COMPARATIVE ANALYSIS OF *IN-SITU* CONSERVATION COSTS OF FOREST COFFEE IN SOUTHWESTERN ETHIOPIA

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Abstract

Ethiopia is the center of origin of coffee, which is the most important agricultural commodity of the country, both economically and socially. There is a very wide variability in its character over location and even within a population of a given location. The country has a good potential to be gene source for coffee breeding and selection measures in achieving varieties of desired traits. This is possible only if the country manages sustainable conservation of forest coffee. This paper, therefore, discusses how participation in collaborative and strict in situ conservation strategies could affect costs of the local people at household level and expenses at institutional level which in turn is related to sustainability issues. Data needed for the study were generated through sampled household survey conducted in Bonga and Yayu areas during 2005. The study showed that the difference in average transaction cost between the two conservation strategies is significant while the overall average cost difference is insignificant. This implies that both conservation strategies give rise to considerable cost to the local community in its current implementation stage. However, other cost components such as institutional level costs, social costs and risk exposure comparison revealed that the collaborative in situ conservation is more cost-effective strategy than the strict in situ conservation. The study proposed decentralization of conservation responsibilities and benefits, implementation of combined collaborative and strict in situ conservation strategy with participation of local people at minimum transaction cost.

Key words: *comparative, cost, collaborative and strict in situ conservation, cost-effectiveness.*

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1. Introduction

Ethiopia is the center of origin of coffee, which is the most important agricultural commodity in Ethiopia, both economically and socially. It is one of the most important export crops. The country ranked ninth in its export and coffee generates 60% of the country's foreign currency earning (EEA, 2000). There is a very wide variability in its character over location and even within a population of a given location (Paulos and Demel, 1999). It has the possibility to have coffee plant materials of desired quality. Today, breeding and selection measures of coffee is focused on achieving varieties adapting to drought, water logging and tolerant to cold as coffee is being displaced from its suitable production area for various reasons. In this regard, wild population of *Coffea arabica*, saturated in afromontane natural forest of Ethiopia, is of paramount importance. Nevertheless, this natural forest is suffering from high encroachment pressure of the local communities. Deforestation has been a continuous phenomenon in the country at greater rate and extent than in the past.

The underlying causes of deforestation are closely related to poverty, population growth, poor economic performance and inappropriate intervention (Demel *et al.*, 2003). Degradation of these natural resources has resulted in low agricultural productivity that in turn reduced quality of life. This has a cumulative impact on actions of these land users that has eventually led to the degradation and depletion of the resources endowed with biological diversity (Shibru and Kifle, 1999). Loss of biodiversity like *Coffea arabica* genetic resource ultimately has considerable economic loss to the country as well as the world, especially, with the current prevalence of biotic and abiotic[1] agricultural problems (Tadesse, 2003).

There is a need to develop suitable conservation strategies to safeguard the coffee genetic diversity along with the entire spectrum to maintain its ecological, social and economic value to the community, the nation and the globe. In this line, IBC and FARM Africa[1] are implementing the rainforest conservation projects at a time through different strategies: strict and collaborative *in situ* conservation, respectively in Southwestern part of the country. These conservation strategies entail costs to the

[1] Biotic problems refer to biological factors to production of coffee such as disease while abiotic factors include non-biological factors to coffee production such as erratic rainfall, drought and so on (Tadesse, 2003).

local people as well as to the implementing institutions. Basically, no strategy can avoid the inevitable cost of conservation. But, failure to measure and lack of enough attention to costs of conservation may lead to unworkable policies and strategies (Kramer *et al.*, 1995). Particularly, countries with poor economy, like Ethiopia, have to go for cost-effective[2] conservation approaches to finance implementation of the strategy but usually receive marginal attention. Hence, this study fills the research gap by providing comparative analysis of the two conservation strategies in terms of costs incurred by the local people at household level, and government expenditure at institutional level to come up with cost-effective *in situ* conservation strategy.

The remaining part of the paper is organized as follows: The next part presents an overview of conservation effort made so far followed by part three that deals with study setting and research methodology. The results of the analyses are presented in the fourth part. Part five summarizes the major findings of the study, and delivers policy implications.

1. Overview of Biodiversity Conservation Efforts in Ethiopia

The history of Ethiopian national conservation programs goes back to the1940s. However, it was during Dergue regime reform in the fourth five-year plan of 1974, that the forestry part was included as a separate component. This was to deal with the state forest protection, commercial and multi-purpose forestry, private, communal and household forestry (Shibru and Kifle, 1999). Later, forestry conservation has received more attention in a ten-year perspective plan from1984 to 1994. In addition, these different development plans were followed by various short term action plans. These were afforestation and reforestation, demarcation of natural forest and for different purposes such as community forest, fuel wood plantation, and industrial plantation. But, the major national efforts of genetic resource conservation began with the

[1] IBC is a governmental organization established to conserve genetic resources of the country. FARM Africa is an NGO involved in rural development and natural resource conservation activities.

[2] Cost-effective conservation strategy refers to the least cost strategy. This is one aspect that has to be considered in designing sustainable *Coffea arabica* genetic resource conservation strategy for intervention. The strategy that can conserve coffee gene pool at the least cost would be selected as the cost-effective strategy. For more explanation of cost-effectiveness see Ferraro (2001), Gittinger (1982), Lwasa and Mwanje (2002), Richard *et al*. (2003).

establishment of Plant Genetic Resource Conservation in 1976 (Melaku *et al*., 2000). However, the success was impeded by the occurrence of drought and civil war.
During the Dergue regime, a significant level of biodiversity was eroded due to extensive cultivation and resettlement program with cleared vast areas of natural forestland. There were also frequent land reallocations all over the country. This had created a strong feeling of tenure insecurity among land users which in turn discouraged farm households to plant trees (Shibru and Kifle, 1999). This has negative impact to conservation of biological diversity in both protected and managed ecosystems.

As to the current regime, lesser attention was given to natural resource conservation during the transition period when the Ethiopian People's Revolutionary Democratic Front (EPRDF) took power. But later, federal government offered attention to it by developing of Natural Conservation Strategy (CSE, 1996) and declaration of different legislations. For instance, Proclamation number 94/1994 had permitted private forest ownership to enhance private investors' participation in the sector. But, there has been lack of clearly defined guideline for investment in forest area (Kumilachew, 2001; as cited in Richerzhagen and Virchow, 2002). This created inconsistent decisions in land allocation to smallholder farmers and large-scale investments. Although, the concern for natural resource conservation is getting more pronounced, this concern could not get out of plan to implementation to achieve the desired results. Most of the issues of implementation have been linked to participation of local people, security of natural resource tenure, access to it and financial capacity (Shibru and Kifle, 1999). The *de facto* open access to state or community owned natural forest had reduced security of tree tenure and exacerbated deforestation (CSE, 1996).

Ethiopia has signed the convention on biodiversity conservation of 1992, which provides sufficient rooms for *ex-situ* and *in-situ* conservation of genetic resource of the nation (Toweldeberhan and Edward, 2000). *Ex-situ* conservation strategy refers to conservation of germplasm out of its natural habitat. It is the collection and preservation of genetic resource under techniques like seed storage, *in verto* storage, DNA storage, pollen storage in gene banks, and keeping living plant in botanical garden or field gene (Tadesse, 2003). Whereas conservation of genetic resources in their natural environment, whether in production or in protected area, is known as *in situ* conservation. This means that a given population of natural resources is maintained within the community in which it is a part, in the environment where it has been developed (Frankel, 1976; Pagiola *et al*., 1997). According to FAO (2001) *in situ* conservation is defined as the conservation of ecosystems and natural habitats and the maintenance and recovery of viable population of species in their natural surroundings. In the case of domesticated or cultivated species, it refers to conservation in their surroundings where they have developed their distinctive properties. *In situ* conservation approach serves as a continuous source of germplasm for *ex-situ* conservation (Tadesse, 2003). It enables to preserve evolutionary process that generates new germplasm under conditions of natural selection to maintain those components in living and viable ecosystems (Swanson and Goeschi, 2000).

Ex-situ conservation of threatened plants and crops in Ethiopia is being carried out on-farm and in gene bank of Institute of Biodiversity Conservation (IBC). There are about 56,558 sample species preserved by IBC in gene bank. *Coffea arabica* is one of the crops being conserved both under *in situ* and *ex-situ* conservation strategy. In this regard, among others, attempts were made for *ex-situ* conservation of coffee biodiversity by Food and Agricultural Organization (FAO) Coffee Mission, Ethiopian National Coffee Collection Program, and recently by IBC and Ethiopian Agricultural Research Organization (EARO) through collection and establishment of field gene bank within the country (Tadesse *et al*., 2001). Besides*, in situ* conservation has been established in Boginda-Yeba (2,764 ha), Geba-Dogi (10,000 ha) and Kontri-Birhan (9,025 ha) of rainforests to preserve the genetic resources of arabica coffee gene pool, financed by European Commission through Coffee Improvement Project (CIP). Furthermore, there is also a plan to establish *in situ* conservation in other five parts of the country namely, southwestern Harareghe, Dambidolo, Mankra, Maji, and Amora-Geddel in Mizani-Teferi (Agrisystems, 2001). Therefore, with the current effort of the nation towards *in situ* conservation, this study aims to contribute to knowledge stock from empirical analysis for appropriate intervention to achieve cost-effective and sustainable conservation strategy.

2. Research Methodology

3.1. The setting

This study was conducted in the South and Southwest parts of Ethiopia, Bonga and Yayu forests. Particularly, Gimbo district from Bonga forest and Yayu-Hurumu district

from Yayu forest, which are about 440 and 520 Km from Addis Ababa, respectively, were selected for this study.
Bonga forest is located in the Southern Nation, Nationalities & People's (SNNP) Region, Kaffa administration zone. It covers a total area of about 161,424 ha with altitude of 1000 to 3350 meter above sea level (Ersado, 2001; as cited in Taye, 2003). The five districts bounding the area are Gimbo, Menjiwo, Tello, Decha and Chena. Another study site, Yayu (Geba-Dagi) forest is located in Yayu-Hurumu district, Illubabor zone of Oromia Regional State. This district covers about 162901 ha. The part of Bonga forest found in Gimbo district covers about 22539 ha. It is located at an altitude of 1550 -1780 meters above sea level. About 10000 ha of Yayu forest is demarcated as protected area for biodiversity conservation (Agrisystems, 2001). The protected area is divided into two, core and buffer zones. Core zone is the zone where it is forbidden for the local community to enter. Whereas, buffer zone is the one from which households with *de facto* land holding are allowed to harvest only coffee. This area was used to deal with the costs of strict *in situ* conservation strategy.

In both areas specialization is very low and mixed farming (with some off-farm) is the main economic activity in household economy of the study areas. There is a linkage among livestock rearing, crop production and forest management and use. Natural forest is a means of livelihood mainly through extraction of non-timber forest products such as wild coffee, honey, charcoal, fire wood and hunting of wildlife. Furthermore, forest remains to be very important source of farm implements and timber for local construction. There are resettlement and investment activities like organic coffee production that were carried out in the forest area. These activities did not take into consideration the degradation of natural forest and wild populations of coffee.

Sampling and data collection

In the study, two natural coffee forests in Gimbo and Yayu-Hurumu districts were selected purposively. Then, a two-stage random sampling technique was adopted in sampling respondents from these purposively identified districts. Primarily, reconnaissance survey was undertaken to prepare sample frame of the households in Peasants Associations (PAs)[1] around the area under conservation. PAs surrounding the conservation areas were identified for both study sites. Accordingly,

[1] Refer to the smallest administrative units in the area, also known as *Kebele.*

in the first stage, 4 sample PAs from each district and a total of 8 PAs were selected randomly. In the second stage, sample households were selected using probability proportional to size technique based on the number of farm households in PAs, so that, each sample units would have equal chances of being selected. The proportional sampling was applied within a district. The sample units in the formal survey were the farm households, including both participants and non-participants of the conservation strategy, in the vicinity of the conservation area. A total of 204 sample respondents were contacted during the formal survey.

For this study, both primary and secondary data were collected. Primary data were collected through focus group discussion and interview of sample households using pre-tested structured questionnaire. The questionnaire consisted of socio-economic variables such as land holding and use, coffee holding under different management practices, difference in benefits before and after establishment of conservation strategies at farm household level and so on. In addition, transaction costs of participation and other relevant information in relation to the area under conservation were also included. Secondary data on capital and recurrent costs under collaborative and strict *in situ* conservation strategies were collected from FARM Africa and IBC.

Methods of Data Analysis

Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) is a technique, which is most often important in assisting decision-makers in selecting preferred choice among possible alternatives. It involves assessing the resource requirements of alternative ways of achieving a given objective. It is derived from cost-benefit analysis. Whenever the valuation of benefit is impossible, cost-benefit analysis cannot be computed. This calls for comparison of costs among different meanses of achieving a given output (Lwasa and Mwanje, 2002). It is the economic decision criteria for alternatives in which the benefits to be achieved do not vary significantly (Richards *et al*., 2003). Moreover, this method of analysis is suitable to deal with a situation where reliable estimation of the benefits of alternative option is not possible (Turner *et al*., 2004).

The basic concepts of cost-effectiveness analysis are being applied to a broad range of problems in natural resource conservation, social and public health programs. It consists of an attempt to minimize cost to meet a given goal. Cost-effective policy or strategy permits minimization of the compliance costs to meet the desired target. Sekar and Chandrasekaran (2001), in their training manual, explained the appropriateness of the approach in dealing with social and environmental programs whose benefit is difficult to monetarize but when there are different meanses to meet a predetermined standard.

There are two approaches in cost-effectiveness study: fixed effectiveness and fixed-cost (Lwasa and Mwanje, 2002). In the former case the best strategy depends on the cost incurred to obtain a given level of effectiveness while in the latter case it depends on the effectiveness obtained at a given cost. Moreover, according to Watzold and Schwerdtner (2004), cost-effectiveness can be identified in two aspects. A given conservation policy is said to be cost-effective than the other if all costs of conservation in the first is less than that of the other to achieve a given conservation goal. This is stated as useful approach in situation with a conservation aim of ensuring a certain survival probability of an endangered species and to find out how this goal can be achieved at least-cost. On the other hand, a given conservation instrument is said to be cost-effective if it generates a higher level of conservation for a given amount of costs. This definition is useful in a situation where the society is willing to devote a certain amount of financial resource for conservation. In our analysis a cost-effective strategy is defined as the one that go for least cost to attain sustainable *in situ* conservation of forest coffee.

Cost estimation

Primarily, costs of both *in situ* conservation strategies were calculated at household level and comparison was made with the level of participation. Besides, expenses of responsible institutions per hectare as effectiveness in this case is measured based on the total area conserved at a given cost and different cost components at household level were estimated per sample household. In this process, descriptive statistics such as mean, percentage and frequencies were employed.

Conservation cost estimation at household level enables to get the cost that the households incur in conservation of coffee forest. These costs arising from implementation of each conservation strategy were calculated as sum of opportunity costs, transaction costs and costs due to wildlife attacks. Opportunity cost of a given conservation strategy is the forgone benefit from other best enterprises (Gittinger, 1982). But here, estimation of opportunity cost based on this definition is misleading. In environmental studies, opportunity cost is benefit forgone because the resources to provide that service are not at disposal (Tietenberg, 2003).

In this study, foregone benefit is the benefits that the household used to harvest from a given conservation area (Ferraro, 2001; Braatz, *et al*., 1992). Forgone benefit in the form of timber forest products (TFPs) and farm implements were estimated at the common demand of households. The households were asked about the timber forest harvested from the conservation area and its lifespan as well as its market price. For those commodities that have no market price, proxy value were considered. Then, the annual value of timber forest products extracted from coffee forest was estimated through straight-line depreciation method[1]. Moreover, all non-timber forest products (NTFPs) were listed exhaustively and information on benefits that the local people access before and after conservation was generated through survey. Then, its value was estimated at local market prices.

Particularly, in collaborative conservation strategy, opportunity cost to the participants of the strategy from forest products was defined as benefits before conservation minus benefit after conservation while for non-participants it is the benefit they used to harvest before establishment of forest users groups in the area since the non-participants are prohibited from entering the conservation area thereafter. Whereas for strict *in situ* conservation, opportunity cost to participants of the strategy was calculated as value of timber forest products they lost plus benefit before conservation as NTFPs minus benefit they get from buffer zone as NTFPs after the area is delineated for protected conservation. This is because in this strategy, it is impossible to take out any TFPs. But, for non-participants in strict conservation strategy it was the value of forest products that the household would have harvested if there were no conservation at all.

As to institutional cost, it was estimated at conservation site and coordination office level. Institutional costs were categorized as capital and recurrent costs. All cost components were considered at project sites and coordination office level for both strategies (Epperson at al., 1997). Since capital cost lasts for more than one year, it

[1] It is an accounting method in which annual depreciation is computed to get the annual value to replace it after a given period of time (Gittinger, 1982).

has to be annualized. In annualization process of capital costs, the capital recovery factor was calculated at current interest rate *i* equal to 3 percent (on deposit) using the formula

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] \quad \textbf{(1)}$$

Where A = Annual capital cost;
p = Intial capital invested;
i = current interest rate on deposit
n = lifespan (years).

Capital cost annualization method was used to get annual cost of capital goods equivalent to recurrent cost (Gittinger, 1982; Lwasa and Mwanja, 2002). According to information from MoFED (Minyashal, B., 2005, personal communication) the life span for building, cars, and office furniture and equipments is, on average, 20, 10 and 5 years, respectively. This was adopted in annual capital cost estimation process. These costs were initially recorded in Euro, GBP and USD then converted to ETB using current exchange rate[1]. The recurrent costs were estimated on average value of annual expenditure of the two projects to conserve their respective areas.

4. Result and Discussion

Socio-economic characteristics of sampled households

The most important socio-economic characteristics of households that determine households' decision in relation to participation in conservation and level of costs that household incur are household assets like landholding, livestock and level of dependency on the natural forest. Landholding of farm households is one of the basic resources that affect decision-making of agricultural production and conservation activities (Konyar and Osborn, 1990). According to the survey result, average total

[1] The conversion factor used was 16.5 ETB for GBP, while it was 11.3 ETB for Euro and that of US Dollar was 8.6 ETB (March, 2005).

landholding of sampled households in collaborative and strict *in situ* conservation areas was 2.38 ha and 2.30 ha, respectively. This difference in average total land holding is not statistically significant between the two *in situ* conservation strategies. Crop production is the primary farming activity of the respondents. Generally, cereals and coffee were the major crop types under production activities followed by pulse, horticulture and other perennial crops like *chat*[1] and *enset* (false banana).

Livestock is also another important asset to the farm households. The average total livestock holding in TLU was 3.9 and 3.5 for collaborative and strict conservation areas, respectively (Table 1). The difference between the two was not found to be statistically significant. The maximum number of oxen per household for collaborative and strict conservation area was 4 and 6, respectively. The maximum number of total livestock in TLU was 17.4 for the collaborative and 21 for strict conservation strategy areas.

Table 1. Average livestock owned by the sample households in TLU

Livestock owned	Collaborative	Strict	t-value
Oxen	1.2	1.2	0.030
Cattle	2.3	1.9	1.381
Small ruminant	0.2	0.2	-0.953
Others♣	0.2	0.2	0.490
Total livestock	3.9	3.5	0.943

Source: Own survey result, 2004

, * statistically significant at 5% and 1% probability levels, respectively.

♣ Include horses, donkeys, mules and chicken.

Household's dependency on coffee forest refers to the level of contribution of the natural forest to the livelihood of that household. It was known that NTFPs play an important role in the well-being of millions of people around the world. Local market prices were used to estimate the value of NTFPs and other sources of income. Accordingly, in 2003/04 production year, non-timber forest products constitute 32 percent of income of sample households from collaborative conservation area while this percent rises to 56 in strict *in situ* conservation area. This implies that respondents in strict conservation area are more dependent on coffee forest for cash

[1] *Catha edulis*, is stimulant perennial crop with chewable leaves.

source as compared to collaborative area. Dependency on natural forest as source of income was significantly different at 1 percent probability level between the two conservation areas.

In case of strict *in situ* conservation, non- participant sample households generate 62 percent of their total income from NTFPs including forest coffee, highly dependent on natural forest as compared to the participants, who generate about 44 percent of their income, which was significantly different at 5 percent probability level. This implies that effective implementation of the conservation strategy will result in loss of considerable portion of their income. This is the challenge for sustainable coffee forest conservation under strict conservation strategy. Those households who respected the rules and regulations of strict *in situ* conservation generate more income (757 ETB) from planted coffee as compared to non-participant household (376 ETB) of the same area. This difference was significant at 10 percent probability level.

Availability of off-farm income to the people in conservation areas may reduce the pressure on biodiversity (Srivastava *et al*., 1996). In the study area, bee keeping was the main off-farm activity. It is practiced more in collaborative as compared to strict conservation area. About 63 and 56 percent of the total sample households involve in apicultural activity for collaborative and strict conservation area, respectively. As it can be seen from Table 2, the average number of beehives was high in collaborative conservation area as compared to the strict *in situ* conservation area. Bee-keeping activity has long history in the life of the people, which was highly linked to their culture and existence of natural forest in the areas. It is of considerable economic importance, particularly for those households with less livestock and cropland holding. The mean income from off-farm activity in strict *in situ* conservation, which is 277.9 ETB for participant and 67.4 ETB for non-participant household, is differing significantly between the two groups at 10 percent probability level. These may imply that households with more income from plantation and off-farm activities are more likely to respect the rules and regulations of strict *in situ* conservation strategy.

Through not well developed, there are some off-farm opportunities in the study area. This is evidenced by the fact that 5 percent of the sample households in each conservation area took part in this activity in 2003/04 production year.

Table 2. Average sample households income in 2003/04 production year

Sources	CC	SC	t-value
Forest coffee$^{\pi}$	157.9	1127.8	-6.409***
Planted coffee$^{\varphi}$	246.4	510.3	-1.981**
NTFPs	330.4	74.3	3.326***
Crops	126.5	197.9	-1.554
Livestock	326.4	175.9	1.767*
Off -farm activities	180.6	141.6	0.558
Total income	1371.6	2227.9	-3.385***
Ratio of income$^{\omega}$	0.32	0.56	-4.775***

Source: Own survey result, 2004

*, **, *** statistically significant at 10%, 5% and 1% probability levels, respectively;

π Includes forest and semi-forest coffee since it is harvested from forest;

$^{\varphi}$ Includes garden and coffee planted on farmland;

ω Refers to ratio of income form NTFPs including wild coffee to total income of household.

Cost of collaborative in situ conservation strategy

Collaborative *in situ* conservation is a strategy to hand over the responsibility of conservation and sustainable use of natural coffee forest to local community through the establishment of forest users groups (Mburu, 2004). It turns the *de facto* open access state forest to regulated and controlled access. In this strategy, first, the forest user groups are established and develop management plan on each patch of forest. Then, agreement is signed with the local government based on their plan for conservation and utilization of natural forest for each five years. The agreement defines the roles and responsibilities of the forest users groups as well as that of the government. Accordingly, the users groups protect the forest from destruction and at least preserve the forest quality to the level it had been at the time of handover from the government. The local government provides technical support in terms of training and legal support to enforce rules and regulations. It also undertakes evaluation and monitoring activities in the process of implementation of the plan based on

assessment to the status of each patch of forest during forest user group establishment.
As indicated in the document of agreement the members are permitted to harvest forest products for house construction and farm implements while the non-members were not entitled with this right. A forest user group elects an executive committee (7 persons) charged with facilitating coordination among members and implementation of the plan. Participants of the management strategy have regulated right to harvest timber and non-timber forest products for consumption on individual basis. Access to natural forest is possible through permission from this committee. This may reduce benefits of the household in terms of NTFPs from the conservation area. On top of this, there is frequent meeting, which increases the transaction cost of the strategy. For instance, *Agama* forest users group is expected to have meetings at least once within 15 days. There are also other obligations that the members are expected to discharge such as forest development and protection activities to continue as a member.

In this strategy, forest coffee and other products from conservation are harvested, for commercial purpose, in common and income generated is distributed among members based on their level of participation. This is supposed to be an economic incentive for the local people to join the forest users groups. The effectiveness of the system, actually, depends on the active participation of the user group members (Agrawal and Östrom, 2001). In our case, only 40 percent of the sample respondents in the collaborative conservation area attended meeting at different time while 60 percent did not attend any meeting on forest or coffee conservation in 2004. Therefore, from 54 percent sampled households with plot(s) in or adjacent to the conservation area, only 64 percent have participated in the collaborative conservation strategy. This implies that there are households who have plot in or adjacent to the conservation area but did not participate in the strategy.

It is predestined that *in situ* conservation of forest coffee entails cost to the local people. Accordingly, the estimated opportunity cost to a participant household in this strategy, on average, was 580.43 ETB per year while it was 780.93 ETB per year for non-participants (Table 3). For details see appendix Table 8. The mean opportunity cost is not found to be significantly different between the two groups. The sample participants of collaborative conservation strategy incur a transaction cost of, on average, about 185.78 ETB per year per household while the non-participants spend only 0.65 ETB per year, which was spent for conflict resolution. Participation involves transaction cost, which was significantly different between participant and non-participants at less than 1 percent probability level. This implies that participation in collaborative conservation strategy results in considerable transaction costs. However, cost due to wildlife attack was 368.59 ETB per year for participant and about 445.68 ETB per year for non-participant. This was not found to be statistically significant between the two groups. This difference is perhaps due to variations in the extent of loss and value of households' property attacked by wildlife.

The total conservation cost of *Coffea arabica* in its natural habitat to the local people, under collaborative conservation strategy was about 1135 ETB per year for the participants while it was 1227 ETB per year for the non-participants. Even though participation involves high transaction cost, still participants bear lower overall cost of conservation. However, the mean difference between the two groups was not significant. This may imply ineffective implementation of the strategy, and the participants could not generate significant benefit form their participation in collaborative conservation.

Table 3. Conservation costs of collaborative strategies at household level in ETB per year

Variables	P	NP	t-value
Opportunity cost	580.43	780.93	-1.237
Transaction cost	185.78	0.65	8.197***
Wildlife attack	368.59	445.68	-1.119
Total cost	1134.80	1227.26	-0.512

Source: Own survey result, 2004; *** statistically significant at 1% probability level.

In addition to costs at household level, *in situ* conservation of forest coffee entails government expenses at institutional level. Accordingly, annual capital cost of collaborative *in situ* conservation of natural forest with *Coffea arabica* is estimated to be 29.5 percent of costs at conservation site (for details of computation see annex 3) and 5 percent of conservation cost at coordination office per year (details is given in annex 4). Recurrent cost is also estimated to be 70.5 percent and 95 percent of conservation costs at conservation site and coordination office, respectively (for detail annex 5 and 6). Total institutional cost, including miscellaneous costs of implementation of collaborative *in situ* conservation of *Coffea arabica* on an area of

22,539 ha is estimated to be about 1,931,436 ETB per year (Table 4). Thus, for coffee biodiversity conservation, costs incurred at institutional level were estimated to be about 86 ETB per hectare per year. In this conservation strategy, about 85 percent of the total cost per annum was incurred at conservation site while the rest 15 percent was at coordination office level.

According to Agrawal and Östrom (2001) the local people can monitor, fine wrong-committers and resolve conflicts through their own informal institutions. But, the local traditional institutions and management system may not be functional to maintain the resource without economic incentives (Richerzhagen and Virchow, 2002). This implies that it is possible to reduce *in situ* conservation cost through participation of local community. This can be achieved through further decentralization of not only responsibilities to protect but also by ensuring tangible and equitable benefit to the local communities.

Table 4: Summary of institutional level costs for collaborative conservation strategy in ETB per year

Cost category	Conservation Site	Coordination Offices	Total
Annual capital cost	441,865	13,823	455,688
Recurrent cost	1,056,853	243,310	1,300,163
Sub-total	1,498,718	257,133	1,755,851
Miscellaneous (10%)	149,872	25,713	175,585
Total	1,648,590	282,846	1,931,436

Source: Computed based on data from FARM Africa, 2002

3.1. Costs of strict *in situ* conservation strategy

In strict *in situ* conservation strategy the natural forest is divided into buffer/transition and core zones. This strategy strictly prohibits entrance to the core zone. But, the local communities, who have land in the buffer zone of conservation area, can only harvest their forest coffee. Withdrawal of other forest product, from any zone of the conservation area, however, is strictly forbidden for any purpose. The exception is that collection and use of dried wood that has fallen on the ground is permissible through PA officials.

About 71 percent of the respondents in strict conservation area expected benefits from conservation of *Coffea arabica* in the natural forest. But, they are not contended with prohibition of managing their coffee in the buffer zone. They expressed their fear that coffee plants would be taken over by the tree canopy and may stop to bear cherries unless well managed. Out of the sampled respondents, about 95 percent had never attended meetings held to discuss on forest coffee conservation in 2003/04. This may be the reason for about 46 percent of the total respondents with farm plot adjacent to the conservation area to expect that the demarcation of conservation will expand to their land.

During the discussion with the community, some of them reported that their forest coffee plot is already demarcated in the conservation zones. They also noted that they used to live there before the villagisation program of the Dergue regime. They still pay tax for those plots. However, the understanding of the local government is that the forestland belongs to the state. This has created sense of tenure insecurity to the farmers. This will have a clear negative impact on sustainable use of forest coffee land in the buffer zone. Besides, most of them told that the idea of buffer zoning is a strategic move, which might force them to abandon their forestland eventually. This implies that there was no adequate and reliable information flow between the forest managing agencies and the local people on the rules and regulations of the conservation strategy. Akin, the demarcation process lacked transparency and sufficient discussion was not made with the local community thereafter.

The opportunity cost at household level in strict *in situ* conservation strategy was 112.70 ETB per participant household per year while it was 1244.30 ETB per household per year for non-participants. This indicates benefit foregone by participant and non-participants in effective implementation of the strategy. This implies that strict *in situ* conservation results in considerable loss of benefits to the local people if they abide by the rules and regulations of the conservation strategy. The difference is found to be statistically significant at 1 percent probability level. This may be due to high dependency of the non-participants on the forest demarcated for conservation. However, there was no significant difference in the transaction cost and cost incurred due to wildlife attack with level of participation. Nevertheless, cost due to wildlife attack (from the conservation area) seems considerable for both groups.

In strict protection, the total estimated cost of conservation per participant sample household was 402.27 ETB per year while it was 1543.18 ETB per household per year to the non-participants. The means were significantly different at 1 percent probability level between the two groups (Table 5). This result also depicts that the non-participants do not respect the rules and regulations since they have lost a considerable amount compared to the participants.

Table 5. Conservation costs of strict *in situ* conservation strategies at household level in ETB per year

Variables	P	NP	t-value
Opportunity cost	112.70	1244.30	-4.854***
Transaction cost	0.68	4.53	-0.371
Wildlife attack	288.89	294.35	-0.070
Total cost	402.27	1543.18	-4.520***

Source: Own survey result, 2004; *** statistically significant at 1% probability level.

In this conservation strategy the responsible institutions spend money for implementation, enforcement, monitoring and evaluation. The total implementation cost under strict *in situ* conservation strategy, including miscellaneous costs is estimated to be about 2,154,415 ETB per annum in order to protect *Coffea arabica* biodiversity over 10,000 hectares of natural forest (Table 6). So, the estimated conservation cost is about 215.44 ETB per hectare per annum. In this strategy, 88 percent of the total expenditure of the implementation cost is allocated to conservation site while the remaining 12 percent goes to the coordination office (for detail computation annex, 7 and 8). Out of the total cost incurred at conservation site, recurrent cost constitutes 58 percent while the remaining 42 percent is capital cost (annex 9 and 10). Whereas at coordination office level, capital and recurrent costs made about 30 and 70 percents of total conservation cost incurred, respectively.

Table 6. Summary of institutional level costs for strict *in situ* conservation strategy in ETB per year

Cost category	Conservation Site	Coordination Office	Total
Annual capital cost	725,566	67,913	793,479
Recurrent cost	1,003,214	161,866	1,165,080
Sub-total	1,728,780	229,779	1,958,559

Miscellaneous (10%)	172,878	22,978	195,856
Total	1,901,658	252,757	2,154,415

Source: Computed based on data from agrisystems, 2000

3.2. Comparison of costs of collaborative and strict *in situ* conservation

Although institutional level costs incurred in the strategies may vary slightly across locations, the basic components remain the same. Thus, it is possible to compare the two conservation strategies to identify the cost-effective one. The estimated institutional level cost of *in situ* conservation in collaborative conservation strategy is more cost-effective than that of strict *in situ* conservation by about 129.57 ETB per hectare. This difference in cost of *in situ* conservation of *Coffea arabica* seems significant.

The over all average opportunity cost incurred was 846.00 ETB per sample household for strict conservation strategy, which is high compared to that of collaborative conservation strategy (673.14 ETB per household) since the local community are prohibited to harvest any timber forest products from the forest area and to manage their coffee plot in strict *in situ* conservation area. The difference in opportunity cost is not statistically significant between the two conservation strategies. This is perhaps due to ineffective implementation of the conservation strategy in the study area. Transaction costs of total sample in collaborative conservation strategy (97.55 ETB per household) were significantly different from that of strict conservation strategy (4.56 ETB per household) at less than 1 percent probability level. This implies that the farm households in the strict *in situ* conservation area were not allowed to participate in decision-making and implementation of conservation efforts except in some conflict resolution activities.

Wildlife attack cost depends on closeness of conservation area to the plot(s) of the farmers, level of forest, and type and number of wildlife available as well as value of farm households' property at risk. Cost of conservation of natural forest with *Coffea arabica* to household due to wildlife attack was high in case of collaborative conservation area (404.57 ETB per household) as compared to strict conservation area (292.43 ETB per household) and significantly different at 5 percent probability level. This may be due to loss sustained by the farmers as a result of lion attack in collaborative conservation area. This result is in line with the finding of Baah *et al.*

(2002), which indicated that wild animals' damages of the property of farm households were a major constraints to households, especially in case of forest coffee based farming.

For the total sample household, estimated conservation cost at household level for collaborative strategy was about 1175.26 ETB per year and about 1142.99 ETB per year for strict *in situ* conservation. The mean difference was not significantly different between the two strategies (Table 7). The possible explanation is that the high opportunity cost of strict *in situ* conservation strategy was balanced by the transaction cost and wildlife attack in case of collaborative strategy.

Table 7. Average cost of collaborative and strict *in situ* conservation strategies at household level in ETB per year

Variables	Collaborative	Strict	t-value
Opportunity cost	673.14	846.00	-1.057
Transaction cost	97.55	4.56	6.239***
Wildlife attack	404.57	292.43	2.307**
Total cost	1175.26	1142.99	0.199

Source: Own survey result, 2004

, * statistically significant at 5% and 1% probability levels, respectively.

In addition, there were also social costs[1] with the collaborative *in situ* conservation strategy in the area. The participants of focus group discussion noted that there was lack of clarity in criteria as to how to exclude the outsider of the forest users groups. As a result there are some social as well as economic conflicts among members of the user groups and the non-users. This is basically between the *de facto* owner of some parts of the forest before the establishment of the forest user groups, and the new members or those considered as outsiders during formation of the forest users groups. The new members did not have *de facto* owned plot(s) in the forest area while it was under state protection.

Similarly, there were also some other costs in strict *in situ* conservation that were difficult to estimate such as cost of social conflicts between locally employed guards and local community, and cost of ineffectiveness of monitoring, which is loss of natural resource. This is mainly because most of the farmers have forest or farm plot adjacent to the natural forest and can easily take out the required forest product illegally. But, there were money, time and other resources spent for the purpose. For instance, about 50 percent of the sample households did not abide to the rules and regulations of the strategy but only 4 percent of them have been punished. This implies that enforcement of the rules and regulations is weak. Moreover, in this strategy enforcement requires involvement of different government institutions. The proceedings in the court also take long time. This results in substantially high enforcement costs.

In strict conservation strategy, guards were not able to prevent farmers from entering the area due to fear of the social conflict. Moreover, with the increase in human population and resource scarcity, unless a large number of agents are appointed, it is impossible to protect the forest area effectively. This will increase the conflict between the local community and forest protecting agents. Besides, strict *in situ* conservation strategy reduces income diversification level of the local community and increases their exposure to risk in case of crop failure. Hence, the strict *in situ* conservation may further marginalize the poor farm household who were highly dependent on natural forest to make their livelihood. These are cost of the conservation strategy to household, which is difficult to estimate in monetary terms.

4. Conclusions and Policy Implications

The comparative analysis of *in situ* conservation strategies depicted that costs at household level for collaborative conservation mainly arise from high transaction cost and absence of enough benefits to offset their transaction cost. This may be due to the infancy stage of implementation of the principle of the strategy. This implies that participation of the local people in collaborative conservation strategy results in considerable cost, which should receive attention. In case of strict *in situ* conservation strategy, costs of conservation are high basically due to huge opportunity cost of the strategy. The study revealed that the rules and regulations of strict *in situ* conservation strategy are respected only by those households who incur significantly less cost in its conservation under the strategy, i.e. those which are relatively less dependent on that coffee forest. Besides the comparative analysis result depicted

[1] Refers to its effect on social relation among the community members. Any break down of social relation can lead to economic losses and erosion of social capital. This will create a problem in working together to take advantage of economies of scale and risk-pool behavior (Ferraro, 2001).

that mean total conservation cost depicted insignificant difference between the conservation strategies. This implies that both conservation strategies give rise to considerable cost to the local community, which implies ineffective implementation of the strategies. However, if other cost components such as institutional level costs, social costs and households risk exposure are considered, it implies that the collaborative *in situ* conservation is the cost-effective strategy as compared to strict *in situ* conservation.

The findings of the study reveal that the local residents incur significant cost in the *in situ* conservation of forest coffee. This creates conflict between the local community and conservation intervention. This in turn mean that decision-makers has to go for a strategy that either minimizes costs borne at household level or has to compensate households for benefits foregone to ensure sustainable conservation of forest coffee. This study suggests a collaborative conservation as a strategy that will minimize cost of conservation to the local communities and at the same time enable sustainable implementation forest coffee conservation. There is also a need to promote participation of the local people in conservation activities at reduced transaction cost, which will further reduce conservation costs and enhance effectiveness of the strategy.

Decentralization of the responsibilities and benefits of forest coffee conservation to the local community can also be suggested as one of the meanses to reduce costs of conservation at institutional as well as at household levels. This implies the need for a combined strategy of collaborative strategy for buffer zone and strict *in situ* conservation for core zone under local community management. This proposed strategy may enable the local community to share both the responsibility to preserve biodiversity and benefits from conservation.

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Annexes

Annex 1: Component of opportunity cost of conservation strategies in ETB per year

Cost components	Collaborative (CC)		Strict (SC)		All cases	
	Participants	Non-participants	Participants	Non-participants	CC	SC
Value TFPs	53.26	69.60	76.30	94.50	60.86	88.00
Value Farm mplements	11.53	14.79	11.30	15.50	13.04	14.00
Forgone benefit from other NTFPs	580.43	696.54	26.50	1134.30	634.38	743.00
Total opportunity cost	580.43§	780.93	112.70	1244.30	673.14	846.00

Source: Own survey result, 2004

§- Excludes the value of timber forest products and farm implements for participants of collaborative conservation strategy

Annex 2. Component of transaction cost of conservation strategy (ETB)

Cost components	Collaborative (CC)		Strict (SC)		All cases	
	Participants	Non-participant	Participants	Non-participant	CC	SC
Forest development activities	89.3	0	0	0	47.80	0
Forest protection	23.05	0	0	0	12.35	0
Meeting	51.45	0	3.96	3.54	27.55	3.69
Negotiation	8.95	0		0	4.75	0
Conflict resolution	8.45	0.65	0.72	0.99	4.80	0.87
Other activities	0.55	0		0	0.30	0
Registration and other cash payment	4.03	0	0	0	2.16	0
Total transaction cost	185.78	0.65	4.68	4.53	97.55	4.56

Source: Own survey result, 2004

Annex 3. Capital conservation cost in collaborative forest coffee conservation at conservation site

Cost category	Units	Quantity	Capital cost (ETB)	Annualization factor	Cost per year (ETB)
Vehicles	Unit	1	256,020	0.1172	30,006
Motorcycle	Unit	1	27,650	0.1172	3,241
Computer	Unit	1	18,431	0.2184	4,025
Champing equipments	Lump sum§	-	9,000	0.2184	1,966
Technical forestry equipment	Lump sum	-	15,706	0.2184	3,430
Infrastructure					
Office and residence	Lump sum	-	4513,333	0.0672	303,296
Fire break	Km	75	1137,394	0.0672	76,433
Fire towers	Units	6	10,17	0.0672	683
Water well	Units	1	202,157	0.0672	13,585
Water tank	Unit	1	33,674	0.0672	2,263
Nursery fencing	Meters	100	13,447	0.2184	2,937
Total capital cost					441,865

Source: Adopted from FARM Africa (2002) with some refinement
§ -Since it is measure in different units, considered in total.

Annex 4. Capital conservation cost in collaborative forest coffee conservation at coordinating office

Cost Category [1]	Units	Total cost (GBP)	Total cost (ETB)	Annualization factor	Cost per year (ETB)
Vehicle	1in numbers	5,141	84,827	0.1172	9,942
Computer and accessories	Lump sum	933	15,395	0.2184	3,362
Office furniture	Lump sum	144	2,376	0.2184	519
Total capital cost					13,823

Source: Adopted from FARM Africa (2003) with some refinement

[1] Includes one-forth of costs incurred since it serves Boreana, Bonga, Chilimo and one project in Tanzania conservation site

Annex 5. Recurrent conservation cost in collaborative forest coffee conservation at conservation site

Cost category	Units	Cost per year (ETB)
Salary [1]	Lump sum	385,798
Allowance	Lump sum	60,687
Transportation fee	Lump sum	7,492
Vehicles Oil and fuel	Lump sum	34,716
Vehicles Maintenance	Lump sum	52,074
Water pump fuel	Litters	9,718
Water pump maintenance	Lump sum	1,413
(Tel/fax, maintenance)	Lump sum	31,946
Office supplies and utilities	Lump sum	38,117
Books other overhead costs	Lump sum	40,946
Other costs		
Annual planning	Lump sum	3,317
Experience sharing	Lump sum	7,379
Support community development fund	Lump sum	123,779
Nursery reorientation program	Lump sum	1,963
Mapping and forest inventory	Lump sum	15,914
Training and workshops[2]	Lump sum	90,192
Research and information		
Studies[3]	Lump sum	49,487
Information dissemination [4]	Lump sum	30,174
Monitoring and evaluation [5]	Lump sum	71,741
Total recurrent cost		1,056,853

Source: Adopted from FARM Africa (2002) with some refinement

[1] Average recurrent cost that includes salary for technical and supporting staff.
[2]Includes only training and workshops regarding collaborative *in situ* conservation strategy.
[3] Includes studies on alternative livelihood, forest certification, ecological assessment, right and responsibility as well as students field works.
[4] Includes seminars and conferences on collaborative *in situ* conservation strategy.
[5] Includes mid term evaluation and auditing.

Annex 6. Recurrent conservation cost in collaborative forest coffee conservation at coordinating offices

Cost Category	Units	Total cost per year (GBP)	Cost per year (ETB)
Personnel			
Salary	Lump sum	9,608	158,532
Allowance and travel	Lump sum	950	15,675
Operation costs			
Office supplies	Lump sum	633	10,445
Fuel and maintenance	Lump sum	2,121	34,996
Backstop from London	Lump sum	29	479
Other overhead cost	Lump sum	1,405	23,183
Total recurrent cost			243,310

Source: Adopted from FARM Africa (2003) with some refinement

Annex 7. Capital conservation cost in strict forest coffee conservation at coordinating office

Cost Category [1]	Units	Total cost (ETB)	Annualization factor	Cost per year (ETB)
Vehicle	1	380471	0.1172	44,591
Computer and printer	1	37968	0.2184	8,292
Photocopier	Lump sum	5424	0.2184	1,185
Communication machine[2]	Lump sum	56387	0.2184	12,315
Other office equipment	Lump sum	7006	0.2184	1,530
Total capital cost				67,913

Source: Adopted from agrisystems, 2000

Annex 8. Recurrent conservation cost in strict forest coffee conservation at coordinating office

Cost Category [3]	Units	Total cost (Euro)	Cost per year (ETB)
Salary	Lump sum	504	5,700
Allowance	Lump sum	1,150	12,995
Operation costs		685	11,300
Office running costs	Lump sum	7,240	81,812
Fuel and maintenance	Lump sum	3,320	37,516
Office supplies	Lump sum	1,110	12,543
Total recurrent cost			161,866

Source: Adopted from agrisystems, 2000

[1] Estimated based on assumption that one-third of the costs of coordination was allocated to Geba-Dogi conservation area.
[2] Include fax and radio.
[3] Estimated based on assumption that one-third of the costs of coordination was allocated to Geba-Dogi conservation area.

Annex 9. Capital conservation cost in strict forest coffee conservation at conservation site

Cost Category	Units	Quantity	Capital costs (ETB)	Annualization factor	Cost per year (ETB)
Infrastructure					
Office and house[1]	Lump sum	-	4513333	0.0672	30,3296
Fire break	Km	51	859365	0.0672	57,749
Fire towers	Units	4	678	0.0672	456
Water well	Units	1	202157	0.0672	13,585
Water tank	Unit	1	33674	0.0672	2,263
Nursery fencing	Meters	100	13.447	0.2184	2,937
Vehicles					
Double cabin pick-up 4x4 w/d	Unit	1	393466	0.1172	46,114
Tractor and accessory	Unit	1	645004	0.1172	75,594
Motorcycles	Units	2	134809	0.1172	15,799
Machinery and equipments					
Electric generators	Unit	1	322502	0.2184	70,434
Whether station equipment	Unit	1	19323	0.2184	4,220
Nursery tools/equip kits	Units	10	2712	0.2184	592
Water pump	Unit	1	16159	0.2184	3,529
House furniture	Units	9	362617	0.2184	79,196
Office furniture	Units	5	34917	0.2184	7,626
Computer & printer	Units	2	80.569	0.2184	17,596
Typewriters	Units	2	3277	0.2184	716
Photocopiers	Unit	1	19323	0.2184	4,220
Radios communication	Unit	1	48364	0.2184	10,563
Water hose	Units	2	3277	0.2184	716
Forest inventory tools and equipments	Lump sum	5	38307	0.2184	8,366
Total capital cost					725,566

Source: Adopted from agrisystems, 2000

[1] Includes investment on office, store, residence, guard house, vehicle shelter and its design and supervision

Annex 10. Recurrent conservation cost in strict conservation of *Coffea arabica* at conservation site

Cost category	Units	Quantity	Costs per year (ETB)
Personnel			
Salary	Month		265,889
Allowance	Days	204	24,182
Wages	Days	3000	102,265
Operation costs			
Office supplies	Lump sum		8,475
Fuel[1]	Liters	8500	41,471
Motorcycle Fuel	Liters	800	6,215
Maintenance[2]	Lump sum		10,396
Generator and water pump fuel	Liters		19,436
Generator and water maintenance	Lump sum		2,825
Building maintenance[3]	Lump sum		42,714
Communication expense	Lump sum		339
Consumable nursery material [4]	Kg	60	339
Revolving fund [5]	Lump sum		357,419
Information generation	Lump sum		42,827
Evaluation and monitoring	Lump sum	-	75,371
Total Recurrent cost			1,003,214

Source: Adopted from agrisystems, 2000

[2] Include expenses to pick-up, motorcycle and tractor.
[3] Include maintenance of all buildings.
[4] Include expenses to polytubes and fertilizers.
[5] Assumed one-third of the revolving fund will be allocated to Geba-Dogi conservation.