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Full Length Research Paper

Cost-benefit analysis of common bean productionin the Central Rift Valley (CRV) of Ethiopia

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Abstract

This study investigated the economic viability of smallholder farmer's common bean production in the central rift valley of Ethiopia. Plot level data were collected from 31 farmers in three districts using a well-designed datasheet. The data were analyzed using descriptive statistics, profitability ratio, and enterprise budget analytical methods. The result showed that labor, oxen draft power, fertilizer and seed were the major input costs of common bean production accounting for 58%, 20, 13 and 10 percent, respectively. Results further showed that farmers obtained about 14017 and 1807 (ETB) per hectare on average from common bean yield revenue and common bean straw sales, respectively. The total variable cost of common bean incurred by the respondents averaged ETB 9459.00/ha, with an average Gross Return (GR) of ETB 15825.00/ha, which resulted in a Gross Margin (GM) of ETB 6366.00/ha. The benefit-cost ratio (BRC) of 1.67 showing the enterprise is profitable in the CRV of Ethiopia.

Keywords: Common bean, gross margin, production economics, profitability and smallholder.

INTRODUCTION

Common bean is one of important legume crops grown worldwide over an area of about 28.78 million hectares (ha) with an annual production of 23.14 million tones and feeding about 400 million population worldwide (FAO, 2014). Bean production in Sub-Saharan Africa is fundamentally done by small-scale farmers whose landholding is less than 2 ha, predominantly by women for both household food security and cash (Rubyogo et al., 2015). The demand for common bean market conditions is anticipated to increase the productivity and motivate households to adopt productivity enhancing inputs such as fertilizer, high yielding variety in the production of common bean. It is essential crop for small-scale farmers since beans are a short duration crop that permits production even when rainfall is erratic. It also improves environmental health and soil fertility through biological nitrogen fixation (BNF) as well as serving as livestock feed, source of fuel and a range of other benefits (Muoni et al., 2019).

Ethiopia is the second-largest producer of grain legumes in the common market for eastern and southern African countries (COMESA region) following Sudan. Sudan and Ethiopia have 32% and 22% share of the total COMESA grain legumes production, respectively. For the major processing companies, Ethiopia is a relatively new source of supply and recent investment site for a number of international companies like Italy, the UK, and Turkey indicating that there is a huge market opportunities both in the country and abroad (CIAT (International Center for Tropical Agriculture) (2008). The demand for legumes is expected to increase as consumers' income with a likely shift in preferences from cereal grains to more nutrient-dense foods (Muoni et al., 2019). Common beans are usually intercropped with complementary crops such as maize and sorghum owing to increasing population pressure on agricultural land and balancing nutrients in the soil.

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Common bean is and predominantly grown in the warmer and low land parts of Ethiopia (CSA, 2018; Getachew, 2019; Tegegne, 2017). In Ethiopia, common bean farming has developed significantly with little intervention, and great potential exists to increase production and productivity. About 3.1 million smallholder farmers are producing common bean on small plots with minimal inputs (CSA, 2012). Thus, common bean ranks second next to faba bean in terms of area coverage among pulse crops and ranks third as an export commodity in Ethiopia, contributing about 9.5% of the total export value from agriculture (Graeub et al., 2015). According to (CSA, 2016), the area covered by common bean production in Ethiopia was 113, 249.95 and 244,049.94 ha in 2016 production year for white and red common bean, respectively with the production of about 540,238.94 tons. The average white and red common bean productivity was 1.41 and 1.56 tons/ha, respectively.

Common beans productivity depends on good weather condition and the use of appropriate technologies (fertilizer, improved seed, and herbicide) with the recommended rate. Accordingly, the Ethiopian Institute of Agricultural Research (EIAR) in collaboration with other national and international partners have been working on development and promotion of improved common bean production technologies such as improved varieties and agronomic practices (fertilizer and other management options). However, information on production and costs-benefits on beans production at smallholder level is very scarce. Hence, this study gives valuable insights on input and output relationship for common bean production in CRV of Ethiopia. Therefore, the main objectives of this study are to, examines the economic viability (estimate bean production costs, output response to inputs) of common bean production.

Conceptual Framework

The conceptual frame of the study is presented in figure 1. Inputs such as farm size, labor, fertilizer use, oxen and amount of seed used greatly affect the output. This means that any change in the level of inputs used will result in changes in output.

MATERIALS AND METHODS

Description of the study area

The study was conducted in the Central Rift Valley (CRV) of Ethiopia, which is located between 38°00’-39°30’ E and 7°00’-8°30’ N covering about one million ha of land. The area has a bimodal rainfall distribution characterized by a short rainy season (Belg) in March and April and a long rainy season (Kiremt), which begins in May/June. The region receives an average annual rainfall of about 855 mm, varying across altitude. The average minimum and maximum temperatures are 14.6 % and 30.1% respectively.

Sampling and data collection procedures

A combination of purposive and random sampling procedures was used to select 31 households for this study. First, Boset, Dugda, and Shalla districts were selected based on the level of common bean production. Secondly, two *kebeles (Peasant Association)*, were selected from each district randomly: Kechachulla and Sara Arada (Boset), Shubi Gamo and Tuchi sumeya (Dugda), and Awara Gama and Lenca Leman (Shalla). Finally, 5-6 households were selected from each *kebele* using probability proportional to size sampling technique. Plot and household level input-output data were collected from sampled smallholder farmers with trained personnel using well-designed data collection formats. The data collection involved observation and record keeping. The cost of fertilizers, improved seeds, labor, oxen, and agrochemicals.

Data Analysis

The analysis is mainly based on primary data collected on the costs and returns associated with common bean production. The data were analyzed using descriptive statistics, and enterprise budget analysis method. The descriptive statistics involve the use of mean, percentages, and standard deviation.

Enterprise budget analysis

The estimate of the costs and returns associated with the production of a product or products is considered as an enterprise that can be defined as distinct part and analyzed separately based on some production input unit— an acre of land for most crop enterprise budgets, or an individual animal unit for livestock enterprise budgets (Smith et al., 2000). In our case the enterprise chosen was common bean and the unit of land was hectare. The procedure involves estimation of Gross return, costs, and gross-margin, break-even and sensitivity analyses as follows:

Gross Return

Gross return (GR) was calculated by multiplying the total volume of output by the average price in the harvesting period which is commonly used and given by the following formula:

$$GR = QP \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where GR is gross return from common bean production where Q is the quantity of maize produced per hectare (ha) and P is the average price of common bean in Ethiopian Birr per quintal.

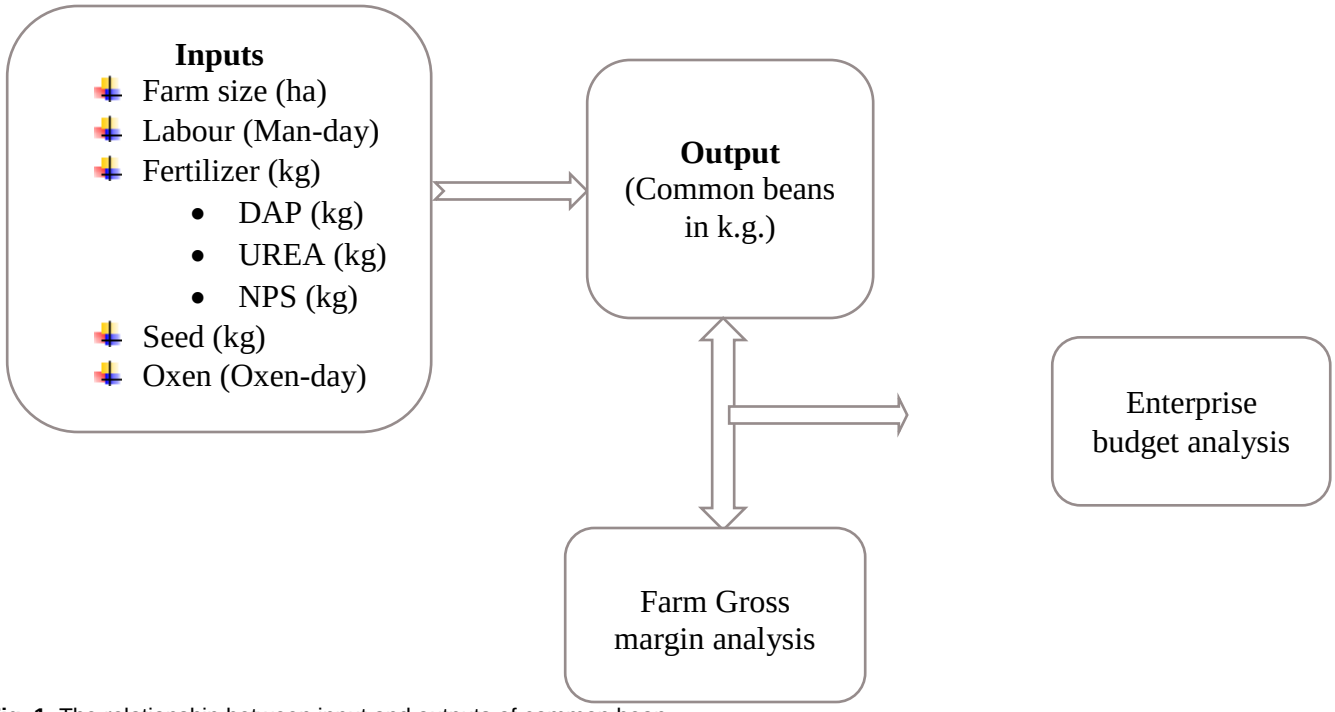


Fig. 1. The relationship between input and outputs of common bean.

Farm Gross margin analysis

Gross Margin analysis involves determining all variable costs and revenue associated with an enterprise. It provides a simple method for comparing the performance of common bean enterprises with maize that have similar input requirements for capital and labor (Heaslip et al., 2013). Gross margin analysis was used to estimate the profitability of common beans production. The difference between revenue and total variable costs is the gross margin for the enterprise (Leslie, 2013).

GM = TR – TVC…… (2)

Where, GM = Gross Margin (ETB/ha.),
TR = Total Revenue (ETB/acre),
TVC = Total Variable Cost (ETB/acre),

Rate of return is the net gain on investment over a specified time, expressed as a percentage of the investment's initial cost. The performance and economic viability of the farmers was determined by the use of the following profitability ratios:

Benefit-Cost Ratio (BCR) = TR/TC …… (3)

Rate of Return (ROR) = NR/TC…… (4)

Break-even analysis

Break-even analysis can be used to determine the minimum level of output (yield) that must be achieved at a given average market price. It is the point where sales and expenses are the same or when the sales of a farm are enough to cover the expenses of the business (Olagunju et al., 2007). The break-even formulas used in the analysis are:

$$\text{Break} - \text{even(Price)} = \frac{\text{Total Costs}}{\text{Total Production}}$$ …… (5)

$$\text{Break} - \text{even (Yield)} = \frac{\text{Total Costs}}{\text{Sale Price}}$$ …… (6)

RESULT AND DISCUSSION

Input use in common bean production

Table 1 show that the mean labor per hectare used for common bean production is 115 (person-day) showing it is the most costly input in the whole production process. The mean common bean seed rate used is 79 kg in the study area while 100 and 50 kg ha-^{1}of ammonium phosphate (DAP) and urea, respectively, were recommended to enhance productivity depending on the fertility status of soil. However, the respondents apply about 67 kg/ha DAP, 6 kgha-^{1} urea and 10 kgha-^{1}NPS (nitrogen, phosphorous and sulfur)total fertilizer rate of 83kg which is low compared to the maximum level of NPS rate 200-250 kg ha-1 (Deresa Shumi et al., 2018). This is common in Ethiopia as in many parts of Africa and some parts of Asia as smallholder farmers apply

Table 1. Input use in common bean production.

Inputs (ha)	Mean	Std.	Min	Max
Labor (Man-day)	115	60	43	119
Fertilizer (kg)	83	39	0	100
• **DAP (kg)**	67	38	0	100
• **UREA (kg)**	6	4	0	100
• **NPS (kg)**	10	7	0	100
Seed (kg)	79	26	40	100
Oxen (Oxen-day)	48	19	8	72

Author's Computation (2019).

lower rates of fertilizer than the recommended amount (Howard et al., 2013).

Major common bean production cost components

Farmers use mainly four types of inputs for common bean production, namely; labor, fertilizer, seed, and oxen rented. According to Leslie (2013), the estimated cost of labor used for family equals the prevailing wage rate of hired labor, which may influence the decision as to whether to grow the crop. Family labor was valued using the principle of opportunity cost and it was assumed that family labor served as a substitute for hired labor. Results of the cost analysis showed that labor was the major input accounting for 58.5% of the costs of common bean production (Fig. 2). Oxen draft power was the second most important input accounting for about 20.2% followed by fertilizer 13% and seed (10%) respectively. This may show the heavy reliance of smallholder farmers on human and oxen power.

Enterprise budget for common bean production in the CRV

The cost and return difference of white and red beans indicated in Fig. 3, the gross margin and gross return of red and white beans are highly increased in the outlay of real price of adjusted current production season than that of the nominal price (during the harvesting time of 2010 E.C). The gross margin of red beans by using nominal price is 9578 ETB/hectare whereas using the real price of adjusted price increased to 24341 ETB/hectare. Moreover, the gross margin and total revenue of red beans are greater than that of white beans in both nominal and real price, for the reason that of the total variable cost of white beans is greater than red beans.

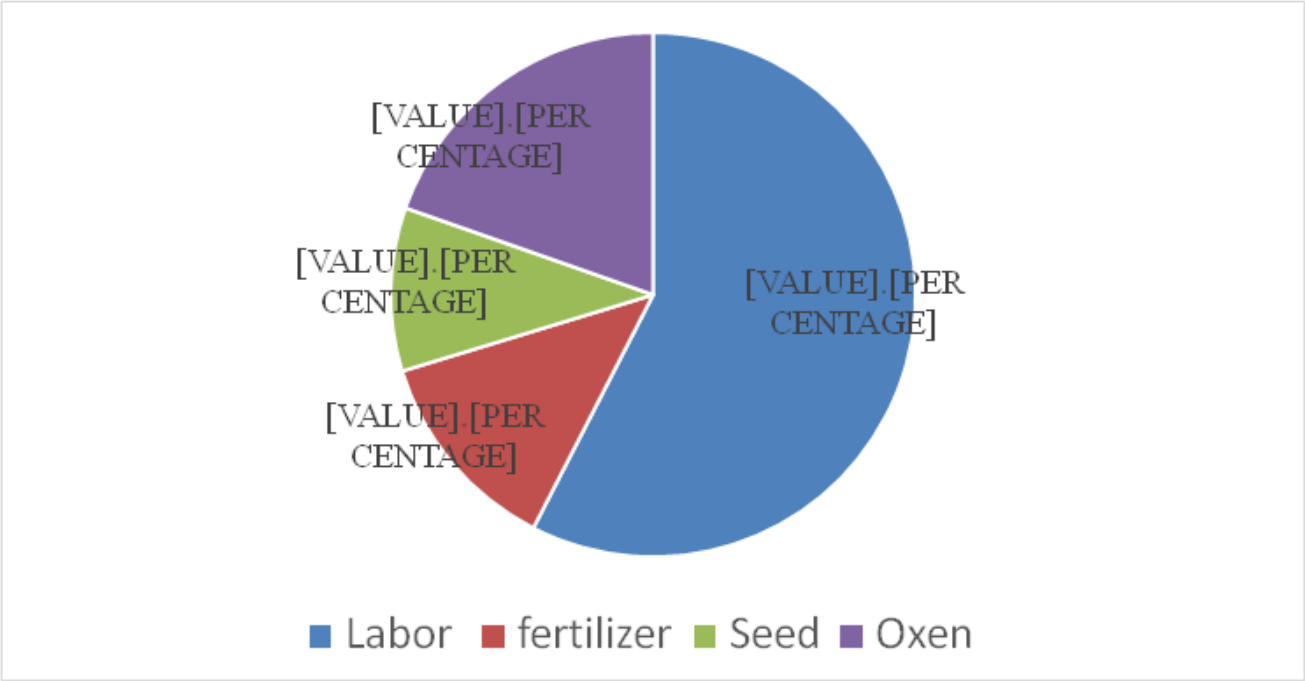
Profitability of Common Beans Production

Common bean is produced for multipurpose where the grain is used for consumption, sources of cash crop while the stalk is used mainly as livestock feed or for sale. The results in Table 2 shows that the average yield of common beans in the study area was about 18 Qt./ha which is lower than the national average (25 Qt./ha). Farmers obtained about 14017 and 1807 Ethiopian Birr (ETB) per hectare on average from common bean yield and common bean straw sales, respectively. A business is profitable and viable if and only if revenue is greater than the total variable cost, which makes the gross margin positive. The average gross margin obtained is very high considering the amount of investment. The average gross farm income among the respondents was found to be 15825 ETB per hectare. The total variable cost of common bean incurred by the respondents averaged to be ETB 9459.00/ha with a Gross Margin (GM) of ETB 6366.00/ha. The study also showed that labor cost was most responsive to the highest variable cost which is about 5444 ETB per hectare and, followed by the cost of oxen, fertilizer, and cost of seeds, respectively.

The break-even and return analysis

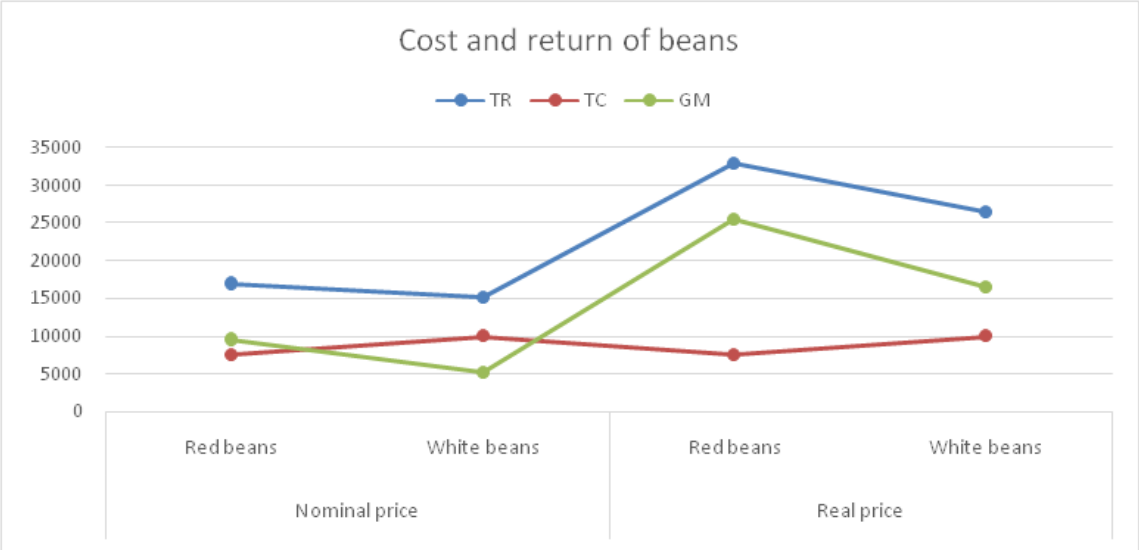
Results of break-even analysis showed that common bean production in the CRV is profitable even if there is a decline in yield up to 12.3 (qt./ha) price remaining constant, and the enterprise will be profitable up to a minimum price level of 525.5 ETB/qt. keeping yield constant. The benefit-cost ratio (BCR) was 1.67. An enterprise with a benefit-cost ratio greater than one, equal to one or less than one indicate profit, break-even, and loss, respectively (Olagunju et al., 2007). In this case, the ratio is greater than one indicating the

Fig. 2. Proportion (percentage) of cost of common bean production.



Author's Computation (2019).

Fig. 3. Cost and return difference of white and red beans.



Author's Computation (2019).

profitability of the enterprise. The rate of returns to common bean farming in the study area is 0.67 (67% return on the amount invested in common bean farming). However, it should be noted that all farmers did not use all inputs and that might have resulted in the lower cost of production. For instance, the households did not apply pesticide and 35.5 % of the farmers did not apply fertilizer in common bean production.

Sensitivity analysis

Analysis of all outcomes helps the management to make appropriate decisions for future planning. Production and market risks are related to the possibility that the yield or output levels will be lower than the projected. The sensitivity analysis is commonly used in the agriculture project cost-benefit analysis to

Table 2. Gross margin of common bean in the CRV.

Gross margin components (ETB ha^{-1})	Mean	STD	Minimum	Maximum
Yield (Qt./ha)	18	6	12	32
Price (Birr/Qt.)	767.7	212.0	500.0	4800
Yield- Revenue	14017	4300	7800	25600
Straw-Revenue	1807	957	400	3280
Gross return (Birr)	15825	4017	9400	26240
Variable costs				
Labor	5444	2681	2628	14410
Fertilizer	1206	535	0	2520
Seed	953	540	240	1700
oxen	1857	109	1560	2000
Total cost	9459	3017	5910	10225
Gross margin	6366	4088	110	18530
Benefit cost Ratio (BCR)	1.67			
Break-even Yield	12.3			
Break-even Price	525.5			
ROR (%)	0.67			
Return on labor	290.7			
Return to fertilizer	1312.1			
Return to seed	1660.7			
Return to oxen	852.3			

Note 1: Qt. (quintal) = 100 Kg

1 Ethiopian birr (ETB) = 0.04US$ in 2018

BCR=Benefit Cost Ratio=Net benefit/Costs that vary; ROR=Rate of Return

Author's Computation (2019).

Table 3. Sensitivity analysis of common bean production in CRV of Ethiopia.

Description	Base case	10% decrease in price	30% decrease in output price	10 % increase in variable cost	10% increase yield	30% increase in yield
Sale Price (Eth. Birr/kg)	767.7	690.93	537.39	767.7	767.7	767.7
Yield (kg/ha.)	1800	1800	1800	1800	1980	2340
Gross return (GR)	15825	14242.5	11077.5	15825	17407.5	20572.5
Variable costs (VC)	9459	9459	9459	10404.9	9459	9459
Gross margin (GM)	6366	5729.4	4456.2	5420	7002.6	8275.8
% change in GM		-11%	-43%	-17%	9%	23%

Author's Computation (2019).

assist forecast (Varlanuta et al., 2010). Table 3 displays the sensitivity analysis of common bean production in the central rift valley area. In this case, the risky scenarios to consider under this analysis include a 10% decrease in output price would cause an 11% decrease in gross margin while a 10% increase in yield would lead to a 9% increase in gross margin.

Likewise, as price decreases by 30%, the profitability of common bean production decreases by 43%, while 30% increase in yield increases the gross margin of the common bean production enterprise by 23%. The implication is that common bean profitability is highly sensitive to price decrease than to yield increment. The other scenario of the sensitivity analysis shows that 10%

increase in the cost of production, the gross margin of the common bean decreases by 17% from base case 6366 to 5420 ETB keeping other factors (yield and output prices) constant.

CONCLUSION AND RECOMMENDATIONS

The smallholders' common bean production is a promising and profitable enterprise in the study area even under the existing low productivity scenario. Cost-benefit analysis revealed that common beans production is profitable in the study area and contributes significantly in improving household nutrition, cash income and hence, playing important role in rural poverty reduction. However, the production and productivity is found to be below the potential. The result also shows that large number of farmers did not apply fertilizer in the study area as well as the rate of fertilizer application is low compared to the national average. The gross farm income obtained was high as the amount of revenue is greater than the total variable cost which makes the gross margin positive and an enterprise profitable and viable in the study area. Furthermore, the sensitivity analysis shows the return to common bean production is more market price sensitive than yield. Therefore, this study recommends that; smallholder farmers can enhance common bean productivity to the potential level than the current low input scenario using the recommended management practices such as fertilizers and rate, seed rate and weed management. The study also suggests that improving access to market and price information is important to encourage the use of improved technologies that enhance the production and productivity.

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