Profitability of Maize and Common Bean Production among Smallholder Farmers in Rift Valley of Ethiopia

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Abstract

Agriculture is a dominant economic sector and the engine of growth to promote the inclusive economic development in Ethiopia. Even though Ethiopia had sustained growth in maize and common production, their yields continue to be lower than the world's average. The study analyzed the profitability of smallholders' maize and common bean production in the Central Rift Valley of Ethiopia. A three-stage sampling technique was used to select 163 households (99 and 64 for maize and common bean, respectively). Plot level panel data generated annually from 163 observations using a well-structured questionnaire in three rounds. Descriptive statistics and gross margin analysis were used for the data analysis. Results of the gross margin analysis showed that the net-farm income for maize and common bean growers were found to be 20654 and 10317.7 Birr/ha, respectively. The average production cost of maize and common bean was 17857.7 and 15247.6 Birr/ha, respectively. The input-output ratios were 1:2.2 and 1:1.67 for maize and common beans, respectively. The result indicated that the lowland yield potential of maize in the area was 12.5 t/ha, implying that farmers realize only around 32.3% of that potential. Similarly, the national yield of common bean increased from 0.7 tons/ha in 2000 to 1.7 tons/ha in 2020. By reducing this prevailing yield gap, smallholders could increase their income approximately from 26,873 ETB (USD 770) to 83,167 ETB (USD 2383) per hectare. As productivity-enhancing understanding are introduced farmers attempts to increase farm productivity, which will lead to the increase of their farm income in the rift valley of Ethiopia.

Keywords: Profitability, maize and common bean, smallholder, gross margin, central rift valley.

Introduction

Agricultural production requires transforming the current paradigm of maximizing productivity to a new paradigm based on diversified agro ecological systems and focusing on simultaneously achieving economic, environmental, and social objectives (UNDP, 2020). Agricultural productivity depends on the use and availability of better agricultural technologies and practices. The demand for improved technologies, including improved seed and fertilizer, has increased in Ethiopia, which could maximize the productivity of farmland with new agricultural inputs (Sisay et al, 2017). Crop productivity remains very low relative to its potential yields in Ethiopia, only averaging 2.21 t/ha between 2010 and 2014 (World Bank, 2014). Agricultural production in

Ethiopia is characterized by subsistence orientation, low productivity, low level of technology and inputs use, lack of infrastructures and market institutions, and extremely vulnerable to rainfall variability (Urgessa Tilahun, 2014).

Productivity performance in the agriculture sector is critical to improvement in overall economic well-being in Ethiopia. The performance of crops in Ethiopian agriculture has been praiseworthy in recent years, and it is assumed that there is enormous potential for further productivity growth of crops, which is important to meet the growing demand and food deficits in the country (Mitik et al, 2016). The country has followed an agricultural production strengthening approach to boost crop productivity in the smallholdings through the application of improved agricultural inputs, primarily improved crop varieties, agronomic practices, and fertilizer technologies (Byerlee et al, 2007). The recent production growth is often attributed to area expansion; there is significant potential for increasing the productivity of food crops in Ethiopia through the introduction of promising crop technologies (Mitik et al, 2016).

The situation of maize and common bean production and productivity in Ethiopia

Maize is the largest and most productive crop in Ethiopia. So far, maize has grown in Ethiopia for direct consumption; however, with the growth of the income of the people, the demand for maize as feed and as an industrial raw material is increasing. The national average yield of maize increased from 1.6 tons/ha in 2000 to 4.3 tons/ha in 2020 as shown in Figure 1. In addition, the national average area of maize increased from 1,655,750 ha in 2000 to 2,274,306 ha in 2020 (FAOSTAT, 2021). Analysis of FAO data revealed that the growth rates in area cultivated, production, and yield were recorded between 2001 and 2020, the area under maize increased by 37.4 percent while a highly significant yield increased by 168.7 percent for maize in Ethiopia during the same period. Though subjected to annual variations, the overall area, yield, and production of maize in Ethiopia have shown an increasing trend during the past two decades.

Common bean is also the most important legume as the source of protein and export commodity. The enhanced common bean production can create opportunities for local value-added processing, stimulate domestic demand, and provide off-farm employment, sources of income, and an enriched diet for resource-poor and smallholder farmers (Getachew, 2019).

Hence, common bean productivity is constrained by a lack of high-yielding varieties, inadequate information about new production technology and insufficient basic agricultural inputs, and low utilization of appropriate

technology (Ronner and Giller, 2013). This may lead to low agricultural productivity per given inputs and reduces the potential for smallholder farmers to meet the growing demand by consumers (Mkonda and He, 2016). Common beans contribute to smallholder crop production, nutrition as a cost-effective source of protein accounting for about 15% of protein consumption, and income as a high-value crop being the third-largest export crop next to coffee and sesame (Getachew, 2019).

The finding of Katungi et al. (2019) showed that consequence of the liberalization and improvements in productivity, the majority of farmers responded by increasing the area under common beans but the use of productivity enhancing technologies, such as fertilizer and improved varieties remained low. Ethiopia's share of total common bean production was stagnant compared to global production while the total production showed a modest rise compared to East Africa (FAOSTAT, 2017). This implies the considerable potential to increase productivity by improving existing production and input use practices. Moreover, the average area of common beans increased from 218,940 ha in 2001 to 740053 ha in 2015 and declined to 281,083 ha in 2020 (Figure 1). However, the national average production of common beans increased from 147210 tons in 2000 to 485547 tons in 2020.

The performance of maize and common bean in Ethiopia compared with the major producing countries

The current performance of maize and common bean in Ethiopia compares favorably with the main maize and common bean producing countries (Fig. 2). In recent times, maize is grown throughout the world where United States, China, and Brazil being the top three maize-producing countries in the world (Ranum et al, 2014). Figure 2 shows that China and Brazil have by distant higher maize productivity than African countries. The same data showed that Ethiopia had better average productivity, which remained well above that of Kenya showing much change in maize productivity over the period (FAOSTAT, 2022). Ethiopia is the second-highest maize producer in Sub-Saharan Africa next to Nigeria (Assefa et al, 2020).

Maize production in Ethiopia increased from 1.8 t/ha in 2001 to 4.7 t/ha in 2020, over two decades on an upsurge at the rate of 161% (FAOSTAT, 2022). It is interesting to see that the increases in maize production in Ethiopia resulted more from increases in productivity rather than area expansion i.e., the yield grew faster than the area (FOA, 2020). The same data showed that Ethiopia had better average productivity of common bean, which remained well above that of Kenya showing much change in common bean productivity over the period (FAOSTAT, 2022). Common bean production in Ethiopia increased from 0.7 t/ha in 2001 to 1.7 t/ha in 2020, over two decades.

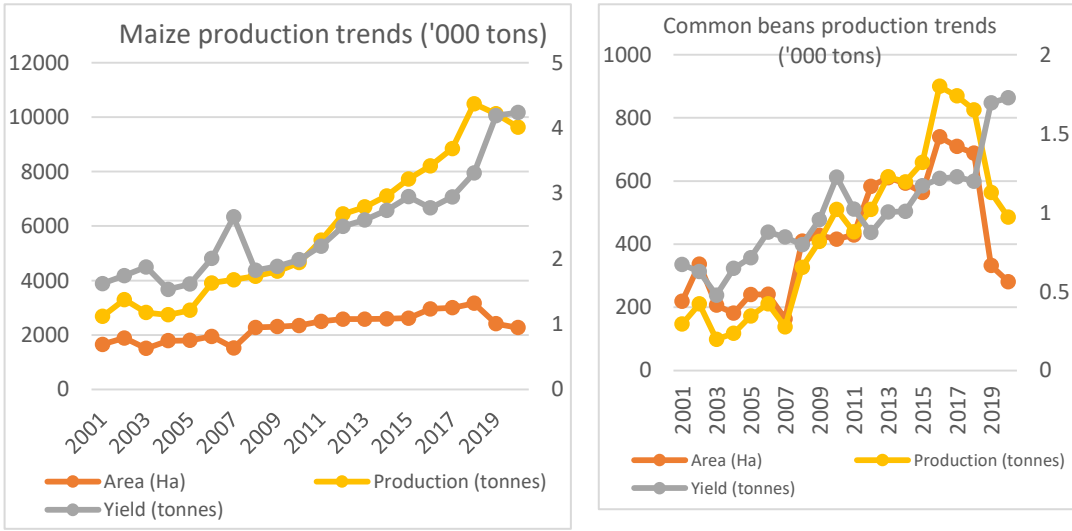

Figure 1: National maize and common bean production trends in Ethiopia 2001-2020 G.C.
Source: FAOSTAT (2021)

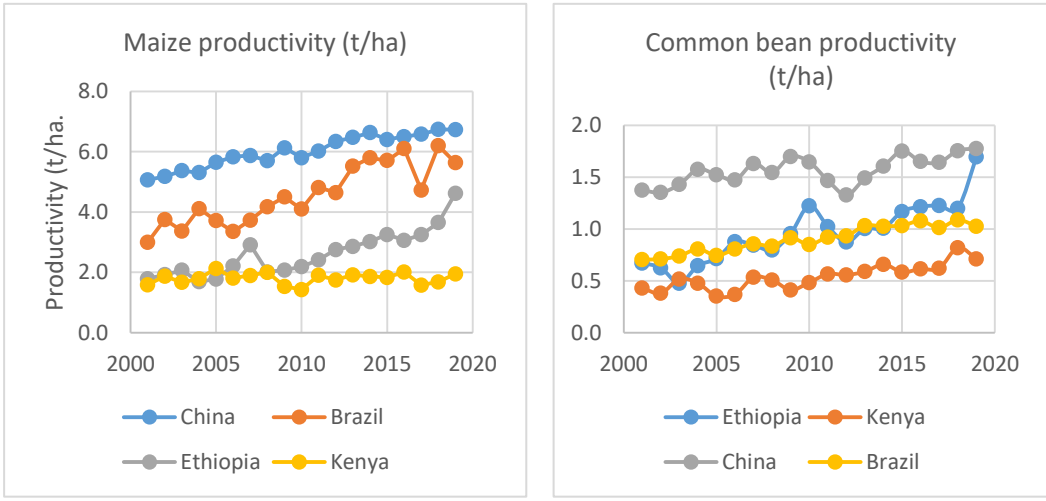

Figure 2. Maize and common bean productivity in Ethiopia compared with major producing countries
Source: FAOSTAT 2021)

Smallholder farmers have limited information on the profitability of common bean and maize in relation to the use of new technologies to enhance the production and profitability of maize and common beans (Venance et al. 2016). Therefore, addressing the knowledge gap will provide useful understanding and information to development planners, policymakers, and other stakeholders in the maize and common beans sector in solving the concerns of production economics as well as increasing income

generation and employment for smallholder farmers.

Over the past years, a lot of efforts, including the release and promotion of drought-tolerant and high-yielding varieties and crop-management practices, have been made through the research and extension system to enhance the productivity and production of maize and common bean in Ethiopia in general and in the central rift valley areas, in particular. However, these crops were not supported by economic information with respect to costs and benefits to smallholder farmers. This study was initiated to generate and provide information to policymakers, smallholder farmers, and other stakeholders on maize and common bean production costs and output responses to inputs to guide a successful farm business

Methodology

Description of the study area

The study site, Dugda, Shalla, and Boset districts are located in the central Rift Valley of Ethiopia. The area falls in the range of 1500-1700 meters above sea level. The rainfall conditions in the central Rift Valley exhibit high intra-seasonal variability with a coefficient of variation of 15 to 40% and a significant increase in temperature (0.12–0.54 °C per decade) over the past 30 years (Kassie et al, 2014). The main crop widely produced in the area are maize, tef, and common beans. Oxen are primarily kept as a source of draft power, while horses, donkeys, and mules are used for transportation and packing. Crop residues are the main source of feed for livestock, particularly during the dry season.

Sampling Technique

A three-stage sampling technique was used to select 163 households (99 and 64 for maize and common bean, respectively) for the study. First Dugda, Boset, and Shalla districts were selected based on current production status and potential of maize and common bean production in the central rift valley of Ethiopia. Secondly, two kebeles were selected from each district purposively. Finally, 5-6 households were selected from each kebele[1] using probability proportional to size sampling technique.

Data source and method of data collection

Plot-level panel data were collected for three consecutive production seasons for maize (2018-2020) and two production season for common bean (2019-2020) using a semi-structured questionnaire. The plot-level data consists of information on the intensity of input use (seed, inorganic fertilizer, human labor (person-day), oxen draft power (oxen-day) and agrochemicals for pest and weed control), farm

[1] The lowest administrative unit

management practice (such as plowing frequency, weeding, harvesting, etc.) and amount of yield.

Family labor was valued using the principle of opportunity cost and it was assumed that family labor served as a substitute for hired labor. Secondary data on the area and production of maize and common beans were also used to supplement the information collected through primary data. Due to differences in the number of inputs used and other factors, production costs can vary from farm to farm. Price shifts for inputs can also change production costs in both the short and long run. The data used to reflect the cost of purchased inputs and return to the farm was estimated using the average market price recorded during the cropping season.

Method of data analysis

This section estimates the costs and returns of smallholders' maize and common bean production on a per-hectare basis. The economic profit is defined to be the difference between the revenue a farm receives and the costs it incurs. The Total revenue (TR) is estimated as the prevailing market price of a given output (Py) multiplied by the quantity of output produced (Qy)and given as $(Py * Qy)$. Total revenue for residues are estimated quantity in quintal and multiplied by price at the local market specifically for livestock feed. Total variable costs is a summation of all input variable costs incurred by a given farm, and the variable input cost is estimated as the market price of a given input (Px_i) multiplied by the quantity of the input used (Qxi) and given as: $(Pxi * Qxi)$. Thus,$TVC = Pxi * Qxi$. The gross margin for each enterprise is calculated as:

$$GM = (Py * Qy) - Pxi * Qxi \dots\dots (1)$$

Net returns were calculated for each system by deducting the total cost of production from the total revenue of maize and common bean. The estimation was done as given below:

$$\begin{aligned} Net\ returns &= Total\ revenue \\ &- total\ cost\ of\ production. \\ &= PiQi \\ &- \sum (P1X1 \dots PnXn) \dots\dots (2) \end{aligned}$$

The performance and economic viability of the farmers were determined by the use of the profitability ratios:

$$Benefit - Cost\ Ratio\ (BCR) = \frac{NI}{TC} \dots\dots (3)$$

$$Input - output\ ratio\ (IOR) = GR/TPC (4)$$

Result and Discussion

Demographic and Socioeconomic Characteristics of maize and common bean producers

The average age of the maize and common bean growers in the CRV was about 47 years, while each family had at least 7 members (Table 1). The average age of the farmer was expected to affect his/her labour productivity and output. The average number of years of schooling (education) among sample household heads is six years. It implies that most of

the farmers had very few years of schooling. and own about 8 tropical livestock units. In addition, the mean farm size in the study area was 1.3 ha, which is insignificantly higher compared to the national average farm size of smallholders, which is about 0.9 ha (IFPRI, 2023).

Table 1. Demographic and Socioeconomic Characteristics (N=163)

Attributes	Mean	STD
Age of the household	47.3	26.0
Education level of the household	5.7	3.4
Total family size	7.4	3.4
Land holding (Ha)	2.3	1.1
TLU	7.9	6.1

Source: author's computation 2022

Yield performance of common crops ground grown in the CRV of Ethiopia

Among all major crops grown in the central rift valley of Ethiopia, maize still has the uppermost potential for additional yield gains (Figure 3). From 2019 to 2021, maize yield averaged 4.14 tones. compared to other major crops grown in the central rift valley of Ethiopia. The average wheat, common bean, and Tef yield per hectare are 2.93, 1.86, and 1.83 tones, respectively (figure 3). According to the Global Yield Gap Atlas (GYGA, 2019), the water-limited yield potential of maize and common bean in Ethiopia is on average 12.5 and 4.2 t/ha. This indicates that there is an option to boost the yield of maize per hectare at the small-scale level by further promoting improved varieties and management practices.

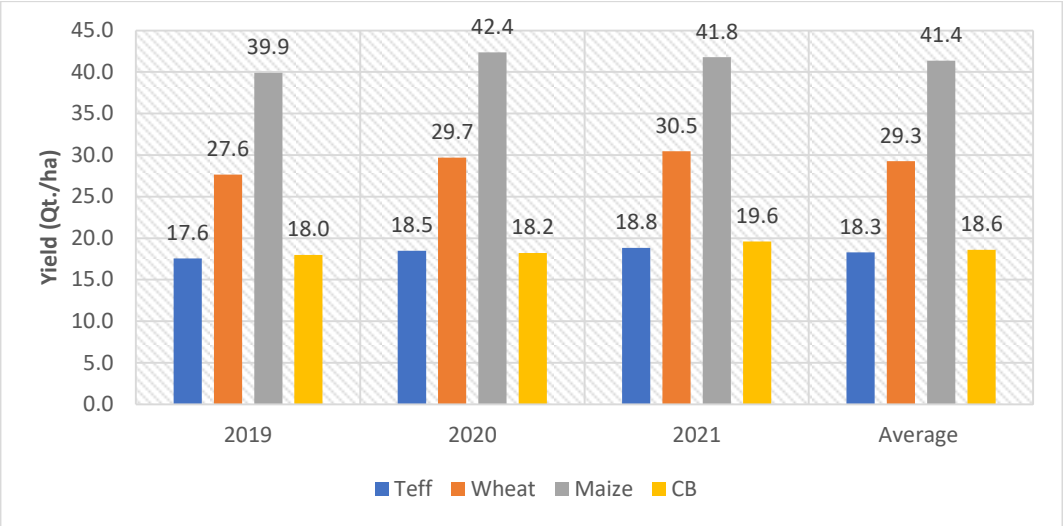

Figure 3. Performance of major crops grown in the CRV of Ethiopia
Source: Authors' computation, based on the CSA data

Major input used for Maize and Common bean production in the CRV of Ethiopia

Table 2 shows that the mean labor per hectare used of maize and common bean production were 90.5 and 84.5 (person-day), respectively and are the he highest inputs in the whole production. Fertilizer is one of the most important inputs to enhance productivity. However, the average fertilizer application of the farmers on maize was about 124.8 kg/ha (81 kg/ha. for DAP/NPS and 43.8 kg/ha, for UREA) which is lower than the national average of 200 kg/ ha (CIMMYT, 2017). However, depending on the fertility status of the soil, (DAP/NPS) 100 kg ha^{-1} and 50 kg ha^{-1} urea are required to enhance common bean productivity although farmers were found to apply 73 and 42 kg of NPS and UREA, respectively. This is common in Ethiopia as in many parts of Africa and some parts of Asia where smallholder farmers apply lower rates of fertilizer than the recommended rate even though fertilizer is strongly associated with higher yields (Howard et al., 2003).

Table 2. Maize and common bean input use, in CRV of Ethiopia (2018-2020)

Input Items (inputs/Ha.)	Maize							
	2018		2019		2020		Overall	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Labour (Person-days/ha)	98.5	15.3	89.2	25	83.9	30.4	90.5	23.6
DAP/NPS (Kg/ha)	85.9	20.6	72.4	28.6	85	40	81.1	29.7
UREA (Kg/ha)	18	5.6	68	22.4	55.4	26.7	43.8	18.2
Seed (Kg/ha)	28.4	9.3	24.2	4.6	30.6	16.1	27.7	10
Pesticides (Kg/lt./ha)	0.6	0.2	0.08	0.04	3.2	1	1.3	0.4
Oxen (Oxen days/ha)	56	17.5	59.7	16.2	33.2	20.7	49.6	18.1
Common bean								
Labour (Person-days/ha)	-	-	95.4	59.4	73.7	35.3	84.5	47.3
DAP/NPS (Kg/ha)	-	-	70.3	25.5	75.5	42.3	73	33.9
UREA (Kg/ha)	-	-	42	25.6	-	-	42	25.6
Seed (Kg/ha)	-	-	79.4	25.6	80.6	46.9	80.0	36.2
Pesticides (Kg/lt./ha)	-	-	-	-	2.5	1.4	2.5	1.4
Oxen (Oxen days/ha)	-	-	47.7	19.3	37.9	21.7	42.8	20.5

Source: author's computation 2022

Cost proportions of maize and common bean

Results showed that labor was the major input cost accounting for 32 and 30.6% of maize and common bean production costs, respectively (Fig. 4). Cost of land rent was the second most important input accounting for about 28.4 and 29.4% used for maize and common bean, respectively and followed by the cost of oxen draft power, fertilizer, cost of seed, and pesticides respectively. This shows the heavy reliance of smallholder farmers on human labor, rent of land, and oxen draft power. Just the use of family labor at such proportions explains the productivity advantage of smallholders. The more family members work on the farm, the higher productivity per hectare. The percentage of farmers' cost of improved seed and applied agrochemicals is very low for both crops and less than 10% (Fig. 4).

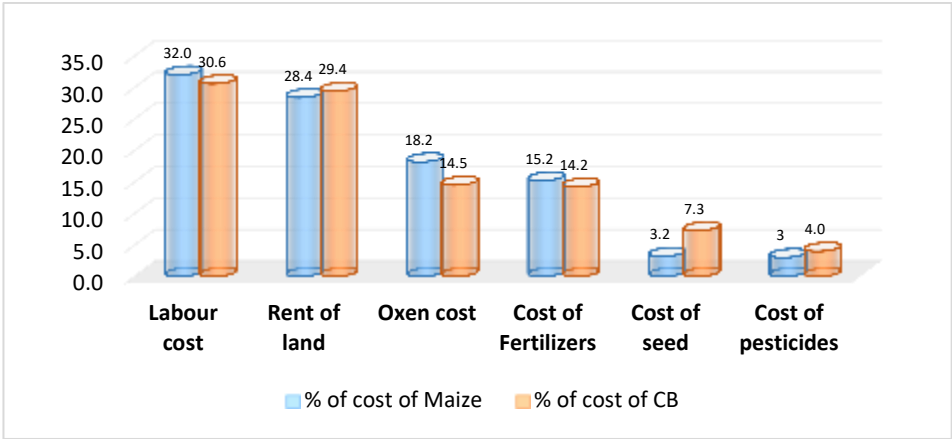

Figure 4. Cost proportion of maize and common bean
Source: Author's computation 2022

Incomes from maize and common bean production

The measurement of maize and common bean productivity was based on the concept of input-output relations. The average maize and common bean yield were recorded at 4.04 and 2.01 t/ha, respectively in the study area (Table 3), which is slightly lower than the national average yield of improved maize and common bean varieties, 4.2 and 2.5 tones ha^{-1}, respectively. According to the Global Yield Gap Atlas (GYGA, 2019), the lowland yield potential of maize in Ethiopia is on average 12.5 t/ha, implying that farmers realize only around 32.3% of that potential. It is estimated that, by bridging this yield gap into underlying demand with the highest current and potential yield from available inputs, smallholders could increase their income from approximately USD 770.2 per hectare to USD 2383. The value of farm production or gross income was calculated by multiplying the physical productivity obtained by the price shows that the selected maize and common bean growers in the central rift valley area on average gross income per hectare earned of ETB. 38511.7 & 25565.3, respectively (Table 3).

Costs and Returns of Maize and Common bean production

Table 4 depicts the average maize and common bean cost of production by smallholder producers in CRV of Ethiopia. Costs are displayed on a per hectare basis for the three growing seasons as well as for the annual average. The study conducted to determine the average per hectare spent on the total cost of production of maize and common bean, 17,858 and 15,248 ETB, respectively. On average, 5084.6 ETB per hectare is spent on maize production labor and other inputs.

Table 3. Maize and common bean productivity (2018-2020).

Crops	Return	2018		2019		2020		Average	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Maize	Average yield (Qt.)	32.5	11.4	42.7	21.2	46	25.6	40.4	19.4
	Average price	494.5	58.5	1103.6	577.7	949	617.8	849	418
	Grain Revenue	16071	666.9	47123.7	12247.2	43654	15815.7	34299.6	8109.2
	Straw Revenue	4311.3	1523.3	4458.7	970.8	3866.3	3558.1	4212.1	2017.4
	Gross Income	20382.3	2190.2	51582.4	13218.3	47520.3	19373.8	38511.7	10126.6
Common bean	Average yield (Qt.)	-	-	18.3	5.5	21.8	5.3	20.2	5.4
	Average price	-	-	767.7	212.0	1417.2	689.5	1092.5	450.7
	Yield Revenue	-	-	14017.5	1172.4	30958.7	3639.1	22488.1	2405.8
	Straw Revenue	-	-	1807.1	957.1	1347.3	832.4	1577.2	894.7
	Gross Income			15824.6	2129.5	32306.0	4471.5	25565.3	3300.5

Source: author's computation 2022
1 US$ = 27.6 (2018), 31.9 (2019) & 34.9 (2020) Ethiopian birr (ETB), respectively.

Accordingly, 1221.5, 803, 554, 539.3, 3248, 576.3, and 5830 were spent on NPS, UREA, improved seed, pesticides, oxen cost, transport, and land rent, respectively (Table 4). The study also showed that labor cost was most responsive for common bean growers to the highest variable cost, which is about 4970.2 ETB per hectare, followed by the cost of land, fertilizers, oxen, cost of seeds, and cost of pesticides respectively. Maize and common bean production require a high labor force to get a better harvest from this crop.

Table 4 shows that the selected maize growers, on average per hectare, earned during the study ETB. 20,654 on net farm income, ETB. 38,511.7 on gross income, and ETB. 17,857.7 on spending total production costs in the central rift valley of Ethiopia. Common bean growers earned ETB 25565.3 per hectare in total revenue, 10317.7 in net farm income, and 15247.6 in the total cost of production, and they reaped an input-output ratio of 1:2.2 and 1:1.67 from maize and common bean growing, respectively in the study area. This indicates that maize and common bean production is a productive enterprise for smallholder farmers in the CRV of Ethiopia.

Table 4. Descriptive statistics of the production costs and return of maize and common beans grain, central rift valley of Ethiopia (2018-2020)

Description of the cost (ETB)	Maize (N=99)		Common bean (N=64)	
	Mean (ETB ha^{-1})	SD	Mean (ETB ha^{-1})	SD
Labour cost	5084.6	1988	4970.2	1810.9
Cost of DAP/NPS	1221.5	425	1170.3	465.8
Cost of UREA	803.1	275.6	823.3	534.1
Cost of seed	554.2	298.0	1108.5	552.6
Cost of pesticides	539.3	470.5	620	34.7
Oxen cost	3248	884	1908.4	434.2
Cost of transport	576.3	261.5	163.6	74.5
Rent of land	5830.7	414.2	4483.3	690.0
Total production costs	17857.7	5016.8	15247.6	4596.7
Quantity harvested (Qt.ha^{-1})	40.4	19.4	20.1	5.4
Price (ETB)	849	418	1092.5	450.7
Revenue from crop sales	34299.6	8109.2	22488.1	2436.1
Revenue from residues	4212.1	2017.4	3077.2	2294.7
Total production revenue	38511.7	10126.6	25565.3	4730.8
Gross Margin (GM=GI-TVC)	26484.7	5524	14801	824.1
Net Farm Income (NFI=GI-TC)	20654	5109.8	10317.7	134.1
Input-output ratio (IOR)	2.2		1.67	
Break-even Yield	21		13.9	
Break-even Price	442		758.6	

Source: author's computation 2022

1 US$ = 27.6 (2018), 31.9 (2019) & 34.9 (2020) Ethiopian birr (ETB), respectively.

Description of production cost and returns for the varieties of maize grain enterprises

In view of hybrid and OPV varieties production as different enterprises, the analysis of the net income by maize variety type (Table 5) showed that, there was a significant difference between hybrid and OPV varieties that is ETB. 31308.3 and 27069.4 respectively. Hybrid maize producers had a higher net farm income and gross income compared to OPV producers. For instance, the yield and total production revenue of the hybrid maize varieties were significantly higher than that of OPVs at 5%. The Gross margin of maize production was found that hybrid maize growers received a higher gross margin which was (35692.5 ETB/ha), whereas the gross margin of OPV maize growers who seem to be lower (31269.42 ETB/ha).

Table 5. Description of the production costs, revenue, and net farm income of maize grain.

Description of the cost (ETB)	Maize (N=99)				
	Hybrid (N=69)		OPV (N=30)		T-test
	Mean	SD	Mean	SD	
Quantity harvested (Qt.ha^{-1})	41.1	11.7	38.4	14.5	1.51**
Price (ETB)	985.3	101.2	931.8	71.7	0.84
Revenue from crop sales	40495.8	1184.04	35781.12	1039.65	1.53**
Revenue from residues	6779	2490	6782	8741.8	-0.14
Total production revenue	47274.8	3674.04	42563.12	9781.45	1.24**
Labour cost	4466.2	2526.5	4390.9	2181.5	1.41*
Cost of DAP/NPS	1043	444.3	1318.8	829.7	-1.05
Cost of UREA	685.5	334.2	454	206.5	1.14
Cost of seed	859.6	304.8	656.7	407.5	1.53*
Cost of pesticides	60	20	0	0	0
Oxen cost	3780	1167.9	3800	987	0.94
Cost of transport	688	274.7	673.3	299.7	1.72
Rent of land	4384.2	346.8	4200	657.3	4.43
Total production costs	15966.5	5419.2	15493.7	5569.2	0.36
Gross Margin (GM=GI - TVC)	35692.5	601.64	31269.42	4869.55	1.83*
Net Farm Income	31308.3	254.84	27069.42	4212.25	1.42*
Benefit cost ratio (BCR)	2		1.7		
Input-output ratio (IOR)	3		2.7		
Break-even Yield	16.2		16.6		
Break-even Price	388.5		403.5		

Source: author's computation 2022
1 US$ = 27.6 (2018), 31.9 (2019) & 34.9 (2020) Ethiopian birr (ETB), respectively.

Description of production cost and returns for the types of common bean

Considering the white and red beans as different enterprises, the analysis of the total product revenue and net farm income of the white bean varieties were significantly higher than that of red beans at 5% (Table 6). The study showed that there was a difference between white and red bean varieties that is 30600.6 and 22461.3 ETB/ha, respectively. For instance, the price and production revenue of the white bean varieties were significantly higher than that of red beans at 1% and 5%, respectively. White beans producers had a higher net farm income and gross income compared to red beans producers 35083.9 ETB/ha) while the gross margin of red bean growers seems to be lower (25944.7ETB/ha). The result of the cost-benefit ratio and input-output ratio in the overall enterprises was that the variety of the white bean was highest compared to the red bean variety. The input-output ratio of white beans is higher than red beans 1:3.1 and 1:2.8 respectively. However, the return to the major inputs was higher for white beans compared to red beans. This implies the need to promote an enterprise that had better returns
for the farmers in CRV of Ethiopia.

Table 6. Description of the production costs, revenue and net farm income of Common beans

Description of the cost (ETB)	Maize (N=99)				
	Hybrid (N=69)		OPV (N=30)		T-test
	Mean	SD	Mean	SD	
Quantity harvested (Qt.ha-1)	41.1	11.7	38.4	14.5	1.51**
Price (ETB)	985.3	101.2	931.8	71.7	0.84
Revenue from crop sales	40495.8	1184.04	35781.2	1039.65	1.53**
Revenue from residues	6779	2490	6782	8741.8	-0.14
Total production revenue	47274.8	3674.04	42563.2	9781.45	1.24**
Labour cost	4466.2	2526.5	4390.9	2181.5	1.41*
Cost of DAP/NPS	1043	444.3	1318.8	829.7	-1.05
Cost of UREA	685.5	334.2	454	206.5	1.14
Cost of seed	859.6	304.8	656.7	407.5	1.53*
Cost of pesticides	60	20	0	0	0
Oxen cost	3780	1167.9	3800	987	0.94
Cost of transport	688	274.7	673.3	299.7	1.72
Rent of land	4384.2	346.8	4200	657.3	4.43
Total production costs	15966.5	5419.2	15493.7	5569.2	0.36
Gross Margin (GM=GI - TVC)	35692.5	601.64	31269.42	4869.55	1.83*
Net Farm Income	31308.3	254.84	27069.42	4212.25	1.42*
Benefit cost ratio (BCR)	2		1.7		
Input-output ratio (IOR)	3		2.7		
Break-even Yield	16.2		16.6		
Break-even Price	388.5		403.5		

Source: author's computation 2022

1 US$ = 27.6 (2018), 31.9 (2019) & 34.9 (2020) Ethiopian birr (ETB), respectively.

Sensitivity Analysis

Table 7 displays the sensitivity analysis based on the ranges of fluctuations around the value of a specific benefit/cost item of the farm enterprise, which captures its impact on the intended built-in financial or economic output indicator of the farm and helps to find the appropriate mitigation measures. Through sensitivity analysis, which is a deterministic analysis, we identify the critical variables. Critical variables are those variables whose small fluctuations within a specific pre-defined range cause a substantial deviation of the development output such as the farmers' net income from their base-case results.

Maize: With the base case, the farmers' net income increases by an estimated ETB 16,020 per hectare. Under maize cultivation per hectare per farmer, an increasing the yield by 10% will result in the farmers getting an additional ETB 2,395 from the base case amount. A 25% increase in the market price of maize leads to ETB 6,722 and 9.4% additional increase in the farmers' net income and profit margin per hectare, respectively. A 25% reduction in all input costs increases the farmers' net income to increase by ETB 3,117 (11.6% profit margin increment on the base case scenario).

Common bean: In the base case, farmers' net income increases by an estimated ETB 8,003 per hectare. If the market price increase by 25% then the incremental farmers' net income per hectare will increase by ETB 3,846 (9.7% profit margin more than the base case). For the recommended best agronomic practices, a 10% increase in the change in expected yield per hectare results in the incremental farmers' net income rising by an additional ETB 1,292 above the base case amount. If all input cost decreases by 25%, the farmers will gain an additional ETB 2,966.5 above the base case amount.

Table 7. Sensitivity analysis of uncertain variables on gross and net farmers' income (ETB/ha.)

Scenarios	Sensitivity	Maize		Profit	Common bean		Profit margin
		GR	NI	margin (%)	GR	NI	(%)
Base case scenario	%	38511.7	20654	53.6	25565.3	10317.7	40.4
Change in expected yield	10%	41941.6	24084	57.4	27232.4	11984.8	44.0
	-10%	35081.7	17224	49.1	22840.5	7592.93	33.2
Change in market price	25%	48139.6	30281.9	63	30526.3	15278.7	50.1
	-25%	29936.8	12079.1	40.3	19546.6	4299.04	22.0
Change in all input cost	25%	38511.7	16189.6	42.0	25565.3	6505.8	25.4
	-25%	38511.7	25118.4	65.2	25565.3	14129.6	55.3
Change in total production revenue	10%	42362.9	24505.2	57.8	28121.8	12874.2	45.8
	-10%	34660.5	16802.8	48.5	23008.8	7761.17	33.7
Change in labor costs	10%	38511.7	20145.5	52.3	25565.3	9820.68	38.4
	-10%	38511.7	21162.5	55.0	25565.3	10814.7	42.3

Source: author's computation 2022

Conclusion and recommendations

This study was conducted to investigate the profitability of maize and common bean analysis in the central rift valley of Ethiopia. Productivity remains below potential due to low input usage and primarily on-farm; national maize and common bean rates are low of harvest when prices are lowest due to farmers' cash needs and smallholders are vulnerable as producers. Thus, based on the present finding from the net return and margin analysis maize and common bean production is a promising and profitable enterprise in the study area even under the existing low productivity scenario. In statement, it is supposed that maize and common bean production in the rift valley of Ethiopia are intensified; it is likely that yield will increase beyond the current levels, and this is likely going to influence food security in the region.

It is therefore important that, along with efforts to improve agricultural productivity, agricultural activities are given due attention as the latter will need to absorb surplus labor and reduce rural underemployment and unemployment. Going forward, all stakeholders in maize and common bean production must consider empowering farmers such that they can have access to more sustainable intensive farming options rather than depending mostly on harvest area expansion. Ensure smallholder farmers access and use inputs at affordable price and at right time. Using improved farm inputs will facilitate farmers to adopt technology and able to increase farm productivity and production which will lead to an increase in their farm income and profitability The study, therefore, suggests that policy focused towards wider adoption of improved technologies with recommended practices by smallholder farmers would bring maize and common bean profitability to a higher level than the current low input scenario in the central rift valley of Ethiopia.

References

Assefa BT, Chamberlin J, ReidsmaP, Silva JV, Ittersum MK (2020) Unravelling the variability and cause of small holder maize yield gaps in Ethiopia. Food Security 12: 83-103.

Byerlee, D. Spielman, D. Alemu, and M. Gautam (2007). Policies to Promote Cereal Intensification in Ethiopia a Review of Evidence. IFPRI Discussion Paper.

CIMMYT, 2017. Fertilizer application on maize in Ethiopia. Report 2017.

CSA (2012). Agricultural Sample Survey 2010/2011 (2004 Ethiopian Calendar). Report on Area and Production of major Crops (Private Peasant Holdings Main Season), Central Statistical Agency (CSA). Vol. IV, P. 58, Addis Ababa.

E. Katungi, D. Horna, S. Gebeyehu and L. Sperling (2019). Market access, intensification and productivity of common bean in Ethiopia: A microeconomic analysis. International Scholars Journals, Vol. 7 (3).

FOA (2020) Food and Agriculture Organization of the United Nations country Ethiopia. FOAUN.

FAOSTAT. (2017). Statistical databases and data sets of the Food and Agriculture Organization of the United Nations at **www.fao.org.**

FAOSTAT. (2021). Statistical databases and data sets of the Food and Agriculture Organization of the United Nations at **www.fao.org**.

FAOSTAT. (2022). Statistical databases and data sets of the Food and Agriculture Organization of the United Nations at www.fao.org.

IFPRI, (2023). Changing farm sizes and farmers' demographics in Ethiopia. DOI : https://doi.org/10.2499/p15738coll2.136703.

GYGA, 2019. Global Yield Gap Atlas (2019)

Howard, J., E. Crawford, V. Kelly, M. Demeke, and J. J. Jeje. 2003. Promoting high-input maize technologies in Africa: the Sasakawa-Global 2000 experience in Ethiopia and Mozambique. Food Policy 28: 335–348.

Lulit Mitik Beyene, Bekele Shiferaw, Amarendra Sahoo, Sika Gbegbelegbe (2016). Economy-wide impacts of technological change in food staples in Ethiopia: A macro-micro approach working paper 2016-17, August 2016.

Kassie, B.; Rötter, R.; Hengsdijk, H.; Asseng, S.; van Ittersum, M.; Kahiluoto, H.; van Keulen, H. Climate variability and change in the Central Rift Valley of Ethiopia: Challenges for rainfed crop production. *J. Agric. Sci.* 2014, *152*, 58–74.

Mkonda, M. Y. and Xinhua, He. (2016). Production Trends of Food Crops: Opportunities, Challenges and Prospects to Improve Tanzanian Rural Livelihoods. Natural Resources and Conservation, 4(4): 51-59.

Ranum, Peter, Juan Pablo Peña-Rosas, and Maria Nieves Garcia-Casal. "Global maize production, utilization, and consumption." Annals of the new York academy of sciences 1312.1 (2014): 105-112.

Ronner, E. and Giller, K. E. (2013). Background information on agronomy, farming systems and ongoing projects on grain legumes in Tanzania. Africa Milestones. Accessed, 17: 09-13.

Sisay, D.T.; Verhees, F.J.; van Trijp, H.C. Seed producer cooperatives in the Ethiopian seed sector and their role in seed supply improvement: A review. *J. Crop Improv.* 2017, *31*, 323–355.

Venance, S. K., Mshenga, P. and Birachi, E.A. (2016). Factors Influencing on-Farm Common Bean Profitability: The Case of Smallholder Bean Farmers in Babati District, Tanzania. Journal of Economics and Sustainable Development ISSN 2222-1700 (Paper) Vol.7, No.22, 2016.

UNDP (2020). Food & Agricultural Commodity Systems Strategy 2020-2030.

Urgessa Tilahun (2014). Review of Challenges and Prospects of Agricultural Production and Productivity in Ethiopia.

World Bank, 2014. World Development Indicators. http://data.worldbank.org/.