

## Analysis of Cost and Return of Soybean Production Under Small Holder Farmers in Pawe District, North Western Ethiopia

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### Abstract

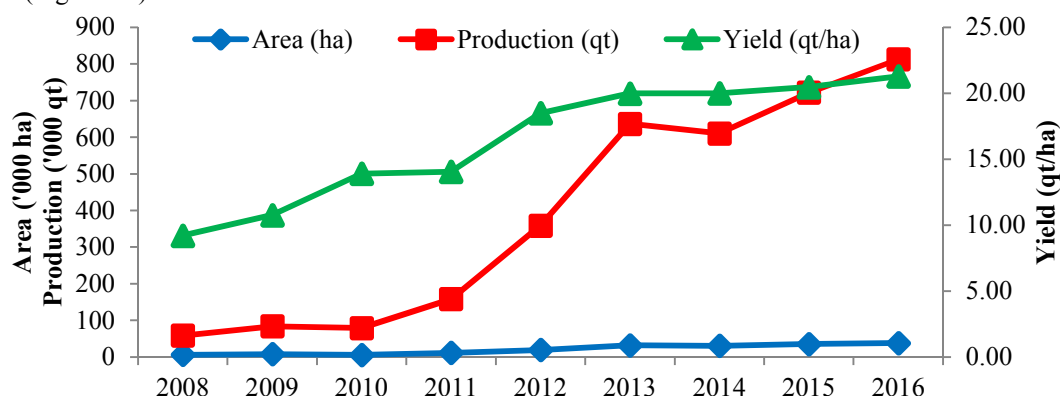
This study aimed at identification and estimation of cost components of soybean production as well as assessing its profitability under small holder farmers. Descriptive method and enterprise budget were used to analyse data collected directly from field records of selected farmers. Results of descriptive analysis indicate that soybean production involved mainly human labor and contribution of female farmers was lower than male but more during weeding. The enterprise budget analysis depicted that sampled farmers obtained gross margin of Ethiopian birr 2025.36 per hectare from soybean production and the gain is statistically significant at 1% level. Moreover, benefit cost ratio of 1.46 was obtained. Sensitivity analysis considering a 10% change in grain price, yield and total variable cost of soybean resulted in higher sensitivity of gross margin due to change in grain price and yield than total variable cost. Thus, the benefits from soybean production indicate that soybean production is a profitable business and it could be enhanced and soybean production could be more attractive through promoting technology packages that improve soybean yield and reduce price volatility like market information system and group marketing.

**Keywords:** Soybean, Gross margin analysis, Sensitivity analysis, Pawe district

### Introduction

Soybean is gaining ground globally due to its multipurpose use as human food, livestock feed, industrial purposes, and more recently, as a source of bio-energy (Myaka *et al.*, 2005). Unlike most other beans it contains 40% protein compared to 20% and 13% protein content in meat and egg, respectively (Greenberg and Hartung, 1998). It also contains 20% non-cholesterol oil and its fortified products are considerably cheaper than other sources of high quality protein. It is the primary source of edible oil globally with the highest gross output of vegetable oil among the cultivated crops with total cultivated area of 117.7 million ha and total production of 308.4 million tons (FAOSTAT, 2015).

Though it is a recent introduction in Ethiopia, records obtained for the period 2008 through 2016 indicate that area, production and yield of soybean have grown very fast at a rate of 30.8%, 45.4% and 11.2% per annum respectively and reached 38,166 ha of land to produce 812,420 quintal of soybean with national average yield of 21.3 qt/ha (Figure - 1).



**Figure 1: Trends in area, production and yield of soybean in Ethiopia**

The current five-year plan, GTP II, has given due consideration for soybean production as industrial crop and its production is expected to increase from 0.72 million quintals in 2015 to 1.2 million quintals by the year 2020 to meet the demand of the market by creating a linkage with the industry and export market (GTP II, 2015). Since it is well adapted to lowland to mid altitude agro-ecologies of the country where most of the potential arable land is found achieving this target is likely mainly in the important soybean growing parts of the country including Western, South western, Southern and North-western parts of the country. The entire low to mid altitude maize belt areas of the country are also suitable for soybean production. Moreover, Ethiopia's strategic location closer to

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the world's largest consumers of soybean and soybean products is also a feature which makes it good opportunity for the country to target soybean as potential export commodity and import substitution in addition to farmers' preference of the crop for soil fertility management. The realization of all these potentials and targets are expanding soybean production vertically and horizontally without adequate understanding of its production economics. Accordingly, this research project aimed at identification and estimation of production costs and its components as well as assessing the profitability of soybean production under small holder farmers condition in the major soybean production area of the country namely Pawe district in 2016.

## Methodology

### Description of the study area

This study was conducted in Pawe district, Metekel zone Benishangul Gumuz region which lies between 36° 20'-36° 32'- longitude and 11° 12'- 11° 21' north latitude and altitude of 1100 m.a.s.l. (Figure - 2). It covers an area of 63,400 hectare with estimated population of 59,127 (50.76% male) inhabitants (CSA, 2013). The area experiences a temperature ranging from 19.40°C to 37.6°C temperature and an annual rain fall of 1186 to 1977 mm. The farming system of Pawe district is characterized by mixed crop-livestock farming system dominated by cereals (PARC, 2010).

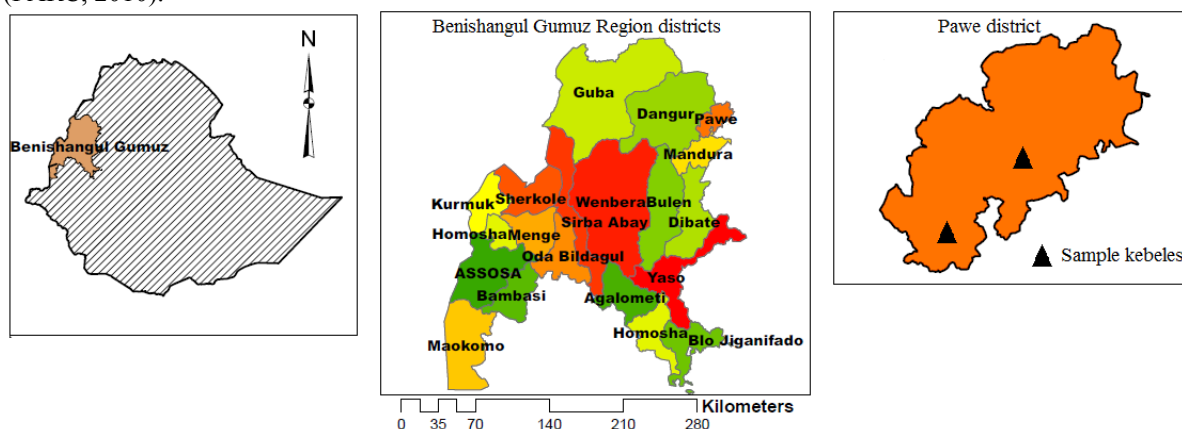


Figure 2: Geographical location of Pawe district

### Data and analysis

From the population of all soybean growing farmers in Pawe district two major soybean producing *kebeles* were selected purposively. Then 26 farmers from one kebele (*village-1*) and 18 farmers from the other kebele (*village-30*) were randomly selected based on proportionate to size. Data was collected from both primary and secondary sources and the primary data were generated using farm record sheets by extension workers with regular supervision. The secondary data were collected from Pawe Agricultural Research Center (PARC) and Central Statistical Agency (CSA). The collected data was then analyzed using descriptive statistics such as mean, standard deviation, frequency and percentages as well as gross margin and sensitivity analysis.

### Gross Margin Analysis

Gross margin analysis was employed to better understand the relationship between sales revenue and cost structures (Kay, 1986) and assess profitability of soybean production to enable informed decision making. The Gross Margin analysis of soybean used to estimate the costs, returns, profitability or loss per hectare is given by the following relationships:

$$GM = TR - TVC$$

Where, GM is Gross Margin, TR is Total Revenue and TVC is Total Variable Cost. The total revenue represents the value of the output from the farm multiplied by the prevailing market price. Total variable cost is specific cost that varies directly with the level of production and includes expenditure on seeds, fertilizer, chemical, labor etc.

### Analysis of mean difference (Paired t - test)

Paired *t* - test used to observe difference in means of TR and TVC. The statistic used to test the hypothesis that the mean difference between TR and TVC is zero is

$$t = \frac{\bar{D}}{SD/\sqrt{N}}$$

where  $\bar{D}$  is the observed difference between the two means, in this case GM, and  $S_D$  is the standard deviation of the differences of the paired observations (TR and TVC).

### Sensitivity Analysis

A sensitivity analysis was undertaken to assess the stability of gross margins of soybean production under varying situations. The grain price, yield and TVC of soybean were subjected to reduction by 10% and to increase by similar percent then new gross margins computed separately against each assumption to evaluate the resultant scenario.

## Results and Discussion

### Socioeconomic Characteristics of sample farmers

Most of the sampled farmers were male headed households (95.45%) and about 39% of them were illiterate, 38.64% attended at least primary education and above while the remaining 22.73% were capable of reading and writing (Table 1).

**Table 1: Socioeconomic characteristics of soybean producer sample farmers**

Particular	Frequency	Percent
<b>Sex</b>		
Male	42	95.45
Female	2	4.55
<b>Total</b>	<b>44</b>	<b>100.00</b>
<b>Education level</b>		
Illiterate	17	38.64
Able to read and write	10	22.73
Primary school (1 <sup>st</sup> – 4 <sup>th</sup> grade)	2	4.55
Junior school (5 <sup>th</sup> – 8 <sup>th</sup> grade)	10	22.73
Secondary school (9 <sup>th</sup> – 12 <sup>th</sup> grade)	5	11.36
<b>Total</b>	<b>44</b>	<b>100.00</b>

Source: Farm level survey data

The average age of the household head was 42 years with total family size of about 6 people and 22 years of farming experience with average total land holding was 3.1 hectares. The total cultivated land was 2.37 hectare of which on average 0.83 hectare allocated for soybean production. The sampled farmers also owned, on average, 6.78 TLU<sup>1</sup> of livestock (Table 2).

**Table 2: Summary statistics of sample soybean producer farmers**

Variable	Mean	Std. Dev.	Min	Max
Age of head ( <i>years</i> )	41.98	10.54	25.00	70.00
Farming experience ( <i>years</i> )	21.74	9.65	3.00	50.00
Family size ( <i>no.</i> )	5.95	2.10	1.00	10.00
Total land holding ( <i>ha</i> )	3.10	1.96	0.00	11.50
Land cultivated ( <i>ha</i> )	2.37	1.03	0.25	6.50
Soybean land area ( <i>ha</i> )	0.83	0.58	0.25	4.00
Livestock ownership ( <i>TLU</i> )	6.78	5.63	0.00	35.20

Source: Farm level survey data

### Soybean production

Majority of the sample farmers (31.82%) cultivated half a hectare, while 27.27% cultivated a hectare and about 22.73% of farmers cultivated 0.75 hectare of soybean from the total cultivated land during the main (*Meher*) production season of year 2015/16. Majority of them (90.91%) also attained soybean yield of less than 20 quintal/hectare which was less than the national average of 21.29 qt/ha (Table 3).

<sup>1</sup>Tropical Livestock Unit

**Table 3: Distribution of area under soybean and attained soybean yield by sample farmers**

Soybean area (ha)	Frequency	Percent	Cumulative Frequency
0.25	4	9.09	9.09
0.5	14	31.82	40.91
0.75	10	22.73	63.64
1.00	12	27.27	90.91
1.25	1	2.27	93.18
1.5	1	2.27	95.45
1.75	1	2.27	97.73
4	1	2.27	100
<b>Total</b>	<b>44</b>	<b>100.00</b>	

Source: Farm level survey data

### Cost of Soybean Production

Soybean production in Pawe district involves different farming activities. Table 4 depicts that threshing, harvesting, land preparation and weeding were the major cost components of smallholder farmers soybean production in increasing order. Soybean producing sample farmers have incurred highest operational cost of ETB<sup>1</sup> 3945.44 of which weeding, including both the first and the second weeding, took the lion's share of 31.63% followed by harvesting (18.33%), land preparation (17.21%) and threshing (15.43%).

**Table 4: Operational cost of soybean production**

Type of Expenses	% of farmers incurring the cost	Mean (ETB)	Std. Dev (ETB)	% of Total operational cost
Land clearing	59.09	124.78	279.21	3.16
Chemical application	38.64	80.37	24.12	2.04
First ploughing	100.00	308.52	168.18	7.82
Second ploughing	47.73	224.39	277.83	5.69
Third ploughing	6.82	21.36	86.20	0.54
Sowing	100.00	257.56	270.10	6.53
Hoeing	11.36	109.55	362.74	2.78
First weeding	100.00	1087.04	626.16	27.55
Second weeding	20.45	160.91	380.67	4.08
Harvesting	100.00	723.19	410.18	18.33
Dumping	93.18	238.88	151.16	6.05
Threshing	100.00	608.89	235.70	15.43
<b>Total</b>		<b>3945.44</b>	<b>1436.93</b>	<b>100.00</b>

Source: Farm level survey data

Table 5 provides the cost structure of sex disaggregated labour across the different farming activities. Accordingly, weeding was observed to employ higher labour (30.61%) followed by threshing (19.18%) and harvesting (14.62%) from the total of 79.27 man-days labour used. The labour contribution of female farmers was relatively lower than that of males and the difference is statistically significant ( $t = -5.887, P < 0.01$ ).

The material expenses of soybean production pertaining to seed, fertilizer and chemical was ETB 491.01 which contributed only about 11.1% of TVC. The cost incurred towards seed was higher than the other cost components. Only 2.27% of the sample farmers used fertilizer while 38.6% used chemical (Herbicide) for soybean production (Table - 6).

<sup>1</sup>Ethiopian birr

**Table 5: Soybean farming activities human labour in Pawe district**

Farming activity	Labour used (Man-days)			Share from total labour
	Male	Female	Total	
Land clearing	3.75 (0.86)	0.61 (0.14)	4.36	5.5
Chemical application	1.5 (0.67)	0.74 (0.33)	2.24	2.83
First ploughing	3.72 (0.97)	0.13 (0.03)	3.85	4.86
Second ploughing	2.14 (0.66)	1.12 (0.34)	3.26	4.11
Third ploughing	0.1 (0.56)	0.08 (0.44)	0.18	0.23
Sowing	3.57 (0.60)	2.34 (0.40)	5.91	7.46
Hoeing	1.61 (0.60)	1.1 (0.41)	2.7	3.41
First weeding	13.48 (0.61)	8.46 (0.39)	21.94	27.68
Second weeding	1.71 (0.74)	0.61 (0.26)	2.32	2.93
Harvesting	9.96 (0.86)	1.63 (0.14)	11.59	14.62
Dumping	4.66 (0.82)	1.04 (0.18)	5.71	7.2
Threshing	12.23 (0.80)	2.99 (0.20)	15.21	19.18
<b>Total</b>	<b>58.43 (0.74)</b>	<b>20.85 (0.26)</b>	<b>79.27</b>	<b>100</b>

Source: Farm level survey data

Figures in parenthesis indicate proportion from total

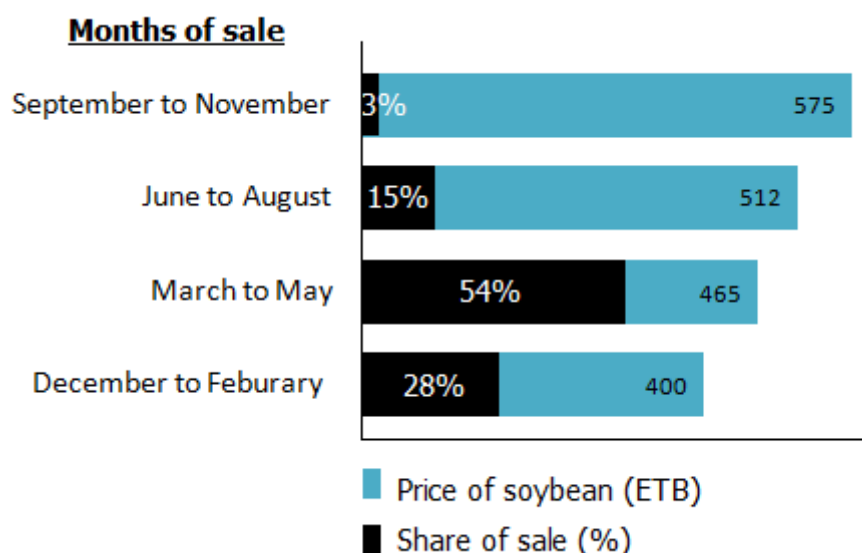
**Table 6: Material expenses of soybean production**

Type of Expenses	% of farmers incurring the cost	Mean	Std. Dev.	Min	Max
Seed	100.00	319.86	155.62	96.38	1024.1
Fertilizer	2.27	8.63	47.49	0	379.5
Chemical	38.64	162.52	239.82	0	1036
<b>Total</b>		<b>491.01</b>	<b>337.66</b>	<b>96.38</b>	<b>1490</b>

Source: Farm level survey data

### Return of Soybean Production

Soybean producer farmers sold majority of the produce (88%) within the first six months after harvest (December to May). The price of soybean was also observed to be low immediately after harvest and high in the last three months (September to November) of the production season (Figure 3).



**Figure 3: Price and share of soybean sale by sample farmers in Pawe district**

Analysis of the total revenue from soybean depicts (Table 6) that the sampled farmers earned, on average, total revenue ranging from ETB 2025 to ETB 11200. Also, it showed that most of the farmers (56.81%) earned between ETB 4000 and ETB 8000.

**Table 7: Total return from soybean production**

Total Revenue (ETB/ha)	Frequency	Percent	Cumulative Frequency
less than 4000	7	15.91	15.91
4000 – 6000	16	36.36	52.27
6001 – 8000	9	20.45	72.73
8001 – 10000	8	18.18	90.91
More than 10000	4	9.09	100.00
<b>Total</b>	<b>44</b>	<b>100.00</b>	

**Gross Margin Analysis of Soybean Production**

The result of the return and cost analysis of soybean farming showed mean total revenue (TR) of ETB 6,461.81 per hectare and total variable cost (TVC) of ETB 4,436.45 per hectare. The result also revealed a significant difference of gross margin (GM) of ETB 2025.36 per hectare ( $t = 5.494, P < 0.01$ ) indicating cost efficiency in the usage of inputs by the respondents (Table 8).

**Table 8: Gross margin of soybean production**

Variable	Obs	Mean	Std. Err.	[99% Conf. Interval]	
TR	44	6461.81	386.39	5420.43	7503.19
TVC	44	4436.45	208.02	3875.38	4996.63
GM	44	2025.81	368.75	1031.98	3019.63

mean(diff) = mean(GR - TVC)  
 Ho: mean(diff) = 0  
 $t = 5.494, P < 0.01$

**Sensitivity analysis of gross margins**

Ten percent decline in price of soybean brought about 32% decreases in GM. Similar percentage increase in yield also resulted in about 32% increase while 10% reduction in total variable cost brings only about 22% improvements (Table - 9).

**Table 9: Sensitivity analysis of gross margins for varying output price, yield and TVC**

Particular	Original	10%	10%	10%	10%	10%	10%
		increase in price	decrease in price	increase in yield	decrease in yield	increase in TVC	decrease in TVC
TR (Birr/ha)	6461.81	7135.54	5815.63	7107.99	5838.17	6461.81	6461.81
TVC (Birr/ha)	4436.01	4436.01	4436.01	4436.01	4436.01	4879.61	3992.41
GM (Birr/ha)	2025.81	2699.53	1379.62	2671.98	1402.16	1582.20	2469.40
BCR <sup>1</sup>	1.46	1.61	1.31	1.60	1.32	1.32	1.62
% change in GM		33.26	-31.90	31.90	-30.79	-21.90	21.90

**Summary and Conclusion**

The result of this study revealed that majority of the respondents were within the productive age but significant portion of them were illiterate. Soybean has covered more than 35% of cultivated land by the farming families and the average 0.83-hectare soybean area planted indicates its importance in the district.

Human labour was the main input in soybean production and labour contribution of female farmers was lower than male but their contribution was very vital mainly in weeding. The operational cost of ETB 3945.44 dominated total variable cost against ETB 491.01 of material cost in soybean production which aggregated to ETB 4436.45. Majority of soybean producer farmers sold their produce shortly after harvest with relatively lower prices and received lower total revenue while the mean total revenue was ETB 6,461.81 per hectare. The paired t-test between TR and TVC revealed a highly significant difference of GM of ETB 2025.36 per hectare ( $t = 5.494, P < 0.01$ ) indicating cost efficiency in the usage of inputs by the producers. Sensitivity analysis indicated sensitivity of gross margin to variation in soybean yield and grain price than TVC.

Even though other enterprises not incorporated in this study, apart from other benefits soybean production observed to be profitable with GM of ETB 2025.36 per hectare and BCR of 1.46. Profitability of soybean production could be enhanced and soybean production could be more attractive through technology packages that improve soybean yield and means to reduce price volatility like market information system and group marketing.

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<sup>1</sup>Benefit Cost Ratio calculated as the ratio of TR and TVC

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