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Factors Associated with the Adoption of the Six Row Rice Transplanter Machine

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ABSTRACT. A study was undertaken to determine the factors associated with the adoption of the New Six-Row Rice Transplanter Machine, and also to estimate the cost that is transferred to the farmer by the manufacturers in the process of developing the machine. A survey was carried out in the Polonnaruwa district of a random sample of four Agricultural instructor's ranges to collect primary data using a structured questionnaire. Data analysis was done using non-parametric methods, supplemented with qualitative information. Several socio-economic factors were tested to identify association with the adoption of the machine. Among these factors, social participation, cultivated land extent, income, wealth, total machine transplanting cost and number of contacts between extension officers are significantly related to the adoption of the Rice Transplanter Machine. The composition of the cost that is transferred to the farmer per season is as follows; cost of repairing including parts and labour, cost of in-filling missing hills, planting of field corners, nursery destruction and cost due to loss of transplanting time. The average cost transfer per season is Rs. 967.75. It varies from a minimum of zero to a maximum of Rs. 9,839.60.

INTRODUCTION

Several institutional and organizational support systems encourage the use of the Six-Row Rice Transplanter Machine among farmers in Sri Lanka. The machine is a modified version of the manually operated Chinese transplanter improved at the International Rice Research

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Institute (IRRI), Philippines and later modified at the Farm Mechanization Research Center, Mahaillupallama. In 1985 there were eight companies manufacturing the rice transplanter and this number has increased to fourteen in 1989. About 161 training sessions and demonstrations were conducted for farmers and officers between 1982 and 1988 by the FMRC. In addition about 28 other activities such as field days, conferences, farmer follow-up activities and exhibitions were also conducted during this period (FMRC, 1990).

An important factor that influences adoption of the machine is its cost. In addition to the initial purchasing cost, the cost that is transferred to the technology-user in the process of refining a new technique by the technology producer could be a major determinant of the adoption of the machine. This cost is incurred by the user due to the machine being imperfect. Such imperfections are manifested in breakdowns and repairs as well as work not completed by the machine which has to be done manually, the costs of which must be borne by the user. Although this machine was introduced several years ago, its adoption rate is low. Hence, adequate measures must be taken to improve its adoption after assessing the factors associated with this behaviour.

This study evaluates the factors that are associated with the adoption of the paddy transplanter machine and its related costs when it is adopted by the user. More specifically it examines the following:

1. The factors that are associated with the adopting of the Six-Row Rice Transplanter Machine.

2. The cost that is transferred to the utilizer.

When considering the conceptual framework for this study, there are several variables which explain the adoption behaviour of an innovation. A comprehensive review of the adoption literature is provided by Rogers and Shoemaker (1971). Many factors may determine adoption bahaviour. The importance of each factor will vary with the type of technology. In agriculture, studies have shown wide variations in rates of adoption. However, the types of variables considered are quite similar and exhaustive (Rogers and Shoemaker, 1971). In this study variables have been selected to measure three major concepts - adoption, communication and technology. Six important variables have been

considered to measure the socio – economic status which would determine adoption behaviour. They are age, education, income, farming experience, cultivated extent and wealth.

Communication behaviour is an important concept that determines rates of adoption. The main indicators of this concept are social participation, cosmopoliteness, change agent's influence, opinion leader contact, and exposure to mass media communication channels. Among these variables, social participation, and change agents' and opinion leaders' contacts, are chosen as important explanatory variable in the analytical scheme. Cosmopoliteness explains the involvements in matters beyond the boundary of an individual's local system. But in this study cosmopoliteness is not an important variable since technology – users in this study are localized in nature and their contacts beyond their social system are marginal. Hence this variable was not considered to keep the explanatory scheme simple. Mass media communication channels is also one means of obtaining information. This variable too was not considered in this analysis since its exposure is uniform in the area, and its reliance on group methods vary.

According to the adoption diffusion literature in Rogers and Shoemaker (1971), personality variables associated with innovativeness have not been considered extensively in adoption studies. This is mainly because of two reasons. First, due to the difficulties of measuring in field interviews. Second, in studies undertaken the contribution of these personality variable to explain innovativeness is very little. Further, their effect disappears with the presence of other socio – economic variables associated with innovativeness. There are five main personality variables used to explain adoption behaviour in theoretical contributions. They are empathy, dogmation, fatalism, level of achievement motivation and aspiration. But, none of these variables are included in this analysis. Although these variables are not included in the empirical analytical scheme they are used in the descriptive explanations provided.

The success of this technology will be partly determined by the implications of the cost transferring proces that occurs in the refinement of the machine. Other factors, such as compatibility, complexity, trialability, and observability were considered to be relatively less important and were omitted in the analysis.

Transferring cost of technology development

In the development of technology, costs are incurred by the producer. If the technology is not perfected, part of the refinement of the technology remains incomplete. Adoption of these imperfect technologies results in the transfer of some costs to the user. The experiences of the user are then used by the manufacturers to improve the technology.

During the use of any technique, certain breakages of parts may occur. These breakages may be either due to normal wear and tear or due to the defects of the new technology. In this study, the total cost of breakages in the rice transplanter includes cost of spare-parts and labour charges for repairing the machine. The total cost of breakages measured was the sum of costs which were incurred in each season when the machine was used. This cost was obtained for each machine owner. However, for the forty machine owners this breakages cost was found to be almost zero. This is not due to absence of breakages, but due to the difficulty of remembering the specific parts which broke during that particular season.

Cost of in-filling missing hills, planting of field corners and nursery destruction also occurs due to imperfections of the machine. The cost which was incurred in hiring labourers to in-fill or replant hills which were missed by the transplanter-machine is considered to be the above cost. The rice field corners which could not be transplanted by means of the machine had to be transplanted by hand. The same labourers who engaged in in-filling missing hills performed this task too. The cost incurred due to nursery destruction is included in this cost calculation. But actually this cost may be either due to the defect of this new technique or due to lack of training about the new technique.

In general, the expected transplanting-efficiency of the mechanical transplanter is around ninety five percent. Hence, in this case too, missing-hills and nursery defects would be expected to be the same amount. Since five percent is considered as expected system-error, it was deducted from the cost of in-filling missing hills, planting of field corners and nursery destruction. After deducting five percent, the balance is considered as actual cost of in-filling missing hills planting of field corners and nursery destruction due to use of the prototype of the transplanter machine.

When the machine is not used there is loss of transplanting time. The value of lost transplanting time measured in hours lost per season due to machine breakages during operation, was considered as a cost, since the time is very valuable to rice farmers during this peak activity period. Further, farmers are compelled to complete transplanting within a certain short period since the water issue is a time-bound operation.

In order to convert time loss into a cost component, certain reasonable assumptions were made. According to the data collected in this regard, in most of the cases, the duration of machine transplanting per day is eight hours. Since this machine is manually operated, it needs an operator and a helper. Field observations provided an estimate of a daily wage rate of Rs. 65.00 per day including meals during the *Maha* 1989/90. Since two persons are required to operate the machine, for an eight hour working day, Rs. 130.00 would be required for the two workers. This work amounts to a value of Rs. 16.25 per hour. The time loss in each case is valued at this rate.

MATERIALS AND METHODS

The farmers who owned a rice transplanter machine and those who did not own the machine were considered units of analysis in the study. Here, the machine-owners could be either continuous machine-users or discontinuous type of machine-users. The rice transplanter machine is used in several districts. However, among these districts Polonnaruwa was chosen for the study since it had the largest number of machines. At the time of the study, 366 machines were found in this district (FMRC, 1991).

Sampling

Polonnaruwa district is divided into two Agricultural Officers' (AO) segments and nine Agricultural Instructors' (AI) ranges. Of these nine AI's ranges, four ranges were purposively drawn so that they were well distributed between the Agricultural Officers' segments. Further, these four AIs' ranges represent the highest number of machine-owners and the lowest number of machine-owners in the two AOs' segments. Selection of AIs' ranges was done in such a way to examine special characteristics in AIs' ranges which influence the distribution of machines.

In addition to those who owned machines, those who did not own machines too were drawn from the same sampled AIs' ranges. Those who did not own machines were selected to represent all Krushikarma Viyapthi Sewakas' (KVS) divisions in the selected AIs' ranges. The distribution of machine owners and non-owners in the sample is given in Table 1.

Table 1. Sample of machine owners and non-owners selected for the study.

Agricultural Officer's segment (AO-segment)	Agricultural Instructor's range (AI-segment)		Transplanter Machine		
			Owners		Non-owners
	Total	Sample	Total	Sample	Sample
Segment - I	5	2	44	44	26
Segment -II	4	2	50	46	29
Total	9	4	94	90	55

In order to estimate the cost that is transferred to the farmer by the manufacturers in the process of refining the machine, following method was used. Among the machine owners who reported machine breakages, a reference period of 3 years was considered. Because, the expected economical machine-life for the transplanter was considered as 3 years (6 seasons).

Data collection

An interview schedule was developed to gather information from the rice transplanter machine owners and non-owners. The pretesting of the interview schedules was done before the final draft of the schedules

was developed. This was filled by interviewing the machine – owners and non – owners.

Measures

The relevant concepts used in the study were measured using a few key indicators. These concepts and the associated variables are presented in Table 2 for purposes of brevity.

Analysis

In order to test the relationship between transplanter machine ownership (dependent variable), and other independent variables, categorical data analysis was performed by using the SPSS package. Model selection procedure was conducted for multivariate models. The "CATMOD" procedure in the SAS (Statistical Analysis System) was used to select models. There were three multivariate models tested in this analysis. Statistical significance was set at $P = 0.05$ level (Schlotzhauer *et. al.*, 1987 and Norusis, 1986). The "CATMOD" procedure is basically used for variables which are discrete in nature. However, for continuous variables which are categorized into classes, this procedure is the best one.

RESULTS AND DISCUSSION

In order to test the relationship between transplanter machine ownership (dependent variable) and other independent variables stated in the text, categorical data analysis was performed. Chi – square tests were done and the level of significance examined. Results of the analysis indicated that the independent variables such as age, education and farming experience were not significantly related to machine ownership at 0.05 level. Other independent variables such as social participation, extension officers' contacts, cultivated land extent, income and wealth were found to be significantly related to machine ownership at 0.05 level (Table 3). These significant variables are discussed below.

According to the results, about 88 percent of the machine owners have participated in social activities and they held one or more

Table 2. Concepts considered in the analysis and their measurements.

Concept	Units	Category
Age	Years	17 – 30 31 & above
Education	Grades	Primary (1 – 5) Secondary (6 & above)
Farming Experience	Years	0 – 10 11 – 20 21 – 30 31 & above
Social participation	Number of membership held in social organizations	0 1 & above
Contacts with agricultural extension officers	Total number of contacts	0 1 & above
Cultivated extent	Hectares	0 0.2 – 2.02 2.03 & above
Income	Rupees	500 – 40,000 40,001 – 80,000 80,001 – 120,000 120,001 & above
Wealth	Rupees	5,000 – 200,000 200,001 – 300,000 300,001 – 400,000 400,001 & above
Time loss	Hours	0 0.33 – 8 9 & above

memberships in different village organizations. Around 73 percent of the machine non – owners too participated in social activities in a similar way. But the results suggest that the participation of machine owners in social activities is greater (Table 4).

Table 3. Results of the chi – square analysis between dependent variable (Transplanter Machine Ownership) and each of the independent variable.

Independent Variable	Chi – Square Value	d.f.	Significance
Age	0.27789	1	0.5981
Education	0.72413	1	0.3948
Farming experience	5.85353	3	0.1190
Social participation	4.15151	1	0.0416*
Extension officers contacts	72.34077	1	0.0000*
Cultivated land extent	25.06969	2	0.0000*
Income	35.36508	3	0.0000*
Wealth	16.31596	3	0.0010*

* Significant at 0.05

Of the machine owners in the sample, about 74 percent have contacted the agricultural extension officers one or more times regarding the known – how and various other problems related to the transplanter machine. But the relationship between machine non – owners and their contacts with extension officers is quite different. Around 94 percent of the non – owners in the sample, have hardly any contact with the officers in the extension activities. This result suggests that the extension activities and contacts with extension personnel have greater influence on machine ownership and its adoption (Table 4).

Cultivated land extent of the respondents was distributed in such a way that about 53 percent (majority) of the machine owners owned and cultivated land 2.03 hectares or more. In other words, they owned a large extent of paddy land. Hence, they are more likely to adopt the machine than others. Around 78 percent of the machine non – owners

Table 4. Distribution of the respondents by machine ownership (dependent variable) and each of the independent variables (N = 144).

Machine Ownership	Social Participation: No	Social Participation: One & above	Total	Chi – Square	Significance
Owners	11 (12.4%)	78 (87.6%)	89	4.15151	0.0416
Non – Owners	15 (27.3%)	40 (72.7%)	55		

	Contacts with agricultural extension officers: No	Contacts with agricultural extension officers: One and above			
Owners	23 (25.8%)	66 (74.2%)	89	72.34077	0.0000
Non – Owners	52 (94.5%)	3 (5.5%)	55		

	Cultivated Low – Land Extent (Hectare): Zero	0.2 to 2.02	2.03 and above			
Owners	5 (5.6%)	37 (41.6%)	47 (52.8%)	89	25.06969	0.0000
Non – Owners	19 (34.5%)	24 (43.6%)	12 (21.8%)	55		

	Seasonal Income (Rs.): 500 to 40,000	40,001 to 80,000	80,001 to 120,000	120,001 and above			
Owners	14 (15.7%)	35 (39.3%)	15 (16.9%)	25 (28.1%)	89	35.36508	0.0000
Non – Owners	34 (63.0%)	9 (16.7%)	7 (13.0%)	4 (7.4%)	55		

	Wealth (Rs.): 5,000 to 200,000	200,001 to 300,000	300,001 to 400,000	400,001 and above			
Owners	17 (19.1%)	28 (31.5%)	22 (24.7%)	22 (24.7%)	89	16.31596	0.001
Non – Owners	25 (47.2%)	15 (28.3%)	10 (18.9%)	3 (5.7%)	55		

have cultivated less than 2.03 hectares of land. Among them 34.5 percent of the non-owners did not own low land. Only about 22 percent of the non-owners have cultivated land extent greater than 2.02 hectares. Hence, cultivated land extent has a great influence on machine adoption (Table 4).

Three income categories were defined based on seasonal income in the study. The seasonal income from Rs. 500.00 to Rs. 40,000.00 as "Low income category", Rs. 40,001.00 to Rs. 120,000.00 as "Medium income category" and Rs. 120,001.00 and above as "High income category". Of the machine owners in the sample, only about 16 percent belonged to the low income category. However, about 63 percent of the machine non-owners belonged to this low income category. About 28 percent of the machine owners, belonged to the high income category while only 7 percent of the machine non-owners belonged to the same category. A large proportion of the machine owners belonged to the medium income category and that was about 56 percent. But about 30 percent of the machine non-owners belonged to this medium income category. Hence, it was indicated that majority of the machine owners belonged to the medium and high income categories while non-owners belonged to the low income category (Table 4).

Three main wealth categories are defined based on present values of total assets. They are; Rs. 5,000.00 to Rs. 200,000.00 as "Low wealth category", Rs. 200,001.00 to Rs. 400,000.00 as "Medium wealth category" and Rs. 400,001.00 and above as "High wealth category". Of the machine owners, only about 19 percent belonged to the low wealth category but about 47 percent of the machine non-owners belonged to the same category. About 25 percent of the machine owners belonged to the high wealth category but only about 6 percent of the machine-non-owners belonged to the high wealth category. About 56 percent of the machine owners belonged to the medium wealth category while about 47 percent of the machine non-owners belonged to this category. The majority of the machine owners belonged to the medium and high wealth categories while majority of non-owners belonged to the medium and low wealth categories (Table 4).

Transplanting is a time-bound operation which could be highly dependent on the cultivated land extent. Time loss due to breakdown of machine and other related problems was only relevant to the machine owners. The relationship between time loss and cultivated extent was

investigated for the owner group only. It was found that the relationship was not significant at P = 0.05 level (Chi-square value = 6.27679; d.f. = 4; Significance = 0.1794).

Multivariate models

By carrying out the chi-square analysis, the important variables that were significantly associated with the adoption behaviour of the transplanter machine were identified. However, it is important to find out whether effects of some of the variables were confounded. Therefore, multivariate models were selected using groups of variables which had interpretative content. Only one of these models showed effect of interactions. This was the model examining the relationship between ownership and monetary aspects. The independent variables used to measure monetary aspect were wealth and cost of transplanting.

Model:

Ownership x Wealth x Cost of transplanting including family labour

(u_1) (u_2) (u_3)

In order to examine the relationship between ownership and economic aspects of the machine, the above model was chosen. In this model, wealth of the farmer was taken into account, that is because wealth fitted better in this model than the seasonal income. Also, the cost of machine transplanting could be related to wealth and machine ownership. Therefore, this model was considered. The best-fit model was:

$\log m_{ijk} = u + u_1 + u_2 + u_3 + u_{12} + u_{13}$ (d.f. = 8; G^2 = 6.84; P = 0.5540).

Notation as in Bishop *et. al.*, 1975 where u_{12} is the term that measures the effect of the interaction between variable 1 and 2. The other terms have analogous meaning.

In this model, u_{12} and u_{13} interaction terms describe the model adequately. The u_{23} interaction term was not important. However, the wealth and cost of transplanting were both related to machine ownership. The results of the u_{12} interaction was already discussed earlier. The u_{13} term is taken up separately. Of the machine owners nearly 8 percent

did not machine – transplant during the *Maha* 1989/90. Hence, the cost of machine transplanting was not incurred. About 47 percent have cultivated, and their cost of machine transplanting with family labour, ranges between Rs. 15.00 to Rs. 1000.00. About 45 percent of the owners incurred a cost of Rs. 1001.00 and above (Table 5).

Table 5. Distribution of respondents by cost of machine transplanting (Rs.) including family labour and machine ownership (N = 143).

Machine Ownership	Cost of machine transplanting with Family Labour			Total
	0	15 to 1000	1001 & above	
Owners	7 (7.9%)	42 (47.2%)	40 (44.9%)	89
Non – Owners	49 (90.7%)	5 (9.3%)	0 (0.00%)	54

The distribution of the total cost transferred to the user by manufacturers and the researchers is examined by means of the "LOTUS" programme. According to the results, the average cost transfer per season is Rs. 967.75. It ranges from a minimum of Rs. zero (0) to a maximum of Rs. 9839.60 per season (St. deviation Rs. 1635.33).

CONCLUSION

In this study, some of the variables considered to measure socio – economic status and communication behaviour were not found to be related to adoption of the machine. Age, formal education and farming experience, hence need not be major concerns in designing extension or promotion programmes for the machine in this and similar areas. Social participation, extension officers' contacts, cultivated land extent, income and wealth of the respondents are significant factors explaining adoption. Contacts with extension officers could be a means of promoting the adoption of the machine. Further, those with more land and wealth, due to the nature of the machine which costs about Rs. 5000.00, are the potential adopters. The analysis clearly shows that the six row rice transplanter machine is favourable to the more wealthy farmers who cultivate larger extent of land and who also have close contacts with the extension officers. Furthermore, those with greater social participation

through organizational membership and activities could interact more with those closely associated with the machine and thus increase their affinity towards the machine. A possible informal network of the machine users is suggested.

Although the initial cost of the machine can be affordable, at around Rs. 5000.00, an additional cost of an average Rs. 967.75 must be borne by each machine owner, each season for the imperfections of the machine. This seasonal cost is identified as the cost of machine imperfections transferred to the user by the machine manufacturer. Hence, this might be a major cause which may slow the rate of adoption of this machine. Therefore, necessary measures must be taken to reduce the additional cost that was transferred to the farmer in the process of refining this technology.

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