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Design and Fabrication of Rice Planting Machine by Using Four Bar Link Mechanism

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ABSTRACT

India is an agrarian country. About 70% of Indians are dependent on agriculture for their livelihood. India is one of the world's largest producers of rice, accounting for 20% of all world rice production. Rice is usually grown by planting rice paddy in the fields manually with hands. With this method of planting rice paddy, labour cost increases and it is a very time consuming process. These problems can be solved with the help of rice planting machine. This machine reduces labor cost and time to plant rice paddy. This machine has a simple mechanism and it is eco-friendly. This machine requires only one person for its operation. This machine can bring revolution in rice production. So, the main aim of this to design and develop a rice planting machine which will help the farmers to make the whole rice planting process mechanical resulting in reduction of labor, cost and time to a large extend.

Keywords: Agriculture Efficient Machine, Rice Planting Machine, Green Revolution, Paddy Mechanization

I. INTRODUCTION

Mechanical transplanting of paddy seedlings is a solution to the prevailing situation in the India to release the work force and to reduce the cost of paddy production. Farmers are aware of the advantages associated with transplanting of paddy over the broadcasting. But they are unable to practice it for high scarcity of labour. Still the transplanting machines available for the country are imported. Engine driven transplanters are high in cost and the inter-raw, intra-raw spacing are fixed which are not suitable for the Indian condition. Existing manually operated transplaners are inefficient. The main reason for the poor acceptance was the low capacity of the machine. A simple engine operated transplanter or manually operated transplanter having an average capacity of one hectare per day would be a better solution. . Rice is mainly produced and consumed in the Asian region. India has the largest area under paddy in the world and ranks second in the production after China. Rice grown in India belongs to the indica. Rice occupies 23.3 per cent of gross cropped area of the country.

The objectives of the study are,

- To develop a two row paddy transplanter.
- To test field performance of the two row paddy transplanter.

II. METHOD AND MATERIAL

The main components of rice planting machine are base wheels, chain drive, gear pair, mechanical arm and paddy support plate.

BASE WHEELS: Wheels are basic yet important part of the whole rice planting mechanism. The power is generated from wheels. As the wheel rotates the power will be transmitted to mechanical arms. The wheels are given guide rods so that wheel can move easily in wet lands. The guide rods are placed such that the holes made by it are actually the place where the paddy seedlings are planted by the mechanical arms.

CHAIN DRIVE: It is used to transmit the power produced by base wheels to the mechanical arms as a result of which it oscillates.

GEAR PAIR: It is used to reverse the rotational direction from anticlockwise to clockwise direction.
MECHANICAL ARM: The mechanical arms are placed parallel to the wheels. The work of the mechanical arms is to grasp the paddy seedlings from the paddy support plate and plant it in the field. The reason to place the mechanical arms parallel to the wheels is that the mechanical arms plant the paddy seedlings in the holes made by the guide rods of the wheel.

PADDY SUPPORT PLATE: The paddy support plate is used to place the paddy seedlings. The main objective of it is to place seedlings such that the seedlings do not fall off while plantation process and the mechanical arms can grasp it easily and the seedlings are not damaged.

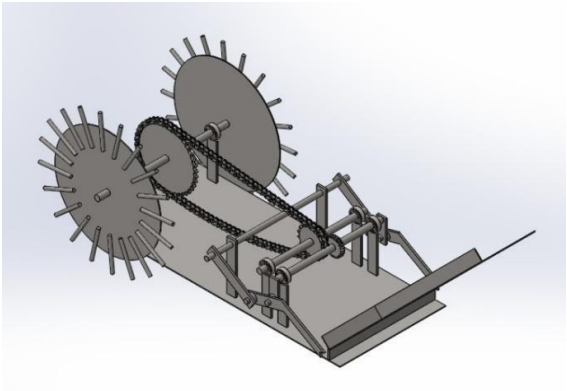

Figure 1. Isometric View of Rice Planting Machine

III. WORKING

In the present experimental set up when the machine is pushed from paddy support plate in the field for operating it, the base wheels rotate in anticlockwise direction. This produces power which is transmitted towards mechanical arms with the help of chain drive. Here, gear pair plays a vital role as it changes the rotational direction from anti-clockwise to clockwise direction. The mechanical arms start oscillating on its axis. While oscillating it grabs the paddy seedlings from paddy support plate and plants it in the field. So, finally rice planting of rice seedlings can be performed

Figure 2. Rice Planting Machine

IV. CALCULATION

Number of teeth of sprocket 1 = 44
Number of teeth of sprocket 2 = 18
Distance between two paddy seedlings in the same column = 300mm Ratio of sprockets = 44/18 = 2.44
NUMBER OF GUIDE ROD:
Now,When sprocket2 rotates360°the rotation of sprocket1 is upto 162°. Because of sprocket ratio =2.44

Table 1

Number of cycles	Displacement of Sprocket 1 (Degree)	Displacement of Sprocket 2 (Degree)
Initial Position	0°	0°
1	148°	360°
2	296°	2(360)=720°
3	442°	3(360)=1080°

4	590°	4(360)=1440°
5	738°	5(360)=1800°
6	886°	6(360)=2160°
7	1032°	7(360)=2520°
8	1180°	8(360)=2880°
9	1328°	9(360)=3240°
10	1476°	10(360)=3600°

A. CALCULATION OF CHAIN LENGTH

Length of chain: $L = L_P * P_d$

Where L_p = The length of continuous chain in multiples of pitches P_d =Pitch diameter

Now to find pitch diameter P_d:

$$a = (30\text{-}50)P_d$$

Where a is the center distance and assume it as 55cm

$$55 = 50P_d$$

$$P_d = 1.1$$

Now to find length L_P:

$$L_P = 2a_p + (z_1 + z_2)/2 + (((z_1\text{-}z_2)/(2*3.14)^2*a_p)$$

Where a_p is the approx. center distance in the multiples of pitches

$$a_p = a/p_d$$

$$= 60/1.1 \quad a_p = 54.54 \text{ cm}$$

Hence,

$$L_p = 2(50)+(44+18/2) + (((44\text{-}18)/(2*3.14)^2*50)$$

$$L_p = 131.08 \text{ cm}$$

Length of chain : $L = L_P * P_d$

$$= 131.08 * 1.2 = 144.19 \text{cm}$$

B.CALCULATION FOR BASE WHEEL

Now, The Highest common factor (H.C.F) of all the above mentioned displacement is 20°.

Therefore,

Number of Guide Rods = Displacement of Sprocket 2 /(H.C.F)

$$= 360°/20 = 18$$

The above calculation shows the reason regarding the number of guide rods on the base wheel.

Number of Guide Rods = 18

Diameter of Wheel: Number of guide rods = 18

Therefore,

= Number of guide rods/ sprocket ratio

= 18/2.44 = 7.38=8

i.e. after every 8th hole a paddy seedling will be transplanted.

Distance between two paddy seedlings in the same column = 350mm ,Therefore =350/(8-1) =50mm

Now, by cross multiplication method, 18° = 50mm

360° = ? , (360*50)/20 = 900

Therefore, Circumference of wheel = 900mm

Diameter of wheel = 900/3.14 = 286.62mm

Hence,

The diameter of wheel is taken approximately 288mm.

C .DIMENSION OF TRAY

Tray is used to keep the paddy seedling on the transplanter.

Tray is to carry the seed mat and to direct the plants to planting arm.

Dimension of tray :

Length of sheet metal =35cm

Breadth of sheet metal =17.5cm

Thickness of sheet metal =0.1cm

D.DIMENSION OF SHAFT

Shaft is a revolving rod that transmits motion or power

Here, The one shaft contain fork and another shaft contain four bar linkage and power is given taken by manually and one shaft contain base wheel for movement of the machine.

Shaft dimension : Length of the shaft =35cm(it is space required between the paddy seedlings)

Diameter of shaft =2cm(it is optimum diameter for 30cm shaft)

E.DIMENSION OF FOUR BAR

A four bar linkage mechanism was used to get the required measurements.The trajectory of the planting unit depends on

: [1] Point P [2] Length L1, L2, L3 and L4 [3] Delta

L1 = 150mm, L2 = 60mm, L3 = 50mm, L4 = 160mm, Delta = 101

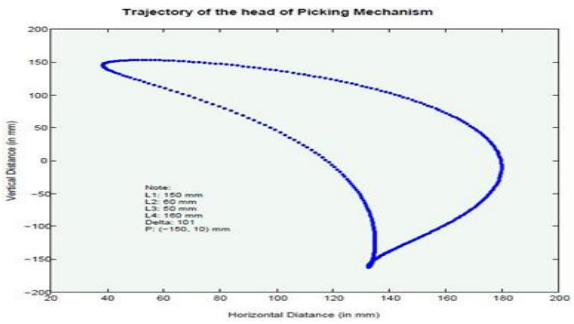

Figure 3. *Optimized length and angle of the Mechanism*

V. RESULTS AND DISCUSSION

Prototype mechanism was evaluated in the field and it worked. There were some points to be redesigned. As the tension is high in the chain, the nylon sprocket gets damaged easily. The sprocket and chain used for the machine were of foot cycle. When machine is operated the sprockets got damaged as bending of teeth takes place. So it is better to use motorcycle chains and sprockets for power transmission.

In this machine, ground wheel supplies the power to operate transplanting arm. Pulling the machine will rotate the ground wheel. Increasing the size and number of guide rods around ground wheels will increase contact area of the ground wheel with the field and make it easy to operate.

The machine has to be pulled for operating it. Ergonomically it is better to push weight rather than to pull. So it is better to turn the handle and the power supplying mechanism to push the machine instead of pulling it.

The machine is used to plant two rows simultaneously. Number of plants per one hill can be increased while altering the tray moving distance and adding engine to power the operation.

Theoretically, when rice planting machine is pushed for 3000mm distance, the number of paddy seedlings transplanted is 10 in one column. So, totally 20 seedlings get transplanted.

Figure 4. Transplantation of Paddy Seedling

Practically, when rice planting machine was brought into action and pushed upto 3000mm, the total number of seedlings transplanted were 20. The time taken for this was 17 seconds. Total number of paddy seedlings transplanted in one hour is 4200.In one hectare area (Square Farm), approx. 330 columns and approx. 330 rows of paddy seedlings can be transplanted. So, total number of paddy seedlings transplanted in one hectare is approx. 1,10,000. The total time required in transplanting is 26.4 to 27 hours.

The dapog mat was compacted due to high tray angle. Tray angle should be reduced to avoid the problem. Suitable dapog for the machine must have a mud layer 1cm or less thick. Increased thickness of the mud layer increases the power requirement to the planting arm.

Diameter of the ground wheel axle should be increased to have better power supply and stability of the machine. Axle of the sprocket wheel must be constructed using iron to reduce the friction.

VI. CONCLUSIONS AND RECOMMENDATIONS

The rice planting machine has been designed and fabricated satisfactorily. Finally, we can say that it is a user friendly and efficient machine with low production cost. But, there is always a room for improvement. So, the improvements can be done before introducing it to the farmers. The machine is driven by man power but engine can be coupled to enhance the performance. Machine can be developed to transplant several rows simultaneously. The dapog must have thin mud layer for easy removal of seedlings.

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