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Research Article

DESIGN MODIFICATION AND PERFORMANCE COMPARISON OF LAWN MOWER MACHINE BY MULCH AND FLAT TYPE CUTTING BLADE

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Abstract- The grass cutting machine is available in various types like Reel (cylinder) mower, Rotary and mulching mower, Riding mower, Robotic mower, and Professional mower. The grass cutting machine is of two types' electric motor and mechanical power. In the modification of lawn mower we used two types of blade, mulching type blade and flat type blade. The mulching type blade having field efficiency is 93.7% with average speed 1.822 km/hr and the flat type blade having field efficiency is 83.17% with average speed 1.89 km/hr. Results shown that the mulching type blade is most suitable.

Keywords- Lawn Mower, Mulching Blade, Flat Cutting Blade, Grass Cutting, Field Efficiency.

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Introduction

The first lawn mower was introduced in 1830 by Edwin Beard Budding. In 1832, Ransoms of Ipswich (under license) stared the making of Budding's mower. Lawn mowers are useful part and applicable at different places throughout the world. In small scale industry, like lawn mowing, has new development and designing which becomes a prestigious art to some. Lawn mowers are complex as a street legal vehicle, and even more expensive than others. However, in a quite some years, many believe lawn mowing will be much more automated, if not completely automated in many areas. Agriculture is the most important sector of Indian economic growth. In India, lawn mower machine has great scope. In our country, as well as other countries, it is used in various fields like golf ground, football ground, cricket ground also in garden for grass cutting purpose [1].

A vertical motor mounted electrical lawn mower is an alternative option to common rotary mower. That grass cutter does the better job of cutting grass or lawn grass [2]. The vertical rotor shaft has many pairs of swinging knives that cuts the grass at equal height. If the blade cannot cut the grass by the first blade then it cuts by the other three remaining blades. The periodical cleaning is the measure problem faced by the people in India. The commercially available units for mowing or grass cutting are casting heavily. Hence considering the needs for development of effective and economic grass cutting management practices, research work is under taken entitled "Modification and performance evaluation of lawn mower" with following objectives [3]-

a) To fabricate mulch type and flat type blade
b) Performance evaluate of fabricated blade in field.
c) Comparative evaluation of type I and II blades.

Materials and Methods:

The available material was used as per the requirement concerning the function of machine and the life of the components [4-8].

Mild steel is known as soft metal, having less than 0.25 % of carbon, able to with stand with the load stand will occur against machine elements, its lower cost, easy availability, machinability it is mostly used in order to reduce the cost of agricultural machine. For fabrication of the machine mild steel was used [9-12].

Design Consideration

The principle and working of lawn mower is to cut the grass by slicing action of the blades above the ground surface without damaging the blades when it strikes on immovable objects such as rock, stone. The cutting of grass takes place due to impact and shearing action.

Now a day work has been done on solar power operated grass cutter. Following are the various parts of grass cutter or lawn mower designed carefully [13-16].

Cutting Unit

The sickle shaped cutting edge has been sharpened for easy cutting fixed at an angle of curve of 180˚ to its horizontal axis. The cutting blade has been used as a curve plane to perform cutting the grass efficiently. Design aspects of cutting unit consist of following consideration [17-22].

Design of Blades

In order to cut the grass the peripheral speed of the blade was calculated by the formula,

$$V = \frac{\pi d N}{60}$$

Where,

V= blade speed, m/s; d = diameter of cutting area.

N = shaft speed, rpm.

Power Requirement for Cutting

The horse power required to cut the grass can found out with the help of formula,

$$P = \frac{2\pi NT}{4500}$$

Where,
P = Power requirement, hp; T = Torque, Kg-m
3.1.1.3 Power Transmission
To achieve desired transmission of power, the blades are directly mounted on motor shaft. So, power transmission is directly from motor to horizontal rotating blades.

Fabrication Process:
Due attention was provided on the following design aspects while designing and fabrication of the grass cutter. There are different sections such as cutting unit; supporting frame; Power unit; Handle
Transporting unit

Cutter Blades
Cutter blades used, were curved with externally sharpened edges. The cutter blades are made of mild steel flats. The cutter blades were hardened and tempered to suitable hardness for longer service life of the cutting edge. The blades were rotated by the motor shaft which was operated electrically and directly fixed on motor shaft.
Two types of blades: - 1. Mulch type 2. Flat type
The grass was cut by the slicing action of blades revolving at 1420 revolutions per min.

Supporting Frame
Supporting frame comprises of rectangular frame made of (470 x 320, 40 mm) was discussed below.
Supporting base: From the economic point of view, to reduce cost of machine, a rectangular wooden plank 460 x 300, 25 mm size which was support the motor weight.

Power Unit
Motor:
Power to the machine was provided with the help of single phase electrical motor of 1 hp to rotate the blades for cutting of grass.

On-off lever: It is used to cut and start the electric supply. It was fixed at the front side of handle for easy operation.

Handle
The handle is made of mild steel hallow pipe with outside diameter 25 mm and inner diameter 23 mm. The adjustable height of handle 950 mm. The handle was provided for ease of driving the lawn mower by walking behind the machine.

Transporting Unit
Transporting unit consist of ground wheel and axle. Two fronts and two rear wheels of 140 mm diameter made of 40 mm rubber wheel to support and carry the machine. The four wheels were axle by 24 mm; M.S. diameter bar.

Modification of Lawn Mower
To avoid human hazard, shaft or blade damage provide supporting small size metal rod to the frame of lawn mower having 50 mm length and 5 mm dia. 12

Performance Evaluation of Lawn Mower
The grass was tested for lab and field test.

Laboratory Test
Laboratory test was carried out at the Workshop of Farm Machinery and Power of Aditya College of Agriculture Engineering and Technology, Beed. During laboratory test, the different parameters were observed carefully and described as below. The observations and measurements of machine were categorized into following unit.

Specification of Grass Cutter
Specifications of the grass cutter are shown in [Table-1]

Cutting Height of Grass
At the height of 20 mm from the ground surface, the blades were fixed, so that the cutting of grass was done.

Measurement of Output Power
Output power at the rotor was calculated by the idle speed and high speed of the rotor shaft and torque as per the formula, $P_o = T \times N974$
Where,
P_o = output power, kW; T = shaft torque, kg-m
N = shaft speed, rpm
Assume
W = Width (mm); L = Length of blade (mm);
T = Thickness; B_T = Total no of blades;
W_T= Total weight of blades (gm);
N_B = Blade Speed (m/s); H_{Avg}=Average cutting height (mm)
D_{Tr}= Diameter of transmission (motor) shaft (mm)
L_{Tr}=Length of transmission shaft (mm)
N_M= Rated rpm of Motor; P_M=Power of Motor (Hp)

Table-1 *Specifications of Lawn Mower with Mulch and Flat type blades*

A] Cutter blades specifications :			
Parameters		Mulch	Flat
W		20	50
L		140	280
T		3	5
B_T		4	2
W_T		280	280
N_B		23.04	20.81
H_{Avg}		20	
B] Motor shaft Specifications:			
D_{Tr}		18	
L_{Tr}		2000	
N_M		1420	
P_M		1 Hp	
C] Field Plot and Grass Specification			
Plot	Size	20 x 10	
	A	200	
Grass	H_{Avg}	50	
	H_{Req}	20	

There are two type of blade are used:
i. Mulch type blade
ii. Flat type blade
The summery of the performance of field test of the grass cutter for given plot is presented in Table. Following observations regarding the different performance parameters of grass cutter are discussed below

Height of Grass
From the [Table-2], it was found that the average height of grass was found to be 50 mm before cut.


Multch (B_1)


Flat (B_2)

Fig- 1

Height of Grass after Cut

The height of cutting grass was not varies with height of grass before cut because the grass cutter was not adjustable. The height of cut grass was same for the ground level throughout the testing which was 20 mm after cut [Table-2].

Table-2 *Performance and Evaluation of Lawn Mower for Mulch and Flat Type Blade with an operating width of 500mm*

Performance Parameters	P	MULCH	FLAT
Total no of strips (0.3X20m) to cover area	S	36	43
Time taken to cover total strips of test plot, sec	T_s	1054.8 (17.58 min)	798.34 (13.30 min)
Total no of turns	N_T	35	42
Time lost to owing to turning, sec	T_L	367.2 (6.32 min)	418.83 (6.98 min)
Speed of operation, km/hr	N_O	1.82	1.89
Total time required to cover the plot including time losses, sec	T_T	1422 (23.7 min)	1217.17 (20.28 min)
Theoretical field capacity,ha/hr	F_{Cth}	0.054	0.0529
Effective field capacity	F_{CE}	0.0506	0.0440
Field efficiency, %	F	93.7%	83.17 %

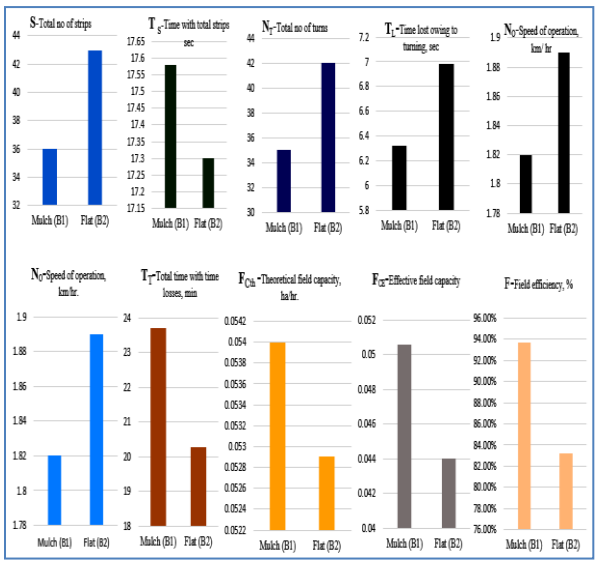

Fig-2 Multch Vs. Flat Blade Graphical Performance

Conclusion

- **For Mulch Type Blade**
- 1) The grass cutter is able to cut grass of height 20 mm above ground level.
- 2) The effective field capacity of machine is 0.0506 ha/hr.
- 3) Field efficiency of grass cutter is 93.7%.
- 4) Grass cutter is operated at an average speed 1.822 km/hr without disturbance in operation.
- 5) 1 Hp single phase electric motor is sufficient to operate for the width of 310 mm.
- **For Flat Type Blade**
- 1) The grass cutter is able to cut grass of height 20 mm above ground level.
- 2) The effective field capacity of machine is 0.0440 ha/hr.
- 3) Field efficiency of grass cutter is 83.17%.
- 4) Grass cutter is operated at an average speed 1.89 km/hr without disturbance in operation.
- 5) 1 Hp single phase electric motor is sufficient to operate for the width of 350 mm.

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Abbreviations:

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Conflict of Interest: None declared

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