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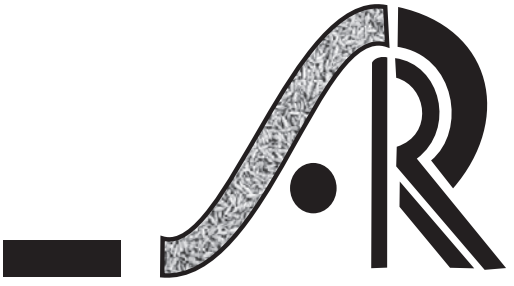

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Contents

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Study of Adoption of Mechanical Rice Transplanters through Custom Hiring in Tamil Nadu- a Case Study

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Abstract

A case study was carried out in selected districts of Tamil Nadu to study the impact of rice transplanter. It was observed that there is a paradigm shift from manual rice transplanting to mechanical rice transplanting, basically due to increased farm power availability, reduction in working manpower, import of mechanical rice transplanter and constant government support through various schemes. It is observed that for the 8 row Yanji rice transplanter, the break even hours of usage is 100 per annum. The total cost of operation of the machine works out to Rs. 200 /h, where in Yanmar rice transplanter, it was found that the break even hours of usage is 550 per annum. The total cost of operation of the machine works out to Rs. 400 /h. Case study clearly depicts that custom hiring services will help both farmers and entrepreneur in rice cultivation.

Keywords: Mechanical rice transplanter, custom hiring, power availability, break even analysis

Introduction

Rice is cultivated in 113 countries and it is the staple food of more than 50 percent population of the world. About 90 per cent rice area exists in Asia (Das, 2012). India is one of the world's largest producers of rice, accounting for 21% of total world's rice production with the annual production of 102.5 MT in 2015 (Anon., 2015). The average rice yield in India is 3.72 t/ha, as compared to world average of 4.55 t/ha (Anon., 2014). Rice is cultivated in almost all the states of India but most of its cultivation is concentrated in the river valleys, deltas of rivers and coastal plains. The main rice producing states are Tamil Nadu, West Bengal, Andhra Pradesh, Bihar, Punjab, Orissa, Uttar Pradesh, Karnataka, Assam and Maharashtra. During various rice cultivation operations agriculture workers undergo high physical strain and fatigue. In overall rice cultivation process manual rice transplanting operation is one of the drudgery prone and back- breaking activity. Due to severe weed problem, farmers often prefer transplanting than direct sowing of seeds. Manual rice transplanting is a labour intensive operation which requires 200-250 man-h/ha. During peak season labourers are not available (Das, 2012). Therefore modern agricultural machineries play a vital role in developing countries. Mechanization increases land productivity by timely completion of farm operations. It increases labour productivity and reduce drudgery of human and animals. It increases production by precision and efficient placement of inputs such as seed, fertilizer, chemicals and irrigation water. Mechanization decreases cost of production by reducing labour needed for particular operation and economy of power and other inputs (Das, 2012).

Though manual transplanting gives uniform crop stand it is quite expensive and requires lot of labour besides involving lot of drudgery. Singh *et al.* (1985) reported that transplanting takes about 250-300 man hours/ha which is roughly 25 per cent of the total labour requirement of the crop. Further, due to rapid industrialization and migration to urban areas, the availability of labour became very scarce and with hike in the wages of labour, manual transplanting is found to be costly leading to reduced profits to farmers. Under such circumstances a less expensive and labour-saving method of rice transplanting without yield loss is the urgent need of the hour (Tripathi *et al.*, 2004). The mechanical transplanting of rice has been considered the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to high productivity. It also Generates an alternate source of income for rural youth through custom services on nursery raising and mechanical transplanting.

Studies were conducted at Agricultural Research Station, Gangavathi, Karnataka state during 2002 to 2004 on the feasibility of mechanizing transplanting operations in rice crop with a view to reduce the cost of cultivation.

An eight row self-propelled rice transplanter was used for the purpose. The performance of the mechanical transplanter was quite satisfactory. The field capacity, field efficiency and fuel consumption of the transplanter were 0.19 ha/h, 78 per cent and 6.25 l/ha, respectively. Cost of mechanical transplanting was Rs.789/ha as compared to Rs.1625/ha in case of manual transplanting provided the machines are used for their maximum usage of 90 hectares in a year. As the usage of the machine in terms of number of hectares/year decreases, the cost of operation increases. To breakeven with the cost of manual operation, the mechanical transplanter should be used at least in an area of 28 hectares per year. Hence, the mechanical transplanting would be economical provided an area of 28 ha and above is covered every year. Grain yield in both manual and mechanical transplanting was on par with mean grain yield of 5.38 and 5.4. t/ha, respectively (Manjunatha *et al*., 2009).

Nagaraj *et al*. (2013) conducted a study to know the knowledge and adoption level of rice growers of Raichur district about farm mechanization practices. The study was conducted in Sindhanur and Manvi taluks of Raichur district of Karnataka comprising 120 respondents from six villages. Majority of the respondents had complete knowledge *i.e.*, mode of operation, frequency of use and specification of the implements such as mouldboard plough, harrow, cultivator, power tiller, cage wheel, puddler, sprayer, combine harvester and thresher. Further, less than half of the respondents (42.50%) belonged to medium level of adoption category. As in case of knowledge level, large majority of farmers used the implements *viz*, Mouldboard plough, harrow, puddler, cultivator, cage wheel, power tiller, sprayer, combine harvester and thresher. However, only (15.00%) of the rice growers possessed skill in the use of rice transplanter.

The area under rice crop is decreasing year by year due to various factors such as increased cost of inputs, labour shortage and less profitability. Transplanting of rice seedlings in the traditional way is a labourious, time consuming and causes drudgery. Non-availability of labourers for transplanting at appropriate time leads to late planting, which results in poor yields. In rice, planting methods have an impact on the growth, yield attributes and yield besides cost of cultivation and labour requirement. Rice transplanting if done manually and requires about 306 man-h/ha, which is roughly 42 per cent of the total labor requirement of rice production. At transplanting time, acute labor shortage results in increased labor wages and delay in the transplanting operation. Manual transplanting also results in non-uniform and inadequate seedling populations. These problems necessitated the introduction of mechanized rice transplanting to achieve timely planting and better crop stands (Sangeetha and Baskar, 2015). The SRI (System of Rice Intensification) transplanting method encourages the planting of one seedling per hill and spaced in 25×25 cm for better usage of water, nutrient and pest management (Ibrahim and Ismail 2014).

Agricultural workers, draught animals, tractors, power tillers, diesel engines and electric motors are used as sources of farm power in Indian agriculture. The availability of draught animals power has come down from 0.133 kW/ha in 1971-72 to 0.094 kW/ha in 2012-13, whereas the share of tractors, power tillers, diesel engines and electric motors has increased from 0.020 to 0.844, 0.001 to 0.015, 0.053 to 0.300 and 0.041 to 0.494 kW/ha, respectively during the same period. The total power availability on Indian farms has increased at a CAGR of 4.58% from 0.293 to 1.841 kW/ha during the last four to five decades.

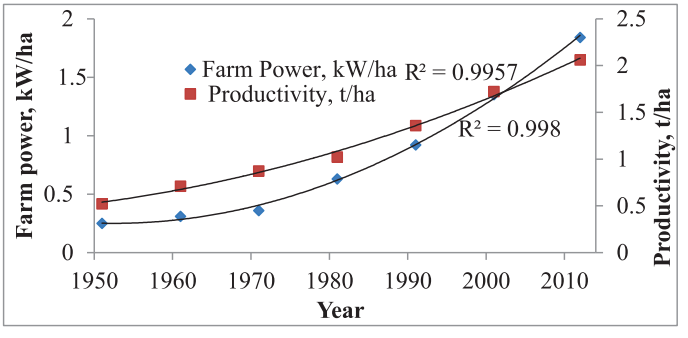

Fig.1 Trend of farm power and agricultural productivity

Farm power availability and productivity in India

Fig.1 shows the relationship between farm power availability and agricultural productivity for the past six decades in Indian agriculture. It is seen from Fig. 1 that the farm power availability and productivity increased from 0.25 to 1.84 kW/ha and from 0.52 t/ha to 1.92 t/ha, respectively over the years from 1951 to 2012. It has been observed that farm power availability and food grain productivity have a direct relationship (r^2= 0.986) during the last six decades *(*Mehta *et al., 2014).*

Status of rice transplanter market in India

Table 1 presents the market overview of the major Rice based machinery used in India.

Table 1: Market overview of the major farm machinery used in India

Name of machinery	Market size annually	Approximate cost, US $
Tractor	600000	7000-12000
Power tiller	56000	2100
Combine harvester	4000-5000	22000 – 35000
Thresher	100000	1600 – 2500
Rotavator	60000-80000	1300-2000
Rice transplanter	1500-1600	
Walking type		2500-4200
Riding type		3300-16600
Self-propelled vertical conveyor reaper	4000-5000	1300-2000
Zero till seed drill	25000-30000	750-850
Multi -crop planter	1000-2000	850-1000
Laser land leveller	3000-4000	5800-6500
Power weeder	25000	8500

Source: Mehta et al., 2014

From the table it is found that the market for self-propelled (walking and riding type) rice transplanters in India was almost nil about 5-6 years back as the rice transplantation was done manually with the use of labour. Presently, many companies in India are importing rice transplanters from China, Japan and Korea and marketing them in all regions of country. The rice transplanters market in India has grown from about 550 in 2008-09 to 1,500-1,600 units in 2013-14. The industry is expected to grow by more than 50% in coming years with Chhattisgarh, Odisha, Bihar and southern states showing positive sign of adoption of mechanized technology.

Role of Government of India in promoting rice transplanters through schemes

Realizing the need to enhance farm mechanisation domestically, the central government under its flagship ministry *i.e.* Ministry of Agriculture has undertaken various steps to promote the usage of machinery by domestic farmers. The central government's efforts towards farm mechanisation have been aggregated under a formal programme *viz.* Sub-Mission on Agricultural Mechanisation (SMAM). It came into existence during the current five year plan (2012-17) at an estimated outlay of Rs. 2000 crore over the five year term. The details of the mission components and government assistance is given in Table 2 and financial assistance for promotion of farm machinery and equipment is given in Table 3.

Table 2: SMAM – Mission components, government's assistance (www. agricoop.nic.in or www.vistar.nic.in)

S. No.	Mission Components	Share of Assistance		Implementing Agency
		Centre	State	
1	Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration	100	0	State identified institutions, ICAR institutions, PSUs of GOI, State Governments
2	Demonstration, Training and Distribution of Post Harvest Technology and Management (PHTM):	100	0	State identified institutions, ICAR institutions, PSUs of GOI,State Governments
3	Financial Assistance for Procurement of Agriculture Machinery and Equipment	50	50	State Governments
4	Establish Farm Machinery Banks for Custom Hiring	50	50	State Governments
5	Establish Hi-Tech, High Productive Equipment Hub for Custom Hiring	50	50	State Governments
6	Promotion of Farm Mechanization in Selected Villages	50	50	State Governments
	Financial Assistance for Promotion of Mechanized Operations/ hectare Carried out			
7	Through Custom Hiring Centers	50	50	State Governments
8	Promotion of Farm Machinery and Equipment in North-Eastern Region	50	50	State Governments of 8 North eastern States

Table 3: Financial assistance for procurement of farm machinery & equipment (www. agricoop.nic.in or www.vistar.nic.in)

Agriculture Machinery	For General Farmers		For SC, ST, Small & Marginal farmers, Women and NE States beneficiary	
	Pattern of Assistance (%)	Max permissible subsidy per machine/equipment per beneficiary (Rs)	Pattern of Assistance (%)	Max permissible subsidy per machine/equipment per beneficiary (|Rs)
Tractors				
1) 05-15 Hp	25	0.75 lakh	35	1.0 lakh
2) 15-20 Hp	25	0.75 lakh	35	1.0 lakh
3) 20-40 Hp	25	1.0 lakh	35	1.25 lakh
4) 40-70 Hp	25	1.0 lakh	35	1.25 lakh
Power Tillers				
1) <8 Hp	40	0.4 lakh	50	0.5 lakh
2) >8 Hp	40	0.6 lakh	50	0.75 lakh
Self Propelled Rice Transplanter				
4 rows	40	0.75 lakh	50	0.94 lakh
8 rows	40	2.0 lakh	40	2.0 lakh
16 rows	40	2.0 lakh	40	2.0 lakh
Self Propelled Machinery				
Reaper cum Binder	40	1.0 lakh	50	1.25 lakh
Paddy Thresher		0.2 lakh		0.25 lakh

Sub-Mission on Agricultural Mechanisation lays emphasis on custom hiring services through the rural entrepreneurship model, thereby making an effort to reach out to small and marginal farmers.

Status of rice transplanter in Tamil Nadu

Tamil Nadu is rapidly transforming to a high level of agricultural mechanization. In the recent years 50-60 crores were allotted for distribution of machinery under supply of subsidized machines under National Agricultural Development Programme (NADP). Due to the sudden change in labour scenario, many farmers adopted mechanization in rice. Different custom hire operators have emerged according to the economic necessity especially for rice harvesting and transplanting in addition to the traditional services of plowing and transport. However the small and medium farmers find it extremely difficult to carry out day to day work. Due to the fragmented holding the farmers are not able to engage private hire operators. Realizing this scenario the Tamil Nadu Government has stepped in to set up custom hire centers under primary agricultural cooperatives. In the past two years about 225 custom hiring centers has been set up in TN. Now the Tamil Nadu Government has planned to expand in a massive scale and to set up 2000 agro service centers in Tamil Nadu. Hand holding support and technical guidance is given to these centres.

Three types of rice transplanter introduced in Tamil Nadu by State Government are Self-propelled single wheel riding type transplanter, Self-propelled walk behind type rice transplanter and Self-propelled 4 wheel type rice transplanter. These transplanters are being custom hired directly or through other agencies.

Self propelled single wheel type rice transplanter was introduced in 8 row models (Fig. 2). Machine was operated by diesel engine with power ranging from 2.94 to 3.68 kW. The machine consisted of power transmission system, handle for operation, main frame and rice transplanting tray, float and transplanting unit. It had a lugged wheel and the weight of the machine rests on the lugged wheel and float at the time of transplanting. The same lugged wheel was replaced by a pneumatic wheel for transportation. Power from the engine is transmitted to front traction wheels through gear train and to the transmission housing of transplanting unit through universal shaft. Six row machine had row spacing of 30 cm and eight row machine had row spacing of 23.8 cm. Plant to plant spacing is adjustable (12-14 and 14-17 cm). Setting is provided for adjusting the number of hills transplanted/sq. meter. Transplanting depth is also adjustable. Brief specifications of machine are given in Table 4.

Self-propelled walk behind type rice transplanter is a 4 row walk behind type machine operated by a 3.2 kW petrol engine (Fig. 3). The machine consisted of power transmission system; handle for steering the machine, main frame and rice transplanting tray, float and two pairs of transplanting units.

Fig. 2. Single wheel riding type transplanter

Fig. 3. Self propelled walk behind type transplanter

It had only two lugged wheels and the weight of the machine rests on the lugged wheel and float at the time of transplanting. The same lugged wheels were used for transportation. Power from the engine is transmitted to front traction wheels through gear train and to the transmission housing of transplanting unit through universal shaft. The machine had 1 forward gear 1 reverse gear. Row to row spacing is 30.0 cm and four settings are provided for plant to plant spacing *i.e.* 12, 14, 18 and 21 cm. Four settings are provided for adjusting the number of hills transplanted/ sq. meter. Transplanting depth is also adjustable. Brief specifications of machine are given in Table 4.

Self-propelled 4 wheel type rice transplanter is a 6 row riding type machine operated by a 12.5 kW petrol engine (Fig. 4). The machine consisted of power transmission system, handle for steering the machine, main frame and rice transplanting tray, float and two pairs of transplanting units. It had four lugged wheels and the weight of the machine rests on the lugged wheel. The position of rice transplanting tray is adjusted by hydraulic system. The same lugged wheels were used for transportation. The machine had hydrostatic transmission with 5 forward and 5 reverse speeds. Row to row spacing is 30.0 cm and five settings are provided for plant to plant spacing *i.e.* 12, 14, 16, 18 and 21 cm. Five settings are provided for adjusting the number of hills transplanted/sq. meter. Transplanting depth is also adjustable.

Fig. 4. Self propelled riding type transplanter

The following advantages were observed with the use of mechanical transplanter in rice cultivation

1. Efficient utilization of resources by saving labour and cost of overall production.
2. Timely transplanting of seedlings of optimal age.
3. Ensures uniform spacing and optimum plant density.
4. Higher productivity compared to traditional methods.
5. Less incidence of disease in seedlings due to less root injury generated due to shock while transplanting.
6. Improving soil health through reduced puddling.

Table 4: Typical specifications of different types of rice transplanters

S. No.	Specification	Observations		
1	Machine	Self propelled single wheel riding type	Self propelled walk behind	Self propelled 4 wheel type
2	Type of nursery used	Mat type	Mat type	Mat type
3	Power Source	Diesel Engine, 2.94 to 3.68 kW	Petrol Engine, 3.20 kW	Petrol Engine, 12.5 kW
4	Type of Steering	Mechanical	Handle type	Hydraulic
5	No. of gear	Forward - 3 (2 for Field and 1 for Road) Reverse – Not Provided	Forward – 1 Reverse – 1	5 Forward and 5 Reverse Speeds
6	Number of rows	6 and 8	4	6
7	Row to row spacing, cm	23.8 and 30	30	30
8	Plant to plant spacing, cm	12-14, 14-17	12, 14, 18, 21	12, 14, 16, 18, 21
9	Number of hills transplanted/m^2	Two settings	Four settings	Five settings
10	Transplanting depth	Adjustable	Adjustable	Adjustable
11	Type of planting finger	Needle type	Plate bar with Notch	Plate bar with notch
12	Material of tray	Galvanized iron sheet	Plastic	Plastic
13	Type and material of traction wheel	Iron wheel with iron lugs	Iron wheel with rubber lugs	Two front non-puncture rubber wheels and two rear iron wheels with rubber lugs
14	Transport wheel type	Pneumatic	-do-	-do-
15	Float type and material	Single piece, fiber	Split bars, plastic	Split bars, plastic

Overall custom hiring scenario in study area

The study was taken up in the rice bowl of Tami Nadu *viz.*, Tanjore, Sivaganga, Kumbakonam, Kancheepuram, Chengalpet and Tiruvannamalai. The following observation was noted during the survey.

1. Rapid growth of custom hiring in transplanting with coverage of about10 % of transplanted area.

1. Emergence of centralized nursery for supply of seedlings at Sivaganga, Kumbakonam and Vaipoor. Emergence of transplanter service providers were seen in these areas.

2. Subsidy provided by government is a great driver for adoption of mechanization.

3. Mechanized transplanting has spread in delta districts and slowly increasing in other districts in south.

4. High demand for mechanized transplanting was noticed in Northern districts of Kancheepuram, Chengalpet Thiruvannamalai.

The details of population of transplanters available in Tamil Nadu is furnished in Table 5.

Table 5: Population of transplanters in Tamil Nadu

Sl. No.	Transplanter-Make	Numbers (aproximate)
	4 WD Transplanters	
1	Yanmar 8 row	60
2	Kubota 6 row	70
3	Deodang 6 Row	35
4	Kukje 6 Row	25
	Walk behind	
1	Kukje 4 row	50
2	Southern agro Chennai	500
3	Kubota 4 row	200
4	Deodang 4 row	6
	Single wheel riding type	
1	Yanchi 8 row	200
	Total	1146

A total of 1146 rice transplanters were available in the 2014 in Tamil Nadu, 17.45% were single wheel riding type rice transplanters, 65.96 % were walk behind type rice transplanters and only 16.57% were 4 wheel type rice transplanters.

Break even analysis

The break even analysis was carried out based on interaction effect between total cost incurred (Rs/year), annual Usage of the machine (hour) and total return obtained (Rs/year).

a. Yanji rice transplanter

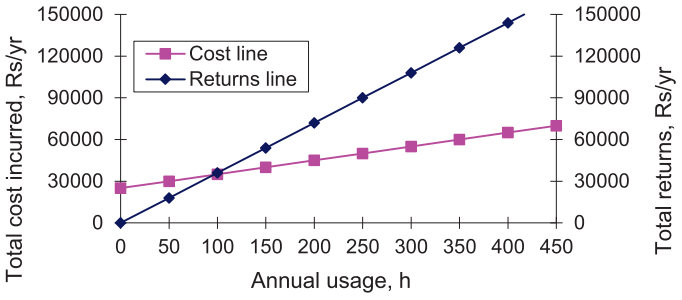

Fig. 5 Breakeven analysis on hiring of 8 row Yanji rice transplanter

On plotting the cost and returns lines for the 8 row Yanji rice transplanter (Fig.5), it was found that the breakeven hours of usage is 100 per annum. The total cost of operation of the machine works out to Rs. 200 /h. Annual machine usage under hire exceeded 1000 h and the machine break-evened the cost in approximately 100 h of operation. On plotting the cost and returns lines for the Yanmar rice transplanter (Fig. 6), it was found that the breakeven hours of usage is 550 per annum. The total cost of operation of the machine works out to Rs. 400 /h. Annual machine usage under hire exceeded 2000 h and the machine break-evened the cost in approximately 550 h of operation.

b. Yanmar rice transplanter

Economics of transplanting

A study was conducted with existing custom hiring operator in Tamil Nadu. The average of the operating cost from various custom hiring service operators operating eight row Yanmar rice transplanter is detailed Table 6. The custom hiring rate and profit details are given in Table 7.

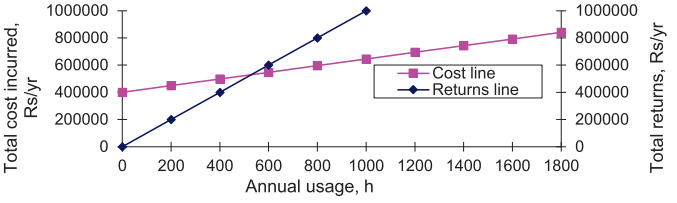

Fig. 6 Breakeven analysis on hiring of 8 row Yanmar rice transplanter

Table 6: Operating cost of riding type six row transplanter

Sl. No.	Cost classification	Average Cost (Rs/ha)
1	Cost of Machine	2500
2	Fuel	625
3	Operator	170
4	Helper	100
5	Maintenance	250
6	Transport of machine	250
	Total	3895

Table 7: Custom hiring rate and profit

Sl. No.	Cost classification	Average Cost (Rs/ha)
1	Operating Cost	3900
2	Seed	1100
3	Sowing labour	250
4	Polyethylene sheet	60
5	Total cost	5300 ~5500
6	Custom rate for transplanting with nursery	7500
7	Profit to service provider	2000
8	Management-overhead	Nursery maintenance-one supervisor and one Manager for overall management

From the table 7, it was inferred that the entrepreneur is getting Rs.2000 per ha and covers about 1000 ha covered per year, the entrepreneur will get profit of Rs. 8,00,000 from the custom hiring of transplanters. Thus custom hiring services will help both the farmers and the entrepreneur in rice cultivation.

Conclusion

Three types of rice transplanter introduced in Tamil Nadu by State Government were Self- propelled single wheel riding type transplanter, Self-propelled walk behind type rice transplanter and Self-propelled 4 wheel type rice transplanter. Out of total transplanters 17.45% were single wheel riding type rice transplanters, 65.96 % were walk behind type rice transplanters and only 16.57% were 4 wheel type rice transplanters. Rapid growth of custom hiring in transplanting with coverage of 10 % of transplanted area at present. The rice mechanization can be further increased by following the steps are listed below

a) Subsidized transplanting machinery.

b) Subsidized nursery sowing machine and nursery centers.

c) Providing incentive to farmer for mechanized transplanting.

d) Training women SHGs to use transplanting machinery in order to ensure alternative employment.

e) Setting up separate training center to train operators or initiating apprentice training under government subsidy.

f) Ensuring only proven machinery that are reliable, serviceable and having adequate service facility.

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