

# **A Logit Analysis of the Factors Affecting Cage Fish Farming Adoption Decisions in the Southwest Coast of India**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

**Aims:** Cage fish farming is an emerging aquaculture technology in India. The successful cage farming demonstrations in the open sea and coastal waters by the ICAR-Central Marine Fisheries Research Institute (CMFRI) led to the popularization of the technology in different maritime states of the country. The aim of the study was to analyse the factors contributing to the adoption decisions of cage fish farming in Kerala, Southwest coast of India

**Study Design:** The data were collected from 100 respondents consisting of 50 each from adopters and non-adopters of cage fish farming in Ernakulam district of Kerala for analyzing the factors driving the adoption decisions.

**Place and Duration of Study:** The study was conducted in Ernakulam district in the Southwest coast of India during October to December, 2019

**Methodology:** Factors contributing to the adoption decisions of cage fish farming were analyzed using logistic regression model

**Results:** The results of the analysis revealed that access to institutional credit, education of the farmers, off farm income and training received were the key drivers of technology adoption decisions of fish farmers in Kerala. The odds favouring education increased by 5.90 times for the respondents. The access to institutional credit increased the odds of adoption of cage farming by

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3.945 times. The availability of off farm income increased the odds of adopting cage farming technology by 3.257 times.

**Conclusion:** Cage fish farming being an emerging aquaculture technology, the results throw light on the necessity of adequate provisions for credit support and capacity development programmes by the institutional agencies for accelerating the technology adoption process. Since the education of the farmers and trainings were significant factors on adoption decisions, the technology could be effectively utilized and linked with employment generation schemes for the educated youth for augmenting fish production and livelihoods.

*Keywords: Adoption; cage fish farming; logistic regression; institutional support.*

## 1. INTRODUCTION

Cage fish farming was initiated in India by the ICAR-Central marine Fisheries Research institute through frontline demonstrations in different maritime states of the country. The successful farming demonstrations in the sea as well as estuarine and coastal waters in the country paved the way for popularization of the technology in the country. Cage farming is a promising aquaculture technology with tremendous scope for augmenting the fish production and livelihoods of fishers and fish farmers. ICAR-CMFRI has developed HDPE (High Density Poly Ethylene) cage structures suitable for open sea cage farming in India and initiated front line demonstrations in the selected maritime states of the country. Thereafter cost effective GI (Galvanised Iron) cages suited for farming in the estuarine and coastal waters of the country were developed and participatory cage farming with involvement of fishers and fish farmers were undertaken in the maritime states of the country which had resulted in further refinement of the technology. The initial investment cost of the GI cages was 2055 USD which was almost half of that of the HDPE cages. The major species of fishes suitable for cage farming in the open sea included Cobia (*Rachycentron canadum*), Silver Pompano (*Trachinotus blochii*), Seabass (*Lates calcarifer*), Snappers (*Lutjanus sp.*), Groupers (*Epinephelus sp.*) and Spiny Lobster (*Panulirus sp.*), whereas Seabass, Milk Fish (*Chanos chanos*), Pearlscale (*Etroplus suratensis*) Grey mullet (*Chanos chanos*) and Nile tilapia (*Oreochromis niloticus*) were preferred for coastal water cage farming. Open sea cage farming is undertaken with institutional support under participatory mode in most of the maritime states. At present there are more than 3000 fish cages installed in the marine and coastal waters of the country under the direct technical supervision of ICAR-CMFRI with an estimated fish production of 5250 t [1].

Even though the cage farming technology was initiated in the past decade, the widespread adoption across the maritime states of the country was constrained by several factors. Economic, social, physical and institutional factors affect the technology adoption decisions of aquaculture technologies. The institutional drivers consisting of credit support schemes, technology backstopping, socio-economic feasibility, easiness in adoption of the technology and market potential decides the large scale adoption of technologies. Identification of the various factors contributing to the technology adoption decisions will help to accelerate the technology adoption process. Kerala state in the South west coast of India is one of the successful adopters of cage fish farming technology in the country. The coastal cage fish farming was successfully adopted in various locations of the state by the fisher's and fish farmers in the state. The factors affecting the adoption of cage farming technology was studied based on the data collected from adopters and non-adopters of the technology in Ernakulam district of Kerala. Ernakulam district (9.98160 N and 76.2990 E) had the highest number of adopters of cage farming technology among the coastal districts in Kerala.

Technology adoption studies in the past had attempted to measure socio-demographic factors, comprising farmer's education, age, experience and household size [2,3,4] and economic, social, physical and institutional factors [5]. Logistic regression model was used by several authors for assessing the factors affecting the technology adoption decisions in Agriculture [6,7,8]. However studies concerning the factors driving the adoption of aquaculture technologies are limited [9,10]. Cage fish farming is a recently developed and popularized technology in India and large scale commercialization is yet to be realized in the country. There are several constraints for the large scale adoption of the technology. Studies

concerning the socio-economics aspects of cage farming are very much limited in India. No previous studies in the country attempted to assess the factors driving the adoption of this promising technology either at micro or macro levels and hence the present micro level study is novel in this regard and the results of the study could throw light on the factors driving the technology adoption process and to inform policies for accelerating fish production through cage fish farming.

## 2. MATERIALS AND METHODS

The factors contributing the adoption decisions of cage fish farming was analysed based on data collected from adopters and non-adopters in Ernakulam district of Kerala using a binary logistic regression model. The logistic model predicts the logit of the response variable (adoption of cage fish farming) from the independent variables. Specific choices were expressed as a binomial dummy variable (either taking 1 if the farmer adopts the technology or 0 otherwise).

The logit model for adoption of cage fish farming is specified as follows

$$P_i = P(Z_i) = P(\alpha + \beta_i X_i) = \frac{1}{1 + e^{-Z_i}} \quad (1)$$

Where,  $P_i$  is the probability that the respondent is adopter or non-adopter of the technology given  $X_i$ ;

$X_i$  represents the  $i^{\text{th}}$  explanatory variables; and  $\alpha$  and  $\beta$  are parameters to be estimated.

The logistic model could be written in terms of the odds and log of odds, which helps to understand the interpretation of the coefficients. The odds ratio implies the ratio of the probability ( $P_i$ ) that an individual would choose an alternative to the probability ( $1 - P_i$ ) that he/she would not choose it [10].

$$(1 - P_i) = \frac{1}{1 + e^{Z_i}} \quad (2)$$

The odds ratio is expressed as

$$\frac{P_i}{1 - P_i} = e^{Z_i} \quad (3)$$

Taking the natural logarithms,

$$Z_i = \ln\left(\frac{P_i}{1 - P_i}\right) = a + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \quad (4)$$

If the disturbance term  $e_i$  is taken into account, the logit model becomes

$$Z_i = \alpha + \sum_{i=1}^n \beta_i X_i + e_i \dots \quad (5)$$

Where  $Y$  = dependent variable with 1 = adopters and 0 = non-adopters;  $a$  = intercept;  $b_1 \dots b_n$  = coefficients of the independent variables;  $X_1, \dots, X_n$  = the independent variables;  $P$  = probability of adopting cage farming;  $1 - P$  = probability that a farmer does not adopt cage farming. With the independent variables of this model ( $X_1$  = Age,  $X_2$  = Education  $X_3$ - Off farm income sources,  $X_4$ - access to institutional credit,  $X_5$ -Training Received), The data were collected from 100 respondents comprising 50 each from the adopters and non-adopters of cage fish farming in Ernakulam district of Kerala. The logistic regression model was estimated using SPSS 22 software.

## 3. RESULTS AND DISCUSSION

Socio-demographic particulars of the respondents revealed that average age of the adopted farmers was 42 years whereas the non-adopted category had an average age of 48 years indicating that the cage farming technology was preferred more by the younger population in the locality. More than 50 % of the adopters had education up to higher secondary level and 34% had education above graduation. In case of non-adopters 44% had education up to high school level and 56% had higher secondary level education (Table 1).

The logistic regression model explained 54.9.0% (Nagelkerke  $R^2$ ) of the variance in adoption of cage farming. Education of the farmers(EDN), off farm income(OFF INC), access to institutional credit (CRED) and training received(TRN) were found to have significant influence on the likelihood of adoption of cage farming technology whereas age(AGE) of the farmers was non-significant with respect to the likelihood of adoption of the technology (Table 2).

The maximum likelihood estimates of the logistic regression model indicated that the overall predictive power of the model was 54.9%, while the significant Chi square ( $P < 0.01$ ) was indicative of the strength of the joint effect of the covariates on probability of adoption among farmers in the region. The quality of conciliation was tested using the Hosmer and Lemeshow statistic, which is one of the most reliable test to reconcile the logistic regression model [11].

**Table 1. Descriptive statistics of the variables used in the model**

Particulars	Adopter	%	Non-adopter	%
Age	42		48	
Education				
Primary	1	2.0	0	0.0
UP	0	0.0	4	8.0
High school	3	6.0	18	36.0
Higher secondary	29	58.0	28	56.0
College	13	26.0	0	0.0
Others	4	8.0	0	0.0
Off farm income	25	50.0	16	32.0
Credit access	40	80.0	22	44.0
Training received	37	74.0	13	26.0

**Table 2. Logistic regression model**

Particulars	B	S.E	Wald	df	Sig.	Exp(B)
AGE	-.030	.026	1.282	1	.257	.971
EDN	1.776***	.526	11.423	1	.001	5.909
CRED	1.373***	.586	5.477	1	.019	3.945
TRN	1.425***	.550	6.714	1	.010	4.158
OFF INC	1.181**	.584	4.096	1	.043	3.257
Constant	-7.614	2.659	8.197	1	.004	.000

\*\*\* and \*\* indicates Significant at  $P < 0.01$ ,  $P < 0.05$ , respectively. B, Parameter estimate; SE, Standard error. Hosmer and Lemeshow Test: Chi-square, 6.847; df., 8; Sig.: 0.553; Cox & Snell R Square, 0.412; Nagelkerke  $R^2$ : 0.549

The results of the logistic regression model indicated that education (EDN) of the farmer had positive influence on farmers' decision to adopt cage farming technology with odds ratio more than one. The Wald statistics corresponding to the variable EDN was significant at 1% probability level. The odds favouring education increased by 5.90 times for the respondents. Similar results were obtained in previous studies on the impact of education on technology adoption process. The education level of a farmer increases his ability to obtain, process and use information relevant to the adoption of a new technology [4]. Age, education and off farm income are significant variables affecting the adoption of innovative technologies by livestock farmers in Tunisia [12]. An additional year of education attained by the farmer is associated with the log odds of adopting no-till Conservation Agriculture (versus non-adoption) by about 1.2 (odds ratio = 1.214) times [5].

Access to credit is considered as one of the most important determinant of technology adoption. The access to institutional credit increased the adoption of cage farming technology by 3.945 times. Access to credit promoted the adoption of risky technologies through relaxation of the liquidity constraint as well as through the

boosting of household's-risk bearing ability [13]. The adopters of cage fish farming in the study area received institutional credit through various subsidy assistance schemes of central and state governments. Since cage farming is an emerging aquaculture technology in the state, the institutional credit support need to be extended till the technology adoption reaches desired levels.

The off farm income of farmers also was a critical factor contributing to the technology adoption decision with odds ratio more than one. The availability of off farm income increased the odds of adopting cage farming technology by 3.257 times. Although the initial investment cost was low in cage farming, the recurring expenses for feed is comparatively higher. It will be difficult for the small and marginal farmers to sustain the farming by meeting the farming as well as living expenses for 7 months without any additional income source. The off farm income also benefits the farmers who have no access to institutional credit to meet the recurring expenses till harvest. Off-farm income is expected to provide farmers some capital for purchasing productivity enhancing inputs such as improved seed and fertilizers [14].

Training and extension have crucial role to play on the successful adoption of new technologies. The training received by the cage fish farmers increased the odds of adopting the technology by 4.158 times. The extension service is the key driving factor behind technology development in the agricultural sector in developing countries. Availability and access to extension services has also been found to be a key aspect in technology adoption [15]. Many authors had reported a positive relationship between extension services and technology adoption. An increase in extension visits, age, education and farmers' positive perceptions significantly increased the likelihood of a farmer adopting no-till conservation agriculture in Zashuke [6]. Access to extension services can counteract the negative effect of lack of formal education of farmers which hinders technology adoption [4].

#### 4. CONCLUSION

The results of the analysis revealed that access to institutional credit, education of the farmers, off farm income and trainings were the key determinants of technology adoption decisions of cage fish farmers in Kerala. Being an emerging aquaculture technology, the results throw light on the necessity of adequate provisions for credit support and capacity development programmes by the intuitional agencies for accelerating the technology adoption process in the state. Since the education of the farmers and trainings were significant drivers of adoption decisions, cage farming technology could be effectively utilized and linked with employment generation schemes for the educated youth for augmenting fish production and livelihoods. The government support for credit and capacity development programmes need to be continued till the desired level of adoption is achieved or the farmers develop self-sustaining farming models with forward and backward linkages for input supply, credit and marketing facilities through organization of cooperatives or farmer producer organisations.

#### CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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