International Journal of Analytical, Experimental and Finite Element Analysis (IJAEFEA), Issue. 1, Vol. 3, March 2016.
e-ISSN: 2394-5141, p-ISSN: 2394-5133, pp 9-12

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Design and Fabrication of Paddy (Rice) Transplanting Machine

***Abstract*—Agriculture is the most important sector of the Indian economy. It is the most important source of employment for the majority of the work force in the country. A major population in India is engaged in agriculture. Among that highest percentage was in paddy sector. Rice is the major stable food of the country. Releasing of work force to sectors other than agriculture, it is important to develop the country. To release the work force in paddy sector mechanization plays a big role. To feed growing population is a huge challenge. Mechanization of paddy sector will lead to higher productivity with releasing of work force to other sectors. The objective of this project is to design a paddy transplanting mechanism to transplant paddy seedlings by small scale farmers in the country.**

***Index Terms*—**Paddy transplanter , planting of rice.

I. INTRODUCTION

Transplanting is one of the major process for establishment of paddy in India. In this method seed is sown in one place and seedlings after they have grown a little are transplanted to another. This is done in order to get higher yields and less weeding. Transplanting of rice is highly labour intensive and it may require 250-350 man-hours per hectares. Seedling are prepared in nurseries where they grow for 15-20 days. After these seedling are been prepared, these are been transplanted manually by labour. The orientation of thelabour at the time of transplanting is hazardous for their health. With manualtransplantation the cost of production of rice also increases. With the help of a Rice Transplanting Machine, the transplantation cost as well as time will decreases with increase in efficiency.

A. Difference between Engine and Manual Operated Transplanter

There are various paddy (rice) transplanters available in the world, which are generally operated by engine or other machines.

The engine operated paddy(rice) transplanters are very difficult to maintenance. Also the cost of its operation and maintenance is very high, due to use of fuels for engine operation. So for small land owner or poor farmers it is impossible to purchase such type of high costing engine transplanter. There are lot of mechanization used in engine rice transplanter which make it complicated to understand for the uneducated farmers. So the machine should be as simple as to understand and operate for user.

The manual paddy(rice) transplanter make this provision for the user, which eliminates above observed problems like cost, skilled operator, complicated mechanism, fuel for operation etc,.

B. Suitable Mechanical Transplanter For Indian Conditions

Transplanting is a labour intensive operation. Further high skill is necessary for this operation so as to achieve uniform number of seedlings per hill spacing between hill to hill and as well as between the rows. The time available between the harvest of one crop and transplanting of paddy is short. The maximum yield is again a function of date of transplanting. These factors emphasis the need for a suitable mechanical transplanter in India. The successful Japanese transplanters have some obvious limitations for introduction in India. These are expensive, composed of complex and precise mechanism that can not be repaired or serviced in the local workshops. In view of this a cheap, simple and effective indigenous transplanter is needed under Indian conditions. Out of all the mechanical transplanters a self-propelled type is considered to be more advantageous.

For the fingers, the fixed fork type is desirable in view of its inherent simplicity. The seedlings may be planted as mat type planting method or simple conventional method which is more suitable for Indian farmers. Therefore for the sake Indian farmers we use the method of simple conventional planting of seedlings.

II. RAW MATERIALS SELECTION

The selection of material is very issue for the making of any machine or mechanism. The selected material should fulfill the basic requirement of the design. There are lots of material, are available for the fabrication purpose like mild steel, stainless steel, cast iron, alluminium alloys, etc,. There are lot of considerations in selection of raw material process like cost, availability, their properties, etc,. Hence we selected the best suitable material for chassis, mechanism, and wheels is mild steel. For power transmission purpose, the material for shaft used is stainless steel. Also for float we use low weight and low density material. The sprocket should be of high strength

for transimitting the required power and good life. The components of machine are as follows:

1. Chassis
2. Mechanism
3. Wheel
4. Shaft
5. Power transmission assembly
6. Pulling handle
7. Tray
8. Float

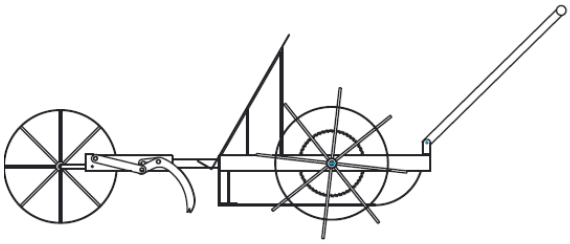

Figure 1: Paddy (Rice) Transplanting Machine

III. DESIGN PARAMETERS

Design parameters on the basis of the machine components are:

A. Chassis

As per the planting distance taken by farmer between two adjacent plant chassis dimensions are taken and also some care taken in design of chassis such as :

a) Planting distance
b) Surrounding planting condition
c) Load on chassis
d) Protection of transplanted plant being harm
e) Mounting of various components

Material: M.S. hallow rectangular bar. 50mm*25mm cross section as shown in fig.2 having density 7800Kg/m3.

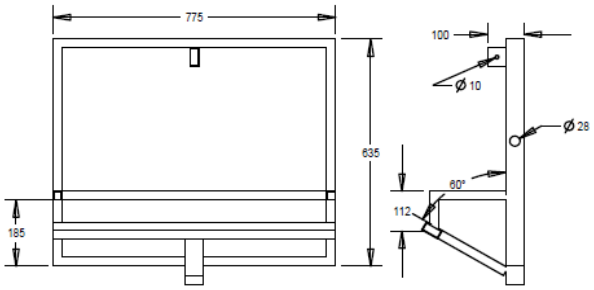

Figure 2: Chassis for transplanter

B. Wheel

Accordance with the working condition (muddy condition) wheel diameter is taken as 355 mm, for better grip in muddy surface some incline plates are provided on wheel surface.

Wheel diameter = 355 mm
Number of arms = 8
Number of extended arm = 8

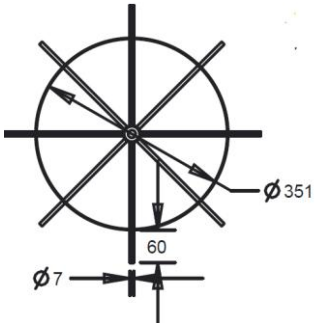

Figure 3: wheel

C. Shaft Design

Human capacity of pulling in muddy surface = 20 m/s
Number of plant per revolution of wheel = 5
Human power =0.25 Hp =186.5 watt
D_o = 20.24 mm = 20 mm, D_i =16 mm

D. Planting Mechanism

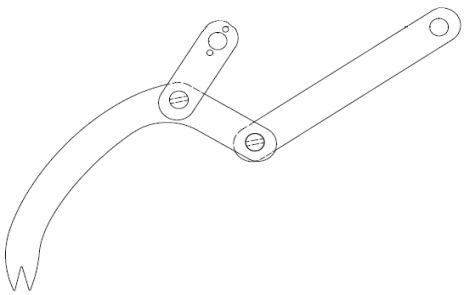

Figure 4: planting mechanism

The Rice Transplanting machine's most important mechanisms are for the planting unit, paddy seedling tray and Power transmission system and attachments. When designing the planting Mechanism following aspects were considered:

- Moving pathway
- Speed of travelling
- Plant catching mechanism
- Depth of planting

a) Plant Catching Mechanism

There are several parameters were considered in designing the plant catching mechanism:

1. Place of catching
2. Number of plant per catching
3. Distance of travel
4. Releasing Point
5. Angle of Planting

Plant should not be damaged while catching and releasing by the planting arm. Suitable speed, position and angle of catching and angle of planting, height of tray, width and length of fingures are the factors governing the proper planting mechanism.

b) Depth of Planting

Planting depth is important for growth of roots and to stand with the submerge condition. Planting depth for the machine is set to be 50mm below the ground level.

E. Power Transmission Unit

As above consideration number of plants to be planted in one revolution of wheel is 5 plants, we required ratio of 1:5 during plantation.

Distance between two plants rows = 230 mm
As per requirement of condition:
Chain Number : #40
Pitch of chain = 12.7 mm
Roller diameter = 7.9375 mm
Chain width = 7.9375 mm
Pin Diameter = 3.969 mm

a) Larger sprocket specification:

Number of teeth = 50
Pitch diameter of sprocket, Dp1 = 202.26 mm
Width of sprocket teeth, b1 = 7.216 mm
Outside Diameter, Do_1 = 209.48 mm
Bottom Diameter, Dr_1= 194.323 mm

b) Sprocket specification:

Velocity ratio required = 1:5
Number of teeth = 10
Pitch diameter of sprocket, Dp_2 = 41.098 mm
Width of sprocket teeth, b_2 = 7.216 mm
Outside Diameter, Do_2 = 46.707 mm
Bottom Diameter, Dr_2= 33.16 mm
Centre Distance, C > 222.809 mm

IV. CONSTRUCTION

The construction of our transplanter is based on the concept that it should fulfil the requirement of the transplanting of the rice. Along with that approaches it should be not be heavy and takes as less material as possible with good efficiency for transplanting of four row transplantation on actual field.

The transplanter is rest upon the wheel so, the wheel should be enough strong to carry the overall load of the machine in the normal field and paddy field too. The wheel are fixed on main shaft so, that the overall rotation of the wheel would be transferred to the shaft. The position of shaft should be in such way that the approximate centre of gravity (CG) should be balanced also the wheels which are on shaft should not touch to other arrangement of the machine especially for tray and float.

The main shaft is nothing but the input shaft for transplanting machine from chassis the overall power is transmitted towards the mechanism. Hence as requirement two sprockets having 50 teeth each are placed on shaft at proper distance. They are also fixed to the shaft so that with shaft and wheel sprocket will be rotate.

The main transplanting mechanism which is four bar mechanism is attached to chassis at its back side with the help of mechanism mounting support which is also the fixed link of four bar mechanism. All the link of mechanism are properly attached to each other by riveting so to get pin joint between them. The two link namely supporting coupler and the crank is attached to the fixed link or support and this support is attached to the chassis bar at backside as shown in mechanism section.

The transplanter is of four row, hence the four mechanism required for each row which are rested on support on either side, likewise two supports are required. They are also properly fixed to chassis bar and strong enough to carry the mechanism load and shocks. The smaller sprocket are placed in between two mechanism which have 10 teeth on it.

The tray on which the plant is rested upon ids mounted on the chassis at rear end at an angle suitable for feeding the plants for transplanting. Generally 60^0 angle gives good efficiency for falling down the plant under the effect of gravity in proper way. The tray should be at suitably so that it should not touches the chain arrangement. The tray support is rested on chassis.

The pulling handle should be suitable in size and shape for pulling. The farmer should able to pull the machine without damage to machine components and also required less efforts to him. Hence the handle is design with the specification as shown in draft design. This handle is placed on the front side of chassis with the help of nut and bolt arrangement to pull the machine.

As total weight of machine is on the backside of machine, one balancing wheel is attached in between the two support of mechanism. For the balancing purpose of the machine. It has adjustable support, so that farmer can provide the required height to the mechanism from the ground level. Also this wheel helps to get proper depth of planting.

V. WORKING

Before the actual transplanting process, the field for the transplanting should be prepared. This require 3 to4 or even more days as the condition of the soil. Procedure is explain before. Now, the first step towards transplanting is to obtain fresh and having good length seedlings for transplanting purpose. There are obtained from different method and every farmer has his own technique to grow them properly. Put suitably the seedlings should not have more soil attached to their roots as they are placed on the tray, hence it should properly washed thoroughly. So the soil on roots should be minimum. This plants are arranged then over the tray, so that they will escape from the tray and only flow downward one by one after every planting of plants.

Hence, this pick up the plants from tray and plants on the ground or in muddy surface. The required depth of planting is initially decided and hence the plant will penetrates inside the muddy surface.

Now, during another half rotation of the crank the planting finger is allowed to escape from the mud without damaging the plants which are planted. This will achieved by providing the preferable path for the finger or fork tip. This ensures proper rotation of fork tip inside the soil. Due to this there is prevention of throwing plant back outside the soil and plant in a proper way inside the soil. This cycle repeated and more plants are planted at each row by respective mechanism.

A. Post transplanting procedure

After completion of transplanting the transplanter is taken out of the field and washed with water. All the attached soil mainly to wheel and float is removed. The chain is removed from the mechanism and proper oiling is provided to it so that it can be used for further use. After drying the wetted transplater provide oiling to various moving joints of the transplanter so that for further use it will be easy to operate instantly without too much servicing it.

VI. RESULT AND CONCLUSION

This mechanical transplanter has following advantages over manual transplating:

1. Transplanting of seedlings at the optimal age
2. Uniform spacing and optimum plant density
3. Higher productivity compared to traditional methods where plant spacing and density may not always be consistent
4. Lower health risks for farm labourers
5. Better employment opportunities for rural youth through the development of Custom service business
6. Addresses the problem of labour scarcity as requirement of labour is too low
7. Increases farmers' net income

Some limitations of mechanical transplanter are also discussed as-

1. Requirement of labour is low hence it tends to unemployment for labour.
2. Protection from rusting is required as this transplanter has to work in wet soil.

TABLE I
COMPARATIVE STUDY OF MANUAL TRANSPLANTING AND MECHANICAL TRANSPLANTING :**(STUDY FOR 1 ACRE)**

Sr. No.	Parameters	Manual transplanting	Mechanical transplanter
1	Labour requirement	High	Low
2	Risk to labour on field	**High** as requirement of labour on field is more than mechanical trasplanter	**Low** there is requirement of only two or three labour on the field
3	Wages of labour	Wages requirement of labour is high (in session one labour take Rs.150 to Rs.200 per day)	As requiremen of labour is low then wages for them are also lower than manual transplanrting.
4	Spacing between plants	In manual transplanting total transplanting is done by the human and hence there is not proper spacing between two plants	The transplanter is work on pulling power only and the power is transmitted from the wheel itself hence spacing is properly maintain in between two plants
6	Time requirement for transplanting	85 to 95 hours required by providing 10 to 15 labour	60 to 65 hours required with only 2 or 3 labour

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