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DESIGN AND DEVELOPMENT OF MULTIPURPOSE AGRO-FARM VEHICLE: A REVIEW

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Abstract - *India's agricultural sector forms the backbone of the nation's economy and social fabric, supporting nearly 58% of its population. However, modern farmers face major challenges, including labor shortages, inefficiencies, and environmental concerns. To address these issues, a new initiative has been launched to develop a specialized vehicle aimed at empowering farmers, boosting productivity, and promoting sustainable agriculture. This initiative focuses on delivering cost-effective solutions, prioritizing the economic needs of farmers. By tackling labor shortages and improving operational efficiency, the proposed vehicle seeks to ease the financial burden on farmers while maximizing their output. In addition, the vehicle integrates eco-friendly features to reduce the environmental impact of farming, contributing to long-term sustainability. The project is progressing well, supported by a solid conceptual model and an initial design, with completion expected by the end of February. However, this milestone is viewed not as the final goal but as a foundation for future research and development. Insights from the first phase will guide further innovation, leading to continuous improvement in agricultural equipment. Ultimately, this initiative takes a holistic approach to modernizing Indian agriculture, balancing economic viability with environmental responsibility. By providing farmers with advanced tools and technologies, it aims to secure their livelihoods while preserving the natural resources essential for farming. This endeavor holds the potential to revolutionize agricultural practices, fostering sustainable growth and prosperity for both farmers and the nation.*

Key Words: **Multipurpose Tractor, Agriculture, Farming.**

1.INTRODUCTION

India, a predominantly agrarian nation, relies heavily on farming as a primary livelihood for its population. However, as the population grows, land holdings within families are becoming increasingly fragmented. In 1951, there were only 8,635 tractors in use, all of which were imported. Domestic production of tractors began in 1961-62, with an output of just 880 units. Today, the average Indian farmer owns a small, two-acre farm, and economic constraints make it difficult for many to afford expensive machinery like tractors and advanced farming equipment. As a result, many farmers continue to depend on traditional methods, relying on animal power such as bullocks, horses, and buffaloes to carry out agricultural tasks. Unfortunately, these traditional methods lack the efficiency and power of modern mechanized approaches used in other countries. In response to these challenges, this project focuses on developing a compact, efficient, and multi-purpose agricultural machine designed to streamline farming operations. The vehicle's chassis will be engineered to support various agricultural tasks, and it will be equipped with an engine, cutter, auger, wheels, cultivator, and row-creation tools. Mechanization in agriculture has already made farming faster and more manageable, with machines available for nearly every step of the farming process, from land preparation to crop harvesting. However, these machines are often too expensive for small-scale farmers in rural areas. The creation of a cost-effective, multi-purpose agricultural machine capable of performing multiple tasks—such as cultivating, digging, and cutting—offers a practical solution. By combining these functions into one versatile piece of equipment, this project aims to improve the efficiency of agricultural practices while addressing the financial challenges faced by farmers. This innovation holds the potential to transform farming in India by making advanced mechanization accessible to more farmers, thus boosting productivity and reducing dependence on traditional methods.[1]

2. LITERATURE REVIEW

Pratik Kumar V. Patel and Mukesh Ahuja, *Research and Design of Multipurpose Agriculture Equipment* [2021]: This research paper explores how traditional agricultural machinery can be transformed into modern, efficient tools. By integrating key findings, the team developed a fertilizer distributor that optimizes fertilizer application across fields. The combination with a seed hopper ensures a streamlined and efficient process.

Dr. C.N. Sakhale et al., *Review Paper on "Multipurpose Farm Machine"* [2021]: This paper discusses the mechanization of agricultural machines, particularly focusing on the ploughing tool. The research highlights how replacing the ploughing teeth can extend the life of the tool, offering valuable insights for improving machine durability.

Dhatchanamoorthy N. et al., *Design and Fabrication of Multipurpose Agriculture Vehicle* [2021]: This research emphasizes the design of the machine's chassis and frame, using lightweight materials to reduce costs. The vehicle is designed to perform various tasks, with the capability to work within specific rows and columns at predefined intervals, catering to different crop needs.

Ramesh D., *Agriculture Seed Sowing Equipment: A Review* [2019]: This paper reviews innovations in seed-sowing equipment, discussing methods to place seeds and fertilizers in rows at the desired depth and spacing. It also covers techniques to ensure proper compaction of soil over the seeds.

Aniruddha Autade et al. [2019]: This study focuses on the advantages of multipurpose agricultural vehicles for small-scale farms. It describes various operations, such as cutting, land leveling, and ploughing, that can be integrated into these machines. The research also offers insights into compact and efficient design, reducing manpower and labor costs.

Francesco Mocera et al. [2019]: This paper presents a multi-body (MTB) model of a small tracked vehicle designed for agricultural applications. These machines encounter various operational scenarios, especially in unpredictable terrains and slopes, which is critical for their design and functionality.

P. Sarec and O. Sarec [2015]: This study investigates soil penetration resistance using cultivators equipped with chisel-shaped shares. The research demonstrated that cultivators like the Väderstad TopDown 400 and Farmet Turbulent 450 showed excellent capacity for embedding plant residues, providing a foundational understanding for the design of our machine.

F.A. Adamu, B.G. Jahun, and B. Babangida [2014]: This paper emphasizes the performance of power tillers, particularly lightweight models. It discusses parameters like fuel efficiency and field capacity, which are considered in the design of a sustainable multifunctional agricultural vehicle.

D.A. Mada and Sunday Mahai [2013]: This research paper highlights the importance of agricultural mechanization, focusing on the need for a multifunctional single-axle vehicle for pre- and post-harvesting operations. The conclusions from this study served as the basis for developing our multifunctional agricultural vehicle.

V.K. Tewari et al. [2012]: This case study on farm mechanization in West Bengal provides insights into the status of agricultural machinery in India. It guided the team in making informed decisions to advance farm mechanization practices in the country.[2]

3. METHODOLOGY

The project focused on developing a multipurpose agricultural vehicle will begin with a thorough identification and definition of the problems within the field. This includes an analysis of existing limitations, inefficiencies, and potential areas for improvement in multipurpose agricultural machinery. Following this initial assessment, all relevant aspects of the research will be detailed, considering factors such as technological advancements, market trends, and user requirements. A structured methodology will then be implemented to outline the project's step-by-step progress. Each phase will be systematically described to ensure clarity and coherence throughout the process. This methodical approach aims to effectively address the identified challenges while leveraging the research framework to guide the project's direction. By meticulously detailing the progression, the project seeks to provide a comprehensive understanding of the challenges and opportunities in developing multipurpose agricultural vehicles. Additionally, this structured methodology will ensure efficient resource utilization and enhance the project's effectiveness. Through this systematic process, the project aims not only to resolve the identified issues but also to offer valuable insights into the advancement of multipurpose agricultural machinery technology. By adhering to a concise yet comprehensive framework, the project is set to achieve its objectives in an organized manner, ultimately leading to impactful outcomes in the agricultural sector.

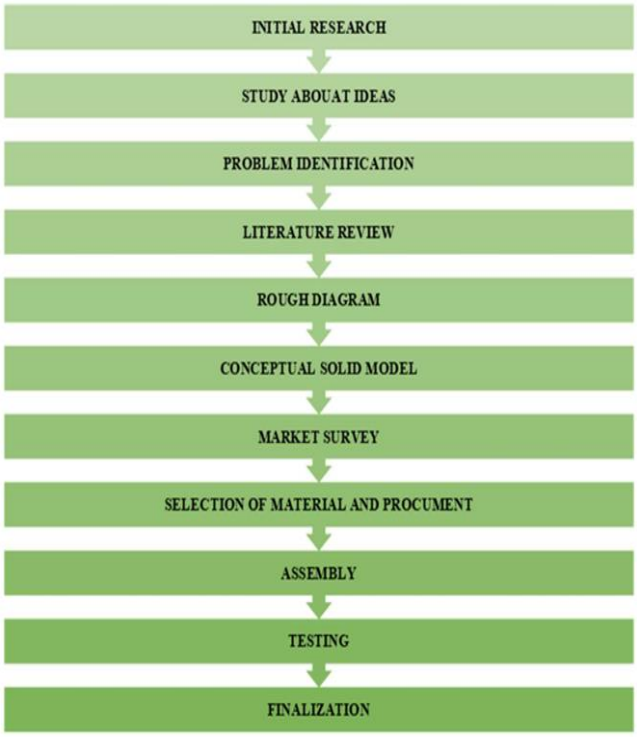

Fig -1: Methodology

INITIAL RESEARCH

We conducted market surveys to analyze the various tractors available and studied the equipment used in these tractors for agricultural purposes. This research helped identify the specific needs of farmers and the agricultural operations that the mini vehicle will address, including tasks such as grass cutting, cultivating, row-making, and auguring.

STUDY ABOUT THE IDEAS

To gain a deeper understanding of the existing mini agricultural vehicle market, we examined competitor products and their pricing strategies to determine where our vehicle fits. We studied how different operations are carried out, how the machines function, and the mechanisms associated with these operations.

PROBLEM IDENTIFICATION

The foundation of any project begins with identifying the problem. We researched a variety of topics, reviewed numerous books, and conducted market surveys to pinpoint the challenges arising in the agricultural sector related to the machinery and tractors currently in use.

ROUGH DIAGRAM

After gathering information and analyzing various parameters, we created a rough sketch of the machine along with its different components and equipment.

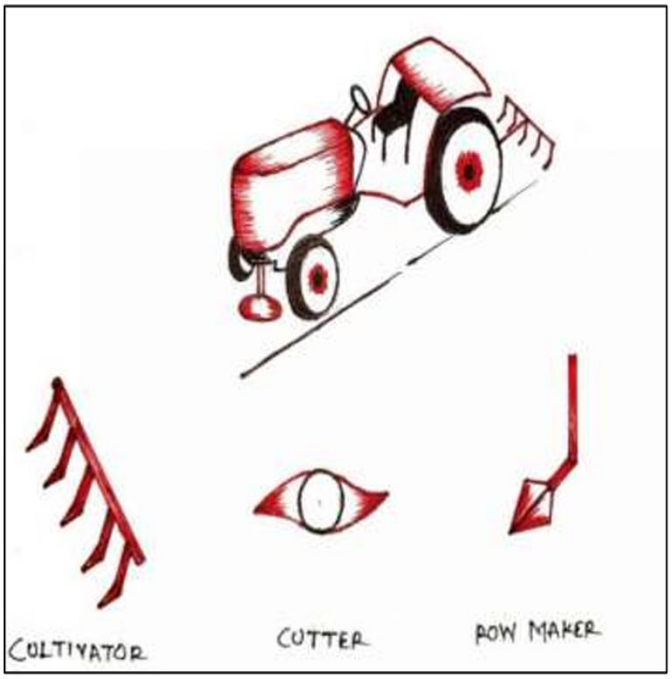

Fig -2: Rough Diagram

SOLID MODEL

We designed all the components and assembled in the model.

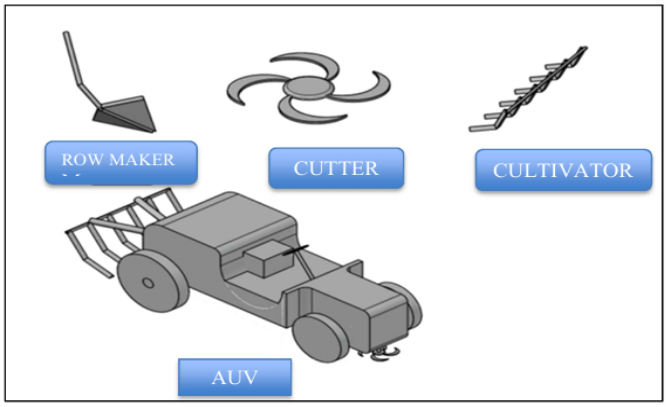

Fig -3: Solid Model

There are three major components which are listed below:

1) Cutter

Before cultivating agricultural land, it is essential to clear away unwanted grass. The cutter is designed to efficiently cut grass and prepare the land for cultivation, utilizing four blades for optimal performance.

- Types: Grass cutters are available in various forms, including: Hand-held string trimmers, Walk-behind or wheeled brush cutters, tractor-mounted models
- Power Source: These cutters can be powered by gasoline engines.
- Usage: Grass cutters are commonly used for: Lawn maintenance, clearing overgrown areas, creating clean edges along walkways and gardens

Fig -4: Cutter

4) Cultivator

Cultivators are essential farm implements used for soil cultivation and weed control. They work by breaking up and aerating the soil, making it more suitable for planting while effectively removing weeds. For our project, we will utilize a stationary cultivator.

- Types: Cultivators come in several forms, including: Hand-operated cultivators, animal-drawn cultivators, tractor-mounted cultivators, some are specifically

designed for smaller-scale gardening, while others are intended for large-scale agricultural use.

- Usage: Cultivators are employed for various tasks, including: Seedbed preparation, weed management, soil loosening prior to planting crops

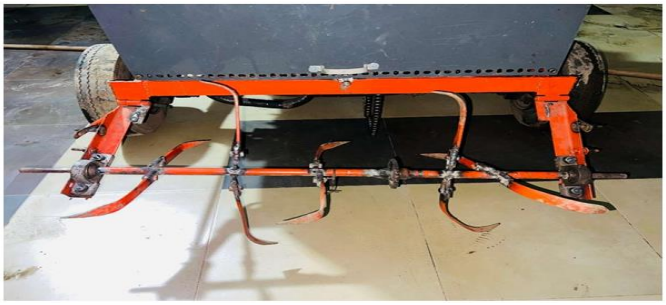

Fig -4: Cultivator

3) ROW MAKER

An agricultural row maker, also known as a row marker or row builder, is a farm implement designed to create evenly spaced rows or furrows in the soil for planting crops. It plays a crucial role in optimizing planting and spacing.

- Types: Row makers can be classified into two main categories: Implements that can be attached to tractors, manually operated tools, depending on the scale of farming
- Usage: They are primarily utilized in row crop agriculture for planting crops such as corn, soybeans, and vegetables, where precise row spacing is essential for effective crop management and maximizing yields.

Fig -5: Row Maker

MARKET SURVEY

A market survey was conducted to analyze existing technologies and components in the agricultural machinery sector. We also performed a quick assessment of the current machinery used for various components in farming. This analysis prompted us to explore how we could design a machine with fewer parts to reduce overall costs. Additionally, we took actual market prices of machine parts into account during our evaluation.

SELECTION OF MATERIAL AND PROCUREMENT

Selecting the appropriate raw materials for the machine components is essential. The chosen standard components must meet quality standards, be readily available, and maintain low costs. Once the materials and parts have been selected, procurement should be initiated to facilitate the next phase of assembly.

Fig -6: Square Pipe

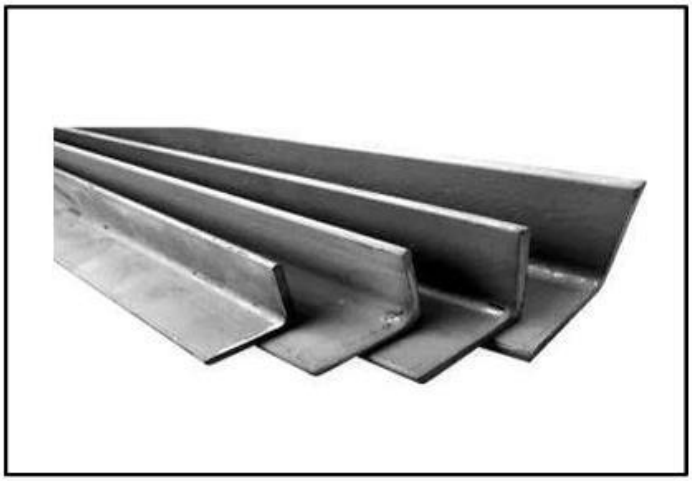

Fig -7: Angled section GI pipe

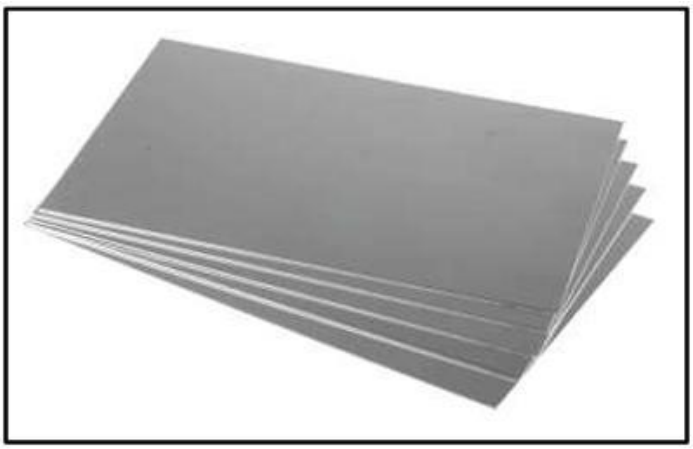

Fig -8: Metal sheets

ASSEMBLY

Once the materials have been procured, we will commence the final assembly of the machine. A well-structured construction plan will be established to ensure that work is evenly distributed among all group members. Our goal is to complete the entire machine ahead of schedule, allowing ample time for any necessary adjustments or modifications.

Fig -9: Scrap Rickshaw

Fig -10: Front extended body

Fig -11: Steering assembly

Fig -12: Cutter assembly

Fig -13: Cultivator shaft

FINAL MODEL

Fig -14: Final model (Side view)

Fig -15: Final model (Front view)

CONSTRUCTION AND WORKING

- The grass cutter is connected to the battery via a switch for easy operation.
- The up-and-down mechanism of the cutter is controlled by a jack attached to it.
- The cultivator is linked to the engine through a chain mechanism.
- A sprocket is connected to the wheel axle, while another sprocket is attached to the cultivator axle.
- When the cultivator shaft is accelerated, the chain connected to the axle via the sprocket rotates.
- This rotation causes the cultivator's blades to penetrate the soil surface, allowing for effective land cultivation through continuous rotation.
- The row maker is portable and can be easily assembled or disassembled as needed.
- It is mounted at the rear on a nut welded to the frame, creating a V-shaped furrow in the soil as the multipurpose agro-farm vehicle moves forward.
- The grass collector is attached to the chassis and collects grass through its V-shaped cutouts, carrying it forward to a designated collection area.
- A lock-and-key mechanism is provided to control the power supply, and a modified kick is used to start the engine.

TESTING

During initial testing of the cultivator on the ground, we encountered a failure due to excessive twisting, which stemmed from overloading near the sprocket area and using low-grade bearings. After this setback, we identified the main issues and made necessary modifications, such as using a solid shaft and upgrading to bearings with bushings, effectively resolving the problems.

FINALIZATION

Upon finalizing our project model, we were pleasantly surprised to discover that it surpassed our initial expectations. We dedicated countless hours, working tirelessly to bring our vision to life. Despite facing challenges during the operation of the cultivator and row maker, we navigated these hurdles with the guidance of our mentor, who supported us throughout the process.

This project has broadened our perspective and introduced us to new ways of thinking. We gained invaluable lessons and developed patience along the way. The innovative nature of our project makes promises for small-scale farmers, offering benefits in terms of budget, compactness, and ease of use.

This transformative experience has taught us the importance of perseverance and collaboration. We take pride in our achievements and are excited about the positive impact our project can have. With our guide's support, we transformed obstacles into opportunities and emerged stronger. Our project stands as a testament to our dedication, hard work, and the power of innovative thinking.[3]

4. RESULT

The multipurpose agro-farm vehicle has been developed to address the challenges faced by agricultural communities, particularly small-scale farmers. Designed for ease of use and portability, the AUV ingeniously incorporates a scrap engine and cost-effective components, resulting in an impressive cost reduction of 35% to 40%. As the first multipurpose agricultural vehicle of its kind, it significantly reduces the reliance on manual labor, marking a new era of efficiency in farming.

Maintenance and service of the multipurpose agro-farm vehicle can be performed by local car or auto rickshaw mechanics, ensuring accessibility even in remote areas. Its portability, combined with straightforward assembly and

disassembly, further enhances its practicality, making it an essential tool for farmers looking to increase productivity. By optimizing resource use, the multipurpose agro-farm vehicle represents a cost-effective solution specifically designed to meet the needs of small-scale farming communities.[4]

SERIAL NO.	OPERATIONS	AREA	TIME	COST
1	Cultivation	14m x 14m	9 minutes	400/day
2	Grass Cutting	1000 m^3	4.7 minutes	350/day
3	Row Making	14m x 14m	10 minutes	400/day

Table 1: Result

PARAMETERS	AUV	COMMERCIAL
Grass Cutting	Cutting speed at 22000 rpm	Cutting speed at 2500 rpm
Cultivating	Cultivator speed 100 rpm	Cultivator speed 540 rpm
Row Making	Single row at a time	Multiple row at a time
Fuel Efficiency	18 km/l to 20 km/l	5.86 km/l to 6.19 km/l
Fuel Capacity	5 Litre	15 Litre
Engine power	10 HP	25 HP
Torque	14 Nm	54 Nm
Size	Compact	Bulky
Handling	Easy to operate	Complex operation
Weight	Less	More
Cost	Less	More

Table 2: Comparison

5. CONCLUSIONS

The multipurpose agro-farm vehicle has been developed to address the challenges faced by agricultural communities, particularly small-scale farmers. Designed for ease of use and portability, the AUV ingeniously incorporates a scrap engine and cost-effective components, resulting in an impressive cost reduction of 35% to 40%. As the first multipurpose agricultural vehicle of its kind, it significantly reduces the reliance on manual labor, marking a new era of efficiency in farming. Maintenance and servicing of the multipurpose agro-farm vehicle can be performed by local car or auto rickshaw mechanics, ensuring accessibility even in remote areas. Its portability, combined with straightforward assembly and disassembly, further enhances its practicality, making it an essential tool for farmers looking to increase productivity. By optimizing resource use, the multipurpose agro-farm vehicle represents a cost-effective solution specifically designed to meet the needs of small-scale farming communities.[5]

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