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Farmers' Perceptions of Land Degradation and Their Investments in Land Management: A Case Study in the Central Rift Valley of Ethiopia

Zenebe Adimassu · Aad Kessler · Chilot Yirga · Leo Stroosnijder

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Abstract To combat land degradation in the Central Rift Valley (CRV) of Ethiopia, farmers are of crucial importance. If farmers perceive land degradation as a problem, the chance that they invest in land management measures will be enhanced. This study presents farmers' perceptions of land degradation and their investments in land management, and to what extent the latter are influenced by these perceptions. Water erosion and fertility depletion are taken as main indicators of land degradation, and the results show that farmers perceive an increase in both indicators over the last decade. They are aware of it and consider it as a problem. Nevertheless, farmers' investments to control water erosion and soil fertility depletion are very limited in the CRV. Results also show that farmers' awareness of both water erosion and soil fertility decline as a problem is not significantly associated with their investments in land management. Hence, even farmers who perceive land degradation on their fields and are concerned about its increase over the last decade do not significantly invest more in water erosion and soil fertility control measures than farmers who do not perceive these phenomena. Further research is needed to assess which other factors might influence farmers' investments in land management, especially factors related to socioeconomic characteristics of farm households and plot characteristics which were not addressed by this study.

Keywords Perceptions · Water erosion · Soil fertility depletion · Investments · Land management

Introduction

The production of food to satisfy basic needs of the population of Ethiopia is crucial to overall socioeconomic well-being. However, there is increasing concern that land degradation resulted from soil erosion and soil fertility depletion seriously limits food security and sustainable agricultural production in Ethiopia (Hurni 1988; Shiferaw and Holden 1999; Tekle 1999; Shiferaw and Holden 2000; Taddese 2001; Bewket and Sterk 2002; Bekele and Drake 2003; Gebremedhin and Swinton 2003). Furthermore, farmers' investments in land management are quite limited (Shiferaw and Holden 1998; Admassie 2000). Farmers generally begin investing in land management when they perceive that there is water erosion and soil fertility depletion (Ervin and Ervin 1982; Shiferaw and Holden 1998; Desbiez and others 2004). Several studies on farmers' perceptions of land degradation and their investments in land management have been carried out in the Ethiopian highlands (Deininger and Jin 2006; Kassie and others 2009). Results show that farmers do actually perceive land degradation as a problem (Bewket and Sterk 2002; Amsalu and de Graaff 2006; Shiferaw and others 2007), but that there is no consistent association between this perception and investments in land management. For example, Green and Heffernan (1987), Kiome and Stocking (1995), and Shiferaw and Holden (1998) reported that if farmers perceive land degradation as a problem they invest more in their land, while other authors reported a lack of association between both factors (Ndiaye and Sofranko 1994; Midmore and others 1996; Bewket and Sterk 2002).

Z. Adimassu (✉) · C. Yirga
Ethiopian Institute of Agricultural Research, P.O. Box 2003, Addis Ababa, Ethiopia
e-mail: zenebeteferi@yahoo.com

Z. Adimassu · A. Kessler · L. Stroosnijder
Land Degradation and Development, Wageningen University, 6700 AA Wageningen, The Netherlands

In Ethiopia, studies related to land degradation and land management have been mainly concentrated in the highlands (Herweg and Ludi 1999; Sonneveld and Keyzer 2002; Descheemaeker and others 2006). The main reason for this skewed efforts in land management is due to a misperception of experts and policy makers that land degradation is sever in Ethiopian highlands resulted from population pressure, long-time cultivation, and intense rainfall (Adimassu and others 2012). Consequently, research related to farmers' perceptions of land degradation and their investments in land management is scanty in other parts of the country, such as in the Central Rift Valley (CRV). In addition, farmers' perceptions of land degradation and their reactions to perceived degradation vary from place to place and from household to household due to variations in socio-cultural, economic and biophysical conditions (Pilbeam and others 2005; Nederlof and Dangbegnon 2007). So, it is questionable if results from elsewhere are applicable to the CRV.

This study is the first attempt to explore farmers' perception of land degradation and their respective investments in land management in the CRV of Ethiopia. The specific objectives of this study are to: (i) assess different land management measures/practices to control water erosion and soil fertility depletion implemented by farmers, (ii) explore farmers' perceptions of land degradation (water erosion and fertility depletion), (iii) assess the extent of farmers' investments in land management for controlling water erosion and soil fertility depletion, and (iv) test whether farmers' investments in land management are influenced by their perceptions of land degradation.

Methodology

Study Area and Households Characteristics

This study was carried out in six *kebeles*[1] of Meskan and Adamitulu Jido-Kombolcha (AJK) w*eredas*[2] of the CRV of Ethiopia (Fig. 1). Beressa, Drama, Dobi, and Mikaelo kebeles are found in Meskan wereda, located about 135 km to the south of Addis Ababa and part of the Southern Nations, Nationalities, and People (SNNP) Region. Worja and Woyisso kebeles are found in AJK wereda of the Oromia Region, about 160 km to the south of Addis Ababa. The elevation of the CRV of Ethiopia ranged from 1,600 m above mean sea level to above 3,000 m above sea level (Meshesha and others 2012). The rainfall of Meskan is represented by the Butajira weather station, whereas that of AJK is represented by the Ziway weather station. The long-term average annual rainfall of Butajira and Ziway stations are 1,130 and 750 mm, respectively (Fig. 2). Rainfall occurs in two distinct rainy seasons, *kremt/meher* rains (also called the "big rains") in summer (roughly June–September) and *belg* rains (also called the "small rains") occurring in spring (roughly March–May).

There are two major farming systems in the study areas: *enset*[3]-based and cereal-based. *Enset* (*Ensete ventricosum)* dominates the *enset*-based farming system. In the cereal-based farming system, farmers rotate cereals such as maize (*Zea mays*), sorghum (*Sorghum bicolor*), and teff (*Eragrostis tef*) with pulses such as field pea (*Pisum sativum*), faba bean (*Vicia faba*), and haricot bean (*Phaseolus vulgaris*). Farmers in Meskan practice intercropping of these cereals with *chat* (*Catha edulis*)[4] and *enset*. They also plant trees around their homesteads and outfields for multiple purposes, including construction, fuel wood, fruits, and cash generation. The main tree species grown around Meskan homesteads are fruit (e.g., avocado and mango) and high-value cash crop trees (e.g., *chat*), whereas non-fruit trees (e.g., *Acacia species*) are grown in the outfields.

More than 80 % of households in the sample are male-headed. On average, about 50 % of the respondents in the sample are literate (who can read and write). The average household size was 6.2 members. The average livestock and land holdings were 3.7 Tropical Livestock Units (TLU[5]) and 1.1 ha, respectively. The size of land among the sample households is highly varied, ranging from 0.13 to 8 ha/household.

Data Collection

A total of six kebeles were randomly selected from three production domains. Domain I (Beressa and Drama) is characterized as food insecure with small land and livestock holdings, whereas Domain II (Dobi and Mikaelo) is

[1] *Kebele* is the lowest level administrative unit in Ethiopia.

[2] *Worde* is the next highest-level local administrative unit above the kebele.

[3] The *Enset* plant, also called "'false banana," is a giant herbaceous tree which may grow up to 13 m high and a diameter of 2 m or more. It is a single-stemmed tree consisting of an above-ground pseudo stem made from overlapping leaf sheaths, a short, compact, and fleshy underground stem called a "corm," and conspicuously large leaves.

[4] *Chat* is an evergreen tree cultivated for the production of fresh leaves that are chewed for their stimulant properties.

[5] Tropical livestock units (1 TLU = 250 kg live weight). Different farm animals have different conversion factor to TLU. Accordingly, oxen/bulls = 1.1 TLU, cows/horses/mule = 0.8 TLU, donkey = 0.65 TLU, heifer = 0.36 TLU, calf = 0.2, chicken = 0.01 TLU, and sheep/goat = 0.09 TLU (Sharp 2003).

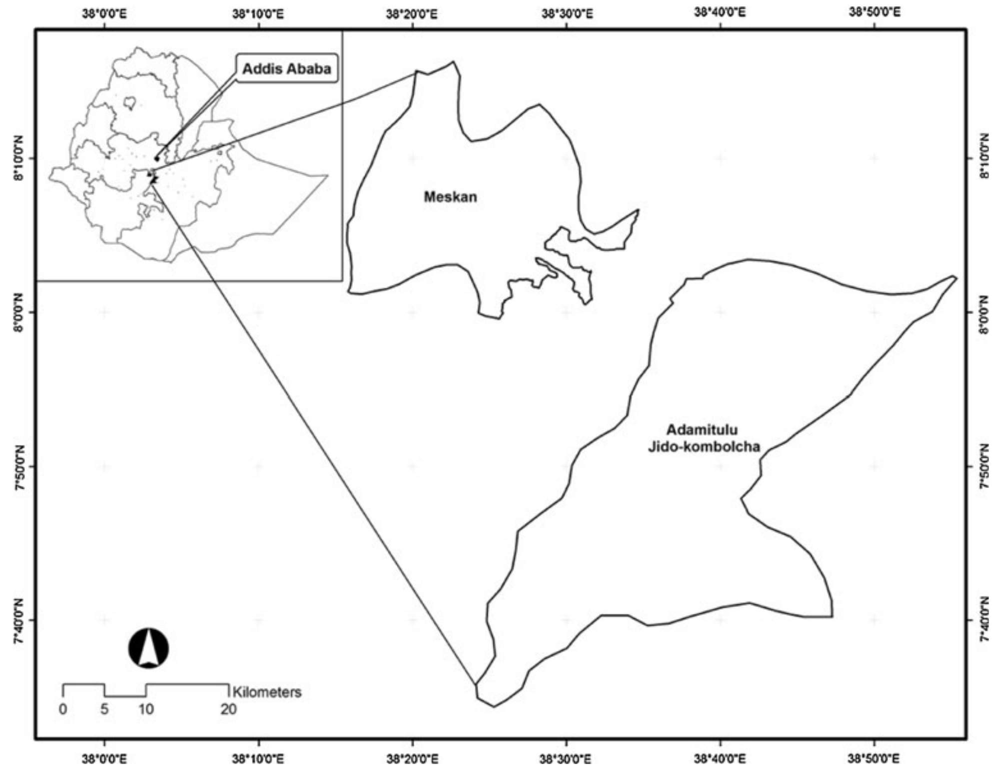
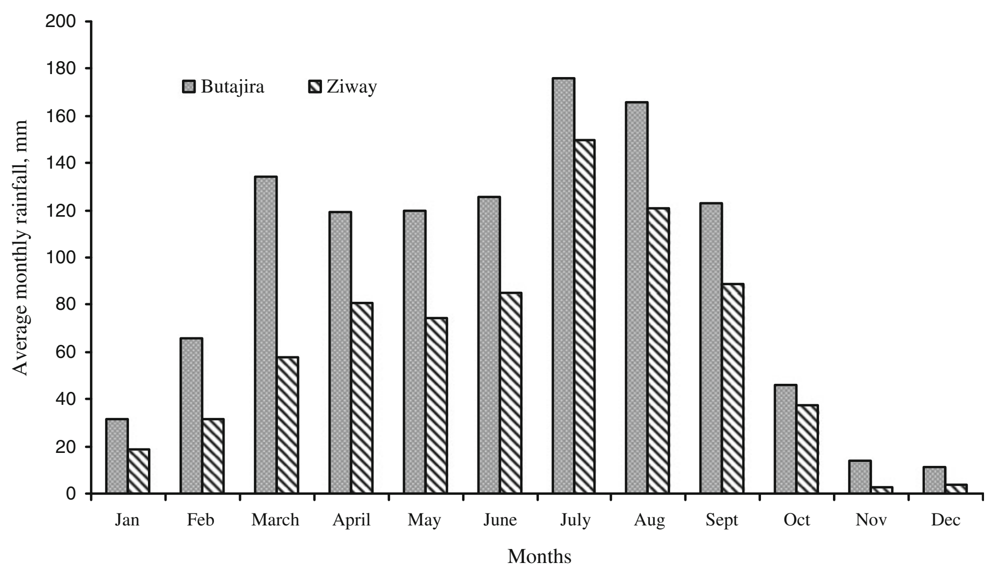


Fig. 1 Map of Ethiopia showing the location of study areas in the Central Rift Valley of Ethiopia

Fig. 2 Mean monthly rainfall (1969–2006) in Butajira and Ziway weather stations



food secure[6] with medium-sized land and livestock holdings. Domain III (Worja and Woyisso) is food insecure but features large land and livestock holdings. Domains I and III are characterized by the cereal-based farming system; domain II features the *enset*-based farming system. Data were collected in two stages using different techniques of data collection. In the first stage, data were collected through key informant interviews and focus group discussions. In this first stage, farmers' perceptions were assessed concerning land degradation—particularly water erosion and soil fertility depletion—and their respective land management investments were discussed. In the second stage of data collection, household surveys were carried out

[6] Food insecure and food secure kebeles are classified as such by the local administration (wereda). A kebele is said to be food secure if most households in that particular kebele could feed themselves without any food-aid or safety net program. Basically, these kebeles are located in the enset-based farming system.

to generate detailed information concerning the perception of farmers toward land degradation, and their investments in land management practices. Accordingly, a total of 240 households were randomly selected from six kebeles and interviewed using a structured and pretested questionnaire. The sampling was done using a list of households obtained from the respective kebele administrations and the household heads were invited for the survey. Detailed data at household ($n = 240$) and plot level ($n = 738$) were collected.

Determination of Land Management Investments

The major land management practices in the study area are soil bunds/stone bunds, application of organic fertilizers (animal manure and compost), and application of inorganic fertilizers [di-ammonium phosphate (DAP) and urea].

Based on information given by each farmer, the total length of both soil and stone bunds (in meters) per household was calculated by summing-up the constructed lengths for all plots of a particular household. The intensity of use of soil/stone bunds per hectare (m ha^{-1}) was obtained by dividing the total length of bunds to the total area on which these bunds were constructed. Investment intensity (man-days ha^{-1}) was calculated according to local working norms, in which one man-day equals 3 m of stone bund, or 10 m of soil bund.

Similarly, the amount of organic fertilizers was obtained by asking the farmers the quantity of manure and compost applied to each of their plots. Farmers estimated this amount using the local measurement called a *kirchat*. A *kirchat* contains on average 20 kg of manure or compost. All values in local measurements were then converted into standardized units (kg). The total amount of organic fertilizer applied by a household was obtained by summing the amount of manure and compost from each plot. This was divided by the total area of organically fertilized plots to obtain the intensity of use (kg ha^{-1}) for manure and compost. For calculating the investment intensity of use of inorganic fertilizers (DAP and Urea) the procedure was the same.

To determine and compare the different land management investments, all of them were converted into a monetary unit (Ethiopian Birr, ETB). For this calculation we used local market prices:

- One man-day = 10 ETB
- 20 kg (1 *kirchat*) of manure/compost = 10 ETB
- 1 kg DAP = 10.82 ETB and 1 kg urea = 8.5 ETB (in 2010)

For the statistical analysis, farmers' investments in land management were categorized into three scales: 1 = no/low (0–250 ETB/household), 2 = medium (251–500 ETB/household), and 3 = high (501–1,200 ETB/household).

Data Analysis

Statistical packages for social sciences (SPSS) software was used to analyse the data. Descriptive statistics—primarily cross tabulation—was employed to summarize the data. χ^2 analysis was undertaken to test the association between farmers' perceptions of land degradation and their investments in land management. Finally, Spearman correlation was used for trend analysis, in this case the association between farmers' perceptions of trends of land degradation and their level of investment in land management.

Results and Discussion

This section presents and discusses the results in three consecutive sections. The first section deals with farmers' perceptions of land degradation, particularly water erosion and soil fertility depletion. The second section assesses farmers' investments in land management. Finally, the third section discusses the association between farmers' investments in land management and their perceptions of land degradation.

Farmers' Perceptions of Land Degradation

Farmers' perceptions are based on two indicators of land degradation: water erosion and soil fertility depletion. Only these two indicators are used because of being the most important forms of land degradation that affect Ethiopian agricultural production (Hurni 1988).

Farmers' Perceptions of Water Erosion

Farmers were asked two major questions to gauge their perception of water erosion: (i) whether water erosion is a problem on their land (yes, no) and (ii) how the trend is of water erosion over years (decreasing, no change, increasing). A highly significant ($\chi^2 = 21.32$, $P = 0.001$) proportion of respondents (92 %) noted the problem of water erosion on their land (Table 1). During transect walks in the study area it was observed that gullies and rills were abundant on cultivated lands. This observation explains the general awareness among farmers of erosion problems.

Farmers also indicated the trend of water erosion over the last 10 years (Table 1). About 66 % of respondents reported that water erosion is increasing. This proportion of households is significant ($P < 0.01$) as compared to other responses, and is consistent with studies elsewhere in Ethiopia (Amsalu and De Graaff 2006; Bewket 2007). An exception is domain III where a low percentage of respondents reported to perceive an increase in water

Table 1 Farmers' perception of water erosion and current trend (% of respondents) in the CRV of Ethiopia

Farmers' perception to	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Water erosion as a problem	100	98	90	81	95	87	92
Trend of water erosion							
Increasing	78	85	85	78	38	31	66
Remaining the same	17	13	12	17	45	65	28
Decreasing	5	2	3	5	17	6	6

erosion over the years. The main reason is that this area is having low rainfall and a flat topography.

The reasons given for the increase in water erosion over the years include increased deforestation, increased susceptibility of soil, and lack of soil conservation activities. Informal discussions with farmers confirmed their general high level of awareness and perception of water erosion as a problem. For example, farmers expressed the opinion that the local government has given minimum attention to land management. Farmers in Dobi and Worja noticed that community mobilization to protect upstream communal lands has been neglected. Farmers reported that in recent years, these upstream communal lands were distributed to landless "youngsters" who began cutting down the trees and grasses that until then had been preserved as communal forest. Moreover, according to farmers, these younger farmers are not investing in land management on the formerly communal lands. Consequently, this upstream land has become a source of run-off for the downstream cultivated lands.

Farmers' Perceptions of Soil Fertility

Two similar questions were asked concerning farmers' perception of soil fertility: (i) is soil fertility depletion perceived as a problem (yes or no) and (ii) what is the current trend of soil fertility depletion (decreasing, no change, increasing). The majority (84 %) of farmers reported that soil fertility depletion is a problem on their plots and a significant ($\chi^2 = 29.32$, $P = 0.001$) proportion (77 %) affirmed the view that soil fertility has declined over the last decade (Table 2). Similar studies have also reported that farmers perceive soil fertility to be declining across different parts of Ethiopia (Amsalu and De Graaff 2006; Eyasu 1998). Moreover, farmers' perceptions of soil fertility depletion over the years are supported by empirical findings (Stoorvogel and others 1993; Haileselassie and others 2005; Moges and Holden 2008). Again, domain III shows to be an exception with a relatively smaller proportion of respondents perceiving a decrease in soil fertility. This is partly explained by the fact that farmers in this domain are more focused on rainfall and water as a limiting factor for crop production than soil fertility.

Land Management Investments

This section presents farmers' investments in land management measures for controlling water erosion and soil fertility depletion. Land management investments are conceptualized as any effort made by farmers to control water erosion and improve soil fertility (Kessler 2006). Most studies in Ethiopia have focused on farmers' investment in land management by only considering percentage of households implementing a given land management measure in at least one of their plots (Amsalu and De Graaff 2006; Bahir 2010). However, these studies do not take into account *how much* farmers invest in land management and the degree to which they invest in these measures. In this article, however, we include the proportion of area covered by each measure, as well as intensities of investments in land management in monetary terms (ETB ha^{-1}).

Land Management Investments for Water Erosion Control

Water erosion control measures are land management practices that control run-off or run-on. Soil bunds and stone bunds are the two major water control measures undertaken in the study areas. Both are physical soil and water conservation measures that are generally constructed along the contour line. Soil and stone bunds are introduced techniques which can be used alternatively based on the availability of stones and labor.

The survey showed that on average 38 % of households constructed either stone or soil bunds in at least one of their plots to counter water erosion. The results vary greatly among domains and kebeles (Table 3). In terms of domains, a large proportion of households in Domain I (61 % in Beressa and 85 % in Drama) constructed water erosion control measures. The small percentage of households (5 %) that had constructed water control measures in Mikaelo is due to the flat topography of the area. Similarly, a relatively small percentage of respondents had constructed water erosion control measures in Domain III (15 % in Worja and 18 % in Woyisso), which is located in an area of low rainfall and flat topography. Moreover, it

Table 2 Farmers' perception of soil fertility and current trend (% of respondents) in the CRV of Ethiopia

Farmers perception to	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Soil fertility depletion as a problem	90	95	98	80	66	75	84
Trends of soil fertility							
Decreasing	85	93	95	78	48	64	77
Remaining the same	12	5	5	22	47	36	21
Increasing	3	2	0	0	5	0	2

was discovered through informal discussions that development agents in these kebeles are mainly disseminating soil fertility control measures (e.g., composting) and only in rare cases inform farmers on the importance of investing in water erosion control measures. Concerning the percentage of the area covered by water erosion control measures, the results show that on average only 20 % of the total cultivated land in the study area is treated with these measures. Again, the highest percentage is found in Domain I, where, respectively, in Beressa and Drama, 34 and 60 % of the farmlands are covered with water erosion control measures.

Nevertheless, both the proportions of households and area covered do not show how much farmers actually invest per hectare of land. Therefore, we calculated the intensity of investment (Table 3) by taking into account the area covered by water erosion control measures and the costs for constructing soil or stone bunds (in ETB). The average intensity of investment was 150 ETB ha^{-1}, with a relatively high intensity in Beressa (330 ETB ha^{-1}) and a low intensity in Woyisso (29 ETB ha^{-1}) kebele. If we use the current exchange rate (1 ETB $\approx$ 0.06 US$), the average intensity of investments of water control measures equals 8.6 US$ ha^{-1}. As expected, the results indicate that farmers in Beressa and Drama (Domain I) constructed water erosion control measures with a higher intensity of investment than the other kebeles. In these kebeles, water erosion control is needed more than in the others. Moreover, in Beressa there is a higher comparative availability of stones which facilitates investments in these measures.

But what does this intensity of investment mean? Is it enough to reduce water erosion to a satisfactory level of control? A study by Gebremedhin and Swinton (2003) estimated that an average length of 700 m of soil bund per hectare is required to effectively reduce water erosion on typical slopes in Northern Ethiopia. Of course, steeper slopes require more bunds, but if we take this 700 m ha^{-1} (which more or less equals an investment of 700 ETB) as our baseline, it results that the average investment in soil erosion control in the CRV is only 21 % of the recommended investment. Even in Beressa, where water erosion control is required on almost all fields, this percentage remains below 50 %. Moreover, the investment calculated in this study is not a 1-year investment, but rather it is the cumulative investment over the previous years on a hectare base. Hence, assuming that farmers have been investing in water erosion control measures for the last 5 years, the average investment in water erosion control measures per hectare per year is only 30 ETB (1.8 US$) which equals only 3 man-days ha^{-1} y^{-1}.

Summarizing, we can state that there is only a small percentage of farmers (38 %), who apply water erosion control measures on a very small proportion of their land (20 %) and with a low average intensity of investment (only 30 ETB ha^{-1} y^{-1}). In conclusion, farmers' investments to control water erosion in this part of the CRV are minimum.

Land Management Investments for Soil Fertility Control

Soil fertility control measures are land management measures/practices such as application of inorganic and organic fertilizers that replenish and/or improve the fertility of the soil. In addition to water erosion control measures, soil degradation can be reduced through soil fertility control practices because crops can grow more vigorously in

Table 3 Investments in water erosion control measures in the CRV of Ethiopia

	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Households (%)	61	85	40	5	15	18	38
Area covered (%)	34	60	21	3	14	9	20
Intensity of investment (ETB ha^{-1})	330	235	66	58	178	29	150

well-managed soils, thereby protecting the soil from erosion much more effectively than weak-growing crops. Both organic and inorganic fertilizers are important for conserving the soil and for increasing crop yield. The main soil fertility control practices in the CRV are application of inorganic fertilizers (DAP and Urea) and organic fertilizers (manure and compost). Organic fertilizers are widely used to control soil fertility depletion in the CRV of Ethiopia, and particularly manure application is a traditional soil fertility management practice in crop-livestock farming systems of Ethiopia (Eyasu 1998).

Table 4 presents investments in land management for fertility control measures in terms of percentage of households, area covered, and intensity of use. The study showed that 83 % of the households applied at least one soil fertility control practice in one of their plots. This percentage varied across kebeles, ranging from 56 % in Beressa to 97 % in Woyisso (Table 4). In terms of domains, the largest proportion of households applying soil fertility control measures is found in Domain III. Better availability of animal manure as a result of high livestock number contributes to this high percentage of respondents applying soil fertility control measures.

Table 4 also depicts the proportions of area covered by the different soil fertility control practices in each kebele. In total, on 46 % of the cultivated land in the study area soil fertility measures were applied in the 2009/2010 cropping season. Considering that all agricultural fields in the study area would require investments in the form of fertilizers, this percentage is quite low. However, it is on average twice as high as the area covered by water erosion control measures.

Like with water erosion control measures, percentage of households and area covered do not show *how much* is actually invested in soil fertility control practices. Using current local market prices the average intensity of investment of soil fertility control measures was calculated to be 719 ETB ha^{-1} (or 43 US\$ ha^{-1}). The highest investment is found in Domain III (1,144 ETB ha^{-1} in Worja and 917 ETB ha^{-1} in Woyisso). If we convert the average investment into values of DAP and urea fertilizers, we find that with 719 ETB we can buy only 47 kg DAP and 47 kg urea. This is only half of the level that is recommended by the national extension service for most crops in Ethiopia (100 kg ha^{-1} DAP and 100 kg ha^{-1} urea).

Nevertheless, farmers' investments (in ETB) in soil fertility control measures are on average five times higher than investments in water erosion control measures. Even in Beressa, where water erosion control is indispensable, farmers invest twice as much in fertility control than in water erosion control. This underlines the importance of soil fertility control and the fact that taking such measures is common cultural practice for most farmers. These measures are also easier to apply as compared to water erosion control measures and generally give a faster return. It is in fact a comparison between annual practices, which are part of annual management (crop fertilization) and investment activities with impact only on the long run (erosion control measures).

However, given that not even half of the total agricultural area is treated with soil fertility control measures, and then even with half of the recommended investment intensity, farmers' investments in soil fertility control measures are still very limited in the study area. Interviewed farmers reported that the main reason for this is a dramatic increase in fertilizer prices coupled with a lack of financial capital, which together constrain their application of inorganic fertilizers. Evidence from elsewhere in the country confirms that Ethiopian farmers use a low level of inorganic fertilizer per hectare (Spielman and others 2010), and that the amount of inorganic fertilizer use is the lowest of any country in sub-Saharan Africa (Jayne and others 2003). Several studies in different areas of the country indicate that crop productivity has been affected by the increasing price of fertilizer and improved seed (Alem and others 2010; Spielman and others 2010).

Do Farmers' Perceptions Matter?

Based on the previous sections there is an apparent contradiction: farmers' awareness of land degradation is high (they perceive it as a problem and generally perceive that water erosion and soil fertility decline are increasing) but their investment in land management (control measures) remains very limited. To confirm this contradiction, χ^2 analysis was used to test the association between farmers' investment in land management (yes/no) and farmers' perception of land degradation as a binary choice (yes/no). Furthermore, Spearman correlation was used to test the

Table 4 Investments for soil fertility control practices in the CRV of Ethiopia

	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Households (%)	56	93	68	95	88	97	83
Area covered (%)	34	51	41	22	55	81	46
Intensity of investment(ETB ha^{-1})	647	709	677	687	1,144	917	719

relationship between the perceived trend of land degradation and farmers' level of investments in land management. In the latter case, ordinal variables were used for farmers' perception of the trend of land degradation (decreasing, no change, increasing) and for their level of investment (no/low, medium, high). Table 5 presents associations between farmers' investments in land management and their perceptions regarding both water erosion and soil fertility depletion.

Farmers' Perception of Water Erosion Versus Investment in Land Management

In this section, two hypotheses were proposed: (i) where farmers are aware of *water erosion* as a problem, they will be more likely to invest in practices for water erosion and/or soil fertility control and (ii) if farmers perceive that *water erosion* is increasing over years, they invest more in practices for water erosion and/or soil fertility control. The χ^2 test shows that respondents' perceptions of water erosion as a problem are not significantly associated with their investments in land management for both water erosion control ($\chi^2 = 6.40$, $P = 0.11$) and soil fertility control ($\chi^2 = 2.14$, $P = 0.21$) measures. Furthermore, the Spearman correlation shows that farmers' level of investment in water erosion control is not significantly correlated ($r = 0.053$, $P = 0.25$) with their perception of the trend of water erosion. Similarly, their investment in soil fertility control measures is not significantly correlated ($r = 0.062$, $P = 0.20$) with perceived trend of water erosion.

Hence, both hypotheses are rejected: farmers who perceive water erosion as a problem on their land or farmers who perceive that water erosion has become worse over the past years do not invest significantly (with $P < 0.05$) more in their land than farmers who do not perceive this.

Farmers' Perception of Soil Fertility Decline Versus Investment in Land Management

Again, two hypotheses were drawn: (i) where farmers perceive *soil fertility decline* as a problem, they will be more likely to invest in water erosion and soil fertility control and (ii) where farmers perceive *soil fertility* as depleting over the years, they will invest more in water erosion and soil fertility control.

Table 5 shows the χ^2 association and Spearman correlations between farmers' investments in land management and their perceptions of soil fertility depletion. None of these analyses do yield significant ($P < 0.05$) results. Hence, despite the fact that most farmers in the study area perceive soil fertility decline as an increasing problem, this perception does not significantly influence their decisions to invest in land management, neither does it influence *how much* they invest in both water erosion and soil fertility control measures. Only farmers' investments in water erosion control measures are marginally significant ($\chi^2 = 6.27$, $P = 0.07$) correlated with farmers' perceptions of soil fertility decline. Although this might indicate that farmers are aware about the effect of water erosion on soil fertility depletion, we assume that this association is rather a coincidence and far from enough to conclude that there is any association between farmers' investment in land management and their perceptions of land degradation. This shows that there is no sound evidence supporting the two hypotheses mentioned above. Similar findings in the Blue Nile basin of Ethiopia (Bewket and Sterk 2002), where farmers' perception of land degradation was not sufficiently associated with their participation in soil and water conservation practices, support the rejection of both hypotheses.

Now that all hypotheses have been rejected and perception of land degradation has shown not to be of any influence on farmers' investments in land, it is justified to ask: Why then do farmers fail to invest in land management in the CRV? From studies elsewhere around the globe, we know that there are other social, economic, and biophysical factors that influence farmers' investments (Gebremedhin and Swinton 2003; Pender and Gebremedhin 2007). Given that such factors are often farmer and site specific suggests the needs for further research into exploring the factors affecting farmers' land management decisions in the CRV of Ethiopia.

Table 5 Associations between farmers' investments in land management and their perceptions of land degradation using χ^2 test and Spearman correlation (P values are in the parentheses)

Perceptions	Investment in water erosion control		Investment in soil fertility control	
	χ^2	Spearman	χ^2	Spearman
Water erosion is a problem	6.14 (0.11)	–	2.14 (0.21)	–
Water erosion increases over years	–	0.053 (0.25)	–	0.062 (0.18)
Soil fertility decline is a problem	6.27 (0.07)	–	0.28 (0.82)	–
Soil fertility depletes over years	–	0.061 (0.20)	–	0.058 (0.22)

Conclusions

The study assessed farmers' perceptions of land degradation and their investments in land management practices in the CRV of Ethiopia. It is clear from farmers' responses that there is widespread awareness of land degradation in the form of water erosion and soil fertility decline. This shows that the water erosion problem is not confined to the highlands but is also a serious issue in the CRV. However, support from research and development institutions to address land degradation in the CRV is very low compared to that of the highlands. This suggests the need for rethinking the distribution of support for land management investments in Ethiopia. Due attention should also be given to the CRV of Ethiopia.

Despite farmers' awareness of land degradation, the use of and investments in land management practices across kebeles is limited. Particularly investments in water erosion control are very low, as demonstrated by the small percentage of farmers who have constructed soil or stone bunds, and the small proportion of land where such measures have been constructed. However, although a relatively large proportion of households applied soil fertility control measures, they did so on a small proportion of the total land area and at a low intensity of investment. This indicates that using the percentage of farmers who applied one or more land management measures to at least one of their plots as the only indicator of investment in land management (i.e., without taking into account the proportion of total land area or the intensity of investment) is misleading.

The study also showed that farmers' investments in land management measures for water erosion and soil fertility control vary among plots, households, kebeles, and domains. Farmers' investments in monetary terms are five times higher for soil fertility control measures than for water erosion control measures. This is because soil fertility control has immediate yield effects as compared to water erosion control. Moreover, these measures are easier to apply, they are common practices that all farmers apply over years, and they are needed on all of the plots, regardless of their slope or susceptibility to erosion. We also understand from this study that agricultural experts both at wereda and kebele levels are more focused on promoting soil fertility control practices rather than water erosion control measures. This shows that higher level (e.g., wereda) administrations are foremost interested in soil fertility control measures, mainly because of their immediate impact on crop yield.

The lack of a significant association between farmers' perceptions of land degradation and their investments in land management for all the study kebeles raises the question of why farmers do not invest more to address the land degradation they perceive. The findings indicate that awareness of the problem of water erosion and soil fertility decline is not a decisive factor when farmers decide to invest in land management. Hence, there are other factors—not addressed by this study—that are probably more important in influencing farmers' decisions whether and how much to invest in land management. Further research should be conducted to assess these factors, particularly those related to the socioeconomic characteristics of individual households and biophysical characteristics of plots in the CRV of Ethiopia.

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