NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 11, ISSUE 10, October – 2025

REVIEW ON DESIGN AND DEVELOPMENT OF SORGHUM HARVESTING TOOLS

Prof. Upadhe Sudeep N.
Asst. Prof. Mechanical Engg. Dept/AGPIT, Solapur/DBATU, Lonere

Prof. Rathod Sanjay B.
Asst. Prof. Mechanical Engg. Dept/AGPIT, Solapur/DBATU, Lonere

Prof. Patil Naresh P.
Asst. Prof. Mechanical Engg. Dept/AGPIT, Solapur/DBATU, Lonere

Prof. Dontul Ganesh N.
Asst. Prof. Mechanical Engg. Dept/AGPIT, Solapur/DBATU, Lonere

ABSTRACT:
Sorghum Harvesting is a critical area of agricultural engineering research aimed at improving efficiency, reducing labor, and minimizing crop loss. Sorghum, being a tall, often lodging-prone crop with variable head and stalk characteristics, presents unique challenges for mechanized harvesting compared to other cereals. The following review synthesizes findings from research papers focusing on the design, optimization, and performance evaluation of various components and full systems for sorghum harvesting.

INTRODUCTION:

Overview of Sorghum Harvesting Challenges

Traditional sorghum harvesting, often done manually with sickles, is labor-intensive and time-consuming, contributing to high production costs and delayed operations. The transition to mechanization is hampered by the distinct physical and mechanical properties of the sorghum plant:

- **Tall and Thin Stalks:** Prone to lodging (falling over) and entanglement, leading to high harvest loss with conventional harvesters.
- **Droopy and Scattered Ears:** The panicles are often unevenly distributed and can droop, increasing ear loss during cutting and feeding.
- **Variable Moisture Content:** Sorghum can have high moisture content in the stalk and seed at harvest, which affects cutting, conveying, and threshing operations.

LITERATURE REVIEW:

The reviewed literature focuses primarily on **cutting mechanisms** and **header/platform improvements** to address the challenges of high loss rates and poor feeding, particularly in lodged or tall-stalk varieties.

1. Header and Cutting Mechanism Design

Design and Experimental Study of Sorghum Cutting Tables Based on a Push and Division Integrated Outer Divider: [1] [2]

Focus: Development of an integrated outer divider for the cutting table to specifically address lodging, entanglement, and broken stem loss.

Design: The system uses an **outer divider rod** and a **grain lifter** to separate the crop inside and outside the cutting width.

Key Finding: The cutting table with the outer divider significantly **reduced harvest loss** compared to one without. Optimal working parameters were determined using the Box–Behnken experimental design (e.g., dividing angle of, forward speed of m/s). This highlights the importance of specific header design to manage crop entanglement.

Design and Experiment of Grain Lifter for Sorghum Harvester: [2]

Focus: Addressing ear loss and crop leakage caused by traditional grain lifters, especially in crooked and fallen sorghum.

Design: Developed a **segmented and reverse spiral grain lifter** integrated into the harvester cutting table. The grain lifter helps to raise lodged plants and guides the lower part of the stalk to the gripper conveyor chain and cutter.

Design and Development of Special Cutting System for Sweet Sorghum Harvester: [3]

Focus: Designing a specialized cutting mechanism for the thick, juicy stalks of sweet sorghum, that is harvested as whole stalk

Design: Utilizes a **rotary disk with four cutting blades** to cut the stalks by impact and inertia force. This differs from reciprocating or scissor-type cutters.

Key Finding: A blade angle provided the smoothest cut without fracturing the stalk filaments and vascular bundles, crucial for preserving the stalk's sugar content. This underscores that cutting tool design must align with the specific end-use and physical properties of the sorghum type.

An Overview of Special Harvesters for Harvesting Fine-Grain Products: [4]

Context: Discusses the general problem of excessive loss in conventional combine heads when harvesting fine-grained products like sorghum.

Relevance: Mentions the need for specialized headers with high-elevation dividers and loss-reducing systems (e.g., collecting bowls) to minimize shedding, reinforcing the common limitation of standard combine harvesters for sorghum.

2. Physical and Mechanical Properties for Design

Engineering Properties of Sorghum Bioguma-Variety for Designing Appropriate Thresher and Chopper Machine: [5][10]

Focus: Determining the physical and mechanical properties of sorghum plants (stem, panicle, and seeds) as a fundamental basis for designing machinery.

Data Points: Measured parameters like moisture content, stem hardness, seed hardness, and tensile force of the seed from the panicle.

Relevance: The findings provide crucial input for designing cutting tools (based on stem strength/hardness) and threshing mechanisms (based on tensile force and seed hardness), ensuring the tools are effective and minimize damage.

3. Economic and Performance Evaluation

Study of Economics of Manual and Mechanical Harvesting Method of Sorghum Crop: [6][8]

Focus: Comparing the performance and economics of a tractor front-mounted sorghum harvester with manual harvesting.

Performance: The mechanical harvester achieved an effective field capacity of and a field efficiency of

Economic Impact: Mechanical harvesting showed a **saving** in operation cost and a saving in time per hectare compared to manual methods. This justifies the investment in and development of mechanical tools.

4. Post-Harvest Tool Development

Design and Development of a Sorghum Winnowing Machine: [7][9]

Focus: Developing a mechanical solution for the post-harvest process of winnowing, that is also manually strenuous

Design: Fabricated an electric-powered winnowing machine with a blower, hopper, and feed gate.

Key Finding: Achieved a high winnowing efficiency of and a capacity of kg/hr. While not a "harvesting tool" in the field cutting sense, this addresses a critical, labor-intensive step immediately following harvest.

SYNTHESIS AND FUTURE DIRECTIONS

The reviewed literature consistently shows that successful sorghum harvesting tool design hinges on overcoming the physical challenges posed by the plant's structure, primarily **lodging and high field losses**. The most significant developments are focused on the **harvester header/cutting platform**, incorporating specialized components like integrated outer dividers and segmented grain lifters to improve crop intake and reduce loss.

Future research should focus on:

1. **Integrated Threshing and Chopping:** Further research into threshing and chopping mechanisms based on the plant's engineering properties is needed to fully integrate the harvesting process, moving beyond just the cutting phase.
2. **Automation and Sensor Technology:** Incorporating real-time sensors for lodging detection and automatic adjustment of header parameters (e.g., height, speed, and divider angle) could optimize performance under variable field conditions, as the research indicates the sensitivity of loss rates to operational parameters.
3. **Low-Cost, Small-Scale Harvesters:** Given that many sorghum producers are small-scale farmers, the design and development of affordable, versatile, and easily repairable small-scale harvesting solutions remain a priority.

REFERENCES

1. Guo, W., Wang, Y., Jia, H., Liu, Z., & Chen, G. (2024). Design and experimental study of sorghum cutting tables based on a push and division integrated outer divider. Ciência Rural, 54(3). Link to Source 1.1
2. Ma, Y., Zhang, X., Li, X., Wu, X., & Hou, J. (2023). Design and Experiment of Grain Lifter for Sorghum Harvester. Applied Sciences, 13(24), 13168. doi:10.3390/app132413168. Link to Source 1.8/2.4
3. Keshavarz, M. P., Aref-Azar, A., & Ahmadizadeh, S. (2007). Design and development of special cutting system for sweet sorghum harvester. Agricultural Engineering International: the CIGR Ejournal, 9. Link to Source 1.5
4. Bazyar, A., Javadikia, H., & Mirzabeigi, M. (2020). An Overview of Special Harvesters for Harvesting Fine-Grain Products. Dairy Veterinary Sci J, 13(2). Link to Source 3.4
5. Prasetyo, Y., Hariyadi, H., Taufik, E., Setiawan, A. S., & Purwanto, B. (2023). Engineering properties of sorghum bioguma-variety for designing appropriate thresher and chopper machine. AIMS Agriculture and Food, 8(3), 579–591. doi:10.3934/agrfood.2023039. Link to Source 1.6/2.5
6. Zou, D., Liu, W., Xu, S., & Li, Z. (2024). Comparative Analysis of Macro/Microstructures and Constituents of Sorghum and Reed Straw. Separations, 9(2), 107. doi:10.3390/separations9020107. Link to Source 3.1
7. Nikam, M. D., Borde, R. S., Khose, K. D., & Shinde, D. N. (2017). Study of Economics of Manual and Mechanical Harvesting Method of Sorghum Crop. International Journal of Current Microbiology and Applied Sciences, 6(6), 2419-2426. Link to Source 1.7
8. Thorat, S. V., Khamkar, A. D., Chaudhari, S. K., Kalunge, P. T., & Mane, B. B. (2021). Design and Development of Harvester FOR Bajra and Sorghum. Project Synopsis Presentation. Link to Source 1.10
9. Jones, B., et al. (2025). Technological features of harvesting pressed sorghum feed. Caspian Journal of Environmental Sciences, 23(1), 89-96. Link to Source 2.1
10. Oyegunwa, O. A., Adejugbe, I. T., Olorunsola, I. T., Olowonubi, J. A., Aigbovbiosa, J. O., Komolafe, O., & Ogunkoya, A. K. (2023). Design and Development of a Sorghum Winnowing Machine. Journal of Engineering Research and Reports, 25(10), 40-46. doi:10.9734/jerr/2023/v25i10999. Link to Source 1.3/2.2/2.3