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Design and Fabrication of Advanced Mowing Machine

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Abstract: Solar energy is converted into the chemical energy, which is used to drive the different units of the system. In this work we have tried to implement how the different agriculture equipment are combined and work together efficiently with reducing the manufacturing cost which will be in affordable budget. The main aim behind this project is to construct the equipment which is essential for the farm field with affordable cost for the farmer along with good efficiency. Another problem is unavailability of labour and also, working cost of them is very high. This affects the working time. The trapping of solar energy and its conversion of it into the electricity is easy. The system consists of a mobile platform equipped with a sprayer, a fertilizer deployment mechanism, and a cutting tool. The sprayer utilizes precision spraying technology, including sensors and actuators, to deliver targeted application of pesticides or herbicides, minimizing waste and environmental impact. The fertilizer deployment mechanism utilizes a rotary disc spreader to ensure accurate and uniform distribution of granular fertilizers across the field. Lastly, the cutting tool is designed for efficient harvesting or pruning of crops, improving overall crop yield and quality. The project aims to address key challenges faced by modern agriculture, such as uneven crop growth, weed infestation, and the need for efficient resource management. By integrating spraying, fertilizer deployment, and cutting functionalities, farmers can streamline their operations, reduce labour requirements, and achieve better control over crop health and productivity.

Keyword: Integrating Spraying, Fertilizer Deployment, and Cutting Functionalities**,** Efficient Harvesting**.**

Introduction:

India is agrarian economies and most of rural populations depend on agriculture to earn their livelihood. The farming methods at present are manual or semi-automatic with high involvement of laborers. In the recent years, the number of increases in their wages. There is a requirement of higher productivity. Hence the device is to be designed which helps farmers to overcome the stated problem. In our project, we are using solar cells for power generation. This energy can be utilized very effectively. The most common difficulties observed in farming that the cost of equipment's likes dusting machine, cutting machine, and spraying machine. The convectional equipment's used, required the fuel for their working, this increases the maintenance of the equipment. The spraying machine is the most important due to which the price is, increasing, it is operated with the help of diesel machine means it will not be able to operate without the electricity or the diesel machine. The pollution is caused by the convectional equipment's is high. Cutting the grass in the farm field requires numbers of labors which are quite difficult, the charges to be pay are increasing day by day which cannot be affordable for the poor farmer and work are not done in time. The convectional dusting machine is very costly and it works on the tractor machine. In the current scenario farmers are facing various problems like low rainfall, draught, and high cost of equipment. While the low rainfall is not in our hand, something can be done to reduce the cost which will eventually take out some burden from the farmers. As of now farmers are using three different tools for spraying, dusting and cutting. Farmers have to carry the sprayer on back and it has its limitation due to its weight. Farmers can't carry the sprayer for long time, so this reduces the efficiency and adds on fatigue and as of duster operation is concerned a metal basin is used to carry the powder and then dusted by hands, and for cutting of weed a separate cutter is used, which results in exhaustive human effort and work. Combine these three tasks and you have major workload which a farmer faces before harvesting season.

About System

A) Fertilizer Deployment System:-

A fertilizer deployment system is a mechanism or apparatus designed to distribute or apply fertilizers to plants or agricultural fields. Its purpose is to ensure the efficient and uniform delivery of fertilizers to crops, promoting healthy growth and maximizing yields. The specific design and functionality of a fertilizer deployment system can vary depending on the scale of operation, the type of fertilizer being used, and the specific requirements of the crops or plants being cultivated. Rotating Discs the spreader is equipped with one or more rotating discs positioned at the bottom of the hopper. These discs are usually driven by a power takeoff (PTO) shaft connected to a tractor or other power source. As the discs rotate, they create centrifugal force, which throws the granular fertilizer away from the center. Fertilizer deployment system is a mechanism or equipment designed to distribute or apply fertilizers onto agricultural fields or other areas where fertilization is required. The system ensures an even and controlled distribution of fertilizers to optimize crop growth and yield. The hopper or tank holds the fertilizer, ensuring a continuous supply during the deployment process. The metering system regulates the flow rate of fertilizer to achieve the desired application rate. It can be manual, mechanical, or electronically controlled. Spreading Mechanism: The spreading mechanism varies depending on the system type. It can include spinning discs, drop tubes, air assist nozzles, or injectors to disperse the fertilizer uniformly.

B) Spray system:-

This small, high volume, 12v fluid circulation pump is very well suited for circulating water through heat exchangers on water inter cooled turbo applications. Magnetic drive motor with sealed pump chamber for long life even with continuous use (up to 3lit per minute.). High temperature capable. Pump can also be as replaced damaged condition. A spraying system in agricultural projects involves the application of liquid solutions, suspensions, or emulsions onto crops or fields for various purposes such as pest control, disease prevention, weed management, and nutrient application. Proper calibration of the spraying system ensures accurate and consistent application rates. Calibration involves determining the flow rate of the sprayer, adjusting nozzle spacing, and ensuring uniform coverage. Calibration methods may vary depending on the sprayer type and the desired application rate. Nozzle selection is crucial for efficient spraying. Factors to consider when selecting nozzles include the desired spray pattern, droplet size, flow rate, and pressure requirements. Different nozzle types, such as flat fan, hollow cone, or full cone nozzles, can be chosen based on the specific needs of the project and the characteristics of the liquid being sprayed.

C) Cutter :-

The engine can be started and stopped using a control panel (control button). The engine starts as soon as the on button is pressed. We are employing a Honda GX50 generalpurpose four-stroke engine, which can generate 2 horsepower at 1200 revolutions per minute. The shaft is driven by this engine. A cutter blade is installed on the shaft. Additionally, the cutter spins along with the shaft. A cutter system is a mechanism or equipment used for cutting various materials, such as crops, vegetation, or other objects, in different applications. The design of a cutter system depends on the specific application requirements, such as crop type, terrain, cutting height, width, and productivity goals. Different projects may require customized attachments, adjustable cutting heights, or intelligent control systems to optimize cutting efficiency. Cutter systems should incorporate safety features to protect operators and bystanders. These may include guards, emergency stop switches, shields, or sensors to prevent accidents or injuries during operation. Grass cutter these cutters are designed for trimming grass and maintaining lawns. They can be handheld trimmers, walk-behind or ride-on lawn mowers, or robotic mowers. They often use rotating blades or strings for cutting grass at adjustable heights.

Problem Statement:

In India, Agriculture with its allied sectors, is the largest source of livelihoods. 70 percent of its rural households still depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. These farmers can't afford costly equipment's and machines. And they have to put more human and animal effort.

1. Lack of Capital
2. Irrigation Problem.
3. Required more man power for performing agriculture process.
4. Excess time Required for performing individual process.

Objectives:

The design of this multi-purpose machine will help Indian farmers in rural side and small farm. It will reduce the cost of spraying, Fertilizer deployment and grass cutting the field and will help to increase economic standard of an Indian farmer.

1. The main objective of this project is to design and fabricate multipurpose agriculture Machine.
2. To minimize the cost so that it should be affordable for everyone.
3. To reduce Human efforts, all operations can be performed by single person.
4. To reduce amount of time for operation.

Methodology:

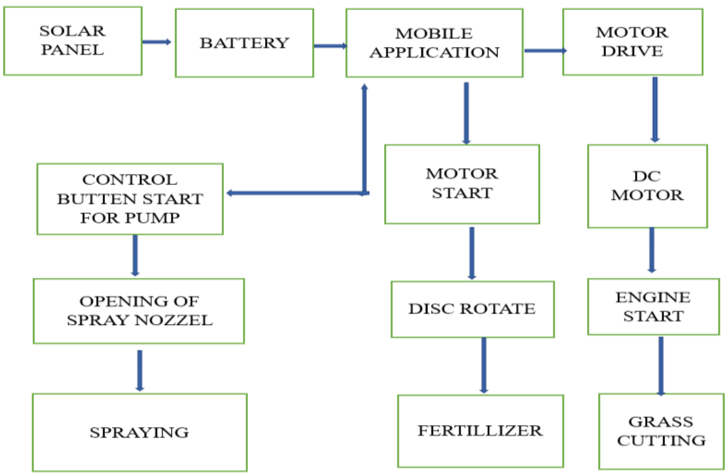

Fig.1 Methodology

Literature Review:

Roshan Raman, Gaurav Sharma, Akshay Kumar[1] have stated th In this paper, collecting of wheat utilizing crop shaper was evaluated. Results demonstrated that the field limit of yield express was 2.44 occasions higher than the manual activity. The work prerequisite was 32.74 and 149.25 man-hr/ha for harvest shaper and manual activity, individually. If there should arise an occurrence of wheat, the field limit of product shaper was 2.23 occasions more noteworthy than manual reaping and work contribution was 23.20 and 115.74 man - hr/ha for yield shaper and manual task, separately. It is expected by the use of this harvesting machine the farmers will be benefiting in terms of money as well as the physical task will be reduced significantly. Overall, the cost of this manufactured machine was approx. 6000 INR.

Niraj B kendre, Abhishek M Lodh, Vipin Tekade, Prashant Shende [2] have stated in the paper there are many developments in the existing cultivating machineries but it is too costly. It is not affordable for each and every farmer in India as It has a complex design and inconvenient to handle. Basically, it is not compact in size and their weight is a major factor for handling purpose and hence, it requires a much effort to accomplish its transportation cost from one place to another place.

P. V. Sawalakhe and Amit, Sontakke [3] have stated in this paper they investigated that there is a rapid development in all sector including the agricultural sector as well. So in order to meet the future food requirements, the farmers need to change their techniques to overcome the traditional method of farming. This Paper describes the various sowing methods implemented in agriculture for seed placements.

Ramya E, Renugha Devi R, Roshni Prasenth K [4] have stated in this paper The paper aims at designing and fabricating a solar grass cutter with water spraying system using RF Technology to reduce man power, pollution and usage of electricity in gardening. Both the grass cutting and the water spraying application can be executed in parallel. Power supply performs an amazing function anywhere people lives and works. The residing values and affluence of a country range at once with the growth with the usage of power. Worlds electricity requirement is growing at an alarming price because of commercial growth, improved and huge use of electrical gadgets. The high-quality alternative opportunity supply is from the sun energy. In this design the source energy is ambitious from the sun radiation by using PV panels and it is stored in 12V rechargeable DC battery. The proposed proto-vehicle performs two operations that are controlled using a switch. The first operation is grass cutting, the grass cutting blade is connected a DC Motor. The second operation is the spreading of water/pesticide, here we use a water pump connected to the spreading nozzle by the means of hoses. The battery is connected to the RF Module with controls all the motors. The RF session encompasses an RF transmission and reception. This Tx/Rx pair (RF module) functions at a frequency of 434 MHz The data required for the RF transmitter is received from series of serial data and is transmitted in wireless manner using the RF antenna. The data that is transmitted is received by RF receiver in the RF module with same operating frequency of transmitter. The RF module has a pair of encoder/decoder and is used with the module itself. The encoder encodes the parallel data for the transmission system and the at the reception decoder unit is used for decoding the data. Input signals are transmitted through four channels and the outputs are observed with a set of four LED's with respect to corresponding switches.

Suneetha Racharla1, K Rajan [5] have stated in this paper The generation of power from the reduction of fossil fuels is the biggest challenge for the next half century. The idea of converting solar energy into electrical energy using photovoltaic panels holds its place in the front row compared to other renewable sources. But the continuous change in the relative angle of the sun with reference to the earth reduces the watts delivered by solar panel. In this context solar tracking system is the best alternative to increase the efficiency of the photovoltaic panel. Solar trackers move the payload towards the sun throughout the day. In this paper different types of tracking systems are reviewed and their pros and cons are discussed in detail. The results presented in this review confirm that the azimuth and altitude dual axis tracking system is more efficient compared to other tracking systems. However in cost and flexibility point of view single axis tracking system is more feasible than dual axis tracking system

Muhammad Haris , Nabeel Tabassum , Hammad ud din Babar , Bilal Hassan , Shahbaz Khan, Zarak Khan & Abdoulie Amhmad Borhana omoran [6]

Have stated in this paper Grass cutter machines have become very prevalent currently. Most of the times, grass cutter machines are used for soft grass cutting. In a time where technology is integrating with environmental sentience, consumers are considering for ways to provide to the relief of their own carbon footprints. Pollution is man-made and can be seen in our own daily lives, more precisely in our own homes. Herein, we recommend a model of the automatic grass cutting machine powered through battery. Automatic grass cutting machine is a machine which is going to accomplish the grass cutting operation on its own. This model reduces both environment and noise pollution. As world is moving towards automation, conventional systems are transformed into automated systems. So, having an automated grass cutter is need of the hour. In this project a conventional push grass cutter is modified into Semi Automatic, RC controlled, battery powered, video surveillance grass cutter. Microcontroller is used to interface ultra-sonic sensors and Remote control with cutter motor and vehicle motors. If an obstacle is detected that is any living or non-living thing micro controller stops all motors and cutter moves backward so that operator can guide it away from obstacle.

Design and Analysis:

Nozzle:

Nozzle sprays play a crucial role in various applications, including agriculture, industry, and household use. They are designed to atomize liquids into fine droplets or create a controlled spray pattern for effective and efficient distribution. Here is some basic design information about nozzle sprays. for design a Nozzle we required Nozzle type, Nozzle Material, Spray Angle, flow rate, spray Pattern. To calculate the spray nozzle for your application, you will need to consider the following parameters:

1. Flow rate of the liquid through the nozzle (Q) in gallons per minute (GPM) or litters per minute (LPM)

2. Pressure of the liquid at the nozzle inlet (P) in pounds per square inch (PSI) or bars

3. Density of the liquid (ρ) in pounds per cubic foot (PCF) or kilograms per cubic meter (Kg/M3)

4. Viscosity of the liquid (μ) in centipoise (CPS) or Pascal-second (Pa.s)

5. Nozzle orifice size (d) in inches or millimetres

First, we need to calculate the cross-sectional area of the nozzle orifice using the following equation:

$A = \pi \times d^2/4$ ……………………………(1)

$A = (3.14 \times 0.8^2)/4$

A = 0.5024 square inches (3.24 square cm)

Next, we need to calculate the velocity of the liquid passing through the nozzle using the following equation:

$V = K \times \sqrt{(2 \times P/\rho)}$ .....……………………….(2)

$V = 0.97 \times \sqrt{(2 \times 40/8.34)}$

V = 35.21 feet per second (10.73 meters per second)

Then, we can calculate the flow rate using the following equation:

$Q = A \times V$ …………………………..(3)

$Q = 0.5024 \times 35.21$

Q = 17.72 GPM (67 LPM)

Finally, we can calculate the spray angle using the following equation:

$\theta = 2 \times \tan^{-1} (W/2 \times L)$ ……………………………(4)

Assuming W = 6 feet (1.83 meters) and L = 5 feet (1.52 meters) $\theta = 2 \times \tan^{-1} (6/2 \times 5)$ θ = 110 degrees

Therefore, a 0.8 inch (20.32 mm) diameter nozzle with a spray angle of 110 degrees can handle a flow rate of 17.72 GPM (67 LPM) at a pressure of 40 PSI (2.8 bar).

Pump:

To design a pump for a 20 mm nozzle, you would need to consider the flow rate and pressure requirements for your specific application. Here are the basic design calculations involved

Flow rate for nozzle 17.72 GPM

Flow Rate (Q) in m³/s = Q / (60 × 1000) ………………………….(5)

17.72 / (60 × 1000) = 0.000295 m³/s

Determine the pressure assume the pressure 1 bar (100000 pascals)

Select the pump centrifugal pump is suitable the spraying operation

Calculate pump power =

Power=(Q*P)/Efficiency …………………………..(6)

=0.0002958*10000/60

= 49 Watts.

Cutter System :

Details of a blade:

1. Material to be cut: Grass
2. Cutter diameter: 10 inches
3. Spindle Speed: 1200 rpm
4. Feed rate: 2 feet / Min
5. Depth of cut: 3 inches
6. Machine Horse power: 2 hp

Calculation for **blade**

1. Cutting speed = 3.147* cutter diameter * spindle speed /12 ……………………………(9)
   = 3.14*10*1200/12
   = 314 FT/ min

2. Chip Load per tooth = feed rate / no of teeth * spindle speed ……………………………..(10)
   = 2/10*1200
   = 0.0001667 inches
3. Power required = chip load* depth of cut * cutting speed * machine HP ……………………(11)
   = 0.0001667*3*314*2
   = 0.6272 HP or
   = 467 watts

Solar Panel

Details :

Power consumption of load = 50 watt

Size of battery = 12 v, 50 Ah

Average Sunlight in day hrs = 5 hrs

Panel efficiency = 16 %

Calculation

Step 1: Calculate the power requirement in watt hrs per day

Power consumption of load = 50

Average sunlight hrs = 5 hrs

Power required = power consumption * time in use ……………………………..(7)

= 50 w * 5 hrs

= 250-watt hrs/day

Step 2: Calculate necessary panel output

Panel wattage required = power required / panel efficiency * average sunlight hours ………………………(13)

= 250/0.16*5

=312.5 watt

Step 3: calculate size of battery

Battery size = power consumption * time use* 2 /12V …………………………..(8)

= 50*5*2/12

= 41.6 Ah

Hence 12v 50 Ah battery would sufficient.

Frame Calculation:

CA mild steel square bars are used in the construction of the frame because of its availability, strength, work ability and cheap. The frame supports the battery, electric motor, eliminator and solar panel and handle frame. They transmit the load of 8kg and its length is 20 = 508mm

where P is the load on each wheel = (8*10)/4 = 20 N

Therefore, Bending moment,

(M) = PL/4 …………………………..(9)

= (20*508)/4

= 2.54 N-m

From the data hand book, Yield stress = 200 N/mm2

Allowable

shear stress = (1/3)*yield stress …………………………..(10)

= 0.577 * 200

= 115.4 N/mm^2

Efficiency calculations:

Efficiency, Ƞ=Pout/Pin

= (20.94/22.8)*100

= 91.85%

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CAD Design:

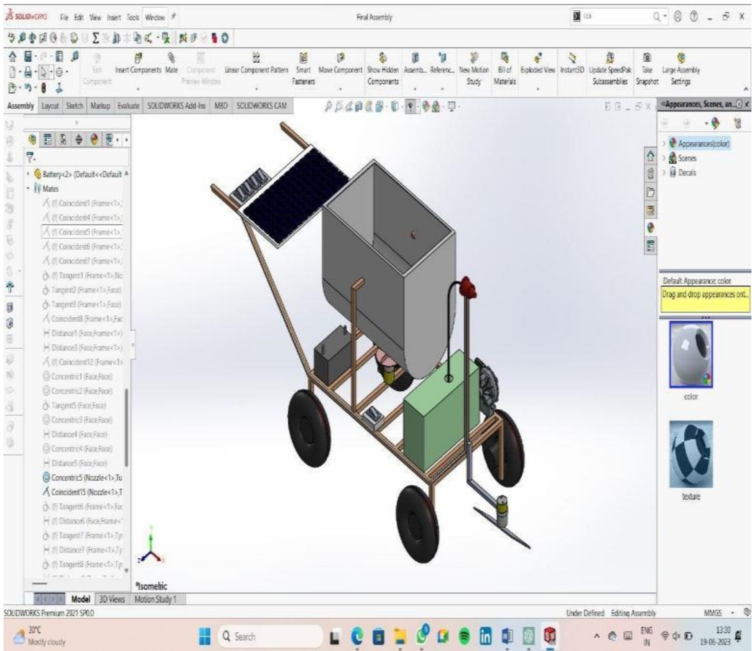

Fig No. 2 Top view of CAD Model of Mowing spray machine

Conclusion:

This project focused on enhancing agricultural practices through the implementation of advanced spraying, cutting and fertilizer deployment systems. The objectives of the project is to improve crop health and yield, increase operational efficiency, enhance cost-effectiveness, enable precision agriculture, and promote sustainable agricultural practices.

Through the integration of cutting-edge technologies, such as GPS guidance, automated control systems, and sensor-based technologies, the project aimed to optimize the delivery of fertilizers, ensure accurate and timely cutting of crops, and achieve precise spraying techniques. These advancements aimed to improve nutrient absorption, maximize crop productivity, and reduce labour and time requirements.

The project also sought to enhance cost-effectiveness by optimizing fertilizer usage, minimizing crop losses during cutting, and maximizing economic returns on agricultural investments. Additionally, the integration of data-driven approaches, remote sensing, and decision support systems enabled precision agriculture, allowing for real-time monitoring of crop health, optimized fertilizer application, and timely cutting based on crop growth stages and yield potential. Overall, the project aimed to revolutionize agricultural practices by leveraging technological advancements to improve the efficiency, effectiveness, and sustainability of spraying, cutting, and fertilizer deployment systems.

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