# Economic Impact and Farmers Feedback assessment on Adoption of Mechanical Transplanter in Rice Cultivation

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***Abstract:*** *During June 2015, the State Government of Tamil Nadu implemented the scheme "Kuruvai (Kharif) Special Assistance 2015 for Cauvery Delta districts" to boost rice production and productivity in the state. One of the main components of this Kuruvai special package was the promotion of 'Machine Transplantation' of rice seedlings in the Cauvery Delta Zone (CDZ), which consists of six districts. At the behest of the State Department of Agriculture of Govt. of Tamil Nadu, an impact study was taken up to evaluate the profitability of adoption of mechanical transplanter for rice cultivation, as well as to collect feedback from farmers. It was found that nearly two-thirds (64.80 %) of the farmers were 100 per cent satisfied with the machine transplantation programme of the state government. There was a saving of Rs.1778.06 (50.08 %) due to mat nursery method, and Rs.2,752.29 (15.65 %) by following mechanical transplanting, over conventional planting. Further, yield increased by 40%, cost of cultivation decreased by 21%, and net returns increased by more than four times (448%) for farmers who adopted the mechanical transplanter. With respect to farmers' feedback, all the farmers opined that they had opted for machine transplanting to overcome labour shortage, and to increase rice yields. Farmers also expressed that the machine transplanter had freed them from mental agony.*

***Key words:*** *Kuruvai, Mechanical Transplanter, Cauvery Delta, Net Return, Feedback*

## INTRODUCTION

Rice is the world's most important staple food crop for more than half of the world's population.India is a traditional rice growing country, which feeds more than 60 per cent of its population. The area under rice crop which was 30.81 million ha in 1950-51has increased to 44 million ha during 2019-20. Production of rice has registered an appreciable increase from 20.58 million tonnes in 1950-51 to 117.47 million tonnes during 2019-20 (Second Advance Estimates of Dept. of Agriculture, Cooperation & Farmers Welfare, Govt. of India), which is above five times. Rice yield which was 668 kgperha in 1950-51, has increased to 3.82 tonesperha during 2019-20 (GAIN Report of USDA 2019). As far as Tamil Nadu is concerned, area under rice is 2.04 million ha with production of 7.98 million tonnes (2018).Transplanting method is more popularin rice cultivation among farmers due to higher yield and less weedgrowth as compared to direct seeded rice. However, itrequires high energy and also it is labour intensive (Verma, 2010). Of late, the availability of manual labour for transplanting rice has decreased drastically due to migration of labour from villages to cities for more wages which has led to manual transplanting difficult. Further, manual transplanting of rice is a tedious process and needs a manual labour of 250-300 man-hours per ha (Reddy, *et al.* 2018).Manually operated drum seeders with separate cylindrical seed boxes to drill

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the pregerminated paddy seed on puddled soil also gained momentum for some time to overcome the transplanting drudgery. But the main concern with drum seeders was less capacity and suitable only for small scale farming community. Moreover, this method requires considerably higher seed rate and often exposes the seed to damage by birds and environment.

The invention of the Mechanical Transplanter in rice is a good example for disruptive technology, with its usage since 1960s. It is fast and efficient; uses less labor and ensures timely planting; reduces stress, work load, and health risks; ensures uniform spacing and plant density;and seedlings recover fast, tiller vigorously, and mature uniformly. Therefore, reducing manpower availability for agricultural work and increased availability of mechanical transplanters is forcing the policy makers to make a paradigm shift toward the enhanced use of mechanical operation in rice farming (Guru, *et al.* 2018). Manjunatha, *et al.* (2009), found performance of themechanical transplanter satisfactory with labourrequirement of three man days per ha against 33 mandays per ha in case of manual transplanting.

During June 2015, the State Government of Tamil Nadu implemented the scheme titled "Kuruvai (Kharif) Special Assistance 2015 for Cauvery Delta districts" to boost rice production and productivity in the state. One of the main components of this Kuruvai special package was the promotion of 'Machine Transplantation' of rice seedlings in the Cauvery Delta Zone (CDZ), for which the State Departments of Agriculture and Agricultural Engineering took substantial efforts for mobilizing machine transplanters. Those farmers cultivated rice during Kuruvaiseasonin the CDZ were covered under this programme, whose fields were machine transplanted at subsidized rates. During execution of the programme, as the State Department of Agriculture wanted to assess the impact of this machine transplantation in the Cauvery delta districts, research was undertaken with the following objectives:

- To assess the economic profitability that resulted due to adoption of Mechanical Transplanter in rice cultivation.
- To analyzefarmers feedback on adoption of mechanical transplanter in rice cultivation.

## MATERIALS AND METHODS

Ex-post facto research design was followed so as to evaluate the economic impact of Machine Transplantation in rice cultivation. Since the "Kuruvai Special Assistance 2015 for Delta districts" programme was implemented by the Government of Tamil Nadu in the six delta districts of CDZ viz., Thanjavur, Tiruvarur, Nagapattinam, Trichy, Ariyalur and Cuddalore, the study was taken up in those districts. Among the total beneficiaries of the "Kuruvai Special Assistance 2015 for Delta districts" programme, 250 farmers were selected as sample size, 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, and in order to compare the improvement, these farmers were also studied.Data were collected from the sample respondents through two rounds of survey using well-structured and pre-tested Interview Schedules. Percentage analysis was carried out for meaningful interpretation of the data.

## 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.

### Brief summary of the Respondents Profile

It was observed that majority (54.00 %) of the farmer respondents belonged to the 30-50 years age group, followed by 43.60 percent in the age group of more than 50 years. Further, over three-fourths (78.00 %) of the respondents had secondary, higher secondary or graduate level of education. Farming experience for more than majority (58.00 %) of the respondents ranged between 21 to 30 years and above. In the study area, above 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. Moreover, aconsiderable section (42.00%) of the respondents belonged to 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%).

**Economic Profitability of Machine Transplanted Rice**

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

**Table 1**
**Economics of Conventional Methodversus and Machine Transplanted Rice (per acre)**

| S.No. | Particulars | Conventional Method (Rs.) | Machine Transplanted Rice (Rs.) |
|---|---|---|---|
| 1. | **Nursery** Operational Cost (Human Labour, Machine power, Seeds, Manures & Fertilizers, PP chemicals, Interest) | 3,549.99 | 1,771.93 (Mat Nursery) |
| 2. | **Main Field** Operational Cost (Land preparation, Pulling seedlings & transport, Planting, Manures & Fertilizers, PP chemicals, Weed management, Harvesting, Interest) | 17,584.24 | 14,831.95 |
| | **Total Cost of Cultivation (1+2)** | **21,134.23** | **16,603.88*** |

* Excluding the subsidy amount of Rs. 2,690/- per acre for mechanical transplanter plus micronutrients.

**Nursery Cost**

In this part of the analysis, two situations were compared viz., Conventional method (traditional method) of raising rice crop, and Machine transplanted rice. The total cost of seedling production under conventional nursery method worked out to Rs. 3549.99 per acre, while in the case of mat nursery method it was Rs. 1771.93 per acre. Therefore, there was a saving of Rs.1778.06 (50.08 %) under mat nursery method.

The saving was due to the following reasons:

- 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 for seedling production, it was just three labour man dayscosting Rs.580.00. Therefore, the net difference in human labour employed between conventional and mat nursery methods was four man days, which in monitory terms worked out to Rs. 330.00 per acre.
- With respect to use of machine power (power tiller) in nursery, the cost incurred was lesser for mat nursery 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. Under conventional method, the seed rate generally followed per acre is 35 to 55 kgs, whereas for mat nursery, the seed rate required per acre is just 20 kgs. Therefore, the net difference in seed rate per acre was 20 to 35 kgs, equivalent to Rs. 600 to 1,050.00.
- As far as fertilizer application, on an average 20 kg of DAP was applied in conventional nursery valued at Rs. 360.00; on the other hand just two kg were 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 was 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 has resulted in a

saving of Rs.62.00 under mat nursery method.

**Main Field Cost**

From Table 1 it is seen that eight 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, harvest and interest. The total cost of cultivation figures indicate that Rs. 21,134.23 was incurred for conventional planting, whereas Rs. 16,603.88 was incurred under mechanical transplanting, with a saving of Rs. 4,530.35 (21.44 %).

The saving was due to the following reasons:

- The average expenditure incurred per acre on land preparation under conventional and mechanical transplanting worked out to Rs. 3,047.17 and Rs. 4,107.16 respectively. Under mechanical transplanting, the expenditure incurred on land preparation was 34.79 per cent 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. 1,750.00 per acre towards pulling of seedlings and transportation to main field. This was one of the major cost components for conventional method.
- With respect to planting, the conventional method required 15.50 women labourers per acre at a cost of Rs. 1,536.67 per acre. In the case of mechanical transplanting, gap filling was an additional activity undertaken after machine planting by employing about two to three 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. 3,307.50 and Rs. 3,127.50 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 pests and diseases, and as a result less expenditure was incurred on plant protection (Rs. 1,163.50/acre), which is 42.66 per cent less when compared to the conventional method of planting(Rs. 1,659.83/acre).
- The analysis indicatedhigher expenditure on weeding in machine planted fields (Rs. 2,193.83 /acre) when compared to manually planted fields (Rs. 2,148.50 / acre). The increase in expenditure on weeding under machine planting was due to excess wages paid for the conoweeder operators ranging from Rs. 300-400 per person per 33 cents at a time. But cono weeding is very much essential for better aeration besides facilitating formation of new roots thereby enhanced uptake of nutrients was made possible.
- There was no significant difference on expenses incurred on harvesting since all the farmers have used the Combined Harvester.
- Interest on working capital @ 7% - 12%, was assessed to be Rs.1525.57 in the case of conventional planting method, whereas for mechanical transplanting it was Rs.1286.79.
- The total cost incurred in the main field for conventional planting was Rs.17,584.24. At the same time it was 14,831.95 in the case of mechanical transplanting, with a saving of Rs.2,752.29 (15.65 %) over the conventional planting.

**Cost and Returns**

The cost and returns with respect to conventional and mechanical planting methods are presented in Table 2.

**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. per acre) | 21134.23 | 16603.88* | Less (-) |
| 4. | Cost of Production (Rs. per quintal) | 1286.32 | 727.92* | Less (-) |
| 5. | Gross return (per acre) | 24250.68 | 33667.56 | More (+) |
| 6. | Net return (per 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.

It is seen from Table 2 that yield (productivity) increase of more than 38.83 per cent was reported in case of mechanically transplanted fields as compared to manually planted fields. Cost of cultivation was almost 21.44 per cent 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 per cent in the case of machine planting as compared to conventional planting. Finally, it is observed that the gross return as well as net return were significantly higher, with 38.83 per cent increase in gross return and almost four times increase in net return (447.54 percent). The almost 40 to 50 per cent 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 3-7.

## Reasons for Adoption of Mechanical Transplantation

The reasons for adoption of mechanical planting method were analysed and the results are presented in Table 3.

**Table 3**
**Distribution of Respondents according to Reasons for adoption of mechanical transplantation**

| S. No. | Particulars | No. of Respon-dents | Percen-tage | Rank |
|---|---|---|---|---|
| 1. | To overcome labour scarcity during planting season | 250 | 100.00 | I |
| 2. | To increase yield | 250 | 100.00 | II |
| 3. | To maintain perfect spacing (optimum plant population) | 196 | 78.40 | III |

From Table 3 it is seen that cent per cent of the respondents had reported that 'to overcome labour scarcity during planting season', and 'to increase yield' 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 plant population, 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).

## Level of Satisfaction on Mechanical Transplanting

The level of satisfaction on mechanical transplanting as reported by the respondents were analysed and the results are presented in Table 4.

It is inferred from Table 4 that nearly two-thirds (64.80 %) of the respondents had reported that they were 100 per cent satisfied with the machine transplantation programme of the state government.

**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) |

This was followed by 33.20 per cent of the respondents who expressed that their level of satisfaction was 51 to 75 per cent 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 per cent, 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.

**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 |

From Table 5 it is seen that cent percent 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.

**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 Conoweeder / 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 leveling 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 |

It is seen from Table 6 that cent percent 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 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 Conoweeder / 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 leveling 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.

**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. | Conoweeder and laser leveler may be made available at Agri depots and PACS (Primary Agricultural Cooperative Societies) | 89 | 35.60 |

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 'Conoweeder and laser leveler 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 leveling 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 Conoweeders through Government Depots under any subsidy scheme. It was also learnt that farmers need to be

given hands-on training on mat nursery technology in their villages.

## CONCLUSION

The results of the study showed that nearly two-thirds (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 per cent level of satisfaction. This clearly indicates the success of the State Government's initiative to introduce mechanical transplanter for rice cultivation in the CDZ for large scale adoption, which has resulted in increasing the efficiency of farm operations and helped to solve labour scarcity. 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.

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