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Coffee Based Rehabilitation of Degraded Land : the Case of Haru District, West Oromia, Ethiopia

[1]Tena Gobena, [2]Kaba Urgessa and [2]Zerihun Kebebew

[1]Jimma University, College of Agriculture and Veterinary Medicine, Ethiopia
[2]Department of Natural Resources Management,
Jimma University College of Agriculture and Veterinary Medicine, Ethiopia

Abstract: Managing the environment in which people live has become more complex. As a result millions of people have become food insecure due to natural resource degradation. In the past few decades rehabilitation efforts have been made to counterbalance environmental degradation. However its implementation has not been successful in most cases, due to various barriers. The study aims at exploring the potential of coffee based rehabilitation strategies, while supporting the livelihood of smallholder farmers. The study was conducted at Haru district found in west Wallaga, Oromia, Ethiopia. A plot of 20 m x 20m was laid to collect vegetation data from 40 coffee farms. Socioeconomics information were collected through household interview using structured and semi structured questionnaire and focus group discussion. The result indicates that 15108ha of degraded land was rehabilitated through coffee based land use system. Vegetation assessment result showed that twenty nine species were recorded in sampled coffee farms. The proportion of indigenous tree and shrubs, exotic fruit tree and shrubs accounted for 79.3%, 17.2 % and 3.5% respectively. Similarly more than 50 percent of the coffee production was found on degraded land greater than 16% slopes. The Shannon diversity index was calculated 2.8. Given the increasingly important issue of land management coffee based land use systems was found among the most promising land uses for achieving both conservation goals and supporting human livelihoods at the landscape scale by promoting community- based management of natural resources.

Key words: Coffee · Rehabilitation · Land use · Degraded land · Ethiopia

INTRODUCTION

Land degradation has become a serious issue in Ethiopia. Many forests have been converted to cultivated land [1, 2] and continuously cultivated without any conservation measures. The removal of this forest has accelerated soil erosion, loss of important species and culminating in land degradation. Due to serious land degradation agricultural productivity is getting low over period of time [3].

Land resources are exhaustively utilized to meet the basic needs of people. Managing the environment in which people live has become more complex. To overcome land degradation problems, rural afforestation and on farm soil and water conservation programs have been practiced in Ethiopia for the past three decades. These activities have declined over the years due to the fact that farmers want to ensure immediate return [4]. The early efforts to reverse land degradation didn't bring remarkable change and still, land degradation is challenging the livelihoods of millions of people in Ethiopia [4, 5-7]. Today, millions of people in Ethiopia are still food insecure. According to Demel and Tegineh [7] Millennium Development Goals report, 38.7 percent of the Ethiopian populations are still living below the food poverty line. The government is working towards eradicating poverty through growth and transformation plan for the year 2010/11-2014/15. Area enclosure, agroforestry, plantation and soil and water conservations are the major techniques that have being in use as best practices in sub-Saharan Africa to reverse land degradation. The choice of a specific method requires consideration of social, economic, ecological and political issues [9]. Demel and Tegineh [7] stated that there is no universal formulae or solution that can work

Correspondening Author: Zerihun kebebew, Department of Natural Resources Management, Jimma University, Ethiopia P.O. Box 307 Jimma, Ethiopia. Tel: +251471123170.

across the board to address land degradation in Ethiopia; rather, solution should be locality specific and closely tied to the socioeconomic setup of the community.

Coffee production is predominantly the occupation of smallholder farmers in the West Wollega. There are two ways of growing coffee in the area; under the shade of dense natural forest and on the cultivated land with small patches of several coffee plants shaded by individual trees. The promotion of growing coffee on farmland under individual shade trees could be an important tool in rehabilitation of degraded land to improve the ecological integrity of the landscapes [10] and livelihood of smallholder farmers. Despite traditional experience of growing coffee on cultivate land in Ethiopia, many previous study has focused on the contribution of traditional coffee production system to biodiversity conservation [11-13]. There is limited effort to exploit coffee production system as tool for rehabilitation of degraded land in study area. The study aims at exploring the potential of coffee based rehabilitation strategies while supporting the livelihood of smallholder farmers in the study area.

MATERIALS AND METHODS

The study was conducted at Haru district found in west Wallaga, Oromia, Ethiopia. Geographically, it is situated between 8° 52' N and 9°7' N latitude and 35° 41' E and 36°10 ' E longitudes. Agroecologically, 80% of the district is categorized under *Weyna-Dega* and the remaining 20% is *Kola*. The area is characterized by uni-modal rainfall pattern. The mean annual average rainfall was about 1853mm.. The rainy season is from March to September and the dry season is from October to February. The altitude of the study area is ranging from 1550 meter to 1950 meter above sea level.

Mixed farming characterizes the agriculture of the area. Due to traditional agricultural practice, most land resource are highly degraded resulting in declining productivity of agricultural. Most cereals are produced for household consumption. Coffee is the main income generating cash crop. Honey and *chat* are also produced for income in the area.

Two stage sampling was used for the study. First, watershed and then coffee farms were selected for the study. 40 coffee farms were purposely selected from *Ujumoo* watershed. Vegetation cover was considered as indicator of rehabilitation of degraded land. Shacklton (2002) used species diversity as indicator of sustainable land practice. Vegetation assessment was conducted between January 1, 2011 to March 15, 2011. A plot of 20 m x 20m was laid to collect vegetation data [14]. In each plot, number of individual plants were counted, hypsometers reading for height, clinometers reading for the slope and diameter at 1.3m using measuring tape were recorded. Azene [15] used for species identification as has been used by many previous studies.

Socioeconomics information were collected through household interview using structured and semi structured questionnaire and focus group discussion. The sample size was estimated using proportional probability sampling technique as has been used by Daniel [16].

$$n = \frac{Z^2 P(1-P)}{d^2} \rightarrow n' = \frac{NZ^2 P(1-P)}{d^2(N-1) + Z^2 P(1-P)}$$

Where:
n = sample size,
Z = Z statistic for a level of confidence,
P = expected prevalence or proportion (in proportion of one) and
d = precision (in proportion of one).
n' = sample size with finite population correction,
N = Population size,

A sample size of 60 households was calculated and randomly selected for household interview.

Socioeconomics data were analyzed descriptively using Microsoft Excel and SPSS package version 16.

Vegetation data was analyzed using Shannon diversity index (*H'*) following [18] using the formula

$$H' = -\sum_i P_i \ln P_i$$

Where pi, is the proportion of individuals found in the i^{th} species and ln=log base n

RESULTS AND DISCUSSION

Socio-Economic Characteristics: Table 1 shows the survey result of socioeconomic characteristics of households. 78% of the respondents were males and 22% of the respondents were females. Most of the respondents were educated. Only 28 % of the respondents were found illiterate. The family size per household ranges from 2 to 12 persons with an average size of 6 persons per household implying shortage of land over period of time. From age categories, the largest number of farm owners were in the age categories of 20 to 30 years old. It implies that rehabilitation of degraded land is becoming must for the youngsters to use land.

Table 1:he socio-economic characteristics of sampled households

	Categories	Percent
Sex	Male	78
	Female	22
Education	Illiterate	28
	First cycle	26
	Second cycle	28
	High school	18
Family size	Small size class	28
	Medium size class	55
	Large size class	17
Age class	20-30	32
	31-40	23
	41-50	27
	51-86	18

Source: Field survey (2011)

Table 2: Land use in the study area

No	Land use types	Area in (ha)	Percent
1	Annual crops	14501	35.4
2	Coffee	15108	32.4
3	Grazing	3092	6.6
4	Forest	4387	9.4
5	Degraded land	1514	3.2
7	Others	6058	13.0
Total	46700	100.0	

Sources: Field survey (2011)

The average landholding size per household was found less than two hectares. But, the size varies from one household to another. The small plot of land was mainly allocated for growing coffee and annual crops cultivation (Table 2). Discussion with key informant indicated that agricultural production and productivity of the main crop is declining from time to time. The average cereal yield was found less than 9 quintal/ha, which is below the national average 12 quintal/ha. The correlation result showed inverse relationship between landholding size and rehabilitation of degraded land through coffee (corr.= - 0.947, P= 0.015). Farmers holding small land size were the one who more involved in rehabilitation of the land. This partly can be explained smallholder farmers exploit the possible land use options to support their family.

Rehabilitation of Degraded Land Through Coffee Production System: The result showed that the total area of land under coffee was estimated to be about 15108 ha (Table 2). Figure 1 depicts integration of coffee with cultivated land. The land users felt coffee cultivation would result in better income from the same unit of land. Holden *et al.* [19] also reported that tree planting as best alternatives in less favored areas of the Ethiopian highlands. However, the chi-square result showed that farm size and age of the respondent influence the participation of rehabilitation of degraded land (Table 3). Analysis of rehabilitated land showed increasing trends of households participation to

Fig. 1: Partial view of rehabilitated land with coffee

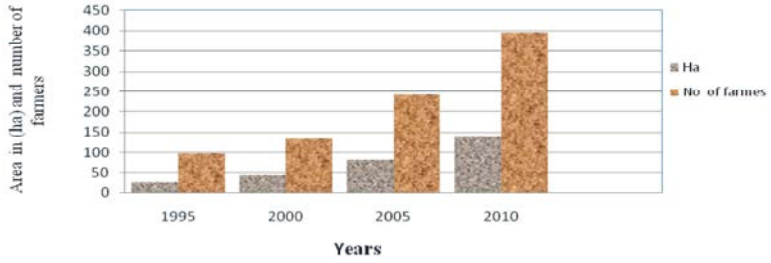

Fig. 2: Rehabilitated land using coffee production
Sources: survey result (2011)

Table 3: Chi square result of relationship between socio-economic factors and participation on coffee based land rehabilitation.

Variable	x^2	DF	P value
Family size	20.897	14	0.104
Total farm size	86.976	28	0.00**
Age of respondent	33.893	21	0.037*
Educational level	28.581	21	0.124
Sex of respondent	8.956	7	0.256

**= Significant at 0.01 % and * = significant at 0.05%

Table 4: The slope of rehabilitated area through coffee production

Percent slope	Number of plots	Percent
3-8	5	12.50
9-15	11	27.50
16-30	14	35.00
More than 30	10	25.00
Total	40	100.00

rehabilitate degraded land with coffee (Fig.2). Hylander and Nemomossa [12] reported that coffee cultivation in degraded lands could be considered a form of landscape rehabilitation and should therefore be promoted in regions already cleared of native vegetation.

Rehabilitation of degraded land through coffee was two steps process. In the first steps, small trees and shrub species are introduced to degraded land together with physical soil conservation measure to improve the site condition for coffee. In the second steps coffee and coffee shade trees are established. This has strong implication in soil fertility replenishment. Previous study, Mulugeta [9] assessed the potentials of planted trees in restoration of soil fertility on degraded land. Rehabilitation of degraded land is more important in sloppy area. The assessment result showed that sloppy area are under coffee production (Table 4).

Smallholder farmers were interested in coffee based rehabilitation of degraded land for various reasons. 85% of the respondent believed that the system improve soil organic matter. All respondents reported that approach improve their livelihoods through diversification of source of income from the land (Table 5). Currently, smallholder farmers are in favor of more integrated land use systems for sustainable land uses.

Vegetation Assessment in Rehabilitated Coffee Farm: Vegetation assessment result showed that a total of 29 species of plants representing 18 families were recorded on coffee plot (Table 6). The proportion of trees, shrubs and fruit tree accounted for 38%, 44.8% and 17.2, respectively (Table 7). The high proportion of native species observed indicates significant contribution of the approach to restore woody vegetation. The Shannon diversity index was calculated 2.87. This has positive implication of the role of coffee production in the conservation of woody flora. This is in agreement with those reported by Mulugeta [20] and Beer *et al.* [21].

Table 5: Preference to rehabilitation of degraded land through coffee production

Reason for preference	No of respondent	%
Tree in coffee farm add organic matter to soil	51	85
Tree in coffee farm protect soil from erosion	48	80
Less or no chemical fertilizer required	55	91.7
Improve aesthetic and environmental value of their land	60	100
Better use of marginal land	6 0	100

Source: Field survey (2011)

Table 6: List of species recorded on coffee farm and their intended uses

Vernacular name	Scientific name	Shade tree type	Cultural status	Use								
				shade	medicinal	firewood	constriction	Food/fruit	timber	forage	soil improvement	other
Lafito	*Acacia abyssinica*	*t*	*In*	*x*		*x*	*x*			*x*	*x*	
Mukaarba	*Albizia gummifera*	*t*	*In*	*x*		*x*	*x*				*x*	
Dogoma	*Albizia schimperiana*	*t*	*In*	*x*	*x*	*x*			*x*	*x*	*x*	*x*
Lolichisa	*Bersama abysinica*	*t*	*In*									
Galano	*Bridelia micrantha*	*t*	*In*	*x*	*x*	*x*		*x*	*x*	*x*	*x*	*x*
Ramiso	*Cassia didymobotrya*	*s*	*In*		*x*	*x*					*x*	*x*
Cheka	*Celtis africana*	*t*	*In*	*x*						*x*		*x*
Burtukan	*Citrus aurantifolia*	*f*	*Ex*	*x*				*x*				
Lomi	*Citrus sinensis*	*f*	*Ex*	*x*				*x*				*x*
Wadesa	*Cordia africana*	*t*	*In*	*x*		*x*	*x*		*x*		*x*	
Bakansa	*Croton macroschiyus*	*t*	*In*	*x*	*x*	*x*	*x*				*x*	*x*
Dankarch	*Dichrostachys cinerea*	*s*	*In*	*x*	*x*						*x*	*x*
Sokoru	*Dovyalis abyssinica*	*s*	*In*			*x*					*x*	
Ulaga	*Ehretia cymosa*	*t*	*In*			*x*			*x*	*x*	*x*	*x*
Mixoo	*Galiniera saxifraga*	*s*	*In*		*x*						*x*	*x*
Bururi	*Grewia ferruginea*	*s*	*In*			*x*		*x*		*x*		
Abayi	*Maesa lanceolata*	*s*	*In*	*x*		*x*					*x*	*x*
Mango	*Mangifera indica*	*f*	*In*	*x*		*x*		*x*		*x*	*x*	*x*
Sotalo	*Millettia ferruginea*	*t*	*In*	*x*		*x*	*x*		*x*		*x*	
Muzii	*Musa sapientum*	*f*	*In*	*x*				*x*			*x*	
Reji	*Myrica salicifolia*	*s*	*In*			*x*				*x*	*x*	*x*
Avocado	*Persea americana*	*f*	*Ex*	*x*				*x*				*x*
Urgesa	*Premna schimperi*	*t*	*In*		*x*	*x*						*x*
Gesho	*Rhamnus prinoides*	*s*	*In*		*x*	*x*					*x*	*x*
Qobo	*Ricinus communis*	*s*	*Ex*	*x*	*x*	*x*						*x*
Bosoqa	*Sapium ellipticum*	*t*	*In*			*x*	*x*					*x*
Sasbania	*Sesabania sesban*	*s*	*Ex*	*x*		*x*				*x*	*x*	
Badessa	*Syzygium guineense*	*t*	*In*									
Ebicha	*Vernonia amygdalina*	*s*	*In*	*x*	*x*					*x*	*x*	*x*

Key T=tree S=shrubs F = exotic fruit tree In =indigenous Ex=exotic

Table 7: Number of trees and shrubs, Average diameter and height of trees and shrubs on coffee farm

Coffee age	Average no plant per sample plot (0.04ha)			Average DBH(cm)	Height (m)
	Tree	Shrubs	Total		
3-5	9.0	18	27	8.13	5.72
6-10	8.0	10	18	14.15	7.81
>10	9.0	6	15	21.26	11.61

Albertin and Nair [22] also indicated that shade coffee production could be used in rehabilitation of degraded areas in densely populated areas where large-scale restoration of forest vegetation is not possible. Farmers are rational in promoting trees on their farm. About 90 % of the respondents explained that the choice of tree to be used in the system was based on selected criteria. This is in agreement with study made by Harvey *et al.* [23] who stated that farmers are rational in making decisions to integrating trees on farm. Legume species are the most abundant in the coffee farm. These legume species have been traditionally promoted by coffee growers as they are thought to enhance nitrogen fixation, provide good shade, abundant litter fall to enhance fertility and minimize soil erosion. The abundance of fruit trees such as *Citrus species*, *Mangifera indica, muscia sapium* and *Persea americana*, were also important from food security point of views. The majority of farmers (95%) stated that in addition to soil erosion prevention, the trees in the coffee farms were also used for firewood, food and construction materials, forage, medicine, poles and living fences (Table 6). Table 7 shows the density and average diameter of recorded trees and shrubs. The result showed that more number of trees and shrubs were recorded on coffee farm rehabilitated between three to five years. The average DBH of trees and shrubs on coffee farm of more than ten years was calculated 21 cm indicating recorded trees and shrubs restored after rehabilitation of degraded land.

Conclusion and Implication to Rehabiliation to Degraded Land: The study generated evidence which demonstrated environmental rehabilitation and restoration through coffee production system. Coffee production system is an integrated approach to solving land-use problems by allowing farmers to produce food, fodder and fuel simultaneously from the same unit of land. It is an important both to people's livelihood, to the conservation of plant species richness and sustainable multiple-production system whose outputs can be adjusted to local needs. Therefore, coffee based land use system is among the most promising land uses for achieving both conservation goals and supporting human livelihoods at the landscape scale.

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