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Agro-economic analysis of rice transplanters in Kerala

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ABSTRACT : Agricultural mechanisation is vital in improving resource use efficiency in agriculture. Mechanisation of the labour intensive operation of transplanting is imperative for ensuring economic viability of rice cultivation in Kerala. Agro-economic analysis of transplanter use in consonance with specific agro-climatic situation is essential for planning and implementing a proper mechanization strategy and hence such an analysis was done. The relevant economic parameters were worked out *vis-a–vis* the agro-climatic and technical factors for three different rice transplanters *viz.*, 8 row riding type, 4 row walk behind type and 6 row 4 wheel riding type. The variation of cost of operation with respect to annual working hours and effective annual area were analyzed to evolve a strategy for mechanization of rice transplanting. The seasonal command areas as well as Break Even Hours (BEH) and Break Even Areas (BEA) for the different machines have also been estimated. The information generated can serve as a guideline to farmers, policy makers and entrepreneurs for the use of rice transplanters in the region.

KEY WORDS : Agro-economic analysis of rice transplanters, Rice transplanters

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Rice is the staple food of people of Kerala and the sustenance of rice cultivation in the state is important for ensuring food security as well as for preservation of its fragile eco-system. In spite of the efforts put by the Government, the area under rice in Kerala is diminishing at a faster rate over the last few decades (Anonymous, 2010). Agricultural mechanisation could not get much encouragement until the recent years, due to the specific socio-politic situation in Kerala. James *et al.* (1995) reported that rice farm mechanization offers employment opportunities in the operation, service, manufacture and marketing of machines, which the educated youth of this highly literate state will find more attractive. There is ample scope for reduction in the cost of cultivation of rice in Kerala by the use of machines, as the wage rates in Kerala are the highest in India (James *et al.*, 1996). Further, mechanization of the highly labour intensive operations like transplanting and harvesting offers a helping hand to the farmer (James and Pillai, 1998). In the current scenario, rice farm mechanisation is regarded as the most important ingredient for sustaining its cultivation in the state.

Economic analysis of farm machinery in relation to the specific agro-climatic and socio-economic scenario provides vital information required for planning and implementing a mechanization strategy (Rajmohan *et al.*, 1998). Hence, an analysis on the economic performance of rice transplanters in the central zone of Kerala was attempted.

METHODOLOGY

A basic economic analysis was done to compare the total cost of operation in conventional rice cultivation as influenced by mechanisation of transplanting. For comparing the economic advantage of transplanting with machine, the Less Mechanised System (LMS) was compared with Machine Transplanted System (MTS). The costs of operations including material cost, labour cost and machinery hire chares were obtained from the farmers in both systems of cultivation and were summed up to obtain the total cost of cultivation (TC). The income was worked out considering that the procurement price of raw paddy as Rs. 15/- per kg and the cost benefit ratio calculated.

Three makes of rice transplanters *i.e.* 8 row riding type Yanji Sakti (TR_1), 4 row walk behind type Kubota NSP 4W (TR_2) and 4 wheel riding type Kubota NSPU-68C (TR_3) were considered for the analysis. The technical details of the machines were obtained from the manufacturers and the agro-climatic information required was gathered from secondary data from authentic sources (FIB, 2010) and the personal experiences of the authors. The data on field capacity, fuel consumption and labour requirement were gathered at the fields during operation under nearly ideal field conditions in plot sizes of approximately 40x25 m. Water from the plots were drained 12 hours prior to operation but the soil surfaces were sufficiently wet (1-3 mm water). The soils were sandy loam.

The procedure for economic analysis of agricultural machinery suggested by Hunt (1977), Rajmohan *et al*. (1998) and James *et al* (2006) were adopted to evolve a strategic guideline for formulating the most appropriate rice mechanization approach with respect to the specific situation. The prevalent market prizes of the machines as on 1st July 2011 (C) were taken into account for working out the costs of operation of the machines. The annual fixed cost (AFC), which included interest on capital (10 % per annum), depreciation, insurance and taxes (1% of C per annum), was calculated assuming that the life of machinery is 10 years and the junk value is 10 % of C. Hourly fixed cost, Rs./h (HFC) was obtained for different choices of Annual Working Hours (AWH), h/annum. AWH is dependant on Effective Annual Area (EAA), ha/year which is the sum of the areas operated in a year in all the seasons. Hourly Variable Cost (HVC) was calculated using the gathered data on fuel consumption, lubricant cost, operator's wage rates, and repair and maintenance charges (0.005% of C per hour of use). The Hourly Operation Costs, Rs./h (HOC) were estimated as the sum of HFC and HVC values for different AWH.

The field capacities of the transplanters (ha/h) were estimated from the field data. The probable Maximum Annual Working Hours (MAWH) for individual machines based on the agro-ecologic situation have been estimated in consideration of the specific agro-climatic factors in the *padasekharams* (agglomerated paddy fields of varying areal extends and individual fields within a specific *padasekharam* have identical agro-ecologic situations), which were considered representative of the central zone of Kerala. The corresponding HOC and Maximum Command Area, ha (MCA) were worked out. The Unit Area Operating Costs, Rs./ha (UAOC) with respect to the variation of AWH as well as EAA were analyzed. Break Even Hours (BEH) and Break Even Areas (BEA) for different machines, at which the UAOCs become equal to prevalent hire charges, have also been estimated.

RESULTS AND DISCUSSION

The major unit operations accomplished in transplanted rice cultivation were land preparation by puddling, repair of bunds, nursery preparation, transplanting, weeding, spraying for plant protection, harvesting, and finally threshing and cleaning. In LMS, all operations were done manually except that tractors were used for puddling and manually operated knapsack sprayers were used for spraying plant protection chemicals. In MTS, 8 row riding type transplanter and manually operated rotary weeders were used for transplanting and weeding, respectively. It was observed that the total cost of operation could be reduced by 16.3 per cent in the MTS compared to LMS. The net profit was worked out considering that the average yield is 4500 kg/ha. The net profit from cultivation increased by 129 per cent in MTS with respect to that from LMS, even though the other operations were done manually. The cost benefit ratio also had increased *i.e.* from 1.13 of LMS to 1.35 of MTS. The low cost benefit ratio is due to the high wage rates prevalent in Kerala and the operations like harvesting were done manually in MTS also. If the yield reduces below 3995 kg/ha in LMS the enterprise will be in loss. This is a highly vulnerable situation in the wake of the threats of climate change. The better resilience of the MTS is quite evident from the threshold yield of 3345 kg/ha.

Different technical parameters of the machines are given in Table 1. The AFC was maximum (Rs.2,52,000/-) for 4 wheel riding type (TR_3) followed by TR_2 (Rs. 45,150/-) and the minimum for TR_1 (Rs. 33,600/-). AFC accounts for the major share of the total operating cost in the case of costly machine (Kubota NSPU-68C), and this is expected for any agricultural machine with high capital investment. As the annual working hours increase, there is a reduction in the hourly cost of operation, as the hourly share of AFC gets reduced even though the hourly variable cost remains same. The total annual days for which transplanting extends in a particular agro-climatic zone assuming that there is no inter *padasekharam* movement

Table 1 : Techno-economic parameters of rice transplanters

Parameters	Kubota NSPU-68C	Kubota NSP-4W	Yanji Sakthi
HP	16.67	4.3	3.5
Capital investment, Rs	12,00,000/-	2,15,000/-	1,60,000/-
Annual fixed cost, Rs	2,52,000/-	45,150	33,600/-
Average fuel consumption, l/h	3.25 (gasoline)	1.25 (gasoline)	1.5 (Diesel)
Operators wages, Rs./h	169	169	169
Fuel cost, Rs./l	65	65	45
Row spacing	30 cm	30 cm	23.8 cm
No. of rows	6	4	8
Actual field capacity, ha/h	0.4	0.14	0.2

of transplanters. Based on the agro-climatic situation in the region, it was considered that maximum days available for transplanting in an individual *padasekharams* of entire central zone was 15 days in '*Virippu*', 15 days in '*Mundakan*' and 10 days in '*Punja*'. The probable maximum AWH in the zone was thus 320 hours (8 hours daily for 40 days).

The variation in the hourly operation costs of different transplanters with AWH is illustrated in Fig. 1. The HOCs were always highest for TR_3 followed by TR_2 and TR_1 due to the influence of the fixed cost factor. The cost curves show power nature and become flattened beyond 100 hours and 150 hours, respectively in the case of TR_1 and 2 and TR_3. The relationships could be described by the following equations:

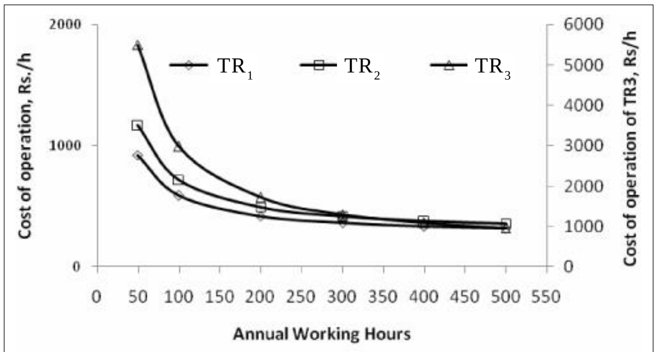

Fig. 1 : Hourly cost of operation of rice temperatures

$$HOC\ (TR_1) = 5179\ (AWH)^{-0.46}\quad (R^2 = 0.974) \ldots\ldots \quad (1)$$
$$HOC\ (TR_2) = 8061\ (AWH)^{-0.51}\quad (R^2 = 0.979) \ldots\ldots \quad (2)$$
$$HOC\ (TR_3) = 10136\ (AWH)^{-0.75}\quad (R^2 = 0.994) \ldots\ldots \quad (3)$$

The R^2 values of the equations were above 0.97 showing a good fit.

In a group mechanization system where the machines are owned by co-operatives or similar organizations of farmers, the unit area operating cost for (UAOC, Rs/ha) is relevant. UAOC is dependent on HOC and field capacities of the machines. TR_3 had the highest field capacity (0.4 ha/h) followed by TR_1 (0.2 ha/h) and TR_2 (0.14 ha/h).

The variation of UAOC with AWH is illustrated in Fig.2.

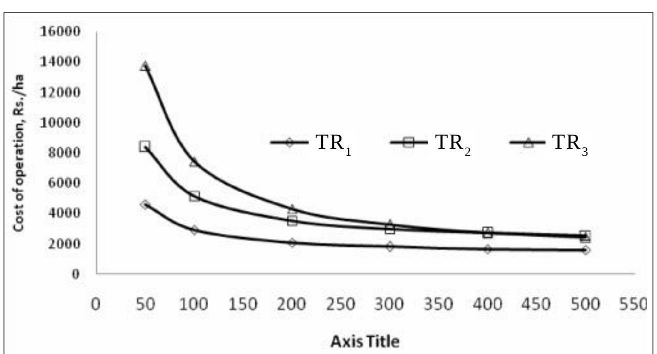

Fig. 2 : Unit area cost of operation of rice transplanters

The UAOC was lowest for TR_1 followed by TR_2 and highest for TR_3 up to an AWH of 400. Beyond 400 hours, the UAOC of TR_3 was lower than TR_2. Thus it was evident that the probable AWH is an important criterion in selecting a transplanter, especially when its operation is confined to a specific *padasekharam*.

The relationships of UAOC with the AWH followed the same trends as that of HOC and could be represented by equations (4) to (6). The R^2 values of the equations were also similar to that of the corresponding equations for HOC.

$$UAOC\ (TR_1) = 25898\ (AWH)^{-0.46}\quad (R^2 = 0.974) \ldots\ldots (4)$$
$$UAOC\ (TR_2) = 57585\ (AWH)^{-0.51}\quad (R^2 = 0.979) \ldots\ldots (5)$$
$$UAOC\ (TR_3) = 25340\ (AWH)^{-0.75}\quad (R^2 = 0.994) \ldots\ldots (6)$$

The probable maximum AWH in the padasekharams of the zone was 320 hours for which the UAOC were Rs.1,780/-, Rs.2,928/- and Rs.3,128/- per hectare for TR_1, TR_2 and TR_3, respectively. The operating cost for TR1 is very low but in actual field situations farmers complained of the requirement of frequent repairs. In certain field situations, the weed problem was also found to be higher since the planting is done on small rides created by the sliding of the float board. The other disadvantage of the machine in actual field conditions was the lack of hydraulic system to lift the float board during crossing of the bunds. The limitation of TR_1 in operation in fields where water could not be drained completely was also observed. In the case of TR_2, the machine was convenient for operation by women as it was light weight and equipped with hydraulic system for lifting. The disadvantage was the requirement for the operator to walk behind the machine. TR_3 was much advanced and ensured speedy and easy operation. The operator could be comfortably seated and ad better ergonomic features.

The BEH were estimated as the AWH at which the hourly custom hire charges became equal to the HOCs. Present hire charges were Rs. 1000/- for TR_1 and TR_2 including the operators wages. TR_3 is presently not available for hire, but the probable hire charge was assumed as Rs.2200/- per hour. It will be economical to purchase TR_3 if the probable AWH is above 124 hours at which the HOC becomes equal to hourly custom hire charges. If there is scope for the owners to operate on a multi-*padasekharam* basis, they are likely to get more working hours than this. The AWH for TR_2 and TR_1 at which the HOC becomes equal to 1000 were 105 and 45, respectively. This indicated that TR_1 can be economical in padasekharams of much smaller size. The corresponding area operated were estimated as BEH and were 9,15 and 45, respectively for TR_1, TR_2 and TR_3.

Conclsion:

It was evident that in general the cost of cultivation could be considerably reduced by mechanisation of transplanting and is profitable to the farmers compared to manual operation. Fixed cost factor was accounted for the major share of the hourly operating cost in the case of the costly transplanter, TR_3. The probable maximum AWH in the *padasekharams* of the zone was 320 hours. The variations in the HOC of different machines with AWH revealed that they were always highest for TR_3 followed by TR_2 and TR_1 up to an AW of 400. The BEH corresponding to the manual unit area operating cost was the lowest for TR_1 followed by TR_2 and TR_3. Even though the BEH for TR_2 were much higher than TR_1, they may find increased use in Kerala due to their versatility, ease of crossing field bunds and other bio-physical factors. The BEA for TR_1 was the lowest followed by TR_2 and greatest for TR_3 signifying the suitability of small machines when they are intended for a specific *padasekharam*. Beyond an AWH of 400 hours, even the costly TR_3 can also be economical, especially for entrepreneurs who can operate at multi-padasekharam basis. The analysis could provide an analytical frame work to assess the transplanters with respect to specific agro-ecological situations.

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