

Design Analysis and Fabrication of Manual Rice Transplanter

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ABSTRACT: Agriculture is most important sector of the Indian economy. It is most important source of employment for the majority of the work force in the country. Rice is primary and major crop cultivated in India. As the large workforce is engaged in this sector, Traditional method is costly, time consuming and labour intensive work. To make the transplanter system several attempt has been made to design and fabricate this machine. This study is focused on design analysis and fabrication of a manually operated rice transplanter for small scale Indian rice cultivators. By achieving the goals like simplifying the mechanism, reduce cost and reduced weight of present rice transplanter. The availability and use of manual rice transplanter in Western Maharashtra is very rare, so design of this project is useful to farmers.

KEYWORDS: Transplanter, synthesis, mechanism, CAD model, Fabrication.

I. INTRODUCTION

A rice transplanter is a specialized machine fitted with a transplanter mechanism (usually having some form of reciprocating motion) driven by the power from the live axle, in order to the transplant rice seedlings onto paddy field. Rice is a major food grain crop of world. Unlike upland row crops, cultivation of low land rice crop is a labour intensive process. In spite of the common belief of availability of surplus agricultural labour in India, there actually exists a scarcity of skilled agricultural workers during the peak transplanting seasons. If this operation is not done in time the yield goes down. In view of this, there is an urgent need to mechanize this operation. The rice translation process is generally manual which involves number of labour. The process of manual rice transplantation is not so efficient as compared to the mechanical rice transplantation. Machine transplanting using rice transplanter requires considerably less time and labour than manual transplanting. It increases the approximate area that a person can plant. The distribution of food grain production which shows the rice production is major in India Mechanism is needed to raise productivity in rain fed upland and rain fed lowland and to increase cropping intensity in irrigated farms. Seed drills give better plant population, reduce cost and give higher yields of rice. Use of pre-germinated paddy seeders in puddled wetland condition give similar yield like manual transplanting but reduce labour requirement by 75-80%. The manual and self-propelled transplanter reduces cost of transplanting by 45-50%.

II. LITERATURE SURVEY

For initializing this project, we searched different types of information regarding of transplanting field with literature review of different research paper. Our literature review is divided into different field of analysis like Ergo-Economical analysis of different paddy transplanting operation, performance of self-propelled rice transplanter and its effect on crop yield, theoretical development of rice transplanting machine. This studies were conducted which gives the parameters, specification, problems arising in already exists transplanter and development & design methodology of transplanter. The unavailability of the rice transplanter in western Maharashtra zone gave the reason to find proper research in this zone and designing transplanter. The unawareness of use of this transplanter in the farmers which leads

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to makes the handy use. The research and literature on the design analysis of hand cranked and self-propelled with the cam-follower mechanism.

III. CONSTRUCTION AND WORKING

1) Ground Wheel: - It is wheel which is contact on ground. It mounted on driver shaft. Its motion gives to the Four Bar Linkage through the chain drive. On the periphery of this wheel, blade is mounted to achieve proper grip in mud.

2) Sprockets: - The main function of sprockets is to transmit torque through chain. There are two sprocket-one drivers and other driven mounted on respective shafts.

3) Chain: - The function of chain is to transmit torque from driver to driven sprockets. The chain is simplex type

4) Four Bar Linkage: - In this four bar linkage one link is fixed and other three linkages are in motion. The links are connecting rod, lever, crank and planting finger or fork. It is mounted on the driven shaft.

5) Tray: - This is used to store the rice plant from where the planting finger pick the plant and saw in the ground. This tray has two vertical guide slots.

6) Planting Finger: - The planting finger is the main element which is responsible for the plantation of the nursery seed. It has the specific shape which picks the nursery seed and plant in mud. It oscillates at certain angle and it is called as fixed fork mechanism.

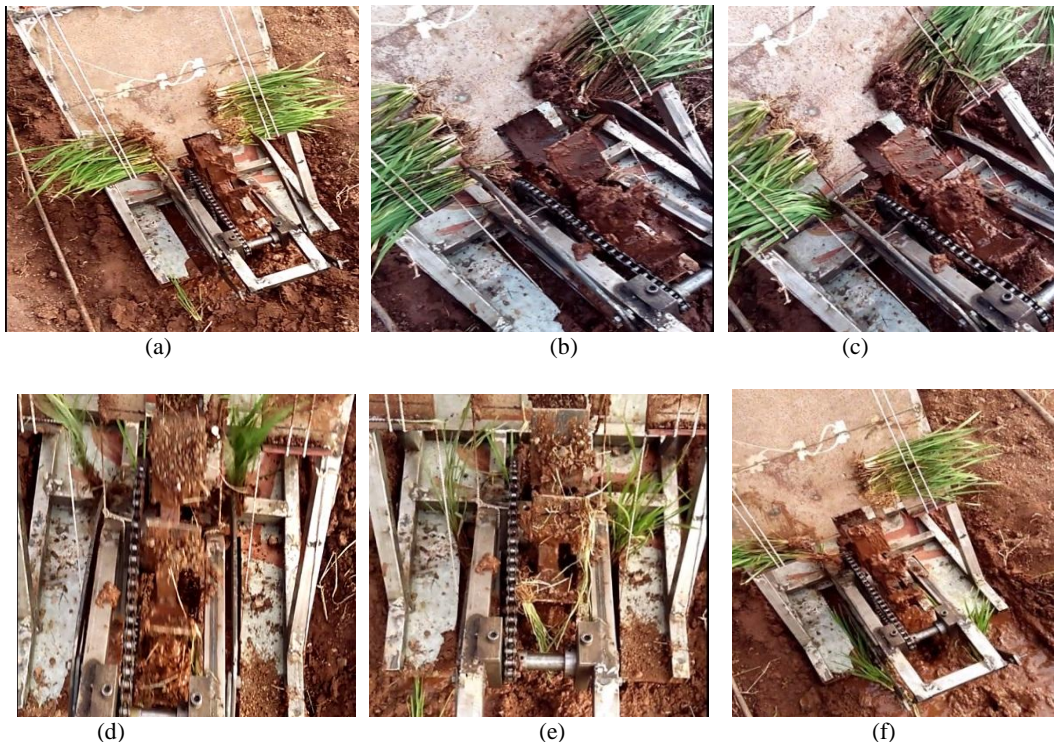


fig (a) initial position, fig (b) picking the plant, fig (c) start to lower down,fig (d) process of lower down, fig (e) start to digging plant, fig (f) finishing of digging of plant.

Working: -

As the process is manual the worker has to provide the initial motion. When the rice transplanter will move forward the ground wheels will get rotate. The wheels are provided with the fins so that they can travel easily in the mud. The ground wheels are used to maintain constant distance between the two successive plants. Then we have larger sprocket is provided on the same shaft with the ground wheels and hence at the same time sprocket will also rotate. The larger

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sprocket is in engagement with the smaller sprocket by using the chain drive. As the power will get transmitted to the smaller sprocket, it will rotate. The speed is increased from driver to driven shaft as we used 3:1 speed ratio. On the same shaft planting finger will be fixed through the four bar linkage so that it will oscillate for certain angle. As the drive is provided by the worker it will not have high speed and hence through this sprocket arrangement we have increase the planting finger speed. As the planting finger will oscillate, it will pick the rice plant from the tray and plant in mud. The planting finger is designed in such a way that rice plant should be easy to pick during the motion and also it should pick during the downward motion only.

IV. RELATED WORK

Design Calculations:-

- A. Diameter Of Ground Wheel:- Circumference = $\pi \times D$ where D= Diameter of wheel
- B. Calculation Of Speed Of Driving Sprocket
 - a) Angular Velocity Of Wheel = $\frac{V_{avg}}{r}$ and b) $N_1 = \frac{\omega_1 \times 60}{2\pi}$
- C. Calculation Of Driven Sprocket Speed:- $\frac{N_2}{N_1} = \text{constant}$ where N1 and N2 are speed of driver and driven sprocket
- D. Sprocket Velocity Ratio:- S. R. = $\frac{N_2}{N_1} = \frac{Z_1}{Z_2} = \text{constant}$ where Z1 and Z2 are No. of teeth on driver and driven sprocket
- E. Selection Of Sprocket On Basis Of Speed Ratio:-
Sprocket No. 25 from Catalogue (Plain Bore)&Simple Type B (One Sided Hub)

Driver and driven sprocket parameter:-

No. of teeth, outside diameter, Pitch diameter, Maximum Bore, Hub diameter, Length through bore (LTB)

- F. Chain Selection parameter:-
Size, Pitch, inside width, Roller diameter, Roller width
- G. Centre Distance (a):- $a = 40p$ where p= pitch of chain
Chain links, $L_n = 2(a/p) + (Z_1 + Z_2/2) + (Z_2 - Z_1/2\pi)^2 \times (p/a)$

$$\text{Correct Centre distance: } - a = p/4 \{ [L_n - (Z_1 + Z_2/2)] + \sqrt{[L_n - \left(\frac{Z_1 + Z_2}{2}\right)^2 - \left(\frac{Z_2 - Z_1}{2\pi}\right)^2]} \}$$

$$\text{Linear velocity of Chain: } - V = \frac{Z_1 \times p \times n_1}{60 \times 10^3}$$

- H. Power transmitted by chain
On the basis of breaking load
 $P = \frac{W_b \times V}{n \times K_s}$ Where, W_b = Breaking load in Newtons
 V = velocity of chain in m/s
 n = factor of safety
 K_s = service factor

$$\text{Factor of safety} = n = \frac{W_b}{W}$$

K_1 = Load factor, K_2 = Lubrication factor, K_3 = Rating factor

Service factor K_s

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$$= K_1 \times K_2 \times K_3$$

I. Tension in chain: $T = \frac{1000 \times KW}{v}$

J. Shaft Design: - The shaft design is based on the load consideration on shaft with the help of shear force diagram and bending moment diagram. The diameter for shaft is then calculated from power transferred as

$$P = \frac{2\pi N M t}{60000}$$

K. Material for Sprocket:-

For power transmission shaft material 40C8 is selected.

$$\tau_{max} = 0.30 S_{yt} \& 0.18 S_{ut} \text{ (Take lowest value), } \tau_{max} = \frac{16}{\pi \times d^3} \times \sqrt{(K_b M_b)^2 + (K_t M_t)^2}$$

L. Bearing Design:-

$$P = X V F_r + Y F_a \text{ Dynamic Load} = C = P(L_{10})^{1/p}$$

$$= P(L_{10})^{1/3}$$

Select Life in hour from catalogue: $L_{10} = \frac{60 \times n \times L_{10h}}{1000000}$

M. Synthesis of Four Bar Mechanism:-

According to **Grashof's Law** for bar mechanism, the sum of shortest and longest link lengths should not be greater than the sum of the remaining links if there is continuous relative motion between the two links.

Crank – AB, Fixed Linkage – BC, Lever – CD, Connecting rod – DC

$$AB + CD \leq BC + DC$$

Hence, this satisfies this law.

Computerised implementation:-

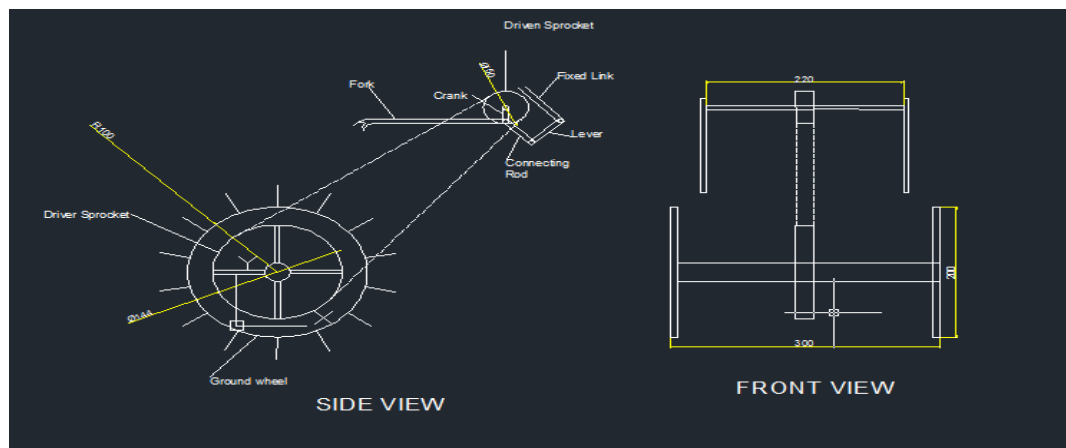


Fig 7 CAD Model of Rice Transplanter mechanism

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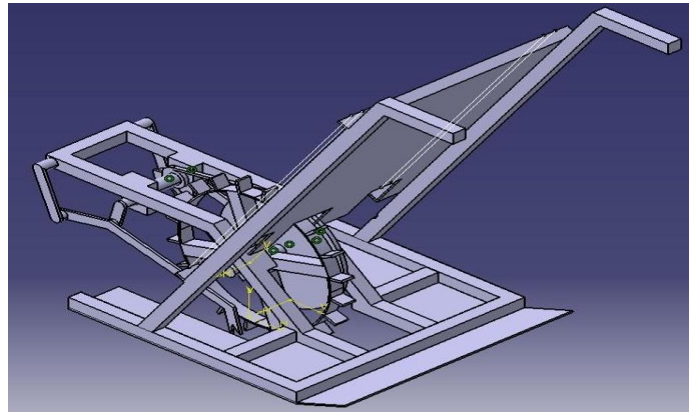


Fig 8 Isometric View of CAD Model

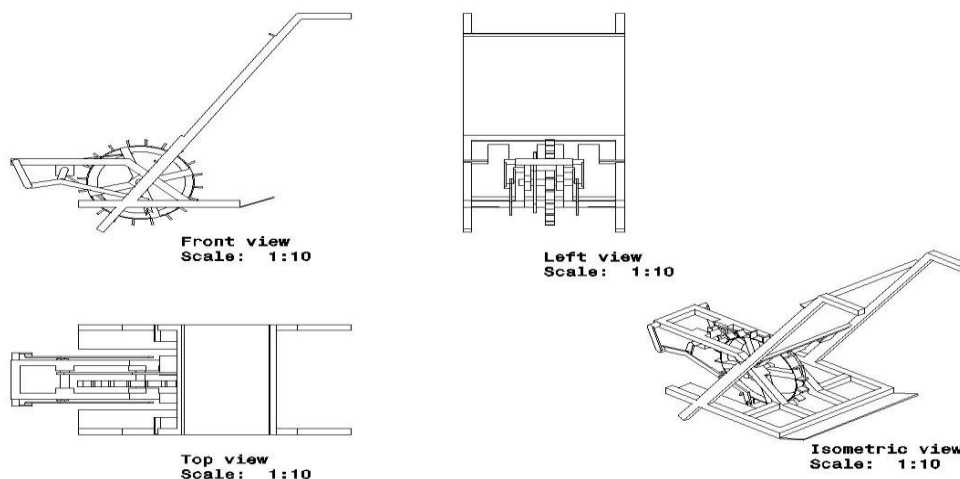


Fig 9 Drafting View of Model

V. EXPERIMENTAL RESULTS AND DISCUSSION

The design of rice transplanter is easy as the basic machine design knowledge is applied to design the parts like shafts, bearings, wheels, chain and sprocket assembly and synthesis of four bar mechanism which uses the standards formulas. The cost of the transplanter is low as possible because use available and local material which leads to lower downs the price in case of mass production. The mechanism used is four bar mechanism in place of cam-follower and rocker-arm mechanism. The availability and use of transplanter in western Maharashtra makes us to fabricate the transplanter with minimum cost used by small scale farmers.

Parameters	value	Unit
Angular velocity of driving sprocket	2.778	Rad/s
Speed of driving sprocket	27	Rpm
Speed of driven sprocket	126	Rpm
Circumference of wheel	942.4	mm
Sprocket velocity ratio	4.7	-
No. of teeth on driving sprocket	44	-

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No. of teeth on driven sprocket	10	-
Distance between two sapling	200	mm
Length of chain	88	Links
Power transmitted by chain (approx.)	0.1	Kw
Linear velocity of chain	0.04238	m/s
Driving shaft diameter	20	mm
Driven shaft diameter	20	mm
No. of sapling plants	2	-

Trial run of transplanter is conducted and from this it is seen the time taken for transplanting per square meter of paddy field is 56 seconds.

No. of sapling is transplanter per square meter is 135.

VI. CONCLUSION

The rice transplanter which we designed working is found to be satisfactory. The cost is cheap than motor and hand cranked mechanical rice transplanter. The four bar mechanism gives the each operating and maintenance with less parts which reduces the weight. After further improvement, this two row paddy transplanter can be transplanter 0.2 to 0.3 hectare/day while manual hand operated gives 0.1 to 0.1.5 hectare/day by considering 8 hours per day of working. The total cost which include material and fabrication cost is Rs. 6000 and easy to operate. This will reduce to Rs. 5000 with mass production.

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