www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 580-582

e-ISSN : 2583-1062
Impact Factor : 7.001

MULTIPURPOSE AGRICULTURAL MACHINE

Preetesh Moroliya[1], Nishant Bawangade[2], Tilak Kothurwar[3], Harsh Janware[4], Prof. Rajendra Dhandre[5]

[1,2,3,4,5]JD College Of Engineering And Management Nagpur, India.

ABSTRACT

This review brings together recent and foundational literature on multipurpose agricultural machines (MPAMs). It focuses on their design types, technological developments, and socioeconomic effects. This review consolidates recent and foundational literature on multipurpose agricultural machines (MPAMs). It emphasizes their design types, technological advances, socioeconomic impacts, field performance, and areas needing further investigation. MPAMs, which range from small, affordable multi-attachment tools to tractor-mounted combined implements and intelligent robotic platforms, aim to reduce labor costs, lower expenses, and improve farm efficiency, particularly for smallholder farms. We analyzed peer-reviewed reviews, FAO reports, journal articles, and engineering project papers to understand the current state of the field, highlight common findings, and identify research gaps. Key findings include: (1) combined and multifunctional implements can decrease the number of passes needed in the field, saving fuel and time; (2) much recent research emphasizes low-cost modular designs for small farms, with increasing interest in automation and IoT; (3) comprehensive field trials, consistent performance metrics, and assessments of lifecycle and sustainability are still limited. , field performance, and areas that need further research. MPAMs, which range from small, affordable multi-attachment tools to tractor-mounted combined implements and intelligent robotic platforms, aim to cut labor costs, lower expenses, and boost farm efficiency, especially for smallholder farms. We examined peer-reviewed reviews, FAO reports, journal articles, and engineering project papers to understand the current state of the field, highlight common findings, and pinpoint research gaps. Key findings include: (1) combined and multifunctional implements can reduce the number of passes in the field, as well as save fuel and time; (2) much recent work focuses on low-cost modular designs for small farms and there is growing interest in automation and IoT; (3) comprehensive field trials, consistent performance metrics, and assessments of lifecycle and sustainability remain limited.

1. INTRODUCTION

Mechanization is a key way to improve agricultural productivity and resilience. Multipurpose agricultural machines (MPAMs) address challenges faced by small and fragmented farms by combining multiple tasks into one platform. MPAMs lower the capital cost per function, reduce labor needs, and decrease the time and energy required for farming operations, which are crucial benefits where access to machinery is limited. International technical reviews and FAO guidance stress mechanization strategies that fit local farm sizes, labor markets, and sustainability goals.

2. METHODS — HOW THIS REVIEW WAS COMPILED

We conducted a focused literature search across academic databases and open repositories such as ScienceDirect, ResearchGate, FAO Open Knowledge, MDPI, and engineering conference or journal sites. Our keywords included: “multipurpose agricultural machine,” “multifunctional agricultural implements,” “combined implements,” “design and fabrication multipurpose machine,” “mechanization review,” and “farm mechanization developing countries.” We prioritized (a) peer-reviewed review articles and meta-analyses, (b) FAO or institutional technical reports, and (c) engineering design and field trials published from 2015 to 2025. We also included many engineering design papers and student projects from 2016 to 2025 to capture grassroots innovations; these often report on small-scale prototypes and details about fabrication. We cite representative sources throughout. (Examples of searches and key documents retrieved are in the references.)

3. TYPOLOGY OF MPAMS REPORTED IN LITERATURE

3.1 Combined/Multi-tool Tractor Implements

These are tools that combine more than one conventional tool (e.g., mouldboard and harrow; tillage and leveling) to reduce the number of passes and energy use. Reviews highlight active–passive and passive–passive configurations, and emphasize matching draft and power requirements with soil interactions. Studies of combined tillage tools and seedbed preparation tools look at fuel and time savings as well as improved seedbed quality.

3.2 Small multipurpose motorized vehicles and walk-behind machines

Numerous design and fabrication papers, often from engineering colleges, describe small, affordable machines for smallholders that accept different attachments (plough, seeder, sprayer, cart). These designs prioritize low cost, ease of

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 580-582

e-ISSN : 2583-1062
Impact Factor : 7.001

maintenance, and versatility for tasks like digging, sowing, spraying, and transporting. However, field testing and standardized performance evaluations are often limited or based on anecdotal evidence.

3.3 Mechanized multifunctional harvesters and combine-plus attachments

For larger farms, research trends explore modular headers and combined chopper-harvester units that adapt to multiple crops and minimize passes (e.g., combine and chopper configurations). Recent engineering reports stress the importance of modularity, allowing a basic machine to be configured differently across seasons.

3.4 Autonomous / IoT-enabled multipurpose platforms

Recent prototypes combine robotics, IoT, Bluetooth control, and battery power to perform tasks such as seeding, spraying, mulching, or weeding using various toolheads. These platforms are emerging as low-impact and precise alternatives that can function as shared services. Much of the reported work is still at the prototype and testing stage.

4. FINDINGS FROM THE LITERATURE

4.1 Performance and operational benefits

Reduced field passes, fuel, and time: Combined and multifunctional implements and MPAMs lessen the number of passes over the field, resulting in measurable cuts to fuel use and time per operation in controlled trials and modeling studies.

Labor savings and accessibility: For smallholders, MPAMs that consolidate operations consistently show a decrease in labor intensity and allow a single operator to handle multiple tasks.

4.2 Design trends and innovations

Modularity: A major design choice is modular attachments that enable reconfiguration for sowing, spraying, cultivation, transport, or harvesting. This low-cost modularity is beneficial for smallholders.

Lightweight and low-power designs: Many studies focus on creating machines suitable for human or tractor power ranges common in South Asia and Sub-Saharan Africa, favoring small engines and battery systems.

Integration of electronics/automation: Prototypes increasingly include Bluetooth/IOT control and basic autonomy to enhance precision and lessen the burden on operators.

4.3 Socioeconomic and sustainability considerations

Reviews and country studies underline the need for mechanization to be tailored to farm size, labor markets, and service provision models (such as rental and custom hiring centers) to be fair and sustainable. FAO and academic reviews warn that mechanization without appropriate service models might exclude smallholders.

4.4 Limitations and recurring weaknesses in the literature

Prevalence of small-scale design reports versus robust trials: Much of the engineering literature consists of fabrication reports and student projects, which often lack long-term field trials or standardized metrics.

Missing standardized performance and safety metrics: Comparative trials across different soil types, climates, and crops are rare. Data on safety, ergonomics, and maintenance cycles are often under-reported.

Environmental and lifecycle assessments are scarce: While fewer passes suggest lower emissions and soil compaction, few papers present quantified lifecycle or soil-health outcomes.

5. REPRESENTATIVE STUDIES (HIGH-VALUE CITATIONS)

Here are several key sources that shaped this review:

FAO / Mechanization resources — thorough technical overviews of mechanization strategies and factors to consider for implementation in developing countries.

Renting et al. (2009) — “Exploring multifunctional agriculture” — a conceptual review discussing the social and environmental aspects of multifunctional technology.

Research Trend / Combined and Multifunctional Implements (2022) — an engineering-oriented review covering combined and multifunctional implements, including active and passive configurations and efficiency benefits.

Springer (Daum et al., 2023) — Mechanization and sustainable agri-food systems — a review linking mechanization trends with sustainability challenges in the Global South.

Frontiers (Yasar et al., 2024) — a study examining how mechanization impacts farm performance, showing that proper adoption can enhance productivity and food availability.

(Engineering design and fabrication papers, along with recent prototype reports from 2016 to 2025, were also reviewed to capture grassroots and student innovations; several are cited throughout.)

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 580-582

e-ISSN : 2583-1062
Impact Factor : 7.001

6. SYNTHESIS — WHAT THE LITERATURE COLLECTIVELY SAYS

MPAMs provide clear operational advantages in time, fuel, and labor, particularly when designed to match local power sources and cropping systems. Solid evidence from studies on combined implements shows fewer passes and reduced energy use.

For smallholders, modular, low-cost MPAMs are promising but need proper service delivery models (such as hiring centers and cooperatives) to overcome capital barriers. FAO and recent reviews stress the importance of these service models.

Emerging automation technologies (like battery vehicles, IoT, and robotic platforms) offer precision and multi-tasking capabilities but remain at the prototype stage. Issues related to cost, reliability, and repair options are still challenges.

The research community is divided. Many design papers exist, but there are fewer rigorous comparative field trials, economic impact studies, or lifecycle sustainability assessments. High-quality interdisciplinary studies that blend engineering trials, economics, and environmental assessments are rare but necessary.

7. GAPS AND RECOMMENDED FUTURE RESEARCH DIRECTIONS

Standardized field trials & metrics: Develop common protocols for measuring power and draft, fuel and energy use per hectare, soil compaction, throughput, and reliability to compare MPAMs across different studies.

Lifecycle and soil-health assessments: Quantify the long-term environmental impacts (like GHG emissions, soil compaction, and biodiversity) caused by reduced-pass MPAMs.

Socioeconomic adoption studies: Assess cost and benefits across different farm sizes and service provision models (like rental, cooperatives, and custom hiring), including gender-sensitive analyses.

Reliability, maintenance, and local repair ecosystems: Research spare parts availability, local technician training, and designs that facilitate maintenance.

Scaling autonomous/IoT solutions: Conduct pilot studies on shared autonomous MPAM platforms with business models for rural service providers.

8. CONCLUSION

The literature shows that multipurpose agricultural machines have great potential to enhance efficiency, cut costs, and expand access to mechanization, especially where farms are small or capital is limited. Combined and multifunctional implements show immediate, evidence-backed gains in energy and time. Small, modular MPAMs are widely developed in engineering literature but require strong field validation and paths for service delivery. Future research should emphasize standardized performance evaluation, lifecycle sustainability, and integrated socioeconomic analyses to ensure MPAMs are both effective and fair.

9. REFERENCES

[1] FAO. Mechanization for Rural Development: A review of patterns and progress from around the world. FAO Open Knowledge Repository. FAOHome

[2] Renting, H., et al. Exploring multifunctional agriculture. (Review on multifunctionality; ScienceDirect). ScienceDirect

[3] ResearchTrend / Joe L. Bovas. Combined and Multifunctional Implements: A Promising Approach for Modern Farm Mechanization. (2022). Research Trend

[4] Daum, T., et al. Mechanization and sustainable agri-food systems. Springer (2023) — review of mechanization, drivers and trade-offs. SpringerLink

[5] Yasar, H., et al. Does farm mechanization improve farm performance and food availability? Frontiers in Sustainable Food Systems (2024). Frontiers

[6] Manivannan, R. et al., Modelling and analysis of agricultural three-in-one machine. (2022) — engineering study on multi-function machine modelling. ScienceDirect

[7] Multiple engineering design/fabrication papers and project reports (IJRPR, IRJET, IJARESCT, IJARSCT, IJFMR, IJARSET) documenting modular small MPAM prototypes and smallholder focused designs (2016–2025). IJFMR+3IJRPR+3IJARIIE+3