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Research Article

On-farm Evaluation of Double Disc Wet Coffee Pulper

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Abstract

Coffee is the world's favorite drink, the most important commercial crop plant, and the second most valuable international commodity after oil. Coffee berries are pulped in two ways: wet and dry pulping. This method preserves the instinctive characteristics of coffee, including aroma, and produces beans that retain their natural quality better, which is most preferred by consumers. The Jimma Agricultural Engineering Research Center has developed a double-disc wet coffee pulper. The purpose of the study was to to evaluate Engine-operated double-disc wet coffee pulpers with farmers in the field. Andode Alega, Elke Togobe, Atiro Sofa, Shani Besira, and Onja were selected based on the potential of coffee production from three districts (Seka Chokorsa, Setema, and Sigimo) for distribution and popularization of the technology. Training was attended by 50 young farmers (25 Female, 25 Male) and 10 agricultural workers (SMS and DAs). Performance evaluation of the technology was made based on the attributes identified. The average pulping capacity of 983.33kg/hr, pulping efficiency of 97.10%, un-pulping loss of 1.87%, and breakage of 1.28% were obtained at feeding rate of 7kg/min and drum speed of 260 rpm. The pulper has good pulping performance as preferred by the participant farmers, which needs to be multiplied for greater popularization.

Keywords

Coffee Pulper, Double-disc, Engine-powered, Performance Evaluation

1. Introduction

Coffee is one of Ethiopia's most important cash crops, accounting for over 28% of the country's foreign exchange earnings. According to [11], Arabica and Robusta are the two most significant coffee species. Coffee is one of the most widely consumed crops. Arabica coffee is the most significant commercial crop plant, the most precious international commodity after oil, and the most popular beverage in the world. About 100 million people rely on coffee for their livelihoods, and there are about 20 million families that grow coffee worldwide. A significant source of coffee genetic resources for the global coffee industry is Ethiopian coffee [10].

Only Ethiopia is the origin and diversity center for Arabica coffee [1] discusses Arabica. The Oromia Regional State's 1,093,268-hectare total land area includes the Jimma Zone, one of the coffee-growing regions [4]. Currently, the Jimma Zone accounts for 43% of the Oromia Region's export share and 21% of the nation's export share. About 28-35 thousand tons of the 40-55 thousand tons of coffee produced in the Zone each year are sent to the central market, with the remainder being consumed locally [4].

Pulping coffee berries is the initial step in post-harvest processing, and there are two ways to do it: wet pulping and dry pulping. Wet pulping is a procedure that can be carried out right away following harvest. Historically, this operations have been carried out using separate machines, which can be

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costly, time-consuming, and inefficient [13]. In addition to producing high-quality green beans and commanding higher prices, the wet method has gained popularity [7]. The wet method produces coffee beans that retain natural quality better and retain the inherent qualities of coffee, like aroma [8], which is primarily what customers prefer. Currently, the degree of fermentation determines how the wet method is applied [5]. The removal of the hull or parchment to extract the two typical beans from the cherry is known as hulling, and it comes after any of the techniques used, which vary depending on the region, coffee varieties, and weather conditions [12]. Minimizing the energy consumption associated with operations could potentially lower the overall carbon footprint of coffee processing in the region [14, 15].

Out of the Jimma coffee sent to the coffee quality inspection center laboratory between 2003 and 2007, more than 60% of the dry-processed coffee was categorized as grade 3, while 80% of the wet-processed coffee was categorized as grades 2 and 3, according to [3]. Poor quality was a major contributing factor, according to the author, because of the area's post-harvest processing and handling issues. The low quality had a significant negative impact on coffee farmers' earnings. Furthermore, because value-added technologies were lacking, the farmers did not profit from their coffee [9].

There is limited use of mechanized pulpers and washers due to a lack of awareness, high costs, and unavailability of suitable machines designed for smallholder needs and conditions [6]. As stated by the farmers at the meeting of the Agricultural Development Partners Linkage Advisory Council (ADPLAC), technologies that enhance coffee processing would be necessary. Their coffee's price would go down if such technologies didn't exist. The farmers had no other choice, so they were forced to sell to local investors who lowered coffee prices [2].

A wet coffee pulper with two discs has been created by the Jimma Agricultural Engineering Research Center. Technology can help with the pulping of wet coffee and give young people employment opportunities. Thus, the purpose of this work was to evaluate the double-disc wet coffee pulper with farmers in particular districts that received FSRP support.

2. Materials and Methods

2.1. Materials

Materials that were used in this study include sheet metals, angle iron, mini disc, pulley, engine 5 hp, flat iron, V belt, sensitive balance, etc.

2.2. Methods

2.2.1. Description of the Machine and Its Working Principle

The pulper was operated by a 5HP motor engine and fed by one person. The machine had two discs attached to one shaft, and the opening of the machine between the discs and guidance was adjusted according to the size of the coffee. Pulping involves the removal of the outer red skin, white fleshy pulp, separation of the pulp, and wet parchment coffee. This machine did these activities by squeezing the cherries between a pulper chopper knife and a disc.

2.2.2. Site Selection, Farmers' Identification, and FRG Organization Techniques

A purposive sampling method was employed to select each representative district and respective kebeles. Accordingly, three districts, namely Seka Chokorsa, Setema, and Sigimo from Jimma zone, were selected purposively based on the status of coffee production. Five kebeles, namely, Andode Alega, Elke Togobe, Atiro Sofa, Shani Besira, and Onja kebeles, were selected purposively based on the existence of coffee & accessibility for distribution.

Selection of FRG members was based on young farmers' consent or interest to be held as members, accessibility for supervision of activities, a good history of harmony with groups, and transparency to share innovations with other farmers. To this end, one FRG having 10 members with the arrangement of all classes of young farmers, including gender, with the proportion of almost 50% to 50% men and women respectively, was established at each selected kebeles to improve communication and learning system among farmers, researchers, and extension agents. Lastly, one representative was selected based on their group's willingness, and one cashier was selected for proximity to all FRG members to attend to all technology activities from each established FRG. To this end, all FRG members and other follower farmers were encouraged to participate in the evaluation conducted at each site.

2.2.3. Capacity Building Techniques

Training was organized at all selected sites through extension teaching methods such as individual methods, group discussion methods, and result and method of demonstration, such as crea0ting awareness and enhancing the knowledge & skills of the farmers toward engine-operated wet coffee pulper.

2.2.4. Type of Data Collected and Data Collection Methods

Both qualitative and quantitative data were collected through several methods of data collection. Those methods are face-to-face interviews, observation, and focus group discussion (FGD). Types of data collected are machine performance like capacity (kg/hr), efficiency (%), and breakage loss (kg), the number of farmers who participated in extension events (demonstration, training, and mini-field days), and farmers' opinions toward demonstrated technology.

Figure 1. *Photo taken during technical training on a double-disc wet coffee pulper.*

2.3. Method of Data Analysis

The collected quantitative data were expressed in numbers and analyzed by descriptive statistics like frequency and percentage, whereas the qualitative data were expressed in words and analyzed by interpretation.

2.4. Performance Evaluation of the Machine

2.4.1. Pulping Capacity

Weight of coffee cherry fed into the pulper per unit of time, expressed in kilograms per hour.

$$pc = \frac{total\ weight\ of\ \ pulped\ coffee}{time\ taken}$$

2.4.2. Pulping Efficiency

The ratio of the total weight of parchment coffee collected at all outlets to the total coffee cherry to the machine, expressed as a percentage.

$$pe = \frac{weight\ of\ \ pulped}{weight\ of\ \ total} * 100$$

2.4.3. Unpulped Loss

The ratio of the total weight of un-pulped coffee cherry to the total input weight of coffee cherry to the pulper is expressed in a percentage.

$$Up\,(\%) = \frac{weight\ of\ \ unpulped\ coffee}{total\ \ weight\ of\ \ input\ coffee} * 100$$

2.4.4. Mechanically Damaged Parchment Coffee

The ratio of the total weight of damaged parchment coffee to the total weight of the sample, expressed as a percentage.

$$Md\,(\%) = \frac{weight\ of\ \ damaged\ coffee}{total\ \ weight\ of\ \ sample} * 100$$

3. Results and Discussion

The wet coffee pulper was multiplied and distributed to a group of unemployed young farmers. Practical and theoretical

training was given to the farmers, subject matter specialists (SMS), and development agents (DAs) at the selected sites on the operation and maintenance of the machine to create awareness during distribution. Accordingly, a total of 50 farmers, 5 DAs, and 5 subject matter specialists participated in the training.

Table 1. Training given to farmers, DAs & SMS on engine-operated coffee pulper.

No	Location		Training Participants				
			Farmers		Workers		Total
	District	Kebele	Male	Female	DAs	SMS	
1	Seka chokorsa	Andode Alega	5	5	1	1	12
		Elke Togobe	5	5	1	1	12
		Atiro Sofa	5	5	1	1	12
2	Setema	Shani Besira	5	5	1	1	12
3	Sigimo	Onja	5	5	1	1	12
4	Total		25	25	5	5	60

Table 2. The mean performance evaluation of the engine-operated wet coffee pulper.

Feeding rate (kg/min)	Speed (rev/min)	Capacity (kg/hr)	Efficiency (%)	Broken (%)	Un-pulped (%)
7	260	983.33	97.10	1.28	1.87

The performance evaluation of the technology was made based on the attributes recognized as important and showed that average the maximum pulping capacity of the machine was 983.33 kg/hr, the maximum pulping efficiency of the machine was 97.10%, higher un-pulped loss of 4.43% was obtained at a maximum speed of the machine 260 rpm and low feed rate of 7 kg/hr and the minimum un-pulped loss was 1.87%, and the minimum broken percentage was 1.28% obtained at 7 kg/min feed rate and 92 rpm of the machine. Thus, the above table indicates that the engine-operated wet coffee pulper machine has good pulping efficiency as preferred by the participant farmers.

Farmers' Feedback

The participant farmers were very happy to see the technology. They confessed that it had the potential to relieve them of the stress of staying on the pulp. They wondered whether they had obtained the machine at any price. In the district, the men and women pulp the coffee by mortar and sell cherries or un-pulped coffee. This process is very difficult and takes a long time. As a result, they reported that they always seek technologies that they find most efficient for doing the pulping. Similarly, they got excited about the technology because they could operate the machine themselves. However, in focus group discussions, they gave some comments that need further exploration.

4. Conclusion and Recommendation

4.1. Conclusion

A wet coffee pulping machine was evaluated, and the following conclusions were drawn: The maximum pulping efficiency of the machine is 97.10% at a 7 kg/min feeding rate and 260 rpm of the machine, with good performance. The maximum pulping capacity of 983.33 kg/hr was obtained at a feeding rate of 7 kg/min and 260 rpm of the machine speed. The minimum un-pulping loss of the machine was 1.87% at a 7 kg/min feed rate and 260 rpm of the machine speed. The maximum percentage of breakage was 1.71% at a speed of 260 rpm and a feed rate of 7 kg/min. The perception responses showed that the participant farmers viewed the wet coffee pulper positively for its good pulping capacity and efficiency, while no respondent responded to its poor level of pulping capacity.

4.2. Recommendation

The research center has to arrange follow-up training for

local microenterprises and end users for sustainable utilization of the technology.

As the improved engine-operated double disc wet coffee pulper was appropriate for small and medium-level coffee producers and private investors, it has to be further multiplied.

Abbreviations

Das	Development Specialists
Md	Mechanical Damage
Pc	Pulping Capacity
Pe	Pulping Efficiency
Up	Unpulped Loss
SMs	Subject Matter Specialists

Author Contributions

Husen Bona: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Teshome Wakeyo: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Tolasa Berhanu: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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