# Modification and Manufacturing of Hand Cranked Rice Transplater

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**Abstract-** Right after the independence of India, there is always scope for development in farming, out ofwhich rice farming is done in many regions in India traditionally over the years rice is transplantedmanually. The major problem faced in manual rice transplanting is high dependency on labours.Hence mechanization in the field of rice cultivation will be a profitable solution. The hand crankedrice transplanter are available in the market which can help to accomplish the above objective. Buta modified hand cranked rice transplanter would be a much better solution for most of smallscale farmers in India, who cannot afford high cost engine driven rice trans planters.

***Key words-****tranceplanting, rice transplanter, hand cranked.*

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## I. INTRODUCTION

Rice is the one of important crop in India. According to the annual report of CRRI for 2013-14, the total roduction of rice is estimated at 106.19 million tonnes which was a new record.Production of 2013-14 is higher by 9.5 lakhs tonnes than the last year's record production of105.24 million tonnes [5]. Hence it the importance of rice farming in India. Although riceproduction is increasing at a rapid rate, but majority of farmers in India are small scale farmers.Mechanized engine driven rice transplanters are available in the market, but since most of themare imported they are of very high cost which the small-scale farmers cannot afford. Anotherfactor is the complexity of mechanized rice transplanters. It requires high maintenance andrepairing cost too, because of which it is not suitable for small scale farmers. Hence some usefulmodifications of hand cranked rice transplanter are proposed in this paper which will definitelyhelp the small-scale farmers to transplant more seedlings in minimum time with drastic reductionin labour costs.The reasons for preferring mechanical transplanting is due to the advantages it poses It overcomethe problem of increased time to grow the crop. So, we get production in less time. Also, itfacilitates better water management system. The distance between two seedlings is mostimportant part for proper growth of the seedlings, by mechanical transplanting it is accuratelycontrolled.

## II. TRADITIONAL RICE FARM

To know more about the transplanting conditions and other details we had gone through adetailed visit in a village. The most important point which completely satisfies the need of ourproject was that they are completely unaware of rice transplanting machine and they do itmanually.

The details gathered from the visit are as follows.
• Date of visit: 2/12/2016.
• Place of visit: Warangaon
There we met 3-4 families of farmers who have been into rice farming since generations. Theyowned fields typically ranging from 1.5 to 3-acre area. Hence the place was suitable for visitingas our machine is mainly aimed for small scale farming. We gathered information from themabout rice farming right from land preparation and to the harvesting stage.

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1. Puddling of field and preparing nurseryThe field is puddle by releasing large amount of water into the field at the same time nurseryis made in the corner of the field. Nursery is of wet bed type. Seeds are broadcasted into thenursery area directly. Seed are then left there to grow for 15-20 days depending upon thetype of rice. In here most of the farmers grow indrayani rice. After 15-20 days seedlings areready for transplantation.

2. Species of rice grownMost of the farmers grow indrani rice. Other rice type such as kolapi and garha is grown in smaller amount by some farmers.

3. Transplanting of seedlingsAll transplanting work is done manually. No machine is used for transplanting work. Mud depth in field during transplanting is 10-15 cm. 10 labours per acre for two days are requiredfor transplanting of 1.5-acre farm. Wages given to one labour is Rs. 300 per day.

4. After transplanting water level in field is raised to ensure proper growth of rice plants. Growthof rice plants is highly dependent on the water levels in fields. Hence proper water level mustbe kept in fields throughout the season.

5. Fertilizers and pesticides used are numina gold and targa super respectively.

6. Rice plants require 4-5 months for complete growth before harvesting which depends on the

water availability.

7. Farmers get yield of 15-16 bags of 80 kg rice each per acre.

8. Overall expenses encountered in rice farming are 15000 rs per acre.

During the visit, we came to know that no farmer is aware of machines that can be used fortransplanting. All transplanting work is done by hand. Labour cost for transplanting work is Rs6000 which constitute to about 40% of total expenditure. Hence any improvement intransplanting methods such as mechanisation can reduce the total expenses considerably.

### III. Advantages Of Rice Transplanting

The seedling is grown in side of farm area and then transplanting process is done. It overcome the time to grow the crop to 3 to 4 weeks. So, we get production in less time. Also get better the water system management. The distance between two seedlings is most important part so its control by trans plating and with the use of less seedling we can get more production.

The visit of Warangao shows that the natural farming is comfortable for small area but it's also costly because of more labours are needed. After introducing the machine rice transplanting the machines cost for most of farmers are not bearable. So, the small machine that work in

small area and budget consideration the hand cranked machine is overcome the natural rice transplanting system.

From the visit study hand cranked machine is well preferable for small area farming because of low cost, small unit and fast work. But to overcome the disadvantage of machine the modification is important in this machine, also the seedling distance is varying by the work done by cranking of machine. This modification is done on the work done that is the pulling operation and cranking of operation. In that pulling is impossible to eliminate so that the modification on cranking with the help of sprockets we can eliminate the cranking mechanism. Also from the accurate gear ratio, we get the fixed spacing between seedling. For the rotation of sprocket wheels are selected. So that the only working that is the pulling operation is done.

Though transplanting has some disadvantages such as need of more labour and requirement of nursery, such disadvantages are offset by higher yield which we get from transplanting method.

### IV. Comparison Of Manual And Hand Cranked Transplanter

Performance of manual transplantation and hand cranked transplanter can be compared in termsof labour requirement and labour cost.

Considering labour cost per day 300 rupees,

a) Labour requirement:

1) Manual transplantation:

Manual transplantation is a labour intensive work. Manual transplantation requires 6-7 laboursper acre for transplanting.Considering 8 working hours per day5

Hence Labour hours required per acre=7*8=56 hours

2) Hand cranked transplanter:

Hand cranked transplanter requires only 2 operators for running the machine to transplant 1 acreof farm in 8 hours.Hence labour hours required per acre=16 hours only

b) Cost of labour:

1) Manual transplantation:

Daily cost per acre=300*7=2100 rupees

2) Hand cranked transplanter:2

Daily cost of labour per acre=2*300=600 rupees

Cost of transplanter:

In China: 7000 rupees

In India: 18000 rupees

### V. Area Of Improvement & proposed modification of hand cranked transplanter

I. Elimination of hand cranking.

II. Only required human effort will be pulling force.

III. More accurate control over seedling spacing.

**2**

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IV. Making operation easier by forward walking.

The proposed modification:

1. Provision of wheels to convert pulling force into torque.
2. Using this torque to drive transplanting mechanism
3. Designing proper chain drives to controller.

### VI. DESIGN AND MANUFACTURING OF HAND CRANKED TRANSPLANTER

#### 1. Design of Chain drive

The transplanting mechanism in the machine is run by rotating the crank. Hence to eliminate this
effort chain drive can be provided between crank shaft and wheel shaft.

- Diameter of the ground wheel =700mm
- Perimeter of the ground wheel =2D=π*700=2199.114mm
- Distance between plants =150mm

(Distance between seedlings is as per by specifications of IRRI)

- Seedlings planted in one crank rotation=2
- Speed reduction ratio between wheels and transplanting mechanism= (2199.114)/ (2*150) = 7.33
- Pitch =12.7 cm
- Module= 12.7/π=4.04

Hence speed ratio between on wheel shaft and crank must be 7.33 to get distance of exact150mm between two seedlings.Such high reduction cannot be obtained in one stage of chain drive. Hence two stage chain driveis required. Thus two chain drives: one between wheel and intermediate shaft and second drivebetween intermediate shaft and crank shaft of the machine.

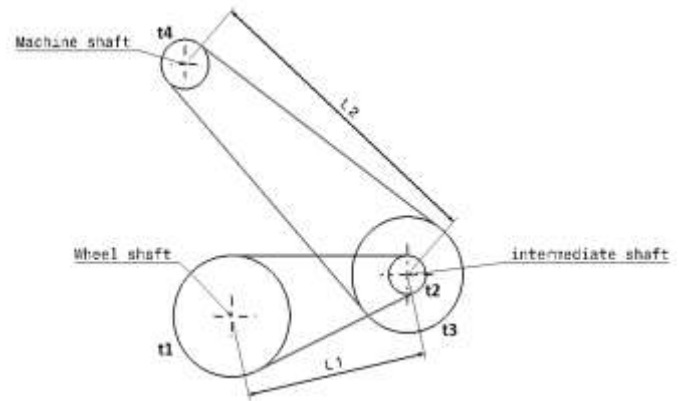1. Speed reduction in stage I= 44/14=3.14
2. Speed reduction in stage II= 42/18=2.33
Hence total speed reduction = 3.14*2.33=7.326
(which is near to the required one)8Location of wheel and intermediate shaft is decided in order to make the drives compact andclose to the machine.
Centre distances of chain drives:
L1=460mm
L2=260mm



Number of links and of length of chain
1) 1st Chain drive Number of links (M)=

$$2*\frac{C}{p}+\frac{Z1+Z2}{2}+\left(\frac{Z2-Z1}{2\pi}\right)2*\frac{P}{C}$$

C=centre distance
P=pitch
Z1, Z2=no of teeth on sprockets
M=2*260/12.7+(44+14)/2+((z2- z1)/2π) ^2*12.7/260
M=71
Length of chain=M*p=900 mm
2) 2nd chain drive
 Similarly,
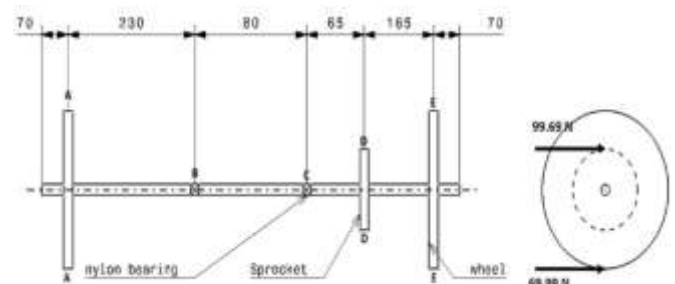  Number of links (M) = 103
  Length of chain = 1308 mm

Fig.1 Chain drives for the machine

| Stage | Members | Sprocket pair (size in terms of no. teeth) |
|-------|---------|--------------------------------------------|
| I | Wheel and intermediate shaft | 44,14 |
| II | Intermediate and crank shaft | 42,18 |

#### 2. DESIGN OF WHEEL SHAFT:



A shaft of en steel (bright bar) of 16 mm diameter to match up with the inner diameter ofsprockets is selected. Wheel shaft is the most stressed part in the machine. Wheel shaft

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issubjected to shear stress caused due to transmitting torque and bending.

The weight of the machine is acts on the float of the machine. Further the chain on sprocket on the wheel shaft is almost horizontal. Hence for analysis purpose only force in horizontal areconsidered.
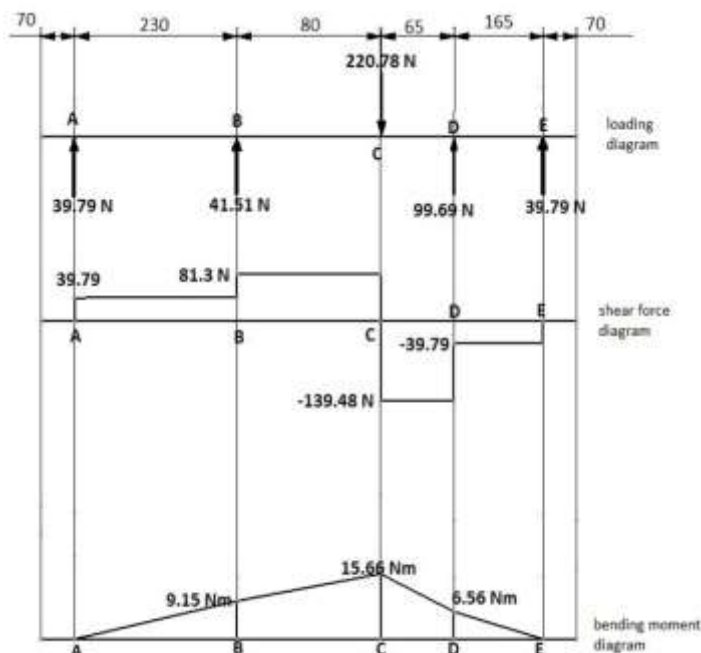
Wheel shaft is subjected to two horizontal force: 1) due to traction of wheels and2) due to chain drive.

1. Force acting at the periphery of wheel=torque/radius

=27854/350

=79.58N

As there are two wheels and assuming equal load distribution

net force =79.58/2

=39.79N

2.Force acting at the periphery of the sprocket=torque/radius=99.69 N



- Bearing reactions:
  Taking moment about B
  $RC \times 80 - 99.69 \times 145 - 39.79 \times 310 + 39.79 \times 230 = 0$
  Hence Rc=220.78 N (downwards)
  $RC + RB = 39.79 + 99.69 + 39.79$
  RB= 41.51 N (upwards)

- Torque required to drive the machine:
  The crank is operated by the operator. The machine offers very little resistance to operate.Assuming 20N force is required at the crank to run the machine.
  Length of the crank=190mm
  Hence torque=190*20
  =3800Nmm

- Torque to be transmitted through wheel shaft:

Reduction ratio between crank and wheels=7.33

Hence torque applied on wheel shaft,

T =7.33*3800

=27,854Nmm

=27.854Nm

- Bending moment acting on the shaft:
  As seen from the bending moment diagram Maximum Bending moment acting on theshaft is given by,
  M =313.21*65+230*39.79=15,631.55Nmm

- Maximum shear stress acting on the shaft (by ASME code):
  $\tau = 16*Te/(\pi*d^3)$
  d= diameter of shaft=16mm
  Te= equivalent twisting moment
  $= \sqrt{(KbM)^2 + (KtT)^2}$

  Where Kb=1.5 and Kt=1 for gradual and light loads

  $T_e = \sqrt{(1.5 * 15.63)^2 + (1 * 27.854)^2}$

  =36.408Nm

Hence,

  $\tau = 16*36.408/(\pi*0.016^3)$

  =45.27MPa

Consider factor of safety=2

As machine is operated manually applied forces are low and fluctuations are moderatehence factor of safety selected is 2.

Syt=530MPa Sut=850MPa

τall=530*0.3 or 850*0.18

=159 or 153 MPa

τall=153 MPa

hence τall=153 MPa/2

=76.5 MPa

….(Which is greater than the applied stress)

Hence the shaft is safe against given loading conditions.

### 3. BEARING SELECTION

To support the wheel and intermediate shaft we could use either ball bearing or nylon bushbearing. By considering working environment of rice farm/paddy Nylon bush bearing is selecteddue to advantages of nylon:

1. Nylon bush bearing are self-lubricating.

2. They are cheap.

3. They have good wear resistance and low coefficient of friction.

4. There working won't be affected due to inclusions such as mud and dirt.

5. Manufacturing is easy.

Nylon bush bearing we used in the machines are all custom made and are manufactured in thecompany itself.

The outer shell of the bearing is turned out from a standard

**4**

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**01 – 06**

MS bar and the nylonbush is made from a solid nylon bar on a centre lathe.

## 4. BENDING OF WHEEL SPOKES

Wheels will be supported by 4 spokes of 8mm diameter and 130 mm long mild steel rods.Strength of wheel spokes must be checked against bending failure. i. e. each spoke is treated ascantilever beam for analysis purpose. Assuming bending moment is equally distributed amongall the wheel spokes and load is shared equally by both wheels. Spokes are welded on to thecentral hub.

Torque applied on wheel shaft=27.854Nm
Torque transmitted by each wheel=27.854/2
=13.927Nm



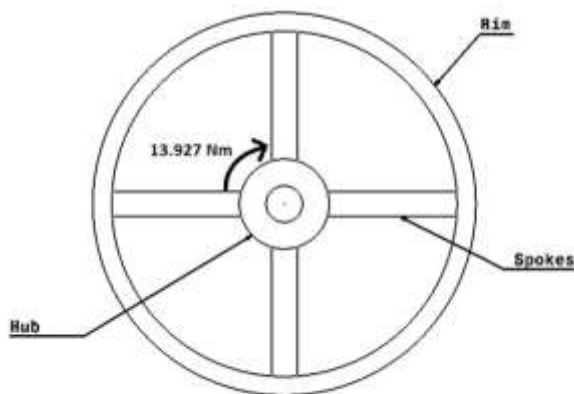Fig 4. wheel spokes

Number of spokes=4
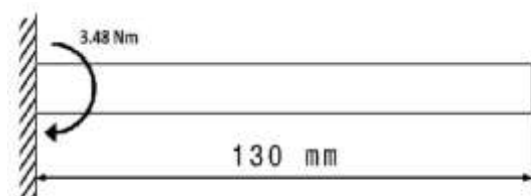Diameter of spokes=8mm
Bending moment on each spoke=13.927/4
=3.48175Nm



Fig 5. Bending of spokes

Yield strength of weld joint(Syt)=272.2 MPa
Factor safety=2
Bending stress=

$$\sigma = \frac{My}{I} = \frac{26.78*0.13*0.008/2}{\frac{\pi}{64}*0.008^4}$$

σ=69.26MPa
allowable stress (σall) =syt/2
=136.1MPa
Hence selected spokes are safe against bending

## VII. TESTING OF MACHINE

### 1. TESTING THE MACHINE ON DRY LAND

To check whether the chain drives will work properly or not, machine was tested on dryland/loose soil. The main objective of the test was to check if whether the motion is transmittedfrom the wheel shaft to the machine or not. For testing purpose machine was dragged on loosesoil by hand. The test was performed within the company premises only. After the test plantingspacing was found out to be in the range of 16 cm. This slippage of 1-2 cm is may be caused dueto inadequate penetration of steel wheel into the solid ground.Hence after performing the test it was confirmed that motion is transmitted from wheels tothe machine.

### 2. Mud Field Test

Date of Test: 10 May 2017.
Test Location: Ring Agro Pvt Ltd.
Plot no-o/s 4/1, Street no-17,
Behind Carbon company,
MIDC, Satpur,
Nashik.

After the assembly of wheels and chain drives, to check the performance of machine inmuddy field, mud field test was performed. The test field was prepared at rose nursery. Theobjective of this test was to check the functioning of machine in actual conditions.To check working of transplanting mechanism of the machine we show some rice seeds toget some rice seedlings, so that we could use them during the test to create actualconditions. However even after several attempts rice seedlings could not grow because ofunfavourable climate.The test was carried out in mud field of around 5-6m long. The depth of mud was around15cm.The first difficulty which we experienced was while doing forward walking. Inforward walking, we experienced huge force and strength to pull the machine. Whereas inbackward walking very small force is required to pull the machine as compared to forwardwalking. Another problem associated with forward walking was the machine tended totopple. Hence backward walking was comfortable and preferable.The next observation we made was the wheels and chain drive were functioning properly.The wheels were receiving adequate traction and rotating properly without any slippage.The plate strips attached at the end of the spokes were providing adequate grip. Thetransplanting mechanism was also working properly.

## RESULT & DISCUSSION

The modified machine was tested in the mud field, and it worked. In this machine ground wheelsupplies the power to operate transplanting mechanism. Pulling the machine rotates the steelwheel. But we could not test the

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machine with actual rice seedlings due to unfavourable climate.The machine should be pulled to operate. Ergonomically it is easier to apply pushing force ratherthan pulling force. However, as the machine will be planting seedlings behind it as we pull itthrough the field, it is better to stay ahead of the machine rather than walking behind it as it maydamage the planted seedlings.Another observation was made about the ways by which we can pull the machine, i.e. by eitherbackward walking or walking straight. During forward walking, more force was required to pullthe machine and it was difficult to maintain balance during walking. Also, machine tends totopple. This may be caused since while forward walking force applied morehorizontally which tends to rotate the machine about leading edge of the float. Operating themachine was way easier while pulling it by backward walking

## CONCLUSION

The modified machine worked satisfactorily. Wheels were able to get enough traction from theground without or with very little slippage. All the chain drives transmitted the motion inrequired speed ratio. We got seedling spacing of 15-16 cm which is the standard requiredseedling spacing. Currently the machine is to be driven by man power but in future light weightengine can be coupled to reduce the human efforts. Weight of the machine can be decreased byusing aluminium parts.

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