



Research Article

Pre-Extension Demonstration and Evaluation of Soybean Grinding Machine for Gender Labour Saving

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Abstract

Soybean is considered to be an important oilseed crop because it contains highly nutritious oil in large quantities. The increasing use of soybean, its high food value, and growth in production and trade have necessitated greater attention to crop-related post-harvest technologies. This study was conducted in FSRP-supported areas of Jimma and Buno Bedele zones of the Oromia region to demonstrate and evaluate the performance of a soybean grinding machine. Two districts, Seka Chekorsa and Banshure, were purposively selected based on soybean accessibility and suitability. Training and a mini-field day were organized to promote the soya bean grinding machine. The machine was evaluated based on grinding capacity, grinding efficiency, and mechanical damage. The results showed that the machine had an average grinding capacity of 407.73 kg/hr, an average grinding efficiency of 91.43%, and mechanical damage of 2.95% at a feed rate of 7 kg/min. Feedback on attributes including minimized soybean wastage, suitability for use, portability, and time and labor saving was collected from farmers. The majority of respondents (on average, 95%) positively perceived the time and labor savings, portability of the machine (80%), suitability to use (77%), and minimized wastage of soybean (70%). Based on the results, further scaling up and popularization of the soybean grinding machine in other soybean-producing areas are recommended.

Keywords

Soybean, Capacity, Demonstration, Grinding, Perception

1. Introduction

Soybean is considered to be an important oilseed crop because it contains highly nutritious oil in large quantities [1, 2]. Soybean contains about 40% protein and 20% oil. Soy protein is the most economical protein produced in the world. The high quality of soy protein is illustrated by its content of all the essential amino acids except sulfur-containing amino acids. Supplementation of the cereal-based diet with soy protein gives amino-acid complementation, which results in increased protein quality and quantity approaching that of animal protein [2].

Nowadays, soybean can be considered an important plant for agriculture because it is one of the main food sources for human and animal nutrition [3]. It is a food source that contains high-quality protein and does not contain cholesterol and saturated fatty acids [18]. The best-known and most widely used products from soybeans are soybean oil and soybean meal [4]. Soybean oil is the most widely used edible oil in the world, and soybean meal is a leading protein and energy source for animal feeds. Soybean oil is used as cooking oil and

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Received: 25 September 2026; **Accepted:** 8 October 2026; **Published:** 28 October 2026



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as the base for shortening, margarine, salad dressings, and mayonnaise [11].

Soymilk is rich in vegetable protein and can contribute to meeting people's protein requirements. It also contains vitamin B1, vitamin B2, iron, and calcium [5, 15]. The development of the soybean milk industry is therefore important and requires appropriate preparation and processing equipment. Soybean processing has increasingly incorporated mechanization and automation through a variety of processing equipment and production systems. Recent work has also examined processing approaches for soybean-derived food products [10].

Japanese soymilk is processed through several stages, including soaking soybeans, grinding, boiling, and filtering. These stages have been increasingly mechanized and integrated to improve processing efficiency and product quality. In China, soymilk preparation has a relatively long history and has traditionally involved the use of stone mills [6, 7].

The use of stone mills for soybean processing originated in China and has a history of more than 2,000 years [13]. The soybean hull is loosely attached to the cotyledons, and rubbing the soybean seed between two surfaces can detach the hull [14]. Different types of soybeans dehulling equipment have been developed, including rotor-concave, hand-operated, power-operated, and cylinder-concave systems [16].

The increasing use of soybean, its high food value, and growth in production and trade have necessitated greater attention to soybean processing technologies [17]. Mechanization of soybean production and post-harvest operations can contribute to improved product quality, reduced losses, and increased processing efficiency. Improved production and processing technologies can also contribute to farmers' income [7, 8].

While performing preliminary trials employing various dehulling methods, it was observed that dehulling based on the principle of centrifugal action gave better performance for soybean seeds compared with rubber-roll shellers and under-runner shellers. Soybean seeds having a flattened shape and loosely bound hull [8, 9] can present difficulties during dehulling using rubber-roll shellers, resulting in a considerable proportion of seeds remaining undecorticated and consequently reducing dehulling efficiency.

Research Objectives

- 1) To evaluate the machine performance under the farmer's management
- 2) To create farmer awareness of soya bean grinder machines among the farmers of FSRP-supported districts
- 3) To get feedback from the users on the soya bean grinder for further improvement

2. Research Materials and Methods

2.1. Materials

Several raw materials, including angle iron, stainless steel, pulley, belt, bearing, bolts and nuts, sheet metal, square pipe,

shaft, mild steel, aluminum sheet, and other materials, were used to manufacture the soybean grinder.

2.2. Site Selection, Farmer's Identification, and FREG Establishment

The study was conducted in potential soybean-producing districts of Jimma and Buno Bedele zones of the Oromia region, Ethiopia. Purposive sampling was used to select FSRP-supported potential districts. Accordingly, two districts, Seka Chekorsa in Jimma Zone and Banshure in Buno Bedele Zone, were purposively selected based on soybean accessibility and suitability for implementation. A Farmers Research Extension Group (FREG) with 20 members was established at each demonstration site based on accessibility and suitability for demonstrations and machine use, with consideration of gender. Host farmers were selected from each FREG based on their interest and suitability.

2.3. Demonstration of Soyabean Grinding Machine

A demonstration of the soybean grinding machine was conducted with a multidisciplinary team of researchers, technical assistants, Woreda agricultural experts, development agents, and farmers. A participatory approach consisting of group meetings and field demonstrations was used as the main method to enhance farmer involvement in all demonstration processes and ensure active engagement through discussions and interactions among participants and facilitators.

Different extension services, including capacity-building training, facilitation of technology-related extension activities, and mini-field days, were used to create awareness among farmers and development agents. Extension teaching methods such as group discussion and individual contact methods were used to enhance better communication among farmers and facilitators.

2.4 Data to Be Collected and Method of Data Collection

Individual interviews, observations, and focus group discussions (FGDs) were used to collect both quantitative and qualitative data. Data to be collected are performance evaluation of the machine, the number of farmers who participated in training and mini-field days, and farmers' feedback about the machine.

2.5. Methods of Data Analysis

Quantitative data, including participant numbers and machine performance measurements, were analyzed using descriptive statistics such as frequency and percentage. Qualitative data were analyzed through narration and summary of participants' opinions.

3. Results and Discussion

3.1. Awareness Creation for Farmers on the Soybean Grinder in FSRP-Supported Districts

During a demonstration of a soya bean grinder machine Agricultural Extension participatory approaches such as group meetings and field demonstrations were used to encourage the involvement of farmers, development agents, and other participants in all implementation processes and ensure interaction among trainees and facilitators. Extension services such as training and mini-field days are also used to create awareness among farmers, development agents, and others toward the machine. Moreover, several methods of extension teaching, such as individual and group methods, were used during

the provision of extension services to create better communication among trainers and trainees.

3.2. Training of the Farmers, Development Agents, and Subject Matter Specialists

In this study, a multidisciplinary team of researchers and technicians provided training to farmers, development agents, and subject matter specialists. Training was given to the farmers of selected sites. It entailed both theoretical and practical training in different areas of the machine such as maintenance and operation of the machine. It employed participatory approaches to ensure maximum engagement through discussions and interactions among participants as well as with the facilitators.

Table 1. Number of farmers, DAs, and SMSs attending training.

Locations			Number of participants in training				Total
			Farmers		Others		
Zone	Districts	Kebeles	Adult	Youth	Das	SMSs	
Jimma	Seka coqorsa	Qacama	20	0	3	0	23
Bunno Bedele	Bedele	Banshure	20	0	1	1	22
Total			40	0	4	1	45

Source; own data



Figure 1. Sample of photo during demonstration and training at Jimma zone Seka coqorsa Kebele.



Figure 2. Sample of photo during demonstration and training at Buno Bedele Banshure Kebele.

3.3. Performance Evaluation

The improved soybean grinding machine was evaluated

based on grinding capacity, grinding efficiency, and mechanical damage. The results showed that the machine had an average grinding capacity of 407.73 kg/hr, an average grinding efficiency of 91.43%, and mechanical damage of 2.95% at a feed rate of 7 kg/min.

Table 2. Performance Evaluation of the Soybean Grinding Machine.

Site	Feed Rate (kg/min)	Grinding Capacity (kg/hr)	Grinding Efficiency (%)	Mechanical Damage (%)
Seka Chekorsa	7	410.40	91.00	2.28
		414.40	91.50	1.43
		408.40	91.60	2.76
Average	7	411.06	91.37	2.16
Bedele	7	400.6	91.5	4.61
		404.40	91.00	3.8
		408.2	92.00	2.84
Average	7	404.4	91.5	3.75
Overall Average	7	407.73	91.43	2.95

3.4. Mini-Field Day

A mini-field day was organized at the place where demonstrations of the machine have been undertaken. It was organized in collaboration with researchers from different disciplines, farmers, Woreda and Kebeles agricultural experts, and other stakeholders to create a wider awareness among the farmers toward the machine and collect relevant feedback

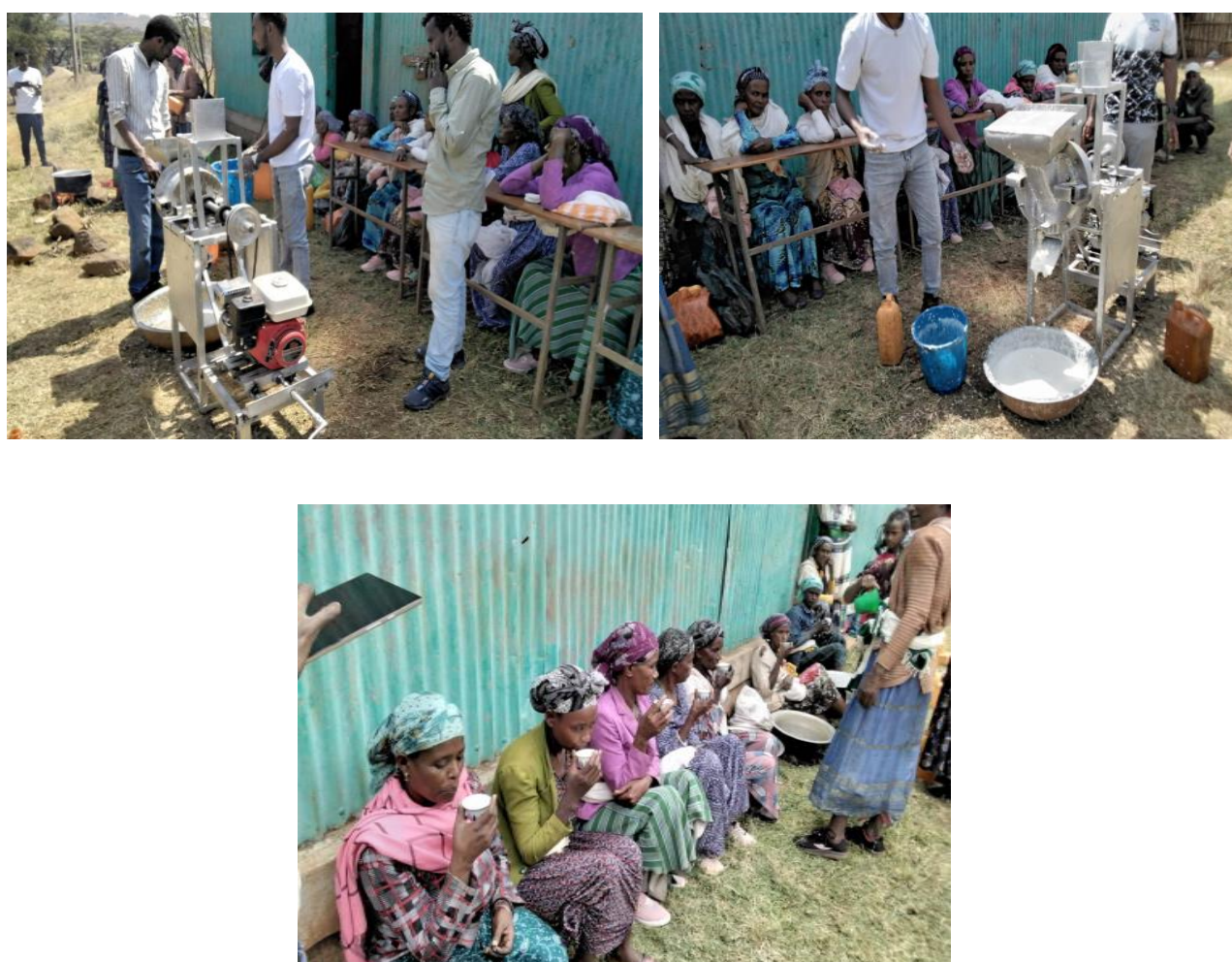
about the machine from the participants.

Accordingly, a total of 68 participants took part in the mini-field day. Of these, 45 were small-scale farmers, including 1 male and 44 female farmers. The participants also included 4 development agents (3 male and 1 female), 1 subject matter specialist, and 18 other stakeholders (16 male and 2 female). Thus, the total number of participants was 68, comprising 21 males and 47 females.

Table 3. Number of participants on the mini-field day.

No.	Participants	No of P on mini-field day by g/disaggregation		Total
		Male	Female	
1	Farmers	1	44	45
2	Das	3	1	4
3	SMSs	1	0	1
4	Others	16	2	18
Total		21	47	68

Source; own data

**Figure 3.** Sample of photo during demonstration and training at Jimmaa zone Seqa district Qacama kebele.

3.5. Farmer's Feedback and Other Key Stakeholders

Feedback during and after the demonstration was collected to assess farmers' opinions about the soybean grinding machine, particularly its performance, time and labor saving,

portability, suitability for use, and ability to reduce soybean wastage. Forty-five farmers and other participants were interviewed. However, the perception table presents 40 complete responses used for the percentage analysis. According to participants and respondents, the soybean grinding machine reduces workload, particularly for women and children.

Table 4. Farmers' perception of the soybean grinding machine (n = 40 complete responses; 45 respondents interviewed).

No of respondent (40/100%) & their Perception level			
Attributes	Perception level	Frequency	Percentage
Minimize wastage or loss	Disagree	0	0.00
	Agree	12	30.00
	Strongly agree	28	70.00
Suitable to use	Disagree	0	0.00
	Agree	9	22.50
	Strongly agree	31	77.50
Easily portable	Disagree	0	0.00
	Agree	8	20.00
	Strongly agree	32	80.00
Save time and labor	Disagree	0	0.00
	Agree	2	5.00
	Strongly agree	38	95.00

Source; from own

As shown in Table 4, 95% of the complete respondents strongly agreed that the soybean grinder saved time and labor, while 5% agreed. No respondent disagreed with the statement on time and labor saving.

Regarding portability, 80% of respondents strongly agreed that the soybean grinder was portable, while 20% agreed. No respondent disagreed. Regarding suitability for use, 77.5% of respondents strongly agreed that the soybean grinding machine was suitable for small-scale farmers, whereas 22.5% agreed. No respondent disagreed.

Regarding soybean wastage, 70% of respondents strongly agreed that the soybean grinder minimized soybean wastage, while 30% agreed. No respondent disagreed.

4. Conclusion and Recommendation

4.1. Conclusion

The use of machinery for soybean production and post-harvest operations can contribute to improved product quality, food value, market competitiveness, and production efficiency. The soybean grinding machine was demonstrated at two farmer group sites, and a total of 68 participants attended the mini-field day. The performance evaluation showed that the machine had an average grinding capacity of 407.73 kg/hr, an average grinding efficiency of 91.43%, and mechanical damage of 2.95% at a feed rate of 7 kg/min.

The existing local soybean grinding practice is laborious and time-consuming, and such work is often performed by women and children. The improved soybean grinding machine can reduce time and workload. Among the complete responses analyzed, 95% of respondents strongly agreed that the soybean grinder saved time and labor.

4.2. Recommendation

Based on the results of this study, the following recommendations are given.

Further popularization of the soybean grinding technology is needed through zonal and district agricultural extension mechanisms to benefit more rural farmers.

The research center should further scale up the technology to reach farmers who need the technology and should strengthen collaboration with agricultural extension offices and other relevant stakeholders.

Abbreviations

DA	Development Agent
FGD	Focus Group Discussion
FREG	Farmers Research Extension Group
FSRP	Food Systems Resilience Program
SMS	Subject Matter Specialist

Author Contributions

Kumale Sadeso: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing

Teshome Wakeyo: Conceptualization, Methodology, Supervision, Writing – review & editing

Tolosa Berhanu: Investigation, Validation, Writing – review & editing, Data curation

Kemaru Dalacha: Investigation, Resources, Writing – review & editing, Data curation

Adem Tibeso: Data curation, Formal Analysis, Validation, Writing – review & editing

Husen Bona: Resources, Supervision, Validation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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