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## On-Farm Demonstration and Evaluation of Engine-Driven Maize Sheller in Kelafo District, Somali Region, Ethiopia

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### ABSTRACT

This study was carried out in the Shabelle zone of the Somali region, specifically in the Kelafo district. Maize powered by engine Sheller assists in separating the cob from the corn. Among the key components of the manufactured design are the machine frame, hopper (feeding chute), bearing, shelling unit, grain and cob discharge unit, air blower portion, body casing, and drum. A B-belt connects the diesel engine motor that powers it to the shelling unit. The maize sheller was exhibited by the SoRLARI-Agricultural Mechanization Research Directorate, which determined it to be between 95.54 and 97.76% efficient with a production capacity of roughly 26.5-30Qu/hr. comparing the machine to other domestically manufactured and imported of comparable capacity, it is comparatively inexpensive, easy to use, and portable. 20 agro-pastoralists from the Kelafo district were selected for the maize sheller demonstration, and one machines were provided for the districts to create wider awareness. The maize sheller machine's cost-benefit analysis made use of the payback time and the benefit-cost ratio. The machine is cost-effective for popularization and scaling, as indicated by the computed machine cost-benefit ratio and payback periods of 1.15 and 1.94.

### INTRODUCTION

One of the most significant cereal crops in the global agricultural economy is maize (*Zea mays* L.) (Win *et al.*, 2019). Because of its significant role in both human and animal diets, it is referred to as the "Queen of cereals" and the "King of fodder" (Teha & Nur, 2020). After rice and wheat, it is the third most significant food grain worldwide (Amine *et al.*, 2021). With an effective irrigation system and mechanical farming, it may be farmed all year round. Maize is a tall plant grown for its large yellow grains. It is the most important cereal plant after wheat and rice in the world. Maize is one of the most important staple crops and the main source of starch (60-80%), protein (8-12%), fat (3-5%), and minerals (1-2%) (Langyan *et al.*, 2021).

Ethiopia's agricultural output was enhanced by the introduction of high-yielding varieties (HIVs), and increased maize yield levels resulted in greater marketable surplus (Yami *et al.*, 2020). As a result, post-harvest activities have become more significant in recent years. Plucking, drying, husking, shelling, milling, and storage are all steps in the processing of maize (Takawira-Nyakuchena & Mushiri, 2020). Post-harvest losses have been identified as one of the factors leading to the food crisis (Bekele *et al.*, 2025). If farmers wish to maximize their maize revenues, they must adopt technical innovations that suit their needs. A major factor influencing maize yield is the absence of post-harvest technologies like shelling. Shelling assumes considerable importance in post-harvest operations because; the crop has to be shelled as early as possible to make way for sowing of another crop in the field. Sometimes, shelling time may also coincide

with heavy rainfall. In low-income nations, maize shelling remains difficult, and further work is needed to make this procedure more advanced (Nsubuga *et al.*, 2022). Because of these situations, suitable technology is necessary for reducing the Shelling time and safe storage of grains at the farm level. The grain moisture content is another aspect that influences maize post-harvest operations. Shelling is accomplished when the grain is sufficiently dry to have a moisture level of 13 to 14 percent (Hamzah *et al.*, 2021).

Although the Somali region has clear potential for the use of farm equipment, various governmental and nongovernmental organizations have not done much to introduce various agricultural implements and equipment that help to boost agricultural productivity and lower post-harvest losses for the farming community. Most of the farmers lack of appropriate maize post-harvest technologies. Majority of the farmers in the area shell most of the corn by using the traditional methods of pounding on bare ground or loosely packing in sacks, manual rubbing maize cobs against one another, using human finger, and biting the cob with wooden plank (Proceeding, 2022). This method has; low productivity, hand shelling take a lot of time, even with some hand operated simple tools causes high physical damage and contamination with foreign matter resulting in low market value and reduced shelf life of the crops (Teha & Nur, 2020).

Therefore, this project was initiated to demonstrate engine driven maize sheller which can minimize the difficulties small-scale farmers face when shelling maize

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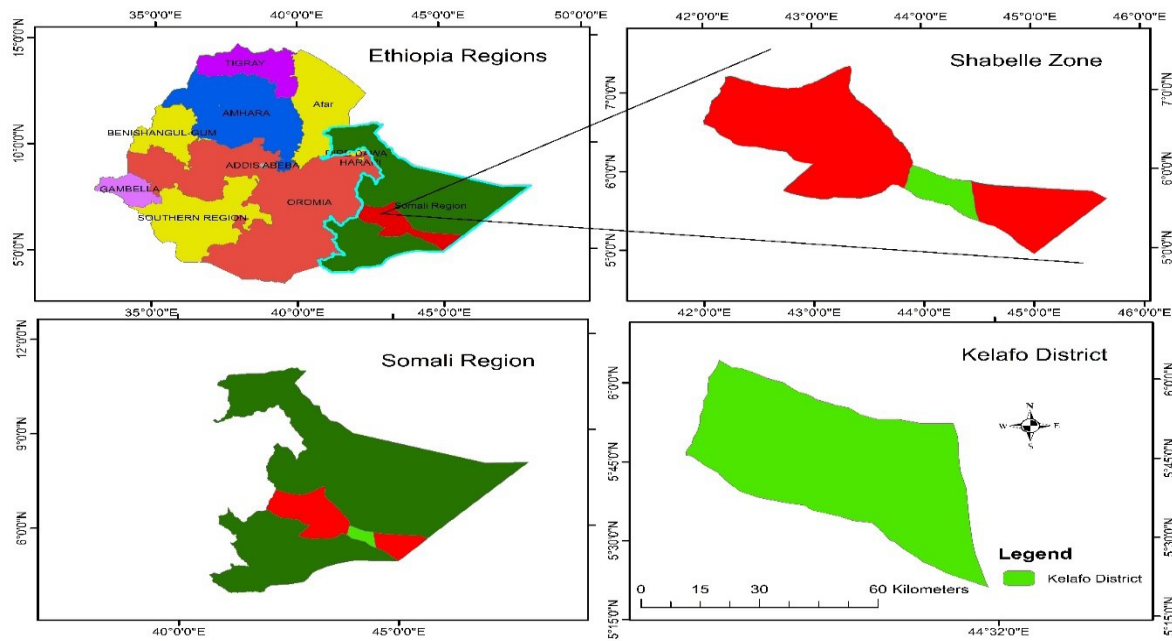
in the Kelafo district of the Somali region of Ethiopia.

**MATERIALS AND METHODS**

**Study Area Description**

This study were conducted in Kelafo district, Somali Region, Ethiopia in 2024. Kelafo is a town in eastern

Ethiopia. Located in the Shebelle Zone of the Somali Region, this town has a latitude and longitude of 05°35'20"N 44°12'20"E and an elevation of 233 meters above sea leve (Figure 1). Based on figures from the CSA, (2007), this town has an estimated total population of 14,242, of whom 7,522 are men and 6,720 are women.



**Figure 1:** Map of the study area

**Selection of Model Small-Scale Farmers**

In cooperation with the Kelafo district SoRLARI center, farmers were purposefully chosen based on their commitment, inventiveness in using maize Sheller technology, willingness to apply the technology, common shelling problems, information sharing, and ability to oversee the planned activities. 20 agro-pastoralists were

selected. The selected agro-pastoralists were divided into two sub-groups having two members in each sub-group by considering gender inclusiveness (women, men, and youth). The training was provided in the established group containing 20 participants (15 male and 5 female), and the maize Sheller technology was handed over to the Kelafo district SoRPARI research sub-center (Table 1).

**Table 1:** Implementation district and number of model participants

District	Type of machine	Qt of machine	Number of participants	Male	Female
Kelafo	Maize sheller	1	20	15	5

**Implementation Methods**

The on-demonstration and evaluation of the engine-driven maize sheller technology were conducted at Kelafo SoRLAR center fields. To create a clear understanding and secure efficient & uniform utilization of selected technologies, practical section-focused training on assembly, operation, and preventive maintenance was provided

**Cost-Benefit Analysis of Engine-Driven Maize Sheller**

Cost-benefit analysis is an imperative part of the process for this study. In the making of any machine, the economics related to it have to be carefully considered to

analyze the costs and go ahead to compute the profit. The maize sheller machine cost-benefit analysis, the payback time, and the benefit-cost ratio were used in the study.

**Payback Period**

The payback period is the length of time it takes to recover the invested capital or until the net benefits equal the investment cost.

$$PBP = ((\text{Initial Investment nital (Birr)} / (\text{Annual Profit (Birr}/(\text{Yr})))) \tag{1}$$

where Annual profit =  $(\sum_i^n \text{Revenu (Birr}/\text{Yr}) - \text{Total cost (Birr}/\text{Yr})) / n$  ; n = number of years of benefits. The acceptability of the project is determined by comparison with the project-required payback period (RPP). Accept

the project when the PBP < RPP, otherwise reject the project (Mottalib *et al.*, 2019).

**Benefit-Cost Ratio**

The benefit-cost ratio is the ratio of the present worth of the benefit stream to the present worth of the cost stream. (Gittinger, 1994).

$$BCR = \frac{\sum \text{Present worth of Benefits (PWB)}}{\sum \text{Present worth of Cost (PWC)}} \quad (2)$$

When the BCR exceeds one, the investment is considered profitable. To avoid double accounting, depreciation and investment interest are excluded from the costs. The inclusion of the investment cost accounts for depreciation, while the discount factor accounts for interest on the investment (Pannell, 2024).

**Data Collection**

The number of small-scale farmers and stakeholders who attended the training, the output capacity (Qu/hr.), the shelling efficiency (%), the grain cleaning efficiency, the grain breakage (%), and the qualitative data were gathered through focus groups, individual interviews, and personal

field observation using a checklist and data sheet tools. Pair, wise, and matrix ranking were used to rate the qualitative data, which included farmers' opinions about the new technology.

**Data Analysis**

Simple descriptive statistics (mean, frequency, and percentage) were used to describe the quantitative data, and narrative explanation was used to examine the qualitative data gathered from field observations, oral histories, and group discussions. To obtain trustworthy information, data from several sources was finally triangulated.

**RESULTS AND DISCUSSION**

**Training for Model Small-Scale Farmers and Other Stakeholders**

By sharing their shelling maize experience and expertise, the Agricultural Mechanization and Socio-extension research team and other stakeholders actively engaged with the theoretical and practical focus training (Table 2).

**Table 2:** Training participants

No.	Participants	District		Total
		Kelafo		
		Male	Female	
1	Agro pastoralist	15	5	20
2	Agricultural experts	4	1	5
	Total	19	6	20

Among the training participant stakeholders, 80% were small-scale farmers. Of those, 14.3% are female participants. Various extension resource materials were

used and given to the attendees. 50 pamphlets and 40 brief instructions regarding the maize sheller operational technique and maintenance prepared in Somali and

**Table 3:** Technical Specification of engine-driven Maize Sheller

S.No	Performance Indicators	Unit	M Sheller
1.	<b>Overall Dimension</b>		
	Length	Mm	1300
	Width	Mm	1200
	Height	Mm	1550
2.	Net Weight	Kg	110
3.	Power source		Petrol Driven Engine
4.	Power Requirement	Hp	7.5
5.	Fuel Consumption	Lit/hr	1
6.	Drum Type		Cylindrical
7.	Blower Type		Centrifugal
8.	Output Capacity	Qu/hr	26.5-30
9.	Threshing Efficiency	%	95.54– 97.76
10.	Cleaning efficiency	%	>93
11.	Grain Damage	%	<0.1

English, were given to the participants of the training. Various queries, viewpoints, and recommendations were made during the training, and the relevant bodies responded to them. The majority of model farmers expressed a strong interest in the technology (Table 3). As a result, everyone involved shared accountability for the next intervention and broader use of the technology.

**Model Small - Scale Farmer Opinion/Perception**

During the machine demonstration, participants' opinions about the performance of the maize sheller

were gathered from those model small-scale farmers. As their main criteria, farmers took into account machine capacity, threshing efficiency, cleaning efficiency, grain damage, labor reduction, human effort/tiredness, and shelling time.

As a result, the majority of farmers favored engine-driven maize shellers over conventional shelling techniques (Table 4).

Based on the result of pairwise ranking matrix the agro-pastoralist/ farmers highly preferred the maize Sheller with high threshing efficacy.

**Table 4:** Variety rankings according to selection criteria used by farmers.

Technologies	Farmers rank	Reasons
Maize sheller powered by an engine	1st	Shorter shelling times, low labor expenses, less grain damage, high machine capacity, excellent shelling and cleaning efficiency, and reduced human fatigue and effort.
Conventional shelling of maize	2nd	Grain damage, low shelling capacity, low shelling efficiency, higher shelling time frame, and maximum human effort and fatigue.

**Table 5:** Variety attributes are ranked using a pairwise ranking matrix.

Code no.	Traits	Machine capacity	Threshing Efficiency	Cleaning Efficiency	Minimize human effort	Reduce time of threshing	Reduce grain damage	Frequency	Rank
1	Machine capability	2	1	1	1	1	4	2nd	
2	Efficiency of shelling	2	2	2	2	2	5	1st	
3	Efficiency of cleaning	3	3	3	3	4	2	4th	
4	Reduce human fatigue and effort	5	5	5	1	5	1	5th	
5	Cut down on shelling	5	5	5	3	5	3	3rd	
6	Minimize grain damage	0	0	0	0	0	0	6th	



**Figure 2:** Theoretical and practical training of the engine-driven maize sheller machine

### Cost-Benefit Analysis

Tables 6 and 7 show the findings of the benefit-cost analysis of the engine-driven maize sheller technology. The shelling technology has a payback period of 1.94 years and a ratio of benefit to cost of 1.15 years. These findings

concur with those of Milufarzana *et al.* (2015), who found that a maize sheller benefit-cost ratio of 2.34 was necessary for it to be greater than one. Furthermore, the Sheller investment would pay for itself in a comparatively short amount of time two years, or around four growth

**Table 6:** Various costs for Maize Sheller

Cost Description	Cost (Birr)
Fixed Cost (cost of the Maize Sheller)	155,000.00
Annual variable cost	55,000.00
Annual gross income from shelling	135,000.00
Annual net returns	80,000.00

**Table 7:** Payback period and benefit-cost ratio of maize Sheller

Cost Description	Cost (Birr)
Description	Details
Payback Period (years)	1.94
Benefit-Cost Ratio	1.15

seasons. For entrepreneurs, maize shelling with modified maize sheller is therefore a lucrative endeavor.

### Discussion

An engine-driven maize sheller is demonstrated, which minimizes human involvement in the operation. The machine's cost-effectiveness and ease of use provide farmers a bright future. Its cheap operating costs and time and energy savings are its primary benefits. The machine can quickly pay for itself with the savings it generates from use.

### CONCLUSION

There are frequently multiple steps involved in maize harvesting and post-harvest operations, including removing the kernel from the cob. Traditionally, the process of shelling maize involves rubbing the cobs against each other with a stone or using a wooden board to bite the cob with a human finger, and trampling with livestock. This is ineffective; do not encourage extensive maize shelling, which is time-consuming and labor-intensive and is one of the main issues that leads to bodily harm. Thus, the maize sheller powered by an engine has been proven to be a crucial piece of technology and the greatest way to reduce post-harvest loss in maize, boost output and productivity, and lessen smallholder farmers' constraints. Additionally, compared to hand shelling, less labor and time were used, and the equipment is affordable with a quick payback period. Thus, the following suggestions were made in light of the farmer's concept and the significance of this technology:

- The technology has to be more widely introduced and scaled up to reach other districts of the region.
- Training and capacity building may be necessary for future advancement of the technology.
- More work needs to be done to make the technology

available, distribute it, and demonstrate it.

Future research on maize technology in various fields may be necessary to reduce post-harvest losses and boost output and productivity.

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