Utilization of rice technologies by limited-resource farm households in Trinidad

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This study examined the utilization behaviour of rice-based farmers in Trinidad. Six recommended practices were investigated from a farm household perspective. The intensity of use of these practices, the main users, and the decision-making patterns were also determined. Data were collected from 100 limited-resource farm households. Descriptive results show that high use was made of recommended varieties (95%), recommended age to transplanting (84%), and recommended spacings (81%). There was an average of 40% of joint decision-making with respect to use of the components. Husbands showed the highest time involvement (43%) over all activities, followed by hired workers (23%). The results of the regression analyses indicated that different variables determined the use of the practices studied. The psychological factors (perception of the technology, perception of risk, and goal orientation) appeared to be more important than the other factors.

Keywords: Technology utilization; Household decision-making; Rice farming

Since gaining political independence many Caribbean states have sought to increase agricultural production through the small farmer. Various strategies have been employed, but a constant factor has been the provision of superior agricultural technology. However, farmers continue to reject or only partially accept new technologies offered to them by researchers. A "technology application gap" exists (Merill-Sands, 1986) and continues to widen.

Many studies have been done on the behaviour of small farmers worldwide in an effort to understand the criteria that should be important as farmers decide to utilize a technology. However, reviews of studies on technology adoption (Feder *et al.*, 1982; Rogers, 1983) indicate that despite all this research, some major deficiencies exist in the knowledge domain.

As the science of extension advances and the technology application gap widens, more interactive and holistic approaches to farmer development are being given greater prominence, and the role of the small farm household is increasingly becoming a focal point for critical analysis. The farm household is being regarded as the socio-economic unit of production and decisions are influenced by the dynamics within households and factors in their immediate environment that impinge upon them.

This study focuses on the role of the small farm household in the technology utilization process, while not denying that national policy, the farmer and the farm, and infrastructural characteristics are important.

Concept of Technology Utilization

Feder *et al.* (1982) emphasized that adoption and diffusion are dynamic processes influenced by a variety of factors and consequently there will be diversity in technology use under different climatic, social, cultural, and economic environments. This diversity is manifested by varying levels of adoption of technological packages and varying levels of use of the individual components.

Small farm families are careful decision makers who test and select carefully among alternative technologies and will either reject, accept fully, partially accept, modify, and (or) adapt technologies offered to them to ensure compatibility with their own circumstances. Koppel (1985) states that "many decisions are often decisions of degree, not simply accept-reject, that can be varied over time". Feder *et al.* (1982) concluded that adoption cannot be categorized simply as adoption or non-adoption, since adoption takes place by degrees. This intensity of use of utilization of technologies if properly understood, can contribute a lot of understanding about farmers' technological needs and the shortcomings of those offered.

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to make a livelihood in the enterprise. It was hypothesized that a positive relationship exists between time of involvement and technology utilization.

Goals of the household — Households' objectives are posited to be the most important determinant of the technology development process in Farming Systems Research (FSR) and it was important to assess them accurately (McKee, 1984). In this study the socio-economic orientation of households was determined using the method of paired comparisons (Bradley, 1976). A positive relationship between economic orientation and technology utilization was hypothesized.

Perception of the technology — Rogers (1983) indicated that the perception of the technology by the user influences the selection process. In this study, underlying factors such as cost, ease of learning, and clarity of information were used to construct Likert-type scales to measure the perception of respondents towards the components. All the scales had good internal consistency (Cronbach alpha > 0.75). It was hypothesized that favourable perceptions of the technologies would be associated with increased utilization.

Perception of risk — How the rational decision maker perceives the risk associated with a technology is different from a risk-averse attitude, and it is possible that many of the studies that generated the concept of "risk averse" farmers may have overstated the benefits of the technology. Biswanger (1980) reported no significant difference in attitude between adopters and non-adopters, but found that it was farmers' perception of risk that was the determinant of adoption. Shaner *et al.* (1982) stated that "the decisions of small farmers concerning adoption of new technology are influenced by their perception of risk". A negative relationship between risk perceptions and technology use was hypothesized.

Farm related variables

Size and number of parcels of land — In situations of restricted room for expansion, farmers would be expected to engage in greater technology use to ensure higher production and, when possible, would seek to increase acreage by securing other parcels of land. Both variables were hypothesized to be positively associated with technology use.

Time spent on rice — The greater the time a household spends on rice farming when compared to off-farm work is an indicator of the value attached to the enterprise as a means of livelihood. As households seek to increase their standard of living, increased technology use should be expected. A positive relationship was hypothesized.

Tenure — In situations of insecure tenure, households are unlikely to make any cash investments, or utilize costly inputs, seeking rather to make as much cash as possible without much expenditure. A negative relationship was therefore expected with technology utilization.

Method

Study population

Rice is grown in three main areas of Trinidad: the Caroni, Nariva, and Oropouche areas. The population under study was the 2500 rice farmers who farmed one hectare or less in the Oropouche Lagoon area.

The Lagoon is an area of approximately 900 hectares in the south-west part of the island. The Lagoon lies below the 25 foot contour in a larger Oropouche Catchment Area (43 600 ha). This area was selected for study because: (1) the highest number of rice farmers (66%) live in this area; and (2) the Government of Trinidad and Tobago has targeted the region for the removal of the exogenous constraints to stimulate increased production.

The study was conducted over a three month period at the end of the rice crop in 1992.

Sample selection

Byerlee and Collinson (1988) suggested that 30–50 farmers in a recommendation domain usually reflect quite well the situation of farmers. The Oropouche farming area was classified as a recommendation domain because of the similarity in soil type, rainfall, resource constraints, topography, market, institution, national policy, ethnicity, religion, and culture.

Interviews were conducted among 100 farm households who farmed one hectare or less of land and they were selected by a simple random sampling procedure. These households constituted a limited-resource category because they produced rice for home consumption and excess for sale; out-migration has led to labour shortages in the sector; opportunities for off-farm employment are small; production is under the rain-fed system; and they are relatively powerless to influence the research system to meet their specific technological needs.

Research instrument

An interview schedule was used to gather data from respondents. Mainly closed-ended questions were used, but also included were four Likert-type scales used to measure attitudes of the respondents to the technologies, and a pair-wise comparison test to establish and score their goal orientations. Internal consistencies of the attitude scales were assessed using the reliability estimate, Cronbach alpha (Carmines and Zeller, 1979).

Objectives

The purpose of this study was to examine the utilization behaviour of limited-resource rice-based farming households with respect to practices offered to them. Specifically, it sought to: (1) determine the overall level of utilization of a package of six component technologies; (2) examine the intensity of use of these six components; (3) identify the utilizers of the specific components; (4) identify the decision-making pattern for utilization across components; and (5) examine the relationships between selected farm household-related variables and the utilization of rice production technologies.

Definition and Measures of Variables

Dependent variables

Technology utilization was operationally defined as the degree of use of research recommendations and indicates the deviation from the optimum. In this study, it was measured in two separate ways: (1) the level of utilization of the package of six recommended practices; and (2) the intensity of use of the six defined components of the package, that is, the utilization of: (i) double cropping; (ii) weed control; (iii) spacing; (iv) variety; (v) transplanting; and (vi) seed testing.

The six components examined were selected in consultation with the cereal agronomist of the Ministry of Agriculture, Land, and Marine Resources of Trinidad and Tobago (MALMR). They were chosen from twelve general recommendations because of their ability to greatly increase production, their adoptability by all farmers, and their length of time in the knowledge system.

Scores were used to measure utilization of the components. Four points were given for full use, and zero for non-use, with scores of one, two, and three indicating the intensity of use of the component.

Independent variables

Thirteen independent variables were categorized into nine farm households and four farm related variables for study purposes. A description and measure of each variable together with an *a priori* expectation of its relationship to the dependent variable follows:

Farm household variables

Size of household — Previous adoption studies have not been definitive in the direction of influence. This study expects a negative relationship with utilization arguing that as household size increases, pressure on limited-resource households to feed themselves would mean that less investment in modern inputs and innovation would be made because of the risks and uncertainties involved.

Household type — Farm families were categorized into two types: nuclear and extended. The type of farm household that operates the farm is expected to be related to the characteristics of the technology, in particular, its labour requirement. Technologies that are labour-intensive will require additional manpower from the household. In such instances, families would tend to be more of the extended type. Where technologies require less labour, nuclear families may predominate. A significant relationship is hypothesized.

Stage of life cycle development — During the course of the development cycle, a family's profile changes in age, size and vigour, goals and aspirations, and education levels are altered. All of these sectors help to shape the decision regarding technology use at the farm level. In addition, the farm household subsystem can be altered during any stage of the life cycle by the hiring of labour, if the farmer has the necessary resources to meet family needs and goals. However, in limited-resource situations, household decision makers are often unable to manipulate resources to match the phases of their life cycle and it is most likely this interaction rather than the age of the farmer so often studied, that influences technology use. Negative correlations between practice adoption and age of farmers may be due to reduced needs and declining vigour of farmers, rather than their educational level or attitude (Gasson *et al.*, 1988). Significant relationships are hypothesized for this variable and utilization, the exact direction of influence varying with the components' characteristics.

Decision-making pattern — Decision-making is a complex issue which varies with culture, social strata, education, and knowledge base, and to assume that the male head of the home is the sole decision maker is an oversimplification. Decision-making may be shared because of the intrinsic value of the activity and the knowledge control in the area. Techniques for assessing decision-making on the farm have been developed. One of the techniques used successfully (Bokemeier and Garkovich, 1987) was adapted for this study. A significant relationship is hypothesized.

Level of education — A negative relationship is hypothesized for this variable, arguing that for the category of households studied and their circumstances in the farming area, as education levels rise, technology utilization levels would not increase. Householders would rather engage in salaried employment either on a part-time or full-time basis to improve family income.

Level of time in rice — The number of years a household has been involved in rice cropping is thought to affect the technology utilization process, through a strategic decision

Table 2 Percentage time spent by household members and (or) hired help on farm activities

Activity	% Time by various workers					
	Husband	Wife	Children	Other family members	Hired	Total
Sowing	60	20	9	4	7	100
Transplanting	21	17	13	6	43	100
Manual weeding	37	18	15	7	23	100
Chemical weed control	83	0	5	3	9	100
Harvesting	20	16	14	5	45	100
Threshing	21	14	12	5	48	100
Storage	50	25	11	5	9	100
Home gardening	46	29	12	6	7	100
Average	43	17	12	5	23	100

significant predictors of the adoption of the package of six components studied. These results confirmed the hypothesis that technology use is positively related to its perception. The recommended technologies have been in the system for at least five years and during this time farmers have experienced increased production. This would serve to improve farmers' perception of the technology. Additionally, as farmers cultivate more parcels of land, their incomes would increase, further reinforcing farmers' positive perception of the technology and increasing utilization. The positive relationship between the number of parcels of land and technology use was also confirmed.

A positive relationship between goal orientation and technology utilization was hypothesized. However the results showed a weak, negative association. It would appear that as farmers' goals tend towards a strong economic orientation, they would move away from rice production, seeking employment elsewhere to improve their incomes. Technology utilization levels would decrease on farms. Also, as perception of risk of the technology increases, technology utilization levels would decrease and the negative relationship hypothesized was also confirmed.

Together, these variables explained only a small amount (26%) of the adoption variability suggesting that other factors not included in the equation, may be more important in predicting the behaviour of these farmers with respect to the utilization of the package of rice production technologies.

One such factor is the guaranteed price and market offered for farmers. The Government of Trinidad and Tobago is committed to purchasing all the rice farmers can produce regardless of quality. In such a situation, if farmers can sell all the rice they produce, then increasing their levels of technology use would serve to increase farmers' rice production and consequently incomes.

Utilization of the double-cropping component

One psychological variable, the perception of the technology, and one other household variable, the level of education of the decision makers were significant predictors of the double-cropping behaviour of households (Table 5). The study confirmed the positive relationship hypothesized between the perception of technology and the double-cropping recommendation. The technologies utilized to produce the first crop of rice are similar to the practices to produce the second or double crop. Consequently, the positive perception that farmers have for the package is not expected to differ when producing the second crop. Moreover, that

Table 3 Distribution of households by participation in decision-making process over six farm-related decisions

Decisions	Participation in decisions (%)					
	Husband decides seldom discusses with wife	Husband decides usually discusses with wife	Husband and wife jointly decides	Wife decides seldom discusses with husband	Wife decides usually discusses with husband	Other arrangements to decide
Planting time	39	11	41	2	2	5
Weed control	42	10	39	1	3	5
Varieties to use	45	9	37	1	3	5
Spacings to use	43	11	37	1	3	5
Hiring of labour	37	7	47	1	3	5
Double cropping	45	9	37	1	3	5
Average	42	9	40	1	3	5

Constant = 1.038 Multiple R = 0.51 Overall F = 7.679

Data Analysis

Empirical approach

The Statistical Package for the Social Sciences (SPSS; Nie *et al.*, 1975) was used to analyze the data. The data were subjected to stepwise multiple regression analysis in order to examine and describe the combination of variables that are important predictors of the utilization behaviour of households.

The form of the regression model utilized in this study is expressed as:

$$Y = a + b_1 x_1 + b_2 x_2 + ... + b_n x_n + e$$

where Y is the value of the dependent variable; a is a constant which indicates the value of Y when x is 0; b_1, b_2, ..., b_n, represent the partial regression coefficients for the independent variables; x_1, x_2, ..., x_n, represent the independent variables; and e is the error term in this study.

The independent variables entered were both continuous and discrete. The discrete variables were recorded into the binary form (as dummy variables) before entry to determine their effects. These variables and their reference categories (in parentheses) were:

Households' type (1 = extended)
Stage of life cycle development (1 = late)
Level of education (1 = low)
Pattern of decision-making (1 = wife involved)
Land tenure status (1 = permanent)

Results

Utilization of technology: overall level and intensity

Data in Table 1 which summarizes average technology utilization scores for the package of six practices, showed that 63% of households sampled made full use of the package studied, with 20% making partial use, and 17% making no use of the practices.

An examination of the utilization of the individual components of the technology package showed that: (i) there was very little variation in households' adoption scores for recommended varieties, recommended spacings, and recommended age at transplanting. More than 80% of the households made full use of these technology components, with recommended varieties showing extremely high use by the majority of households (95%); (ii) only two components of the package, namely recommended weed control time and double cropping showed much variation in their use by farm households, and were used at full levels by 47% and 51%, respectively; and (iii) seed testing showed highest non-use (81%). This was the most recent component to be added to the package and, possibly, farmers may not have had sufficient time to evaluate it.

Table 1 Distribution of households' technology utilization scores for six recommended practices

Technology components	Technology utilization scores: Full use	Partial use			No use
Scores	4	3	2	1	0
	- - - - - - % - - - - - - -
Recommended varieties	95	2	1	2	0
Recommended spacings	81	17	1	1	0
Recommended weed control time	47	34	15	3	1
Recommended age of transplanting	84	14	0	2	0
Seed testing	19	0	0	0	81
Double cropping	51	18	14	0	17
Average	63	14	5	1	17

Involvement of household members in the utilization of components

Data showed that when all the farm tasks were considered, husbands were involved in farm activities for the highest percentage of time (43%), with hired help showing second highest involvement (23%). Wives were involved an average of 17% of the time (Table 2).

The results also showed that husbands spent the most time on almost all farm activities [e.g., sowing (60%), chemical weed control (83%)] with the exception of transplanting, harvesting, and threshing. These tasks were mainly handled by hired workers. There was low participation by children (12%) and other household members (5%).

Decision-making pattern for technology use

It was revealed in Table 3 that the pattern of decision-making among these limited-resource farmers was not male-dominated and that husband and wife jointly participated in 40% of the decision-making.

The highest joint decision-making (47%) was in the hiring of labour, which involved immediate cash expenditure by the family.

Results of multivariate analyses

Utilization of the package

The results of the multiple regression analysis (Table 4) showed that four variables, three psychological and one household-related, were

Table 7 Stepwise multiple regression of recommended spacings on household variables

Variables	B	ß	R^2	R^2 change	T value	Sig. T
Risk perception associated with recommendation	-0.06	-0.24	0.092		-2.25	0.05
Spacing perception recommendation	0.008	0.21	0.132	0.040	2.076	0.05

Constant = 3.229 Multiple R = 0.36 Overall F = 7.02

determinant in the use of the varieties recommendation (Table 8).

The use of the recommended variety is positively related to its perception by farmers. Of all the technologies recommended, improved varieties have been in the system for the longest time, mostly because they have performed well under the constraint of improper water control in the rice fields.

Conclusions and Implications

The findings of this study indicated that limited-resource households utilized the technologies studied at high levels, and various factors influenced the utilization of the components differently. Of all the household and related variables studied, the psychological factors were the more important predictors of their strategic behaviour. The generalized perception of the technology by intended users, and in particular their perception of risk appear to be key ingredients in decision-making. More attention should be given to these factors by researchers and extension workers in the technology design and transfer process.

The shared pattern and decision-making as well as the small, but not insignificant role women play on the farm suggest that they can form a separate target category for intervention. Hired help can also be targeted for training in the activities with which they are involved.

Table 8 Stepwise multiple regression of recommended varieties on household variables

Variables	B	ß	R^2	R^2 change	T value	Sig. T
Perception of the varieties	0.020	0.44	0.191	0.191	4.729	.001

Constant = 1.608 Multiple R = 0.49 Overall F = 22.607

While some of the findings are consistent with those of previous studies, comparison can only be made on a limited basis, primarily because reports of local and regional studies have tended to consist of a synthesis of findings derived from mostly dichotomous measures of adoption behaviour, and not primarily from a household perspective.

The findings of the effects of the variables of this study serve to support the views of other researchers that technology adoption behaviour is extremely complex and varies with circumstances, time, and commodities. Knowledge about the effects of these variables on technology use continues to be unclear, and factors more closely related to the household have been relatively unexplored.

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Table 4 Stepwise multiple regression of adoption of the six components of technology package on household variables

Variables	B	ß	R^2	R^2 change	T value	Sig. T
Perception of package	0.004	0.36	0.119		3.63	0.001
Parcels of rice farmed	0.065	0.31	0.179	0.060	3.22	0.001
Goal orientation	-0.003	-0.22	0.213	0.034	-2.30	0.05
Perception of risk	-0.017	-0.23	0.257	0.044	-2.29	0.05

Constant = 1.038 Multiple R = 0.51 Overall F = 7.679

Table 5 Stepwise multiple regression of utilization of double cropping on household variables

Variables	B	ß	R^2	R^2 change	T value	Sig. T
Perception of technology	0.060	0.41	0.165		4.348	0.001
Level of education (medium)	0.704	0.23	0.220	0.055	2.555	0.01

Constant = -4.560 Multiple R = 0.47 Overall F = 13.265

farmers engage in double-cropping tends to suggest that they have some confidence in the recommended technologies.

The negative relationship hypothesized between level of education and use of the double-cropping recommendation is not supported. The study hypothesized that as education levels rise, farmers would tend to exit the farming system to seek salaried employment elsewhere. However, this does not appear to be the situation. Statistics from the Central Statistical Office (CSO) revealed that during the period of study, the level of unemployment in the area was 25%. This was 3% higher than the national average. There is little scope for salaried employment. The positive relationship determined between education and double cropping may lie in the increased managerial ability required to produce a second crop of rice on the same parcel of land before the onset of the dry season.

Utilization of the weed control recommendation

Two household psychological variables and two farm-related variables together accounted for 53% of the variance with respect to the use of this component, with households' perception of risk contributing the most (39%). The other variables significantly contributing were the size of the parcel (8%), the goals of the household (4%), and the land tenure system (2%) (Table 6).

Spending money on weedicides and labour to control weeds can be perceived as risky, if the expected benefits in increased income are not clearly visible. Risk perception is increased and consequently less use is made of the technology.

The study hypothesized a positive relationship between size of parcel of land and weed control use. The study confirmed that farmers with more land use adopted more of the weed control recommendation, probably to ensure that the benefits of planting larger parcels of land are not lost through insufficient weed control. Also, as land size increases, farmers may choose to engage in chemical weed control rather than more manual or traditional practices to save labour costs.

It was hypothesized that farmers with insecure tenure would not make the cash investment in weed control. The results show that in situations of permanent titles, however, farmers engage in weed control practices to a greater extent than those who have insecure tenure as shown by the significant value of 0.15 (Table 6).

Utilization of the spacing recommendation

Two psychological variables related to the household are related to the utilization of the recommended spacings, perception of risk, and perception of the spacing recommendation (Table 7).

The recommended spacings are much closer than those traditionally practised. Closer spacings require more labour at transplanting and harvesting times. There is also an increased need for fertilizers. Cost of production is higher and farmers may perceive the recommendation as a risk. If they do not believe that they will recover their cost and make a profit at the end of the crop season, they are unlikely to use the technology at levels recommended.

Utilization of the variety recommendation

One psychological variable, that is, the perception of the variety, was an important

Table 6 Stepwise multiple regression of the utilization of weed control recommendation on household variables

Variables	B	ß	R^2	R^2 change	T value	Sig. T
Perception of risk	-0.25	-0.49	0.392		-5.35	.001
Size of parcel	0.08	0.28	0.473	0.081	3.047	.001
Goal orientations	-0.21	-0.19	0.515	0.042	-2.54	.01
Land tenure system (permanent)	-0.11	0.15	0.530	0.015	-2.038	.05

Constant = 8.022 Multiple R = 0.742 Overall F = 27.656