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DEVELOPMENT OF PETROL ENGINE POWERED MULTIPURPOSE FARMING EQUIPMENT

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Abstract:
This research aims to improve the stability of tillers powered by gasoline engines while addressing the limits of electric tillers caused by present battery technology restrictions. The suggested remedy is modifying electric tillers by replacing a high-performance gasoline engine with an electric motor. This modification aims to increase the tiller's power output, increase its operational time, and improve overall dependability. The proposal intends to achieve a compromise between the longer endurance of gasoline engines and the environmental benefits of electric motors by integrating a gasoline engine. The main goals and driving forces of the project are summarized in this abstract, which highlights the need to find an effective and long-lasting tiller technology solution that combines the advantages of both systems.

Keywords:
Tiller, Gasoline engine, Stability, Operational time, Dependability.

1. INTRODUCTION

Modern agriculture relies heavily on sustainable and productive agricultural methods, which are made possible by advances in equipment like tillers. Electric motors, which have historically been fuel-powered, have the potential to provide advantages including lower emissions and upkeep costs. However, the limitations of existing battery technology prevent extended use of electric tillers. We set out to solve this by using high-performance gasoline engines in place of electric tillers, taking advantage of their reliable power output, long operating life, and ease of recharging. This method reduces downtime, which is essential for intensive farming. Furthermore, manual and chemical weed control methods provide labour and environmental issues in places like India; hence, engine-operated weeding equipment is required for lower costs and higher production.

2. LITERATURE REVIEW

Jones et al. (2022) compared the price of gasoline-powered tillers and electric tillers, taking into account things like fuel, maintenance, and initial investment. The study discovered that although the operational costs of electric tillers were lower, their overall cost-effectiveness was affected by the larger initial battery investment. [1].

Smith and Johnson (2022) offered a project in which a small, powerful gasoline engine was installed into an electric tiller to improve operating efficiency and decrease downtime. The case study shed light on the user input, performance assessment, and design factors [2].

Zhang et al. (2021) examined the most recent advancements in battery technology, focusing on enhancements to lifespan, charge-discharge efficiency, and energy density. The study emphasized how these developments could improve the efficiency and runtime of electric tillers [3].

Garcia et al. (2021) examined the possibilities for increased efficiency and less environmental effect when integrating electric and gasoline engines in agricultural machinery. For optimum performance, the study covered the significance of power management plans, control systems, and hybridization approaches [4].

Patel et al. (2019) analysed the effectiveness and efficiency of tillers that run on gasoline and electricity. Environmental impact, noise levels, fuel consumption, power production, and noise levels were all compared in the study. The results indicated that while electric tillers proved advantageous in terms of fewer carbon emissions and noise levels, gasoline-powered tillers showed superior power production and endurance [5].

Johnson and Lee (2019) studied the advantages of using electric motors in agricultural equipment, such as lower maintenance costs, less noise pollution, and benefits to the environment like lower carbon emissions. The study also highlighted how electric motors could support environmentally friendly farming methods [6].

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Lee and Park (2018) carried out a life cycle assessment (LCA) to evaluate how gasoline- and electric-powered tillers affected the environment. The findings demonstrated that although electric tillers produced fewer greenhouse gas emissions when in use, their total environmental impact was increased by the manufacture and disposal of batteries.[7].
Smith et al. (2018) discovered that the comparatively short battery life and restricted capacity prevent electric tillers from operating continuously, necessitating regular battery changes or recharging. Farmers may experience downtime and decreased productivity as a result. The difficulties associated with battery weight and the requirement for additional power storage to match gasoline engine performance in tiller applications were also covered [8].

3. Problem Statement

The project is aimed at stabilizing the current gasoline engine tillers and minimize the drawbacks of electric tillers brought on by limitations in battery technology. Project aims to modify the electric tiller by substituting an electric motor with a high-performance gasoline engine in order to overcome the existing limitations in tillers.
This change has been made to increase the tiller's overall reliability, power, and operating time. The idea aims to find a balance between the advantages of electric motors for the environment and the longer lifespan of gasoline engines by including a gasoline engine.

4. DESIGN CALCULATION

4.1 Selection of Engine:

Power requirement of the weeder:

Power requirement for self-propelled weeder were computed by using below
Formula,

$$Pd = (SR \times d \times w \times v)/75.$$
$$= (0.75 \times 5 \times 36 \times 1)/75$$
$$Pd = 1.8\ hp$$

Where,

Pd= power requirement, hp
SR = soil resistance, (0.75 kg/cm2)
D = depth of cut, (5 cm)
W = effective width of cut, (36 cm)
V = speed of operation.

As per the availability and considering factor of safety, **5hp Engine** is selected to drive the weeder.

4.2 Determination of Shaft Diameter

For a solid shaft having little or no axial loading, the diameter of the
shaft was calculated using the equation given by the ASME code. (ASME, 1995)
Bending Moment Calculation:

$$d^3 = \frac{16}{\pi \times \tau_{max}} \sqrt{(K_b \times M_b)^2 + (K_t \times M_t)^2}$$

For rotating shafts, when the load is suddenly applied with minor shock, Kurmi and Gupta (2005) recommended that values of Kb = 1.2 to 2.0 and Kt = 1.0 to 1.50 be used. Furthermore, it described that for the shaft without a keyway, the allowable stress (τ) must be 55 MN/mm2 and for the shaft with a keyway the allowable stress (τ) should not exceed 40 MN/mm2 y

Determination of torque transmitted by the shaft The torsional moment transmitted through the shaft was calculated using the following formula (Ryder, 1989)

$$Mt = (P \times 60 \times 10^6)/(2 \times \pi \times N)$$

Where,

P = Power, kW
T = Torque transmitted by the shaft, Nm
N = Speed of the shaft, rpm

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$Mt = (3.67×60×10^6)/(2×π×3200)$

Mt= 10951.84 N-mm

<u>Bending Moment Calculation:</u>

The maximum resultant bending moment on the shaft was determined from the following expressions, to know the unknown forces of RA and RB we use equilibrium equation methods.

Load Distributions on shaft,

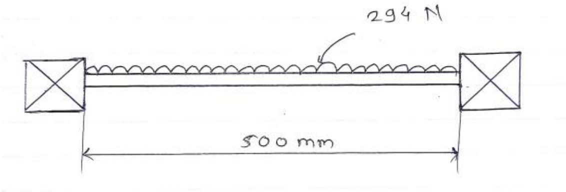

Fig. 4.2.1 Load distribution on shaft

The uniform distributed load is considered on the shaft. For calculation purpose UDL is considered as the point load at the center of the shaft.

As we considered the force at center of the shaft, the reaction at the support will be given as,

$R_A=R_B= 294.3/2$

$=147.15$ N

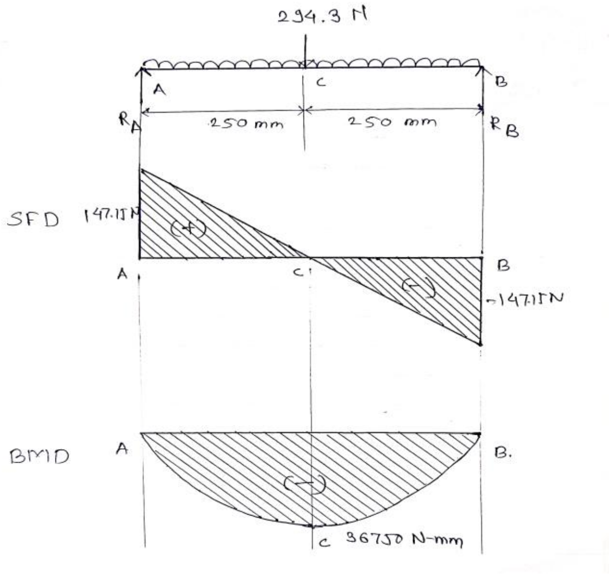

Fig.4.2.2 SFD and BMD of the Shaft

Maximum bending can occur at the center of the shaft, so maximum bending moment can be calculated as,

M_b= RA X 250

= 147.15 X 250

M_b= -36750 N-mm

Now, putting the values of bending moment and torsional moment in the equation of maximum shear stress.

By further calculations,

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d= 16.96 mm
by considering factor of safety, the diameter of the shaft is considered as **30mm**

4.3 Drive Mechanism

In our project a decision was made to use a V-pulley with a 50.8mm diameter for the one attached to the engine's output shaft. The decision was mainly influenced by the pulley's restricted diameter of 70 mm and the resulting space constraints.
Pulley 1's diameter is 50.8 mm.
For the diameter of the second pulley, we carefully considered the speed ratio (N1/N2) to optimize the efficiency of the engine while taking into account the weight and overall size constraints of the pulley system. The chosen speed ratio of 1.5 ensures an effective balance between power transmission and the performance of the engine.

$$\frac{N1}{N2} = 1.5$$

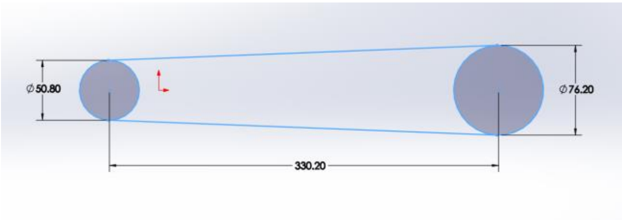
To calculate the diameter of the second pulley, we employed the following formula:

$$\frac{N1}{N2} = \frac{D2}{D1}$$

$$D2 = \frac{N1 * D1}{N2} \qquad D2 = 1.5 * 50.8$$
$$D2 = 76.2\text{mm}$$

where:
D2 = diameter of the second pulley,

<u>Belt length calculation-</u>
The Length of the belt is calculated by using below formula;



$$L = 2C + (D1 + D2)$$

$$L = 2 * 330.2 + (50.8 + 76.2)$$

$$L = 860.37 \text{ mm}$$

$$L = 33 \text{ inch}$$

where:
C= Centre distance between two pulleys, mm
L= Length of pulley, mm

Sr. No.	Particulars	Details
01	Machine Name	Multipurpose Farming Equipment
02	Machine's overall Dimensions (L x W x H)	1650 x 800 x 1050 mm
03	Machine's Weight	34.41 kg
04	Power source	5 hp petrol start petrol run engine
05	Fuel used	petrol
06	Fuel tank capacity	3 lit

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07	Engine details	4 stroke, 1 cylinder
08	Speed at engine	3200 rpm
09	Weight of engine	14 kg

Table 4. 3.1 Specification of the weeder

5. CAD MODEL DESIGN

Fig. 5.1 CAD Model

6. EXPERIMENTATION AND RESULTS

Table 6.1 Observation table

ExptNo.	Test Condition	Total Area Covered (ha)	Area Covered (ha/hr)	Total Fuel Consumed (L)	Average Speed (km/hr)	CO2 Emissions (kg)
1	Dry Soil	0.2	0.2	1	4.8	2.31
2	Wet Soil	0.2	0.17	1.30	3.6	3
3	Uneven Terrain	0.2	0.14	1.58	3	3.64

Fuel economy (ha/L) = $\frac{\mathbf{0.2(ha)}}{\mathbf{1\ (L)}}$ = 0.2ha/L

Work Rate (ha/hr) = **0.2 ha/hr.**

Total Emissions (kg) = 1 L × 2.31 kg/L = **2.31kg/L**

The data presented in following Table shows that weed population before weeding operation was 283 which reduced to 28 after weeding operation by developed power weeder. The weeding efficiency of the developed power weeder was 90.1 %. Basically, three types of weeds were found in the field i.e. Grasses, sedges and broad leaves. It was found that the broad leaved weeds dominated over grasses and sedges in the experimental plot. 93 grasses, 73 sedges and 117 braod leaves were found before the weeding operations. However, it reduced to 9 grasses, 6 sedges and 13 broad leaves after the weeding operations.

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Sr.no	Type of weed	No. of weeds before weeding in $1m^2$	No. of weeds after weeding in $1m^2$	Weeding efficiency %
1	Grasses	93	9	90.32
2	Sledge	73	6	91.78
3	Broad leaves	117	13	88.88
	Total	283	28	90.1

Table 6.2 Observation table

7. DISCUSSION AND FUTURE DIRECTIONS:

While the project achieved its primary objectives, the analytical discussion reveals areas for future research and development. Exploring alternative energy sources, such as electric motors powered by renewable energy, could address the limitations associated with petrol dependence. Additionally, further refinement of the design to enhance user comfort, perhaps through advanced vibration damping and noise reduction technologies, could improve the user experience. Continuous engagement with end-users to collect feedback and iteratively refine the design will be crucial in ensuring the tiller weeder remains responsive to the evolving needs of the agricultural sector.

8. CONCLUSION

This project successfully achieved the development of a multipurpose tiller weeder that aligns with the needs for enhanced agricultural efficiency and sustainability. The findings offer a promising outlook for the adoption of such innovations in farming practices, potentially revolutionizing soil tillage and weeding operations. The developed power operated tiller weeder was operated by 5 HP petrol run engine. It was tested in the experimental plot and observed that the machine worked satisfactorily. The field work capacity and field economy of machine was 0.2 ha/h and 0.2 ha/L respectively. The larger wheels provided better stability during operation and due to presence of lugs in the wheel some weeds were also cut and buried. The operational cost was found to be Rs. 700/hector**.**

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