Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.5, No.27, 2014

Economic Evaluation of Coffee-Enset-Based Agroforestry Practice in Yirgachefe Woreda, Ethiopia: Comparative Analysis with Parkland Agroforestry Practice

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Abstract
This study attempts to estimate the production costs and benefits of Coffee-Enset-Based Agroforestry (CEBAF) and Parkland Agroforestry (PAF) practices as well as evaluating the economic performance of the two agroforestry practices of Yirgachefe *woreda*[1] of Ethiopia. Data were collected from 101 randomly selected households through structured interview. In addition, focus group discussion, key informant interview, field observation and market assessment were employed. The data were analysed by employing Cost Benefit Analysis. Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Returns to Labour (RL) of both agroforestry practices were calculated. The results of the Cost Benefit Analysis aggregated over twenty five years indicated that the total production cost of CEBAF practice was 1.33 times higher than that of PAF practice. The total benefit obtained from CEBAF practice was also 9.76 times higher than the total benefits obtained from PAF practice. The NPV, BCR, IRR and RL of CEBAF practice were 33.63, 6.43, 1.22 and 7.6 times higher than that of PAF practice, respectively. From these, it can be concluded that CEBAF practice has superior economic performance and is less risky. Therefore, for the smallholder farmers to maximize net returns from their land and resource inputs, it is recommended that the adoption of CEBAF practice should be promoted in the study area.
Keywords: Cost Benefit Analysis, Net Present Value, Benefit Cost Ratio, Internal Rate of Return, Returns to Labour

1. Introduction

Degradation of natural resources particularly land and forest has become a matter of serious concern in developing countries where the majority of the rural people rely largely on these resources for their sustenance (FAO, 1999). Since 1945, about 2 billion of the 8.7 billion *acres*[2] of the agricultural land, permanent pasture, forests and woodlands have been degraded by overgrazing, deforestation and poor agricultural practices (Pinstrup-Andersen and Pandya-Lorch, 1998). These resulted in reduced soil fertility, reduced farm output, prices rise, erosion, floods, reservoir siltation and desertification (Allen and Barnes, 1985).

In recent years, one of the most commonly proposed strategies for tackling natural resources degradation, obtaining diversified output and strengthening economic profitability in the rural areas of the tropics is agroforestry (van Noordwijk, 2003). It is an integrated approach for solving land-use problems by allowing farmers to produce food, fibre, fodder, and fuel simultaneously from the same unit of land. Such types of integrated approaches include homegarden, parklands, alley cropping, woodlots and boundary planting (Nair, 1993).

Homegardens are of vital importance to subsistence-level existence of farmers in the tropics (Nair and Sreedharan, 1986; Swift and Anderson, 1993; High and Shackleton, 2000). In Ethiopia, gardens constitute an ancient food production means that has been constantly reaffirmed over history (Zemede Asfaw, 1997). Two types of homegardens were identified based on their contribution to the welfare of households. The first one is a small-scale supplementary food production system around houses in areas where livelihood of the household is based on other land use and/or other activities. This category of homegardens includes a wide range of rural, semi-urban and urban gardens. The well-known homegardens of Java that supplement monoculture rice production (Wiersum, 1982; Soemarwoto, 1987) and most homegardens from Latin America (Padoch and Jong, 1991; Mendez and Somarriba, 2001) belong to this category. The second category of homegardens is extended farm fields around houses that form the principal means of livelihood for farming households. Most of the homegardens in the highlands of Eastern Africa (Oduol and Aluma, 1990) belong to this category. Similarly, the CEBAF practice of Yirgachefe woreda Gedeo zone of Southern Nations, Nationalities and Peoples' Regional

[1] Woreda is the 2nd tier after 'zone' in the administrative structure of Federal Regions and it is composed of a number of *kebele*s. Kebele is the lower administrative units in the government structure.
[2] 1 acre is equal to 0.4047 hectare

State (SNNPRS), Ethiopia is included under this category of homegardens.

CEBAF refers to a practice where coffee and enset (*Ensete ventricosum)* are the two major components of the practice (Tesfaye Abebe, 2005). It is the traditional agroforestry practice in Yirgachefe woreda of Gedeo zone. In some part of the woreda*,* Parkland Agroforestry (PAF) was also commonly practiced (SNNPRBoARD, 2007). The PAF practices were described as stable plant communities of anthropogenic origin, believed to have replaced the open savannas forests (Bourliere and Hardley, 1983). PAF practices are distributed throughout the semi-arid and sub-humid zones of Africa (Lely, 1925; Hall and Walker, 1991). They are also common across the highlands of Ethiopia (Poschen, 1986; Kamara and Haque, 1992; Motuma *et al*., 2008).

The CEBAF as well as the PAF serve improve the livelihood of the households in the Yirgachefe woreda of Ethiopia. Nevertheless, different land uses practiced by individual households involve different levels of benefits. Therefore, it is important for the policy makers to identify which land use practices better serve improve the livelihood of rural households (Pagiola, 2001; Rasul and Thapa, 2006). However, no scientific study has been made to substantiate whether the CEBAF practice is economically better than the PAF practice for the households particularly in context of Yirgachefe woreda. Hence, this study addresses the following questions:

(i) What are the production costs involved and the tangible benefits provided to the farm households from the CEBAF and PAF practices?

(ii) From the two agroforestry practices which one has higher economic performance?

2. Methodology

2.1. General Description of the Study Area

Yirgachefe woreda is located in Gedeo administrative zone of the Southern Nations Nationalities and Peoples Regional (SNNPR) State of Ethiopia. The total area of the woreda covers approximately 304.07 km^2. With an average population density of about 652 persons per km^2, Yirgachefe woreda is one of the densely populated areas in the country (Federal Democratic Republic of Ethiopia Population Censes Commission (FDREPCC), 2008).

Yirgachefe woreda is characterized as humid tropical climate. About 92 percent of the land of Yirgachefe woreda lies in the *weyena dega* (mid altitude between 1500 and 2500 m asl) and 8 percent of the this woreda lies in the *dega* (high altitude above 2500 m asl) agro-climatic zones (SNNPRBoARD, 2007).

The average annual rainfall of the area ranges from 1500 – 1700 mm with considerable inter-annual and inter-seasonal variation. The rainfall pattern is bi-modal with short rain season that extends from March to June and long rain season between August and October. The dominate soil type of the area are clay loam, sandy loam, sandy, loam and clay (SNNPRBoARD, 2007).

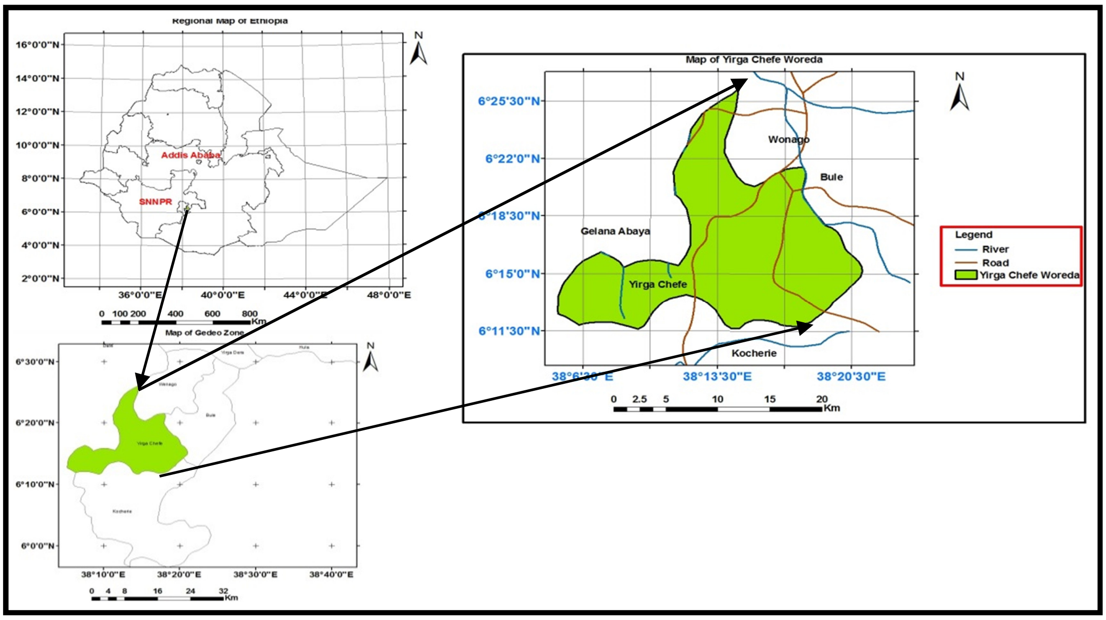

Figure 1 Map of Yirgachefe woreda, Ethiopia, showing the location of the study area

The farming system of Yirgachefe woreda is specifically coffee-enset based and parkland agroforestry practice

Parkland agroforestry practice

Tree species on farmlands comprise mainly *Syzygium guineense* that were mostly growing in association with cereal crops such as maize, barley, haricot bean, bean and sweet potato.

Figure 2 Photo Showing the Parkland Agroforestry Practice of the Study Area

Coffee-enset-based agroforestry practice

Three gardens (Figure 3); namely, homegarden, village forest garden and coffee-enset farm, were identified in the CEBAF practice, following Fernandes and Nair (1986)[1] classification of extended homegardens. In homegarden of this study area, enset is the dominantly grown perennial crop and it is mostly grown in association with trees such as *Erythrina abyssinica* and *Vernonia amygdalina* as well as root crops and vegetables. Likewise, in the coffee-enset plots, coffee (*Coffea arabica* L.), enset and shade trees are grown together. Village forest gardens are also composed of coffee and shade trees. In addition, woodlots of *Eucalyptus camaldulensis* and boundary planting (surrounding the farm of the households) are commonly practiced in the area.

From left to right: Boundary Planting, Homegarden, Coffee-Enset Farm and Village Forest Garden
Figure 3 Photos Showing the Extended Homegarden of Yirgachefe woreda

2.2. Data Sources and Method of Collection

Both primary and secondary data sources were used in this study. The primary data were collected through household survey, focus group discussions, field observation, key informant interview and market survey. The survey data were collected through structured questionnaire from 101(5% of the total households; accordingly 29 households who practice PAF and 72 households who practice CEBAF) randomly selected farm households. Information on specific agroforestry practice such as quantities and prices of inputs and outputs and time spent on practice management activities were also collected through the same survey questionnaire. The head of the

[1] Fernandes and Nair (1986) distinguishes three types of gardens: (i) the homegardens which is managed adjacent to the home and it is dominated with staple food crops; (ii) plots found immediately adjacent to the homegarden but with fewer trees and more staple food crops, and (iii) complex agroforests, which are plots further away in surrounding forests and consisting mainly of cash and tree crops.

household with spouse was contacted for the interview (door to door interview). Focus group discussions and field observation were conducted to assess the production costs and tangible benefits obtained from both types of agroforestry practices. Key informants interview was also conducted to get general information about the study site and the agroforestry practices before conducting the survey. The current prices of the inputs and outputs were collected through market survey in the nearby market. The data were collected from January to April, 2011 G.C. The secondary data like household numbers of study site were taken from the Agricultural and Rural Development Office of Yirgacheffee woreda.

2.3. Data Analysis

The production cost and benefit data obtained from the household survey were analysed by employing Cost Benefit Analysis. In the Cost Benefit Analysis economic performance indicators such as the NPV, BCR, IRR and Returns to (RL) of both agroforestry were calculated and compared.

The NPV determines the net returns by discounting the streams of benefits and costs back to the beginning of the base year using appropriate discount rate over the life time (analysis period) of the production system. The agroforestry practice with higher NPV is taken as better economic option than with lower NPV (Gittinger, 1984; Chandra, 1998). It is calculated using the following formula:

$$NPV = \sum_{t=0}^{n} (Bt - Ct)/(1+r)^t$$

> 0, Where, Bt are benefits flow at time t, Ct are costs of production at time t, t is year, and r is the discount rate.

The BCR compares the discounted benefits to discounted costs. Agroforestry practice with higher BCR is taken as a better economic option and it is computed using the following formula.

$$BCR = \frac{\sum_{t=0}^{n} Bt/(1+r)^t}{\sum_{t=0}^{n} Ct/(1+r)^t}$$

> 1

IRR is equal to the discount rate (r) that brings the NPV down to zero.

$$IRR = \sum_{t=0}^{n} (Bt - Ct)/(r+1)^t = 0$$

, IRR >r

An agroforestry practice is considered economically attractive if the IRR is higher than the opportunity cost of project finance and agroforestry practice with higher IRR taken as a better economic option. Smallholder households seek to maximize return to household labour as it is their main asset. Hence, following Fagerstroem *et al*. (2001), RL is calculated by subtracting the material costs from the gross benefit and dividing the proceeds by the total person-days. An agroforestry practice is attractive if RL is greater than the opportunity cost of the family labour; in the case of two practices the one with a higher RL would be selected.

All values were calculated based on current prices of inputs and outputs and the prices were set constant throughout the life cycle of the practices. The life cycle of the coffee (25 years) was considered in the analysis; because coffee is the main crop in the CEBAF practice of the study area. All values were calculated per hectare base. A discount rate of 10% which is recommended for the evaluation of projects by Ethiopian Ministry of Economic Development and Cooperation of Government Ethiopia (MEDAC GOE, 1998) was used in this study.

It is difficult to predict the future input prices, output prices, yields and discount rates due to lack of data. Hence, sensitivity analysis was carried out to show the effect of the change in these key variables on the NPV. Five assumptions were made in the sensitivity analysis. Because in the adoption of new agroforestry practices, farmers are not only concerned about costs and benefits, but also considered risks associated with them. In the study site, most farm households are deriving their livelihood primarily from agriculture, with which varieties of risks and uncertainties (tenure insecurity, recurrent drought, diseases) are involved. Moreover, the farm households may attach high value on present income and discount the future income at a higher rate.

Assumptions

1. If yield increases/decreases by10%, keeping other key variables constant
2. If wage increases by 10%, keeping other key variables constant
3. If discount rate increases by 10%, keeping other key variables constant
4. If yield increases by 10% and discount rate and wage decreases by 10% (best case scenario)
5. If yield decreases by 10% and discount rate and wage increases by 10% (worst case scenario).

3. Result and Discussion

3.1. Production Cost Estimation

The results showed that the total production cost of CEBAF practice was 1.33 times higher than the production cost of PAF practice (Table 1). The production cost involved cost of establishment and management of the agroforestry practices.

Establishment costs

Results of the analysis showed that the establishment cost of CEBAF practice was 4.67 times higher than the establishment cost of PAF practice. This is because CEBAF involved intensive establishment activities and it needed buying seed and seedlings of various plant types. The establishment cost included labour and non-labour costs. The labour cost of CEBAF practice was 2.22 times higher than the labour cost of PAF practice. Similarly, the non-labour cost of CEBAF practice was 19.28 times higher than the non-labour cost of PAF practice.

Table 1 Production costs (ETB)/ha of the CEBAF and PAF practices

Operation	Year	PAF	CEBAF	Relative (PAF=100%)
Establishment	0			
Labour costs		3510	7785	222%
Non-labour costs		590	11375.50	1928%
Total establishment cost		4100	19160.50	467%
Management cost				
Labour costs	1-25	244,500	325815	133%
Non-labour costs	1-25	32,956	30151.35	91.5%
Total management cost	1-25	277456	355966.35	128%
Total production cost		281556	375114.35	1.33%

Likewise, Rahman *et al.* (2007) found that the establishment cost of multi-strata agroforestry system in Northern Bangladesh was 1.33 times higher than the establishment cost of traditional mono-cropping.

Management Costs

Management costs were costs that incurred through the life cycle of the practices (25 years) and involved labour and non-labour costs. The results showed that the total management cost of CEBAF practice was 1.28 times higher than that incurred for PAF practice (Table 1). The total labour cost incurred in management of components of CEBAF practice was 1.33 times higher than the total labour cost of PAF practice. This is in agreement with other similar studies. For example, Rahman *et al.* (2007) estimated the labour cost of multi-strata agroforestry system to be 3 times higher than the labour cost of traditional monoculture as agroforestry system requires intensive management activities. In contrast, the non-labour costs of the CEBAF practice was 8.5% lesser than the non-labour cost of PAF practice; because most of the seeds sown in the PAF practice are annuals and it requires regular purchase.

3.2. Benefit Estimation

Benefits of CEBAF Practice

The tangible benefit obtained from the CEBAF practice is diverse. The diversified benefits households obtained from CEBAF practice included fuelwood, fodder, construction material, honey, coffee and *kocho*[1]. Coffee was primarily used as source of income (cash crop). Kocho, which is extracted from enset, was mainly used for household consumption (main staple food). Enset leaf is used as fodder and source of income (sold for chat traders). Root crops (taro and yam) are commonly used for household consumption (food). Haricot bean is used for home consumption. The shade trees (pruned branches) are used for home consumption (fodder, fuelwood and building materials) and income generation (pole, timber). *Eucalyptus camaldulensis* is mostly used as a source of fuelwood, house construction and income generation. Honey is used for home consumption since it is produced in small amount.

The CEBAF provided farmers with diverse products/outputs which are reported to be available all year round. Similar studies conducted in North America showed that agroforestry focuses strongly on the increase in income through involving a diversity of components and conservation of natural resources (Williams *et al.*, 1997). The study in Indonesia also indicated that economically complex buffer zone agroforests provide farmers with marketable and sustainable high value product such as resin, firewood, fruits, animal fodder, medicines, and high-grade timber (Retnowati, 2003). A similar study conducted in Burkitu Peasant Association in Oromia region of Ethiopia showed that agroforestry practice provided the households with diversified types of benefits such as source of cash income, household consumption, traditional medicine for both human and livestock diseases and employment opportunity (Biruk Asfaw, 2006). He further explained that agroforestry practice is a means of survival for the prevailing of natural disaster that may cause food insecurity (as a result of less vulnerability of those having diversified types of farming system than having mono-cropping system). Studies conducted in Gedeo zone of Ethiopia also indicated that agroforests provide diversified benefits (Tadesse Kippie,

[1] *Kocho* refers to a food that is extracted from the pseudostem of enset and eaten after fermentation

2002; Tesfaye Abebe, 2005; SLUF, 2006). These benefits included coffee, enset, root crops (yam and taro), vegetables, fruit crops, and medicinal plants for humans and animals, wood for construction, fuelwood and fodder that are serving as source of income and food to household consumption.

Benefits of PAF Practice

A Variety of benefits are obtained from the PAF practices. These benefits included fuelwood, fodder, building materials and food. Annual crops such as maize, teff, bean, barley and haricot bean are used for home consumption whereas sweet potato is used as income generation (main cash crop). The *Syzygium guineense* tree was used as source of fuelwood (lopped branches), building materials, for making farm equipment and income generation (timber).

Different researchers also found that PAF practice provided farmers with different benefits. For example, a study conducted in Burkina Faso indicated that farmers retained trees on their farmlands primarily because of the benefits derived from their fruits (Bayala *et al*., 2002). In the same way, Biruk Asfaw (2006) reported that farmers in south east Langano of Ethiopia maintained trees/shrubs on their farms for different socio-economic purposes including medicinal products, provision of shade and shelter, fodder, fuelwood and the like. A study in Tigray region of Ethiopia also showed that *Balanites aegyptiaca* tree was maintained on the farmland of the households for provision of fuelwood, shade, fodder and as a medicinal plant (Hailemariam *et al*., 2010).

Economic Benefit Estimation

The economic benefit obtained from the different products of the two agroforestry practices is shown in Table 2. The gross benefit of CEBAF practice was 9.76 times higher than the gross benefits of the PAF; because the CEBAF practice provided diversified outputs which altogether increased the total benefits gained from the practice.

Table 2 Economic benefits of CEBAF and PAF practices (ETB)/ha (1$=16.83 ETB)

Products	Year	PAF	CEBAF	Relative PAF=100%)
Maize	1-25	35000	-	
Teff	1-25	56250	-	
Barley	1-25	70000	-	
Bean	1-25	37500	-	
Haricot bean	1-25	131250	11250	
Sweet potato	1-25	33250	-	
Coffee berries	4-25	-	2245580	
kocho	4-25	-	1132950	
Enset leaf	4-25	-	21439	
Forage	1-25	7500	-	
Pole/timber	5-25	6000	93104	
Boundary plant	4-25	-	81600	
Fuelwood	5- 25	570	2270	
Honey	5-25	-	5880	
Taro	1-25	-	31250	
Yam	1-25	-	58680	
Gross benefit		377320	3684003	976%

In a case study of the degraded agricultural lands of Chittagong Hill Tracts Bangladesh), Rasul and Thapa (2006) also reported that the gross benefit obtained from agroforestry practice was 25% greater than the gross benefit obtained from jhum/shifting cultivation. The average annual income/benefit for CEBAF practice was much higher (9.76 times) than the PAF practice. Consistence with this, Rahman *et al.* (2007) reported that multi-strata agroforestry system of Northern Bangladesh is more beneficial (average annual income, Taka, 227300.00) than the traditional mono-cropping system (Taka, 34333.33). The same authors argued that the gross benefit of multi-strata agroforestry system was 14.2 times higher than the gross benefit of traditional monoculture.

3.3. Economic Performance Evaluation

Results of the Cost Benefit analysis revealed that the economic performance of CEBAF practice is much better than PAF practice in terms of all criteria: i.e. NPV, BCR, IRR and RL (Table 3). The NPV of CEBAF practice was found to be 33.63 times higher than the NPV of PAF practice. The BCR of CEBAF practice was also found to be 6.43 times higher than the BCR of PAF practice. Similarly, the IRR of the CEBAF practice was 1.22 times higher than the IRR of PAF practice. RL of CEBAF practice was also 7.63 times higher than RL of PAF practice.

Table3 Economic performance comparison of CEBAF and PAF practices

Criteria	PAF	CEBAF	Relative (PAFP = 100 %)
NPV (ETB/ha)	29817.90	1002867	3363%
BCR	1.28	8.23	643%
IRR	91.25%	111.165%	122%
RL(ETB/person-day)	21.46	163.78	763%

The results indicated that PAF practice was economically attractive activity (NPV > 0, BCR > 1, IRR > r and RL > opportunity cost of family labour) though considerably less attractive than CEBAF practice. This implies that CEBAF practice would enhance economic returns to the growers. In line with this, in a case study of the degraded agricultural lands of Chittagong Hill Tracts of Bangladesh, Rasul and Thapa (2006) reported that financial returns from agroforestry were greater than jhum/shifting cultivation. They also argued that the higher cash incomes provide greater "buying power" with respect to food, especially when agriculture is not practiced, or when the crops fail. In the same way, a study conducted in the Northern Bangladesh showed that the NPV of multi-strata agroforestry system was 5 times higher than the NPV of traditional monoculture (Rahman *et al.*, 2007). The same authors also found that the BCR of multi-strata agroforestry system was 2 times higher than the traditional monoculture. Similarly, a study conducted in the Middle Nepal, Neupane and Thapa (2001) indicated that the BCR for the improved agroforestry-based farming system (2.5) was considerably higher than that for the conventional system (1.8).

However, the question arises as to why households are practicing PAF practice despite higher benefits from CEBAF practices. A better understanding of this is helpful to designing policies and programs aimed at promoting CEBAF practice. Interview held with key informants revealed that despite being aware of the higher return from CEBAF practice many of them find it difficult to adopt CEBAF practices. This is probably due to land insecurity as the result of continuous conflict over land between the Gedeo and the Gujji for a long time, and specifically since 1994 G.C. Households are therefore, reluctant to make investment in such land use practice when they do not have tenure security. Besides, CEBAF practice incurs high investment costs compared to PAF practices. Households who are struggling to secure an adequate livelihood and do not have access to formal credit cannot afford such costs. CEBAF practice, however, takes a relatively long period to provide returns; most of the crops composing PAF practice provide return to households within a short period of time ranging from 3 to 6 months. Farmers who are subsisting on small landholdings and have very limited access to credit find it difficult to wait for returns of CEBAF practices due to a lack of working capital. Lack of credit services is also affecting the returns gained from CEBAF practice. For example, deliberations with focus groups that had practiced CEBAF revealed that they were being forced to sell young trees as fuelwood at a low price to earn some cash income for fulfilling household needs.

Sensitivity Analysis

The sensitivity analysis showed that the NPV was highly sensitive to worst case scenario (10 % increase discount rate and wage increase as well as 10% yield decrease). It was found to be 20.77% and 79.30% lesser than the base NPV of CEBAF and PAF practice, respectively (Table 4).The NPV was more sensitive to yield increase/decrease and it was 17.39% and 45.38% higher/lesser than the base NPV of CEBAF practice and PAF practices, respectively. Hence, the household has to intensively manage the plants composing the CEBAF and PAF practices to avoid yield decrease. In the same way, the NPV was more sensitive to wage increase; it was11.16% and 30.95% lesser than the base NPV of CEBAF practice and PAF practices, respectively.

Table 4 Sensitivity analysis with change in the key variables

Change of key variable	**NPV of PAF**	**NPV of CEBAF**
Yield increase (10%)	145.38%	117.39%
Yield decrease (10%)	54.62%	82.61%
Discount rate increase (10%)	91.60%	89.66%
Wage increase (10%)	69.05%	88.84%
Best case scenario	192.2%	224.50%
Worst case scenario	20.70%	79.23%

Note: Output prices change had the same effect as yield change

Results of sensitivity analysis showed that high rate of discounting affects CEBAF practice negatively; this is because the main benefits obtained from the plant composing the CEBAF practice occurs from the fourth year after planting through the twenty five years of time in contrast to PAF practices; where the main benefits obtained from plant components occur from first year after planting/sowing to twenty five years of time. Similar results were reported by different researchers at different places. For instance, in a study conducted in Zambia, Ajayi *et al*. (2009) reported that increase in discounting rate negatively affects net profit for all practices (continuous maize cropping without fertiliser, continuous maize cropping with fertilizer, *Gliricidia-maize* intercrop, *Sesbania-maize* rotation and *Tephrosia-maize* rotation fertiliser). However, it affects agroforestry practices much more than conventional soil fertility management practices (continuous maize cropping). The different effect was resulted due to variation in time at which the benefits obtained from the practices: i.e. the main benefits from agroforestry practices were obtained in the third through the fifth year only in contrast with conventional practices where benefits (maize yield) occurred throughout the five years period.

4. Conclusion and Recommendation

The result of the economic analysis showed that both CEBAF and PAF practices were economically attractive (NPV > 0, BCR > 1, IRR > r and RL > opportunity cost of household labour). Nevertheless, the CEBAF practice financially more attractive as compared to PAF practice. The result of a sensitivity analysis indicated that the NPVs of both agroforestry practices were highly reduced with reasonable increases in discount rate and labour wage, and a decrease in crop yield. Although the NPVs from both practices were still positive under a worst case scenario analysis (i.e. simultaneous increase in discount rate and labour wage as well as reduction in crop yield), the CEBAF practice showed better economic performance and less risk as compared to the PAF practice.

Based on the findings of this study the following are recommendations.

- The CEBAF practice should be promoted by removing obstacles (tenure insecurity and lack of credit services) that hinder its adoption by the smallholder farmers in the study area and the nearby localities where the biophysical and environmental set up can support such practice.
- The extension service has to provide technical training for the farm households on the management of the components in the two agroforestry practices. Supplying the farmers with improved (drought and disease resistant) variety seeds and seedlings of components is also essential in order to avoid yield decrease.
- In this study, only the marketable benefits were evaluated. Further study is required on quantifying the non-market benefits of both agroforestry practices in order to estimate the total economic value of the two land use practices.

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Acknowledgement
We would like to thank Prof. Donnchadh Mac Cárthaigh and Dr. Assefa Gebre (Associate Professor) for editing this manuscript. We would also like to present our deepest gratitude to DeLPHE-BC Project for its generous financial support.

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