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Cost Benefit Analysis of Black Pepper Production in Ethiopia: Evidence from Commercial Production System

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Abstract: **This study assesses the financial feasibility and risk bearing ability of black pepper production. A nine year (2008-2016), cost and return data was collected from large-scale commercial farms. The economic performance measures such as, net present value, benefit cost ratio and internal rate of return were used for data analysis. Black pepper was found to generate the first revenue after five years of cultivation. Results of economic performance indicators revealed that black pepper farming generated a total discounted revenue of birr 416,024.4 per hectare with benefit cost ratio of 5.7 and internal rate of return of 61%. The finding also indicated that harvesting cost accounted for higher share (about 51%) of the total cost of black pepper production. The break-even yield and break-even price were found to be 213.7 kg per hectare (63.9% below the current minimum yield level) and birr 26.5 per kg (81.2% below the current minimum price level), respectively, indicating the likelihood that black pepper could remain profitable at such considerable yield and price fall. The findings in general reveal that, in spite of high initial investment cost and long gestation period, black pepper farming is a financially viable and a less risky enterprise.**

Keywords: **Black Pepper, Commercial Farm, Financial Feasibility, Risk.**

1. INTRODUCTION

Agriculture has been remained the single most important sector in Ethiopia economy, contributing to about 38.8% of the GDP, 90% of foreign exchange earnings, and 84% of employment opportunity (NBE, 2014/15). A wide range of crops have been grown in Ethiopia due to the diverse agro-ecology of the country.

Spices are one of the traditional high value horticultural crops of Ethiopia. The potential to increase spice production in Ethiopia is very high mainly due to suitable climatic condition, abundant cultivable land and cheap labor, proximity to potential export market (European and Middle East) and favorable policy environment (Herms, 2015). Traditionally various perennial and seed spices such as, turmeric, korarima, long pepper, fenugreek, black cumin, white cumin and coriander are grown in different parts of the country. Most of these spice crops are cultivated by smallholder farmers mainly for income generation and, have considerable importance to the country's economy as export commodities and sources of employment. For instance, according to FAO (2012/13), in 2012, (USD) 28 million was obtained from the export of 23518 tons of spices and the country ranked 9th in world spices production and export.

Black pepper, commonly known as "*King of spices"*, is one of the exotic spice crop which was introduced to Ethiopia in 1979. Since then significant research achievements have been recorded in the area of variety development, post-harvest and processing, agronomic practices and crop protection (Girma *et al*, 2016: Girma *et al*., 2008). Currently some large scale commercial farms in Sheka and Bench Maji zones have started producing black pepper for both domestic and export

markets. For instance, in 2012, Bebeka Coffee Estate Share Company has exported 45.0 tons of dry black pepper (BCESC, 2012). However, black pepper production in the area is hardly organized and is constrained by limited technology transfer. Although some large scale commercial farms have started the business, the rate of expansion in terms of area coverage and volume of production is very minimal.

Black pepper production requires a long gestation period to generate the benefit (yield) and there is no or very limited information and studies in the particular growing areas to guide black pepper production at commercial level. Producers usually make decision on factors of production in their own judgment without full information, and such information gap will inevitably lead to suboptimal resource allocation. Hence, profitability information is indispensable for producers to make informed decision and maximize farm income by selecting a profitable enterprise. This study therefore assesses the cost-return and risk bearing ability of black pepper production under commercial farming system.

2. METHODOLOGY

2.1. Description of the study area:

The study was conducted in SNNPRS, specifically in Sheka and Bench Maji zones. The two zones are designated as black pepper belts of Ethiopia, where almost all of the country's black pepper production is located (Abdu et al, 2016; EIAR, 2016). Sheka and Bench Maji zones are well known for their diverse and suitable agro-ecology for the production of high value horticultural crops such as coffee, spices and tea. The study zones on average receive 600mm to 1980 mm rainfall per annum, whereas the average annual mean temperature is ranging between 17^0C and 32°C (SNNPRS website).

2.2. Sampling procedure and Data collection:

A three-stage purposive sampling technique was adopted for the study. In the first stage, Yeki, and Debub Bench districts were selected from Sheka and Bench Maji zones respectively, on the basis that the districts are the major black pepper producing areas. In the second stage, two large scale commercial farms, Bebeka coffee estate Share Company and Kedija spices plantation farm, were selected since these are the only farms that produce black pepper for commercial purpose. In the third stage, three black pepper farm plots covering a total of 17.5 hectares were selected from the two commercial farms for data collection. Since black pepper is a perennial crop, a nine-year cost of production data and a four-year yield data were collected from the plots.

2.3. Data analysis:

All plot level data were converted to per hectare basis for ease of computation. The widely known financial evaluation tools (Harberger, 1972), such as, net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) were used for the analysis.

While estimating the model, the streams of costs and benefits of black pepper farming were aggregated categorically and computed using the following formula;

$NR = TR - TC$……. (1)

Where, NR=Net return of black pepper; TR=Total revenue of black pepper and TC= Total cost of black pepper production and are further defined as follows:

$TR = Q_t * P_t$ ……..... (2)

Where Q_t: Total quantity of dried black pepper in kg at period *t*; and P_t: Farm gate selling price per kg of dried black pepper at period *t*

$TC_t = VC_t + CF_t$ …….. (3)

Where VC_t: Variable cost at period $_t$, which is the summation of CE_t (Farm Establishment Cost), CM_t (Material and input such as seedling and fertilizer cost), CL_t (Labor cost for major farm operations) and CF_t (Fixed cost at time $_t$)

Costs occur in the current period (t = 0) and the stream of benefits that is obtained next time, where *t*=1 and t=T, has different value. In such circumstances, converting the future stream of expenses and returns to present values is quite important to make comparison possible across the whole period. Therefore, in this study, a 9.5 percent discount rate,

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which is an official lending rate in the development bank of Ethiopia for long term project, was used to calculate NPV, BCR and IRR.

NPV (Net Present Value) measures the net return of a given enterprise using the discounted stream of benefit and cost. As explained by Gittinger (1984) and Chandra (1998), a positive NPV shows the financial feasibility of a given planned business. NPV is calculated using the following formula:

$$NPV = \sum_{i=1}^{n} PVB - \sum_{i=1}^{n} PVC \quad \text{.....(4)}$$

$$NPV = \sum_{i=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{i=1}^{n} \frac{C_t}{(1+r)^t} \quad \text{.....(5)}$$

The BCR (benefit-cost ratio) compares the discounted benefits to discounted costs. B/C ratio > 1 shows the profitability of a planned project and it is computed using the following formula.

$$BCR = \frac{\sum_{i=1}^{n} PVB}{\sum_{i=1}^{n} PVC} \quad \text{.....(6)}$$

Where $\sum_{t=0}^{t=T} PVC_t$ =the aggregated present value of black pepper total cost from time, t=0 to t=T:

$\sum_{t=0}^{t=T} PVP_t$ = the aggregated present value of farm gate price/kg of dried black pepper from time, t=0 to t=T:

IRR (Internal Rate of Return) is the discount rate that brings NPV equal to zero. It measures the sensitivity of an enterprise in relation with financial market fluctuation. The formula for IRR is given by:

$$IRR = r_1 + \left[(r_2 - r_1) * \left[\frac{NPV_1}{NPV_1 - NPV_2} \right] \right] \quad \text{.....(7)}$$

Where, r_1: the lower discount rate, r_2: the higher discount rate, NPV_1: NPV at the lower discount rate, and NPV_2: NPV at the higher discount rate.

It is worthwhile to consider the stability of farming business, since agricultural production is always with full of risk and uncertainties. Hence, we applied sensitivity analysis to evaluate the risk bearing ability of black pepper cultivation under the changing condition of two key variables, yield and output price fluctuation using the following formula:

$$Break-Even\ Yield = \frac{\sum_{t=0}^{t=T} PVC_t}{\sum_{t=0}^{t=T} PVP_t} \quad \text{.....(8)}$$

$$Break-Even\ \text{Price} = \frac{\sum_{t=0}^{t=T} PVC_t}{\sum_{t=0}^{t=T} PVQ_t} \quad \text{.....(9)}$$

Where $\sum_{t=0}^{t=T} PVQ_t$ = the aggregated present value of dried black pepper output in kg from Time, t=0 to t=T

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3. RESULT AND DISCUSSION

3.1. Inputs of Black Pepper Cultivation:

Table 1 presents a nine-year input use of black pepper production. As shown in the table labor, fertilizer, chemicals and equipment such as machete, basket, sack and basket were the major farm inputs that were used in the production of black pepper. Weed control was found to be the most frequently practiced farm operation. Hand weeding and herbicide application were practiced five and three times a year respectively, possibly indicating that weed was the major constraint in black pepper production. Farm management activities require more labor input at early growth periods and stabilize afterwards.

3.2. Cost and Return of Black Pepper:

Figure 1 shows the trend of total cost and cost components over the production years. The cost component includes both variable and fixed costs. As shown in the graph, total cost of production during the initial year was slightly higher, and tends to decline from year two to year five because of the limited farm improvement operations involved over those periods. However, the total cost sharply increases from year five onward mainly due to increased use of labor for harvesting.

Table 1: Farm inputs analysis of black pepper production per hectare of land

No.	Farm Inputs	Frequency per year	Unit	Year								
				0	1	2	3	4	5	6	7	8
1.1	***Labor for farm establishment***		***Man/day***	***61.9***	***45.8***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
1.1.1	Land clearing	1	Man/day	8	0	0	0	0	0	0	0	0
1.1.2	Layout	1	Man/day	8.1	0	0	0	0	0	0	0	0
1.1.3	Hoeing	1	Man/day	27.8	27.8	0	0	0	0	0	0	0
1.1.4	Refilling	1	Man/day	7.4	7.4	0	0	0	0	0	0	0
1.1.5	Planting support tree	1	Man/day	10.6	0	0	0	0	0	0	0	0
1.1.6	Planting black pepper seedling	1	Man/day	0	10.6	0	0	0	0	0	0	0
1.2	***Labor for farm management***		***Man/day***	***49.75***	***109.1***	***109.1***	***109.1***	***77.7***	***63.7***	***63.7***	***63.7***	***63.7***
1.2.1	Weeding	5	Man/day	49.7	70	70	70	45.7	45.7	45.7	45.7	45.7
1.2.2	Fertilizer application	1	Man/day	0	14	14	14	14	0	0	0	0
1.1.3	Mulching	1	Man/day	0	9.1	9.1	9.1	0	0	0	0	0
1.1.4	Herbicide application	3	Man/day	0	0	0	0	9	9	9	9	9
1.1.5	Toping	1	Man/day	0	10	10	10	0	0	0	0	0
1.1.6	Vine training	1	Man/day	0	6	6	6	0	0	0	0	0
1.1.7	Shade tree regulation	1	Man/day	0	0	0	0	9	9	9	9	9
1.3	***Labor for harvesting***		***Man/day***	***0***	***0***	***0***	***0***	***0***	***143***	***150***	***809***	***560***
1.4	***Labor for drying***		***Man/day***	***0***	***0***	***0***	***0***	***0***	***3***	***3.5***	***11***	***8.5***
1.5	***Farm equipment***											
1.5.1	Machete		No	1	1	1	1	1	1	1	1	1
1.5.2	Sack		No	0	0	0	0	0	6	7	25	17
1.5.3	Basket		No	0	0	0	0	0	10	12	30	20
1.5.4	Drying mat		M^2	0	0	0	0	0	10	10	22	22
1.6	***Other Inputs***											
1.6.1	Graphila (support tree) seedling		No	1200	0	0	0	0	0	0	0	0
1.6.2	Black pepper seedling		No	0	1200	0	0	0	0	0	0	0
1.6.3	Fertilizer		kg	0	55.5	55.5	55.5	55.5	0	0	0	0
1.6.4	Chemicals		lit	0	0	0	0	0	15	15	15	15

Source: Own Calculation

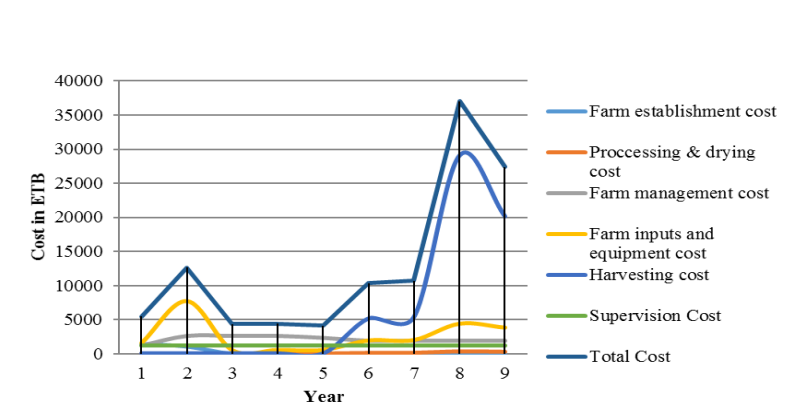

Figure 1: Trends in black pepper cost components

Figure 2 shows the trend of black pepper farm gate price and yield over time. Like any other enterprise, yield and output price are important factors in determining the profit margin of black pepper farming. Black pepper price was found to be volatile within the range of birr 141 to birr 167 per kilogram. However, the average price was birr 153.25 per kg, which was 8% and 9% above and below the minimum and maximum price level, respectively. The figure also showed that black pepper provides the first yield at the 6th year of cultivation, lagging by two years from research recommendation. The annual black pepper yield was ranging from 592 kg to 2240 kg per hectare, showing that the actual yield received over time was varied by 53.8% below and 74.5% above the average yield, respectively. Even though the crop provides relatively higher yield in the third harvesting period, the productivity was still lower by 10.4% from the yield potential of the crop at research center level (MoANR, 2016).

Figure 2: Trends in black pepper cost, farm gate prices and yield

Table 2 present the nine-year cash flow of black pepper production. The finding showed that there was a negative cash flow during the first five years of black pepper production as the crop relatively requires long period to give yield. As shown in Table 2, the total aggregated revenue generated from black pepper production was birr 781, 570.00, whereas the total aggregated cost was birr 116,808.6 per hectare. Revenue reaches the highest at the seventh year of establishment of the crop and tends to decline afterwards. Land renting cost, farm establishment, management, farm inputs & equipment, harvesting, processing and drying costs were the major cost components in black pepper production, though their contribution to total cost would vary over time. However, about 51.4% of the total production cost is attributed to harvesting cost (Figure 3).

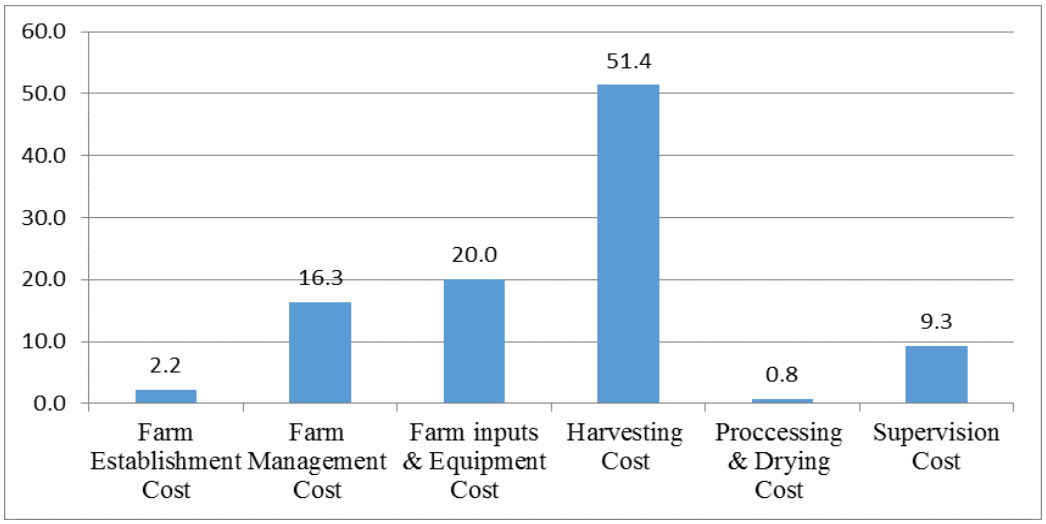

Figure 3: Major cost components of black pepper production

Table 2: Cost and Revenue of Black Pepper Production over the Years

Cost Description	Total Cost over year (ETB/ha)									Total
	0	1	2	3	4	5	6	7	8	
Variable Cost = A= (A1 + A2 +. .A6)	*4363.6*	*11533.9*	*3240.7*	*3288.4*	*3001*	*9223*	*9565*	*35941*	*26311*	*106467.6*
Farm establishment cost =A1	1485.6	1099.2	0	0	0	0	0	0	0	2584.8
Farm management cost =A2	1194	2618.4	2618.4	2618.4	2331	1911	1911	1911	1911	19024.2
Harvesting cost =A3	0	0	0	0	0	5148	5400	29124	20160	59832.0
Processing & drying cost =A4	0	0	0	0	0	108	126	396	306	936.0
Input cost =A5	1440	7566.3	366.3	402	402	1080	1080	1800	1800	15936.6
Farm equipment cost =A6	144	150	156	168	168	876	948	2610	2034	7254.0
Supervision cost	1200	1200	1200	1200	1200	1200	1200	1200	1200	10800.0
Fixed Cost = B	*49*	*49*	*49*	*49*	*49*	*49*	*49*	*49*	*49*	*441.0*
Land rent =B1	49	49	49	49	49	49	49	49	49	441.0
Total cost = C = (A + B)	5512.6	12682.9	4389.7	4437.4	4150	10372	10714	37090	27460	116808.6
Revenue from sell = D	0.00	0.00	0.00	0.00	0.00	85840	107680	315840	272210	781570.0
Net gain/cash flow/ (E=D-C)	-5512.6	-12682.9	-4389.7	-4437.4	-4150	75468	96966	278750	244750	664761.4

Source: Own Calculation

3.3. Financial Feasibility:

Table 3 presents the financial feasibility of black pepper. As indicated in the table, black pepper generated an aggregated discounted revenue of birr 416,024.4, which is much higher (4.7 times) than the total discounted cost of production (72,762.2 birr per hectare). The economic performance indicators verify that black pepper was financially a profitable enterprise, generating a net present value of birr 343,262.2 per hectare with B/C ratio of 5.7 and IRR of 61%.

Table 3: Financial Feasibility

Total discounted Revenue (ETB)	Total discounted Cost (ETB)	Economic Performance Indicators		
		NPV (ETB)	B/C (ETB)	IRR (%)
416,024.40	72,762.2	343,262.2	5.7	61

Source: Own Calculation

The benefit obtained from black pepper could even exceed more than the estimated value since the possible productive life of the crop can extend to 15-20 years. We estimate NPV, B/C and IRR for each specific productive year to see how profitability could change across the successive productive periods. As shown in Table 4, NPV in year-six, year-seven and year-eight increased by 268.9%, 191.4% and 52.7% compared to the year preceding them individually. The value of B/C ratio and IRR was also increasing during the productive years by annual growth rate of 55.2% and 59.9%, respectively. The implication would be that additional benefit could be obtained as the number of harvesting periods extends to the whole productive life cycle of the crop.

Table 4: Trend of financial feasibility by productive year

Economic Performance Indicators	Productive Period (by Cultivation Year)				Average Annual Growth
	5th Year	6th Year	7th Year	8th Year	
NPV (ETB)	20,916.8	77,168.3	224,846.4	343,262.2	171%
		(268.9%)	(191.4%)	(52.7%)	
B/C (ETB)	1.6	2.9	4.8	5.7	55.2%
		(81.3%)	(65.5%)	(18.8%)	
IRR (%)	17	38	56	61	59.9%
		(123.5%)	(47.4%)	(8.9%)	

Figures in parentheses indicate the percentage change of the value of each indicator over successive years

Source: Own Calculation

3.4. Sensitivity analysis:

We assess the risk bearing ability of black pepper farming in relation to yield and price reduction, as variability in yield and price have direct impact on the profitability of the crop. Table 5 presents break-even yield and break-even price. The break-even yield was found to be 213.7 kg, whereas the break-even price was birr 26.5 per kg. The implication is that black pepper farming would be at no loss condition for yield decline of up to 213.7 kg per hectare and price drop of up to birr 26.5 per kg.

Table 5: Sensitivity test

Particulars	Variables				
	Yield (Kg)	Prices (Birr)			
Minimum Actual Value (Base Value)	592	141			
Break-Even Value	213.7	26.5			
Reduction (%) in breakeven yield from base value	63.9%	81.2%			

Source: Own calculation

4. CONCLUSION AND RECOMMENDATIONS

This study examines the financial feasibility and risk bearing ability of black pepper cultivation in Sheka and Bench Maji zones. The result indicates that black pepper production was a profitable business with NPV, B/C and IRR value of birr 343,262.2, 5.7 and 61%, respectively. Moreover, the sensitivity analysis showed that black pepper production withstands a reasonable large drop in yield and price before incurring financial loss. And this indicates that black pepper could be an appropriate business for poor farmers who operate farming activities. Furthermore, the finding showed that harvesting cost was the major cost component contributing more than half of the total aggregated cost of black pepper production followed by cost incurred for farm management. Hence Research institutions need to focus on developing cost effective improved harvesting technology and farm management practices.

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