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# Design, Development And Analysis Of Weed Removal Machine

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***Abstract*— Weeds are one of the major causes of loss of agricultural produce. Weeds compete with crops for essential nutrients. In agriculture, it's a very difficult task to weed out unwanted plants manually as well as using bullock operated equipment's which may further lead to damage of main crops. More than 33 percent of the cost incurred in cultivation is diverted to weeding operations there by reducing the profit share of farmers. Weeders are machines used for weed removal. Mechanical weeding is one of the prominent forms of weed removal. Smaller weeding machines commonly known as portable weeders are solely used for weed removal in agricultural fields, gardens, public parks, etc. Unlike tractors, weeders are non-conventional so far as the displacement of labours is concerned. In promoting weeders especially considering the fact that the majority of farmers are having small land. So they can hardly afford costlier tractors. Therefore, the weeder should become a useful machine in the internal cleaning of crops which having small distance between them like groundnuts, sugarcane, soya bin crops, cultivation of paddy, in particular, and other crops in general for the smaller farmers. Main objective of weeder is to reduce the manpower as in today labours are very hard to find as well as working time is more Rotary tillers power is directly transmitted to the tillage blades, so the power transmission efficiency in rotary tillers is high. Hence there is a need to improve the design of blade through geometrical modifications so that will reduce the blade cost as well as land preparation cost. CAD, CAE & FEM are useful tools for analysing stresses and deformations in design of complex geometries***
***Keywords*— weed, mechanical weeder, small land, labours, manpower, working time, CAD**

## I. INTRODUCTION

Agriculture is the backbone of Indian economy. India being developing nation agriculture and industries based on agriculture products has prime importance in the national economy. As Per the 2010 world agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fresh meats, select fibrous crops also. Majority of the Indian population depends on agriculture and agro-based industries and businesses. Lack of mechanization or automation is one of the major roadblocks to improving the productivity of agriculture. Weeds are one of the major causes of loss of agricultural produce. Weeds compete with crops for essential nutrients. In agriculture, it's a very difficult task to weed out unwanted plants manually as well as using bullock operated equipments which may further lead to damage of main crops. More than 33 percent of the cost incurred in cultivation is diverted to weeding operations there by reducing the profit share of farmers. Weeders are machines used for weed removal. Mechanical weeding is one of the prominent forms of weed removal. Smaller weeding machines commonly known as portable weeders are solely used for used weed removal in agricultural fields, gardens, public parks, etc. Unlike tractors, weeders are nonconventional so far as the displacement of labours is concerned. In promoting weeders especially considering the fact that the majority of farmers are having small land. So they can hardly afford costlier tractors. Therefore, the weeder should become a useful machine in the internal cleaning of crops which having small distance between them like groundnuts, sugarcane, soya bin crops, cultivation of paddy, in particular, and other crops in general for the smaller farmers. Its main objective is to reduce the manpower as in today's scenario labours are very hard to find as well as it reduces the working time.

### *A. Problem Statement*

From survey we found one of the major reasons for lack agricultural productivity is weeds. So we decided to select a project based on weed removal machine. Weed is an everyday term usually to describe a plant considered undesirable. The word weed is commonly applied to unwanted plants in human-controlled settings, such as farm fields, gardens, lawns, and parks. Weeds compete with the beneficial and desired vegetation in crop lands, forests, aquatic systems etc. and poses great problem in non-cropped areas like industrial sites, road/rail lines, air fields, landscape plantings, water tanks and water ways etc. Weeds are unimportant factor in the management of all land and water resources, but its effect is greatest on agriculture. The losses caused by weeds exceed the losses caused by any other category of agricultural pests. Weeds may be unwanted for a number of reasons. An important one is that they interfere with food and fibre production in agriculture, wherein they must be controlled in order to prevent lost or diminished crop yields. Other important reasons are that they interfere with other cosmetic, decorative, or recreational goals, such as in lawns, landscape architecture, playing fields, and golf courses. Similarly, they can be of concern for environmental reasons whereby introduced species out-compete for resources or space with desired plants. Weeds have long been a concern, perhaps as long as humans have cultivated plants.

### *B. Weed Control Methods*

The removal and eradication of weeds from the fields, gardens or land with minimum damage to the desired plants is weed control. Various methods described below are used for removal of weeds from desired plants.

1) *Chemical Weeding:* Chemical control involves the use of herbicides. Herbicides control weed plants either by speeding up, stopping or changing the plant's normal growth patterns; by drying out the leaves or stems; or by making it drop its leaves. Chemical Control with herbicide application can provide the most effective and time-efficient method of managing weeds. Numerous herbicides are available that provide effective weed control and are selective in that grasses are not injured. Weed removal is one of the major activities in agriculture. Chemical method of weed control is more prominent than manual and mechanical methods. However, its adverse effects on the environment are making farmers to consider and accept mechanical methods of weed control. Chemical weeding is the most extensively used method of weed removal. But these chemicals used for weeding are harmful to living organisms and toxic in nature.
2) *Mechanical Weeding:* Mechanical control is the use of powered tools and machinery to manage weeds. It is suitable for larger infestations because it reduces the weed bulk with less manual effort. Mechanical control consists of methods that kill or suppress weeds through physical disruption. Such methods include pulling, digging, disking, ploughing and mowing.
3) *Biological Weeding:* Biological control involves the use of insects or pathogens that affect the health of the weed. It includes the use of living organisms for suppressing or controlling the weeds. Plant, animal or micro organisms may be used for destruction of weeds. The goal of biological control is not eradication, but the use of living agents to suppress vigour and spread of weeds. Such agents can be insects, bacteria, fungi, or grazing animals such as sheep, goats, cattle or horses. Grazing produces results similar to mowing, and bacteria and fungi are seldom available for noxious weed management. Biological control is most commonly thought of as 'insect bio control.
4) *Manual Weeding:* Manual control is the use of the hands or handheld tools to deal with weeds. Extensive amount of cheap manual labour is necessary for manual weeding. Manual weeding is commonly employed by smaller Indian framers for weed removal.

## II. DESIGN OF TRANSMISSION

### *A. Transmission Stage Calculation*

1) *First Stage:* Belt and pulley forms first stage of transmission between engine output shaft and gearbox input shaft. Pulleys are made of EN8 material which is of 82 mm and 130 mm respectively. Input speed is the speed of engine which is 3600 rpm.

From above statement we can write as follows:
Input speed (N1) : 3600 rpm;
Diameter of smaller pulley (D1): 82 mm;
Diameter of larger pulley (D2): 130 mm;
We known that,

$$\text{Speed} \propto \frac{1}{\text{Diameter}}$$

Hence,

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

$$\frac{3600}{N2} = \frac{130}{82}$$

$$N2 = \frac{3600 \times 82}{130}$$

N2 = 2270.77 rpm

N2: Output speed of first stage = 2270.77 rpm

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2) *Second Stage*: Gearbox reduction is used for second stage transmission which is directly taken from market with reduction ratio of 20. Input to gear box is output from first stage which is 2270.77 rpm

Output speed of first stage (N2): 2270.77 rpm
Reduction ratio of Gearbox (G): 20
We know that,

$$G \propto N$$
$$\therefore G = \frac{N2}{N3}$$

$$20 = \frac{2270.77}{N4}$$
$$N4 = \frac{2270.77}{20}$$
$$\therefore N4 = 113.54 \text{ rpm}$$

N4: output speed of second stage = 113.54 rpm

3) *Third Stage:* Third stage is an important stage as it is in direct contact with the cutting element. This stage requires transmission without slip hence Chain transmission is used in this stage with transmission ratio 1

$$\therefore N4 = N5$$
$$N5 = 113.54 \text{ rpm}$$

N5: Required output speed from third stage = 113.54 rpm.

## III.ANALYSIS

Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis incorporates the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often saving physical tests. Structural analysis is thus a key part of the engineering design of structures. For analysis we create CAD model using computer aided design method and analyses by Finite Element Method (FEM) which is one of the most frequently used engineering analysis techniques.

### A. Calculation Of Forces Acting On Blade

Tangential Force Kt is given by

$$Kt = \frac{75\ CsNc\eta c\eta z}{Umin}$$

Soil force Ks acting on the sharpened edge of the blade is given by,

$$Ks = \frac{Kt\ Cp}{iZeNe}$$

Where
Cs is the non-reliability factor equal to 1.5 for non-rockysoils and 2 for rocky soils,
$N$c is the power of the machine taken as 2.7 kW for small weeding machine,
$\eta c$ is traction efficiency taken as 80%,
$\eta z$ is coefficient of reservation of power taken as 0.8,
$Umin$ is minimum peripheral velocity taken as 0.5 m/s,
Cp is coefficient of tangential force taken as 0.8,
i is numbers of flanges taken as 4,
Ze is number of blades on each side of the flange takenas 2.

$$Ne = \frac{\text{Number of blades interacting with soil}}{\text{Total number of blades}}$$

Number of blades interacting with soil are 4.

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Total numbers of blades are 16.

Calculated values of Tangential Force (Kt) & Soil Force (Ks) are 2523.055 N & 4036.9 N respectively.

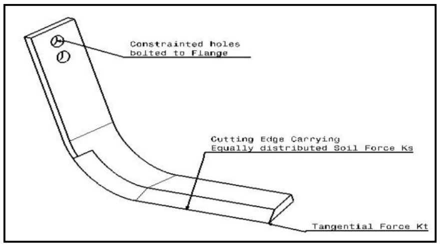


Fig. 1 Blade showing the various forces and constraints

*B. Analysis Of Blade*

A solid geometry of rotary blades were developed in Catiav5 software and exported as IGES file to the ANSYS 15. The next important steps are meshing and applying loading and boundary conditions in the pre-processor so that simulation can be run to get a solution and generate results in the post- processor. The minimum and maximum developed stress in the fastened area of the blade was indicated in the colour chart from blue to red respectively. The colour indicated from blue to red is the minimum and maximum value for all the deflection and stresses on the blade respectively.

TABLE I
MATERIAL PROPERTIES OF BLADE

| Material | Modulus of Elasticity MPa | Poisson's Ratio | Bulk Density Kg/m^3 |
|---|---|---|---|
| Steel EN 8 | 2.1 E+05 | 0.3 | 7850 |

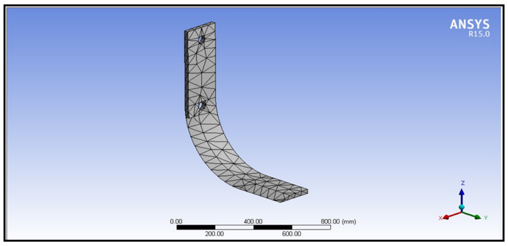


Fig. 2 Blade model meshed

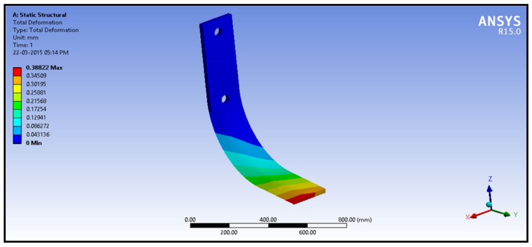


Fig. 3 Deformation of blade

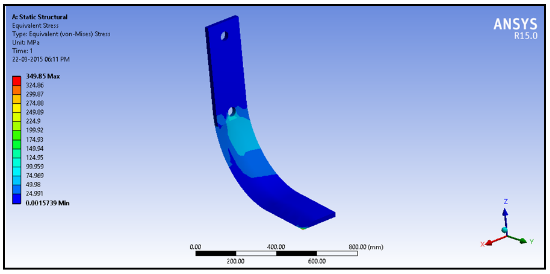


Fig. 4 Equivalent Stress of blade

It was observed that, the maximum and minimum principal stresses were found to be 349.85 and 0.0015MPa respectively with a total deformation of 0.38mm.The results of static structural analysis carried out for blade revealed that, the stress values

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developed in the blade were within the limits of the yield stress of the material (450 MPa). Hence, the blade designed and selected for the study could be adopted for the design of a rotary weeder.

### *C. Analysis Of Shaft*

The maximum working safe load acting up on the shaft is 2000 N and the analysis of this load acting on the shaft is done using ANSYS 15 and its effects are shown below.

#### *1) Static Structural Analysis Of First Shaft*

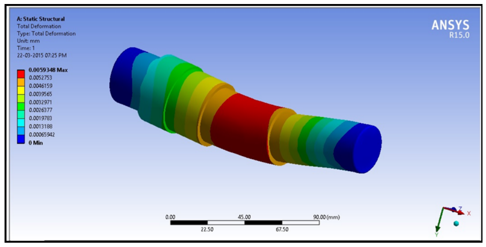

Fig. 5 First shaft deformations

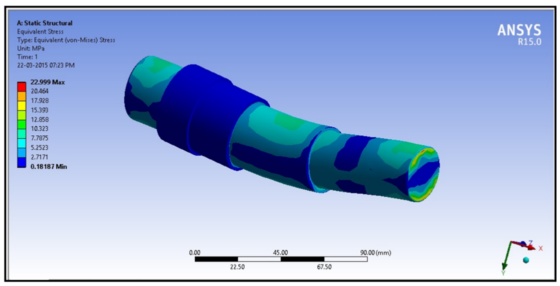

Fig. 6 First shaft stresses

Result of static structure analysis of first shaft indicates that values of total deformation and equivalent stress are 0.0059 mm and 22.99 MPa which are within the limit. Hence design is safe.

#### *2) Static Structural Analysis Of Second Shaft*

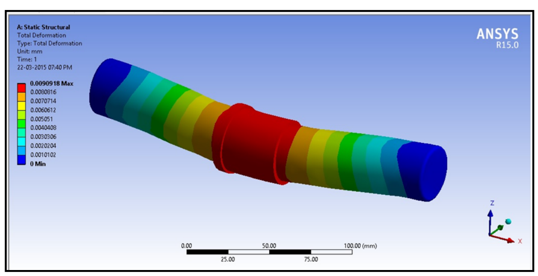

Fig. 7 Second shaft deformations

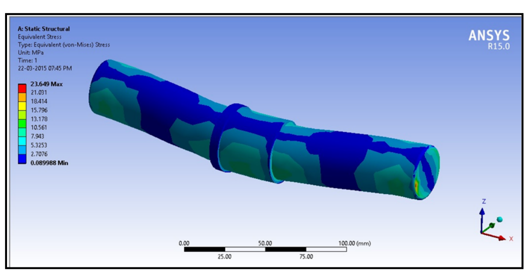

Fig. 8 Second shaft stresses

Result of static structure analysis of second shaft indicates that values of total deformation and equivalent stress are 0.0090 mm and 23.649 MPa which are within the limit. Hence design is safe.

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## IV. ASSEMBLY OF MACHINE

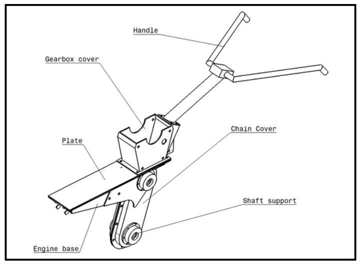

Fig. 9 Assembly of Frame

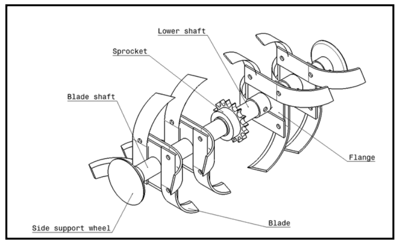

Fig. 10 Assembly of Blade System

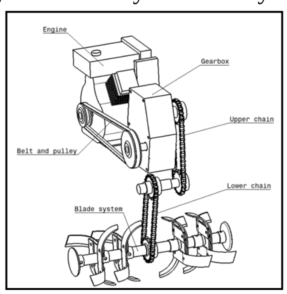

Fig. 11 Assembly of Mechanism

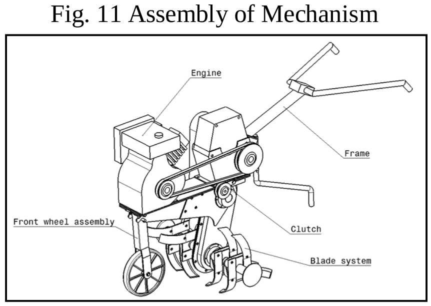

Fig. 12 Assembly of Mechanism

## V. RESULT

### A. *Infield Testing*

Infield testing of machine was performed and results matching to designed output speed were found. Deflection of blade was 0.38 mm and stress as 349.85 N/mm$^2$ from analysis software (Ansys workbench 15) which was satisfactory. Result of static structure analysis of first shaft indicates that values of total deformation and equivalent stress are 0.0059 mm and 22.99 MPa which are within the limit. Result of static structure analysis of second shaft indicates that values of total deformation and equivalent stress are 0.0090 mm and 23.649 MPa which are within the limit. Hence design is safe.

### B. *On-Field Testing*

Comparison of Weeding Cost by Traditional Method and Weed removal machine:

*1) Weeding Done By Manual Process:* Amount paid to the labour for one day = Rs. 250 per labour
Total number of labour required in general to weed the 1 acre = 6
Total amount paid to the labour = 6 x 250 = Rs. 1500 per acre in one day

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Therefore, total expenditure in one day is = Rs. 1500

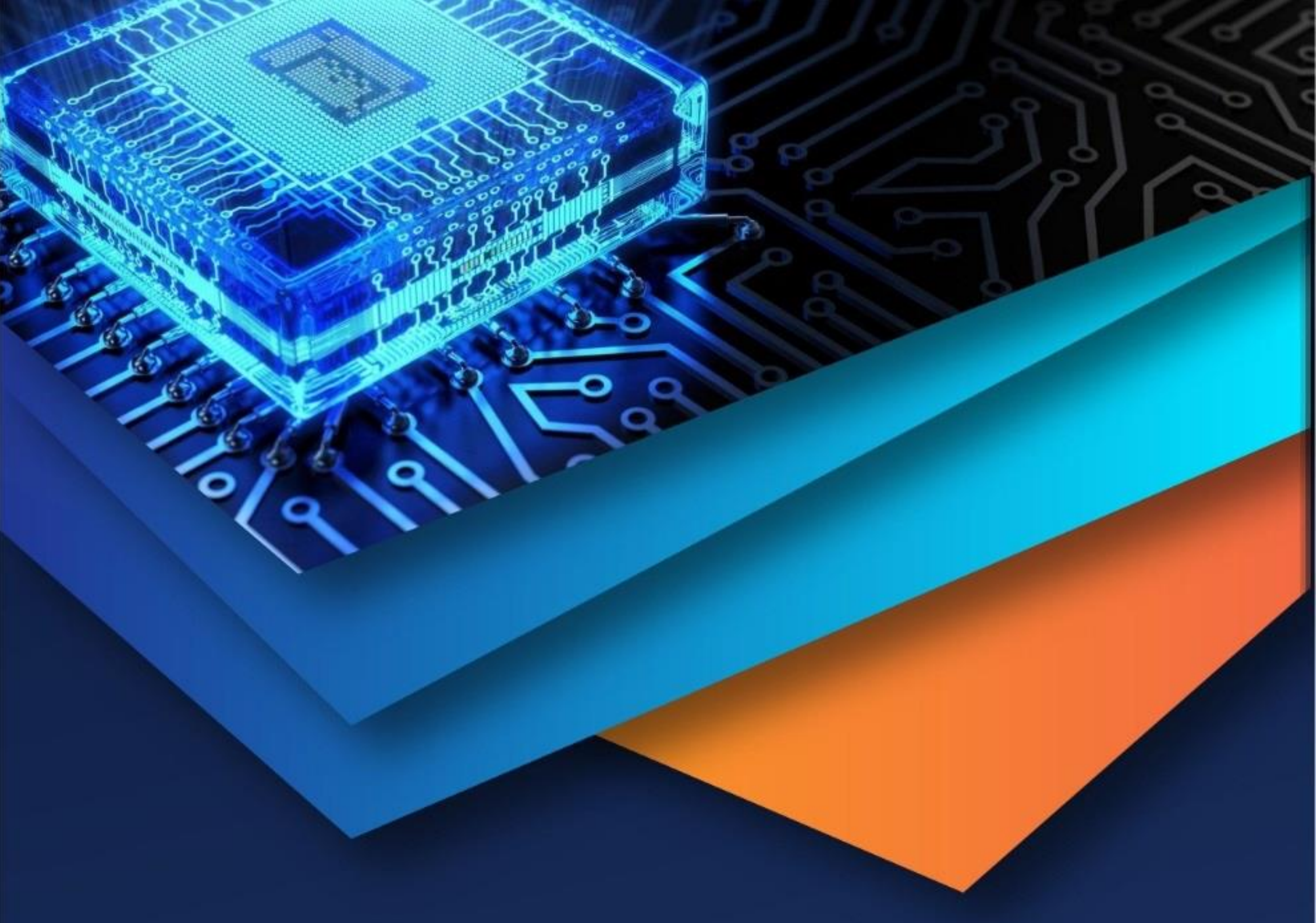
2) *Weeding Done By Machine*: Quantity of kerosene require for 1 acre = 1.5 liter
Cost of kerosene per liter = Rs. 60
Total cost of diesel for 1 acre farm for a day = 1.5 x 60 = Rs. 90
Amount paid to the labour= Rs. 250 per day
Total expenditure = Total cost of diesel + Amount paid to the labour + Maintenance
= Rs. 90 + Rs. 250 + Rs. 100
= Rs. 440 ~ Rs. 500
Amount saved by using the weed removal machine = Rs. 1500 **–** Rs. 500 = **Rs. 1000** per day per acre.

## VI. CONCLUSION

The Weed removal machine is built to be compact and efficient to cut the weeds. The machine was tested on a field to check its weeding capability and efficiency. The test results were successful as the machine performed flawlessly. It can be concluded that the machine is comparatively compact and easy to handle. This machine is able to run of field effortlessly and the efforts of farmers are reduced. The cost of weeding using this machine is considerably less as compare to manual weeding. It is reduced by 66.66% .The weeders available in market are suitable for large farms, so this can be the best machine for the farmers with small land. This semi-automatic machine is developed to reduce the time and effort required for production up to the great extent also this machine manufacturing cost is less as compared to other. By selecting above topic it was able to understand, familiar and know the details of agricultural technology, with the help of this semi-automatic machine .This is little effort to make comfort to our farmers also this machine is manufactured in less cost as compared to other the project also teaches the way of working as a unity proper co-ordination is to be established with student in the project group. It enhances the thinking or filling of mutual co-operation in the project.

## REFERENCES

[1] Design& Development of Rotavator blade", By Subrata Kr. Mandal, Basudeb Bhattacharyya, Somenath Mukherjee, PriyabrataChattopadhyay; 2013.
[2] "Small Machinery", GOVERNMENT OF INDIA Ministry of Agriculture; Department of Agriculture & Cooperation KrishiBhawan, New Delhi; 2012.
[3] "THESIS RESEARCH AND DEVELOPMENT OF ROTARY BLADE FOR ROTARY POWER TILLER UNDER DIFFERENT SOILSIN THAILAND", Kasetsart University; 2008.
[4] "Various aspects of Weeders for Economical Cultivation", By Mr.Vivek D. Raut, Prof.B.D.Deshmukh, Prof. Dinesh Dekate; 2013.
[5] "Static Structural Analysis of Rotary Weeding Blades using CAD Software." By Manjunatha, K., M. Anantachar, Vijayakumar Palled, Sushilendra, K.V. Prakash, Sunil Shirwal; 2014.
[6] "Design Data Book", PSG College Of Technology, Coimbatore; KalaikathirAchchagam, Coimbatore; 2012.
[7] "Design of Machine Elements", V. B. Bhandari; McGraw Hill Education (India) Private Limited; Third Edition, 2013.

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