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Design and Fabrication of Hybrid Rice Seedling Transplanter

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ABSTRACT

India is an agricultural nation and paddy is its primary crop. This project is focused on fabricating a manually operated rice transplanter for small scale Indian paddy cultivators. Since more than 80% of Indian rice landholdings are less than two hectares, there is an urgent need to develop farm machineries for highly labor intensive farm activities, as the labor availability is declining rapidly. Rice transplanters were first developed in Japan in the early 1960's. Since then technology has been contributing very much in this field by providing improved mechanism. . Releasing of work force to sectors other than Agriculture 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. Importation of rice will lead to drain out the economy of the country. Mechanization of paddy sector will lead to higher productivity with releasing of work force to other sectors. The objective of this project was to design a paddy transplanting mechanism to transplant paddy seedlings by small scale farmers in the country. Mechanical transplanting of rice is the process of transplanting specifically raised seedling of rice as a mat using mechanical rice transplanted.

I. INTRODUCTION

Agriculture plays a vital role in India's economy. Rice is one of the chief grains of India. Moreover, this country has the largest area under rice cultivation, as it is one of the principal food crops. It is in fact the dominant crop of the country. India is the second largest producer of rice. India produces 99000 metric tons of rice every year. Rice is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climate. Rice is mainly grown in rain fed areas that receive heavy annual rainfall[2]. That is why it is fundamentally a kharif crop in India. It demands temperature of around 25 degree Celsius and above and rainfall of more than 100 cm. Rice is also grown through irrigation in those areas that receives comparatively less rainfall. Rice is the staple food of eastern and southern parts of India. In 2009-10, total rice production in India amounted to 89.13 million tonnes Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. The method of establishment of rice depends on Age of variety, Availability of moisture, Climatic conditions, Availability of inputs and labour Among these reasons, availability of inputs and labour play a huge role on deciding the method of establishment of rice. The word hybrid transplanter is evolved by combining the mechanisms of preceding rice seedling transplanters i.e. the hand cranked rice seedling transplanter and self-propelled rice seedling transplanters. The hybrid rice seedling transplanter mainly transplants the rice seedling from the tray onto the paddy field. It is a backward walking type two row transplanter which can plant two rows of seedling simultaneously without the requirement of much manual labour when compared to transplanting by hand. This is a manually operated zero energy concept where the whole setup is pulled in the backward direction where the power from the ground wheels is supplied to the gear box which in turn supplies power to the planting arms and tray moving mechanism . Hence, uniform plant spacing and row spacing can be achieved at minimal cost.

1.1 METHODS OF ESTABLISHMENT

.1.1.1 Direct sowing / seeding

I. Wet seeding

Pre germinated seeds are broadcasted into puddled and levelled fields which are free from standing water. At the time of paddling basal fertilizer should be mixed. Irrigation should be done when seedlings are of about 5cm tall. The stand establishment by this method varies with the quality of land preparation, water management and rainfall during the initial period after sowing.

II. DRY SEEDING

Ungerminated dry seeds are sown to dry soil either in rows or in random. Seed rate generally vary with the severity of the environment and the type of physical damages of the seeds. The seed rate varies from 150Kg/ha to 300Kg/ha depending on the level of weed infestation in dry seeded rice. Direct sowing / seeding can be done in two ways by manually or mechanically and also be subdivided in to two categories:

a) Row seeding

This method follows a uniform spacing between plants. This will require planting guides to have uniform spacing. If use mechanical seeders ungerminated seeds have to be used.

b) Random seeding

In this method seeding is done without a definite distance. It is also known as broadcasting. This is the highly practiced method in India.

1.1.2 Transplanting

In this method seed is sown in one place and the seedlings after they have grown a little are transplanted to another. This is done in order to get higher yields and less weeding. In Sri Lanka, the extent of transplanted rice is decreasing due to the scarcity of labour, resources and reduction in cultivation of 4-4 ½ month rice varieties. Manual transplanting is labour intensive and requires 250 -350 man hours per hectare that is 25% of the total labour requirement of the crop.

Paddy transplanting machine has problems of poor traction, sink age and steer ability. Efficient working of self-propelled rice transplanter requires a suitable puddled soil condition, optimum depth of paddling, degree of paddling and soil strength of puddled field. Transplanting will reduce the ability to withstand moisture stress.

Transplanting is recommended for 4-4 ½ month varieties and when 3month varieties are transplanted it should be planted with young seedlings. It is recommended to transplant when land preparation is not up to standard and water management is poor. The reason why transplanting of long age varieties show higher yield compared to broadcasting is that transplanting reduces the excessive buildup of vegetative biomass due to transplanting shock. The spacing of transplanted paddy varies with the age of the variety. For long age varieties(4 -4 ½ months) and short age varieties (3 -3 ½ months) best spacing are 20 x 20 cm^2 and 20 x 15cm^2, respectively. A hill should be planted with 2 -4 healthy seedlings. If random transplanting is practiced, hill density of about 25cm^2 for 4 -4 ½ month varieties and 30 -35 cm^2 for 3 -3 ½ month varieties is optimum. For transplanted rice seedling age is a major factor in determining yield. The set back of growth due to uprooting and replanting of seedlings, transplanting shock is occurred. This increases with the increase of age of seedling of the variety. In general, the effect of transplanting on yield increases, but it decrease with age. Seedling age (in calendar days) also vary with the environmental condition and the type of nursery. The physical and bio-chemical factors would set a minimum and maximum age for a particular nursery. Minimum age of a seedling for transplanting would be about 12 -14 days. For a three month age crop seedling age should not be increased beyond 15 days while for a 4 month crop it is about 21 days. Seedling age of a dapog nursery should not exceed 14 days.

1.1.2.1 Nursery systems

Seedling nurseries use 15 -20% of the total farming area. In preparing the nursery seedbed, the surface needs to be level, free form weeds, and well drained. Low rates of nitrogen and phosphate fertilizer can be applied to the nursery. Seeding rates vary from 400 to 800 kg per hectare of nursery depending on locality, soil type, and seed quality. The choice of a particular nursery system depends on the availability of water, labour, land and agricultural implements.

There are 5 nursery systems for transplanting:

A. Wet-bed method

Figure 1: Wet-Bed Method

Figure 2: Dry-Bed Method

The wet-bed nursery is mainly used in areas where there is enough water. Pregerminated seeds are broadcasted on a soil that is thoroughly puddled and levelled. Drainage canals for proper removal of water must be constructed. Addition of organic manure (decomposed) and small amounts of inorganic fertilizer as basal dressing will increase easiness of uprooting of seedlings and seedling vigour. Total seed bed area is about 1/10 of the area to be transplanted and requires about 100 kg of seed paddy per ha. Seed rate should be adjusted for small grain varieties. Nursery site should be without shade and with adequate irrigation and drainage facilities. Quality rice seeds should be soaked in cleans water for a minimum period of 24 hrs, and incubates in a warm dry place for about 48 hrs. Sprouted seed should then be broadcasted uniformly on the nursery bed. Before seeding the nursery should be drained completely. Thereafter, nursery should be maintained in moist condition for about 5 days. Once the seedlings are established, the nursery is impounded with water and raises the level gradually. The best stage of transplanting seedling is about 15-21 days. Nursery should be free from weeds, any pest or disease incidence and nutrient deficiencies. If such conditions occur it must be treated at the nursery level.

B. Dry-bed method

The nursery is prepared in dry soil conditions. Seed bed is prepared with convenient dimensions with raised soil to a height of about 5-10 cm. Distribution of thin layer of half burned paddy husk could be distributed on the nursery bed mainly to facilitate easy uprooting. Dry or just sprouted seeds are sown in rows, which are about 10cm apart to dry nursery bed. Random sowing also possible but should be discouraged as the weed control is difficult. Adequate irrigation facilities and free of shade are required for the site. Nursery area should be about 1/10 of area to be transplanted. Seed rate is higher than the wet-bed method (about 150 kg/ha) as the germination could be lower. Uprooting of seedlings should be done between 15 - 21 days after germination. Moisture stress should be eliminated in the nursery. If soil nutrient content is low, mixing of basal fertilizer is recommended. The advantage of this method is that seedlings are short and strong, has longer root system than wet bed and can be raised even during heavy rain which is not possible with wet bed. A major 6 drawback is those roots may get damaged during pulling.

C. Dapog method

Figure 3: Dapog Method

Figure 4: Bubble Tray Nursery

This method can be established on a flat surface. If low land paddy field is used, water supply and control should be very reliable. Area required is about 10 m^2/ha of the transplantable land. Dapog method required area is much smaller than conventional nurseries. Seed rate is about 125Kg/ha. Levelled seed bed should be made and centre of the bed should be slightly higher than the edge to permit water to drain off the surface. Banana leaves without mid rib, poly ethylene sheets or any flexible material are recommended to cover the surface to prevent seedling roots penetrating to the bottom soil layer. Cemented floors can also be used for the same purpose. Burned paddy husk or compost is used to cover the seed bed with about 1/4” thick layer. Sow pre-germinated seeds uniformly on the seed bed to a thickness of 2-3 seeds to a density of 700-1000 g/m^2. Splash the germinating seeds with water and press down by hand or with a wooden flat board in the morning and afternoon up to 3-4 days to prevent uneven growth. Frequent irrigation is required if seed were sown without the bedding, and to reduce temperature. Transplanting of nursery should be done in 12-14 days after germination of seeds. The advantage of the "dapog" over wet/dry bed nursery is that less area is needed and the cost of uprooting of seedling is minimal. However since the seedlings are small transplanting is difficult. Very young seedlings from dapog nurseries are subjected to less transplanting shock than of other nurseries, thus these seedlings are more suitable for short aged varieties.

D. Bubble tray nursery

The bubble tray nursery is a good system to develop 12-15 day old seedlings with "root balls". These trays have 434 plugs (micro-pots of 1.3cm dia. and 1.3 cm depth) with a tiny hole in the bottom to facilitate movement of water and nutrients from the 7 soil below into soil plugs through capillary action. Soil is filled into the pots and 2-3 seeds are placed in each pot. When the seedlings are 14-21 days old, they are thrown into the field to be planted at random spacing. It requires 400 -750 trays per hectare of paddy.

E. Seedling boxes for mechanical transplanting Mechanized transplanting

Figure 5: Seedling Boxes for Mechanical Transplanting

It requires techniques that are different from hand transplanting. Usually seedling boxes are used that are adapted to the type of transplanter. In a seedling box, seedlings are grown on a thin layer of soil in 33 cm x 5 cm plastic trays. In some instances, seedlings are grown on larger areas and then cut into rectangular strips (mats of seedlings) that fit into the planting trays of the transplanter. When considering the details, transplanting of paddy is better over other methods as they have got some advantages. When practicing manual transplanting, labour scarcity is a major problem. Mechanical transplanting of paddy seedlings requires high capital and skilled labour and land area also become a problem as prevailing machines required comparatively large land area. Mechanical transplanting machine is a better solution for the Sri Lankan condition. Still problem associate the situation should be solved. Those are high capital, spacing of rows, and weight of the machine and size of the machine.

2. Problem Definition

Mechanical transplanting of paddy seedlings is a solution to the prevailing situation in the India 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 because, the tranplanters imported from other countries do not suite Indian soil conditions. The transplanters imported from other countries fail to hold on 18 day seedlings on the planting arms due to poor traction. 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 small scale Indian farmers. Existing manually operated transplanters are inefficient. The main reason for the poor acceptance was the low capacity of the machine. A simple manually operated transplanter having an average capacity of one hectare per day would be a better solution.

III. RESEARCH OBJECTIVES

1. Design a mechanism for transplanting paddy seedlings.
2. Test the performance of the transplanting mechanism.
3. To achieve a plant spacing of 8 inches.

IV. LITERATURE REVIEW

There are different parameters according to Garg (1992) and Narang (1997) influencing the overall performance of paddy transplanters. These are machine members, seedling nursery types and field conditions. Based on which it is possible to develop different machines that differ significantly on planting mechanism, seedling tray mechanism and tray motion mechanism. transplanting mechanism and other machinery of theoretical analysis and the design of new products[1]. This software have aided tremendously in today's automated transplanted design, another eye opener in paddy cultivation break through. In 2005 Kubota introduce into market a programmable transplanted, with motor sensors, CCD color camera and computer. Using the camera to sense RGB images and interprets the signals into a language of L* a* b* vision for human to determine seedling row locations as well as calculating the angle and movement. The motor steer the transplanted in accordance with its angle, working velocity and displacement but its limitation is deviation of row angle. In 2007 this company (Kubota) Introduce in Thailand a major paddy rice growing zone transplanting machine to help solve some of the major constrains facing rice farmers in the region. As the time went on the company established its branch in the country to meet demand.

In 2010 doubling production of paddy rice in the zone, selling to other countries like India and Vietnam. Manual transplanting characterized by time, labour, energy and resources consuming operations were the major factors considered by Kubota manufacturing company. Leading to series of modifications aimed at solving and improving standard through introduction of features like High Sensitive Transmission (HST) shift, a rotary transplanting to replace reciprocating mechanism results in higher precision. In the year 2010/2011 the company introduces their latest model. Have robust and powerful engine unit of 17 h power, 1.62 m/sec operating speed, four wheel independent suspensions to absorb undulations with less noise and vibration favouring a smoother operation. In like- wise ventures, agricultural practices have done a lot of transitional transformations with the sole aim of increasing productivity at expense of cheap labour through higher effective utilization of scares resource at the out-most use efficiency. The pioneering transplanter manufacturing company in Japan (Kubota) was known for their untiring efforts in design and fabrication to meet the local needs of the farmers. mechanism and then transplant the seedling in the puddle. The existing transplanter catches between 5 to 8 seedlings per hill for planting. Modifications have to be carried out on the planting claw (kuku kambing) so that it will only catch one seedling at a time and moisture content of the soil. Redesign the seedling tray to allow the SRI transplanter to catch one seedling at a time and the planting medium.

Transplanting rice seedlings 20 days old or older has been commonly reported to generate an increase in grain yield as a result of higher tiller production. A series of experiments was conducted at the IRRI farm during the dry and wet seasons to quantify, in a range of plant types, the impact of even younger seedlings and contrasting nursery management on grain yield and to identify plant traits supporting high performance under a given establishment technique. Seedling age at transplanting, ranging from 7 to 21 days, and contrasting nursery types (seedling tray, dapog, mat nursery, and traditional wet-bed seeding) were evaluated for an elite line, a new plant type and hybrid rice.

To avoid any confounding effect, sowing date in the nursery, seed rate and crop management in the main field were all the same. In the two seasons, and for all genotypes and nursery types, transplanting older seedlings induced a delay in the onset of linear dry matter accumulation and tiller emergence, while the rate of dry matter accumulation and tiller emergence was unchanged. This delay reduced nitrogen content in the seedlings. Plants recovered quickly, however, after transplanting. The delay also reduced maximum tiller number, and extended crop duration with delayed maximum tillering, flowering and maturity. Grain yield was consistently higher for younger seedlings, with, in some cases, a difference as large as 1 t ha^{-1} between 7- and 21-day transplanting. This result was valid for the four genotypes evaluated, with a higher impact during the dry season. In contrast, no significant difference was observed for the influence of nursery type on the timing of tiller emergence and on grain yield. Some differences in seedling vigor (plant dry weight, specific leaf area, N content), higher in the case of dapog and wet bed, and in maximum tillering, higher in the case of the seedling tray, however, were observed. But these differences did not have a significant impact on the late increase in crop dry matter and on panicle number at maturity.

No significant interaction between seedling age and nursery management for all genotypes and for all the parameters measured was found. Promoting early tiller emergence as a response to transplanting young seedlings increased grain yield in all cases despite the associated decrease in tillering efficiency. Extended growth inside the nursery, rather than transplanting shock per seedling, appeared to be the main reason for delayed tiller emergence in late transplanting[3].

V. TRANSPLANTING BY HAND

This method is good for small fields and to fill patches. Manual transplanting does not require costly machines and is most suited for labour-surplus areas and for small rice fields. Manual transplanting can be done in fields with less than optimal levelling and with varying water levels. Seedlings are raised in a wet, dry or modified mat nursery. Proper nursery management will produce healthy, vigorous seedlings.

5.1 MANUALLY OPERATED TRANSPLANTERS

Manually operated translators are powered by man power. Operator has to move with the transplanter and power the machine by hand. These machines are small enough to operate manually.

1. Function : For transplanting mat type paddy seedlings. Suitable for all type of transplanted paddy varieties
2. Specification:

i. Type : Manually operated
ii. Power requirement : One operator and one labour to transport mat seedlings
iii. Overall dimensions : 1230 x 1250 x 835 mm
iv. Weight : 17kg
v. Capacity : 0.25ha/day

3. General Information : The machine consists of a seedling tray, forks, handle and skids. By pressing the handle, the forks pick-up the seedlings and plant them in 6 rows. For every stroke of the handle the seedling tray moves side wards for uniform picking of seedlings by the forks. The operator has to pull the machine while punching the handle at the desired spacing. The Row to row spacing is 200 mm.

Figure 6: Hand powered mechanical transplanter

Figure 7: Hand cranked rice transplanter

5.2 BASIC DESIGN OF SHAFT

This system runs by a motor, the power required to run the system efficiently will be 300W (Assumed value).

P = 0.3 KW. Assuming the efficiency of the motor is 90% [$\eta_{mechanical}$ = 0.9]

Therefore power transmitted to the shaft is = 0.3*0.9= P_{actual} = 0.27 KW.

Now assuming that the person pulling the Hybrid Rice Seedling Transplanter is capable of moving a distance approximately 300 inches in a minute, which means giving 4 complete rotations to the ground wheel. With 4 complete rotations of the ground wheel, the shaft that drives the planting arm will rotate 36 times because the total reduction from ground wheel to planting arm is set to 1:9. Therefore the speed of shaft is approximately 30 rpm to 35 rpm.

Selecting the RPM of shaft as 20, 30 and 40, torque is calculated.

Torque, T = $(9.55 * 10^6 * P) / n$

The above equation is taken from Design Data Hand Book, where

T – Torque in N-mm, P – Power in KW, N – Speed in RPM

Calculation for **20 rpm**:

T = $(9.55 * 10^6 * 0.27) / 20$

T = 128925 N-mm

Similarly:

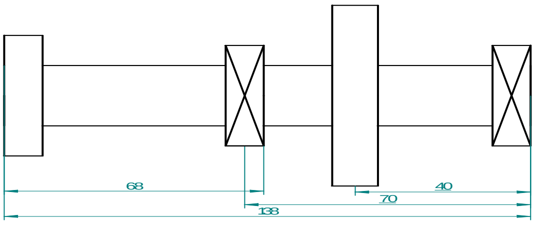
T = 85950 N-mm for 30 rpm

T = 64462.5 N-mm for 40 rpm

5.3 CALCULATION OF TORQUE

Sl. No.	Speed (rpm)	Torque (N-mm)
01	20	128925
02	30	85950
03	40	64462.5

5.3.1 Moment
5.3.2 Calculation:



V = A*t = $\frac{\pi d^2}{4}$ * t = $\frac{\pi*90*90}{4}$ * 12 = **76340.7 mm³**

Density = $\frac{Mass}{Volume} = \frac{M}{V}$ Mass = Volume * Density = 76340.7 * 7.85 * 10^{-6} = 600 g

To be on the safer side mass of the gear is taken as **750 g = 0.75 Kg.**

Weight of the gear = Mass * 9.81

= 750 * 9.81

W = 7.35 N.

To be on the safer side and for ease of calculation Weight of the gear is taken as **7.5 N**.

Mass of the sprocket = 500g

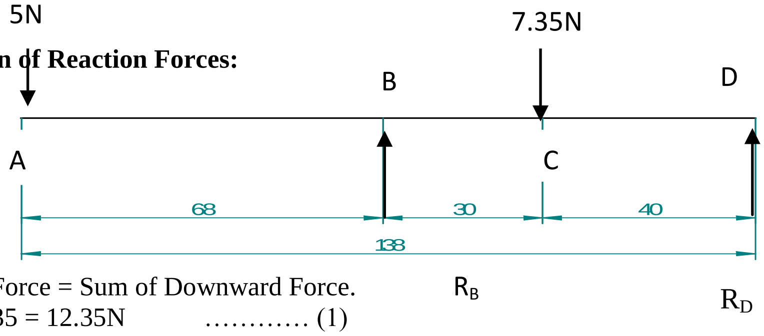
Weight of the sprocket = Mass * 9.81 = 500 * 9.81 = 4.9N

To be on the safer side and for ease of calculation Weight of the sprocket is taken as **5N.**

Terms:

V – Volume of the gear in mm3, A – Area of gear the in $mm^{2,}$ t – Thickness of the gear in mm Density of the gear in Kg/mm^3, M – Mass of gear the in K g, W – Weight in N

5.3.2 Calculation of Reaction Forces:



Sum of upward Force = Sum of Downward Force.

$R_B + R_D$ = 5+ 7.35 = 12.35N ………… (1)

Taking moment about any one reaction point, let us consider point B.

$(R_D*70) – (7.35*30) + (5*68) = 0 \quad R_D = \frac{(7.35*30) - (5*68)}{70}$

R_D = -1.707N

Substituting in equation (1) $R_B = 12.35 - R_D = 12.35 – (-1.707)$ **R_B = 14.057N**

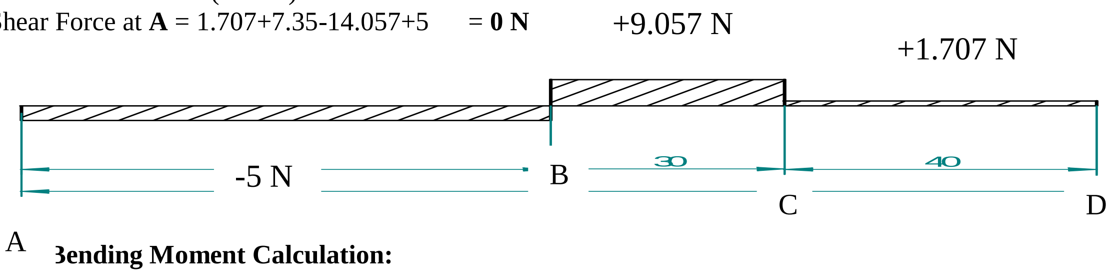
5.3.3 Shear Force Calculation:

Shear Force at **D** = - (-1.707) = **+1.707 N**

Shear Force at **C** = - (-1.707) +7.35 = **+9.057 N**

Shear Force at **B** = - (-1.707) +7.35-14.057 = **-5 N**

Shear Force at **A** = 1.707+7.35-14.057+5 = **0 N**



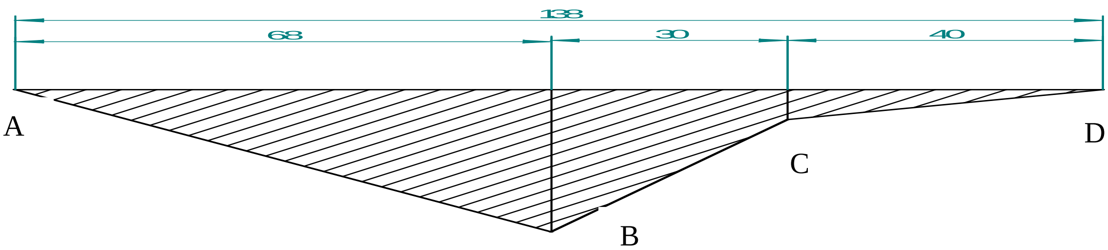
Bending Moment Calculation:

Bending Moment at **D** = **0**

Bending Moment at **C** = -1.707*40 = **-68.28 N-mm**

Bending Moment at **B** = (-1.707*70) – (7.35*30) = **-339.5 N-mm**

Bending Moment at **A** = **0**



According to Maximum Shear Stress theory from Design Data Hand Book,

$$D_o = \left[\frac{16}{\pi * \tau_{max}}\left(\sqrt{(C_m * M)^2 + (C_t * T)^2}\right) * \left(\frac{1}{1-K^4}\right)\right]^{⅓} \quad \text{where}$$

τ_{max} - Maximum allowable stress, M - Maximum bending moment on the shaft, T- Torque applied on the shaft, $K=\frac{d_i}{d_o}$, in case of hollow shaft, K= 0 for solid shaft, C_m- Shock load constant, C_t- Endurance factor

Calculating allowable stress on the shaft for material cast iron with commercially cold rolled.

The elastic limit of shear for shaft is = **122.5 MN/m^2 = τ**

Taking Factor of Safety (FOS) = 2

Maximum Allowable Stress = $\tau_{max} = \frac{\tau}{FOS} = \frac{122.5}{2} = \tau_{max}$ = **61.25 MN/m^2**

For suddenly applied loads considering only minor shocks, shock load factor (C_m) and endurance factor (C_t) is taken from Design Data Hand Book. Shock Load Factor = C_m = 1.5 to 2.0

C_m = 1.75 (Average is considered)

Endurance Factor = C_t = 1.0 to 1.5

C_t = 1.5 (Maximum limit is considered).

5.3.5 Calculation for Diameter of shaft based on Maximum Shear Stress Theory:

$$D_o = \left[\frac{16}{\pi * \tau_{max}}\left(\sqrt{(C_m * M)^2 + (C_t * T)^2}\right) * \left(\frac{1}{1-K^4}\right)\right]^{⅓}$$

When speed is 20 rpm, $D_o = \left[\frac{16}{\pi * 61.25}\left(\sqrt{(1.75 * 340)^2 + (1.5 * 128925)^2}\right)\right]^{⅓}$ **D_o = 25.24 mm**

Similarly when speed is 30 rpm, **D_o = 22.05 mm** and when speed is 40 rpm **D_o = 20.03 mm**

Selecting the standard size of shaft from Design Data Hand Book, the diameter of the shaft (D_o) is taken as 28 mm. But for manufacturer's convenience diameter of the shaft is taken 30mm. Therefore, the shaft on which the bigger gear is attached, with sprocket, the diameter should be 30 mm to withstand all working condition.

Diameter of Shaft for Varying Speed

Sl. No.	**Speed of main shaft(rpm)**	**Torque (N-mm)**	**Maximum Bending Moment(N-mm)**	**Diameter of the Shaft (mm)**
01	20	128925	340	25.24
02	30	85950	340	22.05
03	40	64462.5	340	20.03

5.4 DETERMINATION OF SEEDLINGS PLANTED FOR ONE GROUND WHEEL ROTATION

Diameter of the ground wheel	=	23inch
Perimeter of the ground wheel	=	$2\pi r$ = $2*\pi*23/2$ = 72.26 inches
Distance of plants	=	8 inch
Number of plants per one ground	=	72.26/8
Wheel rotation	=	9.03 ≈ 9

5.4.1 Planting Arm

Figure 8: Planting arm **Figure 9: Tray** **Figure 10: Power Screw**

Planting arm used are spring loaded arms. Tension of the plant should be enough to catch the plants and to prevent release until end point and not to damage the plant during the process. Angle of planting was decided by tray feeding point angle and moving direction.

5.4.2 Tray

Tray is to carry the dapog mat and to direct the plants to planting arm. Basic factors (width, length, angle, speed of movement) were considered in designing the tray mechanism. As two plant rows were planted at once, the tray width was twice as plant space. Movement of the tray per one planting of arm was decided by the volume taken away from the planting finger at a time. The volume taken by finger depends on the space of the finger jaw. Tray movement decides by the speed of ground wheel rotation. To make constant feeding of dapog mat to the planting arm it should come down to the end of the tray by gravity. Higher angle reduce energy requirement

to feed the dapog mat to transplanting arm while too much angle effect on falling down and compaction of nursery at end of the tray making difficult to take out the plants from the nursery by transplanting arm.
Length decided by the power given to the machine. Higher the length of the mat makes higher the power requirement to carry the weight of the mat. So to reduce weight of the machine tray length was reduced to have optimum weight.

5.5 POWER TRANSMISSION

5.5.1 Design of Gear Box

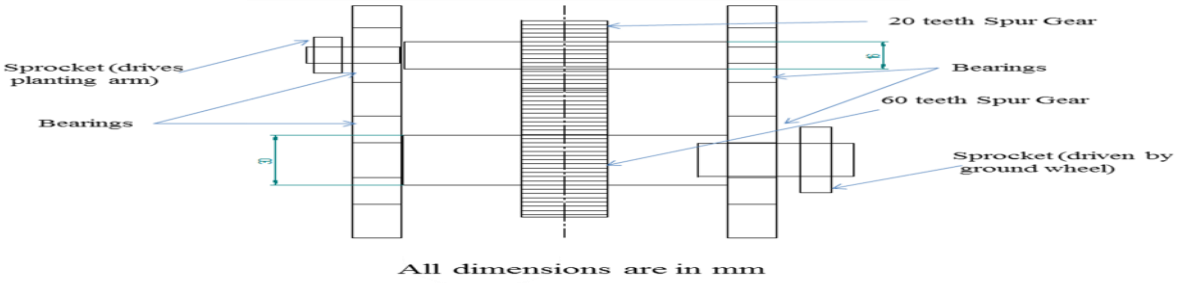
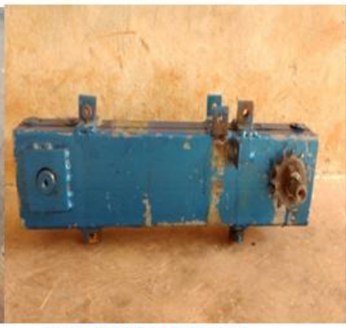


Figure 11: Design of Gear Box

5.5.2 Gear Box

It was calculated to have a row spacing of 9 inches and plant two rows of seedlings simultaneously for one rotation of ground wheel. Therefore a speed reduction of 1:3 was maintained in the gear box i.e. from ground wheel axial up to planting arms. Therefore a 32 teeth sprocket was mounted on the ground wheel axial. A 18 teeth sprocket is used to supply input power to the gear box and 16 teeth sprocket is connected to supply output power from the gear box which in turn is connected to 12 teeth sprocket to drive the planting arms . Gears are constructed using cast iron material and spur gears of 20 teeth and 60 teeth are used to achieve a gear ratio of 1:3. The plates used in the construction of gear box are of cast iron material and is of 12mm thickness. The overall weight of the gear box is about 12kg.



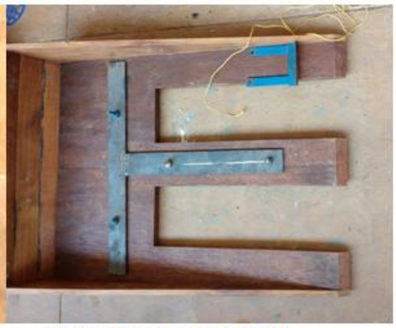


Figure 12: Gear Box **Figure 13: chain box** **Figure 14: Wooden Float**

Gear reduction between 32 teeth sprocket and 16 teeth sprocket wheel	= 32/16 = 2.0000
Gear reduction between 18 teeth sprocket and 16 teeth sprocket wheel	=18/12 = 1.5000
Gear reduction within the gear box	= 60/20= 3.00
Total gear reduction between ground wheel to planting arm	= 2.00*1.50*3.00 = 9.00

5.5.3 Chain Box

Chain box is mainly responsible for transmission of power from the planting arms to the tray moving mechanism. Chain box house is made up of cast iron material. Inner construction of the chain box consists of two sprockets of equal of teeth connected by a chain. There two sprockets externally connected to the chain box. The 12 teeth sprocket from the one end of chain box is connected to the planting arm through chain. The 14 teeth sprocket from another end of chain box is connected to 28 teeth sprocket of the tray moving mechanism by a bike chain. The overall weight of chain box is around 2kg.

5.5.4 Wooden Float

1. Function : It helps the entire setup to float on the muddy soil during the operation
2. Specification:
Type of wood : Jack Tree
Overall dimensions : 20x30x5inch
Weight : 6kg

3. General information: float forms the base for the entire setup. Basically the float should be light in weight and should be capable of holding the entire setup on it. Therefore, float was carved out of jackfruit tree wood as it is both light weight and doesn't absorb water.

5.5.5 Ground Wheel

Figure 15: Ground wheel

1. Function: Reduces amount of human force required to pull the entire Setup and generates power required for the system

2. Specification:

Material	: Cast Iron
Diameter	: 23inches
Weight	: 1kg
Quantity	: 2

3. General information: Ground wheel generates the power for the entire system. It is provided with 8 flaps for smooth movement of system over the muddy soil, as more traction is required for the movement of any system on these soil conditions.

5.6 DESIGN OF HYBRID RICE SEEDLING TRANSPLANTER

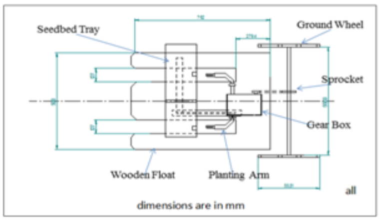


Figure 16: Top view of transplanter design

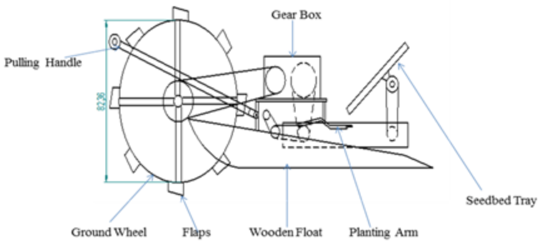


Figure 17: Side view of transplanter design

5.7 ASSEMBLED HYBRID RICE SEEDLING TRANSPLANTER

Figure 18: Side View of Transplanter model

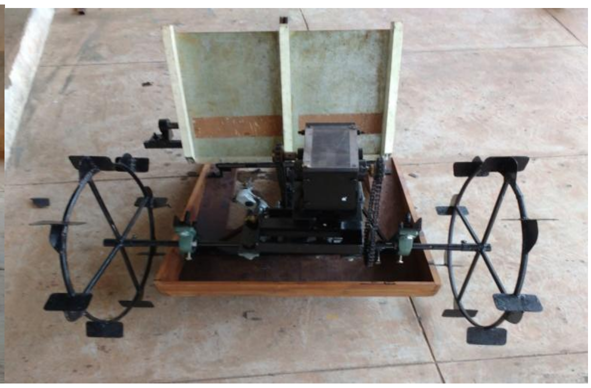


Figure 19: Top View of Transplanter model

VI. RESULT AND CONCLUSIONS

The shifting of manual transplanting to mechanical transplanting with a reorganization of land and labour resources have brought higher levels of farm productivity and income. The existing method of mechanical transplanting of paddy is claimed to be inefficient to produce higher yield. From the survey that was carried out, most of our neighbourhood farmers are looking forward for mechanical rice transplanters as they increase productivity and eliminate labour shortage. Hence, we developed a hybrid rice seedling transplanter by combining mechanisms of its preceding models. As per the objectives we were able to accomplish a plant spacing of 8 inches and row spacing of 9 inches. Plant spacing of 8 inches is achieved by maintaining 1:3 gear ratio within the gear box and overall reduction of 1:9. This also provides with increased torque at lower speeds. Row spacing of 9 inches is achieved by maintaining 9 inches between the two planting arms.

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