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Design of Compact and Multi-Functional Agricultural Machinery

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Abstract: India's economy is mainly based on agriculture, which provides employment to millions of people. However, as the population increases, farming land is decreasing, making farming difficult. Due to financial constraints, many small farmers still use traditional methods. Our solution to this problem is multifunctional agricultural equipment that combines seeding and spraying. The aim of this small agricultural equipment is to support small farmers, reduce labor costs and increase productivity. It combines many agricultural functions in one flexible machine. This development not only reduces operating costs but also enables continuous operation in remote areas with variable electricity. The project shows that with good design, permaculture techniques can be beneficial while having little impact on the environment. India is a land of husbandry which comprises of small, borderline, medium and rich growers. Small scale growers are veritably interested in battery operated backpack sprayers because of their versatility, cost and design. But multiple fungicide sprayer pumps are a combination of both backpack & Battery- operated pump for better effectiveness.

I. INTRODUCTION

India is set to be an agrarian grounded country roughly 75% of population of India is dependent on tillage directly or laterally. Our growers are using the same styles and outfit for the periods e.g. seed sowing, scattering, weeding etc. There's need for development of effective spraying and weeding machine for adding the productivity. India is a land of husbandry which comprises of small, borderline, medium and rich growers. Small scale growers are veritably interested in manually switch operated backpack sprayer because of its versatility, cost and design. Multiple fungicide sprayer pumps are combination of both backpack & Battery-operated pump for better effectiveness. This is a trolleying operated system by using this we can reduce maximum trouble needed for scattering fungicides as well as we can spot fungicides in any direction or around the crops at any height of crops. This is used for weeding, plugging etc. This paper suggests a model of battery operated multi snoot fungicide sprayer pump which will perform scattering at maximum rate in minimal time. A developing country like India is anticipated to continue to calculate more on hand tools for the foreseeable future for civilization. The use of hand tools for land civilization is still predominant in India because draft creatures and tractors bear coffers that numerous Indian growers do not have easy access to. The need for agrarian robotization in India must thus be assessed with a deeper understanding of the small holder planter's conditioning and what values ranch power generated for them. Agriculture script in India India's profitable security continues to rest upon the husbandry sector, and the situation is not likely to change in the future. Indeed, now husbandry supports 58 % of the population, as against about 75 at the time of independence. As of moment, India supports 16.8 of world's population on 4.2 of world's water coffer and 2.3 of global land.

II. LITERATURE SURVEY

After the selection of the topic, the next step was to learn more about the project, so we searched through internet sources and got different papers related to the project. The main papers we looked at were agriculture needs, different research paper on the design and fabrication of multipurpose agriculture machines, seed sowing technology, etc. After gathering all this information, we got a clear idea of how the project should proceed.

Nagesh B. Adalinge, et al., provided this thesis to design a seed sowing machine which sows the seeds in the desired position and hence assists the farmers in saving the labor as well as time. The combination of rotary motion and reciprocating motion was studied which helped in sowing the seeds at a definite interval space. And the improved seed drilling and seed metering mechanism was studied for sowing seeds of different sizes. And then the construction of the seed sowing hopper as well as the Scotch Yok mechanism which was used are studied.

Hanumesh Pujar., et al., [5], [2020]. In this Research paper they have been discuss about the Work has been carried out to design and fabricate a multipurpose agricultural vehicle, to perform agricultural operations like goods carrying, pesticide spraying, inter-cultivating, ploughing.

Use of hand tools for cultivation is still leading in India because tractors need resources which many farmers cannot afford. The need for improvisation in agriculture is very essential, it is important to fill the gap between farmers and technology implementation. But most of the necessary components already exist, the information about the availability and performance of equipment is very poor between farmers and agricultural research and development departments. From the recent years the input to the farms increased such as fertilizer, insecticide, pesticides, HYV seeds, farm labor cost etc. Increase in the cost makes small land holding farmers at risk. Due to this lack of information suicide rate is increasing yearly, we need to identify the common factor for this. Commercialization of the landscape along with a large reduction in investment in agriculture was the beginning of the decline.

III. METHODOLOGY

Identifying the major challenges faced by small-farmers or labour also finding the need of multiple equipment to be use. Analysing existing solutions with their limitations and focusing on voids. Defining the functions that machine must perform (e.g., sowing, weeding, spraying) also evaluating different design approaches and then selecting the most feasible one. Creating detailed 3-D models using CAD software like SolidWorks and then conducting the simulation for the test of design performance and efficiency. Modifying the model according to equipment. Selecting suitable materials based on strength, reliability and cost-effectiveness and considering the availability of materials in context of agricultural use. Manufacturing and assembling the parts ensuring precision and functionality with inclusion of safety features during operation. Testing the machines and evaluating the parameters like efficiency, effectiveness in different soil types. Redefining the design and functionality of machine. Completing the final assembly with providing documentation of each step in process and eventually preparing the manual for farmers detailing operations, maintenance and safety guidelines.

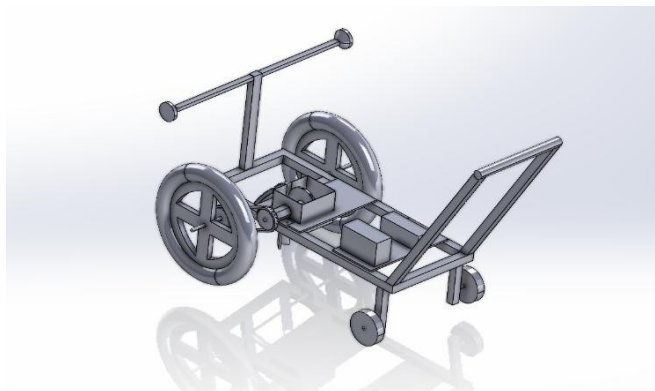


Fig.No13-D Model of Machinery

The main components of agricultural multi sprayers are as follows:

1) Wheel

Wheel is used to carry the whole assembly and move machine from one place to another by rotary motion of it. A bicycle wheel is a wheel, most commonly a wire wheel, designed for a bicycle. Bicycle wheel is designed to fit into the frame and fork via dropouts and hold bicycle tyre. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbon fiber rim which holds a pneumatic rubber tire. We use a tubeless tire wheel.

2) Frame

The frames are used to support all body parts. And it is also called chassis, the frame material is mild steel. The main functions of a frame are: To support the chassis component and body & to deal with static and dynamic loads, without undue deflection or distortion.

3) Nozzle

The nozzle is a critical part of any sprayer. Nozzles perform three functions:

Regulate flow.

Atomize the mixture into droplets. Disperse the spray in a desirable pattern.

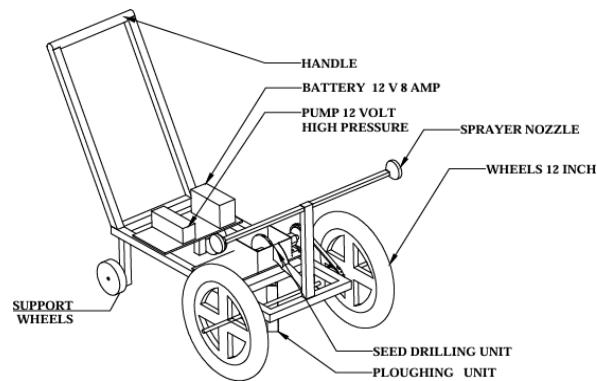


Fig.No.2ComponentsofMachine

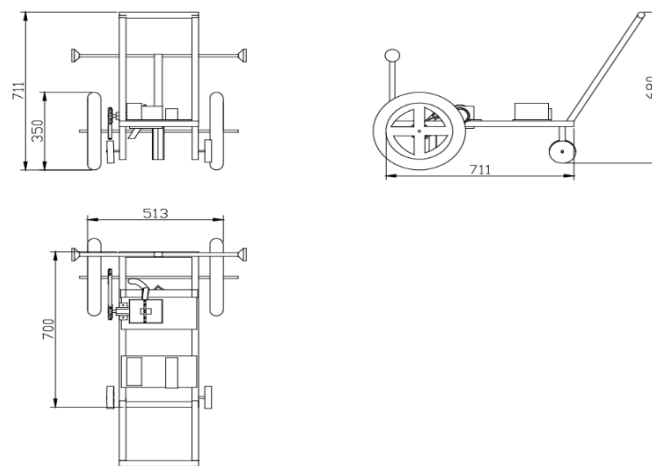


Fig.No.3DimensionsandViews

IV. DESIGN AND CALCULATION

1) Frame

Cantilever Beams are members that are supported from a single point only, typically with Fixed Support. To ensure the structure is static, the support must be fixed; meaning it is able to support forces and moments in all directions.

Sample Cantilever Beam equations can be calculated from the following formulae, where:

Bending stress formula

M_y

$\sigma =$

I

Where, σ = bending stress

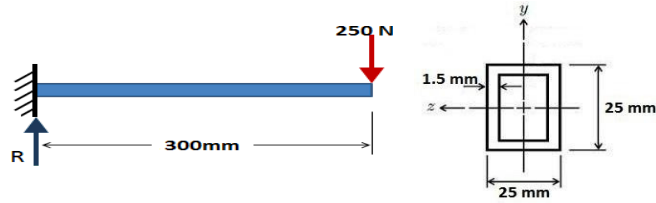
M = bending moment (which is calculated by multiplying a force by the distance between the point of interest and the force),

y = The distance from the neutral axis

I = Moment of Inertia

Cantilever Beams at square section

- Load (W) = 250N
- Member Length (L) = 300mm
- Thickness (T) = 1.5mm
- The distance from the neutral axis (y) = 12.5mm
- Width (B) = 25mm
- Depth (D) = 25mm



$$I = \frac{BD^3}{12} - \frac{bd^3}{12} \quad Y_{\max} = \frac{D}{2}$$

$$Z = \frac{1}{6D} [BD^3 - bd^3]$$

$$I = \frac{25 \times 25^3}{12} - \frac{22.5 \times 22.5^3}{12}$$

$$I = 390625 - 256289.0625$$

$$I = 11419.6614 \text{ mm}^4$$

$$Y = 12.5 \text{ mm}$$

$$M_A - 250 \times 300 = 0$$

$$M_A = 75000 \text{ N.mm}$$

$$\sigma = \frac{M_y}{I}$$

$$\sigma = \frac{75000 \times 12.5}{11419.6614}$$

$$\sigma = 82.09 \text{ N/mm}^2$$

As the value $\sigma = 82.09 \text{ N/mm}^2$ is lower than Ultimate tensile strength we can use the square tube to manufacture the complete structure.

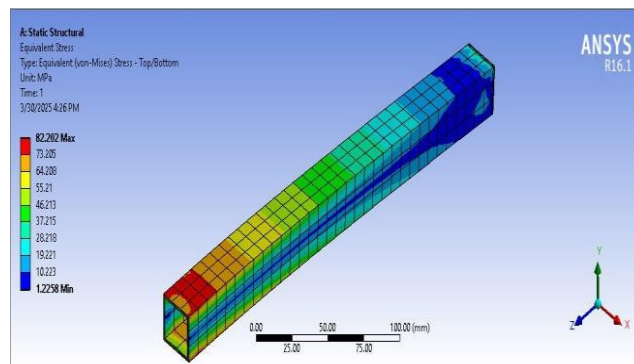


Fig.No.4 Equivalent Stress

2) SHAFTS

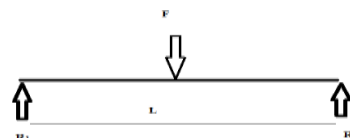
Design of Power transmission shaft considering fatigue load. Shaft material selected as 30C8 steel, diameter 10.80 mm, subjected to rotating bending fatigue loading, fatigue factor = 1.612

Assuming

$$K_{\text{size}} = 0.85, K_{\text{surface}} = 0.83, K_{\text{reliability}} = 0.896, S_e' = 0.5 \sigma_{\text{ultimate}}$$

$$= 245 \text{ mpa}$$

$$S_e = K_{\text{size}} \times K_{\text{surface}} \times K_{\text{reliability}} \times 1 / K_s \times S_e' \quad (2)$$



This fatigue strength calculated is less than endurance strength of standard C30 steel, shows that the design is safe. Considering power transmission shaft as beam

$$Y_{\max} = FL^3 / 48EI \quad (3)$$

$$= 0.00249 \text{ mm}$$

$$E = \text{Young's Modulus } \text{N/mm}^2$$

$$L = 40 \text{ mm assumed } \Sigma \text{ bending} = M/z \quad (4)$$

$$M = \text{Moment, } z = \text{Section Modulus } \text{mm}^3 \quad \Sigma \text{ bending} = 79.66 \text{ N/mm}^2$$

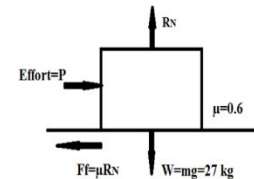
3) Minimum effort Required Formoving the Vehicle

$$\text{Weight of Machine} = 25 \text{ kg; } mg$$

$$= 25 \times 9.81 = 245 \text{ N}$$

$$\text{Coefficient of friction} = 0.6 \quad \text{Normal reaction} = 245 \text{ N} \quad \text{Frictional force} = F_f = \mu RN$$

$$= 0.6 \times 245 = 147 \text{ N}$$



V. CONCLUSION

After designing and analyzing the “Multipurpose Agricultural Machine,” we have drawn the following conclusions: The machine effectively meets the needs of small-scale farmers who often struggle to afford expensive agricultural equipment. Its design reduces both labor requirements and operational time compared to traditional farming methods. If manufactured on a larger scale, the overall cost can be significantly reduced, making it more accessible and addressing the labor shortages in Indian agriculture. This uniquely designed machine combines the functions of fertilizers spraying and seed sowing into a single system. Unlike conventional backpack sprayers that cause discomfort and back pain, our model offers a more ergonomic solution. The calculations and software modeling presented in this study validate its efficiency. Compact and user-friendly, this machine is built to enhance farming operations with minimal effort. It is powered by a two-stroke petrol engine, with intuitive handle-mounted controls and an easy-to-operate steering mechanism. Additionally, a dedicated control switch simplifies spraying operations. Overall, this cost-effective and practical innovation has the potential to significantly benefit small-scale farmers by improving efficiency and reducing manual effort.

VI. FUTURE SCOPE

The petrol engine in the multipurpose farming machine can be replaced with other fuel-efficient alternatives to enhance performance while making it more environmentally friendly. In addition to ploughing and seed sowing, the machine can be modified to include a system for applying fertilizers and manure, further improving its efficiency. The current design allows for sowing in two rows, but this capacity can be expanded to increase productivity. At present, the farmer must walk alongside the machine during seed sowing and ploughing. Adding a seating arrangement would improve comfort and reduce fatigue, making the machine more convenient to use.

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