Irish Interdisciplinary Journal of Science & Research (IIJSR)
Volume 9, Issue 1, Pages 91-104, January-March 2025

Evaluation and Selection of Asella Teff, Votex and FARC Small Grains and Spice Threshers for Black Cumin Threshing

Ashebir Tsegaye[1*], Abulasan Kabaradin[2] & Abdisa Tashome[3]

[1-3]*Oromia Agricultural Research Institute, Asella Agricultural Engineering Research Center, P.O. Box 06, Asella, Arsi, Ethiopia.*
Corresponding Author (Ashebir Tsegaye) Email: tsegayeashebir@gmail.com[*]

DOI: https://doi.org/10.46759/IIJSR.2025.9110

Article Received: 13 January 2025 *Article Accepted: 24 March 2025* *Article Published: 28 March 2025*

ABSTRACT

This research project aimed to evaluate and compare the capabilities of three distinct threshers for the black cumin crop. Three replications were made to determine each machine's performance, and the dependent variables' values were computed. The Asella teff thresher, Fadis spice and small grain thresher, and Votex rice thresher are the three machines that are tested to assess their performance by varying the cylinder speed and feeding rate before the black cumin threshing machine is selected. Ultimately, the selection process was carried out according to the criteria of threshing efficiency, cleaning efficiency, output capacity, and percentage of grain losses. The results of the performance test showed that the Asella teff thresher, Fadis spice thresher, and Votex rice thresher yielded mean values of threshing efficiency of 99.25%, 94.78%, and 88.19%, cleaning efficiency of 91.84%, 67%, and 57.38%, output capacity of 191.77 kg/hr, 190.7 kg/hr, and 189.8 kg/hr, and total grain loss of 4.22%, 4.76%, and 5.47%, respectively. As a result, the results showed that the Asella teff thresher outperformed the others, particularly in terms of threshing and cleaning efficiencies.

Keywords: Capacity; Cleaning Efficiency; Cylinder Speed; Dependent Variables; Feeding Rate; Grain Loss; Output; Teff Thresher; Test; Threshing Efficiency; Threshing Machine.

1. Introduction

1.1. Background

Black cumin (*Nigella sativa* L.) is a member of the buttercup (Ranunculaceae) family of plants. This plant blooms once a year. Black cumin seed is one of the most powerful healing herbs ever discovered. The crop is indigenous to the Mediterranean area, and numerous cultures and civilizations have been using it for thousands of years.

The climate in Ethiopia is favorable for the growth of black cumin seeds. Large tracts of land in the Amara, Oromia, SNNP, and Gambella regions of the nation are used for the production of black cumin seed. The majority of Ethiopians prepare spices at home. Research also supports the use of black cumin seeds as a medicine for both external and internal health issues. Black cumin (*Nigella sativa*) seed is used not only for medicinal purposes but also for the manufacturing of soap, lotions, perfumes, food flavorings, food preservation, nutraceuticals, and cosmeceuticals derived from the oil (Atta MB., 2003, Takrun HRH, Dameh MAF., 1998).

The oil and seed yields of black cumin have garnered a lot of attention lately. Because of this, black cumin is now Ethiopia's second-most-exported cash crop after ginger, indicating a rise in consumption. According to Habtewold K., et al. (2017), Ethiopia produced 18,000 metric tons of black cumin seed annually in 2014–15, with an average productivity of 0.79 tons per hectare.

In Ethiopia, the Bale, Arsi, and South Gonder Zones are where black cumin was adapted and planted. In adapted areas across the country, the productivity of recently released varieties ranges from 0.9 to 1.6 tons/ha-1 on research stations to 0.8 to 1.2 tons/ha-1 on farmers' fields (MOARD, 2009). Among these crops, black cumin (*Nigella sativa*

L.) has a lot of potential for widespread farmer adoption if some of the key processes, like harvesting and threshing, is mechanized.

Harvesting and threshing are the most crucial field operations in the production of black cumin (*Nigella sativa* L.) because; these are labor-intensive processes that require human drudgery. Black cumin is traditionally threshed by trampling animals. Black cumin threshing is frequently delayed due to a lack of threshers, which results in a significant loss of grain. The lack of labor is pushing farmers to produce other crops instead of black cumin, which has an impact on output. The most important factor at this point is how quickly harvesting and threshing operations are completed; using a thresher should be the most suitable method. The traditional threshing method is marked by excessive labor, time waste, and threshing losses. Mechanical threshing minimizes threshing losses and does away with the labor-intensiveness of the traditional threshing system, all while preserving the quality of the finished products. Demand, the degree of agricultural machinery industry, farmers' purchasing power, agricultural infrastructure, and economic development all have an impact on the degree of agricultural mechanization.

Ethiopian agricultural research centers designed and built various crop thresher machines as part of the mechanization process. These machines are used by small-scale farmers to thresh cereal crops. Even when products are available, farmers frequently lack access to or knowledge of the many machines made especially for small-scale farming.

Not all businesses or companies thoroughly test and evaluate portable thresher machines that are imported or produced domestically in order to determine their functional suitability and performance reliability in comparing the performance of machines available in our country. Appropriate assessment of the black cumin thresher machine is essential to the goal of lowering costs associated with agricultural production and raising product quality. There isn't a neutral third party in our country that tests and assesses the portable threshers made by various agricultural research centers. The goal of this study is to evaluate and choose the best threshing machine for black cumin, taking into account the reports on the qualities of other comparable crops and threshing. This will lessen the labor-intensive process of using traditional methods to thresh black cumin capsules, resulting in minimal grain loss and high stripping, threshing, and cleaning efficiencies.

1.2. Research Objectives

1. To evaluate and adapt Asella teff thresher, FARC small grains and spice thresher for black cumin.

2. To adapt one of the best performing threshers for black cumin based on performance data.

2. Materials and Methods

The materials used and methods followed in performance evaluation of the evaluated threshers are described in this chapter.

2.1. Materials and instruments

The following materials and equipment were used to assess and test the engine-operated portable threshers made by Asella, imported rice threshers, and spice and small grain threshers made by Fadis.

- (Asella teff, Fadis Spice and Votex threshers) Threshing machines
- Harvested black cumin spice crop
- Stop watch: used for timing the threshing operation
- Tachometer: measuring the speed of the drum and other rotating parts
- Electric balance: weighing samples
- Grain moisture meter: used to measure moisture content of the grain
- Straw moisture meter: used to measure the straw moisture content
- Plastic bucket: used to collect the threshed grain from the outlet of the thresher
- Spread canvas sheet: used to collect scattered grain of the black cumin
- Graduated cylinder: used to determine fuel consumption.

2.2. Methods

The study was conducted in the Arsi zone Shirka Woreda, which was well-known for producing black cumin. Three machines were brought to Shirka woreda farmers' field to choose the proper black cumin thresher. The Asella teff thresher, the Votex thresher, and the Fadis made spice and small grain threshers are the three machines that were brought to the field.

2.2.1. Test Site Conditions

The thresher was set up with enough room for operation on a level, stable piece of land, and it was oriented so that the wind would carry clean grain and other contaminants away from the operator.

Figure 1. Asella teff thresher (thresher I), votex rice thresher (thresher II) and fadis spice and small grain thresher (thresher III)

2.2.2. Test Procedure

The methods employed to assess the threshers were PAES 205:2015 Philippine Agricultural Engineering Standards. According to the testing standard, machines must be compared to one another when tested under specific crop conditions. The machine was easily powered and set up to make sure different parts worked as they should. To check the machine, it was done for five minutes without any load. Every test trial had a set duration that began with the harvested crop's first feeding and ended with its last feeding. After the sample was taken, all outlet discharge was included. Using a stopwatch, the actual operating time for each test was determined. The threshing area was cleaned following the test trial and ready for the next trial.

2.2.3. Sampling procedures

To represent the various conditions of the test plot, representative samples were taken, including the grain-straw ratio and grain moisture content, for each test trial. To accomplish this, randomly select samples from the harvested black cumin crop. In order to facilitate laboratory analysis, samples that reflected the components used in each test trial were put in the proper containers.

2.2.4. Determination of moisture content

The moisture content of grains and straw can be expressed using either a dry weight basis or a wet weight basis. It was always expressed on a wet-weight basis in seed testing. Grain and straw moisture meters were used in this experiment to measure the grains and its moisture content.

2.2.5. Grain-straw ratio

The grain-to-swab ratio was calculated by manually separating the grain from the straw and then weighing each separately with a balance. Equation (2) was then used to determine it (Manfred, 1993).

$$Grain - straw = \frac{Weight\,of\;grain(g)}{Weight\,of\;straw(g)} \qquad \ldots(1)$$

2.2.6. Performance evaluation

Threshing capacity (TC), threshing efficiency (TE), cleaning efficiency (CE), and threshing losses were the metrics used to assess the threshing machine's performance (FAO, 1994).

2.2.6.1. Threshing efficiency (TE)

The ratio of threshed grain received from all outlets to total grain input, expressed as a percentage, was used to calculate threshing efficiency, which measures how well the thresher performs its primary function of threshing. Equation (2) was used to calculate this ratio.

$$TE = 100 - \frac{\mathrm{UM}}{\mathrm{TM}} \times 100 \qquad \ldots(2)$$

Where: T.E = threshing efficiency (%), UM = weight of unthreshed material in unit time (kg), TM = weight of total material input in unit time (kg).

2.2.6.2. Threshing capacity (TC)

The threshing capacity was employed to assess the thresher's speed at which it could complete the assigned threshing task. Equation (3) was used to calculate it.

$$\text{TC (Kg/hr)} = \frac{Total\ weight\ of\ threshed\ grain\ (Kg)}{Time\ taken\ to\ thresh\ (hr)} \quad \ldots(3)$$

2.2.6.3. Cleaning efficiency (CE)

Equation (4) was used to calculate the thresher's cleaning efficiency, which is defined as the weight ratio of clean grain to grain containing straw expressed as a percentage.-

$$CE\ (\%) = \frac{\text{weight of clean grain in unit time at grain outlet (kg)}}{\text{total weight of material collected at the grain outlet (kg)}} \times 100 \quad \ldots(4)$$

2.2.6.4. Threshing Losses

Cylinder loss and separation loss are the two types of threshing losses. To thoroughly evaluate the machine's performance, the threshing grain losses by the thresher were taken into consideration. Equations (5 and 6) were used to calculate the following drum loss and separation losses:-

$$D_L\ (\%) = \frac{W_{unstripped} + W_{unthreshed}}{W_t} \times 100 \quad \ldots(5)$$

$$S_L\ (\%) = \frac{W_{un-separated}}{W_t} \times 100 \quad \ldots(6)$$

Where: - $W_{Un\text{-}stripped}$ = Weight of un-stripped seed (g), $W_{Un\text{-}threshed}$ = Weight of unthreshed seed (g), and Wt = Total weight of input seed (g). $W_{Un\text{-}separated}$ = Weight of un-separated seed (kg).

2.2.6.5. Fuel consumption

Refill methods were used to quantify the fuel consumption. Before the test run, the fuel tank was completely full to its capacity. Then, the engine was shut off when the threshing was finished, and the fuel tank was filled back up using the graduate cylinder to find out how much fuel had been used. Quantity of fuel the thresher refueled after the test was conducted.

2.3. Experimental design and data analysis

Based on the factorial experiment design principle, the experiment was set up as a split-split plot with three replications. The three cylinder speed levels assigned to the sub plot, the three feed rate levels assigned to the sub-sub plot, and the three thresher types assigned to the main plot, each with three replications. There were 81 test runs overall (3x3x3x3 = 81) in the experimental design, which was laid out as 3^3 with three replications. Using GenStat 16th edition statistical software, the data were subjected to an analysis of variances procedure appropriate for the experiment design (Gomez and Gomez, 1984).

The least significant difference (LSD 5%) test was used to separate the treatment means that differed at the 5% levels of significance. The mean values of threshing capacity, threshing efficiency, cleaning efficiency, and grain loss in relation to thresher type, cylinder speed, and feeding rate were tested using the least significant difference (LSD) test.

3. Results and Discussion

The evaluation results of the three types of portable threshers for black cumin—the Votex rice thresher, the Asella-made teff thresher, and the Fadis-made spice and small grain thresher—are covered in this chapter. Tables and graphs were used to display the results. This section includes an analysis and discussion of the results.

3.1. Crop characteristics

The crop characteristics of black cumin crops were measured from 5 randomly taken samples and the mean values are presented in Table (1).

Table 1. Characteristics of Black Cumin Crop

S. No.	Particulate	Value
1	Av. sheaf length (cm)	45.67
2	Av. moisture content of capsules (%)	12.96
3	Av. moisture content of grain (%)	10.6
4	Av. grain-straw ratio	1:3.18

3.2. Performance testing of threshers

Performance assessments of various thresher types were carried out for the black cumin crop. Three feed rates (8, 10, and 12 kg/min) and three cylinder speeds (700, 800, and 900 rpm) were used to evaluate the performance. The relationship between feeding rate,cylinder speed and the dependent variable, viz. For every thresher, threshing loss, output capacity, cleaning efficiency, and threshing efficiency were examined.

3.3. Thresher Capacity

Threshing capacity is the thresher's output in kilograms per hour measured in relation to time. The threshing machine's output capacity is primarily determined by its cylinder speed. The greater the capacity, the shorter the threshing time is at higher speeds. A specific thresher's capacity would always be provided at a specific speed.

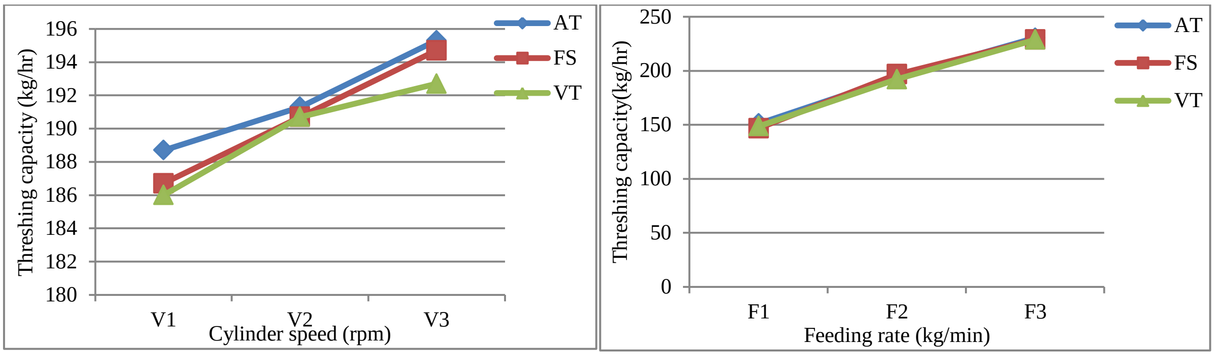

Figure 2. Effects of cylinder speed and feeding rate on grain output capacity

The findings displayed in Fig. 2 illustrate how each thresher's output capacity for black cumin crops is affected by the feed rate and cylinder speed. Figure 2 illustrates how cylinder speed and feed rate relate to grain output. It was found that as cylinder speed increased, so did the feed rate. When the cylinder speed increased from 700 rpm to 900 rpm, the feed rate increased linearly.

3.4. Threshing Efficiency

The results of the analyses of variance (ANOVA) showed that the feeding rate and thresher type interaction had no significant effect (p >0.05) on threshing efficiency, while the cylinder speed and its interactions with the thresher type, feeding rate, and cylinder speed and feeding rate had a significant impact (p < 0.05) on threshing efficiency.

The effects of feeding rate, thresher type, and drum speed on the mean percent of threshing efficiency are displayed in Table 2. The relationship between feeding rate and drum speed on threshing efficiencies is depicted in Figure 3. The findings showed that the type of thresher, feeding rate, cylinder speed, and the combined effect of these factors significantly influenced the percentage of threshing efficiency. The high stripping and impacting forces applied to the black cumin seed materials, which tend to enhance the threshing operation and increase threshing efficiency, contributed for the increase in the percentage of threshing efficiency by increasing drum speed.

Furthermore, the high frequency of impacts and collisions between spikes and grain capsules, as well as the increased abrasion between the concave and grain capsules, may be contributed for the threshing efficiency increase with cylinder speed. Afify et al.'s 2007 study on the impact of drum speed on black cumin threshing found that higher drum speeds resulted in higher threshing efficiency. In the case of black gram crops, Nishanth et al., 2020 also discovered higher threshing efficiency at high drum speed. Conversely, threshing efficiency decreases with increasing feed rate. The threshing chamber's overabundance of plants was blamed for the rising feed rate. As a result, the stalks and their capsules exit the apparatus before being fully threshed.

Table 2. Effects of drum speed and feed rate level on threshing efficiency (TE)

Parameter	**Source of variation**				**Measure of differences**
	Thresher type	**Drum speed level**			
		V_1	**V_2**	**V_3**	**LSD (5%)**
TE (%)	**AT**	98.80[a]	99.022[a]	99.928[b]	0.2931
	FST	91.236[b]	95.551[c]	97.558[d]	
	VT	87.591[c]	88.244[d]	88.72[e]	
	Thresher type	F_1	F_2	F_3	0.2191
	AT	99.496[a]	99.199[b]	99.056[b]	
	FST	95.019[c]	94.851[c]	94.474[d]	
	VT	88.461[d]	88.367[d]	87.728[e]	
	Interaction(Ds*F)				0.2341
	Drum speed level	F_1	F_2	F_3	
	V_1	92.874[a]	92.629[b]	92.123[c]	
	V_2	94.55[b]	94.311[c]	93.957[d]	
	V_3	95.551[d]	95.477[d]	95.178[e]	

Means followed by the same letter (or letters) do not have significant difference at 5% level of probability.

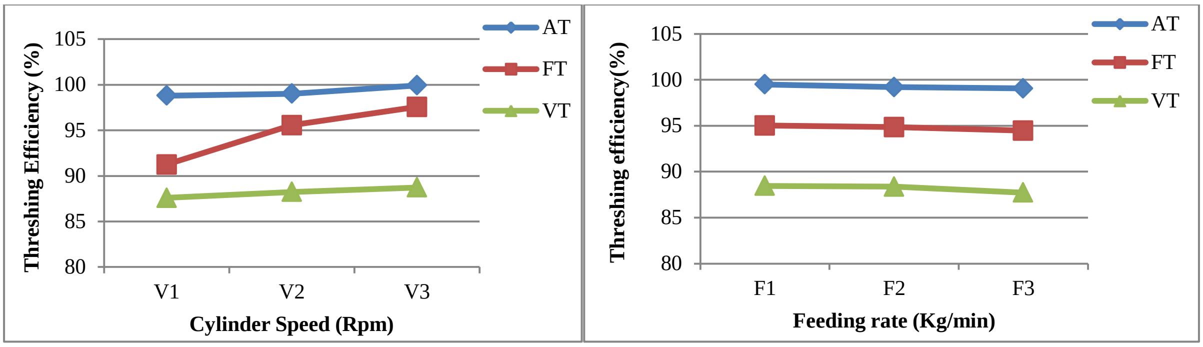

Figure 3. Effects of cylinder speed and feeding rate on threshing efficiency

3.5. Cleaning Efficiency

The results of the analyses of variance (ANOVA) indicate that the following factors significantly affected cleaning efficiency: cylinder speed, feeding rate, type of thresher, and feeding rate with thresher interaction ($p < 0.05$). In contrast, the factors feeding rate with cylinder speed, type of thresher interaction, and cylinder speed, feeding rate, and thresher interaction did not significantly affect cleaning efficiency ($p > 0.05$).

The effects of feeding rate, thresher type, and cylinder speed on cleaning efficiency are displayed in Table 3. Figure (4) illustrates the relationships between cleaning efficiency, cylinder speed, feeding rate, and thresher type. The outcome shows that the type of thresher, feeding rate, and cylinder speed all significantly impacted cleaning efficiency. The threshers' cleaning efficiency rises with increased drum speed and falls with increased feed rate. This might be the result of increased impact action, as the chaff was broken up into small pieces that were easily blown away due to the chaff's decreased mass and decreasing terminal velocity. Gete Basa (2018) found that increasing the cylinder speed increased the cleaning efficiency in the study of the comparative performance evaluation of wheat threshers. Fulani et al. (2013) discovered a comparable outcome. Higher feeding rates cause more grain and straw to build up over the sieve for a short amount of time. This insufficient time allows the aspirator to not fully suction up the straw, allowing some straw to pass through and resulting in inefficient cleaning.

Table 3. Effects of drum speed and feed rate level on cleaning efficiency (CE)

Parameter	Source of variation				Measure of differences
	Thresher type	Drum speed level			
		V_1	V_2	V_3	LSD (5%)
CE (%)	AT	90.543^a	91.8^b	93.168^c	0.7626
	FST	65.64^b	66.954^c	68.392^d	
	VT	56.391^c	57.349^d	58.392^e	
	Thresher type	F_1	F_2	F_3	0.6619
	AT	93.626^a	91.477^b	90.409^c	
	FST	67.28^d	66.987^d	66.72^d	
	VT	57.738^e	57.446^e	56.949^e	

	Interaction(Ds*F)				
	Drum speed level	F_1	F_2	F_3	
	V_1	71.543[a]	70.678[b]	70.353[b]	
	V_2	72.802[b]	71.918[c]	71.383[c]	0.7410
	V_3	74.298[c]	73.313[d]	72.341[e]	

Means followed by the same letter (or letters) do not have significant difference at 5% level of probability.

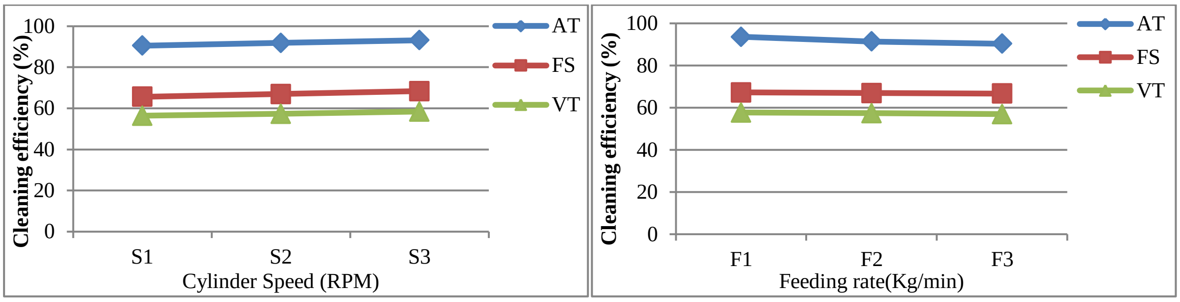

Figure 4. Effects of cylinder speed and feeding rate on cleaning efficiency

3.6. Threshing Losses

Losses from threshing are cylinder loss and separation. It was discovered that thorough measurement of these factors was not practical or particularly informative when testing small-scale machines, despite the fact that these losses might be substantial for these machines. Rather than relying solely on quantitative measurements to assess the threshing quality, one could ask the farmers themselves to assess the threshing loss and output.

3.7. Cylinder loss

The results of the analyses of variance (ANOVA) indicate that the following factors had a significant impact on cylinder loss: cylinder speed, feeding rate, type of thresher, and the combination of cylinder speed and feeding rate ($p < 0.05$). On the other hand, cylinder loss was not significantly affected ($p >0.05$) by the combinations of cylinder speed, feeding rate, and thresher type, or by the interaction of cylinder speed and feeding rate.

Table 4 demonstrates that the feeding rate, thresher type, and cylinder speed all significantly impacted the percentage of cylinder loss. The relationship between cylinder speed, feeding rate, thresher type, and cylinder loss percentage is depicted in Figure 5.

Cylinder speed is a crucial factor to take consideration when cylinder loss is taken into account. The outcome demonstrates that each thresher's cylinder loss reduced with an increase in cylinder speed and increased with an increase in feed rate. Because fewer un-threshed grains were received at the cylinder outlet at higher cylinder speeds, it was observed that cylinder loss decreased as cylinder speed increased.

Similar phenomena were seen for all threshers and at all feeding rates: as cylinder speeds increased in relation to the corresponding feed rates, cylinder loss decreased. In general, as feed rate increased and threshing drum speed increased, the threshing losses—expressed as cylinder losses, which represent un-threshed seed losses—increased.

Table 4. Impact of Feed Rate Level and Drum speed on Cylinder Loss (CL)

Parameter	Source of variation				Measure of differences
	Thresher type	Drum speed level			
		V_1	V_2	V_3	LSD (5%)
CL (%)	AT	1.2^{a}	0.931^{b}	0.072^{c}	0.1044
	FST	2.404^{b}	1.883^{c}	1.242^{d}	
	VT	3.471^{c}	2.883^{d}	2.242^{e}	
	Thresher type	F_1	F_2	F_3	0.1124
	AT	0.504^{a}	0.763^{b}	0.936^{c}	
	FST	1.694^{b}	1.847^{c}	1.989^{d}	
	VT	2.694^{c}	2.847^{d}	3.056^{e}	
	Interaction(Ds*F)				0.1198
	Drum speed level	F_1	F_2	F_3	
	V_1	2.089^{a}	2.296^{b}	2.691^{c}	
	V_2	1.711^{b}	1.918^{c}	2.069^{d}	
	V_3	1.093^{c}	1.243^{e}	1.22^{e}	

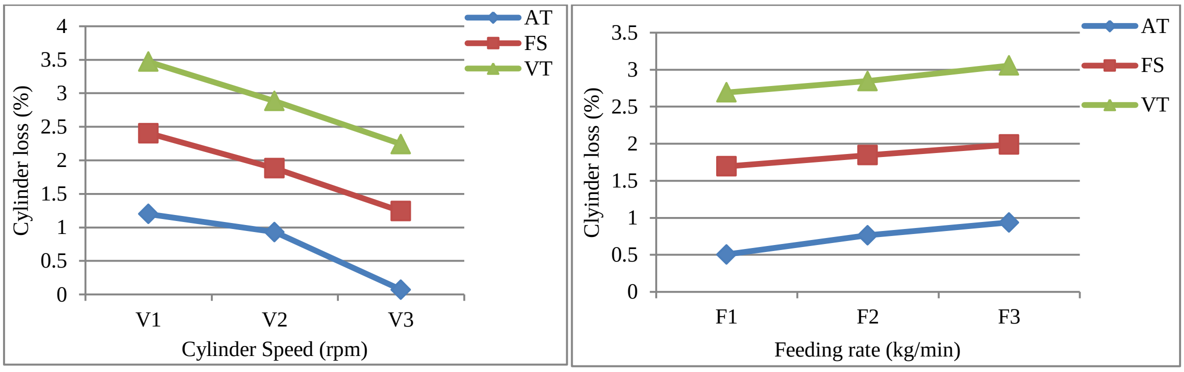

Figure 5. Effects of cylinder speed and feeding rate on cylinder loss

3.8. Separation loss

The results of the analyses of variance (ANOVA) indicate that the following factors had a significant impact on separation loss: cylinder speed, feeding rate, thresher type, and the interactions between cylinder speed and feeding rate, thresher type and feeding rate, and cylinder speed, thresher type, and feeding rate ($p < 0.05$). In contrast, the interaction between cylinder speed and thresher type did not significantly affect separation loss ($p > 0.05$).

Table 5 demonstrates that the feeding rate, thresher type, and cylinder speed all significantly impacted the percentage of separation loss. The relationship between cylinder speed, feeding rate, thresher type, and percentage of separation loss is depicted in Figure 6. As the cylinder speed and feed rate increased, so did the separation losses. As the feed rate was increased from 8 to 12 kg/min while the cylinder speed remained constant, the separation

Irish Interdisciplinary Journal of Science & Research (IIJSR)
Volume 9, Issue 1, Pages 91-104, January-March 2025

losses increased (Fig. 6). The reason for this increase is thought to be the overabundance of plants in the threshing chamber, which prevents the capsules from completely threshing and increases the amount of un-separated seeds.

Moreover, separation losses increased when the cylinder speed was raised from 700 to 900 rpm while maintaining a constant feed rate. The elevated stripping and impacting forces exerted on the plants were the reason for the rise in the percentage of separation losses observed upon increasing cylinder speed.

Table 5. The Impact of Feed Rate Level and Drum Speed on Separation Loss (SL)

Parameter	**Source of variation**				**Measure of differences**
	Thresher type	**Drum speed level**			
		V_1	**V_2**	**V_3**	**LSD (5%)**
SL (%)	**AT**	2.4711^{a}	2.9222^{b}	3.3767^{c}	0.11502
	FST	2.5078^{a}	2.87^{b}	3.3678^{c}	
	VT	2.1344^{b}	2.4789^{d}	3.2644^{c}	
	Thresher type	F_1	F_2	F_3	0.06194
	AT	2.6444^{a}	2.9444^{b}	3.0811^{c}	
	FST	2.7978^{c}	2.9222^{b}	3.0256^{c}	
	VT	2.5044^{d}	2.6411^{e}	2.7322^{f}	
	Interaction(Ds*F)				0.08926
	Drum speed level	**F_1**	**F_2**	**F_3**	
	V_1	2.5233^{a}	2.6678^{b}	2.9222^{c}	
	V_2	2.8456^{b}	3.1122^{c}	3.3133^{d}	
	V_3	3.3778^{c}	3.7278^{d}	3.9033^{e}	

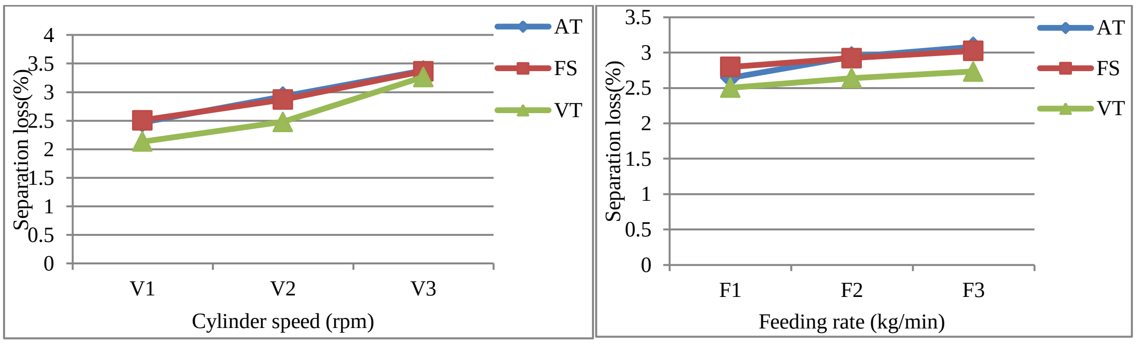

Figure 6. Effects of cylinder speed and feeding rate on separation loss

3.9. Total loss

Figures 5 and 6 shows, the total seed losses, which include both cylinder losses and separation losses, based on the analysis and results from the previous study. It is evident that for every type of thresher, the lowest overall seed losses were obtained at the lowest cylinder speed and feed rate.

3.10. Comparison among Asella Teff, Fadis Spice and Votex Rice Threshers

The results of the performance test (Table 6) indicate that there was a significant difference in the machines' efficiencies. The Asella teff, Fadis spice, and Votex rice thresher comparison revealed that grain losses, cleaning efficiency, and threshing efficiency are all important factors. However, there is no significance difference in the output capacity between Votex rice threshers, Fadis spice, and Asella teff. Asella outperformed Votex rice thresher and Fadis spice in terms of performance.

Table 6. Comparison among Asella Teff, Fadis Spice and Votex Rice Threshers

Parameter	Mean value			Measure of differences (LSD (5%))
	Asella teff thresher	Fadis spice thresher	Votex rice thresher	
Threshing efficiency (%)	99.250^{a}	94.781^{b}	88.185^{c}	0.1917
Cleaning efficiency (%)	91.837^{a}	66.996^{b}	57.377^{c}	0.4271
Output capacity (kg/hr)	190.4^{a}	190.7^{a}	189.8^{a}	8.38
Cylinder loss (%)	0.734^{a}	1.843^{b}	2.866^{c}	0.0620
Separation loss (%)	3.923^{a}	2.915^{b}	2.626^{c}	0.0495
Total grain loss (%)	4.657^{a}	4.758^{b}	5.492^{c}	0.0991

4. Conclusion

This study compared the effectiveness of three different kinds of threshers for threshing black cumin. Using actual research data, the threshing capacity, threshing efficiency, and threshing seed losses were examined for all three Asella teff threshers; Fadis spice threshers, and Votex rice threshers. The cylinder speed and feed rate significantly impacted the threshing machine's efficiency. Asella teff, Fadis spice, and Votex rice threshers were found to have the following average values for their respective performance parameters: threshing efficiency of 99.25%, 94.78%, and 88.19%; cleaning efficiency of 91.84%, 67%, and 57.38%; output capacity of 191.77 kg/hr, 190.7 kg/hr, and 189.8 kg/hr; and total grain loss of 4.22%, 4.76%, and 5.47%. When the Asella teff, Votex rice thresher, and Fadis spice were compared, it was evident that the Asella teff thresher had a higher output capacity, threshing efficiency, and cleaning efficiency than the other two. In comparison to Votex and Fadis spice threshers, Asella teff thresher likewise achieved the lowest grain loss. Overall, the Asella teff thresher performed better than other models in every category, with threshing percentage and cleaning efficiency being two of the best. Therefore, Asella teff thresher was thus suggested for threshing black cumin crop since it was more effective than the Votex rice thresher and the Fadis spice thresher.

5. Recommendation

Based on the study, the following suggestions are made in an effort to address the current issue with locally made portable black cumin threshers:- Because these machines were chosen based on standard performance parameters;

➢ The Asella teff thresher's results are encouraging, and large-scale demonstrations are advised for all regions that produce black cumin crops.

After the portable black cumin thresher has been continuously improved and scaled up to a marketable product, there may be viable businesses producing and distributing it.

Declarations

Source of Funding

This research does not benefit from grant from any non-profit, public or commercial funding agency.

Competing Interests Statement

The authors have declared that no competing financial, professional or personal interests exist.

Consent for publication

All the authors contributed to the manuscript and consented to the publication of this research work.

Availability of data and material

Supplementary information is available from the authors upon reasonable request.

Acknowledgments

The authors are deeply grateful to the principals, researchers, and staff of agricultural machinery and farm power team for their invaluable cooperation and participation in this study. Their willingness to share their experiences and knowledge made this research possible.

Reference

Atta, M.B. (2003). Some characteristics of Nigella (*Nigella sativa* L.) seed cultivated in Egypt and its lipid profile. Food Chemistry, 83(1): 63–68. https://doi.org/10.1016/s0308-8146(03)00036-1.

Afify, M.K., El-Sharabasy, M.A., & Ali, M.M. (2007). Development of a local threshing machine suits for threshing black seed (*Nigella sativa*). MISR Journal of Agricultural Engineering, 24(4): 699–724.

FAO (1994). Testing and evaluation of agricultural machinery and equipment: Principles and practices (Agricultural Services Bulletin No. 110). Food and Agriculture Organization. http://www.fao.org/3/t0515e/t0515e00.htm.

Fulani, A.U., Kuje, J.Y., & Mohammad, M.I. (2013). Effect of moisture content on performance of a locally fabricated cowpea thresher. Journal of Engineering and Applied Sciences, 5(2): 1–15.

Gete Basa (2018). Comparative analysis and performance evaluation of engine operated portable wheat threshers. Master's Thesis, Adama Science and Technology University.

Habtewold, K., Demes, F., Tewodros, L., Dejene, B., Haimanot, M., & Wakjira, G. (2017). Seed spices production guideline. Ethiopian Institute of Agricultural Research. http://publication.eiar.gov.et/handle/123456789/3107.

Ministry of Agriculture and Rural Development (2009). Crop registered variety. Addis Ababa, Ethiopia.

Nishanth, M.S., Kumar, A., Wankhade, R.D., Malkani, P., Rani, A., & Sharma, E. (2020). Modification and performance evaluation of thresher for black gram. International Journal of Current Microbiology and Applied Sciences, 9(3): 3213–3227. https://doi.org/10.20546/ijcmas.2020.903.368.

Takrun, H.R.H., & Dameh, M.A.F. (1998). Study of the nutritional value of black cumin seeds (*Nigella sativa* L.). Journal of the Science of Agriculture, 76: 404–410.

Tamiru, D., & Teka, T. (2015). Evaluating and selecting of existing machines for rice threshing. Journal of Multidisciplinary Engineering Science and Technology, 2(7): 3159–0040.