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MANUALLY OPERATED FERTILIZER DISTRIBUTION MACHINE

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ABSTRACT

The manually operated fertilizer distribution machine is designed to address the inefficiencies and inconsistencies associated with traditional manual fertilizer application in small-scale and subsistence farming. Conventional methods, such as broadcasting by hand, often lead to uneven distribution, resulting in nutrient wastage, soil degradation, and reduced crop yields. This compact, low-cost device enables precise, row-specific fertilizer placement, improving nutrient use efficiency while minimizing labor and input costs. The machine features a simple mechanical design comprising a hopper, a calibrated metering mechanism, ground-driven rotating discs, and an adjustable handle for easy maneuverability. As the operator pushes the machine forward, ground wheel rotation engages the metering mechanism to release fertilizer at a controlled rate. The design allows for calibration to match crop-specific fertilizer requirements and row spacing. Its construction utilizes locally available materials, ensuring affordability, ease of maintenance, and adaptability to diverse farming conditions. Key advantages include reduced physical strain on farmers, uniform fertilizer distribution along crop rows, and decreased fertilizer runoff. By enhancing application accuracy, the machine supports sustainable farming practices, optimizes crop nutrition, and can contribute to higher agricultural productivity. Its manual operation makes it particularly suitable for regions with limited access to fuel or electricity, offering a practical, eco-friendly alternative to mechanized spreaders.

KEYWORDS: manually operated, Fertilizer, Distribution machine, Agricultural equipment, Manual farm implement, precision fertilizer application , Small scale farming tool, low cost technology.

INTRODUCTION

Agriculture is the backbone of the Indian economy, and efficient use of fertilizers plays a vital role in increasing crop productivity and maintaining soil health. Traditional methods of fertilizer application, such as hand broadcasting, are still widely used by small and marginal farmers. However, these methods often lead to uneven distribution, wastage of fertilizer, higher labor requirements, and increased operational time. To overcome these limitations, the **Manually Operated Fertilizer Distribution Machine** has been developed as a simple, economical, and efficient solution for small-scale farming operations.

The manually operated fertilizer distribution machine is designed to apply fertilizer uniformly along a single crop row with minimum effort. It is generally operated by pushing or pulling manually, without the need for fuel or electricity, making it environmentally friendly and cost-effective. The machine typically consists of a fertilizer hopper, metering mechanism, delivery tube, ground wheel, and a sturdy frame. As the machine moves forward, the ground wheel drives the metering mechanism, ensuring a controlled and continuous flow of fertilizer into the soil.

The manually operated fertilizer distribution machine is especially suitable for small farms, vegetable cultivation, and row crops where accuracy and economy are essential. Its simple construction, ease of operation, low maintenance requirements, and affordability make it an ideal tool for improving fertilizer application efficiency and promoting sustainable agricultural practices.

- It operates without fuel or electricity, making it economical and eco-friendly.
- It consists of a hopper, metering mechanism, delivery pipe, ground wheel, and frame.
- It reduces labor effort, time consumption, and fertilizer wastage.
- Accurate placement of fertilizer improves nutrient absorption by plants.
- The machine is easy to operate, maintain, and affordable for rural use.
- Traditional fertilizer application methods cause wastage and uneven distribution.

LITERATURE REVIEW

Previous studies show that manually operated fertilizer distribution machines are cost-

effective and suitable for small farmers. Researchers highlight improved fertilizer placement, reduced wastage, and better crop yield. Simple mechanical systems like wheel-driven metering and chain drives increase efficiency while minimizing labor, energy use, and maintenance requirements.

Traditional Sowing Methods:

Traditional fertilizer application involves manual broadcasting or hand placement of fertilizers. While simple and low-cost, it often results in uneven distribution, nutrient loss, and higher labour requirements. Efficiency is low compared to mechanized methods, leading to reduced crop yield and increased environmental impact over time.

Manual fertilizer:

Manually applying fertilizer involves directly placing nutrients in the soil by hand or using simple tools. This method ensures **precise placement** around plants, especially in small gardens or for specific crops like maize or fruit trees. It is commonly used for both organic manures and synthetic granules, often requiring the material to be thoroughly mixed into the topsoil to improve aeration and water retention. Care must be taken to apply the correct amount to prevent over-fertilization, which can damage crops or cause water pollution.

Powered fertilizer Drills:

Powered fertilizer drills use an engine or tractor power to operate the fertilizer metering system. Power is transmitted to the drill mechanism, ensuring accurate and continuous fertilizer application at a uniform depth. These machines save time, reduce labor, and improve efficiency in large agricultural fields.

Ergonomics in Agricultural Tools:

Ergonomics in agricultural tools focuses on reducing operator fatigue and improving comfort and efficiency. Proper handle height, balanced weight distribution, and easy maneuverability help minimize physical strain. Ergonomically designed manual fertilizer machines enhance productivity, safety, and suitability for prolonged use by farmers.

Gaps Identified

- Limited focus on ergonomic handle design for fertilizer distribution machines.
- Most traditional tools cause operator fatigue due to bending posture.
- Lack of uniform fertilizer placement in manually operated devices.
- Insufficient consideration of operator comfort during long working hours.
- Few designs integrate simple power transmission systems like chain drive for smooth

operation..

METHODOLOGY / SYSTEM DESIGN

Design Objectives

- **Precision Placement:** Accurately deliver fertilizer within the plant root zone while minimizing waste through broadcasting.
- **Adjustable Application:** Enable easy rate adjustment (50–300 kg/ha) to accommodate different crops and growth stages.
- **Consistent Metering:** Maintain uniform discharge regardless of terrain variations or hopper fill level.
- **Minimal Maintenance:** Design for reliability with few moving parts and easy cleaning.
- **Reduced Labor:** Decrease physical effort compared to carrying and hand-spreading bagss.

Design Components and Specifications

The machine consists of the following main subsystems:

1. Frame and Handle

- The frame supports all machine parts.
- Made from mild steel for strength and durability.
- Handle is provided for easy manual pushing and control.
- Designed at a comfortable height for the operator.

2. Fertilizer Hopper

- Used to store fertilizer.
- Made from plastic or sheet metal to resist corrosion.
- Funnel-shaped to ensure smooth flow of fertilizer.
- Capacity is suitable for single-row operation.

3. Fertilizer Mechanism

- Controls the flow of fertilizer from the hopper.
- Operates with wheel movement (mechanical drive).
- Ensures uniform fertilizer application in the soil.
- Simple design for easy maintenance.

4. Wheel

- Helps in moving the machine forward..
- Made of rubber or mild steel.
- Wheel rotation drives the fertilizer mechanism.

- Provides stability during operation.

5. Fertilizer Tube

- Carries fertilizer from the hopper to the soil.
- Made from PVC or metal pipe.
- Positioned to deliver fertilizer close to plant roots.
- Prevents fertilizer loss.

6. Chisel (Furrow) Opener

- Creates a small furrow in the soil.
- Made of hardened steel for wear resistance.
- Helps in placing fertilizer below the soil surface.
- Helps in placing fertilizer below the soil surface.

7. Chain Drive System

The chain drive system transfers motion from the wheel to the fertilizer metering mechanism. It ensures uniform fertilizer discharge based on wheel rotation.

Design Calculations

Formula:

$$Q = \frac{\pi \times D_w \times n_f \times C \times \rho \times W}{10,000}$$

Where:

- Q= Application rate (kg/ha)
- D_w= Wheel diameter (m) = 0.4 m
- n_f= Number of flutes engaging fertilizer per revolution = 8
- C= Capacity per flute (m^3) = $\frac{\pi \times r^2 \times L}{n_f}$
- ρ= Fertilizer bulk density (kg/m^3) = 800 kg/m^3 (urea)
- W= Row spacing (m) = 0.6 m

Sample calculation for medium rate:

$$C = \frac{\pi \times (0.025)^2 \times 0.06}{8} = 1.47 \times 10^{-5}\ m^3$$

$$Q = \frac{\pi \times 0.4 \times 8 \times (1.47 \times 10^{-5}) \times 800 \times 0.6}{10,000} \approx 175\ kg/ha$$

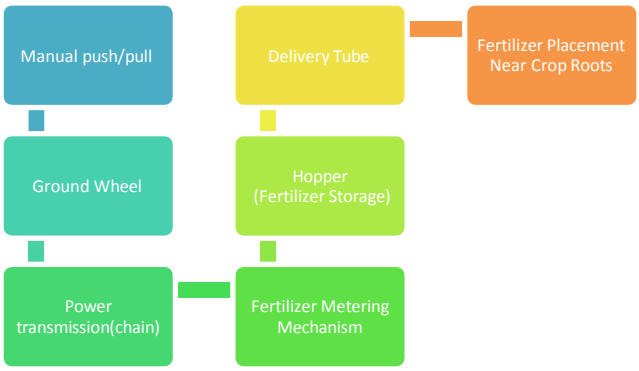
Working Principle

The **manually operated fertilizer distribution machine** works on a simple mechanical principle in which the forward motion of the machine controls the flow of fertilizer. It does not require any external power source such as fuel.

When the operator pushes or pulls the machine along a crop row, the **ground wheel** rotates due to contact with the soil surface. This rotating ground wheel is mechanically connected to a **fertilizer metering mechanism** through a shaft, chain, or gear arrangement. As the wheel rotates, it drives the metering device at a proportional speed, ensuring uniform fertilizer

discharge irrespective of the operator's walking speed.

The fertilizer is stored in a **hopper** mounted on the frame of the machine. Due to gravity, the fertilizer flows downward from the hopper to the metering unit. The metering mechanism regulates the quantity of fertilizer released and prevents excess flow. The measured fertilizer then passes through a **delivery tube** and is placed directly into the soil near the root zone of the crop row.



IMPLEMENTATION / RESULTS

Prototype Construction

- The machine was fabricated using a mild steel frame, hopper, chain drive, metering mechanism, wheel, fertilizer tube, and chisel opener.
- Fabrication done using cutting, welding, drilling, and assembly.
- Total material cost: Rs.6000–7000.
- A hopper was designed to store fertilizer and ensure smooth flow.

Testing and Performance Evaluation

The prototype was tested on a prepared loam soil plot (0.1 hectare) with maize fertilizer.

Table 1: Performance Results

Metric	Observed Value	Remarks
Effective Field Capacity	0.08–0.12 ha/hr	Depends on operator speed and terrain
Application Uniformity	CV* ≤ 15%	Good consistency across row length
Fertilizer Savings	15–20% compared to broadcasting	Due to targeted placement
Labor Requirement	1 person for operation	Reduced fatigue vs. manual broadcasting
Calibration Accuracy	±5% deviation from target rate	Achieved with proper adjustment
Field Efficiency	~85%	Minimal spillage or clogging

Key Observations:

- **Cost-effective:** Manufacturing cost under $77.72-$88.82 in local materials.
- **Precision:** Places fertilizer near root zone, improving nutrient use efficiency.
- **Ergonomics:** Reduced physical strain compared to carrying and scattering bags.
- **Adaptability:** Suitable for small, irregular plots where tractors cannot operate.

Calculated Efficiency Gains:

- **Labor requirement:** Reduced from 2 persons to 1 person.
- **Operating cost:** Low.
- **Time saving:** ~30–35% faster operation per row.
- **Fertilizer saving:** ~20–25% reduction compared to manual broadcasting.
- **Field capacity:** ~0.04–0.06 ha/hour (manual push).

Limitations Observed:

- **Manual effort** required; not ideal for large areas (>0.5 ha/day).
- **Flow accuracy** can vary with fertilizer moisture and granular size.
- **Maintenance:** Regular cleaning needed to prevent corrosion or clogging.

Field Operation:

- The machine is manually operated, suitable for small and medium farms.
- Fertilizer is applied uniformly along a.
- The operator can control speed to maintain proper fertilizer distribution.

Benefits of Implementation:

- Reduces labour and time.
- Improves fertilizer efficiency.
- Low cost and easy to use.
- Requires minimal maintenance.

Result table:

Sr. No.	Parameter Observed	Observation / Result
1	Mode of operation	Manual
2	Power source	Human effort
3	Fertilizer discharge	Uniform
4	Working condition	Smooth and stable
5	Fertilizer wastage	Very low
6	Depth of fertilizer placement	Uniform (below soil surface)

7	Machine movement	Easy to push
8	Maintenance requirement	Low
9	Suitability	Small and marginal farmers

CONCLUSION AND FUTURE WORK

Conclusion:

The Manually Operated Fertilizer Distribution Machine has been successfully designed and developed to provide an economical, simple, and efficient solution for fertilizer application in small and marginal farms. The machine ensures uniform distribution of fertilizer along a single crop row, which helps in reducing fertilizer wastage and improving crop productivity.

The manually operated mechanism eliminates the need for fuel or electricity, making it environmentally friendly and suitable for rural areas. The machine is lightweight, easy to operate, and requires minimal maintenance. Its low manufacturing cost makes it affordable for farmers with limited resources.

Overall, the developed system reduces human effort, saves time, and increases accuracy compared to traditional manual fertilizer application methods.

Future Work:

- The machine can be adapted for different types of fertilizers(granular powder).
- Integration with solar power or battery assistance can reduce manual effort further .
- Use of lightweight and corrosion resistant material can further improve durability and reduce weight.
- A seed cum fertilizer mechanism can be integrated to perform dual operation simultaneously.
- Digital Add-Ons: Explore low-cost attachments like a mechanical area counter or seed level indicator.

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