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Full length Research paper

Title: Determination of Seed Production Cost and Net benefit of hybrid Maize at Bako Agricultural Research Center, Western Oromia, Ethiopia

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Maize is the primary staple food crop in many developing countries. Maize is Ethiopia's most important cereal crop in terms of production level and area coverage. Maize productivity in the country seems to be the highest with an average yield of 4.2 tons ha^{-1}. Thus, the work was conducted to assess the cost-benefit analysis of maize hybrid seed production. The seed production of male and female parental lines of Maize hybrid (BH-661, BH-546, BH-547 and BH-549) was multiplied at Bako Agricultural Research Center in Seed Research and Technology Multiplication team during the 2021/2022 cropping season. The cost of production includes labor, fuel and material inputs on working capital. The observations indicated that about 64.2% of variable costs are due to human labor, 9.99% to fuel costs and 25.79% to material inputs of cost. The total value of gross production involving processed hybrid seed, rejected seed and fodder was estimated at 160,400, 000 Birr. The benefit/cost ratio worked out is 1.35 with the net income of 41595 ET birr per hectare for maize hybrid seed production. However, this benefit/cost ratio can be expected only under normal favorable conditions, with the availability of all facilities and inputs to carry out seed production.

Key Benefit, cost, Maize, Net income, production

INTRODUCTION

Maize (Zea mays L.) is the world's widely grown cereal and the primary staple food crop in many developing countries ((Erenstein *et al*., 2022). Among the cereal crops in the world, maize occupied the third and first position in terms of area and production, respectively. Global maize production has been rising continuously. Due to the high potential yield, versatile uses, almost year-round growth ability and higher per hectare yield than the other cereals, the area and production of maize are increasing day by day in Ethiopia due to the cultivation of hybrid maize and its popularity among the farmers (CSA, 2021).

Generally, the hybrids give 20-30% higher yield than the normal open-pollinated varieties. Hybrid maize cultivation has been increasing at the rate of about 20-25% per year since the nineties (Bhuiyan, 2012). Its production has increased significantly in the country because of the high demand for food consumption and animal feeds. Maize is Ethiopia's most important cereal crop both in terms of level of production and area coverage. About 80% of the total farmers produced eight million tons of maize from two million hectares (CSA, 2021).

Though, Ethiopia is one of the largest maize-producing countries in Africa (FAO, 2021).

The total land area of about 12,979, 459.91 hectares are covered by grain crops and out of the total grain crop area, 81.19% was under cereals. Maize covered 21.40% of cereal crops and about (2,526,212.35) hectares and gave 105,570,935.92 tons of grain yields (CSA, 2021).

Seed is a means of dispersal for plant populations in space (spatial) and time (temporal), representing continuity and change, and thus adaptation to the local environment. The seed has played a critical role in agricultural development since prehistoric humans domesticated the first crops (Igrejas, Branlard 2020).

Newly released crop varieties need to be multiplied and made available to farmers as quickly as possible for farmers to access and benefit from the genetic gain of the crop improvement programs. Seed production is a key

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component of a functional seed system and is expected to produce a sufficient quantity of seeds of adequate quality within the national prescribed rules, regulations and standards. Formal seed production follows a limited generation system although the number of generations depends on the mode of reproduction of the crop, risk of contamination, multiplication factor and ultimately the quantity of certified seed required ((Igrejas, Branlard 2020). Ethiopia adopted the Organization for Economic Cooperation and Development (OECD) nomenclature for seed production and certification with some minor variations: breeder seed, pre-basic seed, basic seed and certified seed (Atilaw *et al*., 2016; Desalegne *et al*., 2016). Applying the recommended technical procedures and agronomic management practices (Elias, 2018). During variety maintenance and seed production would ensure the producing EGS of the highest varietal purity and identity and seed quality. This includes observing the basic principles of seed production such as seed source, cropping history, isolation, rouging, cleaning, treatment, storage and quality assurance during EGS production (Elias, 2018).

Maize productivity in the country seems to be the highest in Ethiopia with an average yield of 4.2 tons ha-1. This is due to favorable growing conditions during the maize growing season (May to July) the increased use of hybrid seeds and improved production practices by growers (CSA, 2020). It is increasing at an exponential rate. Seed is one of the main limiting factors for expansion of maize area in the country. Ethiopia is in a favorable situation to expand and develop a strong and efficient maize seed industry. Private seed companies and NGOs need both technical and financial support to produce hybrid seed locally. Seed production is a specialized and essential industry today. Hybrid seed production is a specialized operation that calls for a higher level of competence to meet quality requirements when compared to commercial grain crops. The cost of production of a crop is the total cost incurred for raising that crop. It included the pre and post-harvest activities and their costs or charges (Muhammad *et al*., 2017). Overall productivity is determined by combining the paddy and straw yields of the cultivars. In contrast, net production is computed by taking the total amount produced for each variety and subtracting the production cost. The cultivars' combined yield of paddy and straw is used to calculate overall productivity. As opposed to this, net production is calculated by deducting the production cost from the total amount produced for each variety (Chanda *et al*., 2019). Labor cost includes the actions and activities of the labor in crop production such as handling of crop, application of chemicals, irrigation, and pre and post-harvest activities (Muhammad *et al*., 2017). Most of the seed production innovations are the outcome of the efforts of the producers and researchers, which made maize production a viable industry in the country. The cost of cultivation and net profit value are the basis of the development of the seed industry and hybrid seed growers. So, to work out the economics of hybrid maize seed production at the experimental station with specific objectives to examine the cost of hybrid seed production and to understand the net return of maize hybrid seed production to provide a scientific basis for fixing compensation to the hybrid seed growers (Kumar *et al*., 2017). A study was conducted to assess the costs and benefits of seed production of maize parental lines at the Bako Agricultural Research Center of western Oromia.

MATERIALS AND METHODS

The study was conducted in Bako Agricultural Research Center in western parts of Oromia central Ethiopia. The seed production field with the male and female parental lines of hybrid maize BH-661 (142-1-e x (CML-395 x CML-202)), BH - 546 (BKL - 001 x (CML - 395 x CML - 202)), BH - 547 (BKL 001 x (BKL-002 x CML-312)) and BH-549 (BKL-003xBKL-004) and parental line seed Production 142-1-e, BKL-001, BKL-003 and BKL-004 were Multiplied at Bako Agricultural Research Center in Seed Research and technology Multiplication field during rain feed season of 2021/2022. The total area under maize basic seed production in the 2021/22 cropping season was 69 hectares. Out of total area cultivated maize in two cropping season; CML-395xCML-202 (30ha), 142-1-e (5ha), BKL-001 (15ha), BKL-003 (4ha) and BKL-004 (15ha). The total cost of producing the basic seeds was summed up and converted to hectares. The cost of Production including variable costs like human labor, tractor charge, thresher charge, field inspection cost, material inputs, seed processing cost, interest on working capital and risk allowance and fixed costs involved in hybrid maize seed production such as land rent, land tax, management cost, and depreciation of implements were worked out to estimate the cost of seed production, net income and benefit-cost ratio. The mean values of the observations on seed production plots of different maize hybrids were used for the calculation of these estimations. The economic analyses were carried out using the procedures described by CIMMYT (1988). The current price of basic seed and fodder yield of maize was valued at an average price of basic seed at Bako Agricultural Research Center which were 100 ETB kg^{-1} and 0.5 ETB kg^{-1}, respectively. The operation cost such as labor was 75 birr day^{-1} and input materials including Fertilizer, Seed, Herbicide (pre-emergence) 46.5 ET birr kg^{-1},100 ETB kg^{-1}, 1200 ETbirrLt^{-1} respectively. All operation costs and material inputs were recorded and used for this analysis. The net margins were used for the analysis accordingly. Percentages were used to analyze the share (computed as a percentage of the total variable costs) of each cost item in the total variable costs. Land was assumed as a fixed cost and was excluded from the analysis. Computation for net margins involved budgetary

analysis specified as:
AGM = ATR - AVC
Where AGM is the average gross margin, ATR is the average total revenue; and AVC is the average variable cost. Gross output in hybrid maize seed production constitutes those products that become available after harvest as seed and grain. A sensitivity analysis using the estimated economic values (costs and benefits) was undertaken to incorporate uncertainty into economic evaluation. Necessary information from the field was collected to get actual data. However, the main focus was on various inputs and operation costs used in maize basic seed production (Kumar *et al*., 2017). The Cost and benefit of Maize basic seed production were compared through benefit-cost ratios (Elahi *et al*., 2022).
Benefit Cost Ratio of Maize=TR/TC
Whereas, TR is the total benefit generated from Maize production ha-1 and TC is the total cost of Maize cultivation ha^{-1}.
Profit Function =Total Revenue (TR)-Total Cost (TC)

RESULTS AND DISCUSSION

The total operation cost of seed production was estimated 88,155 ET birr (Table 1). The operational cost, fuel cost and material input cost of maize parental line seed production were worked out (Table 1 and 2). To compare the cost and revenue of seed production, the Benefit Cost Ratio (BCR) has been calculated by: TR/TC. Therefore, BCR for cross-breed seed production = 160400 / 118805 =1.35 and BCR for inbreed line = 160400/112505=1.425 The BCR indicates that the Maize cultivation is profitable Figure 1 and Table 5.
The total cost of seed production was estimated 118,805 ET birr ha^{-1} (Table 3). The total estimated operation cost of hybrid seed produced was 76,275 ET birr and the fuel cost for operation was 11,880 birr (Table 1) which is 64.2% and 9.99% of the total operation cost of production respectively (Table 3). The material input costs such as seed cost, fertilizer cost, and chemical cost of maize hybrid seed production per hectare were 30,650 ET birr (Table 2) and 25.79% of the total cost of production (Table 3). The Operation costs include labor, tractor fuel and lubricant, and material inputs (fertilizer, seeds and pesticides) on working capital. The observations indicated that about 64.2% of variable costs are due to human labor, 9.99% due to fuel costs and 25.79 due to material inputs costs (Table 3). Hybrid seed crop involves some specific practical operations such as row spacing pattern, planting ratio of male and female lines, fertilizer and synchronization of flowering of male and female lines, rouging, detasseling and separate harvesting and threshing of male and female lines. To perform all these special operations for maintaining genetic purity standards of a seed crop requires additional cost for labor and material inputs and thus the portion of these two costs among other variable costs are high (Rubyogo *et al.,* 2019).
Seed production involves additional expenditure on inspection charges of the plant breeder, expenses on an agreement executed with the company, transport of the seed to the processing plants, and value lost in leftovers after processing.
Further, the seed lots are to be certified for minimum quality standards. In the case of seed crops, the risk of rejection due to low-quality standards would add to the cost of production (Kumar *et al.,* 2017). The new hybrid seeds undergo processing operations where some portion (20-30%) of the seed lot is rejected. On the return side, the quantity of processed seed is less than the yield of a parental line seed production.

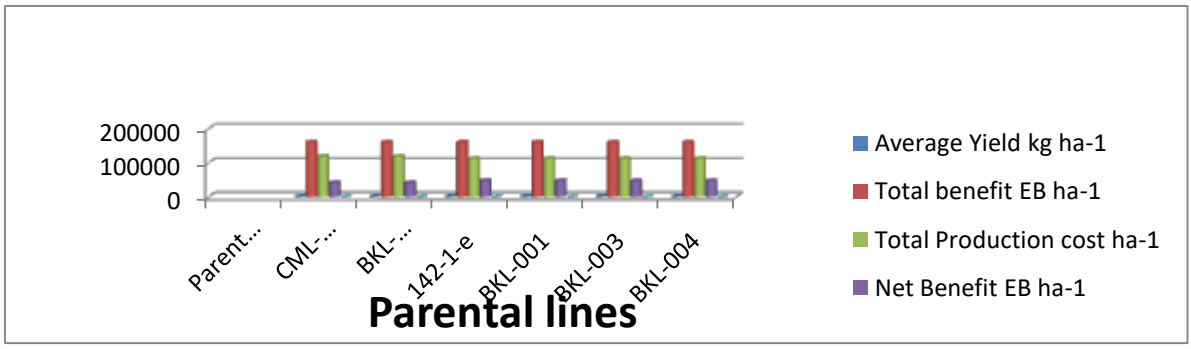

Figure.1 Costs and returns in Basic seed production of Maize parent lines at BARC in 2021/22

When compared to crossbreeds and inbred lines, the cost of producing basic seeds is higher. (Figure 1). The labor cost of detasseling was considered a factor in the increased cost of crossbreed production seeds when compared to inbred lines (Figure 1).
As shown in Figure 1, we are informed that the value of production costs of crossbred and inbred lines hold differences. The cost of production of crossbred seeds is higher than that of inbred lines. The cost yield of crossbred seeds like (CML-395xCML-202) and (CML-312xBKL-002) is higher than that of inbred lines (BKL-001, BKL-003,BKL-004 and 142-
1-e). The reason is that cross breed seeds are added to the price of a day laborer who removes the flower.

Table 1. Estimation of total operational costs involved in parental line seed production (ha^{-1})

No	Human labor operational costs ha^{-1}	No. of person ha^{-1}	Unit cost	Total
1	Land preparation	8	75	600
2	Weeding	20	75	1500
3	Planting and Fertilizer (NPSB) application	15	75	1225
4	Thinning	8	75	600
5	Top dressing(urea fertilizer)	5	75	375
6	Detasseling for 21 days	4	75	6300
7	Roughing(4 times)	2	75	600
8	Spraying herbicide	4	75	300
9	Harvesting & Transport	30	75	2250
10	Threshing & Cleaning	20	75	1500
11	Sun drying	4	75	300
12	Seed Treatment	4	75	300
13	Bagging	4	75	300
14	Cob Selection	15	75	1125
15	Guarding for 165 days	4	75	49500
16	Field inspection and Management cost	4	600	9600
	Sub Total cost			**76,275 ET birr**
II	**Fuel and lubricant used by Tractor ha^{-1}**	Quantity Lt ha^{-1}	Unit cost/lt	Charge per hectare (Birr)
1	Land preparation			
1.1	First tillage	30lt	68	2040
1.2	Harrowing	30lt	68	2040
1.3	Row making/Ridging	30lt	68	2040
2	Transportation	60lt	68	4080
3	Seed threshing by tractor ha^{-1}	10lt	68	680
4	Lubricant cost ha^{-1}	2kg	500	1000
	Sub total			**11,880**
	Total operational cost			**88,155 .00birr**

Table 2 Estimation of cost material inputs of maize seed production (ha^{-1})

	Input	Quantity ha^{-1}	Unit cost/quant	Total cost
1	Seed male line	6.25kg	100	625
2	Seed female line	18.75kg	100	1875
3	Fertilizer (NPSB)	150kg	48	7200
4	Fertilizer(Urea)	200kg	45	9000
5	Herbicide/ pre emergency	3 Lit	1000	3000
6	Seed treatment chemicals	1kg	250	250
7	Labeled bag cost for ha	30 pcs	50	1500
	Total material cost			**30,650 birr**

The tractor and land resource that were used is an existing asset of the company. The total value of the gross produce involving processed clean seed, rejected seed and fodder was estimated at 160, 400. 00 EBha-1 (Table 4). The benefit/cost ratio worked out is 1.45 with the net income of 41,595.00 EBha-1 for maize parental line seed production (Table 5). However, this benefit/cost ratio can be expected only under normal

Table 3. Total variable cost involve in hybrid maize seed production (ha^{-1})

S/No	Variable costs	Expenditure ($ETBha^{-1}$)	% to the total seed production cost
1	Total Human Labor cost	**76,275**	64.2
2	Total Fuel and Lubrication	11,880	9.99
3	Total Material Input	30,650	25.79
	Total cost of seed production ha^{-1}	**118,805**	**100**

Table 4. Total value estimation of Maize parental line seed production (ha^{-1})

No	Product	Yield ha^{-1} (kg)	Unit price kg^{-1}	Total price ha^{-1}(kg)
1	Cleaned seed	1500	100	150,000.00
2	None seed	200	22	4400.00
3	Fodder	12000	0.5	6,000.00
	Total			**160,400.00**

Table 5. Profit estimation of maize parental line of seed production (ha^{-1})

No	Particular	Cost and profit in ET birr (cross breed seeds)	Cost and profit in ET birr (inbreed line seeds)
1	Gross income	160400	160400
2	Gross expenditure	118805	112505
3	Net income	41,595	47,895
4	Benefit Cost Ratio	1.35	1.425

favorable conditions, with the availability of all facilities and inputs to carry out seed production this result indicated by Gupta et al., (2019). The seed crop like any other crop is prone to risks of adverse weather, and pest attacks. Seed crop also has the risk of rejection for failing to meet the minimum standards prescribed for certification. As seed production is more risky than commercial crops, it needs to payment of enough compensation (price) to seed growers considering the economics of hybrid seed production to involve them in seed activity reported by Harris, and Fleming (2017). Thus, the present study helps to understand the various components of the cost of seed production and value estimation and provides a scientific basis for identifying compensation rates for maize seed growers.

The hybrid seed yield is normally lower and the seed crop in general is more risky than the commercial crop. The production of seed is consistently below the requirement in most of the crops as reported by Pham et al. (2021). The present study has identified that, even if the production of hybrid maize is lower, it benefits the end users if they use it in full package.

CONCLUSIONS

The study suggests that producing maize parental line seed production (breeder seed, Pre-basic seed and basic seed) was lower in profitability and lower yield advantage when compared to certified seed production. It can be concluded that the profitability of maize parental line seed production is more sensitive to price fluctuations than certified seed production. The idea of this research prompted us to write that the price at which the seed multiplier sells to the farmer varies from company to company.

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