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Determinants of Land Leasing Decisions in Shrimp Farming in West Bengal, India: Implications for Government Policy

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ABSTRACT

Using primary data collected from 208 shrimp farming households in West Bengal, this study found that demographic and economic factors influence land-leasing decisions in both traditional and scientific shrimp farming. The Tobit model results indicate that the household's land holding size is positively related with extent of leased in land in traditional shrimp farming; the relationship was negative in the case of scientific shrimp farming. This signifies that the market does not facilitate land leasing for traditional shrimp culture among households with small landholdings but does so in the case of scientific shrimp farming. Moreover, the household head's age had a negative relationship with extent of land leased out in both traditional and scientific shrimp farming. This indicates that existing institutional arrangements in shrimp farming in West Bengal have not been successful in motivating young rural people to undertake shrimp farming themselves instead of leasing out land for shrimp culture. Aquaculture policies should address this matter.

Keywords: shrimp farming, leasing-in, leasing-out, leasing market, Tobit model
JEL classification: Q11, Q22, C25

INTRODUCTION

Shrimp is one of India's most important aquaculture products in terms of export earnings. It constitutes 44 percent of the country's total marine product exports in terms of value and 21 percent in terms of volume. As such, the economic issues pertaining to shrimp aquaculture have attracted researchers' attention. The issues of interest are mainly on the profitability of various shrimp farming systems, the environmental costs of shrimp farming, and the institutional aspects. In the Indian context, many studies have dealt with the first two aspects; the institutional aspects have been relatively less explored.

Studies on land leasing for shrimp culture in India (e.g., Yadava 1997; Bhatta 2001) have mainly addressed two important issues: (1) land leasing policies and practices, and (2) shrimp culture regulations (Birthal and Krishnan 2001). Land leasing policies in many states are directed by government, except in Goa and West Bengal. State policies toward land leasing for shrimp culture have largely been used as a means to promote shrimp farming and direct available suitable land to the poorer section

of the society; the latter was done by fixing a certain ceiling of land for leasing to the poor. In many cases, shrimp farming has emerged as a commercial activity, resulting in changes in land leasing institutions. Such changes include increases in land rent and changes in the land tenure systems (Bhatta 2001; Rajalakshmi 2002). Despite all the regulations and policy initiatives, however, shrimp culture continues to face a number of challenges. Delay in the allotment of land by state governments, non-acceptance of leased in land for mortgage, and delay in sanction of loans act as disincentives to the beneficiaries. Moreover, despite the government's effort to redistribute coastal lands suitable for shrimp culture to ensure access of such lands to all the sections of society, private leasing markets for shrimp farming exists.

None of the studies so far had examined the nature and pattern of the land leasing market of shrimp farming in the Indian context. The studies mentioned above mainly describe the institutions involved in land leasing for shrimp culture but had not analyzed in-depth the land leasing market of aquaculture. Nor had there been any systematic analysis of the leasing market for shrimp culture from both the demand and supply sides.

This paper intends to address this gap in the existing literature and to analyze the determinants of leasing in or leasing out decisions in shrimp farming in India. This would help determine whether or not the private lease market functions efficiently by providing more land to households with smaller lands for shrimp farming. The results of such investigation are expected also to facilitate policymaking to address the needs of resource-poor shrimp farmers in terms of leasing-in land to expand their farming operations.

The paper is divided into five sections. The following (second) section provides some insights from the literature about determinants of leasing decision. The third section outlines the model specification and the variables used to examine the determinants of land leasing in shrimp farming. The fourth section describes the data sources. The fifth section presents the estimation results and discussion. The last section presents the conclusions and policy implications.

FARM HOUSEHOLDS' CHARACTERISTICS AND LEASING DECISIONS: INSIGHTS FROM THE LITERATURE

Studies on the determinants of farm households' participation in the leasing market (Yao 2001; Skoufias 1995; Bliss and Stern 1982) are based on a few theoretical models that have two basic assumptions: (1) there exists imperfect land, labor, and credit market in the agricultural context; and (2) individuals differ in terms of their initial wealth, specific human capital, and off-farm employment opportunities (Vranken and Swinnen 2002). These studies broadly suggest that the main factors affecting farm households' participation in the leasing market family are labor, total land endowment, factors that determine the managerial capacity of family laborers, and off-farm employment opportunities. The following discussion shows the interaction of these variables with the leasing decisions of the farm households.

The labor input needed for cultivation can be supplied by either the members of the farm family or hired labor. For the latter, a farm family would still need to assign a family member to supervise the work of hired laborers. There is an upper limit to the number of hired workers that a family worker can supervise (Taslim and Ahmed 1992). Once this limit is exceeded, proper supervision becomes difficult and could cause production to suffer. Thus, families with sufficient number of workers are expected to lease in more land. On the other hand, those with more family workers face the challenge of gainfully employing family

labor on their land holdings. In many cases, hiring out family labor as daily wage laborers is not socially desirable (Swain 1999). The management capability of family labor can thus be employed gainfully if the farm family leases in land instead of hiring out family labor as daily wage laborers (Binswanger, Deininger, and Feder 1995). In cases where the market for family labor is imperfect, the higher the number of male workers, the higher will be the amount of leased in land.

The total land endowment of the farm family is also an important factor in determining its leasing decisions. Leasing-in land itself is a result of an adjustment of the household toward an optimal operational scale (Bliss and Stern 1982).[1] Households lease in or lease out land to close the gap between the desired and actual amount of land they own. Thus, households owning lesser land are expected to lease in land and households having more land will lease out land ceteris paribus (Tikabo and Holden 2004; Skoufias 1995; Deininger and Jin 2002). The variables affecting the management capability of a particular farm family also bear on its leasing decisions. The household head makes the important decisions on the use of the household's land. Thus, the household head's socioeconomic characteristics may influence leasing decisions. Age is expected to have a positive influence on leasing-out decisions. This implies that household heads who are old would not be able to cultivate on their own and would prefer to lease out their lands. Education level is expected to have a positive influence on leasing-in decisions. Off-farm labor opportunities are expected to negatively affect leasing-in decisions. Higher off-farm labor opportunities will lead to leasing out of land, with the households preferring to go for off-farm activities. The economic status of the farm households may also affect the leasing decision.

VARIABLES AND MODEL SPECIFICATION

Censored regression or the Tobit model was used to analyze the factors influencing leasing decisions in shrimp farming. Three types of households are present in this context: (1) those who lease in land for shrimp culture, (2) those who leased out land for shrimp culture, and (3) those who do not participate in the leasing market (owner operators). An ordinary least squares (OLS) estimate, which would have the extent of leased in and leased out land as dependent variable and the possible factors affecting the leasing decision as independent variables, would not consider observations pertaining to households who did not participate in the leasing market (owner-operators). In such case, the exclusion of the owner-operators in the analysis may generate biased estimates for the factors affecting leasing decisions. Thus, the study used the groups of lessees, lessors, and owner-operators as sample in the estimation of Tobit regression for the factors influencing the households' leasing decision.

Separate estimates were done for leasing decisions in traditional and scientific shrimp farming.[2] In the case of traditional shrimp farming, the Tobit model sample consisted of 58 lessees, 50 owner-operators, and 40 lessors—a total of 148 households. In the case of scientific shrimp farming, the sample consisted of 33 lessees, 67 owner-operators, and 29 lessors—a total of 129 households. The Tobit model for leasing in and leasing out was left censored at zero. This means that in the model on leasing-in decision, the dependent variable assumed

1 See Taslim and Ahmed 1992; Skoufias1995.
2 Detailed characteristics of traditional and scientific shrimp farming are mentioned in Appendix A.

positive values if the household had leased in land for shrimp culture and zero if the household was an owner-operator or had leased out land. In the model on leasing-out decision, the dependent variable assumed positive values if the household had leased out land for shrimp culture and zero if the household was an owner-operator or had leased in land. The Tobit model for factors affecting leasing decisions of the households is specified as follows:

$$Y* = b'X + e$$
$$Y = 0, \text{if } Y* \leq 0$$
$$Y = Y*, \text{if } Y* > 0$$

where Y is a vector of extent of land leased in (or leased out) for shrimp culture, which is censored at zero; X is a matrix of explanatory variables, which are hypothesized to influence the amount of land leased in (or leased out) for shrimp culture by the households; b represents vector of unknown parameters to be estimated corresponding to the explanatory variables; and e is the disturbance term assumed to be normally distributed.

The explanatory variables in this case reflect the heterogeneity among the households in terms of demographic composition of the family and other socioeconomic variables. The explanatory variables include number of adult male members in the family (ADMALE); number of children in the family (CHILD); total land owned by the household (TOLAND) in acres; age of the household head (AGEHH) in years; whether or not the household is associated with fishery related occupation (OFISH) (OFISH takes the value 1 if household is associated with fishery related occupation and zero otherwise); *gram panchayat*[3] to which the household belongs (GP); and value of household's non-farm assets (NASSET) ('00,000 INR). It should be mentioned that in the case of traditional shrimp farming, GP=1, if the household belongs to Bermajur-I gram panchayat, and GP=0, if the household belongs to Sandeshkhali gram panchayat. In the case of scientific shrimp farming, GP=1, if the household belongs to Heria gram panchayat, and GP=0, if the household belongs to Tikasi gram panchayat. Therefore the final model is,

$$Y^* = b_0 + b_1 ADMALE + b_2 CHILD + b_3 TOLAND + b_4 AGEHH + b_5 OFISH + b_6 NASSET + b_7 GP + e$$

In the Tobit regression, number of adult male members and number of children were included as separate variables to capture the influence of the different types of family labor in leasing decisions. As discussed earlier, if the market for family labor is imperfect, ADMALE was expected to have a positive impact on leasing-in decisions of the household. This implies that households with more adult male members were expected to gainfully employ their family labor in shrimp culture instead of hiring out their labor to other occupations. The variable CHILD was expected to have a positive influence also on leasing-in decisions. As the number of children (dependents) increases, households may lease in more land to expand their shrimp farming activities in order to support their family. Moreover, these households were expected to offer lesser land in the lease market for shrimp culture.

As discussed earlier, total land owned by the household (TOLAND) was expected to have a negative impact on leasing-in decisions and a positive influence on leasing-out decisions

3 Gram panchayat refers to an elective village council in India. The household survey was conducted in four such village councils: Bermajur-I and Sandeshkhali village councils for traditional shrimp farming; Heria and Tikasi village councils for scientific shrimp farming.

in shrimp culture. If the households who are interested in undertaking shrimp farming possess less land, they are likely to lease in more land to expand their shrimp farming activities. Such negative influence of total landholdings on leasing-in decisions suggests that the land lease market in shrimp farming is operating efficiently and facilitating the distribution of land toward households interested in shrimp culture but have less land in their possession. Household head's age (AGEHH) was expected to have a negative influence on leasing-in decisions due to the assumption that younger farmers would be enthusiastic to expand their shrimp farming activity by leasing in land. The variable OFISH, representing households' association with fishery related business, was expected to have a positive impact on leasing in decisions. The assumption is that such association would expose the households to better information, which could encourage them to lease in land for shrimp culture. The impact of household's non-farm assets (NASSET) would depend on many exogenous factors prevalent in the study area. The assets of the lessees may serve as an incentive for lessors to lease out their land to wealthy people so that timely payment of the rent would be assured. Thus, wealthy households are more likely to access the lands offered in the lease market for shrimp culture. Moreover, the process of leasing out land for shrimp culture might be easier for wealthy households because they generally have higher political influence in the rural setting. In this sense, NASSET might have a positive influence on the supply side of the leasing market also. The households' leasing decisions in shrimp farming may also be influenced by the gram panchayat to which they belong. The institutional and locational factors specific to the gram panchayats may affect the households' decision-making. For example, shrimp farming in Sandeshkhali gram panchayat, the study area for traditional shrimp farming, had undergone several changes. Household-level shrimp farming has been a recent phenomenon in this gram panchayat; earlier the village had a few large shrimp farms owned by outsider entrepreneurs. Households who had small pieces of land along the river sides used to lease out their lands to those entrepreneurs. This indicates that land leasing has long been practiced in the area. Location specific factors like existence of more land worth leasing for shrimp culture in a particular gram panchayat may also influence the leasing decisions of the households. The variable GP was incorporated to capture such influences on leasing decisions in shrimp farming.

DATA SOURCE

The study used primary data collected in culture year 2004-05[4] from 108 traditional and 100 scientific shrimp farming households in two shrimp farming districts of West Bengal, India, using the multistage stratified random sampling technique. The existing leasing practices in West Bengal are dominated by private markets, providing a suitable ground for analyzing factors that determine or influence leasing decisions of households in shrimp farming. To analyze the supply side of the leasing market, data on sample households who had leased out land for shrimp farming were collected using

4 Though the study was based on data collected in 2004–05, an analysis of leasing decisions in shrimp culture still assumes importance. In India the area under shrimp farming and production has entered into a re-declining stage since 2006 (Prusty, Mohapatra, and S.K. Mukherjee 2011). The current land use policies in shrimp culture have not succeeded in expanding the area under production. Hence, the aquaculture authority should promote leasing of coastal lands as a means to promote shrimp culture. Therefore, an analysis of the land lease market in the context of shrimp culture is important.

Table 1. Descriptive statistics of the variables

Variables	Traditional Shrimp Farming			Scientific Shrimp Farming		
	Owner Operators	Lessees	Lessors	Owner Operators	Lessees	Lessors
Sample	50	58	40	67	32	29
Leased in (or leased out) land (acres)	-	6.24 (15.96)	1.2 (0.91)	-	0.99 (0.69)	1.50 (0.66)
Total land owned (acres)	1.86 (2.04)	1.81 (2.37)	2.15 (0.58)	2.03 (1.44)	1.93 (1.34)	4.8 (2.2)
No. of male members	2.57 (1.19)	2.8 (1.73)	3.0 (0.82)	2.39 (1.2)	2.04 (1.00)	2.9 (1.1)
No. of children	1.88 (1.58)	1.69 (1.27)	1.38 (1.40)	2.17 (1.99)	1.76 (1.28)	1.48 (0.98)
Association with fisheries related business (%)	28.6	56.9	26.2	19.40	27.27	31.03
Age of the household head	49.24 (11.02)	41.52 (12.4)	48.6 (16.4)	51.75 (19.6)	52.72 15.9)	51.0 (18.6)
Value of non-farm assets (INR)	31,826 (12,096)	41,970 (25,946)	42,445 (28,229)	104,968 (46,513)	112,340 (63,121)	12,356 (10,365)

Notes: Figures in parentheses indicate standard deviations
USD 1 = INR 44.93, during the period of the primary survey (2004–2005)

random sampling from the study villages of traditional (40 households) and scientific (29 households) shrimp farming. These villages are engaged in small-scale shrimp culture; the average farm size is less than two acres (1 acre = 0.40 hectares [ha]).

EMPIRICAL RESULTS

Table 1 presents the descriptive statistics of the variables. Of the 108 traditional shrimp farming households sample, 50 households were owner-operators in shrimp culture (i.e., using their own land). Their average landholding size (1.86 acres, 0.75 ha) was slightly higher than that of households leasing in land for shrimp farming (1.81 acres, 0.73 ha). That of lessors (2.15 acres, 0.87 ha) was highest among the three household groups. Lessors had more male family members than the other types of households in both traditional and scientific shrimp farming.

In general, more lessees were associated with fishery related activities than owner-operators. Moreover, the average age of the heads in owner-operator households was higher than that of the lessors. It is observed also that households who leased in lands had higher value of non-farm assets (INR 41,970 and INR 112,340 for traditional and scientific shrimp farming, respectively) than owner-operators (INR 31,826 and INR 104,968, respectively). This suggests that the amount of assets have a favorable impact on leasing in land for shrimp culture.

The estimation results of the Tobit models for leasing decisions in traditional shrimp farming are presented in Table 2, which include

Table 2. Maximum likelihood estimates of the Tobit model for factors influencing leasing decisions for traditional shrimp farming

Variables	Leasing In		Leasing Out	
	Coefficients	*p*-values	Coefficients	*p*-values
Constant	–20.06 (–2.54)	0.01	0.99 (0.87)	0.38
ADMALE (number)	–0.29 (–0.25)	0.80	0.41 (2.25)	0.02
CHILD (number)	0.29 (0.25)	0.76	–0.34 (–2.24)	0.02
TOLAND (acres)	3.12 (4.30)	0.00	0.06 (0.57)	0.56
OFISH (dummy)	9.76 (3.54)	0.00	–0.71 (–1.71)	0.08
AGEHH (years)	0.15 (1.19)	0.23	–0.05 (–2.68)	0.00
GP (dummy)	–8.74 (–3.07)	0.00	–0.67 (–1.71)	0.08
NASSET ('00,000 INR)	0.06 (1.31)	0.18	0.02 (2.69)	0.00
Sigma	12.88 (10.24)	0.00	1.67 (7.95)	0.00
LR $chi^2(7)$	50.74		31.79	
Prob>chi^2	0.00		0.00	
Log–likelihood	–271.49		–119.09	
Number of observations	148		148	

Notes: Figures in the parentheses indicate the *t*-values
USD 1 = INR 44.93, during the period of the primary survey (2004–2005)

the maximum likelihood estimates of the coefficients. The variable TOLAND is observed to have a statistically significant influence on the amount of land leased in for shrimp culture. The positive sign of the coefficient implies that, holding everything else constant, households with bigger landholdings are likely to lease in more land for shrimp culture. Shrimp farmers owning bigger lands are likely to be preferred by lessors because possession of more land poses as an assurance for timely payment of land rent.

On the other hand, households with more land holdings could afford to keep a portion of their land for agricultural purposes. That is, possession of agricultural land might have served as a risk covering measure for the households, encouraging them to undertake shrimp culture on leased in land. Thus, the lease market in traditional shrimp farming does not facilitate leasing in land for shrimp farming by small landowners. This means that households with smaller landholdings do not get a chance to lease in land to increase their shrimp farm area and get the benefits of economies of scale. This situation hinders the small shrimp farming households from earning higher income.

The estimation results also show that OFISH has a positive and statistically significant influence on households' leasing-in decisions. This implies that households associated with fishery related activities will likely lease in

more land for shrimp farming. This may be because such households have higher access to information on the lease market for shrimp culture in the locality.

Interestingly, the locational and institutional factors captured by the variable GP were found to also have a significant influence on leasing-in decisions of households in traditional shrimp farming. The negative coefficient of GP signifies that households belonging to Bermajur-I gram panchayat leased in lesser land than households in Sandeshkhali gram panchayat. As mentioned earlier, this could be a result of the prior existence of leasing practices and existence of more land suitable for shrimp culture along the riversides in Sandeshkhali gram panchayat.

Table 2 also presents the estimation results for factors influencing households' decision to lease out land for traditional shrimp culture. The variables related to the demographic characteristics of the households (i.e., number of adult male members in the family, number of children, and age of the household head) are observed to play a significant role in the supply side of the lease market in traditional shrimp farming. The positive and statistically significant coefficient of the variable ADMALE indicates that households having more adult male members leased out more land for shrimp farming. This result is contrary to the expectation. One reason could be the risky nature of shrimp farming. Households with more male members may rather prefer to diversify their economic activities by engaging themselves in agriculture and other businesses instead of just shrimp farming and thus lease out land suitable to shrimp culture. On the other hand, households with more children in the family offered lesser land in the lease market for shrimp culture. One reason for this could be that these households preferred to retain their land for future use rather than leasing them out for shrimp culture.

The negative coefficient of the variable AGEHH indicates that in the case of traditional shrimp farming the younger the household heads were, the more land they leased out. This signifies that young rural people did not have enough motivation to engage in shrimp culture on their own; they would rather lease out their land for shrimp culture. They also preferred to have an annual fixed income and to engage themselves in other occupations. The positive coefficient of NASSET implies that ceteris paribus households possessing higher non-farm assets leased out more land for shrimp farming. This means that relatively wealthy households leased out more land for traditional shrimp farming instead of engaging in shrimp culture themselves. On the other hand, total land owned (TOLAND) did not have any significant impact on leasing-out decisions of households in traditional shrimp farming.

The estimated coefficient of the variable OFISH is negative and statistically significant. This implies that among households who leased out land for shrimp farming, those associated with fishery-related businesses leased out lesser land. The households' association with fishery related activities may have exposed them to more information on shrimp farming practices, which might have motivated them to culture shrimp on their own and, thus, offer less land in the lease market. Similar to the demand side of the lease market for shrimp farming, in the supply side, the variable GP was found to be statistically significant and negatively influencing households' decision to lease out land. In this case, households belonging to Sandeshkhali gram panchayat leased out more lands than those belonging to Bermajur-I gram panchayat. This implies that households' participation in both supply and demand sides of the leasing activities for shrimp culture was common in Sandeshkhali Gram panchayat. The significant value of sigma, which is the

inverse Mill's ratio, reveals that exclusion of the observations with zero value of the variable *Y* would bias the results for both sides of the lease market for shrimp farming.

Similar to the case of traditional shrimp farming, the study also explored the factors influencing households' leasing decisions in scientific shrimp farming following the Tobit models specified earlier. The resulting estimated coefficients are presented in Table 3. In this case, the estimation results do not indicate significant influences of the households' specific demographic and socioeconomic characteristics on their leasing decisions. A possible reason for such results could be that leasing for shrimp farming had been practiced in a very limited manner in the study area. Only 33 percent of the scientific shrimp farmers had leased in land for shrimp culture; only 29 households in the four study villages were found to lease out land. This may have restricted the study from identifying the specific household characteristics that significantly influence leasing decisions.

Table 3 presents results that suggest specific characteristics influencing households' leasing decision in shrimp culture. In the case of leasing in land for scientific shrimp farming, the only variable found to have a statistically significant influence on such decisions is TOLAND. The sign of the estimated coefficient reveals that, ceteris paribus, households having lesser land endowment leased in more land for shrimp culture. This result is contrary to that obtained in traditional shrimp farming, where the impact of TOLAND on leasing-in decision was positive. A possible reason for this difference is the very high returns on scientific shrimp farming.[5] Households having lesser land undertake the risk of leasing-in because just 2–3 years of successful harvests can turn their fortune. Moreover, such households do not culture shrimp on their own land because if they convert their entire land into shrimp ponds and incur losses, the land would not be suitable for agriculture in the next few years. The results indicate that the existing lease arrangements benefit households who had lesser landholdings to lease in for shrimp culture. The variable TOLAND has positive and significant influence on the households' decision to lease out land. Thus, ceteris paribus, households owning higher amounts of land would lease out more land for shrimp culture. This is consistent with the expected results.

Thus it can be said that the land market in the case of scientific shrimp farmers facilitates the transfer of land from big landowners to small ones. It was observed also that the younger the household head, the higher the amount of land leased out for shrimp culture. This implies that the younger farmers leased out their land and engaged their family labor in off-farm business related activities, instead of taking risks in shrimp farming.

CONCLUSIONS AND POLICY IMPLICATIONS

This paper examined the nature of the land lease market in shrimp farming from both demand and supply sides. The analysis of factors influencing the leasing decisions of the shrimp farming households reveals that in the case of traditional shrimp farming, households with bigger landholdings leased in more land for shrimp culture. This suggests that private

5 The primary data suggest that the average gross returns from traditional shrimp farming and scientific shrimp framing are INR 31,030 per acre (INR 12,562.75/ha) and INR 311,885 per acre (INR 126,269.23/ha), respectively. The average net returns (over the paid out costs) from traditional and scientific farming are INR 13,803 per acre (INR 5,588.26/ha) and INR 60,053 per acre (INR 24,312.96/ha), respectively. Detailed costs and returns are provided in Appendix B.

Table 3. Maximum likelihood estimates of Tobit model for factors influencing leasing decisions in scientific shrimp farming

Variables	Leasing In		Leasing Out	
	Coefficients	*p*-values	Coefficients	*p*-values
Constant	−1.27 (−1.30)	0.19	−1.27 (−1.17)	0.24
ADMALE (number)	−0.24 (−1.36)	0.17	0.22 (1.39)	0.16
CHILD (number)	−0.09 (−0.71)	0.47	−0.09 (−0.67)	0.49
TOLAND (acres)	−0.21 (−2.45)	0.01	0.48 (4.89)	0.00
OFISH (dummy)	0.11 (0.27)	0.66	0.55 (1.35)	0.18
AGEHH (years)	0.02 (1.13)	0.25	−0.04 (−2.21)	0.00
GP (dummy)	−0.05 (−0.12)	0.90	0.17 (0.43)	0.18
NASSET ('00,000 INR)	0.005 (1.46)	0.15	.018 (0.42)	0.66
Sigma	1.54 (6.42)	0.00	1.41 (6.56)	0.00
LR chi^2 (7)	20.00		51.81	
Prob>chi^2	0.01		0.00	
Log-likelihood	−100.76		−80.38	
Number of observations	129		129	

Note: Figures in parentheses indicate *t*-values

lease market in traditional shrimp farming does not facilitate leasing in land among households with less landholdings. As such, West Bengal's fishery department may address the situation by implementing policies such as redistribution of coastal land (like in the states of Andhra Pradesh and Tamil Nadu) to such households. In the case of scientific shrimp farming, it was found that households with lesser landholdings leased in more land for shrimp farming. This indicates that the existing lease market facilitates leasing in land to households with lesser landholdings, enabling shrimp farmers to enjoy the benefits of economies of scale and earn higher income. In this regard, the coastal land redistribution to smaller shrimp farming households may be focused on traditional shrimp farming areas.

Households' association with fishery related occupations was found to have a favorable impact on their leasing-in decisions in the case of traditional shrimp farming. This implies that the development of fishery-related businesses (e.g., supply of seed and fisheries equipment, hatcheries, marketing of shrimp) in the shrimp farm areas will give more exposure to shrimp farming households and motivate them to expand their operations by leasing in land for shrimp farming. On the supply side, it was found that households with more male members preferred to lease out more land rather than employ their male workforce in shrimp culture. Moreover, in both traditional and scientific shrimp farming system, the young household heads leased out more land. These

results indicate that the present prospects and institutional arrangements in shrimp farming have not been successful in catching the imagination of young rural people to go into shrimp farming themselves. To make shrimp farming more attractive to the rural youth who have aquaculture lands, government should provide support to shrimp farming, such as help farmers by reducing the risk of disease outbreaks and by providing crop insurance.

The study's results suggest that to facilitate land leasing in order to expand the current shrimp farm sizes, West Bengal's fisheries department should seriously consider the following: (1) redistribute coastal lands to traditional shrimp farming households with small landholdings, (2) promote development of ancillary business related to shrimp culture in the shrimp farm areas, and (3) adopt suitable steps to reduce the risk of crop failure in shrimp culture.

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APPENDICES

Appendix A. Characteristics of traditional and scientific shrimp farming

Traditional Shrimp Farming	Scientific Shrimp Farming
• Fully tide fed • Salinity varies according to monsoon regime • Fry of mixed species from the adjoining creeks and canals due to auto stocking • Additional stocking of natural fry • Dependence on natural food • Water intake and drainage managed through sluice gates, depending on the tidal effects • Periodic harvesting during full and new moon periods, collection at sluice gates by traps and net bags	• Ponds are manured and fertilized, water filling and exchange are done by pumping • Selective stocking with hatchery fry at 6–25 PL/m^2 or more • Use of highly nutritive feeds • Usage of aerators • Harvesting at the end of one crop season, normally 120 days

Source: Bhattacharya (2007)

Appendix B. Costs and returns from traditional and scientific shrimp farming across shrimp farmer categories (INR/acre)

	Traditional Shrimp Farming					Scientific Shrimp Farming				
Categories of Shrimp Farmers	Gross Returns	Paid-out Costs	Total Cost	Net Income over Paid-out Cost	Net Income over total Cost	Gross Returns	Paid-out Costs	Total Cost	Net Income over Paid-out Cost	Net Income over Total Costs
Marginal	27,735	16,151	24,893	11,584	2,842	273,477	248,623	275,561	24,854	–1,690
Small	27,464	15,909	20,977	11,555	6,487	292,062	224,135	239,026	67,923	53,881
Medium	30,226	15,535	18,455	14,821	11,939	580,408	333,450	348,168	246,958	233,871
Large	38,603	17,416	18,624	21,187	19,979	-	-	-	-	-
All	31,030	16,152	21,456	13,803	8,817	311,885	251,833	274,414	60,053	38,115

Source: Primary survey