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On Farm Evaluation of Faba Bean Threshing Machine for Pulse Crop Threshing

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ABSTRACT

Pulses are an important source of energy and protein, essential amino acids, dietary fibers, minerals, and vitamins, and play a significant role in addressing global nutritional security. Traditionally, pulse crops are threshed by manual beating of plants with sticks or trampling under the hooves of animals which is not only labour intensive, tedious and time consuming but also causes damage in form of bruising of seed coat or splitting, resulting in low recovery. The purpose of this study was to evaluate the performance of a faba bean threshing machine for pulse crop threshing. Performance tests of the fabricated finger millet thresher were conducted at three different levels of cylinder speed (600.00, 700.00, 800.00 rpm) and three levels of feeding rates (8.00, 10.00, 12.00 kg/min) at constant moisture content for chickpea and soybean. The experimental design was RCD with factorial arrangement having three replications of each treatment, i.e. 3x3x3.comparison between treatment means was made using the least significance difference (LSD) at 5.00% level. The results indicated that the mean threshing capacity, threshing efficiency, and cleaning efficiency, are 395.22 kg/hr and 98.72kg/hr, 98.72% and 98.52 %, 93.94% and 98.62% respectively. Based on the performance evaluation results, it is concluded that the faba bean thresher can be effectively used in pulse producer farmers.

Keywords: Soybean; Chickpea; Feeding Rate; Cylinder Speed; Threshing Capacity; Threshing Efficiency; Cleaning Efficiency; Percent of Grain Damage; Coefficient of Variation; Least Significant Difference.

1. Introduction

Pulses are an important source of energy and protein, essential amino acids, dietary fibers, minerals, and vitamins, and play a significant role in addressing global nutritional security (Nalawade et al., 2026). In Ethiopia, pulse crops rank second in importance after cereals, occupying about 15.2% of the total cultivated areas and contributing about 11.9% of the total production. Common pulse species grown in the country include faba bean, soybean, field pea, chickpea, lentil, grass pea, cowpea, pigeon peas, and mung beans (CSA, 2021).

Soybean (*Glycine max* (L.) Merr) is an economically, agriculturally and industrially (food, textile, pharmaceuticals, paper) important crop on a global scale. It is often referred to as a 'wonder legume' and 'gold from the soil' due to its substantial value and versatile nature. Soybean seeds are rich in proteins and serve as a vital source of macronutrients, micronutrients, vitamins, and minerals. It holds a crucial role as a multi-purpose crop, serving both as animal feed and as stapling human diets (Mishra et al., 2024). Chickpea is an important food legume in Ethiopia, which provides sources of livelihood for millions of smallholder farmers. Currently, it has become an important high value pulse crop that promotes commercialization (Ferede et al., 2021).

Traditionally, pulse crops are threshed by manual beating of plants with stick or trampling under the hooves of animals which is not only labour intensive, tedious and time consuming but also causes damage in form of bruising of seed coat or splitting, resulting in low recovery. The available mechanical threshing machines in the markets are mostly for crops like wheat and paddy (Sinha et al., 2019). The aggressive nature and design of wheat and paddy threshers are optimized for harder, less fragile grains. Applying them to softer, more brittle pulse crops results in unacceptable levels of seed damage, loss, and poor separation, making them unsuitable for effective and efficient pulse threshing. The market still lacked threshing machines specifically designed for pod pulse crops like haricot bean, soybean, chickpea, field pea, and cowpea. Therefore, this research project was initiated to evaluate a faba bean threshing machine for pulse crops, focusing on defining its key operational circumstances for improved threshing efficiency and accessibility.

1.1. Study Objectives

General objective: To evaluate the performance of faba bean threshing machine for pulse crops.

Specific objectives: To evaluate the performance of faba bean thresher machine for soybean; to evaluate the performance of faba bean thresher machine for chickpea.

2. Material and Method

2.1. Experimental site

The prototype faba bean thresher was manufactured at Jimma Agriculture Engineering Research Center. The performance of the thresher was evaluated at Dedo and Nada District, Jimma Zone, and Oromia Regional State for chickpea and soybean respectively due to on the potential of the area for production.

2.2. Materials

Material and devices used for the experiment are:

- Faba bean thresher machine
- Tachometer
- Oven dry
- Digital timers
- Weighing scale
- Graduated cylinder

2.3. Performance Evaluation of Thresher Machine

The performance of the machine was evaluated from the data collected during, before, and after testing. The data were collected from field and laboratory tests based on the measurement or test required. The data collected included crop parameters (Moisture content, Grain –straw ratio)) and machine performance (threshing capacity, threshing efficiency, cleaning efficiency, percent of grain damage).

2.3.1. Threshing capacity

The thresher capacity of the machine was determined using the relationship as determined by Ndirika, (1994) and Akintayo, (2015).

$$T_c = \frac{Q_s}{t} \qquad (1)$$

Where:

T_c = Threshing capacity expressed in kilogram per minute (kg /h).

Q_s = quantity of grains collected at the grain outlet in kilogram.

t = time taken to thresh in minutes.

2.3.2. Threshing efficiency

The threshing efficiency of the machine was determined using the relationship as determined by Ndirika, (1994) and Akintayo, (2015).

$$T_E = 100 - \frac{Q_u}{Q_t} \times 100 \qquad (2)$$

Where:

T_E= threshing efficiency in percentage.

Q_u =unthreshed quantity of grains in a sample.

Q_t = the total quantity of grains (kg) threshed and unthreshed in the Sample.

2.3.3. Cleaning efficiency

The cleaning efficiency was determined using the relationship determined by Ndirika, (1994) and Akintayo, (2015).

$$C_E = \frac{(W_t - W_c)}{W_t} \times 100 \qquad (3)$$

Where:

C_e = Cleaning efficiency in percent.

W_t = total weight at the outlet in kilogram.

W_c= chaff weight at the outlet in kilogram.

2.4. Experimental Design

Performance tests of the faba bean thresher were conducted using a 3x3 factorial arrangement with three replications. The treatment consisted of three levels of cylinder speed (600.00, 700.00, and 800.00 rpm) and three levels of feeding rate (8.00, 9.00, and 12.00 kg/min). These tests were performed on two different pulse crops: soybean and chickpea. Treatment means were compared using the Least Significant Difference (LSD) test at a 5.00% significance level.

2.5. Data Analysis

The data was analyzed by using R-statistic software and treatment means that are different at a 5% level of significance was separated using LSD.

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3. Result and Decision

The performance of the faba bean thresher machine was evaluated at various drum speeds and feed rates, at constant moisture contents of 12.3% for soybean and 14.6% for chickpea. The evaluation focused on threshing capacity, threshing efficiency, cleaning efficiency, and percentage of grain damaged.

3.1. Main effect of feed rate on performance of thresher machine

The results revealed that feed rate had a significant effect on the threshing capacity, cleaning efficiency, and percent of grain damage for soybean grain. Similarly, for chickpea, the results showed that feed rate had a significant effect on threshing capacity and cleaning efficiency. In both pulses, as the feed rate increased from 8 kg/min to 12 kg/min, the threshing capacity of the machine increased from 250.69 to 359.55 kg/hr for soybean and from 244.99 to 416.69 kg/hr for chickpea, respectively. Conversely, as the feed rate increased from 8 kg/min to 12 kg/min, the cleaning efficiency of the machine decreased from 85.45 to 79.58% for soybean and from 96.63 to 95.79% for chickpea. These findings are supported by Akendola et al. (2025). Their results revealed that feed rate significantly affected threshing capacity, cleaning efficiency, and percent of grain damage. Specifically, they found that an increased feed rate led to increased threshing capacity and increased grain damage, while threshing efficiency and cleaning efficiency decreased.

Table 1. Main Effects of Feed Rate on Performance Metrics of Soybean and Chickpea Threshing Machine

Soybean					***Chickpea***		
Feed rate (kg/min)	TC(Kg/hr)	TE (%)	CE (%)	GD (%)	TC(Kg/hr)	TE (%)	CE (%)
8	250.69[c]	97.31[a]	85.45[a]	1.66[c]	244.99[a]	96.63[a]	85.35[a]
10	301.88[b]	96.72[a]	82.64[b]	2.07[b]	343.26[b]	96.00[a]	83.40[b]
12	359.55[a]	96.20 [a]	79.58[c]	2.53[a]	416.69[c]	95.79[a]	80.81[c]
LSD	17.33	2.29	1.08	0.33	23.70	1.04	0.91
CV	5.70	2.63	1.42	0.13	6.91	1.72	1.16

where TC= Threshing capacity, TE = Threshing efficiency, CE= Cleaning efficiency, GD= percent of grain damage, LSD = least significant difference, CV = coefficient of variation.

3.2. Main effect of drum speed on performance of thresher machine

The results showed that drum speed had a significant effect on the threshing capacity, threshing efficiency, cleaning efficiency, and percent of grain damage for both soybean and chickpea. For soybean, as the drum speed increased from 600 to 800 rpm, the threshing capacity increased from 279.09 to 332.01 kg/hr, threshing efficiency increased from 96.20 to 97.21%, cleaning efficiency increased from75.72 to 90.82%, and percent grain damage increased from 1.24 to 3.01%.Similarly, for chickpea, as the drum speed increased, the threshing capacity increased from 296.48 to 379.02 kg/hr, cleaning efficiency increased from 77.89 to 88.56, and threshing efficiency increased from 94.67 to 96.42% . This finding aligns with the work of Kumar et al. (2022), who observed a similar relationship. They found that drum speed had a significant effect on threshing capacity, threshing efficiency, cleaning efficiency, and percent of grain damage. As drum speed increased, it led to increased threshing capacity, grain damage, threshing efficiency, and cleaning efficiency.

Table 2. Main Effects of speed on Performance Metrics of Soybean and Chickpea Threshing Machine

Drum speed Rpm	Soybean				Chickpea		
	TC(Kg/hr)	TE (%)	CE (%)	GB (%)	TC(Kg/hr)	TE (%)	CE (%)
600	279.09[c]	96.20[c]	75.72[c]	1.24[c]	296.48[c]	94.33[c]	77.89[c]
700	300.94[b]	96.72[b]	81.17[b]	2.02[b]	329.44[b]	96.42[b]	83.09[b]
800	332.01[a]	97.21[a]	90.82[a]	3.01[a]	379.02[c]	94.67[a]	88.56[a]
LSD	17.33	2.29	1.08	0.33	23.70	1.04	0.91
CV	5.70	2.63	1.42	0.13	6.91	1.72	1.16

3.3. Interaction effect of feed and speed on performance of pulse thresher machine

The results revealed that the interaction of feed rate and drum speed had a significant effect on the threshing capacity for both soybean and chickpea. The maximum threshing capacity for soybean was 395.22 kg/hr, achieved at the maximum drum speed (800 rpm) and a feed rate of 12 kg/min. Similarly, the maximum threshing capacity for chickpea was 451.87 kg/hr, also obtained at the maximum drum speed (800 rpm) and a feed rate of 12 kg/min. The findings align with those of (Akendola et al., 2025.), who noted an increase in the threshing capacity of a soybean thresher both drum speed and feed rate.

As shown in Table 3, the interaction between feed rate and drum speed had a significant role in maximizing the threshing efficiency of for soybean and chickpea. The highest threshing efficiency recorded was 98.72% for soybean and 98.62% for chickpea, occurring at a drum speed of 800 rpm and a feed rate of 6 kg/min. The results were in agreement with result (Chansrakoo et al., 2018) in soybean that when feeding rate increased, threshing efficiency consistently decreased at all drum speeds. However, threshing efficiency increased as drum speed increased.

The highest cleaning efficiency for soybean, 93.94%, was observed at a feed rate of 8 kg/min and a drum speed of 800 rpm. Conversely, the lowest cleaning efficiency for soybean, 72.79%, occurred at a feed rate of 12 kg/min with a drum speed of 600 rpm, as illustrated in Table 3. Similarly, for chickpea, the highest cleaning efficiency of 98.62% was observed at a feed rate of 8 kg/min and a drum speed of 800 rpm, as illustrated in Table 3. Their results indicate a direct relationship between cleaning efficiency and drum speed: an increase in drum speed corresponds to an increase in cleaning efficiency, while an increase in feed rate leads to a decrease in cleaning efficiency

The results show that the interaction of feed rate and drum speed had a significant effect on grain damage percentage in soybean. The maximum grain damage percentage was 3.71 % obtained at combined effect of 12kg/min feed rate and 800rpm of the machine. The percentage grain damaged increases with increasing the feed rate and speed of drum. This result aligns with (Chansrakoo et al., 2018) which observed that increased rotor speed and feed lead to higher grain breakage.

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Table 3. Interaction effect of feed rate and speed on metrics of pulse thresher for soybean and chickpea

Speed (rpm)	Feed rate (kg/min)	Soybean				Chickpea		
		TC (kg/hr)	TE (%)	CE (%)	GD (%)	TC (kg/hr)	TE (%)	CE (%)
600	8	224.07[e]	96.05[c]	78.26[f]	0.82[d]	202.17 [f]	94.99[cde]	80.29[e]
	10	277.44[cd]	95.34 [cd]	76.12[g]	1.33[cd]	306.112[e]	94.81[de]	78.18[f]
	12	335.76[b]	94.14 [d]	72.79[h]	1.56[c]	318.10[c]	93.20[e]	75.21[g]
700	8	256.29[d]	97.12[b]	84.17[d]	1.57[c]	228.72[f]	96.64[bc]	84.86[c]
	10	298.10[b]	97.07 [b]	80.73[e]	2.16[b]	344.49[d]	96.45[bc]	83.24[d]
	12	341.66[b]	96.12 [c]	78.26[f]	2.32[b]	415.11[b]	96.16[bcd]	81.19[e]
800	8	271.71[cd]	98.72 [a]	93.94[a]	2.60[b]	304.07 [e]	98.62[a]	90.90[a]
	10	329.10[b]	97.55 [b]	91.14[b]	2.72[b]	379.12[c]	97.52[ab]	88.77[b]
	12	395.22[a]	97.33 [b]	87.39[c]	3.71	451.87[b]	96.96[ab]	86.03[b]
LSD		**30.02**	2.98	1,87	0.58	41.05	1.81	1.59
CV		5.70	2.63	1.42	0.13	6.91	1.72	1.16

4. Conclusion and Recommendation

The effects of feed rate and cylinder speed on threshing capacity, threshing efficiency, cleaning efficiency, and percent of grain damage computed during the performance evaluation. The following conclusions were drawn from the results obtained.

1) The main effect of feed rate feed rate significantly affected threshing capacity, cleaning efficiency, and percent of grain damage.

2) The main drum speed had a significant effect on threshing capacity, threshing efficiency, cleaning efficiency, and grain damage.

3) Increased feed rate led to increased threshing capacity and increased grain damage, while threshing efficiency and cleaning efficiency decreased.

4) As drum speed increased, it led to increased threshing capacity, grain damage, threshing efficiency, and cleaning efficiency.

5) Based on the results obtained, the faba bean thresher's performance was generally found to be satisfactory. It offers an improvement over traditional pulse crop threshing techniques, which are known for being time-consuming, labor-intensive, and inefficient.

5. Future Suggestions

1) The thresher was found difficult to move manually from place to place as needed due to a lack of transportation. Therefore, it is recommended that wheels be provided to facilitate easier movement.

2) Conduct additional field tests with various pulse crops and under different environmental conditions to assess the versatility and adaptability of the thresher design.

3) Implement training programs for farmers to ensure they are familiar with the machine's features and can operate it effectively. Proper training can maximize the machine's performance and longevity.

4) Incorporate adjustable concave and sieve for different crop types and moisture levels to optimize threshing performance.

5) Utilize lightweight yet durable materials in the construction of the thresher to reduce its overall weight while maintaining structural integrity.

Declarations

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Competing Interests Statement

The authors have not declared any conflict of interest.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

Informed Consent

Not applicable for this study.

Availability of data and material

Supplementary information is available from the authors upon reasonable request.

Institutional Review Board Statement

Not applicable for this study.

Ethical Approval

Not applicable for this study.

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References

[1] Akendola, F.A., Komolafe, C.A., Ankrah, A.A., & Yemoh, O.O. (2025). Design, fabrication, and performance evaluation of a soybean threshing machine. International Journal of Advanced Technology and Engineering Exploration, 12(122): 53–73. https://doi.org/10.19101/ijatee.2024.111101148.

[2] Adekanye, T.A., Osakpamwan, A.B., & Osaivbie, I.E. (2016). Evaluation of a soybean threshing machine for small scale farmers. Agricultural Engineering International: CIGR Journal, 18(2): 426–434.

[3] Chansrakoo, W., & Chuan-Udom, S. (2018). Factors of operation affecting performance of a short axial-flow soybean threshing unit. Engineering Journal, 22(4): 109–120. https://doi.org/10.4186/ej.2018.22.4.109.

[4] Central Statistical Agency (CSA) (2021). Agricultural sample survey report on the area and production of major crops and livestock products. Statistical Bulletin, Ethiopia.

[5] Ferede, S., Fikre, A., & Ahmed, S. (2018). Assessing the competitiveness of smallholders chickpea production in the central highlands of Ethiopia. Ethiopian Journal of Crop Science, 6(2): 51–65.

[6] Mishra, R., Tripathi, M.K., Sikarwar, R.S., Singh, Y., & Tripathi, N. (2024). Soybean (*Glycine max* L. Merrill): A multipurpose legume shaping our world. Plant Cell Biotechnology and Molecular Biology, 25(3–4): 17–37. https://doi.org/10.56557/pcbmb/2024/v25i3-48643.

[7] Nalawade, R.D., Singh, R., Mahore, A., Arif, M., Meena, A.L., Ansari, M.A., & Kumar, S. (2026). Mechanization of pulse crops: Engineering challenges, technological advances, and opportunities for yield gap reduction. Journal of Food Legumes, 39: 115–127. https://doi.org/10.53550/jfl.v39ispecialissue.2372.

[8] Ndirika, V.I.O., Asota, C.N., Yiljep, Y.D., & Mudiare, O.J. (1996). Predicting the power requirement and threshing efficiency of stationary grain threshers using mathematical models. Journal of Agricultural Engineering and Technology, 4(1): 39–49.

[9] Sinha, J.P., Dahliwal, I.S., & Sinha, S.N. (2009). Effect of machine parameters on threshing quality for seed crop of chickpea. Journal of Agricultural Engineering, 46(4). https://epubs.icar.org.in/index.php/jae/article/view/14572.

[10] Vejasit, A., & Salokhe, V.M. (2006). Machine-crop parameters affecting performance of an axial-flow soya bean thresher. AMA, Agricultural Mechanization in Asia, Africa and Latin America, 37(3): 32.

[11] Sabo, J., & Adeyeye, O. (2025). Analysis of a block method developed with six generalised grid points for solving fourth order initial value problems. Journal of Mathematical Analysis and Modeling, 6(1): 155–173. https://doi.org/10.48185/jmam.v6i1.1361.

[12] Tumba, P., Skwame, Y., & Raymond, D. (2021). Half-step implicit linear hybrid block approach of order four for solving third order ordinary differential equations. Dutse Journal of Pure and Applied Sciences, 7(2b): 124–133.