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Cost of Production of Coffee in Jimma Zone, Southwest Ethiopia

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የዚህ ጥናት አላማ በአነስተኛ አርሶ-አደር ዘንድ ያለዉን የቡናን ትርፋማነት ለማጥነት ነዉ፡፡ ጥናቱ በጅማ ዞን ሊሙኮሳ፣ ጎማ፣ ማና እና ጉማይ ወረዳዎች ባጠቃላይ 90 አርሶ-አደሮችና 110 የቡና ማሳ ላይ የተደረገ ነዉ፡፡ መረጃዉ ከተሰበሰበ በኋላ ቡናዉ በአምስት የዕድገት ደረጃዎች (ደረጃ 1 እስከ ደረጃ 5) ተከፍሏል፡፡ የጥናቱ ግኝት እንደሚያመለክተዉ ቡና በደረጃ 1 የዕድገት ደረጃ (ከማሳ ዝግጅት እስከ አነድ አመት) ከፍተኛ ወጪ (ዓመታዉ ወጪ ብር 79920.95) እና ምንም ምርት የማያስገኝበት ደረጃ ላይ ስለሆነ ኔጋቲቭ ያልተጣራ ማርጅን ያሳያል፡፡ በደረጃ 2 (ከ2-3 ዓመት ቡና) የዕድገት ደረጃም እንዲሁ ኔጋቲቭ ያልተጣራ ማርጅን ስኖረዉ ወጪዉ በከፍተኛ ደረጃ ይቀንሳል (ዓመታዉ ወጪ ብር 19053.14)፡፡ ከደረጃ 3 እስከ 5 ቡናዉ ምርታማ የሚሆንበት ደረጃ ስሆን ደረጃ 3 (ከ4-8 ዓመት ቡና) ከሁሉም ደረጃዎች የበለጠ ከፍተኛ ምርት ያስገኛል (867.05 ኪ.ግ/ሄክ ቅሸር ቡና)፤ ዓመታዊ ወጪዉም ብር 22039.29 ነዉ፡፡ ነገር ግን ከፍተኛ ያልተጣራ ማርጅንና የላቀ የቡና የጥቅም-ወጪ ንፅፅር የሚገኘዉ በደረጃ 4 (ከ9-13 ዓመት ቡና) ስሆን ከዚያም እየቀነሰ ይሄዳል፡፡ ባጠቃላይ በሁሉም የዕድገት ደረጃዎች አማካይ የቡና የጥቅም-ወጪ ንፅፅር 1.13 ስሆን ይህም የቡና ትርፋማነት ዝቅተኛ መሆኑን ያሳያል፡፡ ስለሆነም ምርትን በማሳደግ ገቢን ለማሳደግ ምርጥ የቡና ዘሮችን መጠቀም፤ በሌላ በኩል ወጪን ለመቀነስ የተለያዩና አዳዲስ የፈጠራ ዘዴዎችን (ለምሳሌ ማሽኖች) መጠቀም እንደሚገባ ይህ ጥናት ያስገነዝባል፡፡

Abstract

The main objective of this study was to provide detail information on production costs and gross profits of coffee production under smallholder farmers. The study was conducted at four districts of Jimma zone namely Limu Kosa, Gomma, Manna and Gumay Districts. A total of 110 coffee plots from 90 coffee producing households were selected for this study. Data was categorized under five coffee growth stages and analysis was undertaken based on the stages. Stage I covers from coffee establishment stage to coffee age of one year. Stage II covers a coffee age of two and three years. Stage III covers coffee age of four to eight years. Stage IV covers a coffee age of nine to twelve years. Finally, stage V covers coffee age of greater or equals to thirteen years of age. Descriptive, gross margin, benefit-cost ratio, sensitivity, and break-even analysis was conducted to summarize the data. The result of the study showed that at stage I, seedling purchase cost is the most important cost. For the establishment of a hectare of new coffee and plant management until one year, Birr 79920.95 is needed. A single coffee tree need Birr 31.9 at this stage. At stage II, the highest cost is cost of slashing followed by watering and digging. The mean total variable cost at this stage is Birr19053.14 and the mean cost per tree is Birr 7.62. At stage III, the highest cost share goes to harvesting followed by weeding and digging. The mean per hectare total variable cost at this stage is Birr 22039.29 and the mean cost per tree is Birr 8.82. Harvesting, weeding and digging are three important cost of coffee production at stage IV. The mean total variable cost and per tree cost is Birr 18247.00 and Birr 7.3, respectively. The highest cost at stage V goes to harvesting and digging. The mean total variable cost at this stage is Birr 19843.27 and the mean per tree cost is Birr 7.94. The overall mean cost of coffee production per year per hectare of land was Birr 24696.53. The maximum clean coffee yield per hectare was observed at stage III (867.05 kg/ha). Gross Margin is negative at stage I and stage II, and it is positive and peak at stage IV. The highest benefit-cost ratio was observed at stage IV (2.01) followed by stage III (1.67). The overall gross margin was Birr 3156.40 and the benefit-cost ratio was 1.13. The study realized that high cost of production at all stages has jeopardized the gross margin. Therefore, encourage utilization of improved coffee seeds and seedlings to boost the gross return and cost minimization through utilization of different creative and innovative ideas such as machines are crucial to increase the gross margin.

Introduction

World coffee production grew steadily over the last 50 years despite climatic shocks. It will be difficult to maintain this trend mainly because of the continued rise in production costs as well as problems related to pests and diseases which could affect this steady growth in production. Ethiopia is the center of origin for *Coffea arabica* and possesses a diverse genetic base for this Arabica coffee with considerable heterogeneity (Minten *et al*., 2014). Arabica is considered as the noblest of all coffee plants and providing 75% of world's production, and Coffea Canephora (Robusta) is considered to be more acid but more resistant to plagues and provides 25% of world's production (Etienne, 2005; Belitz *et al.*, 2009). Caffeine is the most important component of coffee beans. In raw Arabica coffee, caffeine can be found in values varying between 0.8% and 1.4%, while for the Robusta variety these values vary between 1.7% and 4.0%. The low caffeine content of coffee Arabica drives to high demand among consumers around the world. Coffee bean is also constituted by several other components, including cellulose, minerals, sugars, lipids, tannin, and polyphenols (Santos and Oliveira, 2001; Grembecka *et al.*, 2007; Belitz *et al.*, 2009). The country produces 9% of world's Arabica coffee with a value of 7.2 million 60kg bags annually. Brazil and Colombia ranked first and second with 57% and 22% of the total production, respectively (Olmos *et al.*, 2017). It is also the largest producer in Africa, accounting for about 40 percent of continental's production (USDA, 2018).

According to ICC (2014) for a sustainable development of coffee economy, producers should receive a level of prices that covers the cost of production, living costs, and environmental costs in a competitive context. Access to credit and diversification, and access to commercial information and marketing chains should also be improved for the producers at different level. Changes in production costs over time can severely affect a producer's ability to make a sustainable living from their coffee crop.

The main components of production costs for coffee producers are labor, cost of soil fertility maintenance and phytosanitary products such as pesticides. Costs of production in coffee exporting countries are increasing over time, while coffee prices go both up and down. The dramatic decline in world coffee prices observed between 2011 and 2013 has caused many producers to sell their product at a price that is not remunerative, falling below the costs of production in many countries. Whenever prices paid to producers are lower than their production costs, there is likely to be a consequential fall in production and quality because of reduced farm maintenance.

Measurement of the cost of production at farm level can improve farmers' decisions by providing a means for assessing management strategies in order to achieve greater efficiency and a high profit. Moreover, the use of cost of production estimates has been extended. Today it regards not only farm management specialists and producers, but also the policymakers who use the estimates to set prices, subsidies, agricultural policies and so on.

In spite of the undoubted importance of accounting, the agricultural sector has a low level of bookkeeping and accounting practices. This can become a problem especially if the accounting information is used to improve the farm management or when it is directly or indirectly a base for policy makers in the decision-making procedure.

Coffee land coverage and dependency of smallholder farmers on coffee is high especially in southwest Ethiopia. Samuel *et al*., (2018) found that the share of coffee income from total income in coffee producing districts of Jimma zone is 77%. On other hands, share of land allocated to coffee crop in these areas is more than 69%. This shows that coffee is not only the source of cash and income; but also the means of livelihood for the smallholder farmers of the area. In spite, there was no information (no any study) which realize the profitability of coffee on the area and even in Ethiopia. This report aims to fulfill the above gaps. Detecting coffee profitability have high academic contribution in filling knowledge gap and identifying the way to further increase coffee profitability in sustainable manner. Furthermore, the precise determination of the production costs of coffee is required to properly gauge the economic incentives offered in coffee sector. The results are likely to be used by policy analysts, national and regional research centers, other organizations, and agencies such as district, zonal and regional departments of rural developments, NGOs, and other organizations. In the end, this research will be helpful for different researchers as an input for further studies.

Methodology

The study area

The study was conducted at four districts of Jimma zone namely Limu Kosa, Gomma, Manna and Gumay districts. Jimma is the capital of the zone, which is located 335 km to the South west of Addis Ababa. The zone extends between $7^0$13’ and $8^0$56’ North latitudes and $35^0$49 and $38^0$38’ East longitudes. It is bordered with east Wollega zone in the north, with west Shewa Zone and southwest Shewa Zone in north east, with south nation, nationalities and people’s administration in the South East and South part, and with Buno Bedele zone in the West. The zone is characterized by a tropical highland climate with heavy rainfall, warm temperatures, and a long wet period. Based on the general characteristics of traditional ecology, Jimma zone consists of three major climates. Subtropical, temperate and tropical or thermal zones respectively constitutes 78%, 12% &10% respectively. The mean annual rainfall ranges between 1,200mm and 2,500mm. Coffee is produced in 13 of 18 districts of Jimma zone which implies that coffee is the major contributor to the socio economic well-being of the peoples of the Zone.

Limu Kosa district extends between $7^0$50' to $8^0$36' north latitudes and $36^0$44' to $37^0$29' east longitudes. It is bordered with Limmu Seka District in north and West Shewa Zone in north east, with Tiro Afeta in southeast, with Manna and Kersa Districts in south, with Buno Bedele Zone and Gomma District in west. It is situated in the north central part of the zone. Sub-tropical and temperate agro climates do respectively constitute 70% and 15% of the district’s areas. The remaining 15% of the district’s agro climate does have tropical climate. The mean annual temperature of the district ranges from 18-23^0c. The mean annual rainfall of the district ranges from 1300 to 2300 mm. Maize and coffee are the main crops grown in the district.

Gomma district extends between $7^{0}40^{'}$ to $8^{0}04^{'}$ north latitudes and $36^{0}17^{'}$ to 36^{0} 46' east longitudes. It is bordered with Didesa District in north, with Limmu Kosa District in east, with Manna District in southeast, with Seka Chekorsa in south and with Gera district in west. It is situated in the central part of the zone. Most part of the district belongs to subtropical and temperate agro-climates. Sub-tropical and temperate agro climates do respectively constitute 88% and 12% of the district's area. The mean annual temperature of the district ranges between 15^{0}c and 22^{0}c. The vast area of the district's annual rainfall varies between 1700mm and 2100 mm. Maize and coffee are the main crops.

Manna district extends between $7^{0}38^{'}$ and $7^{0}54^{'}$ north latitudes and $36^{0}38^{'}$ to 36^{0}53' east longitudes. It is bordered with Gomma and Limmu Kosa Districts in north, with Kersa District in east, with Seka Chekorsa district in south and with Gomma district in west. It is also situated in the central part of the zone. Sub-tropical and temperate agro-climates do respectively constitute 80% and 20% of the district's total areas. The vast part of the district does have with mean annual temperature ranges between 18^{0}c and 20^{0}c. The district has mean annual rainfall, which lies between 1300 and 1700 mm. Maize, and coffee are the main crops.

Gumay district is located 71 km away from Jimma Town. The district extends between $7^{0}49^{'}$ to $8^{0}4^{'}$ north latitudes and $36^{0}17^{'}$ and 37^{0}37' east longitudes. It is bordered with Didesa district in north, Gomma district in East, Gera District in south and Setema District in west. It is situated in the northwest part of the zone. Sub-tropical and temperate agro climates do respectively constitute 53% and 33% of the district's areas. The remaining 14% of the district's agro climate does have tropical climate. The temperature of the district is warm ranging between 27 and 30^{0}c. The amount of mean annual rainfall ranges between 1400 and 1500mm. Tef and coffee are prominent crops produced.

Sampling procedure

A three stage sampling technique was employed to select the sample for the study, which involved both purposive and random sampling techniques. In the first and second stage, districts and kebeles were purposively chosen, respectively based on proximity of the areas for follow up and record keeping of the coffee plots. Secondly, 29 households participated on coffee technology demonstration and additional 61 coffee producing households were purposively and randomly chosen, respectively based on the age of the coffee trees. The reason for selecting farmers participated on demonstration was to have a sample of coffee (plot) for establishment period since it is difficult to find newly established coffee on a separate land (plot) for record. Thus, 110 coffee plots from 90 households were investigated for this study (difference shows selection of more than one plot from a single farmer).

Data collection

The cost and benefit data was collected from farmers participating on demonstration of coffee improved varieties and other randomly selected farmers of the districts in collaboration with bureau of agriculture and livestock development. Farmers' plot was selected based on the age of coffee trees, and data collection was undertaken at 4 months interval for one year. Finally, data was categorized under five coffee growth stages and analysis was undertaken based on the stages recommended by coffee breeding and agronomy researchers. The major data collected for the study were yield, output and input prices, cost items (labor, seedlings and so on) and other socio economic characteristics of farmers.

Coffee production stages

The study has classified coffee production in to five stages based on tree age namely stage I, stage II, stage III, stage IV and stage V. The yield and the cost are different at these different growth stages.

Stage I

This stage covers from coffee establishment stage to coffee age of one year. At this stage, huge establishment cost and zero yields is expected. Land preparation are expenses under this stage. All coffee establishment and management activities such as site preparation, hole digging/refilling, weeding, hoeing, mulching, watering, guarding and others are variable costs intensively implemented at this stage.

Stage II

Stage II covers a coffee age of two and three years. It is the stage of intensive plant management especially weeds control and other soil fertility management activities. At this stage, nil yield is expected.

Stage III

Stage III covers coffee age of four to eight years. It is a period of high production and productivity. Therefore, high harvesting cost and soil fertility management is expected at this stage.

Stage IV

This stage also covers a coffee age of nine to twelve years. It is also stage of high production and low cost of weed control and high harvesting cost. Low weed intensity is expected at this stage as the canopy covers the space and suppress the weed growth.

Stage V

Coffee of this stage is huge and old. At this stage, specifically age of greater or equals to thirteen years of age, the yield is expected to decline and management cost is expected to rise to maintain the productivity of stages III and IV.

Data analysis

There are four basic types of farm budgets: whole-farm, cash flow, partial, and enterprise. All budgets include income and expenses from the farm operation. The income sources and expense items included in the budget determine the budget type. Coffee cost of production analysis were done based on enterprise budget analysis. Enterprise budgets form the basis for constructing whole farm, partial, and cash flow budgets. The term "enterprise budget" is used to refer to both projections and summaries of costs and returns. Projections of annual costs and returns for an enterprise are called enterprise budgets, but they are also known as gross margin calculations, projected budgets, or pro forma budgets. Summaries of costs and returns for an historic period may also be called enterprise budgets, but they are often referred to as cost of production studies, income and expense budgets, enterprise statements, or enterprise accounts. Historic records are essential to developing projected budgets. An enterprise budget includes all the costs and returns associated with producing one enterprise in a particular manner. Enterprise budgets are constructed on a per unit basis such as per acre or per head, to facilitate comparisons among alternative enterprises. An enterprise budget contains all of the income and expenses associated with a single enterprise including direct and indirect expenses. Direct expenses are those that are directly associated with a specific enterprise. Indirect expenses are those costs that are associated with more than one enterprise. Direct expenses are relatively easy to estimate. Indirect expenses, however, must be allocated to all associated enterprises. Generally, every enterprise budget includes all the possible sources of revenue and all of the associated costs, both fixed and variable (Peabody, 2007). Most enterprise budgets also list physical resources needed for production, which is useful information for prospective new producers. In addition to producers, other agribusiness professionals often find enterprise budgets to be valuable information sources. These include lenders, assessors, appraisers, consultants, and lawyers. An enterprise budget represents the expected costs and returns associated with a particular farm situation. Enterprise budgets can be detailed and time-consuming to construct. In addition, data for enterprise budgets are often difficult to find, especially if creating a budget for an enterprise that has never been produced in a given area. It is important to stress that these budgets are not averages, but represent typical parameters to a common area.

The analysis was based on a hectare of land through scalar transformation of all individual observations' coffee plots. Prevailing market price was used to value economic costs and returns. Farmer supplied inputs has been valued at the market opportunity cost (the cost of purchasing the same on the market) including unpaid family labor. The principle of opportunity cost was also applied to other inputs produced and used (e.g. manure). Quantities produced were valued at the farm-gate price at the time the production is actually sold. Inputs were also valued using the corresponding market price at the time the input is used. Revenues and costs was brought to a common point in time and price to ensure that they are comparable (FAO, 2013). Descriptive, Gross Margin, Benefit-Cost Ratio, Sensitivity and Break-even Analysis was done to summarize the data based on enterprise budget analysis.

Gross margin (GM)

Gross margin is the difference between the Gross Return (GR) and the Total Variable Cost (TVC).

$$GM = GR - TVC$$

It is a useful planning tool in situations where fixed capital is negligible portion of the farming enterprise in the case of small-scale subsistence agriculture (Olukosi and Erhabor, 1988).

Benefit-cost ratio (BCR)

Benefit-Cost Ratio is given by the percentages Total Variable Cost to the Gross Return.

$$BCR = \frac{GR}{TVC}$$

Where;

$$GR = Total\ dry\ coffee\ production\ (kg) X\ Sale\ price\ (ETB)$$

$$TVC = Summation\ of\ costs\ on\ all\ variable\ inputs\ (ETB)$$

If the ratio is less than one, then the costs exceed the benefit. However, if the ratio is more than one then the benefits exceed the costs (Gittenger, 1982; Jehanzeb, 1999).

Break-even analysis

In economics, break-even analysis can be performed at various levels. It is the point where gross margin and total variable cost (TVC) are the same or when the sales of a farm are enough to cover the expenses (variable costs) of the farm. The goal of calculating a break-even price is to find out at what price a product would have to be sold for in the market place in order to pay for its production. Break-even yield also shows at what production potential (yield per unit area) a product is economically feasible given the variable cost and price. Accordingly:

$$Break - even\ Yield = \frac{TVC}{Sale\ Price}$$

$$Break - even\ Price = \frac{TVC}{Total\ Production}$$

Sensitivity analysis

The sensitivity analysis is a technique used to determine the effect of different values of input parameters on a certain dependent variable (Gross Margin) in predetermined conditions. It is used to identify key sources of variability and uncertainty for the variation of an expected result in order to take the best decisions. Gross Margin is influenced decisively by the sales price of the product, yield, variable costs, and subsidies. The sensitivity is calculated to explore the impact of assumptions regarding the changes of these determinant factors on the gross margin, by using the principle “what if” (Dachin and Ursu, 2016). For our case 15 % decrease in coffee prices, 10% increase in operating variable costs, and 15% decrease in coffee yield was observed based on the current trend of price, cost, and yield variation along the year.

Result and Discussion

Socio-economic characteristics of the farmers

Ninety farmers' 110 plots were investigated on the study. The descriptive result showed that 92% are male-headed and 8% are female-headed households. Regarding marital status, 87% are married, 8% are widowed, and 5% are singles. When we see the socio-demographic characteristics of the investigated farmers, the mean age of the sampled households were 45.23 years. The higher mean total family size was seen at Gumay district and lower at Limu Kosa District with the overall mean of 6.36 persons. The mean active labor force, which is between 15 and 65 years of age, was high at Manna district and the overall mean is 4.01 persons. Education of the households on this study was measured in number of completed years of education. Accordingly, the mean education level was 5.16 completed years of education.

Table 1: Socio-demographic characteristics of coffee farmers

Particular	Overall [n=90]		Gomma [n=25]		Manna [n=20]		Gumay [n=20]		Limu Kosa [n=25]	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Household head age	45.23	11.36	44.69	10.13	47.78	10.88	41.94	10.21	46.08	12.94
Total family size	6.36	2.43	6.38	2.09	6.50	2.67	7.03	2.25	5.81	2.55
Family size 15-65 (years)	4.01	2.33	3.99	2.39	4.28	2.47	3.88	2.41	3.89	2.41
Education (year)	5.16	3.32	5.89	3.03	5.58	3.25	3.77	2.68	5.25	3.72

Source: Own computation, 2018

The land ownership of the households revealed that the farmers of Limu Kosa own the higher mean land and the lower is at Gumay District with the mean of 1.67 hectares. On other hands, the mean coffee land was 1.12 hectare. When we see the mean proportion of land allocated for coffee, the higher proportion was observed at Limu Kosa District (73%) and lower at Gumay District (60%) with a mean of 67% [Table 2].

Table 2: Land ownership of coffee farmers

Particular	Overall [n=90]		Gomma [n=25]		Manna [n=20]		Gumay [n=20]		Limu Kosa [n=25]	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Total land in hectares	1.67	1.18	1.91	1.44	1.14	0.78	1.09	0.68	2.25	2.22
Coffee land in hectares	1.12	1.07	1.16	0.95	0.78	0.44	0.65	0.46	1.65	2.11
Share of coffee land (%)	67		61		68		60		73	

Source: Own computation, 2018

Farmers' accessibility to outputs and input markets affects the cost of coffee production, which in turns affects the gross margin and profitability. Mean distance from output market is 5.06 km and mean distance to input market is 3.86 km. Accordingly, Limu Kosa District is more accessible to both output market and input markets [Table 3].

Table 3: Accessibility of coffee farmers to input and output markets

Particular	Overall [n=90]		Gomma [n=25]		Manna [n=20]		Gumay [n=20]		Limu Kosa [n=25]	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Distance to nearest output market (km)	5.06	3.47	5.94	2.95	4.97	3.49	5.73	2.27	4.01	4.22
Distance to nearest input market (km)	3.86	3.15	6.36	3.25	2.67	2.65	5.13	2.55	1.96	1.98

Source: Own computation, 2018

Costs of production for different growth stages

Establishment cost is relatively higher cost in coffee production. Establishment cost covers the cost of site clearance to a one-year-old coffee management. At this stage, seedling cost is the top cost that covers 13.15% of variable total cost followed by guarding and fencing. On average, for the establishment and management of new coffee plantation until one year on one hectare of coffee land, Birr79, 920.95 is needed. Concomitantly, a single coffee tree need Birr 31.97 until one year for establishment and management [Table 4].

Coffee cost of production at stage II covers the coffee age of two and three years. At this stage high cost for slashing was exhibited which shares 24.07% of total cost. The canopies of coffee plants do not cover the area under the trees and high weeding (slashing) cost is expected. The second most important cost at this stage is cost of watering followed by digging. The mean cost per tree at this stage is Birr 7.62 [Table 5].

Table 4: Coffee cost of production: stage I

Cost category	Establishment and year one cost (n=22)			
	Mean	S.D	Mean cost per tree	Share of total cost (%)
Land clearance	5,446.71	4963.37	2.18	6.82
Peg preparation	1,148.41	888.46	0.46	1.44
Field layout	4,414.79	783.14	1.77	5.52
Hole digging	2,202.19	2948.28	0.88	2.76
Hole refill	929.16	1421.89	0.37	1.16
Transporting seedlings	1,653.20	739.81	0.66	2.07
Plantation	2,030.01	728.93	0.81	2.54
Mulch preparation	1,500.58	2747.39	0.60	1.88
Mulching	443.73	353.73	0.18	0.56
Shade tree plantation and management.	1,749.53	1165.59	0.70	2.19
Hat construction and installation	7,152.31	4103.51	2.86	8.95
Guarding	8,439.89	6155.15	3.38	10.56
Watering	6,331.00	3989.49	2.53	7.92
Fencing	7,659.60	7099.54	3.06	9.58
Slashing	5,018.26	3479.66	2.01	6.28
Digging	5,563.68	3459.57	2.23	6.96
Compost application	2,295.98	1983.60	0.92	2.87
Fertilizer application	908.16	581.42	0.36	1.14
Herbicide application	415.84	255.48	0.17	0.52
Compost cost	2,295.98	2103.10	0.92	2.87
Herbicide cost	1,157.63	541.17	0.46	1.45
Seedling cost	10,509.76	2335.84	4.20	13.15
Shade tree seedlings cost	654.10	398.34	0.26	0.82
Total	79,920.95	63,113.33	31.97	100.00
Note: 1$=27.13 Birr				

Source: Own computation, 2018

Table 5: Coffee cost of production: stage II

Cost category	Year 2 and 3 (n=22)			
	Mean	S.D	Mean cost per tree	Share of total cost (%)
Replace died seedlings	272.00	142.58	0.11	1.43
Watering	3,001.00	1414.21	1.20	15.75
Fencing and maintenance	2,200.00	1000.00	0.88	11.55
Slashing	4,585.30	2196.74	1.83	24.07
Digging	2,605.56	1297.25	1.04	13.68
Compost application	1,613.00	1131.37	0.65	8.47
Harvesting	1,297.62	1004.73	0.52	6.81
Transporting output home	130.67	66.09	0.05	0.69
Drying bed construction	115.43	110.33	0.05	0.61
Drying and storing	220.00	174.81	0.09	1.15
Compost	2,003.00	1697.05	0.80	10.51
Seedlings	834.00	297.62	0.33	4.38
Other costs	175.56	162.68	0.07	0.92
Total	19053.14	12254.50	7.62	100.00
Note: 1$=27.13 Birr				

Source: Own computation, 2018

The cost of coffee production at stage III also showed that the highest cost share was given to harvesting which accounts 30.71% of total variable cost. The next important costs at this stage was cost of weeding/slashing followed by digging the whole farm and compost application. The mean cost per tree at this stage is Birr 8.82 [Table 6].

Table 6: Coffee cost of production: stage III

Cost category	Year 4-8 (n=22)			
	Mean	S.D	Mean cost per tree	Share of total cost (%)
Slashing	4,139.17	2004.23	1.66	18.78
Digging	3,277.50	1087.15	1.31	14.87
Compost application	3,000.00	516.39	1.20	13.61
Harvesting	6,768.65	3575.96	2.71	30.71
Transporting output home	354.47	284.64	0.14	1.61
Drying bed construction	488.67	291.09	0.20	2.22
Drying and storing	1,613.42	1005.32	0.65	7.32
Compost	1,500.00	707.12	0.60	6.81
Other costs	897.41	623.62	0.36	4.07
TOTAL COST	22,039.29	16595.52	8.82	100.00
Note: 1$=27.13 Birr				

Source: Own computation, 2018

Harvesting, weeding and digging are three main costs of coffee production at stage IV. These costs account 75.66% of the total costs on aggregate. The mean cost of production per tree at this stage is Birr 7.30.

Table 7: Coffee cost of production: stage IV

Cost category	Year 9-12 (n=22)			
	Mean	S.D	Mean cost per tree	Share of total cost (%)
Slashing	3,914.60	1508.27	1.57	21.45
Digging	3,433.33	1354.70	1.37	18.82
Herbicide application	480.00	113.14	0.19	2.63
Pruning	1,185.00	1039.45	0.47	6.49
Harvesting	6,274.32	4840.31	2.51	34.39
Transporting output home	228.22	270.75	0.09	1.25
Drying bed construction	466.75	413.83	0.19	2.56
Drying and storing	1,040.00	674.49	0.42	5.70
Other costs	974.78	974.94	0.39	5.34
Herbicide cost	250.00	70.71	0.10	1.37
Total	18,247.00	13889.17	7.30	100.00
Note: 1$=27.13 Birr				

Source: Own computation, 2018

Coffee cost of production for stage V has also been analyzed based on the data record. Accordingly, the highest cost goes to harvesting and digging. Other important costs are weeding and compost application. The mean per tree production cost at this stage is Birr 7.94.

Table 8: Coffee cost of production: stage V

Cost category	>=13 (n=22)			
	Mean	S.D	Mean cost per tree	Share of total cost (%)
Slashing	3,269.87	2,295.41	1.31	16.48
Digging	3,668.57	655.93	1.47	18.49
Herbicide application	263.90	208.64	0.11	1.33
Compost application	2,848.00	408.55	1.14	14.35
Harvesting	6,259.29	3,415.32	2.50	31.54
Transporting output home	153.88	122.14	0.06	0.78
Drying bed construction	401.40	308.19	0.16	2.02
Drying and storing	561.32	319.24	0.22	2.83
Compost	1,626.67	360.74	0.65	8.20
Other costs	552.19	253.83	0.22	2.78
Herbicide cost	238.18	113.99	0.10	1.20
Total	19843.27	1161.98	7.94	100.00
Note: 1$=27.13 Birr				

Source: Own computation, 2018

The result of the study also showed that slashing and digging are the main costs of coffee production at all stages despite difference among the stages. Based on the result, both digging and slashing costs are higher at early stages and reduced at late stages [Figure 1].

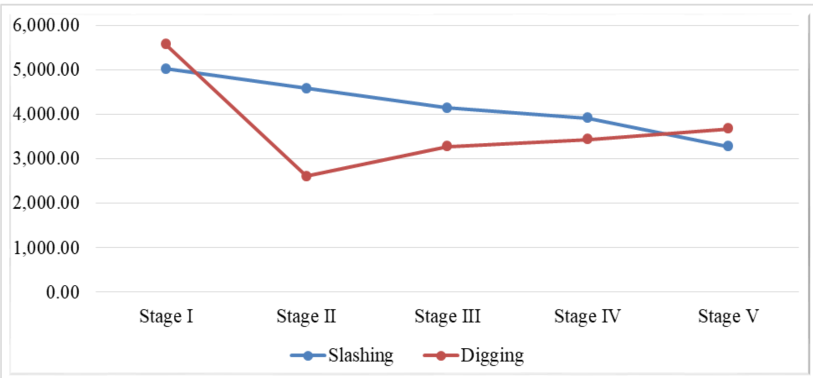

Figure 1: Slashing and digging costs are each stages
Source: Own computation, 2018

Benefit-cost analysis

The summary showed that, at stage I and II there is no production, thus gross margin is negative and equals to total variable cost. The mean price of dry coffee locally called *jenfel* coffee is ETB 21.17. The highest dry coffee per hectare was seen at stage III with a mean of 1,734.09 kg. This also implies for per tree cost and gross revenue. However, the highest gross margin and benefit-cost ratio was seen at stage IV (9-12 years). This result implies that the highest return was attained at stage III and highest gross margin at stage IV. Why? The reason is difference in variable cost between the two stages. Coffee at stage III need intensive management so that it need high management cost. The cost of coffee management especially weeding declines as we move from stage I to stage V as the canopy of the coffee closes the area between coffee trees and suppress weed growth.

The overall gross margin was Birr 3156.40 and the benefit-cost ratio was 1.13. Both break-even price and break-even yield were safe at all stages except non-productive stages (stage I and II).

Table 6: Summary of coffee production costs and revenue

Category	Establishment and one year	Years 2 and 3	Years 4-8	Years 9-12	>= 13 years	Overall (establishment to 13 years)
Mean dry coffee (kg/ha)	_	_	1734.09	1728.81	1518.14	1315.68
Mean clean coffee (kg/ha)	_	_	867.05	864.41	759.07	657.84
Mean price of dry coffee/kg	_	_	21.17	21.17	21.17	21.17
Mean clean coffee (kg/tree)	_	_	0.69	0.69	0.61	0.53
Gross revenue (Birr/ha)	_	_	36710.69	36598.91	32139.02	27852.93
TVC	79920.95	19053.14	22039.29	18247.00	19843.27	24696.53
Gross margin	-79920.95	-19053.14	14671.40	18351.91	12295.75	3156.40
Benefit-cost ratio	_	_	1.67	2.01	1.62	1.13
Break-even price (kg of dry coffee)	_	_	12.71	10.55	13.07	18.77
Break-even yield (kg dry coffee/ha)	_	_	1041.06	861.93	937.33	1166.58

Source: Own computation, 2018

The summary of revenue and total variable cost exhibited high cost and nil benefit at early stages (non-production stages). The revenue goes to peak stage at stage III and then decline. The cost of coffee production decline at stage IV and then rise due to need of soil fertility management cost [Figure 2].

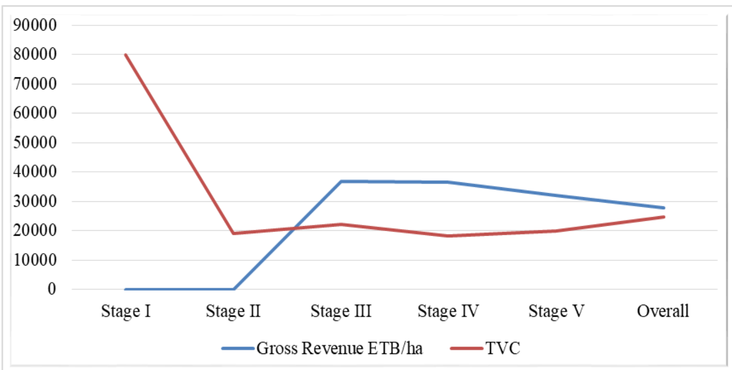

Figure 2: Gross revenue and total variable cost at each stages
Source: Own computation, 2018

The result also exhibited that the gross margin of coffee production is negative at early stages and goes to peak at stage IV. Then after, the gross margin declines at stage V [Figure 3].

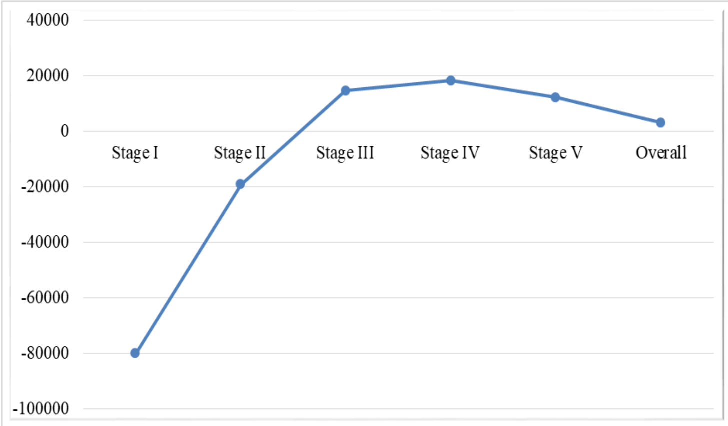

Figure 3: Gross margin of coffee production at each stages
Source: Own computation, 2018

The study resulted that benefit-cost ratio was zero at early stages. On other hands, benefit-cost ratio reached at peak stage at stage IV and then decline. The overall benefit-cost ratio reached to 1.13 [Figure 4].

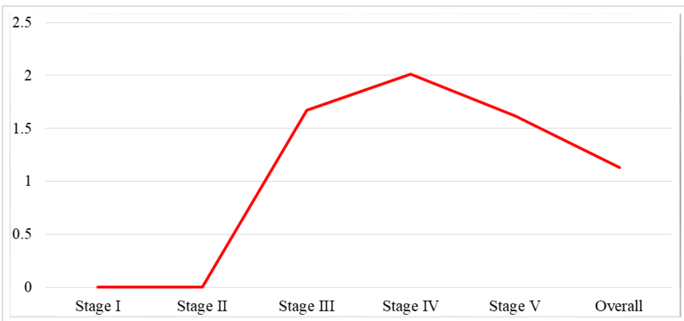

Figure 4: Cost benefit ratio at each stages
Source: Own computation, 2018

Sensitivity analysis

Sensitivity of gross margin to different agricultural risks has also been observed for coffee production. The sensitivity has been seen for 15% decrement of coffee price, 15% decrement of coffee yield and 10% increment of variable (operating) costs based on the current trend of coffee price, cost and yield variation along the year. These risky situations make coffee producers non-profitable (benefit-cost ratio less than 1).

Table 9: Sensitivity analysis of Gross Margins

Category	Original value	15 % decrease in coffee prices	10% increase in operating costs	15% decrease in coffee yield
Mean dry coffee (kg/ha)	1315.68	1315.68	1315.68	1118.33
Mean price of dry coffee/kg	21.17	17.99	21.17	21.17
Gross revenue (Birr/ha)	27852.93	23674.99	27852.93	23674.99
TVC	24696.53	24696.53	27166.19	24696.53
Gross Margin	3156.39	-1021.54	686.74	-1021.54
Benefit-Cost Ratio	1.13	0.96	1.03	0.96
Break-even price (kg of Dry coffee)	18.77	18.77	20.65	22.08
Break-even yield (kg dry coffee/ha)	1166.58	1372.45	1283.24	1166.58
Change in gross margin (%)		-132	-78	-132

Source: Own computation, 2018

Conclusion and Recommendations

Based on the findings of the study the following conclusions were drawn

Supply of improved coffee seeds and seedlings

Result of the study revealed that decrease in coffee yield is sensitive and negatively affect the gross margin. Observation and different studies also showed smallholder farmers' coffee farms in Ethiopia are extremely aged and are low yielders. Thus, encouraging and incentivizing farmers in renewing coffee trees through stumping and replacing in improved varieties is a serious option to be given emphasis by stakeholders such as extension, research centers, Universities and NGOs. This could affect the gross margin by increasing Gross Return per unit of land.

Cost reduction

The result of the study also showed that the production of coffee is capital and labor intensive. Especially weed control (weeding and digging) and harvesting are costly and needs relatively large capital. These operations are frequently undertaken annually and the minimum wage in coffee areas is very high as compared to the other cereal crop producing farming systems. This high labor and capital demanding feature of coffee is discouraging as coffee productivity is lower in Ethiopia relative to other countries especially South American countries. There is no doubt that technological advances can play an important role in lowering production costs as well as contributing in other areas such as quality improvement and coffee tree management. Nevertheless, technological advances require investment, both in maintaining an adequate research and extension infrastructure and in terms of capital expenditure and appropriate use of improved inputs. Thus, cost reducing mechanisms such as innovative machines related to labor intensive operations should be given due weight.

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