHRS study (FAO, 1986) estimated a 2.2% decline in average crop yields annually as a share of the 1985 level of cropland and a 0.6% decline for grassland per annum

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[1] The Ethiopian highlands, defined as areas above 1500 m a.s.l., cover about 44% of the 1.127 million km^2 of the total territory of the country.

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which are together translated into an annual average loss of about 2% of the agricultural GDP in 1982/83. If losses of non-market ecosystem services were included, the total loss could be significantly higher than the above estimate. Thus, addressing the problem of soil degradation is a national priority in Ethiopia.

The interactions of numerous socio-economic, demographic, natural, and institutional factors constitute the underlying causes of soil degradation in Ethiopia. Factors such as high degree of dependence on natural resources, bad agricultural management practices, lack of alternative employment opportunities, land tenure insecurity, persistent poverty, rapid population growth, and lack of adequate investment on natural resource development have led the country to severe soil degradation. Exiting studies indicate that land tenure insecurity as the major factor behind farmer's unwillingness to invest in soil conservation measures in Ethiopia (Osman and Sauerborn, 2001; Taddese, 2001; Gebremedhin and Swinton, 2003; Ayalneh et al., 2006; Holden et al., 2009). Concerning land tenure and property rights to natural resources in Ethiopia, article 40(3) of the Constitution of the Federal Democratic Republic of Ethiopia (FDRE) states: "The right to ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the State and in the peoples of Ethiopia. Land is a common property of the Nations, Nationalities and peoples of Ethiopia and shall not be subject to sale or to other means of exchange" (FDRE, 1994). Accordingly, land is not a private property and individuals have only usufruct rights on land in Ethiopia. This constitutional constraint, fuelled by land fragmentation, population growth, and poverty left very little room for private land investments among Ethiopian smallholders, particularly on long-term soil conservation investments.

However, apart from the general assertion on institutional constraints and claims on the lack of resources among smallholders, there exist evidence gaps on the contextual factors that actually determine investments on soil conservation among smallholders in Ethiopia. Moreover, though few studies claim that low or negative initial returns to soil conservation technologies undermine investments on soil management practices (Shiferaw and Holden, 1999), to the best of our knowledge, no substantive empirical evidence exist on specific mechanisms for farm households to induce investment in soil management measures. Thus, understanding the constraints and preferences of smallholders for alternative soil management practices is a vital component in designing policy and incentive mechanisms for sustainable soil management (Balana et al., 2011). It is also important to have a broader understanding of the benefits of multiple ecosystem services emanating from the investment on soils and their wider livelihood impacts on rural households and communities. This could provide appropriate evidence to support sustainable soil management decisions and policies.

Using data generated through a stated preference technique (a choice experiment survey) designed to eliciting preferences and choices on alternative soil management options among 359 smallholder farmers in Southern Ethiopia and applying a random parameter logit model, the objectives of this paper were to: 1) understand the preferences of smallholder farmers to alternative soil management options, 2) identify the major factors influencing the choice or adoption of alternative soil management practices, 3) investigate the link between property rights in land and adoption of soil management measures, and 4) draw policy implications in designing land/soil management contracts with smallholder farmers. The next section presents a brief literature review on soil management practices and adoption constraints. Section 3 explains the method including survey design and the econometric modeling. The results of descriptive and econometric analyses are reported in Section 4 followed by the concluding section with key policy implications.

2. Brief Literature Review

Yesuf and Blufstone (2007) show that a high degree of risk aversion significantly reduced the probability of adoption of soil conservation measures among smallholder farmers in Ethiopia. Kassie et al. (2007) and Benin (2006) argue that adoption of soil conservation measures depends on the agro-ecology, for instance, plots with stone bunds are found to be more productive than those without in semi-arid areas but not in higher rainfall areas because the moisture conserving effect of this technology is more beneficial in drier areas. In Tigray region of Northern Ethiopia, for instance, while higher crop yields were recorded from plots with stone terraces in the semi-arid highlands; graded bund and fanya juu terraces have very low payoffs and do not seem to offer poor farmers sufficient economic incentives compared to investment in grass strips which appeared promising in a high rainfall areas (Kassie et al., 2007). The studies claim that new technologies that increase scarcity of land and decrease crop yields in the short term, and low or negative initial returns could undermine incentives to investment on soils. Furthermore, population pressure, poverty and land scarcity may even drive removal of existing conservation structures introduced in the past through food-for-work programs in Ethiopia. Few studies suggest that the most promising approach to encourage investments in soil conservation measures among smallholders in Ethiopia is via the provision of targeted subsidies (e.g., cost-sharing). When farmers are able to perceive the benefits of the conservation measures (i.e., return on investment) and their use-rights are secure, they are able to adopt conservation technologies without additional incentives (Kassie et al., 2007; Benin, 2006; Shiferaw et al., 2005).

With regard to the link between tenure security and investment in land improvement, two schools of thought seem to appear in the literature. The first asserts that formal land rights through land titling are not important for investments in land improvements and claim that the correlation between tenure security (e.g., in terms of transfer rights or possession of title) and investments found to be weak (McCulloch et al., 1998). The second school of thought argues that land rights specifically privatization of land are important for investments on the premise that it helps farmers obtain credit to make investments (Feder et al., 1988; Place and Otsuka, 2000; Gebremedhin and Swinton, 2003).

It is worth to give a particular attention to literature focusing on practices specifically targeted on 'soil conservation' measures as against 'soil fertility' management. Though soil conservation and soil fertility management are often used interchangeably, we make distinction between the two as the former is mostly used to represent long term soil management practices while the latter represents short term soil management measures. Studies reveal that severe soil nutrient depletion is the main element in the vicious cycle of declining yields, decreasing rural incomes, deepening poverty, and increased degradation of the natural resource base in Ethiopia. Due to the depleting soil fertility, the expected benefits from soils are declining unless soil fertility enhancing interventions are made. The most common field-level soil fertility management practices that have been promoted in Ethiopia include inorganic fertilizer, legume rotation, liming and compost (Chilot and Hassan, 2008). Because it was believed that these practices could have a high adoption rate due to the fact that the practices can be implemented at any scale irrespective of the field or plot size and farmers realize the immediate returns if they adopt these practices.

Based on the brief review of literature, the key factors affecting adoption of soil management practices in Ethiopia include agro-ecology, whether the technology increases land scarcity, return on investment, and farmer's risk-averse behavior. Though inconclusive, the literature review also indicates that land tenure security also affects adoption of soil management technologies. Most of the studies reviewed considered stone bunds, strip grasses (vegetative bund), graded bund, and fanya juu as the most common soil conservation technologies. With regard to soil fertility management; technology attributes, farm and farmer characteristics were found to affect the adoption.