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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 scalegrowers 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

Indiaissetto bean agrarian grounded country roughly 75 of populationofIndiaisdependentontillingdirectlyorlaterally. 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 husbandrywhichcomprises ofsmall, borderline, mediumand rich growers. Small scale growers are veritably interested in manually switch operated backpack sprayer because of its versatility,costanddesign.Multiplefungicidesprayerpumps are combination of both backpack & Battery-operated pump for better effectiveness. This bone is trolleying operated systembyusingthiswecanreducemaximumtroubleneeded forscattering FungicidesaswellaswecanspotFungicidesin anydirectionoraroundthecropsatanyheightofcrops.This isusedfor weeding, plugging etc. This paper suggestsamodel of battery operated multi snoot fungicides 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 thefuture.Indeed,now husbandry supports 58 °/s ofthepopulation,asagainstabout75atthetimeofindependence. As of moment, India supports 16.8 of world's population on 4.2 of world's water coffers and 2.3 of global land.

II. LITERATURE SURVEY

Aftertheselectionofthetopic,thenextstepwastolearnmore abouttheproject,sowesearchedthroughinternetsourcesand gotdifferent papers relatedtotheproject.Themainpaperswe looked atwereagricultureneeds,differentresearch paperson the design and fabrication of multipurpose agriculture machines,seedsowingtechnology,etc.Aftergatheringallthis information, we got a clear idea of how the project should proceed.

NageshB.Adalinge,etal.,providedthisthesistodesignaseed 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 hopperaswellasthe ScotchYokemechanismwhichwasused are studied.

Hanumesha Pujar., et al., [5], [2020].In this Research paper theyhavebeendiscussabouttheWorkhasbeencarriedoutto design and fabricate a multipurpose agricultural vehicle, to perform agricultural operations like goods carrying, pesticide spraying, inter-cultivating, ploughing.

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Use of hand tools for cultivation is still leading in India because tractors need resources which many farmers cannot afford. The need for improvisationinagricultureisveryessential,itisimportantto 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 researchanddevelopmentdepartments.Fromtherecentyears the input to the farms increased such as fertilizer, insecticide, pesticides,HYVseeds,farmlaborcostetc.Increaseinthecost makes small land holding farmers at risk. Due to this lack of information suicide rate is increasing yearly, we need to identifythecommonfactorforthis.Commercializationofthe 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 themodelaccordingtoequipment.Selectingsuitablematerials 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.

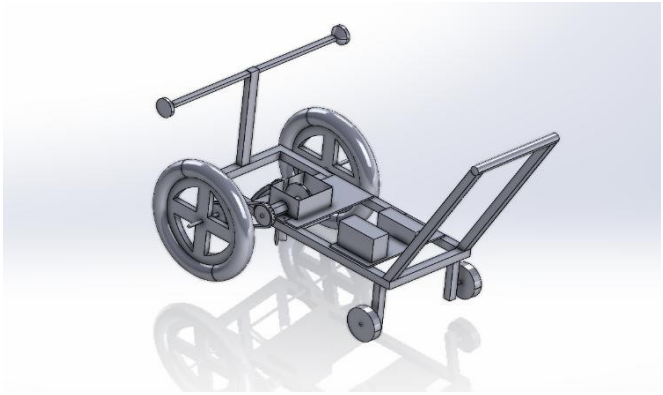


Fig.No13-DModelof Machinery

The main components of agricultural multi sprayers are as follows:

1) Wheel

Wheelisusedtocarrythewholeassemblyandmovemachine from one place to another by rotary motion of it. A bicycle wheelisa wheel,mostcommonlyawirewheel,designedfor a bicycle. Bicycle wheel is designed to fit into theframe and fork via dropouts and hold bicycle tyre. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbonfiberrim which holdsapneumaticrubbertire.Weuse a tubeless tire wheel

2) Frame

The frames are used to support all body parts. And it is also called cheesy, the frame material is mild steel. The main functions of a frame are: To support the chassis component sand 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:

Regulateflow.

Atomize the mixture into droplets. Dispersethesprayinadesirablepattern.

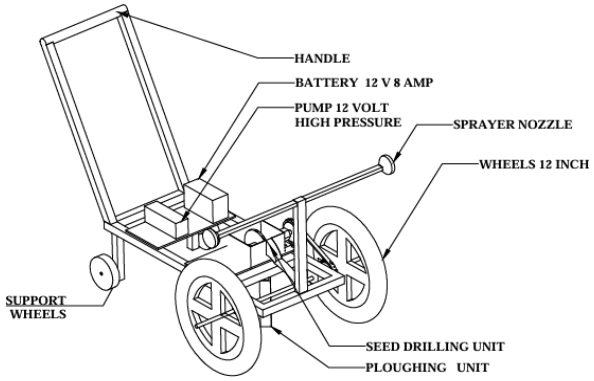


Fig.No.2ComponentsofMachine

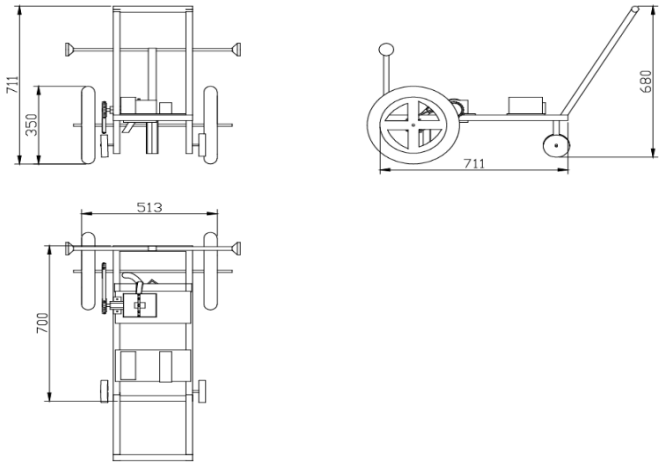


Fig.No.3DimensionsandViews

IV. DESIGN AND CALCULATION

1) Frame

Cantilever Beams are members that are supported from a singlepointonly,typicallywithFixedSupport.Toensurethe structureisstatic, thesupportmustbefixed;meaningitisable to support forces and moments in all directions.

SampleCantileverBeamequationscanbecalculatedfromthe following formulae, where:

Bendingstressformula

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

Where,σ=bending stress

M=bendingmoment(which iscalculatedbymultiplyinga force by the distance between the point of interest and the force),

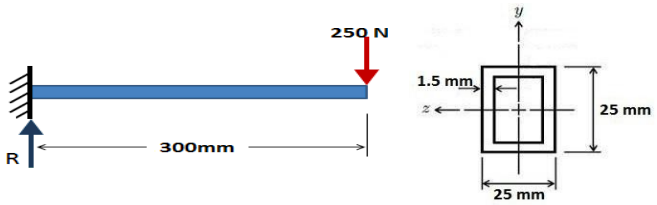
y=Thedistancefromtheneutral axis

I=MomentofInertia

CantileverBeamsatsquaresection

- Load(W)= 250N
- MemberLength(L)=300mm
- Thickness(T)=1.5mm
- Thedistancefromtheneutralaxis(y)=12.5mm
- Width(B)=25mm
- Depth(D)=25mm

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

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

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

$$I=390625-256289.0625$$

$$I=11419.6614mm^4$$

$$Y=12.5\ mm$$

$$M_A-250*300=0$$

$$M_A=75000N.mm$$

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

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

$$\sigma=82.09N/mm^2$$

As the value σ = 82.09 N/mm^{2}is lower than Ultimate tensilestrengthwecanusethesquaretubetomanufacture the complete structure.

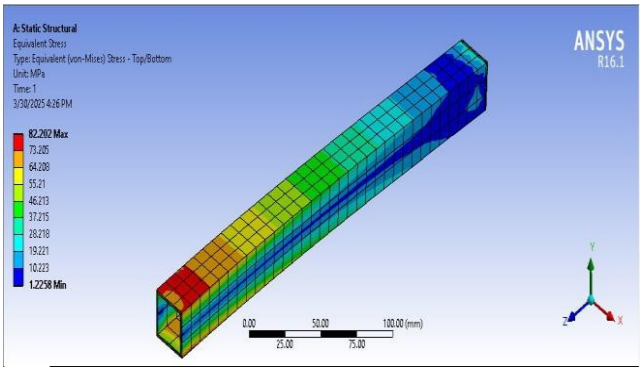


Fig.No.4Equivalent Stress

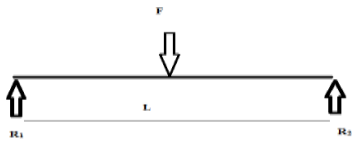
2) SHAFTS

DesignofPowertransmissionshaftconsideringfatigueload. Shaft material selected as 30C8 steel, diameter 10.80 mm, subjected to rotating bending fatigue loading, fatigue factor=1.612

Assuming

K size= 0.85K surface= 0.83K reliability= 0.896 $S_e'=0.5\sigma_{ultimate}$ =245mpa

$S_e=k_{size}\times k_{surface}\times k_{reliability}\times 1/k_S\times s_e$ (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

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

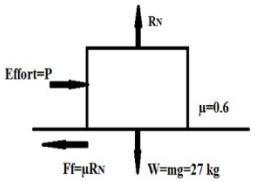
=**0.00249mm**

E=Young'sModulusN/mm^2

,L=40mmassumed $\Sigma_{bending}=M/z$(4)

M=Moment,z=SectionModulusmm^3 Σ bending= **79.66N/mm^2**

3) Minimum effort Required Formoving the Vehicle



WeightofMachine=25kg;mg

=25*9.81=245N

Coefficientoffriction=0.6 Normal reaction= 245 N Frictionalforce=Ff=μRN

=0.6*245=147N

V. CONCLUSION

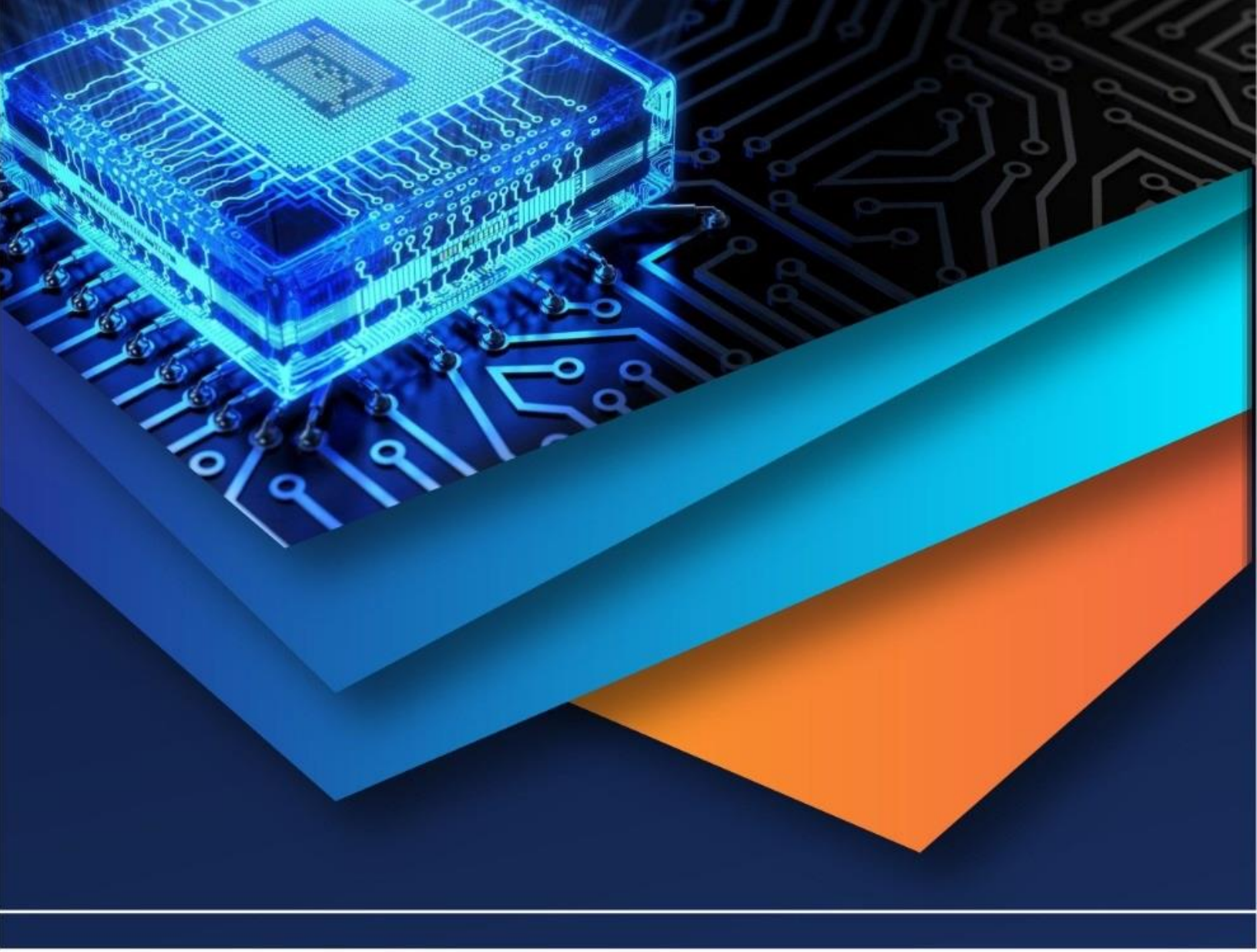
After designing and analyzing the "Multipurpose AgriculturalMachine,"wehavedrawnthefollowingconclusions: The machine effectively meets the needs of small-scale farmers who often struggle to afford expensive agricultural equipment. Its design reduces both labor requirements and operational time compared 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 functionsoffertilizersprayingandseedsowingintoa single system. Unlike conventional backpack sprayers that cause discomfort and back pain, our model offers a more ergonomicsolution.Thecalculationsandsoftware 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 canbe replaced with other fuel-efficient alternatives to enhance performancewhilemakingitmoreenvironmentally 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. Atpresent, 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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