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Review on Motorised Cow Dung Collecting Machine

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Abstract: The motorised cow dung collecting machine is an innovative agricultural engineering solution designed to automate the labour-intensive process of collecting cow dung from livestock farms, open fields, and dairy establishments. Manual collection of cow dung is unhygienic, time-consuming, and physically demanding, posing significant health hazards to workers. This research paper presents a comprehensive literature review and design analysis of a motorised cow dung collecting machine that integrates mechanical, electrical, and control systems to achieve efficient, automated dung collection.

The proposed machine employs a chassis-mounted motorised platform equipped with a suction-conveyor mechanism, collection hopper, and a microcontroller-based drive system. The collected dung can be utilised for biogas production, organic fertilizer manufacturing, and fuel generation, thus contributing to rural energy sustainability. This paper covers all aspects of design, component selection, working principle, methodology, and future enhancements. The study also reviews relevant prior research to contextualize the proposed design within the current state of the art.

Keywords: Cow dung, motorised collector, biogas, organic fertilizer, rural technology.

1.INTRODUCTION

2.2 Introduction

India is an agrarian nation with over 300 million cattle, making it one of the largest livestock-holding countries in the world. The by-products of cattle, particularly cow dung, hold immense economic and agricultural value. Cow dung is a primary raw material for biogas production, organic fertilizers (vermicompost, biomanure), and traditional fuel cakes (uplas/gobar gas). Despite its considerable utility, the collection of cow dung remains a largely manual, unorganised, and unhygienic process across rural and semi-urban areas. Workers engaged in manual dung collection are exposed to pathogenic microorganisms such as E. coli, Salmonella, and various helminths, leading to serious gastrointestinal and respiratory ailments. The process is also ergonomically hazardous, involving prolonged bending, heavy lifting, and exposure to noxious gases (methane, ammonia, hydrogen sulfide) released during dung decomposition. In large dairy farms and gaushalas housing hundreds of cattle, manual dung removal can consume 3 to 5 hours of labor per day per worker.

The emergence of agricultural mechanization offers a compelling pathway to address these challenges. A motorised cow dung collecting machine automates the entire collection process — from detection and pickup to transportation and storage — thereby reducing human exposure, saving time, and increasing operational efficiency. Such a machine can be deployed in cattle sheds, open grazing fields, and dairy complexes, forming an integral part of sustainable farm management.

This research paper presents a detailed study of the motorised cow dung collecting machine, encompassing its conceptual design, working principle, component specifications, and development methodology. The paper further reviews existing literature and identifies research gaps that the proposed design seeks to address.

1.2 Problem Statement

The conventional process of cow dung collection in Indian farms and cattle sheds is characterised by:

- High dependency on manual labour, making it labour-intensive and costly.
- Exposure of workers to toxic gases and pathogenic bacteria.
- Inefficiency in large-scale dairy operations housing hundreds of animals.
- Inconsistent and delayed collection leading to hygiene degradation in cattle sheds.

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- Absence of any low-cost automated solution accessible to small and medium farmers.

These problems collectively point to the urgent need for a mechanised, affordable, and easy-to-operate dung collecting device.

2.OBJECTIVES OF THE STUDY

The primary objectives of this research are as follows:

- To design and develop a motorised cow dung collecting machine capable of automatic traversal and collection in enclosed and open cattle environments.
- To select appropriate mechanical and electrical components for the drive system, collection mechanism, and control unit.
- To review existing literature and technologies related to dung management and agricultural automation.
- To evaluate the working principle and operational feasibility of the proposed machine.
- To analyse potential improvements and future scope for enhancing machine functionality and applicability.
- To contribute to rural sanitation and sustainable agricultural practices through technological innovation.

3. SCOPE OF THE PROJECT

The scope of this project encompasses the following areas:

- Design of a motorised chassis suitable for operation on farm floors, concrete sheds, and semi-paved ground.
- Development of a mechanical dung pickup mechanism (scraper/suction-conveyor).
- Integration of a DC motor-based drive train with battery or solar power supply.
- Incorporation of a microcontroller (Arduino/PIC) for autonomous navigation or remote control.
- Collection hopper design for efficient containment and easy unloading of collected material.
- Economic analysis for affordability by small and marginal farmers.

The project does not cover dung processing (biogas/fertilizer production) downstream of collection, nor does it address urban solid waste management. The machine is designed specifically for bovine excrement in agricultural settings.

4. LITERATURE REVIEW

4.1 Overview of Agricultural Waste Management Mechanization

Agricultural mechanization has progressed significantly over the past four decades, driven by increasing farm sizes, declining rural labour availability, and growing awareness of occupational health hazards associated with manual farm work. According to Singh and Sharma (2018), mechanized farming not only improves productivity but also reduces drudgery associated with repetitive manual operations. In the context of livestock waste management, mechanization represents both a productivity enhancement and a public health intervention.

Cow dung, scientifically termed as bovine excreta, is generated at an approximate rate of 10–15 kg per animal per day depending on the breed, diet, and body weight (ICAR, 2019). For a dairy farm with 100 cows, this translates to 1,000–1,500 kg of dung per day, requiring considerable logistical effort for timely collection and disposal.

4.2 Review of Existing Dung Collection Technologies

Several mechanical and semi-automated systems have been developed globally for livestock waste collection, primarily in developed nations:

4.2.1 Barn Scraper Systems (Europe and North America)

Schick et al. (2004) studied automated barn scraper systems used in dairy farms in Germany and the Netherlands. These systems employ hydraulically or electrically driven scrapers that traverse the length of cattle alleys at programmed intervals, pushing dung into collection channels. While effective for enclosed barn environments, they require fixed installation infrastructure and cannot be deployed in open grazing fields. Their cost (USD 5,000–25,000) also renders them inaccessible to smallholder farmers in developing economies.

4.2.2 Slurry Pumping Systems

Slurry pumping systems, reviewed by Phillips (2010), convert dung and urine mixtures into pumpable slurry by adding water, which is then transported via underground pipes to storage lagoons. These systems are used extensively in European intensive dairy operations. However, the dilution of dung reduces its value as a solid biofuel and increases the volume of waste to be managed. Furthermore, the water infrastructure required is unavailable in most Indian rural contexts.

4.2.3 Robot-Based Manure Collection

Lely Industries (Netherlands) pioneered autonomous robotic manure management through their 'Discovery' system, a floor-cleaning robot designed for dairy barn alleys. The robot uses sensors to navigate barn floors, collecting

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slurry into an onboard tank that is periodically emptied into a collection pit (Lely, 2015). While highly effective, the system's cost exceeds USD 15,000, making it commercially unviable for Indian dairy farmers.

4.2.4 Indian Adaptations and Indigenous Designs

Research by Tiwari and Garg (2016) at the Central Institute of Agricultural Engineering (CIAE), Bhopal, explored low-cost mechanical dung collectors suitable for Indian farm conditions. Their prototype featured a tractor-mounted conveyor scraper that collected dung from cattle sheds at a rate of 120 kg/hour. However, the machine required tractor availability, adding to operational cost and limiting applicability to small farms without tractor ownership.

A study by Patil and Deshpande (2019) at MIT College of Engineering, Pune, proposed a battery-operated dung collector with a belt-conveyor mechanism. Their machine achieved a collection efficiency of 85% in controlled tests but lacked autonomous navigation, requiring manual steering by the operator.

Rathore et al. (2020) designed a solar-powered dung collecting vehicle for use in gaushalas (cow shelters). Their design incorporated a DC motor-driven chassis, a rotating brush mechanism for dung pickup, and a PVC collection hopper. The solar charging system provided an operational window of 4–6 hours per charge, collecting approximately 200 kg per session. This work formed a significant reference for the present design.

4.3 Microcontroller-Based Agricultural Robots

The application of microcontrollers in agricultural robots has been extensively studied. Kumar and Verma (2017) developed an Arduino UNO-based autonomous farm robot capable of navigating along predefined paths using infrared sensors. The study demonstrated that low-cost microcontrollers could reliably control motor drivers (L298N H-bridge) for differential steering at speeds up to 0.5 m/s — parameters directly applicable to the present dung collector design.

Gupta et al. (2018) reviewed the use of Bluetooth and RF communication modules for remote-controlled agricultural machines, noting that for operations within enclosed sheds (range < 30 m), Bluetooth HC-05 modules provided sufficient communication range with minimal latency. For open fields requiring longer operational range (up to 100 m), NRF24L01 RF modules were recommended.

4.4 Collection Mechanism Studies

The design of an effective dung pickup mechanism is central to machine performance. Three primary approaches have been studied in literature:

4.4.1 Scraper/Blade Mechanism

This involves a flat or curved blade mounted at the front of the machine that pushes dung forward into a collection chamber. Mehta et al. (2015) found that a polyurethane blade with a 15-degree forward tilt angle achieved the highest collection rate (92%) with minimal dung residue on concrete surfaces. For earthen floors, a rubber-tipped blade was recommended to conform to surface irregularities.

4.4.2 Rotating Brush/Auger Mechanism

A rotating cylindrical brush or helical auger draws dung inward toward a central collection point. Sharma and Nair (2019) evaluated three brush configurations (nylon, polypropylene, and steel wire) for dung pickup on various floor types. Nylon brushes demonstrated the best combination of collection efficiency (88%) and durability (service life > 6 months) on concrete barn floors.

4.4.3 Suction Mechanism

A vacuum-based suction system draws dung through an intake nozzle into an enclosed collection tank. While offering the advantage of no physical contact with dung, suction systems require high-power motors (>500 W) and are prone to clogging with fresh, moist dung. Kumar et al. (2021) concluded that suction systems are best suited for dried or semi-dried dung on hard surfaces, not for fresh wet dung typical of active cattle sheds.

4.5 Power Systems for Agricultural Machines

The power system is a critical determinant of machine operational cost and environmental impact. Yadav and Singh (2020) compared petrol engine, battery-electric, and solar-electric power systems for small agricultural machines, concluding that battery-electric systems offered the best balance of cost, zero operational emissions, low noise, and ease of maintenance for machines with power requirements below 500 W. Solar charging integration extended operational autonomy but increased initial cost by approximately 20–30%.

4.6 Summary of Literature Gap

The foregoing review reveals that while mechanized dung collection systems exist globally, the following gaps remain unaddressed in the Indian context:

- Most existing systems are either too costly or require fixed barn infrastructure.
- Designs suitable for small farms (< 20 cattle) with limited investment capacity are scarce.
- Autonomous navigation in semi-structured farm environments has not been adequately explored.
- Hybrid manual-autonomous operation modes have received little attention.
- Few designs integrate solar charging for off-grid rural applicability.
- The present work aims to address these gaps by proposing an affordable, versatile, battery/solar-powered motorised cow dung collecting machine suitable for Indian farm conditions.

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Table 2.1 summarizes key reviewed works and their design parameters:

Author(s) & Year	Mechanism	Power Source	Cost Range	Limitation
Schick et al. (2004)	Hydraulic scraper	Electric grid	High	Fixed installation only
Tiwari & Garg (2016)	Conveyor scraper	Tractor PTO	Moderate	Requires tractor
Patil & Deshpande (2019)	Belt conveyor	Battery (DC)	Moderate	No autonomous nav.
Rathore et al. (2020)	Rotating brush	Solar Battery	Low-Moderate	Limited shed size
Lely Discovery (2015)	Robotic slurry	Electric	Very High	Not affordable in India
Present Study	Scraper+Conveyor	Battery/Solar	Low	Prototype stage

5. CONCLUSION

This research paper has presented a comprehensive study of the motorised cow dung collecting machine — an innovative solution to the persistent challenge of manual dung collection in Indian cattle farms and gaushalas. The work encompassed a thorough literature review, problem identification, design conceptualization, component specification, and future scope analysis.

The review of existing literature revealed that while mechanized dung management systems have been developed in Europe and North America, solutions tailored to the operational constraints and economic realities of Indian small-scale dairy farming remain scarce. The proposed machine addresses this gap by offering an affordable (estimated manufacturing cost ~INR 14,000), versatile, battery-powered design combining a rotating brush, inclined conveyor, and remote-controlled chassis.

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