Design And Fabrication of Multipurpose Agricultural Machine

Mr. Vijee Kumar[1], Mr. M Arvind[2], Mr. Amith S Valke[3], Mr. Gokul G[4], Mr. B Mahantesha[5]
[1, 2, 3, 4, 5] Dept of Mechanical Engineering
[1, 2, 3, 4, 5] REVA University.

Abstract- *Agriculture is the backbone of India. It constitutes about 14% of our national GDP. It employs around 50% of our overall workforce. Over the years, we have seen vast improvement in agricultural practices. The green revolution after the independence helped boost this sector. The usage of technology has helped in improving production. The usage of technology however is helping only the large scale farmers. Most of the technology available in market, we believe is consciously made to cater only large land areas. In India, the average land area owned by a farmer is only 2 acres. This has brought a major gap between small scale and large scale land owners. We as students notice this area of improvement and have come up with a design to help the small scale land owners. This design includes a tiller, sowing unit, soil closing and a water dripper. This multipurpose machine would help in completing all these process at once. Thereby reducing the cost of hiring a tractor for each process and the human labour associated with it.*

Keywords- Agriculture, Multipurpose, Sowing, Soil closing, Tiller, Water spraying.

I. INTRODUCTION

Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. "A man without food for three days will quarrel, for a week will fight and for a month or so will die". Agriculture is the science and art of farming including cultivating the soil, producing crops and raising livestock. It is the most important enterprise in the world. Historically in India, we can see the agricultural practices have been carried out by small land holders cultivating between 2 to 3 hectare, using human labour and traditional tools such as wooden plough, yoke, leveller, harrow, mallet, spade, big sickle etc. These tools are used in land preparation, for sowing of seeds, weeding and harvesting.

Due to the green revolution after the independence of our country, in recent years we can see improvements in usage of modern equipments and machinery for agricultural practices. But we can also notice that these agricultural techniques and equipments are not easily available for small land holders because these equipments are too expensive and difficult to acquire. By adopting scientific farming methods, we can get maximum yield and good quality crops which can save a farmer from going bankrupt but majority of small scale farmers spend too much in this process of utilizing the modern equipment.

Sustainable improvement in the livelihoods of poor farmers in developing countries depends largely on the adoption of improved resource conserving cropping systems. While most of the necessary components already exist, information on the availability and performance of equipment is lacking and effective communication between farmers and agricultural research and development department is unsuccessful.

II. LITERATURE REVIEW

D.A. Mada et al.;[2013][1] "The economic situation at agricultural industry has been change rapidly in Adamana state from 1999-2013, the population in farming areas decreased sharply and the labour demand increased. The farm size reduced and the farm rural wage had increased. These were the driving forces of mechanization in the agricultural industry. To sustain the income of small scale farmers and welfare of rural farming communities, the manual power in Adamana state was gradually replaced by single axle multipurpose machines from land preparation until post harvest stages. There should be plans for joint utilization system of agricultural machinery, to improve quality and production of the agricultural produce".

Narendra patel et al.; [2017] [2] "Nowadays population of India is increasing day by day. So, meeting its own food demand is a major problem. But the increase in agricultural produce is halted due to the cost of the usage of these modern machinery, especially for small scale farmers. So, it requires to make a new machine which does the major three operations in an agricultural field like ploughing, seeding, levelling. By using these three equipments in one single unit, cost is reduced. As a result, small scale as well as medium scale farmers are benefitted to a large extent".

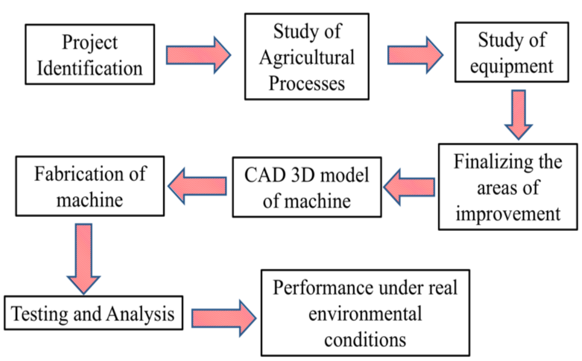
Amol B Rohokale et al.; [2014] [3] "For the growth of Indian economy, mechanization is necessary. The main purpose of mechanization in agriculture is to improve the overall productivity and production. Planting is historically done manually which involves both humans and animals. This results in a higher cost and higher time duration of cultivation. The main purpose of this paper is to compare between conventional sowing method and the newly proposed machinery which can perform a number of operation simultaneously".

Shree Harsha B T el at.; [2017] "The design, development and fabrication of the vehicle which can dig the soil, sow the seeds, leveller to close the soil and pump to spray water. This whole system of the vehicle works with the battery and solar power. The advantage of these vehicle is that its hands free and have fast input operations. This vehicle is more efficient for small farmers than the traditional large tractors".

III. OBJECTIVES

1. To concise the functions like ploughing, sowing and water spraying into a single machine.
2. To improve the affordability for the farmers.
3. To minimize labour in various stages of cultivation.
4. To minimize the overall work time.
5. To make the technology available to all the farmers.

IV. METHODOLOGY



V. DESIGN CALCULATION

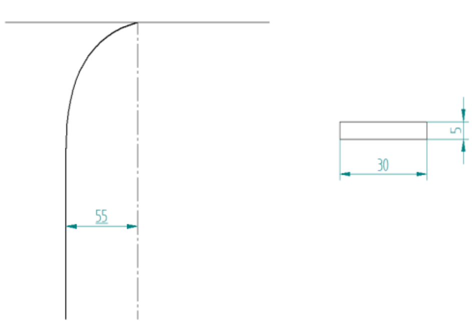


Fig 5.1 Cross section of the tiller blade

a = 5mm b = 30mm c = 55mm
Mass of each blade = 800gm = 0.8kg

W.K.T. Velocity = $\frac{distance}{time}$

Vehicle average speed = 5kmph

□ velocity = $\frac{5\times(\frac{5}{18})}{1}$ = 1.38m/s

W.K.T, if a body is moving in a straight line, the linear velocity and acceleration are same.

Velocity equation is given by,

$$V = U_0 + at$$

Where, U_0 = initial velocity
t = time
a = acceleration

$V = U_0 + at$
$1.38 = 0 + a\,(1)$
$\therefore\ a = 1.38 m/s^2$

From Newton's II law of motion,

$F = m \times a$
$F = 0.8 \times 1.38$
$F = 1.104N$

Therefore, force acting on one blade is 1.104N.

Hence, force acting on 4 blades is given by,

$4\times F = 4 \times 1.104 = 4.416N$

Torque developed at the blade,

$T = F \times r$
$T = 1.104 \times 55$
$T = 60.72$ N-mm

Power required to till the surface,
For one blade,

$P = \frac{2\pi NT}{60} = \frac{2\times\pi\times1.38\times60.72}{60}$
P= 8.774 W

For 4 blades,

Power = 4× 8.774

Power = 35.099 W $\cong$ 36 W

Inner radius of curved beam, r = 55mm
Outer radius of curved beam, $r_0 = r_i + 30$
= 55 +30 = 85mm

Radius of centroidal axis, $r_c = 55 + \frac{30}{2} = 70$mm
Radius of neutral axis, $r_n = \frac{h}{\ln\frac{r0}{ri}} = \frac{30}{\ln\frac{85}{55}} = 68.915$mm
Distance of neutral axis to centroidal axis, $e = r_c - r_n = 70 - 68.915 = 1.085$mm

Distance of neutral axis to inner radius, $C_i = r_n - r_i = 68.915 - 55 = 13.915$mm

Distance of neutral axis to outer radius, $C_0 = r_0 - r_n = 85 - 68.915 = 16.085$mm

$l = 18 + r_c = 88$mm
$M_b = F \times l = 1.104 \times 88 = 97.152$N/mm^2

Stress at inner fibre, $\sigma_i = \frac{F}{A} + \frac{Mb\ Ci}{AeRi} = \frac{1.104}{(5\times30)} + \frac{97.152\times13.918}{(5\times30)(1.085)(55)}$
= 0.1583 N/mm^2 (Tensile)
Stress at outer fibre, $\sigma_0 = \frac{F}{A} - \frac{Mb\ Co}{AeRo} = \frac{1.104}{(5\times30)} - \frac{97.152\times16.085}{150\times1.085\times\times85}$ =
- 0.1056N/mm^2(Compressive)

Maximum Shear Stress, $\iota_{max} = \sigma_0 = 0.5 \times 0.1583 = 0.07919$ N/mm^2

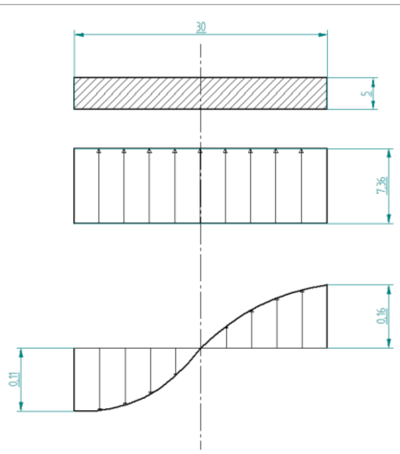


Fig 5.2 SFD and BMD diagrams for the tiller blades.

Total length of blade = 40cm = 400mm

For one blade,

Bending Moment, $M_b = F \times l = 1.104 \times 400 = 441.6$ N-mm

Stress acting per blade, $\sigma = \frac{F}{A} = \frac{1.104}{(5\times30)}$
= 7.36×10^{-3} N/mm^2

Bending stress $\sigma_b = \frac{Mb}{I} \times c = \frac{441.6}{312.5} \times 2.5$
= 3.532 N/mm^2

Moment of Inertia, $I = bd^3 \div 12 = \frac{30(5)3}{12}$
= 312.5 mm^4

Shear Stress, $\iota = 0.5\sigma = 0.5\times 7.36\times10^{-3}$
= 3.68×10^{-3} N/mm^2

Maximum deflection for cantilever beam is given by,
$y_{max} = \frac{Wl^4}{8EI} = \frac{1.104\times9.81\times(400^4)}{8\times(2\times10^3)\times312.5} = 554.508$ mm

ENGINE SPECIFICATIONS

- Name - TVS XL heavy duty.
- Engine Description - 2 Stroke, single cylinder.
- Displacement - 69.9CC
- Max Power - 3.5 BHP @5000rpm
- Max Torque- 5NM @3750rpm
- Ignition - Electronic ignition.
- Bore - 46mm
- Stroke - 42mm
- Fuel Type **–** petrol

VI. CAD MODEL

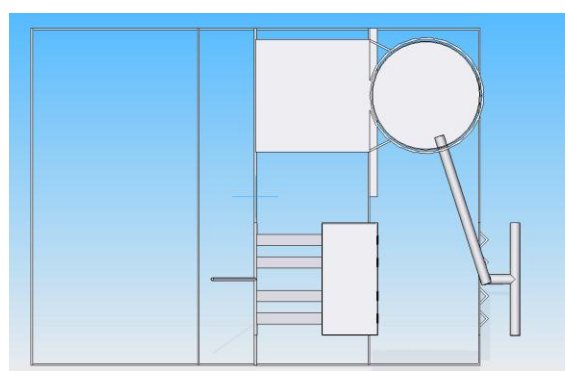


Fig 6.1 Top view of the model

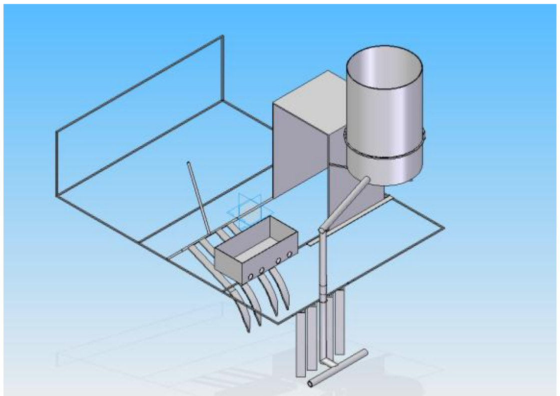


Fig 6.2 Isometric view of the model

VII. RESULTS AND OUTCOME

1. Decreasing the time and money of a farmer which is wasted by using different equipments for the each operation.
2. The machine is easily usable and does not require skilled labour.
3. The area of cultivation is increased.
4. The number of crop cycles is increased.
5. Availability of technology to rural areas in achieved.

VIII. CONCLUSION

This multipurpose farming machine has considerable potential to greatly increase the productivity of crops. It incorporates multiple operations into the time required for a single operation. Less man power needed to operate this machine. One driver is sufficient for its operation.

The overall cost of production is therefore considerably reduced. Design and fabrication of the vehicle has been done at an affordable price. This helps in easy access for small scale farmers. The multipurpose farming machine can be readily made from local components in workshops. This helps in easy production of the vehicle without any need for modern manufacturing techniques or machinery.

This machine is hence more beneficial to a small farmer who cannot afford farming equipments at higher costs. For more quantitative purpose this equipment can be made with a better design to handle the additional loads and an engine of more capacity can used to cater the loads.

IX. FUTURE SCOPE

1. The number of rows/ lines of tilling and seed sowing can be increased.
2. Water dripper can be enhanced to add a fertilizer unit to cater certain varieties of crops.
3. The engine used can be changed. A biogas adaptable engine can be used to help better utilization in rural areas.
4. Number of operations can be increased in the vehicle.
5. A weed cutter can be added to the front of the vehicle.
6. Gear arrangement can be added to the power transmission unit to improve torque or speed according to the requirement.

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