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Design and Development of Rice Planting Machine

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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 labour 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 labour, cost and time to a large extend.

Keywords— Agriculture Efficient Machine, Rice Planting Machine, Green Revolution, Paddy mechanization

I. INTRODUCTION

India is known to be an agricultural country (Krushipradhan Desh). About 70% of the population of India is dependent on farming directly or indirectly. The farmers are using the same methods and equipment since ages. The time is changing and things need to change as well in order to develop the methods and equipment. So, that productivity increases. Agriculture also plays a vital role in the Indian economy. Its contribution in the GDP is now reached one sixth of the total. The Government of India has also started taking steps in the form many initiatives in which the farmers are made aware about the technologies they can use in farming. There are basically five steps that a farmer needs to do properly to get increased productivity. These five steps namely are: [1] Ploughing [2] Seed Sowing [3] Irrigation Process [4] Harvesting [5] Threshing

As we know that the rice is one of the staple foods of the India. A large scale of farmers is involved in the cultivating and production of rice. Introducing the technology to the rice farming will result in many advantages such as: • Better production • Good quality • Less labour required • Saves time • Low cost

Today, India is facing a big problem of child labour along with the farming. The highlighted point is that child labour and farming are interrelated to a great extent. If the technology in farming increases, the requirement of labour will decrease. This will help the nation to get rid of two major problems. The highest number of labour required in rice planting is for transplanting i.e. seed sowing. Many new equipment are invented and modified in order to rescue the effort and get more result in this process. To plant the rice seedlings a rice transplanter is being developed and in many countries like china, japan, korea, etc it is already brought in use. But here in India the rice transplanter is not affordable to the farmers. The rice transplanter in foreign country is runned on diesel engine and the current situation of the Indian farmers is not well enough to buy the transplanters to use it. So, a manual rice transplanter is being developed in India so that the cost of transplanter decreases. In manual transplanting practice, 8-12 labourers are required to transplant one acre. However, if a self-propelled rice transplanter is used, three people can transplant up to four acres in a day.

II. RESEARCH PROBLEM

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.

III. DESIGN

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.

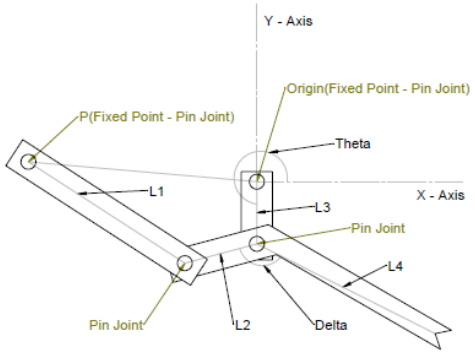

Fig. 1 Mechanical Arm

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.

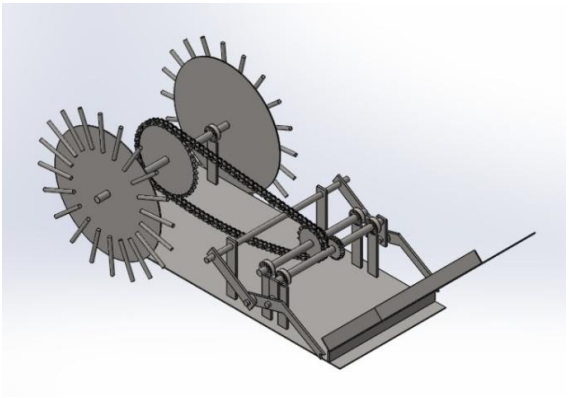

Fig. 2 Isometric View of Rice Planting Machine

IV. **CALCULATION**

Data:
Number of teeth of sprocket 1 = 40
Number of teeth of sprocket 2 = 18
Distance between two paddy seedlings in the same column = 300mm
Ratio of sprockets = 40/18 = 2.22
Number of Guide Rod:

Now,
When sprocket 2 rotates 360° the rotation of sprocket 1 is upto 162°.
Because of sprocket ratio = 2.22

TABLE I
DISPLACEMENT OF WHEEL IN DEGREE

Number of cycles	**Displacement of Sprocket 1 (Degree)**	**Displacement of Sprocket 2 (Degree)**
Initial Position	0°	0°
1	162°	360°
2	324°	2(360)=720°
3	360+126=486°	3(360)=1080°
4	360+288=648°	4(360)=1440°
5	2(360)+90=810°	5(360)=1800°
6	2(360)+252=972°	6(360)=2160°
7	3(360)+54=1134°	7(360)=2520°
8	3(360)+216=1296°	8(360)=2880°
9	4(360)+18=1458°	9(360)=3240°
10	4(360)+180=1620°	10(360)=3600°

Now,

The Highest common factor (H.C.F) of all the above mentioned displacement is 18°.

Therefore,

360°/18°=20

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

Number of Guide Rods = 20

Diameter of Wheel:

Number of guide rods = 20

Therefore, 20/2.22 = 9

i.e. after every 9th hole a paddy seedling will be transplanted.

Distance between two paddy seedlings in the same column = 300mm

Therefore, 300/(9-1) = 37.5mm

Now, by cross multiplication method,

18° = 37.5mm

360° = ?

(360*37.5)/18 = 750

Therefore, circumference of wheel = 750mm

Diameter of wheel = 750/3.14 = 238.85mm

Hence, the diameter of wheel is taken approximately 240mm.

Mechanical Arm[7]:

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

The trajectory is plotted in MATLAB with all the variations of the above discussed variables. The optimised plot was chosen for which the values are: P: (-150, 10) mm, L1 = 150mm, L2 = 60mm, L3 = 50mm, L4 = 160mm, Delta = 101°

The plot of the trajectory is shown below:

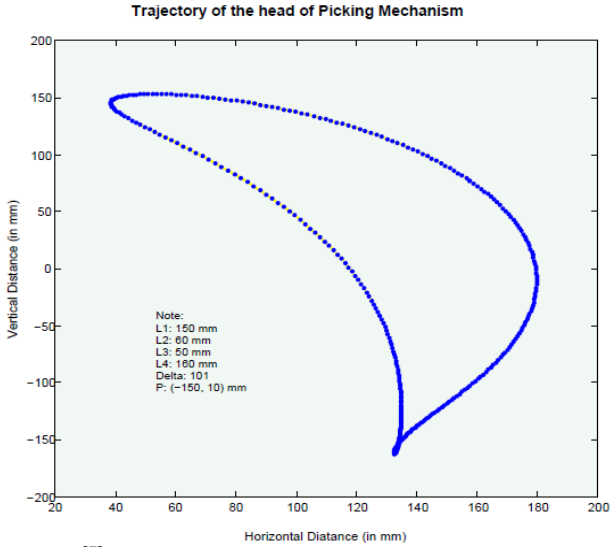

Fig. 3[7] Optimized length and angle of the Mechanism

V. **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.

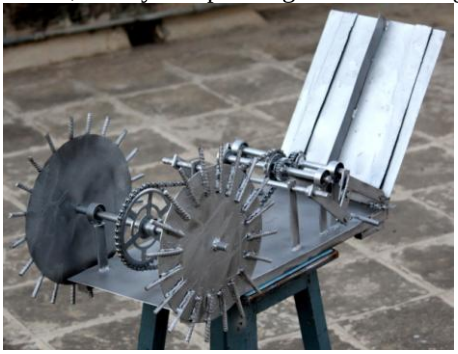

Fig. 4 Rice Planting Machine

VI. 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.

Fig. 5 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 and play.

VII. CONCLUSIONS AND RECOMMENDATIONS

The rice planting machine has been designed and fabricated satisfactorily. Finally we can say that it is an 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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