EVALUATION OF POWER-TILLER OPERATED PADDY TRANSPLANTER

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19

PROJECT REPORT

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DECLARATION

We hereby declare that this project report entitled **Evaluation of Power-Tiller Operated Paddy Transplanter** is a bonafide record of project work done by us during the course of project and the report has not previously formed the basis for the award of any degree, diploma, associateship, fellowship, or other similar title of any other University or Society.

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Tavanur,

30th Oct., 1993.

CERTIFICATE

Certified that this project report entitled **Evaluation of Power-Tiller Operated Paddy Transplanter** is a record of project work done jointly by **Neeraj Bhatia** and **Vinaya, K.N.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to them.

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CONTENTS

LIST OF FIGURES

LIST OF PLATES

SYMBOLS AND ABBREVIATIONS USED

Agrl.	-	Agricultural
APAU	-	Andhra Pradesh Agricultural University
ASAE	-	American Society of Agricultural Engineers
CIAE	-	Central Institute of Agricultural Engineering
cm	-	centimetre(s)
Dept.	-	Department
dia.	-	diameter
edn.	-	edition
et al.	-	and other people
F.C.	-	Field capacity
Fig.	-	Figure
FIM	-	Farm Implements and Machinery
ha	-	hectare(s)
hp	-	horse power
hr	-	hour
ICAR	-	Indian Council of Agricultural Research
Inc.	-	Intercontinental
IRRI	-	International Rice Research Institute
ISAE-	-	Indian Society of Agricultural Engineers
J.	-	Journal
KAU	-	Kerala Agricultural University

KCAET	-	Kelappaji College of Agricultural Engineering & Technology
kg	-	kilogram
km/hr	-	kilometre per hour
m	-	metre(s)
min	-	minute(s)
mm	-	millimetre(s)
MS	-	Mild Steel
No.	-	Number
P	-	pages
PAU	-	Punjab Agricultural University
RNAM	-	Regional Network for Agricultural Machinery
rpm	-	revolution per minute
Rs.	-	Rupees
s	-	seconds
wt.	-	weight
/	-	per
%	-	per cent
°	-	degree

INTRODUCTION

Since the sixties the Indian rice programme has been oriented towards achieving self-sufficiency through all modern scientific exercises.

Rice is the major food crop of the world. In India although area grown for paddy is less than that of wheat it is one of the most important sources of food. World Statistics (FAO, 1973) reveals that India covers 27.8 per cent of total paddy area but producing only 20.70 per cent of total production. India is the second largest paddy producing country in the world. In 1988-89 it produced 70.67 million tonnes of paddy from an area of 41.86 million ha. Still productivity in paddy is only 1.75 tonnes per ha which is very less compared to other countries. Any progress towards solution of problems relating to paddy production would, therefore result in increased supply for people who are urgently in need of food.

Most of the field operations like paddy transplanting weeding and harvesting are done manually. The preparation of seed-bed and transplanting accounts for over 23 per cent of total working hours for paddy cultivation. Manual transplanting of paddy crop requires 300-350 man-hrs/ha which is most tedious and time consuming. Moreover during peak

season labour shortage is observed. In the modern multiple cropping system the farmers should complete the transplanting operation within a particular period of time, keeping in view the time of release of canal water schedule, age of seedlings and seasons.

In Kerala, the area and production of paddy is gradually reducing for the last ten years due to the high cost of cultivation. Labour scarcity is also experienced during peak seasons for transplanting, harvesting and threshing. Introduction of labour saving and economical farm machinery is the need of the hour. Attempts were taken to introduce manually operated transplanters in Kerala. Due to low field coverage and the requirement of special (mat) type seedlings, the manual transplanters were not accepted by farmers.

A transplanter with high field capacity using conventional root washed seedlings, which can be operated by the commonly available power tillers will readily be accepted by the farmers of Kerala. This will reduce the cost of cultivation as well as labour scarcity in paddy cultivation in addition to increase in the annual use of power tiller.

Rice crop can be raised by direct sowing also but transplanting is better as it gives higher yields, less seed requirement, intercultivation and weed control are

facilitated, seeds are placed in rows, seedlings are healthy which are lesser sensitive to draught and heavy rain, less weed control problem.

The advantages of transplanting and limitations of manual transplanting have pushed the demand for the development of suitable equipment needed to mechanize this operation.

Hence it is proposed to develop a power tiller operated paddy transplanter using conventional root washed seedlings with the following objectives:

(i) To select a promising paddy transplanter for operating with power-tiller.

(ii) To study the various components, sub-assemblies of the power-tiller to improve the functions.

(iii) Completing preliminary trials in laboratory conditions and that in field conditions.

(iv) To carry out the required modification and evaluation of field performance.

REVIEW OF LITERATURE

Experience and experiment in all the more important areas of rice production confirm that higher yields may be expected from transplanted paddy than from direct broadcasting or drilling.

In India the increase in yield through transplanting has been 15 to 30 per cent (Ramaiah, 1954).

Recent work in Philippines showed that there is, in fact little difference in yield between broadcast and transplanted rice, but that direct sowing requires the use of non-lodging varieties and a much higher standard of management. Transplanting may be advisable as a protection against pests, to offset the effects of low seed viability, poor water supply and control, and to facilitate weed control (Grist, 1986).

It reveals that transplanting is beneficial to the plant and results in increased yields. But a very great care is taken in preparation of the nursery. It must be admitted that transplanting offers difficulties, the chief of which is the necessity of hand labour, but where these difficulties can be overcome, or circumvented by the use of mechanical transplanters.

2.1 Transplanting methods

2.1.1 Manual transplanting

The most common method of transplanting is to place seedlings in the puddled field by hand. For transplanting, healthy seedlings have to be raised in the seed bed. The wet or dry method for raising seedlings can be adopted, depending primarily on availability of water. Following are the steps in raising wet nursery. Plough and harrow the field two or three times until the soil is thoroughly puddled and levelled. Construct raised beds 5 to 10 cm high, 1 to 1 1/2 m wide and of convenient length with drainage channels between the beds. The total seed bed area should be 1000 square metre for each hectare of the field to be transplanted.

Treat the seeds by wet method. Drain and incubate in warm, moist place for sprouting. Never allow the seeds to dry up. Moisten them occasionally. Sow germinating seeds on the third day.

The dry method is practiced in areas where sufficient water is not available and time of planting uncertain. The method involves through ploughing to incorporate the weed and straw into the soil. Apply compost or cattle manure at the rate of 1 kg per sqm of nursery bed. Sow seeds evenly over

the bed and cover with fine sand. Water the nursery as and when required depending upon the receipt of rains.

Seedings are ready to be pulled out when they are in the 4-5 leaf stage; about 18 days after sowing for short duration varieties and 20 to 25 days after sowing for medium duration varieties. Irrigate seed bed about a day before pulling out the seedlings to soften the soil and to facilitate washing of roots. Pull out one or a few seedlings at a time to reduce damage. Wash-off mud and soil from the roots carefully and group seedlings into bundles of convenient size for transplanting.

Before transplanting manuring and fertilising are necessary. Transplant seedlings at a depth of 3-4 cm, by hand (Anon., 1978b).

Investigations proved that the transplanting of paddy has a series of advantages over other methods. But manual transplanting requires considerable labour and is of a laborious nature. In many areas the manual transplanting is done not in rows which in turn creates greater problems. This method is painful to the labourers as there is bending position through out the time of transplanting. Besides approximately 30 per cent of the total labour requirement for rice production is accounted for transplanting and often

results in labour scarcity during the peak season. Transplanting in rows of one hectare area normally requires 30 man days.

2.1.2 Mechanical transplanting

Timeliness of transplanting is considered as very essential for various yield and there has been an increase in realisation among rice growing countries to design and develop transplanters capable of performing precise and timely transplanting of rice seedlings at an acceptable cost (Kurup et al., 1981).

Some transplanting machines have mechanical transplanting devices that are hand fed but automatically place the seedlings. This arrangement allows the operators to work in more comfortable positions and tends to give more uniform placement. The device must be carefully designed to ensure that the plants will not be damaged and to preclude any possibility of injury to the operator. A brief review of some of the developed machines is presented in this section (Kepner et al., 1987).

Around 1950, a hand transplanting aid was developed and used in Taiwan (Stout, 1968). It was a simple aid consisting of an iron rod with a fork forged on one end. A wooden handle was mounted on the other end of the rod. It had

a length of 45 cms. Two to four seedlings were slipped into the fork and the tool was plunged into mud and withdrawn leaving the seedlings in its place. This contributed to an increased rate of transplanting by about 20 per cent but as it required considerable skill and experience it soon became absolute.

In 1964, development project of a simple hand operated transplanter was initiated at the NIAE in United Kingdom. The machine is mostly made of wood and weighs only 20 kg. It is operated by one man and transplant four rows (22.5 cm) apart at a time. The mechanical fingerset when actuated by the operator picks seedlings from seedling tray, returns back and plants them in soil. the machine has a field efficiency of 4.96 ha per 8 hours day under optimum field conditions.

Ben-Nun (1975) reported the design of a wooden paddy transplanter with platform that could be drawn over the field by a single animal. It had 240 cm length, 70 cm width and 12 cm height with eight adjustable pegs for making underneath. The persons sat on the platform in cross-legged posture. A worker picked up 6 to 8 seedlings from the bunch kept on his lap, divided them into two halves and then transplanted them by both hands in two adjacent markings left by the pegs. It was claimed that four trained workers and driver could do the work of fifteen labourers.

Mandhar (1975) designed and developed a three row transplanting aid for paddy. It consists of main frame, three seedlings dropping tubes, a spring loaded and hinged seedlings, retainer at the bottom, three planting fingers and an actuating mechanism. The device was reported to require about 300 man hours per hectare which practically saved no labour.

2.2 Non conventional and conventional seedlings

Non conventional seedlings are those which raised in a special nursery using frames such as band type, continuous band type, pot type or mat type seedlings. In band type, the box was divided by partitions to provide bands of seedlings which were 7 to 10 mm wide. The bands were cut at the time of transplanting into blocks of 10 to 15 mm length. In continuous band type the partitions did not span from edge to edge, so that the seedlings when grown took the shape of a continuous band extending from one corner of the box to the diagonally opposite corner. This was also to be cut into blocks at the time of transplanting. In the pot type, the box was divided into blocks or pots by lattice like partitions. The seedlings grown in this were ready to use without cutting (Biswas, 1981).

In mat type two methods were adopted. One is single

frame method, frames were kept side by side and the seedlings grow like a mat, with their roots inter woven. The frames could be removed one week after sowing. The lower frame serve as guide for the knife while removing the seedling mat. The transplanting unit was able to cut and slice out block of seedlings from the mat.

Band type - Non washed seedlings are grown in a box, had a corrugated polythene sheet below it. These seedlings had less soil thickness than others.

2.3 Transplanters using non conventional seedlings

Transplanters using mat type (soil bearing type) seedlings have gained more popularity in countries like Japan because of their labour saving feature as well as better quality of transplanting. Individual seedlings are not uprooted in this type but a specified piece of seedlings along with the soil known as mat is lifted. Uprooting of mats is much faster than the traditional seedlings. Obviously, this method cannot be adopted by the Indian farmers because of high initial investment. Also, the double frame method used in Philippines to grow mat type seedlings is costly to suit Indian conditions. Efforts were therefore, made to evolve a method wherein the initial investment can be substantially reduced.

After repeated periods of trial and error for over 50 years, it was only in 1965 that automatic paddy transplanters for non-washed seedlings successfully introduced in Japanese farmers. It consists of a seedling holder with seedling band of 7 mm width pulled out from a seedling holder and cut to about 1 cm by a blade and star wheel. The claw then planted these seedlings by pushing into the soil. Under ideal conditions the machine transplanted at a rate of one hectare in thirty hours with missing hills less than ten per cent.

In 1969 Hoshino reported about a two row self-propelled machine which had a float and it used continuous band type seedlings.

All the Japanese transplanters which had passed the National tests were engine driven machines of walking type with floats using non-washed seedlings. They were two row or four row, engine driven (1.6 to 2.5 hp) transplanters (Yoshia Kimosi, 1975). The floats and wheel system were adjustable which provided excellent right direction mobility of machine under all swampy conditions and a constant planting of seedlings were made by the planting fork. The planting fork was attached on a planting arm and the blocks were transplanted along a straight line. the different arrangements were of the planting forks to cut and release the

seedlings, worked by a link mechanism driven by a crank arm mounted on a shaft was powered by engine.

For the first time in India, two different makes of Japanese transplanting using mat type seedlings have been tested in 1975. Both these machines are self-propelled, two row and walking type. The seedling platform, which oscillates side wise, accommodates two nursery beds at a time. Specially designed transplanting arms pick up a block of seedlings (5-8 members). The machines have only one forward and no reverse speed. It had a capacity to cover an area of 0.046 to 0.12 ha/hr.

Singh and Garg (1977) reported the development of a six row rice transplanter using mat type seedlings in Punjab. It had three units and each unit had been given separate power drive. The average row spacing was 300 mm and the plant distance could be varied from 140 mm to 160 mm. the working of this machine was found quite satisfactory, with coverage only 0.1 hectare per hour and was not economical in comparison to hand transplanting. This unit was modified later, as tractor driven ten row transplanter which increased the field capacity to 0.17 ha/hr.

Development and evaluation of a tractor mounted paddy transplanter was started in 1974, at Budni, a tractor mounted

manual metering type, 7 row paddy transplanter was developed and tried in the puddled paddy fields. The main difficulty experienced during the trial was that the seedlings were getting buried due to the movement of soil caused by cage wheels. Another automatic tractor mounted, 12 row paddy transplanter also developed. The operation of transplanting arms is very similar to Japanese design. Preparation of mat-type seedlings was the only problem for the success of such transplanters (Biswas, 1981).

The five row and six row transplanters were developed in the lines of four row unit by the IRRI. The operation of the five row transplanter was similar to four row rice transplanter . Karunanithi et al. (1983) evaluated the five row manually operated rice transplanter. They studied the different methods of preparation of mat type nursery and the performance of the manually operated rice transplanter. They found that the capacity of the machine was 0.1 ha/day. There was 40 per cent saving in labour cost and 9 per cent saving in transplanting including nursery preparation as compared to the traditional method.

Reddy et al. (1984) designed and developed a ground wheel driven manually pulled paddy transplanter in Andhra Pradesh. The principle of four bar mechanism was used for operating the planting fingers. The drive was taken from the

ground wheel and transmitted through chain and sprocket arrangement and through gear wheels. The seedling tray frame was fabricated similar to that of IRRI-5 row transplanter. For planting fingers at a distance of 20 cm each were fixed on an angle iron bar, which was bottled to four bar mechanism. The intermediate shaft motion transmitted, operate the tray movement and nursery pushing mechanism. During the initial trials machine gave a field capacity of 0.4 to 0.3 ha per day.

Garg and Sharma (1985) reported developments, carried out on paddy transplanters at Bhopal, Ludhiana, Coimbatore and Hyderabad. It has been reported that all these centres started their work with the IRRI paddy transplanter as the base model.

A riding type engine operated paddy transplanter was developed at Ludhiana during 1985. This machine uses mat type seedlings. Experiments at different places indicated that the machine can transplant about 0.11 to 0.15 ha/hr. Labour and financial savings were found to be 68 per cent and 33 per cent respectively.

In Kerala Agricultural University, the IRRI-5 row and six row paddy transplanters were intensively tested from 1982 onwards. Minor modifications and adjustments were carried out. After conducting preliminary field trials with the six

row paddy transplanters the unit was found to give satisfactory performance. But raising of mat type nurseries as per the specifications was found difficult in actual field conditions (Anon., 1990).

2.4 Transplanters using conventional seedlings

At Coimbatore a manually operated transplanting mechanism was tried in 1962. It had two rows with eight pickers. The working was found similar to the Chinese hand operated transplanter. But its performance was reported to be not satisfactory (Anon., 1978a).

Two wheel tractor mounted root washed seedling type paddy transplanters appeared in Japan in 1965 (Miura, 1966). The conventional seedlings are kept in an upright position in the seedling box. The planting unit was attached to a two wheel tractor and was driven from the P.T.O. through a belt pulley. The planting claw moved to the seedling box and grasped a hill of seedlings which was pulled then out and transferred to the ground. Then the claw opened again and moved to its original position to repeat the operation. The claw opened at the upper end to pick up the seedlings and again at the lower end for planting. The machine was provided with a device to check the extra seedlings to be grasped by the fingers. The tray was moved transversely

after every picking to enable to grasp from fresh place. The depth of planting was adjustable by moving up and down the levelling board. The row to row spacing was 30 cm and hill distance was adjustable from 12 cm to 18 cm by changing the belt pulley. The major problem was the significant variation in the number of seedlings per hill.

Stout (1968) described a Chinese hand operated transplanter. It consisted of a box for holding seedlings mounted on a sledge platform. The seedlings were pushed to the near end of the box by a movable position and they were grasped by a remotely controlled set of seven pincers and forced into the puddled soil. He also reported that another manually operated paddy transplanter was developed in the Philippines. By a simple lever mechanism, the seedlings were picked up by the fingers from the tray and picking mechanism releasing the seedlings to the field.

Hoshino (1974) reported a power tiller operated transplanter which was commercially available during the sixties in Japan. The seedlings were washed and arranged and then transferred to the seedling box. Two to four seedlings were taken out by a resin claw. The holding claws made of rubber held them at the lower part of the seedlings and carried them above the seedlings receiving spring.

Sandhu (1975) reported the development of a bullock drawn paddy transplanter for conventional seedlings. A wooden circular disc of 75 cm diameter with twelve spring loaded fingers of 15 cm length each arranged serially at the periphery of the disc was the main part of the machine. The disc was driven by a ground wheel by means of a chain and sprocket. The seedlings were arranged in a box after cleaning and proper sizing which were gripped and planted in the soil by the fingers that were opened and closed by a pair of stationary wooden cams. It was also observed that the performance of the machine was not satisfactory.

Mahapatra (1976) developed an indigenous paddy transplanter named Annapurna in Orissa. It had ten rows, made use of root washed, pruned seedlings. The major component of the machine were body handle, finger set handle, finger opening lever, seedling tray, marker, float, clamp type fingers and finger guide channel. When the finger opening lever was pressed, all fingers opened for gripping the seedlings. The seedlings were pressed into the puddled soil and released. The machine was pushed back to repeat the operation. Seedlings were planted 2 to 4 cm deep into the soil, and average of the machine was about 0.16 hectares per day.

It has been reported an automatic paddy transplanting mechanism at Kharagpur was developed by Parida and Das (1977). It consisted of tray assembly, finger mechanism and an oscillating mechanism for fingers. Laboratory tests showed that the number of seedlings in a hill varied from 1 to 8 and planting was done at 60 degrees to 90 degrees from horizontal with 12.5 to 21.0 percentage of missing hills.

It has been reported from China that a self-propelled, riding type, 12 row paddy transplanter was developed for seedlings of 20 to 30 cm height with washed an timmed root. Working width of the machine was 210 cm. Row spacing varied from 10 to 20 cm and planting depth varied from 3.5 to 7.0 cm. The output of the machine at different row spacing varied from 0.14 to 0.23 hectare per hour (Biswas, 1981). With these experience a six row, self-propelled transplanter with the working speed of 0.36 to 0.50 metre per sec was developed in Korea.

In Tavanur, the IRRI six row paddy transplanter, designed for mat type nursery seedlings was modified and tested for conventional seedling (Bainu, 1990). The test results showed that the field capacity improved from 0.0139 ha/hr to 0.162 ha/hr and also improved the field efficiency from 48.26 per cent to 56.87 per cent.

Though there were many attempts for developing a transplanter using conventional seedlings, there is not much success reported so far. But the development of a transplanter for conventional seedlings is very essential for reducing the drudgery of labours and also to reduce cost of transplanting and for making paddy cultivation more profitable. Hence an attempt has been undertaken to modify and to test a suitable power tiller mounted transplanter for conventional seedlings.

MATERIALS AND METHODS

In this chapter the selection of prime mover for operating a suitable paddy transplanter, along with details of its different components, operating method and evaluation of paddy transplanter are discussed.

3.1 Selection of prime mover

In every paddy growing area where the operating holdings are smaller, the walking type two wheel tractors along with the rotavator attachment are found common. In Kerala also the power tillers are manufactured and are widely used in paddy cultivation. Considering its simplicity of operation and affordable cost a power tiller is selected as the prime mover for operating the paddy transplanter.

The 8-10 HP air cooled diesel engine mounted power tiller (Mitsubishi make) which is available in the Department of Farm Power Machinery and Energy is selected for further studies on paddy transplanter.

3.2 Selection of paddy transplanter

The six-row paddy transplanter developed at IRRI, Philippines was widely tested in India. The simple design, easy construction, low cost and minimum number of components

of the IRRI paddy transplanter are its advantages. As it was pulled and operated manually the field capacity is very low a suitable paddy transplanter is needed to be operated with power tiller as its prime mover. At Andhra Pradesh Agricultural University, Hyderabad researchers were undertaken to develop a suitable paddy transplanter. The prototype which developed was got fabricated by the Andhra Pradesh Agro Industries Corporation.

The IRRI designed transplanter requires special mat type nursery. From the experiences from Kerala the preparation of this special nursery is a difficult task because of heavy rainfall. It is decided to develop a transplanter which can use only the conventional root wa ed loose seedlings.

3.3 Description of components

The complete diagram of the APAU power tiller operated 8-row paddy transplanter is given in Fig.1. The details of main components are given below.

3.3.1 Auxillary gear box

For operating the picker assembly of the paddy transplanter rotary power is to be transmitted from the power tiller gear box. The rotavator assembly is to be dismantled

All dimenstion in cm

1. Tray
2. Picker
3. Four bar mechanism
4. Power tiller
5. Supporting hitch
6. Engine
7. Float
8. Transporting wheel

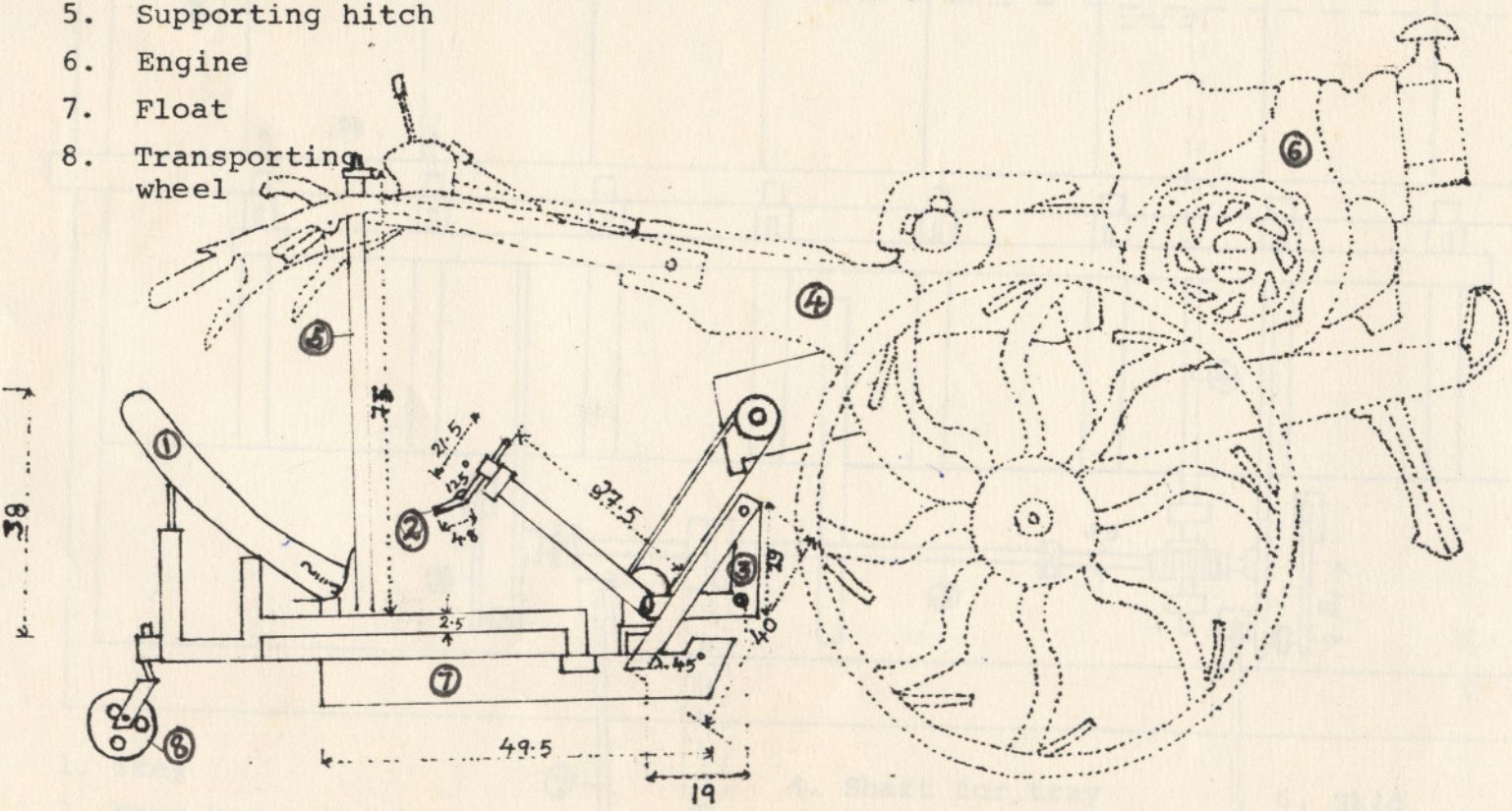
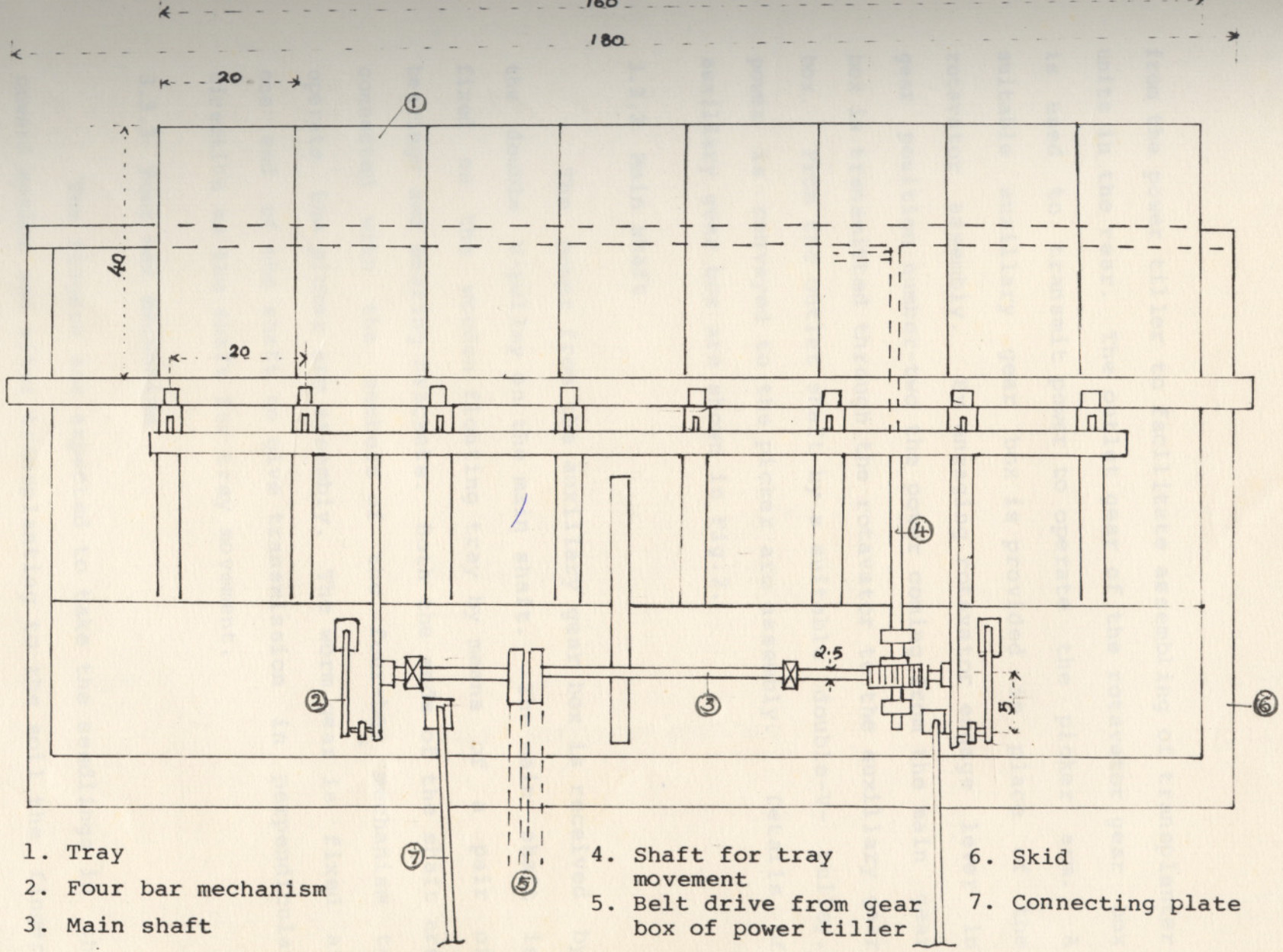


FIG.1a SIDE VIEW OF POWER-TILLER MOUNTED 8-ROW PADDY TRANSPLANTER



1. Tray
2. Four bar mechanism
3. Main shaft
4. Shaft for tray movement
5. Belt drive from gear box of power tiller
6. Skid
7. Connecting plate

FIG.1b TOP-VIEW OF POWER-TILLER MOUNTED 8-ROW PADDY TRANSPLANTER

from the power tiller to facilitate assembling of transplanter units in the rear. The outlet gear of the rotavator gear box is used to transmit power to operate the picker arm. A suitable auxillary gear box is provided in place of the rotavator assembly. By engaging rotavator engage lever in gear position number-two the power coming from the main gear box is transmitted through the rotavator to the auxillary gear box. From the outlet shaft by a suitable double-V- pulley, power is conveyed to the picker arm assembly. Details of auxillary gear box are shown in Fig.2.

3.3.2 Main shaft

The power from the auxillary gear box is received by the double V-pulley on the main shaft. The main shaft is fixed on the wooden floating tray by means of a pair of bearings and bearing brackets. Both the ends of the shaft are connected with the members of the four-bar mechanism to operate the picker arm assembly. The worm gear is fixed at one end of the shaft to give transmission in perpendicular direction to the shaft for tray movement.

3.3.3 Four bar mechanism

The fingers are expected to take the seedlings in the onward motion and after transplanting to the soil the fingers have to return in a different path without disturbing the

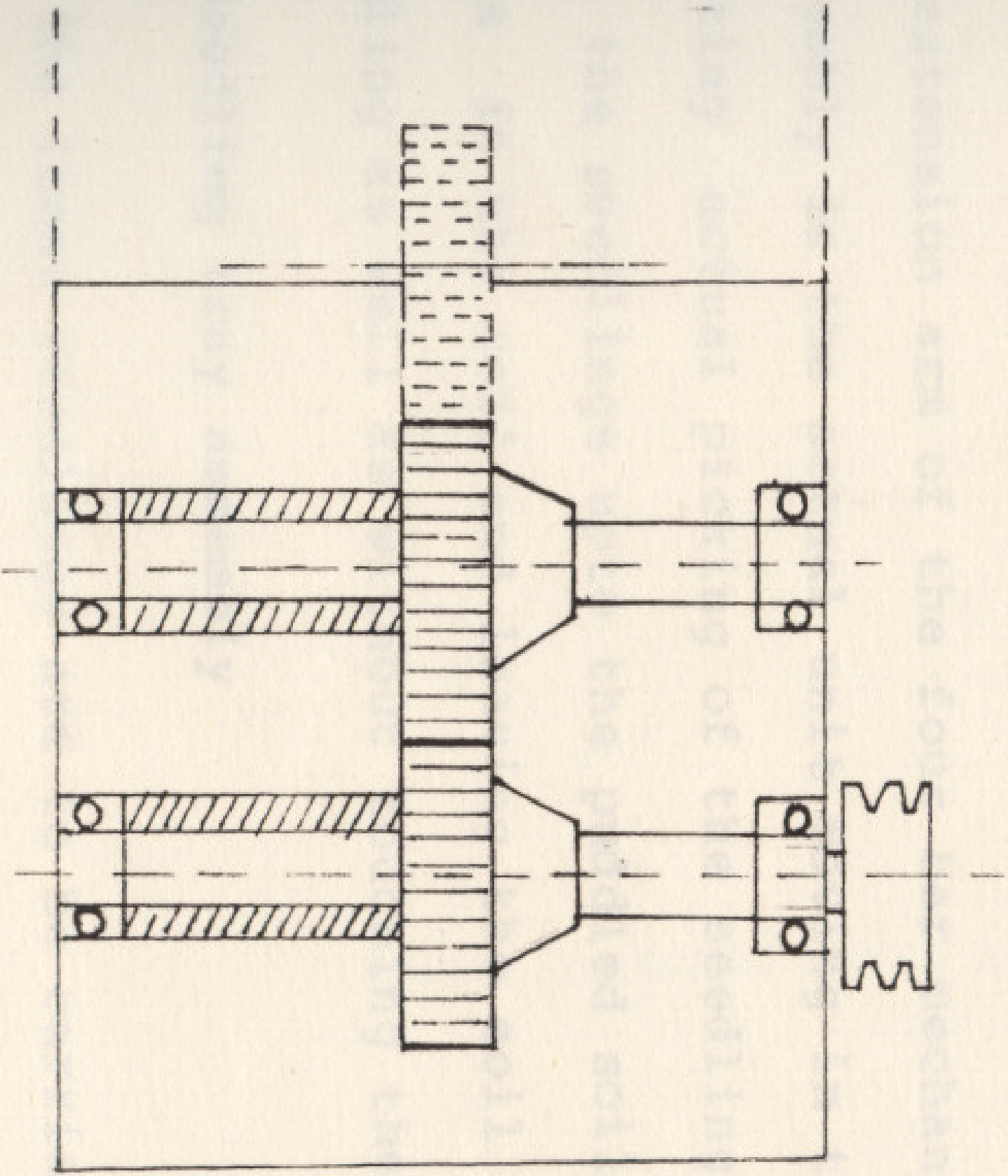


FIG.2 AUXILLARY GEAR-BOX

seedlings in the tray. To achieve this a special locus forming four bar mechanism was incorporated. The details of the four bar mechanism is given in the Fig.3.

3.3.4 Picker arm assembly

The picker arm assembly consists of fasteners for fixing the fingers on the square bar and fingers are connected in the extension arm of the four bar mechanism. The picker arm assembly is the actual unit moving in the required locus facilitating actual picking of the seedlings by the fingers carrying the seedlings upto the puddled soil transplanting the seedlings in the soil and leaving the soil without removing the seedling as well as without touching the tray assembly.

3.3.5 Seedling tray assembly

The loose seedlings are to be carried and is to be fed through the opening for picking in the tray. To feed continuously the seedlings the tray has to move in a reciprocating manner. The tray assembly consists seedling tray, holding platform, partitions, guide and rollers, pressing plate, and crank. The crank is getting power from rotary motion of the worm and gear shaft.

3.3.6 Float

A float or wooden skid is provided as the platform for

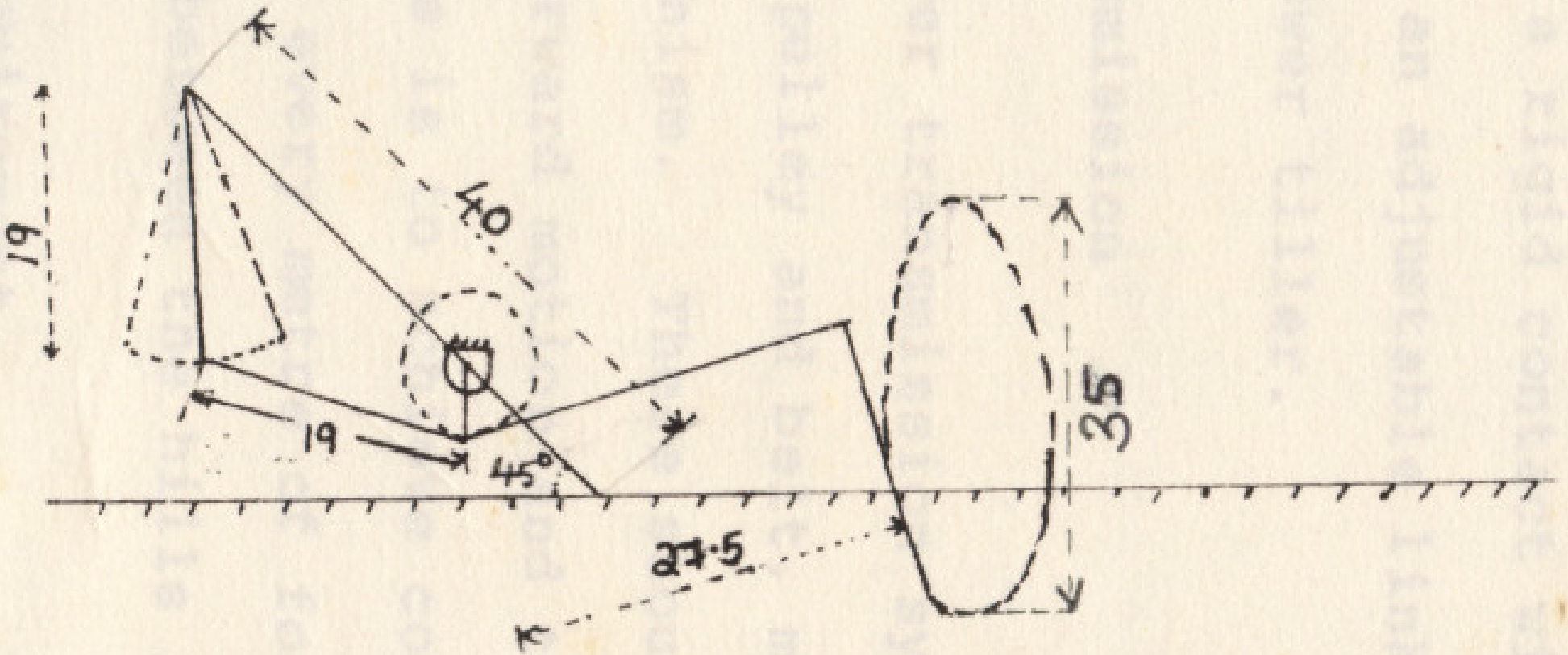


FIG.3 FIGURE SHOWING FOUR BAR MECHANISM

fixing the tray assembly, main shaft and other parts and also to level the land before transplanting. The float assembly is rigidly fixed with the power tiller by a pair of fixing arms. To have a rigid contact with power tiller the float is connected with an adjustable link which is connected to the handle of the power tiller.

3.4 Power transmission

The power transmission system consists of auxillary gear box, the pulley and belt, main shaft, worm gear, and picker arm mechanism. There should be a linear relationship between the forward motion and the speed of the picker arm assembly. This is to achieve correct number of strokes of the fingers for every metre of forward travel so as to have correct spacing between the hills in the row.

3.5 Seedling requirement

The pulled root washed seedlings of 15-30 days of age are enough for operating with paddy transplanter. The calculation for length and diameter of seedlings are shown in Appendix-I.

3.6 Main land preparation

The main land should be puddled and is to be perfectly levelled. Enough time is to be allowed for settling the

coagulated particles so as to have a firm soil for operating the paddy transplanter. When the soil is settled the water is to be drained and power tiller with transplanter can be taken to field for operation.

3.7 Operating method

Seedlings are to be loaded uniformly in all the eight compartments of seedling tray and the press plate is allowed to give enough pressure for continuous feeding to the fingers. When the transplanter gear is engaged the power from the engine through the main gear box and axillary gear box will operate the four bar mechanism to take the seedlings from the tray. In the same time immediately after the seedlings are taken the tray will move horizontally so as to feed the seedlings for the next stroke. When the tiller is in the forward motion the picker arm will transplant in eight rows having 20 cm spacing between row to row.

3.8 Evaluation

The transplanter which was received from Hyderabad was assembled. After rectifying the defects in the individual components preliminary trials were taken up in the laboratory and all the defects were recorded. After rectifying the operating defects the unit was operated in the stationary position for 20 hrs. Again the machine was taken on the road

and was operated for 10 hrs to find that the defects in the gear box connecting, connecting arms, float and four bar mechanism. When it was found satisfactory the machine was operated for 5 hrs in the puddled land without any seedlings to find out its feasibility. During these preliminary trials, the operator was also get accomplished with various functions of the power tiller and transplanter.

In the puddled, levelled and settled land the unit was taken after loading with seedlings. After completing the preliminary trials the unit was operated in the field, and all the observations were taken. The defects recorded were rectified and trials were carried out for a week. Improvements were carried out in all the assemblies.

3.9 Feasibility studies

The cost of operation for transplanting paddy with power tiller operated paddy transplanter was compared with conventional method to find out the benefit of using the improved paddy transplanter.

Plate I - 8 row Paddy Transplanter ready for transplanting.

Plate II – Paddy transplanter in operation.

RESULTS AND DISCUSSION

The details of the power tiller operated paddy transplanter are given below:

4.1 Specification of paddy transplanter

Type of machine	:	Power tiller drawn paddy transplanter
Operating width 'cm'	:	160
Weight of machine without seedlings 'kg'	:	83
Crop for which machine is suitable	:	All varieties of paddy
Sources of power	:	10 HP Diesel engine fitted power tiller
Number of planting fingers	:	8
Row to row spacing 'cm'	:	20
Provision for adjustment of row to row spacing	:	Nil
Plant to plant spacing 'cm'	:	10-15
Arrangement for changing plant to plant distance	:	By shifting the gear lever
Provision for changing plant numbers per hills	:	By changing finger fork width
Size of compartments in seedling tray 'cm'	:	20 x 40 require total of 8 numbers
Angle of nursery tray with respect to horizontal	:	40°

Planting fingers

(i) Type	:	Fixed fork
(ii) Opening b/w	:	4 mm

Expected forward speed of travel 'km/hr'	:	1.2
Theoretical field capacity 'km/hr'	:	0.1

Number of persons required

(i) Transplanting	:	One
(ii) Nursery transplanting and filling trays	:	One
(iii) Gap filling	:	One

Materials for construction of important components

a.	Gears	:	Hardened steel
b.	Pulley	:	Cast iron one and one Aluminium
c.	Belt	:	Non-elastic fibre
d.	Nursery tray	:	Aluminium
e.	Float	:	Hard wood and G.I. sheet
f.	Frame	:	M.S. angle
g.	Hitching limbs	:	M.S. plates, Two sides limbs One outer limb

4.2 Modifications carried out

4.2.1 Auxillary gear box

The auxillary gear box was attached to the power tiller gear box. Due to mis-alignment of gears and insufficient spacing maintained between the shafts connected to gears, proper engagement could not be achieved.

The gears of auxillary gear box were properly aligned and the rough surface of the casing was faced. Various packing materials were tried but the rubber packing of 6 mm thickness was only found suitable. The gear box was again fitted to power tiller. Oil was filled and gear could be shifted smoothly. But still oil leak was observed from the bearing through which shaft of auxillary gear box was connected to pulley. Oil seal and a housing was provided to all the points to prevent any oil leak. After these modifications the auxillary gear box was found to work smoothly without any problem.

4.2.2 Tray movement

The belt was attached between the pulley of main shaft and the pulley of auxillary gear box. All the nuts and bolts were tightened. Where so ever needed spring washers and locknuts were provided. It was operated and irregularity in tray movement was observed for sometime and then movement

stopped completely. It was due to too much clearance between worm and pinion, which was leading to slippage of pinion over the worm. Also since the shaft for tray movement was not tightly fitted to the bearings, there was a sliding movement. The clearance between worm and pinion was reduced and the diameter of the shaft was increased at the bearing positions for getting a tight fit. Also the diameter of the shaft at one of the ends was increased slightly again to arrest any possible sliding due to load. Now the tray was found to work satisfactorily.

4.3 Speed reduction

The rotary motion available at the auxillary gear box was transmitted to the picker arm mechanism through pulley without any reduction. When the engine cam shaft is running at the maximum speed of 495 rpm, it is found that the four bar mechanism gives 150 strokes per minute. From the main shaft the power transmitted for tray movement by worm and pinion gear, the speed reduction of 10:1 was observed and it was found that the tray has 15 strokes.

4.4 Field evaluation

The evaluation of paddy transplanter was carried out in K.C.A.E.T, Farm, Tavanur during the month of September-October 1993. The main land was puddled with power tiller

cage wheel twice and was levelled perfectly. When the soil got settled after 30 hrs the water was drained, leaving only a thin layer of water. The seedlings of the age of 25 days were loaded in the transplanter tray and the observations were taken.

4.5 Results

The results of the critical evaluation of the 8-row paddy transplanter using conventional seedlings are as follows:

Test I

A. Seedlings

(i)	Paddy variety	: Red Triveni
(ii)	Average number of leaves per plant	: 3
(iii)	Average length of roots in 'mm'	: 40
(iv)	Average height of seedlings in 'cm'	: 25

B. Type of soil : Sandy loam

C. Area of plot 'm^2' : 1120

D. Transplanting in first gear of power tiller

(i)	Average depth of transplanting 'mm'	: 45

(ii)	Average number of seedlings/ hill	:	2-4
(iii)	Hill per m^2	:	40-45
(iv)	Plant to plant spacing 'cm'	:	10-12
(v)	Length of row 'm'	:	70
(vi)	Percentage of missing hills	:	6.43 per cent
(vii)	Percentage of floating hills	:	12.34 per cent
(viii)	Percentage of buried hills	:	2.30 per cent
(ix)	Average time lost in operation/row (sec)	:	52
(x)	Average time taken for transplanting per row (min)	:	6.02
(xi)	Average speed of operation (m/min)	:	11.62
(xii)	Finger strokes per minutes	:	113.25
(xiii)	Theoretical field capacity (ha/hr)	:	0.11
(xiv)	Actual field capacity (ha/hr)	:	0.097
(xv)	Field efficiency	:	87 per cent

Test No.2

A. Seedlings

(i)	Paddy variety	:	Red Triveni
(ii)	Average number of leaves per plant	:	3
(iii)	Average length of roots in 'mm'	:	40
(iv)	Average height of seedling in 'cm'	:	25

B.	Type of soil	:	Sandy loam
C.	Area of plot 'm^2'	:	1120
D.	Transplanting in II gear of power tiller		
	(i) Average depth of transplanting in (mm)	:	45
	(ii) Average number of seedlings per hill	:	2-4
	(iii) Hills per m^2	:	30-35
	(iv) Plant to plant spacing 'cm'	:	15-17
	(v) Length of row 'm'	:	70
	(vi) Percentage of missing hills	:	8.23 per cent
	(vii) Percentage of floating hills	:	10.50 per cent
	(viii) Percentage of buried hills	:	3.00 per cent
	(ix) Average time lost in operation/row (sec)	:	36
	(x) Average time taken for transplanting per row (min)	:	5.05
	(xi) Average speed of operation (m/min)	:	15.66
	(xii) Finger strokes per minutes	:	130
	(xiii) Theoretical field capacity (ha/hr)	:	0.15
	(xiv) Actual field capacity (ha/hr)	:	0.10
	(xv) Field efficiency	:	66.61 per cent

It was observed that the transplanter could be transported by its own wheel using power tiller to any other place where the power tiller can move. For completing the

transplanting operation, after entering the field we should leaving spacing of 1.8 m width. Cover the entire plot in a zig-zag manner. A spacing of same 1.8 m width should be left from all the four sides of the field.

4.6 Economy

Nearly 40 man days are required for transplanting manually in one hectare. The cost of transplanting comes out to be Rs.3000 per ha. The total cost of transplanting by using power tiller operated paddy transplanter includes depreciation cost, insurance, taxes etc. the per hectare operating cost was compared to the hiring charge of power tiller in the local region. The hiring charge of power tiller is Rs.100 per hour. As the unit is for transplanting 0.1 ha/hr. It is possible to complete one hectare within 10 hours. The total cost comes out to be Rs.1000 per ha which is three times lower than the manual transplanting. In this way the farmer can save an amount of Rs.2000 per hectare.

Moreover the labour shortage felt during harvesting, threshing and transplanting which coincides often will also be reduced.

Calculation of operating of a power tiller operated 8-row paddy transplanter

A. Power tiller

a. Basic information

(i)	Cost	:	Rs.50000
(ii)	Life	:	10 years
(iii)	Labour requirement	:	3 men
(iv)	Fuel charge	:	Rs.7/lt
(v)	Number of hours used/year	:	800

b. Calculation

(i)	Depreciation cost/hr	:	Rs.5.62
(ii)	Interest/hr	:	Rs.4.125
(iii)	Insurance and taxes/hr	:	Rs.1.25
(iv)	Repair and maintenance/hr	:	Rs.3.75
(v)	Fuel cost/hr	:	Rs.8.40
(vi)	Labour charge for 3 labour/hr	:	Rs.28.12
(vii)	Lubrication charge/hr	:	Rs.2.52
	Total cost of power tiller/hr	:	Rs.53.79

B. Paddy transplanter

a. Basic information

(i)	Cost	:	Rs.16000
(ii)	Life	:	5 years
(iii)	Number of hours used/yr	:	300

b. Calculation

(i) Depreciation cost/hr : Rs.9.60

(ii) Interest/hr : Rs.3.52

(iii) Insurance and taxes/hr : Rs.1.06

(iv) Repair and maintenance/hr : Rs.3.20

Total cost of paddy transplanter/hr : Rs.17.38

Total cost/hr for power tiller and paddy transplanter = 53.79 + 17.38

= 71.17/hr

$\therefore$ Cost/hr = 71.17 x 0.1

= 711.70/ha

C. Let wages for labourer = 75/day

then 40 man day are needed to cover one hectare of manual transplanting, therefore cost/ha by manual transplanting

= Rs.3000/ha

SUMMARY

Paddy which is the major food crop in India needs high labour investment. In Kerala the wage rate for labourers are very high and scarcity of labourers is also felt during peak seasons. Due to these problems area under paddy is decreasing every day.

To help the farmers to continue the paddy cultivation labour saving machines should be introduced. Transplanting of the paddy which often coincides with harvesting and threshing is one of the major labour intensive operation. It was decided to evaluate a power tiller operated paddy transplanter for the conventional seedlings.

The IRRI manually operated paddy transplanter is simple in construction and operation but the field capacity is very low. To get higher per capita work output it was decided to evaluate a power tiller operated paddy transplanter. Mistibishi power tiller was selected for this purpose.

The APAU, 8-row transplanter was got fabricated and received. It was mounted with power tiller and evaluated in laboratory conditions. The problems in mounting the paddy transplanter, in assembling the auxillary gear box with power

tiller gear box, oil leak in auxillary gear box shaft, alignment problem of main shaft, slipping of worm and pinion gear, finger contact with the seedling tray, the problem in reciprocating movement in seedling tray are rectified in several stages. The unit was operated in the laboratory for so many hours and was taken to road for finding its manourability. In different stages the machine was operated in puddled land and the problems were observed and rectified.

The power from the power tiller gear box is taken through auxillary gear box which is mounted with paddy transplanter.. The output of the gear box is transmitted through double groove V-pulley and belts to the main shaft of transplanter. The transplanter consists of a float on which the main shaft is mounted with two bearings. The main shaft gives power to the picker arm through a pair of four-bar mechanism and also to a reciprocating tray movement through warm and pinion, shaft and crank. The seedling tray consists of 8 ~~components~~ compartments of 20 cm width and seedlings holding platform with slots. The fork fingers mounted in the picker arm assembly take the seedlings from the slot by the action of four bar mechanism, while the moving tray feeding the seedlings continuously.

The ordinary paddy seedlings (Red Triveni variety) which were pulled and root washed, ready for manual

transplanting were used in the paddy transplanter. The power tiller operated 8-row paddy transplanter was operated to transplant paddy seedlings at K.C.A.E.T. Farm, Tavanur during September-October 1993. The power tiller was operated at a forward speed of 11.62 m/min in the first gear, 2 to 4 seedlings were transplanted at a spacing of 10-12 cm. In the second gear the spacing between the seedlings was 15 to 17 cm. The field capacity was found to be 0.1 ha/hr. The average density/m^2 of area was 30-35 hills. Missing, floating and buried hills were found to be slightly in higher range which needed attention for improvement.

Compared to manual transplanting timeliness of operation, saving in labour cost at the tune of four folds was achieved by using the transplanter.

SUGGESTIONS FOR IMPROVEMENT

(i) The height adjusting rod should be shifted slightly away from the locus of picker arm.

(ii) Additional support is to be provided at the cantilever end of the main shaft to avoid slippage of pinion over worm gear and to get perfect reciprocating motion.

(iii) The pressure plate is to be modified to get uniform pressure at all the positions of it.

(iv) The entire transplanter unit should be an integral part of the power tiller. For this additional supports are to be provided from the handle.

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*Originals not seen

Appendix-I

Diameter and height of seedlings in a conventional nursery of 25 days age

Sl. No.	Diameter of seedlings (mm)			Height of seedlings (mm)
	I	II	Average	
1.	1.28	2.40	1.840	265
2.	1.36	2.92	2.140	257
3.	1.06	1.87	1.465	252
4.	1.13	2.54	1.835	235
5.	1.17	2.32	1.745	249
6.	1.40	2.16	1.780	243
Average			1.8	250.2

Average size of seedlings = 1.8 mm

Average height of seedlings = 250.2 mm

EVALUATION OF POWER-TILLER OPERATED PADDY TRANSPLANTER

By

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ABSTRACT OF THE PROJECT REPORT

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ABSTRACT

As a solution for the high cost of cultivation and labour shortage in paddy cultivation a power tiller operated paddy transplanter was evaluated at K.C.A.E.T. Farm, Tavanur during September-October, 1993. The 8-row APAU power tiller operated paddy transplanter was got fabricated. Improvements were carried out on the power transmission system, picker arm assembly and tray assembly. The conventional root washed paddy seedlings were used. With the first gear, at a forward speed of 11.62 m/min, the transplanter could transplant 2 to 4 seedlings per hill of paddy at a spacing of 10 to 12 cm. When the tiller was operated in second gear, at a forward speed of 15.66 m/min the actual field capacity was 0.1 ha/hr. A saving of Rs.2000/ha and reduction of 28 man day/ha was achieved for transplanting operation alone in paddy cultivation compared to manual transplanting. With further improvements this transplanter will be highly accepted by farmers of Kerala.