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# Performance Evaluation of Motorized Millet Thresher

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Millets are grown in semi-arid regions of the world which require less water to grow, particularly these crops were grown in Asia and. African continents of the world. Telangana has a semi-arid weather condition which is a suitable environment for the cultivation of millets. Commonly cultivated millets in Telangana are Sorghum, Pearl millet, Finger millet (major millets) Foxtail, little, Kodo, Proso and Barnyard millet (minor millets). A study was conducted to evaluate the performance of CIAE developed motorized thresher. The thresher was evaluated for three millets, Foxtail, Barnyard and Finger millets. The evaluation was conducted by AICRP on Farm Implements and Machinery, PJTAU, Rajendranagar at Regional Agricultural Research Station (RARS), Palem, Nagarkurnool District. Key performance indicators of thresher *viz.,* feed rate, input capacity, output capacity, blower loss, un threshed grain, threshing efficiency and cleaning efficiency were measured. Results indicate that threshing efficiency for Foxtail millet, Finger millet and Barnyard millet are 97.94%,

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92.17% and 97.52% respectively. The cleaning efficiency of Foxtail millet, Finger millet and Barnyard millet were 99%, 92.47% and 94.00% respectively.

*Keywords: Millet thresher; threshing efficiency and cleaning efficiency.*

## 1. INTRODUCTION

Millets have been a cornerstone of traditional agriculture in India for centuries, playing a crucial role in the country's food security and rural livelihoods. These hardy, drought-resistant grains, including varieties such as Sorghum (Jowar), Pearl millet (Bajra), Finger millet (Ragi), and small millets, are well-adapted to the semi-arid and arid regions of India. Historically, millets were staple crops in many parts of the country, valued for their nutritional richness, requiring minimal inputs and being resilient in the face of climate variability. In recent years, there has been a renewed interest in millets, driven by their health benefits and ecological sustainability. Rich in essential nutrients, including fiber, protein, vitamins, and minerals, millets offer significant advantages over more commonly consumed cereals such as Wheat and Rice. Their low glycemic index makes them particularly beneficial for managing lifestyle diseases like diabetes (Khatri et al., 2021; Singh et al., 2015; Kamble et al., 2003). Additionally, millets contribute to environmental sustainability by requiring less water and chemical inputs compared to other cereals, making them a key crop in the context of climate change and sustainable agriculture.

In Telangana, the cultivation of Jowar (Sorghum) spans an area of 0.56 lakh hectares, resulting in a production of 1.04 lakh tonnes with an average yield of 1,853 kg per hectare. Bajra is cultivated on 0.06 lakh hectares, producing 0.11 lakh tonnes, with a yield of 1,833 kg per hectare. During the 2021-2022 period, Ragi was grown on 0.01 lakh hectares, yielding 0.02 lakh tonnes and achieving a productivity of 1,657 kg per hectare. Additionally, small millets are cultivated across 0.62 lakh hectares in the state, producing 1.15 lakh tonnes with an average yield of 1,851 kg per hectare.

In India, the threshing and cleaning efficiency of foxtail millet, finger millet (ragi), and barnyard millet can generally range between 80-95%. A millet thresher is specifically designed to handle the unique characteristics of millets, separating the grains from the chaff with minimal damage and loss (Balappa et al., 2024). Evaluating the performance of a millet thresher involves assessing various parameters such as threshing efficiency, grain quality, throughput capacity, power consumption, and ease of operation. High-performing threshers not only reduce the time and labor required for post-harvest processing but also ensure a higher recovery of clean, undamaged grains, thereby enhancing the market value and profitability for farmers.

The performance of a millet thresher is a critical aspect of post-harvest processing in millet cultivation, directly impacting the efficiency, quality, and profitability of grain production. Millets, due to their small seed size and tough outer husks, traditionally require labour-intensive and time-consuming methods for threshing, which can lead to significant grain losses, contamination, and physical strain on farmers. As agricultural practices evolve, the mechanization of threshing has become essential to improving the productivity and sustainability of millet farming. One of the constraints in millet production are low productivity, difficulty in processing, low efficacy of millet processing machinery *etc.,* Therefore, to minimize the post-harvest losses CIAE has developed millet thresher and to investigate the functional effectiveness of the thresher its performance was evaluated by AICRP on FIM at Regional Agricultural Research Station (RARS), Palem.

## 2. MATERIALS AND METHODS

A millet thresher is a specialized machine designed to separate millet grains from their husks or chaff. The construction and components of a millet thresher are tailored to handle the small size and tough husks of millet grains efficiently. Millet thresher consists of the following components:

**Feeding Hopper:** The hopper is where the millet stalks are fed into the machine. It is designed to ensure a steady flow of material into the threshing mechanism (Agidi Gbabo et al.,2013).

**Threshing Drum/Cylinder:** The core component of the thresher, the threshing drum, is fitted with beaters, pegs, or rasp bars that rotate at high speed to beat the millet heads, separating the grains from the stalks and husks (Shalini Chaturvedi & A. K. Shrivastava 2023).

**Concave:** Positioned beneath the threshing drum, the concave is a semi-circular grid that holds the crop in place while allowing the separated grains to pass through the gaps. The design and clearance between the drum and concave are crucial for effective threshing.

**Blower/Fan:** The blower is used to create airflow through the machine, which helps to separate the lighter chaff and husks from the heavier grains. This component is critical for cleaning the grains as they exit the threshing drum.

**Sieves/Screens:** After threshing, the grain passes through a series of sieves or screens that filter out any remaining debris or unthreshed material. The size and type of sieves can often be adjusted to suit different grain sizes.

**Grain Outlet:** The cleaned millet grains are discharged through the grain outlet, typically collected in a bag or bin for further processing or storage.

**Chaff Outlet:** The chaff and other waste materials are expelled through a separate outlet, usually at the rear or side of the machine.

**Drive Mechanism:** The thresher is powered by an electric motor. The drive mechanism transfers power to the threshing drum and other components.

**Frame/Chassis:** The sturdy frame supports all the components and ensures the machine's stability during operation. It is usually made of heavy-duty steel to withstand the stresses of threshing.

**Transmission System:** The transmission system, which includes belts, pulleys, gears, and shafts, transfers power from the engine to the various moving parts of the thresher.

**Adjustment Mechanisms:** These are provided to adjust the speed of the drum, the clearance between the drum and concave, and the air flow rate through the blower. These adjustments are necessary to optimize the threshing process for different millet varieties and moisture levels.

**Safety Guards:** To prevent accidents, millet threshers are often equipped with safety guards over moving parts like belts and pulleys.

The above components work together to ensure that millet grains are efficiently threshed, cleaned, and collected, reducing the manual labor required and increasing the overall productivity of millet processing.

**Operational principle:** The threshing drum fitted with three rows of canvas strips and three rows of cutting knives placed alternately as some of the millet crop requires cutting action and some requires shear for complete threshing. The knives arrows provide impact cutting of crop stem during threshing and the canvas strip rows gives gentle abrasion and shear on the crop for removing the grains.

**Performance evaluation of thresher:** The performance of CIAE designed motorized millet thresher was evaluated by AICRP on Farm Implements and Machinery, PJTSAU for three millets *viz.,* foxtail millet, Finger millet and Barnyard millet at Regional Agricultural Research Station, Palem, Nagarkurnool District. Singh et al. ( 2010) studied different physical properties of barnyard millet. Baryeh (2002) evaluated different physical properties of millets and expressed as function of moisture content between 5−22.5%. The thresher was tested with feeding only the ear heads. The feed rate for foxtail millet and finger millet were kept 120 kg $h^{-1}$ and Barnyard millet was kept 75 kg $h^{-1}$. Moisture content of the millets ranged from 12.3% to 13.8%. Thresher was powered with two hp, single phase electric motor and power is transmitted to the threshing drum, aspirator with the help of belt drive. The thresher was evaluated at a constant cylinder speed of 540 rpm and the parameters like blower loss, un threshed grain, threshing efficiency and cleaning efficiency were studied while threshing.

**Fig. 1. Motor operated millet thresher**

**Table 1. Specifications of millet thresher**

| S. No. | Particulars | Details |
|---|---|---|
| 1. | Size of thresher, mm | 385x330 ø |
| 2. | Type of cylinder | Raspbar |
| 3. | Power source of motor, kw & rpm | 2.2 & 1400 |
| 4. | Chute length and width, mm | 880 x 500 |
| 5. | Top sieve dimension | |
| | Size of sieve, mm | 540 x 410 |
| | Hole size, mm | 6.5 Circular shape |
| 6. | Bottom sieve dimension | |
| | Size of sieve, mm | 720x460 |
| | Hole size, mm | 2.5 |
| 7. | Concavity, mm | 100 |
| 8. | Concave clearance, mm | 12-15 |
| 9. | Number of spikes on each bar | 8 |
| 10. | Total no of spikes | 48 |
| 11. | Peripheral distance between two Spikes, mm | 40 |
| 12. | Number of outlets (Main grain+ sieve over flow + husk + straw) | 04 |
| 13. | Overall dimensions (length x breadth x thickness), mm | 2060x1220x1250 |
| 14. | Cost of machine, Rs. | 77,000/- |

## 3. RESULTS AND DISCUSSION

Millet thresher was evaluated as discussed in above the results are tabulated in Table 2.


**Fig. 2. Field evaluation of millet thresher**

**Table 2. Performance evaluation of millet thresher**

| S. No. | Parameters | Observations | | |
|---|---|---|---|---|
| 1. | Number of tests | 4 | | |
| 2. | Total duration, h | 4 | | |
| 3. | Crop | Foxtail millet | Finger millet | Barn yard |
| 4. | Crop Variety | PKS 22 | PRS 38 | VL 207 |
| 5. | Grain moisture, % | 13.8 | 12.3 | 13.8 |
| 6. | Feed Rate (Fr), kg $h^{-1}$ | 120 | 120 | 75 |
| 7. | Threshing cylinder speed, rpm | 540 | 540 | 540 |
| 8. | Input, kg $h^{-1}$ | 120 | 120 | 75.00 |
| 9. | Output, kg $h^{-1}$ | 62.40 | 87.12 | 57.9 |
| 10. | Broken, % | 1.33 | 1.34 | 0.75 |

| | | | | |
|---|---|---|---|---|
| 11. | Blower loss, % | 1.94 | 1.48 | 2.33 |
| 12. | Un threshed, % | 2.05 | 7.82 | 2.47 |
| 13. | Threshing efficiency (Te), % | 97.94 | 92.17 | 97.52 |
| 14. | Cleaning efficiency (Ce), % | 99.00 | 92.47 | 94.00 |

**Foxtail Millet** **Finger Millet** **Barnyard Millet**

**Fig. 3. Different types of millets after threshing**

From the above Table.2 it was observed that threshing efficiency of Foxtail millet, Finger millet and Barnyard millet are 97.94 %, 92.17 % and 97.52% respectively, Cleaning efficiency of Foxtail millet, Finger millet and Barnyard millet are 99.00 %, 92.47 % and 94.00% respectively. Threshing efficiency and cleaning efficiency of Foxtail millet is higher and Finger millet is lower among the three millets threshed. Output of Foxtail millet, Finger millet and Barnyard millet are 62.40 kg $h^{-1}$, 87.12 kg $h^{-1}$ and 57.9 kg $h^{-1}$ respectively. Broken percentage of Barn yard millets (0.75%) is lower than finger millets (1.48%) and foxtail millets (1.94%). Unthreshed percentage of foxtail millet, finger millet and barnyard millet is 2.05,7.82 and 2.47% respectively. Blower losses of foxtail millet, finger millet, barnyard millet are1.94,1.48, 2.33% respectively.

## 4. CONCLUSIONS

The study revealed that while threshing Foxtail millet (PKS 22) and Barnyard millet (VL 207), high threshing, cleaning efficiencies and low percentages of unthreshed grains were observed. However, Barnyard millet has a slightly higher blower loss. The higher unthreshed grain percentage for Finger millet indicates that the threshing cylinder speed or feed rate might need to be optimized. The results suggest that different millet varieties respond differently to the same threshing conditions, emphasizing the need for variety-specific adjustments to optimize processing outcomes. Bansal and Lohan (2009) reported higher cleaning efficiency at lower moisture content in case of seed crops. Simonyan et al., (2006) also reported same result in case of cleaning performance of stationary sorghum thresher. Fulani et al. (2013) found higher cleaning efficiency at lower moisture content during threshing of cowpea thresher. Cleaning efficiency was observed slowly decreasing with increase of feed rate in case of all the experimental range of moisture content, threshing sieve size and drum speed.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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