Crop Res. **53** (5 & 6) : 257-264 (2018) DOI : 10.31830/2454-1761.2018.0001.30
Printed in India

Use of mechanical transplanter for rice cultivation in Cauvery delta districts of Tamil Nadu : Impact and feedback assessment

RAVI KUMAR THEODORE* AND N. VENKATESA PALANICHAMY[1]

Kumaraguru Institute of Agriculture
Sakthinagar-638 315, Erode District (Tamil Nadu), India
**(e-mail : rk.theodore@gmail.com)*

(Received : October 15, 2018/Accepted : November 10, 2018)

ABSTRACT

The Government of Tamil Nadu during June 2015 had announced the "Kuruvai Special Assistance 2015 for Delta Districts" programme to boost rice production and productivity in the state. Among others, promotion of 'Machine Transplantation' of rice seedlings was one of the main components of this special package. To assess the success of this programme, a study was conducted to assess the impact of mechanical planting versus conventional planting, cost and returns, and feedback of farmers. The comparative economics of conventional and machine planting revealed the following : yield increased by nearly 40.00%; cost of cultivation decreased by 21.00%; cost of production reduced by 43.00% and ultimately net returns increased by more than four times (448.00%), over the manually planted fields. Farmers' feedback on machine planting was very optimistic with all the beneficiaries expressing that they had opted for machine planting to overcome labour scarcity, and to increase their yields. Major merits perceived by the beneficiaries included : mental agony due to rice cultivation had reduced significantly, significant increase in productive tillers, and reduction in seed rate which led to decrease in cost of production. On the whole, it was found that nearly two-third (65.00 %) of the beneficiaries were cent per cent satisfied with the government initiative.

Key words : Combined harvester, mat nursery, mechanical transplanter, rice, transplanting

INTRODUCTION

Rice (*Oryza sativa* L.) is the predominant crop in Tamil Nadu and is one of the leading rice growing states in India, cultivating rice since time immemorial as this State is endowed with all the favourable climatic conditions suitable for rice cultivation. During 2013-14, the total area under rice was 17,25,730 ha, with production of 71,15,195 tonnes, and productivity of 4,123 kg/ha (Department of Economics and Statistics, Chennai).

The Cauvery Delta Zone (CDZ) in Tamil Nadu comprising six districts viz., Thanjavur, Tiruvarur, Nagapattinam, Trichy, Ariyalur and Cuddalore is called as the Rice Granary of Tamil Nadu, due to its immense potential for rice production. Any disturbance in rice production in the CDZ adversely affects the foodgrain production of the State of Tamil Nadu. For this reason, modernization of rice production is constantly pursued with fervor by the State Government machinery with the active support of the Tamil Nadu Agricultural University (TNAU).

Among the modernization efforts, mechanization in rice cultivation in Tamil Nadu is becoming the need of the hour in view of escalating wages of the farm labour and their scarcity particularly during the peak transplanting period. According to Kulkarni (2016), though India has abundant labour force in agriculture, non-availability of manpower during peak crop season is a growing problem. On account of this, the Paddy Transplanter has been introduced in Tamil Nadu, which is gradually gaining momentum and replacing manual transplanting of rice seedlings. The machine is less labour intensive, helps in line transplanting, and enables easy weeding and intercultural operations. However, appropriate

[1]Professor (Agril. Economics), Department of Agricultural & Rural Management, Tamil Nadu Agricultural University, Coimbatore-641 003 (Tamil Nadu), India (nvpchamy@tnau.ac.in).

policy measures and programmes are required so as to encourage farmers to use the mechanical transplanter in their farms. According to Adhya (2011), India can occupy first position in world rice production, provided appropriate policies and institutional mechanisms are implemented. Nagaraj *et al.* (2013) reported that more than 90% of the respondents were found using combined harvester, MB plough, harrow and puddler in paddy cultivation; about 89 and 67% of respondents were using the cultivator and sprayer, respectively; whereas, less number of the farmers were observed to use paddy transplanter and cono weeder.

Among the several state government initiatives, during June 2015 the State Government of Tamil Nadu launched the "Kuruvai Special Assistance 2015 for Delta Districts" to boost rice production and productivity. One of the main components of this Kuruvai (June to September) special package was the promotion of 'Machine Transplantation' of rice seedlings, for which the State Departments of Agriculture and Agrl. Engineering took substantial efforts for mobilizing machine transplanters. Those farmers who went for Kuruvai rice cultivation were covered under this programme, whose fields were machine transplanted at subsidized rates.

In order to assess the impact of this machine transplantation programme, a study was conducted with the following objectives :

- To evaluate the economics of mechanical transplantation in rice cultivation, especially in terms of productivity and net profit advantages.
- To analyze the feedback regarding use of mechanical transplanter for rice cultivation, so as to understand the potential for sustained adoption.

MATERIALS AND METHODS

Ex-post facto research methodology was followed in order to trace the effects of machine transplantation in rice cultivation. The study was conducted in the six delta districts of Cauvery viz., Thanjavur, Tiruvarur, Nagapattinam, Trichy, Ariyalur and Cuddalore, in which the "Kuruvai Special Assistance 2015 for Delta Districts" was implemented by the Government of Tamil Nadu to boost rice production during Kuruvai season in 2015.

In order to select the sample farmers for the study, the list of beneficiaries covered under the "Kuruvai Special Assistance 2015 for Delta Districts" was obtained from the Office of the Joint Directors of Agriculture of the respective delta districts. As on 31 July, 2015, a total number of 1,006 farmers were covered under the mechanical transplantation component of the Kuruvai package. It was decided to select 25% of the population as sample for the study, and accordingly the sample size was fixed as 250, which was selected from the above six districts by following proportionate random sampling method. The selected 250 farmers were post-stratified into conventional and machine transplantation farmers. Out of the 250 farmers, 72 of them had followed conventional planting also, and in order to compare the improvement, these farmers were also studied.

The primary data were collected from the sample respondents through two rounds of survey. Two well-structured and pre-tested interview schedules were used to collect the primary data during the two rounds of survey. The data collected were tabulated in excel sheet. Percentage analysis was carried out for meaningful interpretation of the data generated.

RESULTS AND DISCUSSION

This chapter highlights the findings of the study in terms of profile characteristics of the farmer respondents, economics of conventional and machine transplanted rice, cost and returns, and farmers' feedback.

Personal Characteristics of the Respondents

Majority (54.00%) of the respondents were in the age group of 30-50 years, followed by 43.60% in the age group of more than 50 years. More than three-fourth (78.00%) of the respondents had secondary, higher secondary or graduate level of education. Farming experience of a majority (58.00%) of the respondents ranged between 21 to 30 years and above. More than one-third (36.00%) of the respondents were large farmers, followed by medium farmers (34.40%), small farmers (26.65%), and the rest (3.60 %) were marginal

farmers. A large proportion (42.00%) of the respondents were in the income category of less than one lakh rupees per year, followed by the income category of one to two lakh rupees per year (39.60%).

Comparative Economics of Conventional and Machine Transplanted Rice

The comparative economics of conventional and machine transplanted rice per acre is given in Table 1.

Nursery Cost

In this part of the analysis, three situations of seedling production were considered for computing the economics of nursery cost viz., (i) Conventional method of seedling production for conventional planting (traditional method), (ii) Mat nursery method of seedling production by farmers themselves for mechanical transplanting, and (iii) Direct purchase of seedlings from commercial nurseries for mechanical transplanting.

With regard to use of human labour in conventional nursery, for seven man days employed the cost incurred was Rs.910.00 per acre. Whereas in the case of mat nursery seedling production, it was just three labour man days at a cost of Rs. 580.00. Therefore, the net difference in human labour employed between conventional and mat nursery methods was four man days, which in monetory terms works out to Rs. 330.00 per acre.

Similarly, with respect to use of machine power (power tiller) in nursery, the cost incurred was lesser for mat nursery

Table 1. Comparative economics of conventional and machine transplanted rice (per acre)

S. No.	Particulars	Conventional nursery		Mat nursery		Purchase from commercial nursery
		Physical quantity	Cost (Rs.)	Physical quantity	Cost (Rs.)	Cost (Rs.)
I.	**Nursery operational costs**					
	Human labour (Man days)	6.40	910.00	2.60	580.00	2300 to 2800
	Machine power (h)	1.16	604.80	0.80	320.00	
	Seeds (kg)	38.26	1247.20	19.96	624.20	
	Manures & fertilizers (kg)-DAP	17.00	360.00	2.20	36.00	
	Plant protection chemicals (ml)	118.00	120.00	56.00	58.00	
	Interest on working capital @ 7-12%	-	307.99	-	153.73	
	Total cost		**3549.99**		**1771.93 (1770-2550)**	
II.	**Main field operational costs**					
	Land preparation (Bund clearing and cage wheel ploughing)	2 A type labour+ 1.95 h (tractor/power tiller)	3047.17	4 A type labour+2.15 h (tractor/power tiller)	4107.16	
	Pulling of seedlings and transportation to main field	5.71 A type labour	1750.00	-	-	
	Planting	15.50 B type labour	1536.67	3 B type labour for gap filling	360.00*	
	Manures and fertilizers	160-180 kg	3307.50	144.83 kg	3127.50**	
	Plant protection	480 ml	1659.83	367.33 ml	1163.50	
	Weed management (Cono weeder as applied to mechanical transplanting @ Rs. 300-400 per labourer for 33 cents)	11.83 labour	2148.50	9 B type labour	2193.83	
	Harvest (Combined harvester)	1.30 h	2609.00	1.27 h	2593.17	
	Interest on working capital @ 7-12%	-	1525.57	-	1286.79	
	Total cost (after planting)	-	**17584.24**	-	**14831.95**	
III.	**(Grand) total cost of cultivation (Summation of I & II)**	-	**21134.23 (100.00)**	-	**16603.88*** (100.00)**	
	Productive tillers/sq. m	334.17		467.83		
	Yield (kg/acre)	1643.33		2281.00		

*Excluding the subsidy amount of Rs. 2375 per acre for mechanical transplanter.
**Excluding the subsidy amount of Rs. 315 per acre for micronutrients.
*** Excluding the subsidy amount of Rs. 2690 per acre for mechanical transplanter plus micronutrients.

method (preparation of nursery beds) to the tune of Rs. 320.00, when compared to conventional method (Rs. 604.80).

In the case of seed rate, there was significant difference between seed rate followed in conventional method and mat system of seedling production. Under conventional method, the seed rate generally followed per acre is 35 to 55 kgs, whereas for mechanical transplanting, the seed rate required per acre is just 20 kg. Therefore, the net difference in seed rate per acre was 20 to 35 kg, equivalent to Rs. 600 to 1,050.00.

As far as application of fertilizers is concerned, on an average, 20 kg of DAP was applied in conventional nursery valued at Rs. 360.00; and on the other hand just two kg was applied in mat nursery method at a cost of Rs. 36.00. As a result, there was a saving of Rs. 324.00 due to mat nursery method.

In respect of use of plant protection chemicals, on an average, 118 ml of insecticides/fungicides were used in conventional nursery, which costs Rs.120.00. Compared with mat nursery method, the respondent farmers had used only 56 ml of insecticides/fungicides costing Rs. 58.00. This resulted in a saving of Rs. 62.00 under mat nursery method.

Further, the total cost of seedling production under conventional method of planting worked out to Rs. 3549.99. In the case of mechanical transplanting, the cost of seedlings worked out to Rs. 1771.93 per acre for mat nursery prepared by the farmers themselves, and Rs. 2300 to 2800.00 per acre for purchase of seedlings from commercial nurseries. Therefore, there was a saving of Rs.1778.06 (50.08%) under own mat nursery method, and Rs. 1049.99 with purchase of seedlings (29.57%).

Main Field Cost

From Table 1, it is seen that seven major components were considered to work out the cost of rice cultivation in the main field viz., land preparation, seedling pulling and transportation to main field, planting, manures and fertilizers, plant protection, weed management and harvest.

The average expenditure incurred per acre on land preparation under conventional and mechanical transplanting worked out to Rs. 3047.17 and 4107.16, respectively. Under mechanical transplanting, the expenditure incurred on land preparation was 34.79% higher than that of conventional method, since extra efforts were taken by farmers for land levelling.

Further, farmers who did conventional planting spent about Rs. 1750.00 per acre towards pulling of seedlings and transportation to main field. This was one of the major cost components under conventional method of rice planting.

With respect to planting, the conventional method required 15.50 women labourers per acre at a cost of Rs. 1536.67 per acre. In the case of mechanical transplanting, gap filling was an additional activity to be undertaken after machine planting by employing about 2 to 3 women labourers per acre leading to an additional cost of Rs. 360.00 per acre.

The average cost of manures and fertilizers for conventional and mechanical planted rice crop per acre was Rs. 3307.50 and 3127.50, respectively.

As far as plant protection was concerned, the crop in the main field was found to be uniform and well established under machine planting when compared to conventional method due to optimum population coupled with young seedlings planted at shallow depth. Machine planting with optimum inter- and intra-row spacing also paved way for better micro-climate with good aeration, which led to less incidence of pest and diseases, and as a result less expenditure was incurred on plant protection (Rs. 1163.50/ acre), which is 42.66% less when compared to the conventional method of planting (Rs. 1659.83/acre).

The study indicated that there was more expenditure on weeding in the case of machine planted fields (Rs. 2193.83/acre) as compared to manually planted fields (Rs. 2148.50/acre). The increase in expenditure on weeding under machine planting might be due to excess wages paid for the cono weeder operators ranging from Rs. 300-400 per person per 33 cents per time. But cono weeding is very much essential for better aeration besides facilitating formation of new roots thereby enhanced uptake of nutrients is made possible.

There was no significant difference on expenses incurred on harvesting since all the

farmers have used the Combined Harvester.

The total cost incurred in the main field for conventional planting was Rs.17584.24. At the same time, it was 14831.95 in the case of mechanical transplanting, with a saving of Rs. 2752.29 (15.65%) over the conventional planting.

The total cost of cultivation figures indicated that Rs. 21134.23 were incurred for conventional planting, while Rs.16603.88 were incurred under mechanical transplanting, with a saving of Rs. 4530.35 (21.44%).

Cost and Returns

The cost and returns with respect to conventional and mechanical planting methods are presented in Table 2. It is seen from Table 2 that yield (productivity) increase of more than 38.83% was reported in case of mechanically transplanted fields as compared to manually planted fields. Cost of cultivation was almost 21.44% lesser in the case of mechanically transplanted fields as compared to conventionally transplanted fields because of reduction in cost of seed, manures and fertilizers and plant protection chemicals. The reduction or saving in the cost of cultivation automatically resulted in the fall of cost of production by 43.41% in the case of machine planting as compared to conventional planting. Finally, it was observed that the gross returns as well as net returns were significantly higher, with 38.83% increase in gross returns and almost four times increase in net returns (447.54%). The almost 40 to 50% increase in number of productive tillers per hill under machine planting would have paved way for increase in yield/productivity of the crop, which reflected in increased net income per acre.

Farmers' Feedback

Farmers' feedback regarding mechanical transplantation in rice cultivation was elicited so as to understand the potential for sustained adoption. The analysis of farmers' feedback is presented in Tables 3, 4, 5, 6 and 7.

Reasons for Adoption of Mechanical Transplantation

The reasons for adoption of mechanical planting method were analyzed and the results are presented in Table 3. From Table 3, it is seen that cent per cent of the respondents had reported that 'to overcome labour scarcity during planting season', and 'significant yield increase' as the major reasons for adoption of machine planting arranged by the government. This was followed by 'to maintain perfect spacing between plants and rows which ensured optimum population' (as per recommendation), which resulted in good aeration and less pest and disease incidence (there was no report of blast disease in machine transplanted fields, whereas blast occurrence was reported in conventionally planted fields).

Table 2. Cost and returns in rice cultivation

S. No.	Particulars	Conventional planting (Rs.)	Mechanical transplanting (Rs.)	Sign
1.	Yield (productivity) in quintals per acre	16.43	22.81	More (+)
2.	Average price received (per quintal)	1476.00	1476.00	Nil
3.	Cost of cultivation (Rs./acre)	21134.23	16603.88*	Less (-)
4.	Cost of Production (Rs./q)	1286.32	727.92*	Less (-)
5.	Gross returns/acre	24250.68	33667.56	More (+)
6.	Net returns/acre	3116.45	17063.68	More (+)

*Excluding the subsidy amount of Rs. 2690 per acre (Rs. 2365 plus Rs. 315) for mechanical transplanter plus micronutrients.

Table 3. Distribution of respondents according to reasons for adoption of mechanical transplantation

S. No.	Particulars	No. of respondents	Percentage	Rank
1.	To overcome labour scarcity during planting season	250	100.00	I
2.	Significant yield increase	250	100.00	II
3.	To maintain perfect spacing (optimum plant population)	196	78.40	III

Table 4. Distribution of respondents according to level of satisfaction on mechanical transplantation programme

S. No.	District	Level of satisfaction (%)				
		0-25	26-50	51-75	76-100	Total
1.	Thanjavur	-	03	21	04	28 (11.20)
2.	Tiruvarur	-	-	27	103	130 (52.00)
3.	Nagapattinam	-	-	22	23	45 (18.00)
4.	Cuddalore	-	-	04	21	25 (10.00)
5.	Ariyalur	-	02	07	03	12 (4.80)
6.	Trichy	-	-	02	08	10 (4.00)
Overall Cauvery Delta		-	05 (2.00)	83 (33.20)	162 (64.80)	250 (100)

Level of Satisfaction on Mechanical Transplanting

The level of satisfaction on mechanical transplanting as reported by the respondents was analyzed and the results are presented in Table 4. It is inferred from Table 4 that nearly two-third (64.80%) of the respondents had reported that they were 100% satisfied with the machine transplantation programme of the state government. This was followed by 33.20% of the respondents who expressed that their level of satisfaction was 51 to 75% due to the reasons that : it may not be a suitable method of planting during rainy season as the field requires extra care for the first 20 days after mechanical transplantation in terms of providing proper drainage facility, and irrigation should be given as and when disappearance of water from the field. The rest (2.00 %) of the respondents were only satisfied up to the level of 26 to 50%, since they felt that their fields were clayey in nature and machine planting the seedlings too deep in the soil caused delay in establishment of seedlings during the initial period, moreover, providing proper drainage in clay soil also becomes difficult.

Merits of Machine Transplanting

The findings on the merits of machine transplanting are given in Table 5. From Table 5, it is seen that cent per cent of the beneficiaries have reported that 'mental agony of rice cultivation reduced significantly', 'increase in number of productive tillers', and 'reduction in seed rate resulted in decreased cultivation cost' as the major merits in machine transplanting. This was followed by the merits viz., 'reduction in time period of planting' (85.60%), 'timely planting made possible' (78.40%), 'possible to plant young seedlings' (71.60%), 'labour scarcity addressed' (42.80%), and 'nursery management significantly reduced' (18.00%).

Demerits of Machine Transplanting

The findings on the demerits of machine transplanting are given in Table 6. It is seen from Table 6 that cent per cent of the respondents reported that 'skill involved in nursery preparation', and 'more care should be given after planting in main field' as the two major demerits in mechanical transplanting. This was followed by 'cost of gap filling as

Table 5. Distribution of respondents according to merits of mechanical transplanting

S. No.	Merits	No. of respondents	Percentage
1.	Mental agony of rice cultivation reduced significantly	250	100.00
2.	Increase in number of productive tillers	250	100.00
3.	Reduction in seed rate resulted in decreased cultivation cost	250	100.00
4.	Reduction in time period of planting	214	85.60
5.	Timely planting made possible	196	78.40
6.	Possible to plant young seedlings	179	71.60
7.	Labour scarcity addressed	107	42.80
8.	Nursery management significantly reduced	45	18.00

Table 6. Distribution of respondents according to demerits of mechanical transplanting

S. No.	Demerits	No. of respondents	Percentage
1.	Skill involved in nursery preparation	250	100.00
2.	More care should be given after planting in main field (minimum 15 days extra care should be taken)	250	100.00
3.	Cost of gap filling as additional expense to be incurred by farmer	205	82.00
4.	Not suitable for rainy (wet) season (Thaladi season)	179	71.60
5.	Not suitable for highly clayey soils (fluffy soils)	116	46.40
6.	Non-availability of Cono weeder/power weeder	107	42.80
7.	Lack of expertise in mat/tray (cake) nursery making	89	35.60
8.	Proper drainage facility required	89	35.60
9.	Proper land levelling necessary before transplanting	89	35.60
10.	Uneven planting in deep clay soils	27	10.80
11.	Difficulty in mobility of transplanter between fields (in small fields) and low lying lands	27	10.80

Table 7. Distribution of respondents according to suggestions for improvement of the programme

S. No.	Suggestions	No. of respondents	Percentage
1.	Subsidy may be extended for few more years to increase adoption rates	107	42.80
2.	Cono weeder and laser leveller may be made available at Agri depots and Primary Agricultural Cooperative Societies (PACS)	89	35.60

additional expense to be incurred by farmer'(82.00%), 'not suitable for rainy (wet) season' (71.60%), 'not suitable for highly clayey soils' (46.40%), 'non-availability of Cono weeder/power weeder' (since they have positive impact on tillers) (42.80%), 'lack of expertise in mat/tray (cake) nursery making', 'proper drainage facility required', and 'proper land levelling necessary before transplanting' (35.60%), 'uneven planting in deep clay soils' and 'difficulty in mobility of transplanter between fields (in small fields) and low lying lands' (10.80%).

Suggestions for Improvement of the Programme

The analysis of the suggestions for improvement of the programme is presented in Table 7. From Table 7, it is seen that two suggestions viz., 'subsidy may be extended for few more years to increase adoption rates' (42.80%) and 'Cono weeder and laser leveller may be made available at Agri. depots and PACS' (35.60%) were offered by the respondents for further improvement of the programme.

Majority of the respondents had realized the importance of land levelling as a pre-requisite for machine planting. As a result, farmers have insisted government support in terms of monetary or subsidized custom hiring facilities in all revenue villages. Farmers have felt that Cono weeding under machine planted field improves the crop growth and productivity and hence, they have demanded supply of adequate number of Cono weeders through Government Depots under any subsidy scheme. It was also learnt that farmers needed to be given hands-on training on mat nursery technology in their villages.

CONCLUSION

The results of the study showed that nearly two-third (64.80%) of the respondents were cent per cent satisfied with the mechanical transplanter programme of the Government of Tamil Nadu, followed by about one-third (33.20%) of the respondents who had expressed 51-75% level of satisfaction. This clearly indicates the success of the State Government's initiative to introduce mechanical transplanter for rice cultivation in the CDZ in a large scale, which has resulted in increasing the efficiency of farm operations and solved the labour scarcity problem facing rice cultivation.

Farmers have demanded that 'Subsidy may be extended for few more years to increase adoption rates', which was fulfilled adequately, as in the subsequent years the subsidy package was implemented in the CDZ. Farmers have also expressed that 'skill involved in nursery preparation', and 'extra care should be given after planting in main field' as their major concerns in following mechanical transplanting, which needs to be addressed by the State Department of Agriculture for sustained adoption of the mechanical transplanter.

REFERENCES

Adhya, T. K. (2011). *Vision 2030.* Central Rice Research Institute, ICAR, Cuttack, Odisha, India.

Kulkarni, S. D. (2016). *Mechanization of Agriculture.* Central Institute of Agricultural Engineering, Bhopal. Available at : *http://www.unapcaem.org/activities%20files/a09105thtc/ppt/in-doc.pdf.*

Nagaraj, P., Dhananjaya Swamy, S., Madhushree, A. and Vidyadhara, B. (2013). A study on knowledge and adoption of farm mechanization by paddy growers in Tungabhadra Project Area, Karnataka. *Int. J. Agric. and Food Sci. Technol.* **4** : 385-90.

Negalur, R. B. and Halepyati, A. S. (2017). Dry matter partitioning and yield of machine-transplanted rice (*Oryza sativa* L.) as influenced by age and number of seedlings. *Crop Res.* **52** : 4-9.