A PROJECT REPORT ON

DESIGN AND PROTOTYPE OF SOLAR POWERED MULTIPURPOSE AGRICULTURAL VEHICLE

Submitted in Partial Fulfillment of the Requirement for the Award of Degree

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

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ABSTRACT

In today's era, all sectors are experiencing rapid growth through the use of advanced technologies. Agriculture is no exception. To meet the increasing demand for food, farmers must implement advanced techniques that enhance soil quality and boost overall food production.

This report presents the design and prototype development of a solar-powered multipurpose agricultural vehicle aimed at enhancing sustainability and efficiency in agricultural practices. The primary advantage of this technique is its ability to minimize the time and human effort involved in planting seeds. The solar sprayer uses solar panels as its power source to run the fan, eliminating the need for additional power supplies. This innovative mechanical project can save considerable time in the sowing process and reduce labor costs, making it particularly beneficial for small-scale farmers.

Prototyping included the fabrication of a scaled model and testing under simulated agricultural conditions, and iterative design refinements based on performance data. The prototype demonstrated promising results, achieving significant energy savings and operational effectiveness. Field tests confirmed the vehicle's ability to perform essential agricultural tasks while maintaining a sustainable energy balance.

This report concludes that the solar-powered multipurpose agricultural vehicle has the potential to revolutionize agricultural practices by reducing reliance on fossil fuels, minimizing operational costs, and promoting environmental sustainability. Future work will focus on scaling the prototype for commercial use, enhancing energy storage solutions, and expanding the range of functionalities to further meet the diverse needs of the agricultural sector.

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NOMENCLATURE

1. **V**: Voltage (Volts, V)
2. **I**: Current (Amperes, A)
3. **P**: Power (Watts, W)
4. $\boldsymbol{\omega}$: Angular Speed (Radians per Second, rad/s)
5. **RPM**: Rotations Per Minute
6. $\boldsymbol{T}$: Torque (Newton-meters, Nm)
7. $\boldsymbol{P_{total}}$: $Total\ Power\ Consumption\ (Watts, W)$
8. $\boldsymbol{I_{total}}$: $Total\ Load\ Current\ (Amperes, A)$
9. $\boldsymbol{T_{in}}$: $Input\ Torque\ (Newton - meters, Nm)$
10. $\boldsymbol{\omega_{in}}$: $Input\ Angular\ Speed\ \left(Radians\ per\ Second, \frac{rad}{s}\right)$
11. $\boldsymbol{T_{out}}$: $Output\ Torque\ (Newton - meters, Nm)$
12. $\boldsymbol{\omega_{out}}$: $Output\ Angular\ Speed\ (Radians\ per\ Second, \frac{rad}{s})$
13. $\boldsymbol{P_{in}}$: $Input\ Power\ (Watts, W)$

CHAPTER 1

INTRODUCTION

In Agriculture, the cultivation of crops and the rearing of animals, stands as the cornerstone of human sustenance and economic stability worldwide. As the global population continues to burgeon, the demand for agricultural produce escalates, necessitating the adoption of innovative farming technologies. In response to this imperative, this project endeavors to conceptualize and construct a groundbreaking solution: a solar-powered multipurpose agricultural vehicle. By harnessing solar energy, this vehicle aims to revolutionize traditional farming practices and propel agricultural productivity to new heights.

1.1 SOLAR CELLS

Solar cells and photodetectors are devices that convert optical input into current. A solar cell is an example of a photovoltaic device, i.e., a device that generates voltage when exposed to light. The photovoltaic effect was discovered by Alexander-Edmond Becquerel in 1839 in a junction formed between an electrode (platinum) and an electrolyte (silver chloride). The first photovoltaic device was built using a Si PN junction by Russell Ohl in 1939. The functioning of a solar cell is similar to that of a photodiode (photodetector). It is a photodiode that is unbiased and connected to a load (impedance). There are three qualitative differences between a solar cell and a photodetector:

1. A photodiode works on a narrow range of wavelengths, while solar cells need to work over a broad spectral range (solar spectrum).
2. Solar cells are typically wide-area devices to maximize exposure.

3. In photodiodes, the metric is quantum efficiency, which defines the signal-to-noise ratio, while for solar cells, it is the power conversion efficiency, which is the power delivered per incident solar energy. Usually, solar cells and the external load they are connected to are designed to maximize the delivered power.

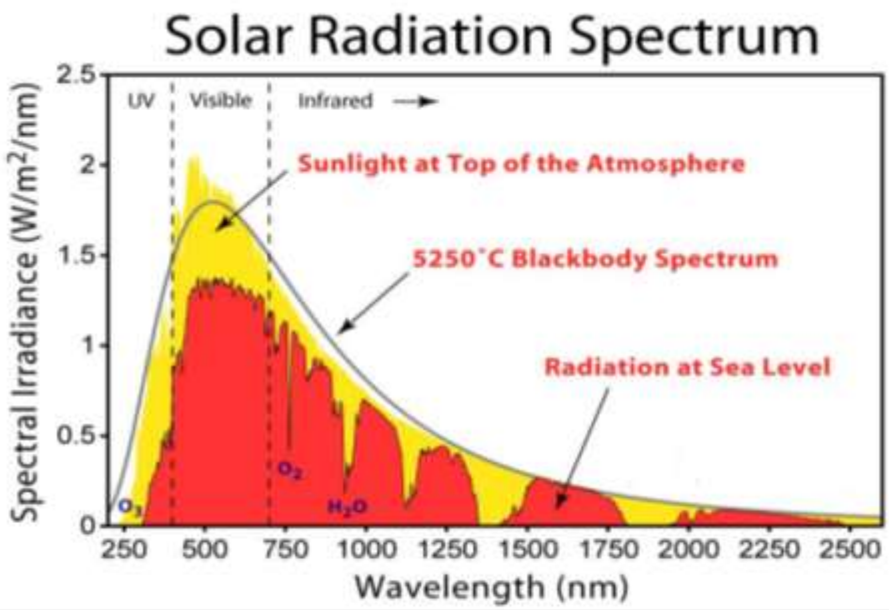


Figure 1.1: Solar radiation

Table 1.1 Wavelength and sun light.

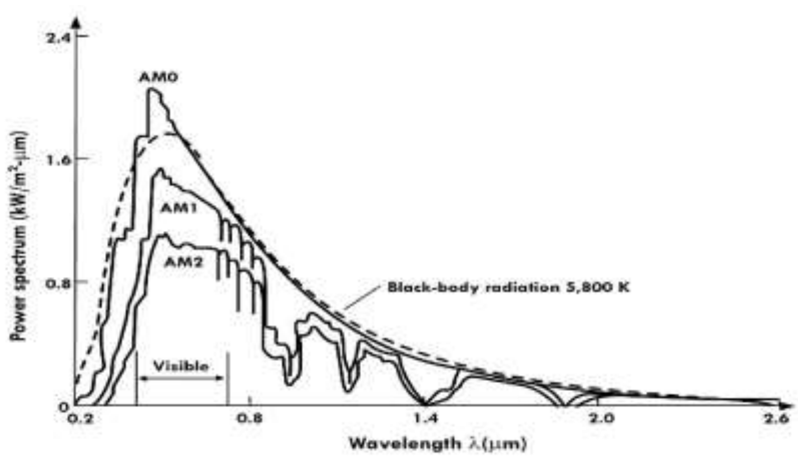
Wavelength (nm)	**Sunlight at Top of Atmosphere (W/m²/nm)**	**Radiation at Sea Level (W/m²/nm)**
250	0.5	0.2
500	2.2	1.8
750	1.9	1.5
1000	1.5	1
1250	1	0.5
1500	0.7	0.3
1750	0.4	0.2
2000	0.2	0.1
2250	0.1	0.05
2500	0.05	0.02

1.1.1 Solar Spectrum

The solar spectrum typically extends from the IR to the UV region, with a wavelength range from 3 µm to 0.2 µm. But the intensity is not uniform. A typical solar spectrum, as a plot of spectral irradiance vs. wavelength, is shown in Figure 1.1 The area under the curve gives the total areal intensity, which is approximately 1.35 kW/m^2. The solar spectrum can be approximated by a black body radiation curve at a temperature of approximately 5250°C. There is also a difference in the spectra measured at the top of the atmosphere and at the surface due to atmospheric scattering and absorption.

The path length of the light in the atmosphere depends on the angle, which varies with the time of day. This is given by the air mass number (AM), which is the secant of the angle between the sun and the zenith (sec θ). AM0 represents the solar spectrum outside the earth's atmosphere. AM1 is when the angle is zero, i.e., the sun is at the zenith, and it has an intensity of 0.925 kW/m^2. AM2 is when the sun is at an angle of 60° and its intensity is 0.691 kW/m^2. The different spectra are plotted in Figure 1.2.1

Figure 1.1.1: Typical solar spectrum for different air mass conditions.



1.1.2 Solar Cell Working Principle

A simple solar cell is a PN junction diode. The schematic of the device is shown in Figure 1.1.4. The n-region is heavily doped and thin so that light can penetrate through it easily. The p-region is lightly doped so that most of the depletion region lies in the p-side. The penetration depends on the wavelength and the absorption coefficient increases as the wavelength decreases. Electron-hole pairs (EHPs) are mainly created in the depletion region, and due to the built-in potential and electric field, electrons move to the n-region and holes to the p-region. When an external load is applied, the excess electrons travel through the load to recombine with the excess holes. Electrons and holes are also generated within the p and n regions, as seen from Figure 1.1.4. The shorter wavelengths (higher absorption coefficient) are absorbed in the n-region, and the longer wavelengths are absorbed in the bulk of the p-region. Some of the EHPs generated in these regions can also contribute to the current. Typically, these are EHPs that are generated within the minority carrier diffusion length Le for electrons in the p-side and Lh for holes in the n-side. Carriers produced in this region can also diffuse into the depletion region and contribute to the current.

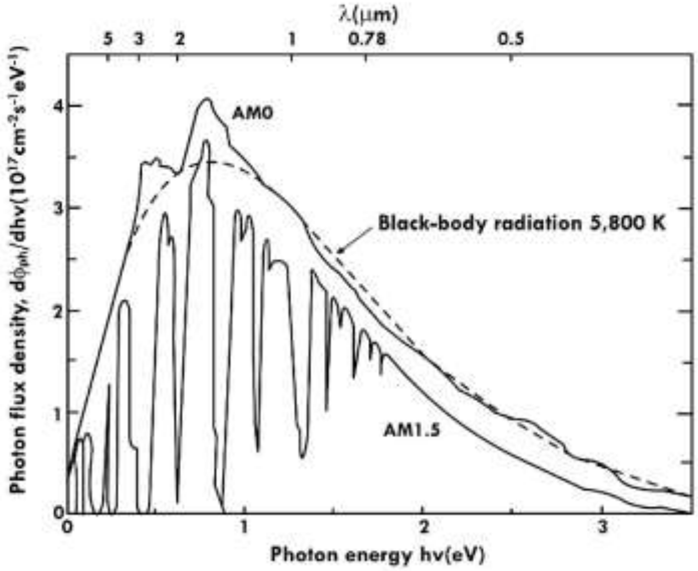


Figure 1.1.2: Solar spectrum plotted as photon ux density vs. energy.

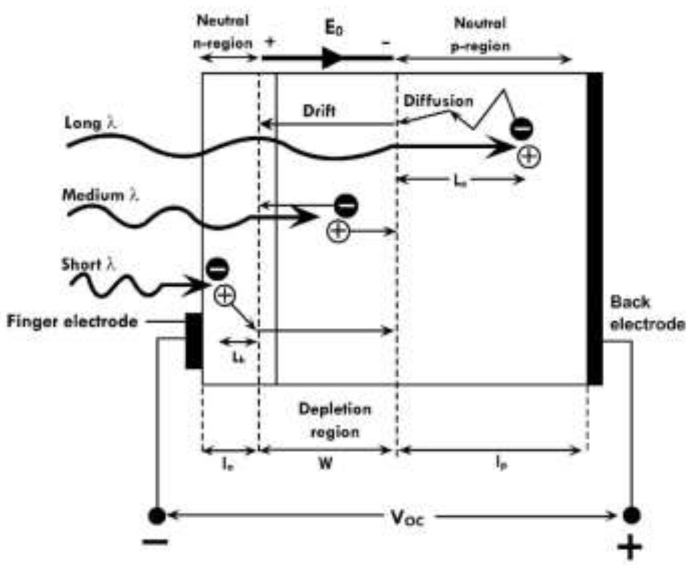


Figure 1.1.3: Principle of operation of a PN junction solar cell.

Consider a solar cell made of Si. The band gap E.g. is 1.2.1 eV so that wavelengths above figure 1.2.2 μm are not absorbed since the energy is lower than the band gap. Thus, any wavelength greater than 1.1 μm has negligible absorption. For wavelengths much smaller than 1.1 μm,,

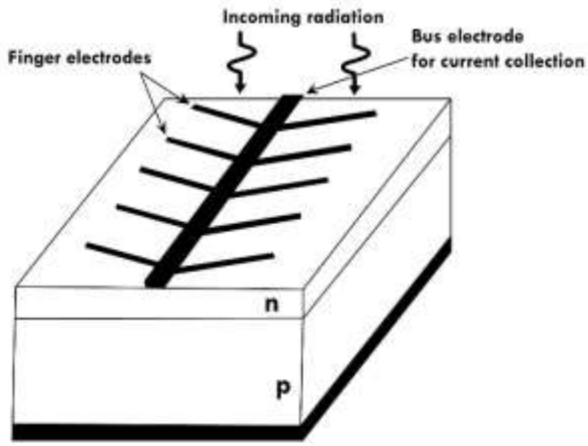


Figure 1.1.4: Finger electrodes on a PN junction solar cell.

1.2 PLOUGH

The primary implement used for primary tillage is a plough. Ploughing essentially involves opening the upper crust of the soil, breaking up clods, and preparing the soil for seed sowing. The purposes of ploughing can be summarized as follows:

a. To create a deep seed bed with good texture.
b. To increase the soil's water holding capacity.
c. To improve soil aeration.
d. To eliminate weeds and grasses.
e. To control insects and pests.
f. To prevent soil erosion.
g. To enhance soil fertility by incorporating vegetation.

1.2.1 INDIGENOUS PLOUGH

An indigenous plough is drawn by animals. It penetrates the soil, breaking it open and forming V-shaped furrows with a top width of 15-20 cm and a depth of 12-15 cm. It can be used for ploughing dry land, garden land, and wetlands. The size of the plough is determined by the width of the body, and its field capacity is approximately 0.4 hectares per day of 8 hours. The functional components include the share, body, shoe, handle, and beam. Except for the share, all other parts are made of wood. In villages, local artisans craft and supply these ploughs to farmers. These ploughs are also referred to as country ploughs.

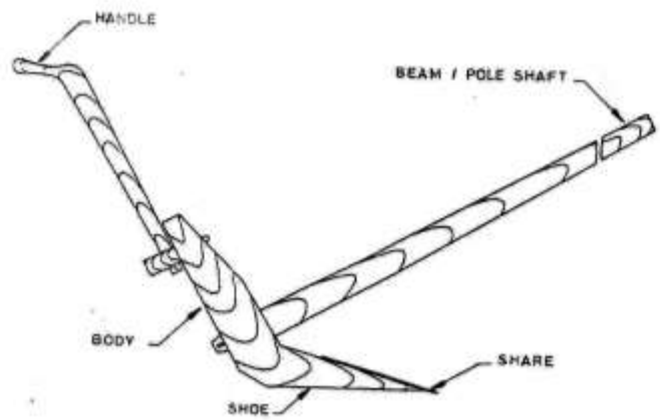


Figure1.3.1: Plough

1.2.2 Indigenous Plough Components:

a. **Share:** This is the working part of the plough, attached to the shoe, with which it penetrates the soil and breaks it open.
b. **Shoe:** The shoe supports and stabilizes the plough at the required depth.
c. **Body:** The main part of the plough to which the shoe, beam, and handle are attached. In country ploughs, both the body and shoe are often made from a single piece of wood.
d. **Beam:** A long wooden piece that connects the main body of the plough to the yoke.

1.2.3 Operational Adjustments:

a. By adjusting the free end of the beam in relation to the plough body, the share angle with respect to the horizontal surface can be altered. This adjustment directly impacts the depth of ploughing—raising the free end increases the share angle, deepening the cut, while lowering it decreases the angle, resulting in shallower ploughing.
b. Similarly, modifying the length of the beam between the plough body and the yoke of the animals can also adjust the depth of ploughing. Shortening the beam reduces the depth of the cut, whereas extending it increases the depth, providing flexibility in adapting to different soil conditions and tillage requirements.

1.2.4. Moldboard Plough Functionality:

The moldboard plough, revered as one of the oldest and most essential agricultural implements, serves multiple critical functions:

1. **Cutting the Furrow Slice:** With its sharp blade, the plough effortlessly slices through the soil, creating furrows in preparation for planting.
2. **Lifting the Furrow Slice:** Once cut, the plough efficiently lifts the soil slice, readying it for the next stage of tillage.
3. **Inverting the Furrow Slice:** As the plough progresses, it flips the soil slice over, exposing fresh soil to the surface while burying weeds and incorporating organic matter.
4. **Pulverizing the Furrow Slice:** Through this process of inversion, the soil is effectively broken down and aerated, facilitating better root penetration and nutrient absorption for crops.

Moldboard ploughs are adaptable implements, available in configurations suitable for operation with animals, power tillers, or tractors. Their pivotal role in tillage operations cannot be overstated, as they lay the foundation for successful crop cultivation by preparing the soil in an optimal manner.

1.2.5. ADJUSTMENT OF MOLDBOARD PLOUGH

For proper penetration and efficient work by the moldboard plough, some adjustments are made from time to trim. They are (i) Vertical suction and (ii) Horizontal suction.

a) Vertical suction (Vertical clearance)

It is the maximum clearance under the land side and the horizontal surface when the plough is resting on a horizontal surface in the working position. It is also defined as the vertical distance from the ground, measured at the joining point of share and land side. (Fig.7a). It helps the plough to penetrate into the soil to a proper depth. This clearance varies according to the size of the plough.

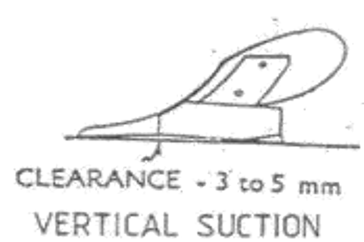


Figure 1.3.2 (a) Horizontal clearance (b) **Vertical clearances**

b) Horizontal suction (Horizontal clearance)

It is the maximum clearance between the land side and the furrow wall. This suction helps the plough to cut the proper width of furrow slice. This clearance also varies according to the size of the plough. It is also known as side clearance.

c) Throat clearance

It is the perpendicular distance between share point and lower position of the beam of the plough.

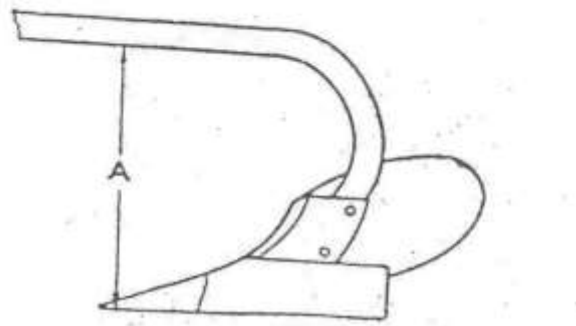


Figure1.3.3 Throat clearance of plough

1.2.6. TYPES OF MOLDBOARD PLOUGHS

1) Fixed type (one way) moldboard plough

One-way plough throws the furrow slice to one side of the direction of travel and is commonly used everywhere. It may be long beam type or short beam type

2) Two-way or Reversible plough

It is a moldboard plough which turns furrow slice to the right or left side of direction of travel as required. Such ploughs have two sets of opposed bottoms. In such a plough, all furrows can be turned towards the same side of the field by using one bottom for one direction of travel and the other bottom on the return trip. Two sets of bottom are so mounted that they can be raised or lowered independently or rotated along an axis. Two way ploughs have the advantage that they neither upset the slope of the land nor leave dead furrows or back furrows in the middle of the field.

3) Turn wrest plough

There are some reversible ploughs which have single bottom with an arrangement that the plough bottom is changed from right hand to left hand or vice versa by rotating the bottom through approximately 180° about a longitudinal axis. This type of plough is called turn wrest plough . While moving in one direction, the plough throws the soil in one direction and at the return trip the direction of the plough bottom is changed, thus the plough starts throwing the soil in the same direction as before.

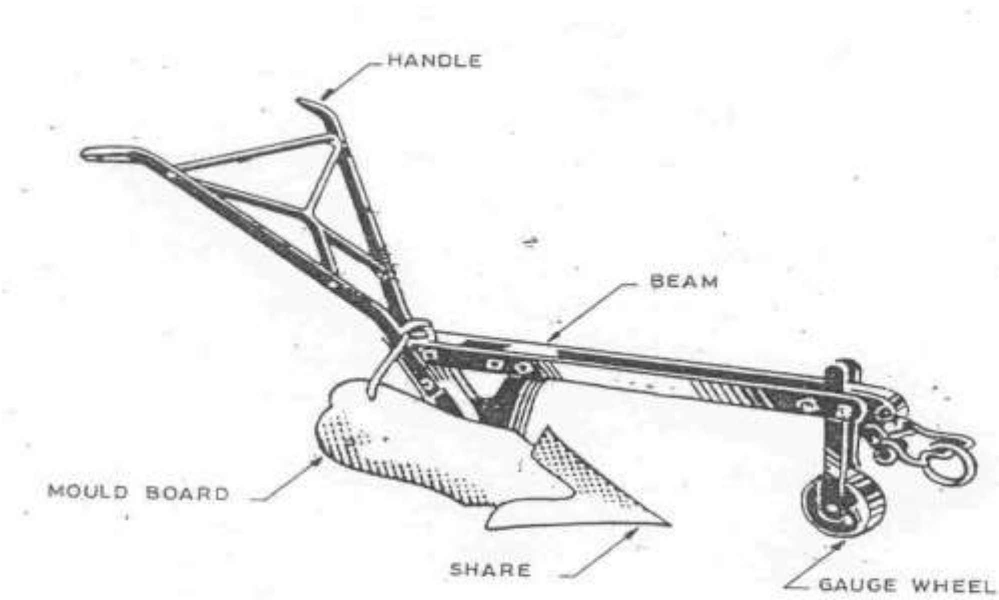


Figure 1.3.4 Turn wrest plough

1.2.7. Other Terms Connected with Ploughs

1. **Vertical Clevis**

   A **vertical clevis** is a vertical plate with several holes, fitted at the end of a beam. This allows for vertical adjustments of a plough, enabling the operator to control its depth of operation. By adjusting the clevis, the plough can be set to work at various soil depths, optimizing soil penetration and turnover.

2. **Horizontal Clevis**

   A **horizontal clevis** facilitates lateral adjustments of the plough relative to the line of pull. This adjustment ensures proper alignment of the plough with the tractor, maintaining straight and uniform furrows. It is particularly useful in fields with varying terrain or when multiple ploughs are used in tandem.

3. **Plough Size**

   The **plough size** is defined as the perpendicular distance from the wing of the share (the cutting part) to the line joining the point of the share and the heel of the land side (the rear stabilizing end). This size determines the width of the soil cut, influencing the number of passes required to plough a field and overall operational efficiency.

4. **Centre of Power**

   The **centre of power** is the true point of hitch on a tractor, which is essential for maximizing traction and control. This point, usually located at the tractor's rear hitch, ensures effective transfer of engine power to the implement, reducing slippage and improving fuel efficiency.

5. **Centre of Resistance**

   The **centre of resistance** is the point where the resultant of all horizontal and vertical forces acting on the plough converge. This centre lies at a distance equal to three-fourths the size of the plough from the share wing. Understanding the centre of resistance helps in adjusting the line of pull, ensuring smooth operation without excessive lateral or vertical forces that could destabilize the plough.

6. **Line of Pull**

   The **line of pull** is an imaginary line passing through the centre of pull, the hitch point, and the centre of resistance. Proper alignment along this line minimizes drag and ensures even furrow formation. Operators must adjust the hitch points and clevis settings to maintain an optimal line of pull, especially when dealing with different soil conditions or plough sizes.

7. **Pull**

   Pull refers to the total force required to move an implement through the soil. This force includes the frictional resistance of the soil, the weight of the implement, and any additional resistance due to soil compaction or obstacles. Pull is usually measured in pounds or kilograms and is a critical factor in determining the horsepower needed for a tractor to effectively operate a plough or other implements. Efficient ploughing requires minimizing the pull force by optimizing equipment settings and soil conditions.

1.2.8. DISC PLOUGH

A action of a disc plough is similar to the moldboard plough. Disc plough cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel concave discs. A disc plough is designed with a view to reduce friction by making a rolling plough bottom instead of sliding plough bottom as in the case of moldboard plough. A disc plough works well in the conditions where moldboard plough does not work satisfactorily.

Figure1.3.5 Two bottom disc plough

1.2.9. Advantages and Disadvantages of disc plough

1. A disc plough can be forced to penetrate into the soil which is too hard and dry for working with a moldboard plough.
2. It works well in sticky soils in which a moldboard plough does not scour. ♦ It is more useful for deep ploughing.
3. It can be used safely in rough, stony and stumpy soils without much danger of breakage.
4. A disc plough works well even after a considerable part of the disc is worn out in abrasive soils
5. It works well in loose soils also (such as peat) without much clogging.
6. It is not suitable for covering surface trash and weeds as effectively as a moldboard plough
7. Comparatively, a disc plough leaves the soil in rough and cloddy condition than that of a moldboard plough.
8. Disc plough is much heavier than moldboard plough for equal capacities because penetration of disc plough is effected largely by its weight rather than suction. (Moldboard plough is forced into the soil by the suction of the plough, while the disc

1.2.10 DISC PLOUGHS

Disc ploughs are of two types (i) Standard disc plough and (ii) Vertical disc plough.

1. Standard disc plough

A standard disc plough consists of a series of individually mounted, inclined disc blades on a frame supported by wheels. These ploughs usually have from 2 to 6 disc blades, spaced to cut 18 to 30 cm per disc. Each disc revolves on a stub axle in a thrust bearing, carried at the lower end of a strong standard which is bolted to the plough beam The discs are tilted backward at an angle of 15 – 25º from the vertical (tilt angle) and with a horizontal diameter disc face angle of 42 – 45 º (disc angle) from the direction of travel. Disc diameters are commonly 60 – 70 cm. In action, the discs cut the soil, break it and push it sideways. There is little inversion of furrow slice as well as little burying of weeds and trashes compared to moldboard plough. Scrapers are furnished as regular equipment on most standard disc ploughs which assist in covering trash and prevent soil build up on discs in sticky soils. Disc ploughs are most suitable for conditions under which a moldboard plough do not work satisfactorily, such as in hard, dry soil, in sticky soils where a mould board will not scour, and in loose push type soil such as peat ands Figure Disc Plough(A moldboard plough in soils and moisture conditions where it works satisfactorily does a better job than a disc plough and has a low specific graft)

A few important terms connected with disc plough are explained below

Disc: It is a circular, concave revolving steel plate used for cutting and inverting the soil.

Disc angle: It is the angle at which the plane of the cutting edge of the disc is inclined to the direction of travel . Usually the disc angle of good plough varies between 42° to 45

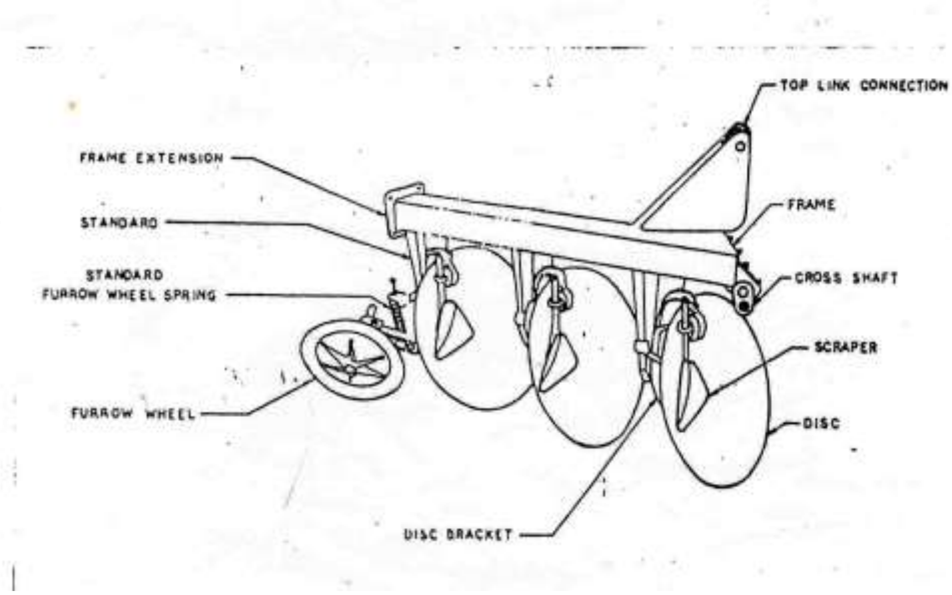


Figure 1.3.6: Disc Plough

Tilt angle: It is the angle at which the plane of the cutting edge of the disc is inclined to a vertical line. The tilt angle varies from 15° to 25° for a good plough.

Scraper: It is a device to remove soil that tends to stick to the working surface of a disc. **Concavity:** It is the depth measured at the centre of the disc by placing its concave side on a flat surface.

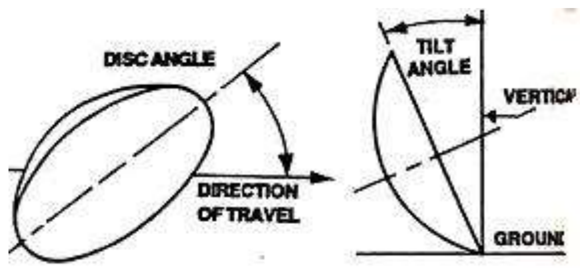


Figure1.3.7 Angles of disc plough

1. Adjustments in disc plough

To obtain proper degree of pulverization and depth of cut there are certain adjustments to be made the disc plough as follows

1. Increase the tilt angle to increase penetration (depth of cut)
2. Increase the disc angle to increase the width of cut. But increasing disc angle will reduce the depth of cut
3. Addition of weights on the plough will increase the penetrations
4. Keep the disc edges sharp. This will reduce the draft requirement

Adjust the plough wheels properly to keep the plough running level

2. Reversible disc plough

It is similar to standard disc plough, except that it can turn over the furrow slice to left or right side. It not only improves the rate of work but also leaves the field flat and level. This plough is found very successful for contour ploughing because the operation can be performed back and forth. on the contour line without any problem. The soil is turned in the direction required to prevent soil erosion. Slopes can also be gradually leveled just by ploughing down the slope every year. It saves water and time, improves irrigation efficiency and ensures an even crop

Figure1.3.8 Rotary tiller- Tractor operated

1.2.11 CHISEL PLOUGH

Chisel ploughs are used to break through and shatter compacted or otherwise impermeable soil layers. Deep tillage shatters compacted sub soil layers and aids in better infiltration and storage of rainwater in the crop root zone. The improved soil structure also results in better development of root system and the yield of crops and their drought tolerance is also improved. The functional component of the unit include reversible share, tire (chisel), beam, cross shaft and top link connection .

1.3 ROTARY TILLER

The rotary cultivator is widely considered to be the most important tool as it provides fine degree of pulverization enabling the necessary rapid and intimate mixing of soil besides reduction in traction demanded by the tractor driving wheels due to the ability of the soil working blades to provide some forward thrust to the cultivating outfit.

The functional components include tires, rotor, transmission system, universal joint, leveling board, shield, depth control arrangement, clutch and three point linkage connection Rotary tiller is directly mounted to the tractor with the help of three point linkage. The power is transmitted from the tractor PTO (Power Take Off) shaft to a bevel gear box mounted on the top of the unit, through telescopic shaft and universal joint. From the bevel gear box the drive is further transmitted to a power shaft, chain and sprocket transmission system to the rotor. The tires are fixed to the rotor and the rotor with tires revolves in the same direction as the tractor wheels. The number of tires varies from 28 - 54. A leveling board is attached to the rear side of the unit for leveling the tilled soil. A depth control lever with depth wheel provided on either side of the unit ensures proper depth control. The cost of the unit varies from Rs.62, 000/- to 1,10,000/-. The following types of blades are used with the rotor.

The benefits of the rotary tiller are effective pulverization of soil ensures good plant growth, stubble and roots are completely cut and mixed with the soil and proper ground leveling after the operation.

1.4 Main Features of Indian Agriculture

(i) Source of livelihood:

Agriculture is the main occupation. It provides employment to nearly 61% persons of total population. It contributes 25% to national income.

(ii) Dependence on monsoon:

Agriculture in India mainly depends on monsoon. If monsoon is good, the production will be more and if monsoon is less than average then the crops fail. As irrigation facilities are quite inadequate, the agriculture depends on monsoon.

(iii) Labor intensive cultivation:

Due to increase in population the pressure on land holding increased. Land holdings get fragmented and subdivided and become uneconomical. Machinery and equipment cannot be used on such farms.

(iv) Under employment:

Due to inadequate irrigation facilities and uncertain rainfall, the production of agriculture is less; farmers find work a few months in the year. Their capacity of work cannot be properly utilized. In agriculture there is under employment as well as disguised unemployment.

(v) Small size of holdings:

Due to large scale sub-division and fragmentation of holdings, land holding size is quite small. Average size of land holding was 2 to 3 hectares in India while in Australia it was 1993 hectares and in USA it was 158 hectares.

(vi) Traditional methods of production:

In India methods of production of crops along with equipment are traditional. It is due to poverty and illiteracy of people. Traditional technology is the main cause of low production.

(vii) Low Agricultural production:

Agricultural production is low in India. India produces 27 Qtls Wheat per hectare. France produces 71.2 Qtls per hectare and Britain 80 Qtls per hectare. Average annual productivity of an agricultural labour is 162 dollars in India, 973 dollars in Norway and 2408 dollars in USA.

(viii) Dominance of food crops:

75% of the cultivated area is under food crops like Wheat, Rice and Bajra, while 25% of cultivated area is under commercial crops. This pattern is cause of backward agriculture.

1.4.1 Major Challenges Faced By Indian Agriculture

1. **Stagnation in Production of Major Crops:** Production of some of the major staple food crops like rice and wheat has been stagnating for quite some time. This is a situation which is worrying our agricultural scientists, planners and policy makers. If this trend continues, there would be a huge gap between the demand of ever growing population and the production.
2. **High cost of Farm Inputs:** Over the years rates of farm inputs have increased. Farm inputs include fertilizer, insecticide, pesticides, HYV seeds, farm labour cost etc. Such an increase puts low and medium land holding farmers at a disadvantage.
3. **Soil Exhaustion:** Soil exhaustion means loss of nutrients in the soil from farming the same crop over and over again. This usually happens in the rain forest.
4. **Depletion of Fresh Ground Water:** Most of the irrigation in dry areas of Punjab, Haryana and Western Uttar Pradesh was carried out by excessive use of ground water.

Today fresh ground water situation in these states is alarming. In the coming few years if this type of farming practice continues, these states are going to face water famine.

5. **Adverse impact of Global Climatic Change:** Among various challenges, global climatic change is the recent one. It is predicted that due to climate change, temperature would increase from 2°C to 3°C, there would be increase in sea level, more intense cyclones, unpredictable rainfall etc These changes would adversely affect the production of crops.
6. **Impact of Globalization:** You can see the effect of globalization on the farm sector in India. All developing countries have been affected by it. The most evident effect is the squeeze on farmer‘s income and the threat to the viability of cultivation in India. This is due to the rising input costs and falling output prices. This reflects the combination of reduced subsidy and protection to farmers.
7. **Providing Food Security:** Before the introduction of green revolution in India, we were not self sufficient in terms of our food grain production. With the introduction of green revolution, production of food grains increased substantially and India became self sufficient. However, during the last one decade the total production has become stagnant. On the other hand we have added another 16 to 18 million populations over this period. Although India has become self sufficient in good it is yet to ensure food security which is dependent upon accessibility, affordability as well nutritional value of the food available. One of the biggest challenges facing India is Providing Food Security to its population.
8. **Farmers Suicide:** Every suicide has a multiple of causes but when you have nearly 200,000 of them, it makes sense to seek broad common factors within that group. The suicides appear concentrated in regions of high commercialization of agriculture and very high peasant debt. Cash crop farmers seemed far more vulnerable to suicide than those growing food crops. Yet the basic underlying causes of the crisis remained untouched. Commercialization of the countryside along with massive decline in investment in agriculture was the beginning of the

decline. Withdrawal of bank credit at a time of soaring input prices and the crash in farm incomes compounded the problems. Shifting of millions from food crop to cash crop cultivation had its own risks. Privatization of many resources has also compounded the problems. The devastation lies in the big 5 States of Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh and Chhattisgarh. These states accounted for two-thirds of all farm suicides during 2003-08.Some of the major factors responsible are indebtedness, crop failure and deterioration in economic status. Decline in social position, exorbitant charges by local money lenders for the vulnerable farmers, chronic illness in the family, addiction etc. have made life of farmers difficult.

Table 1.4.1: Global ranking of India in farm production and productivity

Crop	Production rank	Productivity rank
Paddy	2nd	30th
Wheat	2nd	22nd
Maize	7th	35th
Total cereals	3rd	36th
Groundnut	2nd	40th
Rapeseeds	3rd	28th
Pulses	1st	44th
Potato	4th	26th
Fruits	2nd (10 per cent share)	-
Vegetables	2nd (9 per cent share)	-

Average size of farm holdings gradually reduced from 2.58 ha to 1.57 ha. Small and marginal farmers have limited resources especially in rain-fed regions where only animal power is used resulting in low productivity. Though agricultural production is high, per hectare productivity is much lower than world average. There is an urgent need to increase productivity.

1.4.2 Farm Mechanization

(i) Ensure timely field operations to increase productivity, reduce crop losses and improve quality of agro produce.

(ii) Increase land utilization and efficiency

(iii) Increase in labor productivity using labor saving and drudgery reducing devices besides, being cost effective and eco-friendly. Appropriate machinery have been adapted by farmers for ensuring timely field operations and effective application of various crop production inputs utilizing human, animal and mechanical power sources.

Table1.4.2 : Level of Mechanization

Sl. No.	Operation	Percentage
1.	Tillage Tractor Animal	40.2 15.6 24.7
2.	Sowing with drills and planters Tractors Animal	28.9 8.3 20.6
3.	Irrigation	37
4.	Thresher- Wheat Paddy and others	47.8 4.4
5.	Harvesting Reapers	0.56 0.37
6.	Plant protection	34.2

1.4.3 Advantages of Tractor Powered Equipment

a. Time consumption is very less.

b. Operation is easy.

c. Most suitable for larger fields.

1.4.4 Disadvantages Of Tractor.

a. Costly, High initial cost (6 to 8 lakh), high maintenance cost (diesel cost) and service cost for replacing and repairs of the parts.

b. Tractor wheels will destroy furrows. An average weight of tractor is around 2 tons, when its weight acts on soil it tends to form a clods these clods prevents the root growth. Produces large amount of clods, hence clod breaker has to be used.
c. Tractors are not enough flexible for variations like edge tilling and corner furrowing.
d. Requires skilled person. The handling of tractor in an agricultural field is comparatively difficult than conventional technique.
e. Once the crop is germinated tractor has no further use in cultivation process.

1.5 Specifications:

Table 1.5 : specification

Component	Specification
Frame	Material: Steel
	Dimensions: 20" (L) x 10" (W) x 12" (H)
	Thickness: 1 mm
Solar Panel	Voltage: 12V
	Power: 5 Watts
Battery	Voltage: 12V
	Capacity: 7 Amps
Vehicle Motor	Voltage: 12V
	Speed: 60 RPM
	Current: 500 mA (0.5 Amps)
Plowing Motor	Voltage: 12V

	Speed: 10 RPM
	Mechanism: Rack and Pinion
Sprayer System	Pump Motor: 12V
	Nozzles: 2
Seeding Motor	Voltage: 12V
	Speed: 10 RPM
Controller	Arduino Uno
Motor Driver	L293D

CHAPTER 2
LITERATURE SURVEY

Kshirsagar Prashant et al. (2016) [1] in the International Journal of Research in Advent Technology investigates multifunctional agricultural vehicles. They analyze how these vehicles, capable of tasks like plowing, planting, and harvesting, operate and suggest improvements using computer models. Their findings emphasize the importance of integrating new technologies into these vehicles to enhance farming efficiency. This research is valuable for farmers and engineers, offering insights for developing more effective farm machinery. It also underscores the need for ongoing research to further enhance these vehicles and support farmers in the future.

Sonali Sardar Chechar*1 et al. [2] emphasize that today's era is witnessing rapid growth across all sectors, including agriculture. To meet future food demands, farmers must implement new techniques that enhance crop production without degrading soil texture. In this project, an attempt has been made to design and fabricate a solar-powered seed sprayer machine. In this technique, seeds in a hopper are sprayed onto the land using a fan or blower, eliminating the need for human effort. This process allows seeds to be sown at the time of ploughing. The main benefits of this method include reducing the time required to plant seeds and minimizing human labor. Unlike traditional sowing methods that require significant manpower, this machine operates without the need for human power.

Shantanu S. Chilgar1 2019 et al. [3] In this current era farmers needs a new techniques of seed sowing so as to achieve there goals. The current machinery used in our era is consuming so much amount of fossil fuels and emitting high amount of pollutants , and considering availability of fossil fuels, we need to develop an machines which can run on renewable energy sources . This research paper is based on development of a such seed sowing machine which can be used for multiple things and which can help to reduce cost of the sowing and can be used multi purposely. Sowing machine should be suitable to all farms, all types of crops, robust construction, also is should be reliable, this is basic requirement of sowing machine. Thus we made sowing machine which is operated manually but reduces the efforts of farmers thus increasing the efficiency of planting also reduces the problem encountered in manual planting. For this machine we can plant different types and different sizes of seeds also we can vary the space between two seeds while planting. This also increased the planting efficiency and accuracy. We made it from raw materials thus it was so cheap and very usable for small scale farmers. For effective handling of the machine by any farmer or by any untrained worker we simplified its design. Also its adjusting and maintenance method also simplified

M. Tejaswini 2022 et al. [4] This paper endeavors to evolve a robot capable of performing automatic seed sowing there have been a lot of advanced techniques got included in agricultural sectors; in that automation is one of the genres and this concept is the next level of revolution that will affect this century. Current work focuses on developing Automatic Seed Sowing Robot (ASSR). This helps to reduce human power. Consideration of specific rows and columns distance between two seeds will be entered manually. IR sensors are used to find whether the seed container is empty or not. The ultrasonic sensor is used to detect the obstacle. As this is an electromechanical vehicle DC motors are used to drive wheels. Programming of Arduino is done in assembly language.

Yuvraj Vilas Deshmukh1 (2018) et al. [5] The idea of applying robotic technology in agriculture is very innovative, the opportunities for robot enhanced productivity is vast. Our prototype agriculture robot performs agriculture operations like seed sowing, ploughing and water spraying. Here we are using a regulated DC power supply (12V) to power the Arduino and DC motors which are connected to the wheels of the robot also with the help of Bluetooth; we will connect all the instructions through our mobile phone. We believe that this low cost and portable multipurpose robot will help the farmers and reduce their labor costs.

Prof. Ayane swapnil1, 2018 et al. [6]This paper strives to develop a robot capable of performing operations like automatic ploughing, seed dispensing. It also provides manual control when required and keeps tabs on the humidity with the help of humidity sensors. The main component here is the AVR Atmega microcontroller that supervises the entire process. Initially the robot tills the entire field and proceeds to ploughing, simultaneously dispensing seeds side by side. The device used for navigation is an ultrasonic sensor which continuously sends data to the microcontroller. On the field the robot operates on automated mode, but outside the field is strictly operated in manual mode. For manual control the robot uses the Bluetooth pairing app as control device and helps in the navigation of the robot outside the field. The field is fitted with humidity sensors placed at various spots that continuously monitor the environment for humidity levels. It checks these levels with the set point for humidity and alerts the farmer. The alerting mechanism is GSM module that sends a text message to the farmer informing him about the breach in set point. The farmer then responds via SMS to either switch on the water sprinklers or ignore the alert. The water sprinklers, if on, bring down the humidity level thus providing an ideal growing environment to crop

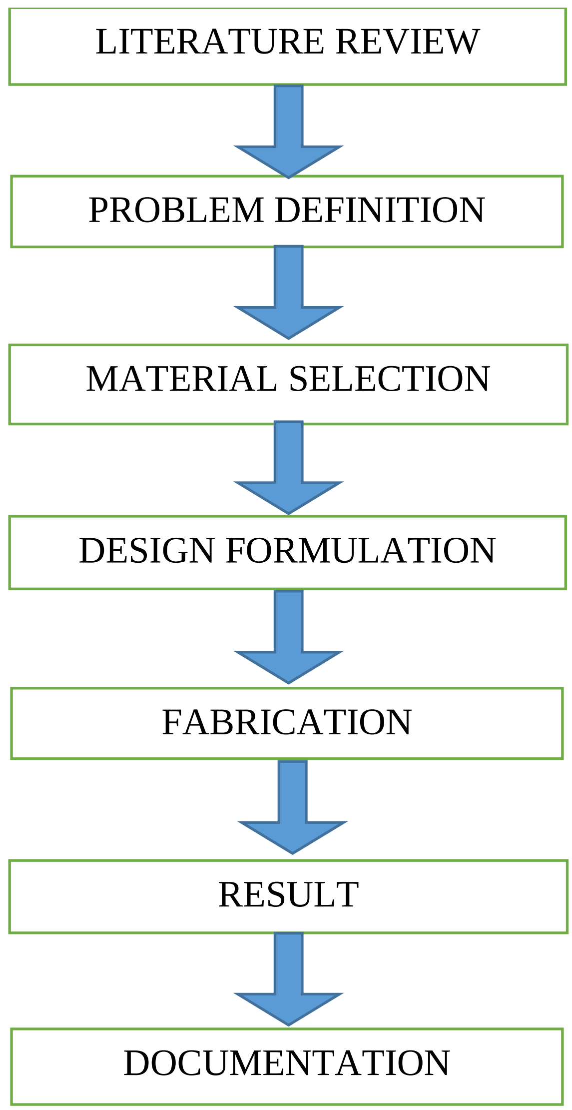
Pratikkumar V. Patel et al. [7] The paper titled “RESEARCH AND DESIGN OF MULTIPURPOSE AGRICULTURE EQUIPMENT” by Pratikkumar V. Patel and Mukesh Ahuja, published in 2020 in the International Research Journal of Modernization in Engineering Technology and Science, presents an in-depth study on the development of versatile agricultural machinery designed to perform multiple tasks. The primary objective of this research is to address the limitations of traditional single-purpose farming equipment, which often results in increased operational costs and inefficiencies. The authors propose a multipurpose agricultural machine capable of executing various functions such as ploughing, seeding, and fertilizing. This innovation aims to consolidate several agricultural processes into one piece of equipment, thereby enhancing the efficiency and productivity of farming operations. The design process involves meticulous planning and selection of components to ensure the machine's adaptability to different agricultural tasks and conditions. The researchers emphasize the importance of creating a machine that is not only efficient but also cost-effective and easy to operate for farmers. The paper also discusses the potential benefits of this multipurpose equipment, including reduced labor requirements, lower operational costs, and improved crop management. By integrating multiple functions into a single machine, the proposed design seeks to streamline farming practices, making them more sustainable and economically viable. Through their comprehensive research and innovative design, Patel and Ahuja contribute significantly to the modernization of agricultural machinery, offering practical solutions to contemporary farming challenges.

P. Baladarshini et al. [8] The paper titled “DESIGN AND FABRICATION OF UNIVERSAL SEED SOWING MACHINE” by P. Baladarshini, S. Monika, N. Dhanalakshmi, and Dr. A. Asha, published in 2017 in the International Journal of Advanced Technology in Engineering and Science, explores the creation and development of a universal seed sowing machine. This study aims to address the inefficiencies and challenges associated with traditional manual seed sowing methods, which are often labor-intensive and inconsistent. The proposed universal seed sowing machine is designed to automate the sowing process, ensuring uniform seed distribution and depth, which are crucial for optimal crop growth. The authors detail the design process, highlighting the machine's capability to adjust to different seed types and planting conditions, making it versatile for various crops. The fabrication process involves the selection of appropriate materials and components to construct a durable and efficient machine.

Dr. C.N. Sakhale et al. [9] The review paper titled “A Review Paper on ‘MULTIPURPOSE FARM MACHINE’” by Dr. C.N. Sakhale, Prof. S.N. Waghmare, and Rashmi S. Chimote, published in September 2016, examines the development and application of multipurpose farm machines designed to enhance agricultural efficiency and productivity. The authors argue that traditional farming techniques are labor-intensive and time-consuming, with rising labor costs and the necessity for timely operations amplifying the need for versatile machinery. Multipurpose farm machines address these issues by performing multiple tasks such as ploughing, sowing, and harvesting, thereby reducing the need for separate specialized equipment. The paper delves into the design and development aspects of these machines, emphasizing the importance of creating adaptable and efficient solutions to meet diverse agricultural needs. This approach aims to streamline farming operations, reduce costs, and improve overall farm management.

CHAPTER 3

METHODOLOGY



The methodology section of our project outlines the systematic approach we employed to design, assemble, and test the solar-powered multipurpose agricultural vehicle. In this section, we detail the step-by-step process undertaken to bring our project from conception to fruition. From the careful selection of materials and components to the precise integration of subsystems, each aspect of our methodology was meticulously planned and executed to ensure the optimal performance and functionality of the vehicle. Through comprehensive testing and optimization, we aimed to validate the efficacy of our design and identify areas for improvement. This methodology section provides a roadmap for understanding the methods and techniques utilized in the development of our innovative agricultural vehicle, serving as a guide for future research and implementation endeavors in this field.

1) Material Selection
2) Frame Design
3) Battery Installation
4) Vehicle Assembly
5) Wiring and Control System
6) Solar Panel Integration
7) Testing and Optimization

3.1 Material Selection:

Figure 3.1: Chassis with mild steel

MS Steel: Chosen for its durability and strength, MS (Mild Steel) is a common material used in engineering applications due to its ability to withstand heavy loads and harsh environments.

3.1.1. Composition:

I. Mild Steel, also known as low carbon steel, is an alloy of iron and carbon with small amounts of other elements such as manganese, silicon, and phosphorus.

II. The carbon content in mild steel typically ranges from 0.05% to 0.25%, making it relatively low compared to other types of steel.

3.1.2. Properties:

I. Strength: Mild steel offers good tensile strength and hardness, making it suitable for various structural applications where strength and durability are required.

II. Ductility: It possesses excellent ductility, allowing it to be easily formed, bent, and welded without undergoing significant deformation or cracking.

III. Toughness: Mild steel exhibits good toughness, enabling it to absorb impact and withstand sudden shocks or loads without fracturing.

IV. Weldability: Mild steel is highly weldable, allowing for easy joining with other metals through various welding techniques such as arc welding, MIG welding, and TIG welding.

V. Machinability: It has excellent machinability, meaning it can be easily cut, drilled, and machined using conventional machining processes.

VI. Corrosion Resistance: While mild steel is prone to corrosion when exposed to moisture and oxygen, it can be protected through methods such as painting, galvanizing, or applying protective coatings.

3.1.3. Applications:

I. Construction: Mild steel is widely used in the construction industry for manufacturing structural components such as beams, columns, and plates due to its strength and durability.

II. Automotive: It is used in the automotive sector for manufacturing vehicle chassis, body panels, and other structural components due to its high strength-to-weight ratio.

III. Machinery: Mild steel is commonly used in machinery and equipment manufacturing for producing gears, shafts, and other mechanical parts due to its excellent machinability and toughness.

IV. Fabrication: It is preferred in fabrication processes such as welding, bending, and forming due to its ductility and ease of workability.

V. Infrastructure: Mild steel is utilized in the infrastructure sector for constructing bridges, pipelines, and other infrastructure projects due to its strength and reliability.

3.1.4. Grades and Standards:

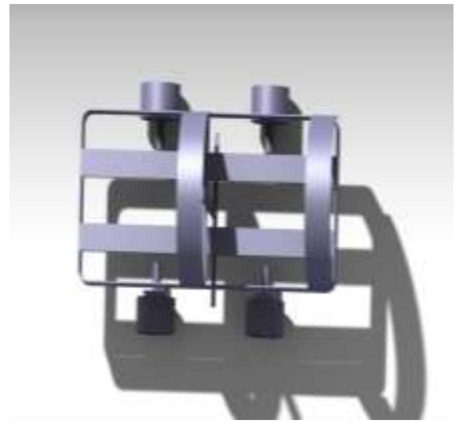
I. Mild steel is categorized into various grades based on its chemical composition, mechanical properties, and intended use.

II. Common grades of mild steel include ASTM A36, S275JR, and S355JR, each with specific properties and applications.

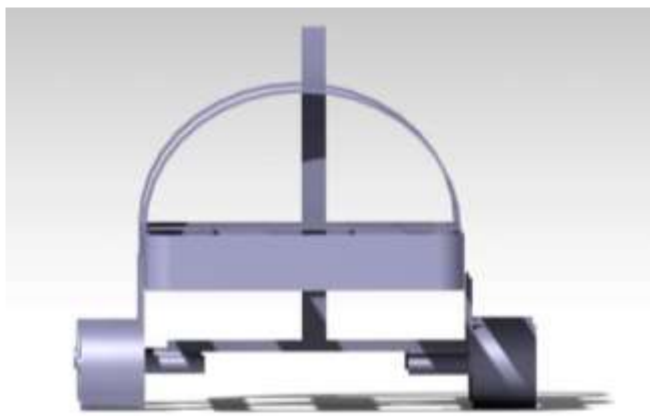
III. Mild steel is also governed by industry standards and specifications set by organizations such as ASTM International, the American Iron and Steel Institute (AISI), and the British Standards Institution (BSI).

3.2 Frame **Design:**

(A)



(B)



(C)

Figure 3.2 (A) side view (B) Top view (C) front view

Dimensions: The frame measures 10 inches by 20 inches in length, with a height of 12 inches and a thickness of 1 mm. These dimensions are chosen to provide adequate strength while keeping the weight of the frame manageable.

3.2.1. Purpose:

The frame serves as the structural foundation of the agricultural vehicle, providing support and stability for mounting various components and subsystems.

3.2.2. Dimensions:

I. The frame dimensions are carefully determined based on factors such as the size and weight of the vehicle, the intended load capacity, and the space required for mounting components.

II. The frame measures 10 inches by 20 inches in length, with a height of 12 inches and a thickness of 1 mm.

III. These dimensions are optimized to strike a balance between strength and weight, ensuring adequate support while minimizing overall vehicle mass.

3.2.3. Design Considerations:

I. Strength: The frame design prioritizes structural strength to withstand the stresses and forces encountered during operation, including dynamic loads from uneven terrain and heavy agricultural implements.

II. Rigidity: The frame is designed to maintain rigidity and stability to prevent flexing or bending, which could compromise vehicle performance and safety.

III. Mounting Points: Strategic mounting points are incorporated into the frame design to facilitate the secure attachment of various components, including the solar panel, battery, motors, and control systems.

IV. Accessibility: The frame design ensures easy access to key components for maintenance and servicing, allowing for quick and efficient repairs or replacements as needed.

3.2.4. Construction Techniques:

I. Welding: The frame components are joined together using welding techniques such as arc welding and MIG welding.

II. Welded joints provide a strong and durable bond between the steel sections, ensuring structural integrity and longevity.

III. Careful attention is paid to weld quality, ensuring proper penetration and fusion to minimize the risk of weld defects or failures.

3.2.5. Mounting Provisions:

I. Brackets and Mounting Hardware: Brackets and mounting hardware are used to securely attach components to the frame.

II. These mounting provisions are designed to withstand the forces and vibrations encountered during vehicle operation, ensuring that mounted components remain firmly in place.

3.2.6. Integration with Other Components:

I. The frame design incorporates provisions for integrating other vehicle components, such as the solar panel, battery, motors, and control systems.

II. Mounting points and attachment features are strategically positioned to facilitate seamless integration and efficient operation of the entire vehicle system.

3.3 Solar Panel Integration:

Figure 3.3: Solar panel

Solar Panel: A 12V, 5W solar panel is mounted onto the frame using brackets or mounting hardware. This panel converts sunlight into electrical energy, which is then stored in the battery for later use.

3.3.1. Purpose:

The solar panel is the primary source of renewable energy for the vehicle, converting sunlight into electrical power to charge the battery and run the vehicle's motors and other electrical components.

3.3.2. Selection of Solar Panel:

I. A 12V, 5W solar panel is selected based on the vehicle's power requirements and available surface area for mounting.

II. The panel’s voltage and wattage are matched to the battery and overall electrical system to ensure efficient energy transfer and storage.

3.3.3. Mounting Location:

I. The solar panel is mounted on the top of the vehicle frame where it can receive maximum sunlight exposure.

II. The mounting location is chosen to avoid shading from other components and to optimize the angle of incidence for sunlight.

3.3.4. Mounting Hardware:

I. Brackets or mounting hardware are used to securely attach the solar panel to the frame.

II. The brackets are designed to accommodate the size and weight of the solar panel, ensuring it remains stable during operation.

III. Anti-vibration mounts or pads may be used to reduce stress on the panel caused by vehicle movement or rough terrain.

3.3.5. Electrical Connections:

I. The solar panel is connected to the battery using appropriate wiring to ensure efficient power transfer.

II. Wires are selected based on their current-carrying capacity and resistance to environmental factors like heat and moisture.

III. Proper connectors are used to ensure secure and corrosion-resistant connections.

3.3.6. Positioning and Angle:

I. The angle of the solar panel is optimized to maximize sunlight absorption.

II. The panel can be fixed at an optimal angle based on geographic location or designed with an adjustable mechanism to change angles throughout the day or seasonally.

3.3.7. Protection and Maintenance:

I. The solar panel is protected from physical damage using a frame or casing.

II. Regular cleaning is necessary to remove dust, dirt, and debris that can reduce efficiency.

III. The panel's surface is periodically inspected for any signs of damage or wear, ensuring it remains functional.

3.3.8. Integration with the Vehicle’s Electrical System:

I. The solar panel’s output is integrated with the vehicle’s overall electrical system.

II. Power distribution from the battery supplies energy to the motors, control systems, and any other electrical components.

III. The system design ensures that the solar panel can continuously charge the battery even while the vehicle is in operation.

3.3.9. Monitoring and Feedback:

I. A monitoring system may be installed to track the solar panel’s performance, battery charge levels, and energy consumption.

II. This system provides real-time feedback to optimize energy usage and manage power distribution efficiently.

3.4 Battery Installation:

Figure 3.4 : Battery

Battery: A 12V, 7Ah battery is installed onto the frame. This battery serves as the primary power source for the vehicle, storing energy generated by the solar panel and supplying it to the various components as needed.

3.4.1. Purpose:

The battery serves as the energy storage unit for the vehicle, storing electrical energy generated by the solar panel and supplying power to the vehicle's motors and electronic components.

3.4.2. Selection of Battery:

I. A 12V, 7Ah battery is selected based on the power requirements of the vehicle's components and the energy output of the solar panel.
II. This capacity provides a balance between sufficient energy storage and manageable weight.

3.4.3. Mounting Location:

I. The battery is mounted on the vehicle frame in a location that ensures stability and minimizes impact from vibrations or shocks.
II. The location should also allow for easy access for maintenance and replacement.

3.4.4. Mounting Hardware:

I. Secure brackets or battery trays are used to hold the battery in place.
II. The mounting hardware is designed to accommodate the size and weight of the battery, ensuring it remains stable during vehicle operation.
III. Rubber pads or anti-vibration mounts can be used to reduce the impact of shocks and vibrations on the battery.

3.4.5. Electrical Connections:

I. The battery terminals are connected to the vehicle's electrical system using appropriate wiring.
II. The connections should be tight and secure to prevent accidental disconnections or power loss.
III. Proper connectors and insulated terminals are used to ensure safe and reliable electrical connections.

3.4.6. Safety Considerations:

I. The battery is equipped with a fuse or circuit breaker to protect against overcurrent and short circuits.

II. Proper insulation and shielding are used to prevent accidental contact with the battery terminals and to protect against electrical hazards.

III. The battery compartment should be ventilated to prevent the buildup of gases that may be emitted during charging and discharging cycles.

3.4.7. Wiring and Power Distribution:

I. Wires are routed from the battery to the vehicle's motors, control systems, and other electrical components.

II. A power distribution system is used to manage the flow of electricity from the battery to various parts of the vehicle.

III. Appropriate wire gauges are selected based on the current requirements of the connected components.

3.4.8. Monitoring and Maintenance:

I. A battery monitoring system can be installed to track the battery's state of charge, voltage, and health.

II. Regular maintenance includes checking the battery terminals for corrosion, ensuring connections are tight, and monitoring the battery's performance.

III. Periodic testing of the battery's capacity and functionality is conducted to ensure reliable operation.

3.4.9. Environmental Protection:

I. The battery is housed in a protective enclosure to shield it from environmental factors such as moisture, dust, and extreme temperatures.
II. The enclosure is designed to be robust and weather-resistant, ensuring the battery remains protected in various operating conditions.

3.5 Vehicle Assembly

Motors: The vehicle is equipped with several motors, including a 12V, 60 RPM motor for propulsion, a 12V, 10 RPM motor for plowing, and a 12V, 10 RPM motor for seed dispersal. These motors provide the necessary torque and speed for different tasks.

3.6 Wiring and Control System

I. Wiring Harnesses: All electrical components, including motors, sensors, and controllers, are connected using appropriate wiring harnesses. Proper wiring ensures reliable communication between components and prevents electrical faults.
II. Control Programming: The Arduino Uno microcontroller is programmed to control the vehicle's operation. This includes managing motor speed and direction, processing sensor data, and implementing safety features.

3.7 Control Unit

3.7.1. Arduino Uno

The Arduino Uno, with its versatile array of over 20 pins, stands as a fundamental platform at the intersection of software and hardware. Grounding connections, critical for maintaining consistent voltage levels across circuits, ensure accuracy in measurements and reliability in operations. Powering options, including USB, DC power jack, and Vin pin, provide flexibility in energy sources, facilitating seamless integration with various components.

Digital pins, numbering from 0 to 13, enable binary operations, serving as conduits for both data acquisition from sensors and command transmission to actuators. Analog pins, denoted A0 to A5, expand the Uno's capabilities by facilitating precise voltage measurements, essential for interpreting sensor data accurately.

Integration of communication protocols such as UART, I2C, and SPI augments the Uno's versatility, enabling seamless interaction with a wide range of peripheral devices. Incorporation of advanced components like Bluetooth modules and motor drivers such as the L293D further extends the Uno's utility, empowering users to explore wireless communication and precise motor control. Understanding the nuances of the Uno's pins unlocks a realm of possibilities, making it an indispensable tool for electronics enthusiasts of all levels.

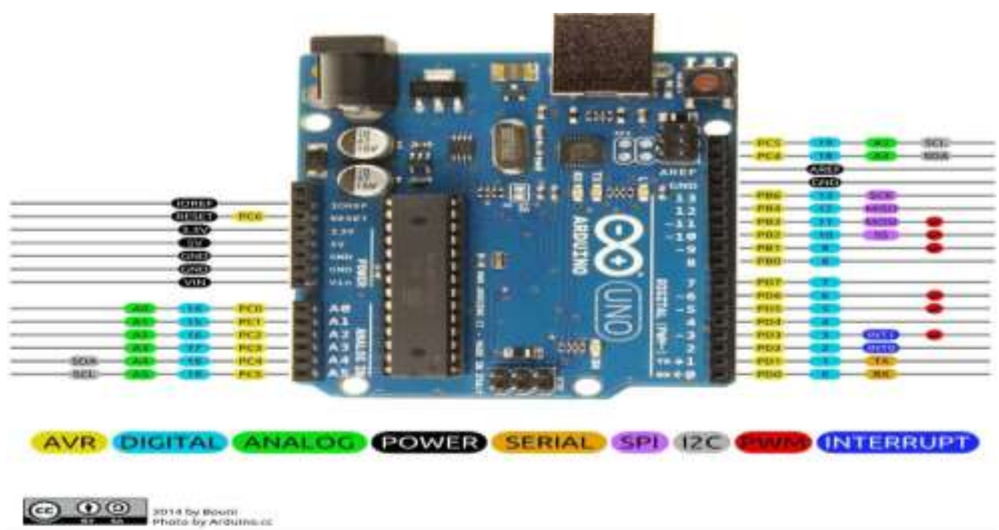


Figure 3.7 : Ardino uno R3 pinout

3.7.2 Bluetooth Module

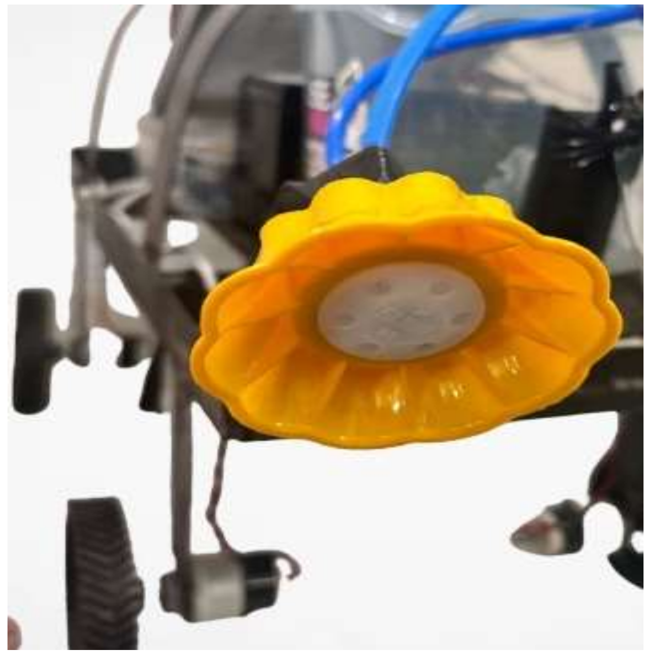
To establish a connection between a Bluetooth module, such as the HC-05, and an Arduino Uno and command it through AT commands, the hardware and software setup must be carefully configured.

Firstly, in the hardware setup, the VCC pin of the Bluetooth module should be connected to the 5V pin on the Arduino Uno for power, while the GND pin of the module is linked to any GND pin on the Arduino to create a common ground. Additionally, the TXD pin of the Bluetooth module is connected to a digital pin (e.g., pin 2) on the Arduino to receive data, and the RXD pin is linked to another digital pin (e.g., pin 3) on the Arduino to transmit data.

In the software configuration, the Arduino IDE is utilized to write a sketch that initializes serial communication between the Arduino Uno and the Bluetooth module. The Software Serial library is employed to create a virtual serial port on the designated digital pins. Baud rates for both the Arduino Uno's hardware serial port (Serial) and the virtual serial port (Software Serial) should match the baud rate of the Bluetooth module. After initializing both serial ports in the setup () function of the sketch, AT commands can be sent via the Serial Monitor in the Arduino IDE to command the Bluetooth module. For instance, commands like "AT" to check communication status or "AT+NAME=Newname" to change the device name can be used, with the responses displayed in the Serial Monitor window.

Through this configuration, users can effectively establish a connection between a Bluetooth module and an Arduino Uno, commanding the module via AT commands for various configuration purposes

3.8 COMPONENTS



(a) **(b)**

Figure 3.8: (a) Plough and (b) Sprinkler

The design and development of a solar-powered multipurpose agricultural vehicle stand at the forefront of innovation. At the heart of this endeavor lie several essential components, each playing a pivotal role in ensuring the vehicle's functionality and effectiveness. From the high-efficiency solar panels harnessing renewable energy to the rechargeable batteries storing this energy for uninterrupted operation, every component serves a crucial purpose. Robust electric motors propel the vehicle forward and drive various agricultural tasks, while durable chassis and frame materials provide the necessary structural integrity. Control systems, including advanced sensors and navigation technologies, enable autonomous or semi-autonomous operation, facilitating precise and optimized agricultural practices. Additionally, the integration of specialized agricultural implements further enhances the vehicle's versatility and productivity in the field. Together, these components form the foundation of a transformative solution poised to revolutionize farming practices, promoting sustainability, efficiency, and productivity in agricultural operations.

3.8.1. DC MOTOR

The DC motor selected for our solar-powered multipurpose agricultural vehicle is a crucial component driving its propulsion system. Operating at 12 volts with a speed of 60 RPM and a power rating of 500mA, this motor offers the ideal balance of torque and efficiency for traversing various agricultural terrains. With its low power consumption and compatibility with our power source, the motor ensures optimal performance while conserving energy. Its specifications align perfectly with the requirements of our project, making it a reliable choice for powering our vehicle's movement across fields and farms

Figure 3.8.1 DC MOTOR

3.8.2. Working of the DC Geared Motor

The DC motor works over a fair range of voltage. The higher the input voltage more is the RPM (rotations per minute) of the motor. For example, if the motor works in the range of 6-12V, it will have the least RPM at 6V and maximum at 12 V.

Figure 3.8.2. Functional Mechanism of Gear Assembly

The working of the gears is very interesting to know. It can be explained by the principle of conservation of angular momentum. The gear having smaller radius will cover more RPM than the one with larger radius. However, the larger gear will give more torque to the smaller gear than vice versa. The comparison of angular velocity between input gear (the one that transfers energy) to output gear gives the gear ratio. When multiple gears are connected together, conservation of energy is also followed. The direction in which the other gear rotates is always the opposite of the gear adjacent to it.

In any DC motor, RPM and torque are inversely proportional. Hence the gear having more torque will provide a lesser RPM and converse. In a geared DC motor, the concept of pulse width modulation is applied. The equations detailing the working and torque transfer of gears are shown below:

Figure 3.8.3: Gear Assembly Placed in Gear Head

In a geared DC motor, the gear connecting the motor and the gear head is quite small, hence it transfers more speed to the larger teeth part of the gear head and makes it rotate. The larger part of the gear further turns the smaller duplex part. The small duplex part receives the torque but not the speed from its predecessor which it transfers to larger part of other gear and so on. The third gear’s duplex part has more teeth than others and hence it transfers more torque to the gear that is connected to the shaft.

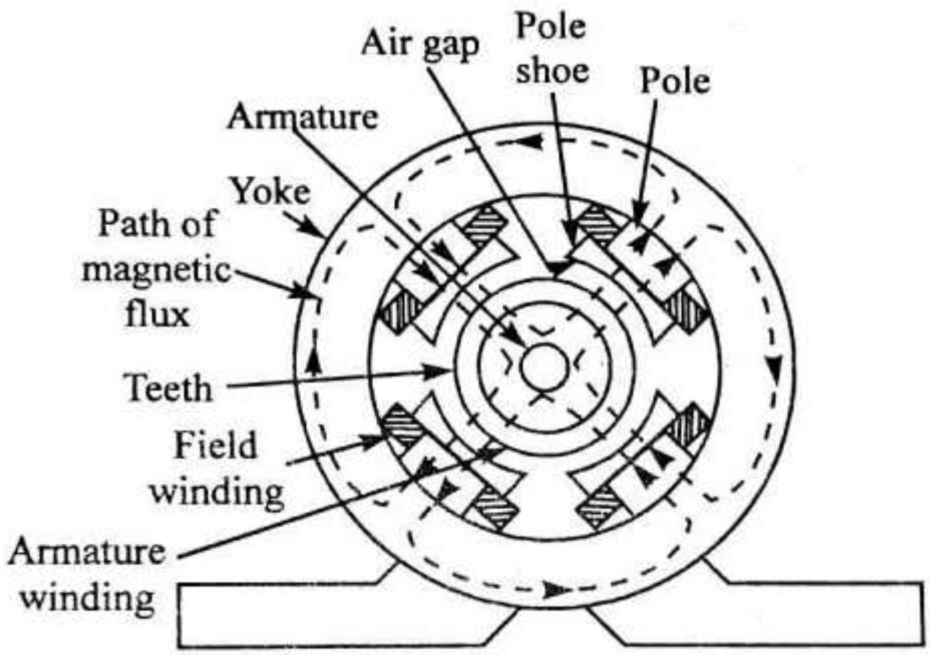


Figure 3.8.4: commutators

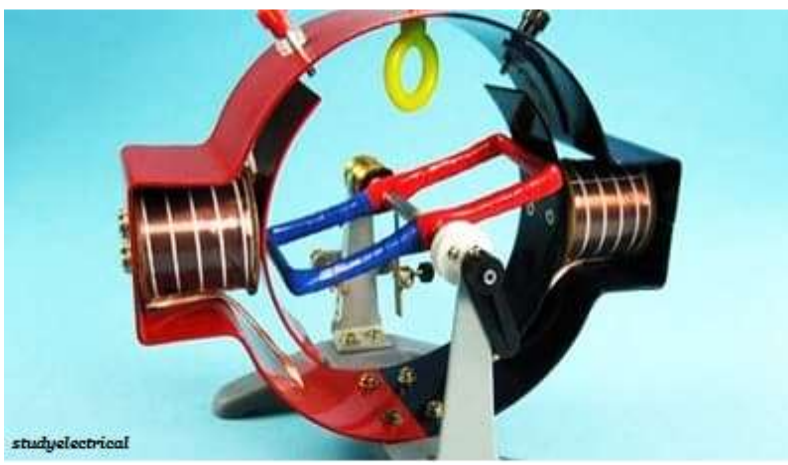


Figure 3.8.5: Fleming's left-hand rule and its magnitude decide the direction of this force.

When armature winding is connected to a DC supply, an electric current sets up in the winding. Permanent magnets or field winding (electromagnetism) provides the magnetic field. In this case, current carrying armature conductors experience a force due to the magnetic field, according to the principle stated above.

3.8.3 DC PUMP MOTOR

The 12V pump motor is a crucial component in various applications, providing efficient fluid transfer capabilities. Designed to operate with a 12-volt power supply, this motor delivers reliable performance across a wide range of tasks, from water circulation systems to automotive applications. With its compact size and robust construction, the 12V pump motor is ideal for both indoor and outdoor use, offering versatility and durability in demanding environments.

Equipped with high-quality internal components, including precision-engineered gears and bearings, this motor ensures smooth and consistent operation, minimizing friction and wear for extended lifespan. Its low power consumption makes it suitable for use in battery-powered systems, offering energy efficiency without compromising performance.

Figure 3.8.6: DC PUMP MOTOR

3.9 Fabrication model construction

A chassis is one of the key components of the vehicle. It consists of an internal frame work that supports the container of grass cuter in its construction and use. It is a dead vehicle which is connected to the frame to carry the load. It serves as a frame work for supporting the body. It should be rigid enough to withstand the shock, twist, and other stresses & its principle function is to carry the maximum load for static and dynamic condition safely.

3.10 Analysis:

a. Testing: The assembled vehicle is subjected to comprehensive testing under various operating conditions to evaluate performance and identify any issues.
b. Optimization: Based on testing results, adjustments and optimizations are made to improve the vehicle's efficiency, reliability, and overall performance. This may include fine-tuning motor control algorithms, adjusting component placement, or reinforcing structural elements.

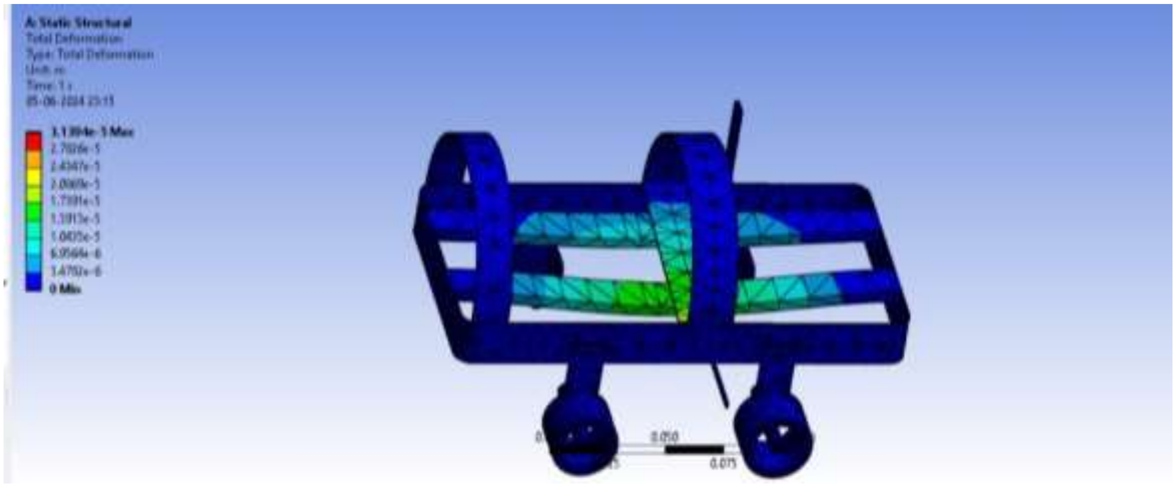


Figure 3.8.7: Analysis

c. In conclusion, the design phase of the project for the solar-powered multipurpose agricultural vehicle has been completed we have developed a capable of performing various agricultural tasks The meticulous design process, including structural analysis and simulation, has ensured that the vehicle meets all specified requirements while optimizing performance and durability. Moving forward, the finalized design serves as a solid foundation for the next phase of prototyping and testing, bringing us closer to realizing our goal of revolutionizing agricultural practices with eco-friendly technology.

3.11 RACK AND PINION

Rack and pinion systems serve as fundamental components in various mechanical applications, offering a straightforward yet effective means of motion conversion. At their core, these systems comprise a linear gear known as the rack and a circular gear called the pinion. The interaction between these components facilitates the conversion of rotary motion into linear motion or vice versa, making them versatile solutions across industries.

One prominent application of rack and pinion systems lies in steering mechanisms, particularly in automobiles. Here, the rotational motion of the steering wheel is translated into linear motion through the rotation of the pinion gear. This motion is then transmitted to the rack connected to the vehicle's wheels, enabling precise control over steering and directional movement.

Beyond automotive use, rack and pinion systems find widespread application in linear actuation scenarios, such as CNC machines, robotics, and industrial automation. In these settings, the mechanism converts the rotational motion of a motor or actuator into linear motion along a defined axis, facilitating precise positioning and movement control for various manufacturing and automation processes.

Overall, rack and pinion systems embody a simple yet effective mechanical principle that underpins a wide range of applications across industries, from automotive to manufacturing and construction. Their versatility, reliability, and ease of implementation make them indispensable components in countless mechanical systems, contributing to enhanced performance and efficiency in various engineering endeavors.

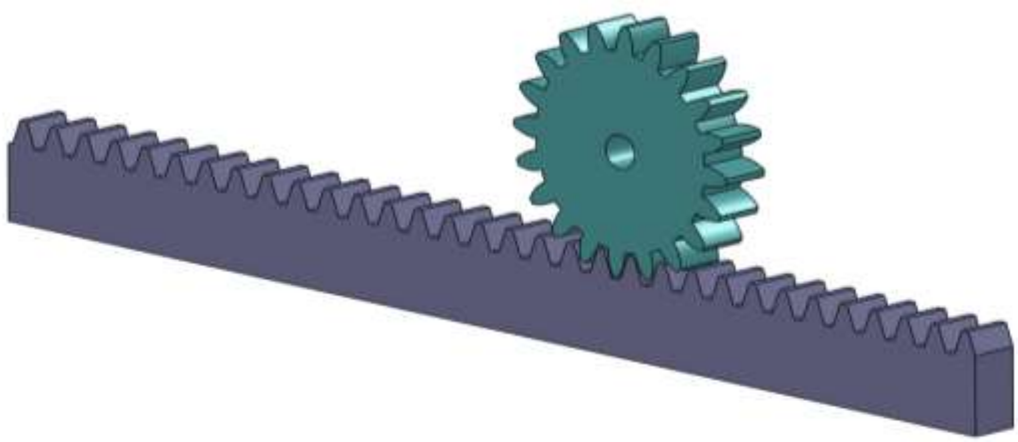


Figure 3.8.8 RACK AND PINION

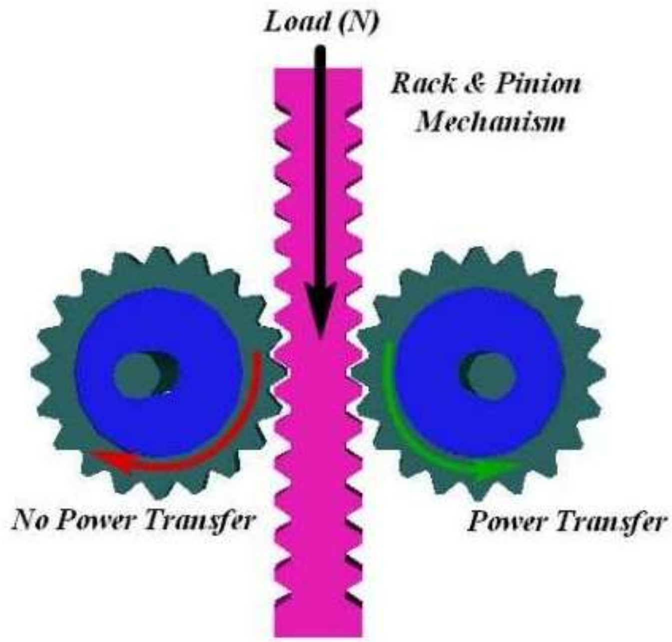


Figure 3.8.9 RACK AND PINION

3.12 Calculation

Components

Vehicle Motors (4 motors)

- Voltage: 12V
- Speed: 60 RPM
- Current: 500 mA (0.5 A) each

Plowing Motor

- Voltage: 12V
- Speed: 10 RPM

Sprayer Pump Motor

- Voltage: 12V

Seeding Motor

- Voltage: 12V
- Speed: 10 RPM

Power Consumption for Each Motor

Vehicle Motors (4 motors):

$Power\ per\ motor = V \times I = 12V \times 0.5A = 6W$

$Total\ power\ for\ 4\ motors = 4 \times 6W = 24W$

Plowing Motor:

$Power = 6W$

Sprayer Pump Motor:

$Power = 6W$

Seeding Motor:

$Power = 6W$

Total Power Consumption

$$P_{total} = Power\ for\ 4\ vehicle\ motors + Power\ for\ plowing\ motor + Power\ for\ sprayer\ pump\ motor + Power\ for\ seeding\ motor$$

$$P_{total} = 24W + 6W + 6W + 6W = 42W$$

Total Load Current

$$I_{total} = \frac{Ptotal}{Battery\ Voltage}$$

$$I_{total} = \frac{42W}{12V} = 3.5A$$

Battery Life

$$Battery\ Life = \frac{Battery\ Capacity}{Itotal}$$

$$Battery\ Life = \frac{3.5A}{7Ah} = 2hours$$

Given the fundamental relationship in gear systems:

$$T_{in} \cdot \omega_{in} = T_{out} \cdot \omega_{out}$$
$$T_{in} \cdot \omega_{in} = T_{out} \cdot \omega_{out}$$

Where,

T_{in} = input torque by the driver gear

ω_{in} = angular speed of the driver gear

T_{out} = output torque of the driven gear

ω_{out} = angular speed of the driven gear

Vehicle motor (driver gear): 60 RPM

Plowing motor (driven gear): 10 RPM

Input torque (T_{in}): Assume we have the input power, so we can calculate the input torque.

Convert RPM to Radians per Second

Angular speed (ω) in radians per second can be found from RPM using:

$$\omega = \frac{(RPM \times 2\pi)}{60}$$

For the driver gear (vehicle motor):

$$\omega_{in} = 60 \times \frac{60 \times 2\pi}{60} 2\pi = 2\pi rad/s$$

For the driven gear (plowing motor):

$$\omega_{out} = \frac{10 \times 2\pi}{60} = 1.047rad/s$$

Input Power to Torque

Let's assume the input power (Pin) is 6W (calculated earlier for one vehicle motor).

Using:

P=T·ω

We can solve for Tin:

$$T_{in} = \omega_{in} P_{in}$$

$$T_{in} = \frac{6}{2\pi} = 0.955Nm$$

Output Torque Calculation

Using the relationship:

$$T_{in} \cdot \omega_{in} = T_{out} \cdot \omega_{out}$$

Solve for T_{out}:

$$T_{out} = \frac{T_{in} \cdot \omega_{in}}{\omega_{out}}$$

$$T_{out} = \frac{0.955 \cdot 2\pi}{1.047} = 5.73Nm$$

the total power consumption for the vehicle, plowing, sprayer pump, and seeding motors is 42 watts. This is derived from the combined power usage of the four vehicle motors, each consuming 6 watts (24 watts in total), and the additional plowing, sprayer pump, and seeding motors, each also consuming 6 watts. The total current draw from the system is 3.5 amperes when operating at a voltage of 12V. Given a battery capacity of 7 ampere-hours, the system can sustain continuous operation for approximately 2 hours before requiring a recharge. Furthermore, using the gear relationship, the input torque from the vehicle motor at 60 RPM (which equates to an angular speed of 2π2\pi2π radians per second) results in an input torque of 0.955 Nm. This input torque, when transferred to the plowing motor operating at 10 RPM (1.047 radians per second), translates to an output torque of approximately 5.73 Nm.

3.13 FABRICATION

Figure 3.13: Final Prototype

Fabricating a solar-powered multipurpose agricultural vehicle involves several steps and the integration of various components:

a. Frame: Mild steel material, 10 inches by 20 inches in length, height of 12 inches, and thickness of 1 mm.
b. Solar Panel: 12V, 5 Watts.
c. Battery: 12V, 7 Ah.
d. Vehicle Motor: 12V, 60 RPM, 500 mA power.

e. Plowing Mechanism: 12V motor at 10 RPM, Rack and pinion mechanism.

f. Sprayer: 12V pump motor, 2 nozzles.

g. Seed Dispenser: 12V motor at 10 RPM.

h. Control System: Arduino Uno, L293D motor driver.

Steps to Fabricate a Solar Powered Multipurpose Agricultural Vehicle

Build the Frame

1. **Construct the Frame:**

   a. Use mild steel to build a frame with dimensions of 10 inches by 20 inches in length, a height of 12 inches, and a thickness of 1 mm.
   b. Cut the steel sheets to the required dimensions using a metal cutting saw or laser cutter.

2. **Weld the Frame:**

   a. Weld the cut pieces together to form a rectangular frame structure.
   b. Ensure all corners are at right angles using a square tool.
   c. Grind down the welds and smooth any rough edges for a clean finish.

Install the Solar Panel

1. **Mount the Solar Panel:**

   Secure a 12V, 5-watt solar panel to the top of the frame using brackets to maximize sunlight exposure.

2. **Connect the Solar Panel:**

Wire the solar panel to the charge controller input to regulate the voltage and current going to the battery.

Install the Battery

1. **Mount the Battery:**

   Place a 12V, 7 Ah battery in a secure compartment within the frame to protect it from environmental elements.

2. **Connect the Battery:**

   Attach the battery to the charge controller output, ensuring correct polarity to avoid damage.

Setup the Vehicle Motor

1. **Install the Vehicle Motor:**

   Use a 12V motor with a speed of 60 RPM and a power consumption of 500 mA.

   Secure the motor to the frame in a position where it can effectively drive the wheels or tracks.

2. **Connect the Vehicle Motor:**

   Wire the motor to the Arduino Uno through the L293D motor driver, ensuring proper connections for control and power.

Setup the Plowing Mechanism

1. **Install the Plowing Motor:**

   Use a 12V motor with a speed of 10 RPM.

2. **Install the Rack and Pinion Mechanism:**
    a. Secure the rack and pinion mechanism at the rear or front of the vehicle frame.
    b. Ensure the motor drives the pinion, moving the rack to perform the plowing action.
3. **Connect the Plowing Motor:**

    Wire the motor to the Arduino Uno via the motor driver for precise control.

Setup the Sprayer Mechanism

1. **Install the Pump Motor:**
    a. Use a 12V pump motor.
    b. Secure the pump motor to the frame and connect it to a water reservoir.
2. **Install the Nozzles:**

    Position 2 nozzles at strategic points on the frame for optimal spraying coverage.
3. **Connect the Pump Motor:**

    Wire the pump motor to the Arduino Uno for control, allowing automated or manual operation.

Setup the Seed Dispenser Mechanism

1. **Install the Seed Motor:**
    a. Use a 12V motor with a speed of 10 RPM.
    b. Secure the motor to the frame and connect it to a seed hopper.

2. **Connect the Seed Motor:**

   Wire the motor to the Arduino Uno for precise seed dispensing.

Setup the Control System

1. **Install the Arduino Uno:**

   Secure the Arduino Uno microcontroller to the frame in a protected area.

2. **Connect the Motor Driver:**

   Attach the L293D motor driver to the Arduino Uno and then connect it to the respective motors for vehicle propulsion, plowing, spraying, and seed dispensing.

3. **Program the Arduino Uno:**

   Write and upload the control program to the Arduino Uno, ensuring it handles inputs and controls outputs for all connected devices.

Test the System

1. **Initial Testing:**

   a. Power on the system to test the operation of each component (vehicle motor, plowing motor, pump motor, seed motor).
   b. Ensure the cooling effect is sufficient and the system responds to temperature changes appropriately.

2. **Adjustments:**

   Make necessary adjustment for the different components such as seed dropper, plough and other electrical components.

CHAPTER 4

RESULT AND DISCUSSION

The research and development of a multipurpose agriculture vehicle yielded significant findings and practical outcomes. The vehicle was designed with a mild steel frame, dimensions of 10 inches by 20 inches in length, 12 inches in height, and a thickness of 1 mm. It featured a 12V, 5-Watt solar panel and a 12V, 7 Ah battery to provide sustainable power. The vehicle utilized a 12V motor with a 60 RPM output and 500 mA power for movement, ensuring efficient and controlled operation.

For plowing, the vehicle was equipped with a 12V motor operating at 10 RPM, utilizing a rack and pinion mechanism to facilitate effective soil turning. The spraying function incorporated a 12V pump motor and two nozzles to ensure even distribution of liquids over the crops. Additionally, the seeding mechanism employed a 12V motor running at 10 RPM to provide precise seed placement and depth control.

The control system was managed by an Arduino Uno and an L293D motor driver, allowing for precise and flexible operation of the various components. This integrated approach not only demonstrated the feasibility of a multi-functional agricultural machine but also highlighted its potential for reducing labor dependency and operational costs.

The prototype successfully performed tasks such as plowing, seeding, and spraying, showcasing its versatility and practical applicability in real-world farming scenarios. The incorporation of solar power and automated control systems further underscored the vehicle's potential for promoting sustainable and efficient farming practices. Overall, the multipurpose agriculture vehicle presents a promising solution for enhancing productivity and reducing labor demands in the agricultural sector.

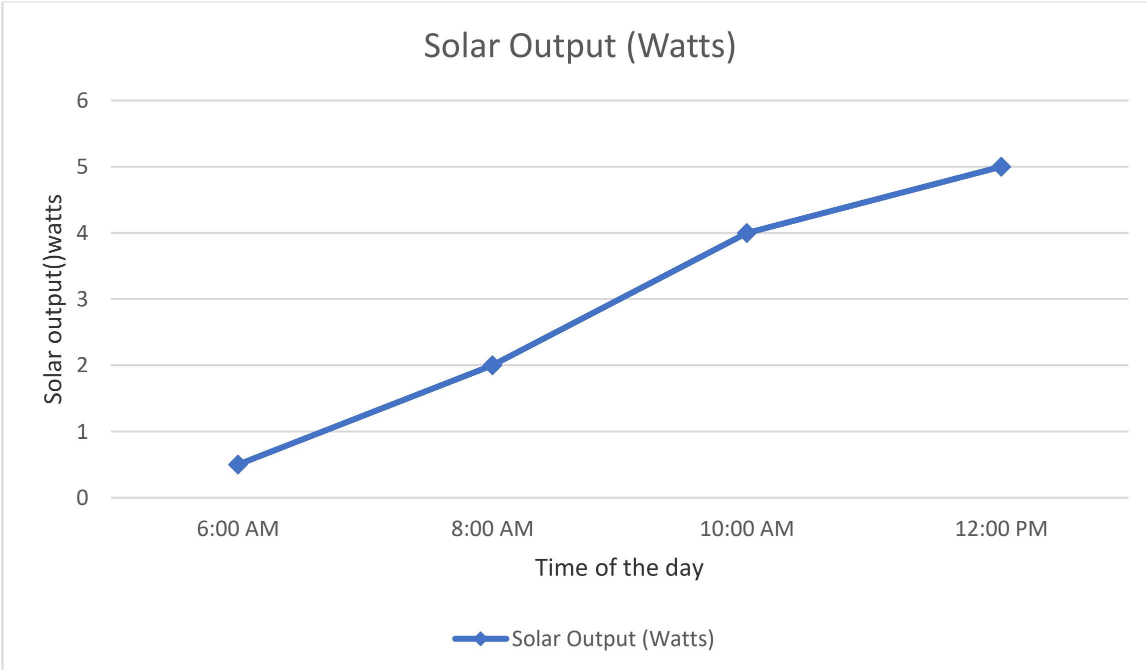


Figure 4.2 : **Time of Day vs Solar Output**

Time of Day vs Solar Output: This graph illustrates how solar output, measured in watts, varies throughout the day. At 6:00 AM, the solar output is 0.5 watts. This increases to 2 watts by 8:00 AM, 4 watts by 10:00 AM, and peaks at 5 watts at 12:00 PM. The trend shows a steady increase in solar output as the day progresses, reaching its highest at noon.

Table 4.1: Time of Day and Solar Output

Time of Day	**Solar Output (Watts)**
6:00 AM	0.5
8:00 AM	2
10:00 AM	4
12:00 PM	5

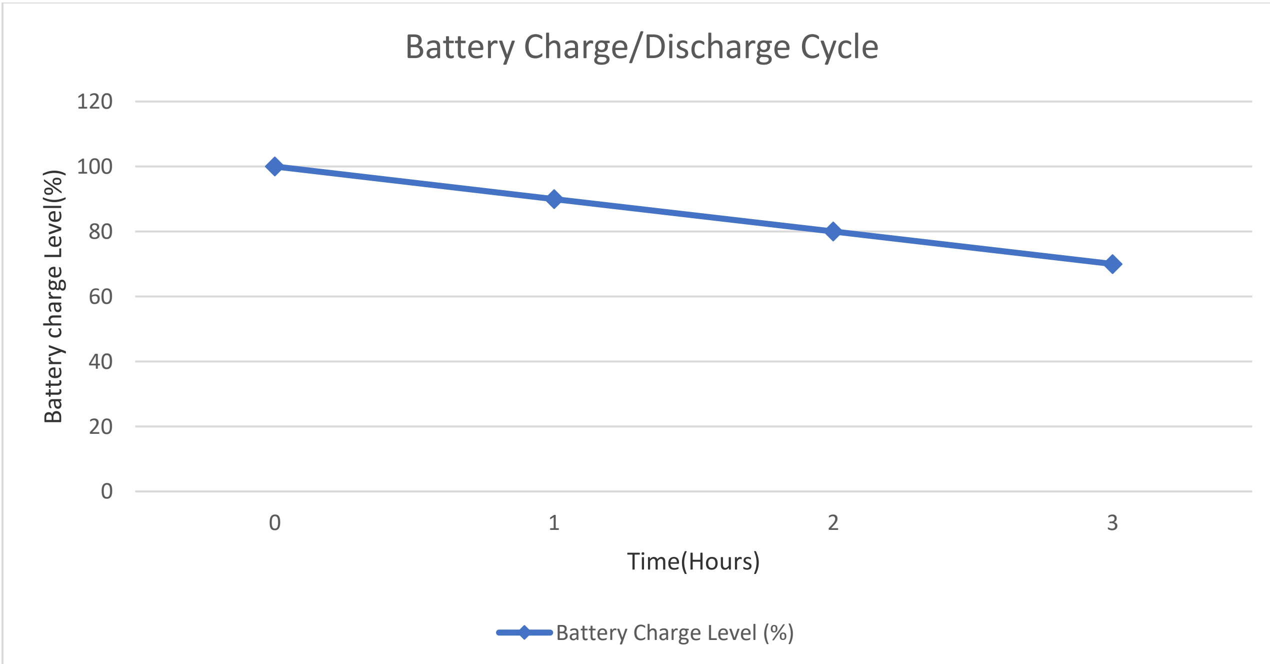


Figure 4.3: **Time vs Battery Charge Level**

Battery Charge/Discharge Cycle: This graph shows the battery charge level percentage over time in hours. Initially, the battery is fully charged at 100%. After 1 hour, the charge drops to 90%, then to 80% after 2 hours, and 70% after 3 hours. The trend indicates a consistent discharge rate of 10% per hour.

Table 4.2 : **Time vs Battery Charge Level**

Time (Hours)	**Battery Charge Level (%)**
0	100
1	90
2	80
3	70

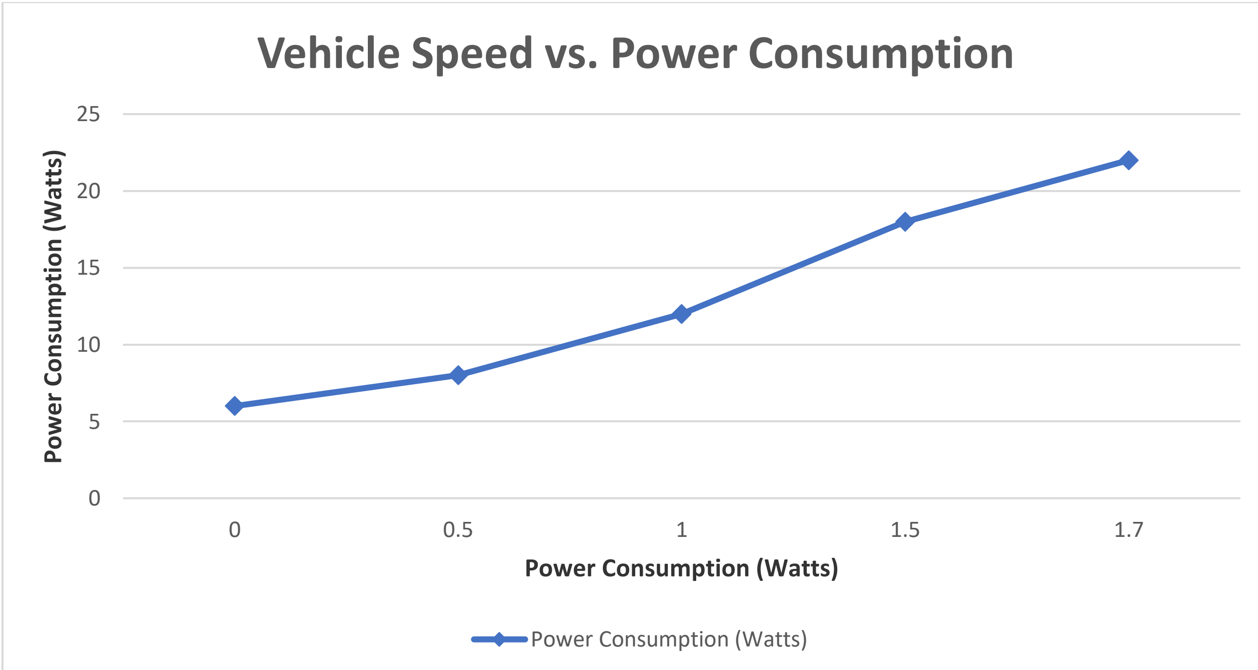


Figure 4.4: **Vehicle Speed vs Power Consumption**

Vehicle Speed vs Power Consumption: This graph illustrates the power consumption in watts as the vehicle speed in km/h increases. At a standstill (0 km/h), the power consumption is 6 watts. As the speed increases to 0.5 km/h, power consumption rises to 8 watts, reaching 12 watts at 1 km/h, 18 watts at 1.5 km/h, and 22 watts at 1.7 km/h. The trend demonstrates that power consumption increases with vehicle speed.

Table 4.3: Vehicle Speed vs Power Consumption data

Vehicle Speed (km/h)	Power Consumption (Watts)
0	6
0.5	8
1	12
1.5	18
1.7	22

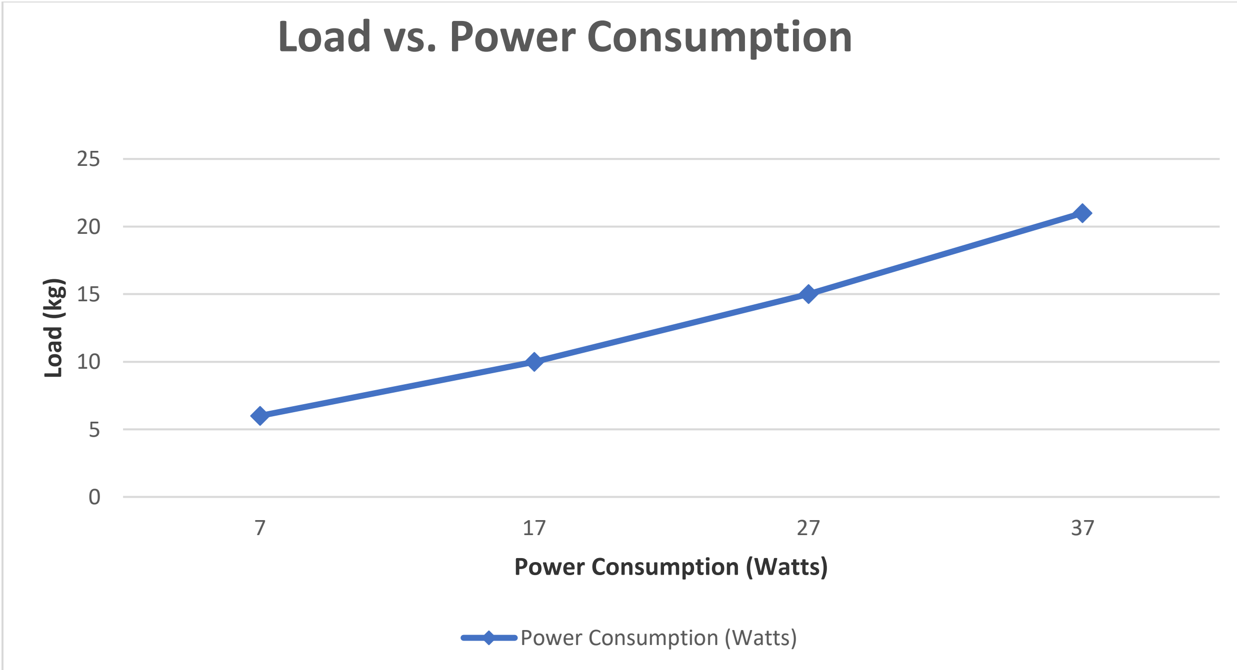


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Figure 4.5: **Load vs. Power Consumption**

Load vs Power Consumption: This graph presents the power consumption in watts relative to the load in kilograms. For a load of 7 kg, the power consumption is 6 watts. As the load increases to 17 kg, power consumption rises to 10 watts, then to 15 watts at 27 kg, 21 watts at 37 kg, 28 watts at 47 kg, and 36 watts at 57 kg. The trend shows that power consumption increases as the load becomes heavier.

Table 4.4: Load and Power Consumption Data

Load (kg)	Power Consumption (Watts)
7	6
17	10
27	15
37	21
47	28
57	36

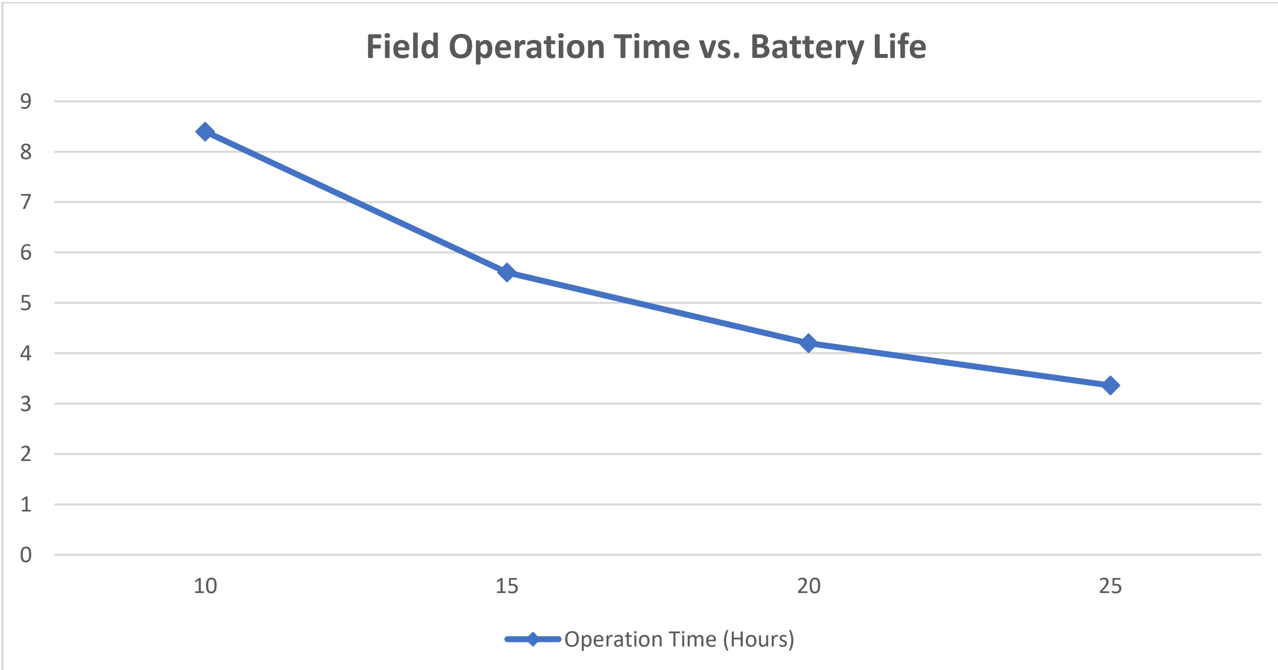

Figure 4.6: **Field Operation Time vs. Battery Life**

Field Operation Time vs Battery Life: This graph shows the operation time in hours for various levels of power consumption in watts. For a power consumption of 10 watts, the operation time is 8.4 hours. As power consumption increases to 15 watts, the operation time decreases to 5.6 hours, 4.2 hours at 20 watts, 3.36 hours at 25 watts, and so on, illustrating that higher power consumption results in shorter battery life.

Table 4.5: **Field Operation Time and Battery Life Data**

Power Consumption (Watts)	Operation Time (Hours)
10	8.4
15	5.6
20	4.2
25	3.36
30	2.8
35	2.4
40	2.1

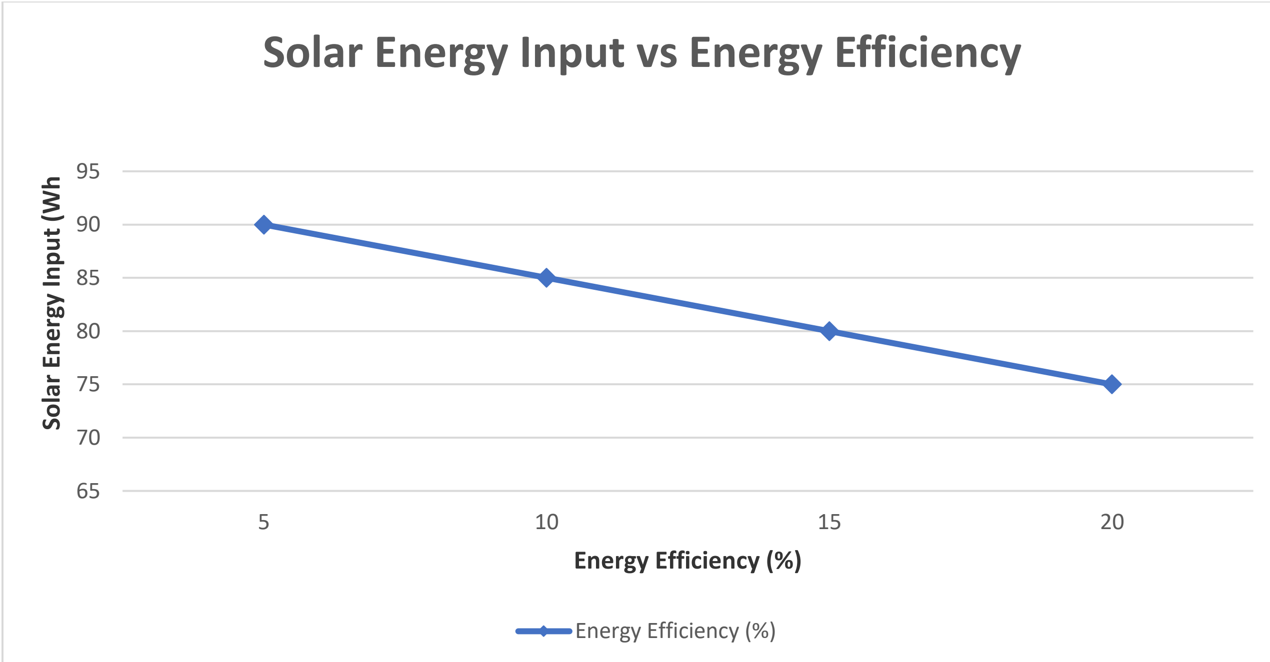

Figure 4.7: **Solar Energy Input vs Energy Efficiency**

Solar Energy Input vs Energy Efficiency: This graph illustrates the relationship between solar energy input, measured in watt-hours (Wh), and energy efficiency, measured in percentage. At 5 Wh, the energy efficiency is 90%. As the solar energy input increases to 10 Wh, the energy efficiency decreases to 85%, then to 80% at 15 Wh, 75% at 20 Wh, 72% at 25 Wh, and 67% at 30 Wh. The trend shows that energy efficiency decreases as the solar energy input increases.

Table 4.6: **Solar Energy Input and Energy Efficiency**

Solar Energy Input (Wh)	**Energy Efficiency (%)**
5	90
10	85
15	80
20	75
25	72
30	67

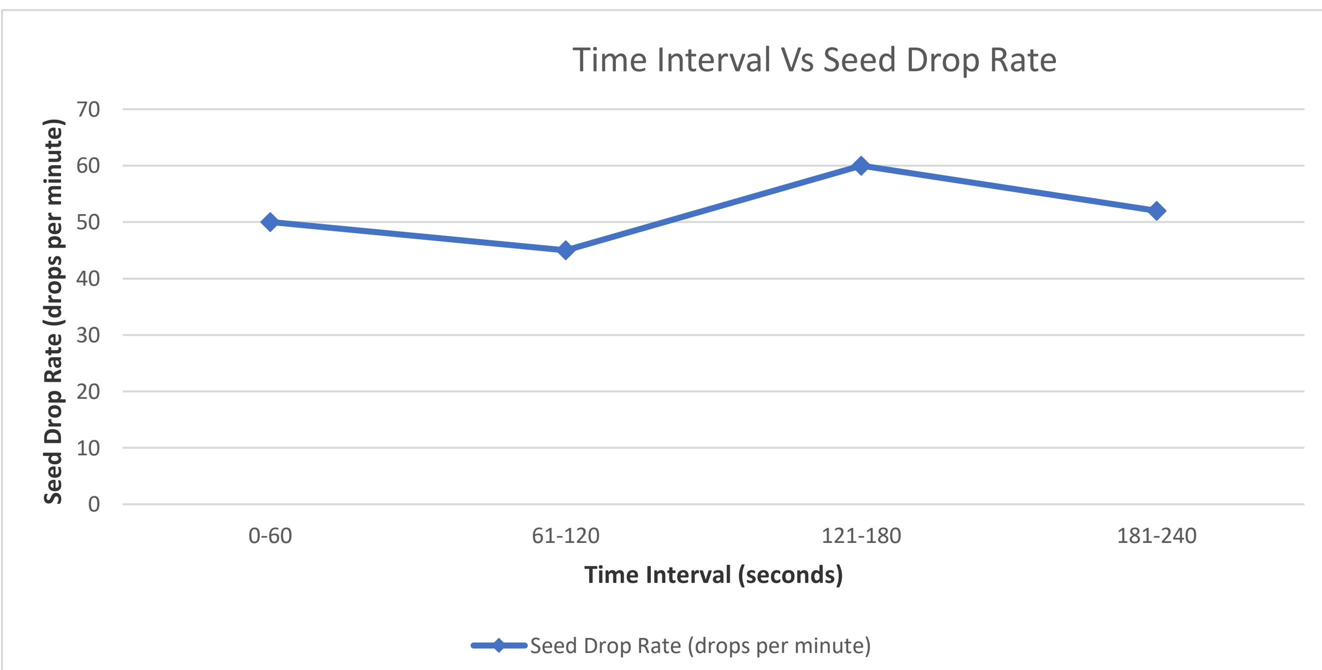

Figure 4.8: Time Interval Vs Seed Drop Rate

Time Interval vs Seed Drop Rate: This graph shows the seed drop rate, measured in drops per minute, at different time intervals in seconds. From 0 to 60 seconds, the seed drop rate is 50 drops per minute. From 61 to 120 seconds, it decreases to 45 drops per minute, increases to 60 drops per minute from 121 to 180 seconds, then decreases again to 52 drops per minute from 181 to 240 seconds, and further to 48 drops per minute from 241 to 300 seconds. The trend shows fluctuations in the seed drop rate over different time intervals.

Table 4.7: Time Interval and Seed Drop Rate Data

Time Interval (seconds)	**Seed Drop Rate (drops per minute)**
0-60	50
61-120	45
121-180	60
181-240	52
241-300	48

CHAPTER-5

CONCLUSION

1. Developing the multipurpose agriculture vehicle, for performing major agriculture operations like goods carrying, solar power seeding urea, inter-cultivating a
2. Increase the efficiency and reduce the production and handling cost.
3. Modifications were carried out, and the modification includes fabricating a vehicle which is small, compact in size which can move easily across the fields. Which consists of various
4. container, plough,
5. Which can be easily assembled and is –assembled by a single person, the cost of equipment is less by 83% compared to a tractor. And 40% compared to a tiller (price in India)
6. Ploughing is one of the first steps in farming. During this process we till the land and make it ready for the seed sowing. By tilling we mean that a plough will be used which will have teeth's like structure at the end and will be able to turn the top layer of soil down and vice versa.
7. Seed sowing comes next where the seeds need to be put in ground at regular intervals and
8. these needs to be controlled automatically. Limiting the flow of seeds from the seeds
9. chamber is typically doing this.

The development and prototyping of the multipurpose agriculture vehicle demonstrate its significant potential to transform farming practices. By integrating multiple functions such as plowing, seeding, and spraying into a single machine, it offers a cost-effective and efficient solution for small to medium-scale farmers. The use of sustainable energy sources, like solar power, and advanced control systems, such as the Arduino Uno, highlights the feasibility of combining modern technology with traditional agricultural practices. The successful performance of the prototype in real-world scenarios underscores its practicality and adaptability, providing a strong foundation for further development and widespread adoption.

Looking ahead, the future scope of this multipurpose agriculture vehicle is vast. Advancements in technology, such as GPS and IoT integration, promise to enhance its precision and data-driven capabilities, while improvements in power systems can extend its operational efficiency and reliability. Expanding the vehicle's functionality to include automated harvesting, crop monitoring, and soil analysis can further solidify its role as an essential tool in modern agriculture. Continuous innovation and collaboration with agricultural experts will be key to refining this technology, ensuring it meets the evolving needs of farmers and contributes significantly to sustainable and productive farming practices.

5.1 Future Scope

In the realm of agricultural technology, the future holds promising opportunities for sustainable and efficient solutions, exemplified by the development of a solar-powered multipurpose agricultural vehicle. This innovation integrates renewable energy sources, such as solar power, to revolutionize farming practices. By reducing reliance on fossil fuels and mitigating environmental impact, these vehicles offer versatile functionality with attachments for plowing, seeding, and harvesting. They enable precision agriculture through advanced sensors and data analytics, optimizing resource usage and yields. Autonomous operation and connectivity enhance efficiency and safety, while promoting rural electrification and economic growth. Collaboration between stakeholders fosters research and development, accelerating the adoption of these transformative solutions for global food security and sustainable rural development.

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APPENDIX-1

PROJECT PLANNING AND DURATION

Project Title: **Design and prototype of Solar powered multipurpose agricultural vehicle**

Project Members	Roll No.
Mir Alamdar Hyder	**1604-20-736-012**
Syed Rehan Abdullah	**1604-20-736-008**
Mohammed Abdul Samee	**1604-20-736-020**

Project Guide: Dr V. Dharam Singh, Assistant Professor

Task ID	Task Description	Duration (days)	Start Date	End Date
1	Project proposal	3	18-10-23	21-10-23
2	Research	20	22-10-23	14-11-23
3	Discussion of problem	10	15-11-23	24-11-23
4	Establishing design criteria and constraints	10	24-11-23	03-12-23

5	Evaluate alternate designs	4	04-12-23	08-12-23
6	Rough tool proposal	2	09-12-23	11-12-23
7	Rough methodology PPT & report	15	12-12-23	26-12-23
8	Design changes	5	27-12-23	31-12-23
9	3D prototype design	9	01-01-24	09-01-24
10	Re-visit methodology	2	10-01-24	12-01-24
11	Re modeling	5	13-01-24	18-01-24
12	Thesis report presentation and seminar update	10	19-01-24	28-01-24
13	Re designing of parts completion of 3D design in SolidWorks	8	29-01-24	05-02-24
14	Completion of 3d design in solid works	30	06-02-24	06-03-24

15	PPT completion	10	01-05-24	10-05-24
16	Review of all work and research	3	11-05-24	13-05-24
17	Completion of project	1	14-05-24	15-05-24

APPENDIX- 2

	Title of the project	Roll No. of the Students	Project Supervisor	Relevance			Type Application, product, Research Review.
				Environment	**Human Safety**	**Ethics**	
1	Design And Prototype Of Solar Powered Multipurpose Agricultural Vehicle	(1604-20-736-012) (1604-20-736-008) (1604-20-736-020)	Dr V. Dharam Singh	3*	3*	3*	Design and Research

Program Outcomes

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural,societal, and environmental considerations.

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, andmodern engineering and IT tools including prediction and modelling to complex engineeringactivities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibility is relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of,and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a memberor leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activitieswith the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding ofthe engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Function in the software industry in the area of design and development of softwaretool such as CATIA.

PSO2: Work in power plants, 3D design and manufacturing industry in the sphere ofoperation and maintenance.

MAPPING WITH POs AND PSOs

3 = Highly Relevant; 2 = Moderately Relevant; 1 = Less Relevant

PO/PSO	Relevance	Details
PO1	3	Application of engineering fundamentals such as mechanics, electrical systems, and renewable energy principles to design and prototype the agricultural vehicle.
PO2	3	Identification and analysis of agricultural needs and the formulation of solutions using engineering principles to develop a sustainable vehicle.
PO3	3	Design of the vehicle to address agricultural tasks such as plowing, seeding, and spraying, ensuring it meets safety, societal, and environmental standards.
PO4	2	Use of experimental design, data analysis, and interpretation to validate the performance and efficiency of the prototype in agricultural conditions.
PO5	3	Utilization of CAD software like CATIA for design, and other modern engineering tools for simulation and prototyping.
PO6	3	Assessment of societal needs, such as reducing labor and operational costs, and enhancing agricultural productivity with minimal environmental impact.

PO7	3	Development of a vehicle powered by renewable energy (solar power), promoting sustainability and reducing dependency on fossil fuels.
PO8	3	Commitment to ethical principles in the development and use of the vehicle, including safety, sustainability, and social responsibility.
PO9	3	Collaboration among team members to design, prototype, and test the vehicle, enhancing teamwork and leadership skills.
PO10	3	Documentation and presentation of project findings, designs, and performance results to stakeholders and the academic community.
PO11	3	Management of project timelines, resources, and budget to ensure the successful completion of the prototype within constraints.
PO12	3	Engagement in continuous learning about new technologies, sustainable practices, and advanced engineering methods to improve the project and adapt to future challenges.
PSO1	3	Extensive use of CATIA software for designing the agricultural vehicle components and overall structure.
PSO2	2	Focus on the practical application of design and operational knowledge in the context of agricultural machinery, emphasizing ease of maintenance and operational efficiency.