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Enabling Aquaculture Extension Strategy in Agricultural Technology Management Agency (ATMA), India

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ABSTRACT: The strengthening of aquaculture extension systems can accelerate the scope of targeted fish production in India. Agricultural Technology Management Agency (ATMA) is implemented as a bottom down approach in several states in India and is designed to integrate extension activities across all line departments. With the inception of the convergence strategy of ATMA, there is a need to develop an enabling aquaculture extension strategy, and statistical tools like Factor analysis and Ordinal regression model were used to develop the strategy. Thus, a study was conducted in five best performing ATMA districts in Kerala that is located along the southwest coast of India and a total of 225 fish farmers were selected for this study. Variables chosen for this research study concentrated around four factors namely Line Department Convergent Extension Approach, Marketing Extension Approach, Elementary Extension and Commodity Specific Approach that represented Aquaculture extension and Information Communication Technology (ICT) or Media Facilitated Approach. The proposed strategy addresses to initiate with factor three, that is, Elementary Extension and Commodity Specific Approach, that deals with fish farming variables and then to branch out to the other mentioned factors. In order to raise the income from fish culture, the expenditure needs to be elevated and the fish farmers require particular support for fisheries from the developmental departments and such a parallel support should predominantly be extended to the pond owners too. The main challenge lied with identifying the target group associated with this study and with the data collection procedure with the subjects that were spread along five different districts in the state. In the end, suggestions have been made as to improve the income of aquaculture farmers through the four proposed aquaculture extension approaches.

Keywords: Line Department Convergent Extension Approach, Marketing Extension Approach, Elementary Extension and Commodity Specific Approach, Media Facilitated Extension Approach.

INTRODUCTION

India currently produces nearly 7.6 percent of the world's total fish production (GoI, 2022), and ranks second in aquaculture production (DoF, 2023). Fish production in India has touched 9.06 million tonnes in 2013to 162.48 lakh tonnes in 2021-22 (Tofler, 2023), from mere 0.75 million tonnes in 1950-51 (DAHD, 2013). The Indian aquaculture market size reached 12.4 million Tons in 2022 (IMARC, 2022). The targeted fish production of India by 2024 is 22 million metric tonnes (Economic times 2022, Planning Commission, 2004). It is forecasted that from 2020 to 2025, India's total fish production will increase from 13.74 million MT to 16.59 million MT (Ojha and Dey 2019), which is less than the targeted production. Therefore, there is a need to strengthen and revamp aquaculture extension systems in the country (Nath *et al.*, 2020). India, in consultation with the World Bank, has designed a new extension system that focuses on small farmers' income through the Agricultural Technology Management Agency (ATMA) during 1998–2005 in 28 districts (Singh *et al.*, 2009; Claire *et al.*, 2010). ATMA later was extended to 614 districts in 28 States and three Union Territories in India (Planning Commission, 2011). This is a semi-autonomous agency and is designed to (1) integrating extension programmes across all key line departments (Singh *et al.*, 2013) (2) linking research and extension activities (MPRA, 2013) and (3) decentralizing extension decision-making through a participatory programme planning process (Swanson *et al.*, 2008). Moreover, transparency and stakeholder participation are required in monitoring such extension programmes (Joffre *et al.,* 2010). With changing overall extension strategy, after the inception of ATMA, there exists a gap in the form of a need to develop an enabling aquaculture extension strategy in ATMA to achieve the set targets. An enabling need-based aquaculture extension strategy helps in increasing aquaculture production through sustainably utilizing the available aquatic resources (FAOLEX Database, 2023).

MATERIALS AND METHODS

In India, in the state of Kerala, that is an emerging region in terms of aquaculture, was selected for this study (DAHD, 2012). ATMA was implemented in Kerala in the year 2010 and it is still in an evolving stage in the state. Hence, it was necessary to know about the enabling strategies of the Department of Fisheries that is coping up with ATMA strategies and finally suggest approaches in order to mainstream fisheries in ATMA. As per the perception of the officials at the state headquarters, five best ATMA performing districts, namely, Alappuzha, Ernakulam, Kollam, Kottayam and Thrissur were selected. A schedule was prepared, considering the variables described in Table 1. From the list of fish farmers who were benefited from the ATMA support, a total of 45 fish farmers were randomly selected from each of the above-mentioned districts, for collecting primary data. Thus, a total of 225 fish farmers were selected for this study.

Table 1: Description and measurements of the variables selected (scores are indicated in parentheses).

Variables	Description	Measurement (scores are indicated in parentheses)
INCf	Income from fisheries (per month in Aquaculture)	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, <₹ 1000/US$16 (one); ₹ 1001- ₹ 5000/ US$80 (two); ₹ 50001- ₹ 10000/ US$160 (three); >₹ 10001 (four)
TOF	Type of Farming (Type of fish culture practiced by the fish farmer)	Monoculture (one); Polyculture (two); Both (three)
FISHSPP	Fish Species (Number of fish species cultured)	Each fish species cultured score (one)
MARK	Marketing (Strategies used to market the fish species)	Word of mouth (one); Using sign boards (two); advertising in gatherings, festivals; leaflets (three); Through coordinators (four)
EXPENf	Expenditure in fisheries (incurred per month for aquaculture)	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, <₹ 1000/US$16 (one); ₹ 1001- ₹ 5000/ US$80 (two); ₹ 50001- ₹ 10000/ US$160 (three); >₹ 10001 (four)
SSUPPf	Specific Support in fisheries (The support provided by ATMA in the form of Training, Demonstration, Exposure visit, Farmer-scientist interaction, Rewards and Incentives, Innovative activities and Mobilization of fish farmer groups)	Awareness: Yes (one); No (zero) / Duration: Orientation training based on presentations by experts (one); One day field trip (two); one to three days exposure visit (three); All (four) / Level of satisfaction: Highly satisfied (five); Satisfied (four); Unsatisfied (three); Highly unsatisfied (two); No comments (one)
EDU	Educational qualification (of fish farmers)	Primary (one); Secondary (two); Higher Secondary (three); Under Graduate (four); Post Graduate (five)
CFU	Communication Facility Utility (Different communication channels utilized)	Post office (one); Telephone (one); Internet (one); Television (one); Radio (one); Kisan Call Centre (one). Total CFU scores = Sum total of scores
MMEf	Mass Media Exposure in fisheries (Sources of media used and their frequency of use for seeking fisheries information)	The sum total of the number of channels used for fisheries information x Respective accessing regularity. Each channel score = 1; Fisheries information on Newspaper (one); Fishery related magazines (one); Fishery related programmes on radio (one); Fishery related programmes on Television (one). Each Accessing regularity score: Daily (four); Weekly/Fortnightly (three); Bimonthly/Monthly (two); Occasionally (one); Never (zero)
FIDAf	Farm Information Dissemination Assessment in fisheries (Assessment of information dissemination through different sources by the respondents)	Each relative frequency level score for the perceived importance of a given information source in aquaculture: Strongly Agree (four); Agree (three); Disagree (two); Strongly Disagree (one); Don't Know (zero). Each relative frequency level score for accessing regularity of the source: Regularly (three); Rarely (two); occasionally (one); Don't Know (zero). Each Relative frequency level score for utility satisfaction of the source: Highly Satisfactory (four); Satisfactory (three); Unsatisfactory (two); Highly Unsatisfactory (one); No comments (zero)
AUA	Area brought under Aquaculture (in hectare)	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, < 0.04 ha (one); 0.04 – 0.08 ha (two); 0.08 – 0.12 ha (three); 0.12 – 0.16 ha (four); > 0.16 ha (five)
OWN	Ownership of the pond	Owned (two); Leased (one)
EXP	Experience (Number of years experienced in aquaculture)	One year (one); Two years (two); Three years (three); Four years (four); More than four years (five)
NOW	Numbers of Workers employed	No worker (zero); One worker (one); Two workers (two); Three workers (three)
GSUPPf	General ATMA support in fisheries	Yes (one); No (zero)
AGRICROP	Agriculture Crop cultivated	For each cultivated crop (one)
INCAG	Income from Agriculture (Approximate monthly income from agriculture)	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, <₹ 1000/US$16 (one); ₹ 1001- ₹ 5000/ US$80 (two); ₹ 50001- ₹ 10000/ US$160 (three); >₹ 10001 (four)
EXPENAG	Expenditure in Agriculture (Approximate monthly expenditure incurred in agriculture)	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, <₹ 1000/US$16 (one); ₹ 1001- ₹ 5000/ US$80 (two); ₹ 50001- ₹ 10000/ US$160 (three); >₹ 10001 (four)

TOTALINCO	Total Income from aquaculture and agriculture	Since the data furnished by respondent was at an approximate figure, it was categorized with Quantile classification, that is, <₹ 1000/US$16 (one); ₹ 1001- ₹ 5000/ US$80 (two); ₹ 50001- ₹ 10000/ US$160 (three); >₹ 10001 (four)
GSUPPam	General ATMA support in agricultural marketing	Yes (one); No (zero)
CONCEPT	Awareness of Concept of ATMA	Aware (one); Not aware (zero)
TTG	Type of Training Got (Participated in the type of training organized by ATMA for fishfarmer)	Awareness training based on presentations by experts (one); One day field trip (two); one to three days exposure visit (three)
TRGY	Training Year (Year in which fish farmers attended the ATMA training)	2012 (one); 2011 (two); 2010 (three). Earlier training facilitates more time to practice.
TrgTop	Training Topic (Topics of training that the farmers attended like ornamental fish culture, prawn culture, carp culture, best management practices)	Each training topic attended (one)
TRGIMPL	Training know-how Implemented (follow-up farming practices after attending training)	Mostly Implemented (four); Implemented (three); Not Implemented (two); Not at all Implemented (one)
LOS	Level of Satisfaction after attending training	Highly Satisfactory (four); Satisfactory (three); Not Satisfactory (two); Not at all Satisfactory (one)
CAS	Comparing ATMA Support between aquaculture and agriculture (Comparison of ATMA activities in aquaculture and agriculture)	Highly Satisfactory (four); Satisfactory (three); Not Satisfactory (two); Not at all Satisfactory (one)

Principal component analysis was used to categorize the 27 selected variables under a few factors. Further, the ordinal regression model was attempted from the variables that were significant in the Factor three that represented an Elementary aquaculture extension and commodity specific approach.

RESULTS AND DISCUSSION

Factor analysis (Table 2) revealed that the variables were concentrated on four factors (Mohsen, 2020) namely, Line Department Convergent Extension Approach (Raabe, 2008), Marketing Extension Approach (Planning Commission, 2011), Elementary Extension and Commodity Specific Approach (FAO, 1997) and Information Communication Technology (ICT) or Media Facilitated Approach (Fu and Akter 2011).

The factor loading less than 0.5 are suppressed. Factor one contains all variables that are related to integrated farming that needs Line Department Convergent Extension Approach (FAO, 2005). Similarly, factor two illustrates profit motive and needs Marketing Extension Approach (Goel and Verma 2011). Factor three symbolizes aquaculture extension, where the fisheries extension professionals can focus on. Factor four signifies knowledge management aspect where ICT/Media Facilitated Approach (Meera *et al.*, 2004) is needed.

All the four factors together explained 47.43 percent of the total variance and among the factors, maximum variance was caused by factor one. This may be because the fish farmers were observed to be engaged in integrated fish farming to achieve food security and to minimize risk (Oshoke *et al.*, 2014). Accordingly, the extension interventions need to be broad based, converging fisheries extension with agricultural extension at the field level. To initiate this convergence, the enabling strategy for aquaculture extension might be to initially address factor three, that incorporates variables that are related to fish farming and subsequently branch out to other factors. While addressing factor three, there is a need to recognize the influence of variables involved in that factor with respect to income from aquaculture (INCf).

In Table 3, the threshold estimate of Income from fisheries (INCf) was classified into three levels and under location, expenditure in fisheries (EXPENf) has the highest estimate of 2.12. In the table, the model fitting information, gives the –2 log likelihood (-2LL) values for the baseline and final model along with the chi-square to test the difference between the -2LL for the two models. The significant chi-square statistics ($p < 0.001$) indicates that the final model gives significant improvement over the baseline intercept only model. From this table, the pseudo R^2 value (of Nagelkerke is 0.846, that is, 84.6 percent) indicates that the predictor variables under location explain a large proportion of variation in the outcome variable, that is, Income from fisheries (INCf). Parameter estimate depicted in the same table, shows the coefficient, their standard error, Wald test, associated p value and 95 percent confidence interval of the coefficient. All the three predictor variables (OWN, SSUPPf, and EXPENf) under location are statistically significant, but SSUPPf and EXPENf are highly significant. So, for EXPENf, it can be said that for a one unit or level increase in EXPENf (i.e., going from level one to two or two to three), it is expected a 2.12 increase in ordered log odds of being in higher level of dependent variable INCf, given all of the other variables in the model are held constant. In other words, it can be said that for a one unit or level increase in the predictor variable EXPENf, the odds in favour (likelihood) of increase in any higher level of income versus other combined low level of income is 8.33 times {= exp (2.12)} greater or odds in favour of increase in any higher combined level of income versus lower level of income is 8.33 times greater, given that all of the other variables in the model are held constant under the proportional odds assumption of the ordinary logistic regression. Similarly, for a one unit or level increase in the predictor variable SSUPPf, the odds in favour of an increase in any higher level of income versus combined lower level or individual level is 1.5 times {= exp (0105)} times greater; given that all of the other predictor variables are held constant under the proportional odds assumption of the ordinary logistic regression. Hence, it can be said that the predictor variables EXPENf play a more important role as compared to SSUPPf to raise income exponentially.

Therefore, in order to raise fish farmers' income, the farming expenditure need to be raised. The fish farmers also need specific support for fisheries (SSUPPf) from the developmental departments in the form of trainings, demonstrations, exposure visits, etc. and these departments need to ensure that such kind of support should primarily go to the owners of the ponds (OWN) to re-create a better farm demonstration-effect for other fellow fish farmers.

Table 2: Factor analysis of the selected variables.

Rotated Component Matrix[a]	**Components**			
	One	**Two**	**Three**	**Four**
	Line Department Convergent Extension Approach	**Marketing Extension Approach**	**Elementary Extension and Commodity Specific Approach**	**ICT/Media Facilitated Extension Approach**
% of Variance	15.27	14.25	10.19	7.72
Cumulative variance %	15.27	29.52	39.71	47.43
TOTALINCO	.802			
INCAG	.722			
EXPENAG	.687			
INCf	.631		.553	
GSUPPa	.621			
EXPENf	.617		.563	
AGRICROP	.609			
NOW	.543	-.514		
FID		.933		
MARK		.760		
EXP		.674		
AAC		.645		
FISHSPP		.636		
TTG		.633		
AUA		.542		
TrgTop			.643	
TOF			.637	
OWN			.617	
SSUPPf			.559	
TRGY			.540	
MME				.726
EDU				.609
CFU				.565
CONCEPT				.524
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				

Table 3: Results of ordinal regression model for income from fisheries.

A. Pseudo R-Square		**B. Model Fitting Information**				
Cox and Snell	**.795**	**Model**	**-2 Log Likelihood**	**Chi-Square**	**df**	**Sig.**
Nagelkerke	.846	Intercept Only	589.602			
McFadden	.564	Final	232.858	356.744	3	.000

C. Parameter Estimates

		Estimate	**Std. Error**	**Wald**	**df**	**Sig.**	**95 percent confidence interval: Lower Bound**	**Upper Bound**
Threshold	[INCf = 1.00]	9.008	1.140	62.472	1	.000	6.774	11.242
	[INCf = 2.00]	13.362	1.654	65.241	1	.000	10.120	16.604
	[INCf = 3.00]	17.667	2.122	69.313	1	.000	13.508	21.826
Location	EXPENf	2.120	.541	59.957	1	.000	3.129	5.250
	OWN	.585	.220	7.093	1	.008	.154	1.016
	SSUPPf	.105	.024	19.572	1	.000	.059	.152

CONCLUSIONS

The factor analysis helps in understanding the factors and variables associated with increasing the income of fish farmers that further helps in manifesting the strategies required in aquaculture extension. The following six steps are suggested to build up a strategy for aquaculture extension. Firstly, the pond owners in our area may be identified, as they are likely to increase the income. Secondly, specific support in fisheries by ATMA should be extended to the pond owners identified, in the form of trainings, demonstrations, exposure visits, farmer-scientist interactions, rewards and incentives and any other innovative activities (SAMETI, Mizoram, 2017), as these activities have significantly increased the income of the fish farmers. The performance of all the selected farmers for such activities may be assessed and scored. Additionally, the increase in investment by the fish farmer and their corresponding increase in income may also be assessed. Thirdly, the best performing farmer can be made as Farmers Friend (FF) (Manage, 2014). Demonstrations and on-farm trials can be organized in consultation with local Farm Science Centres in the ponds of FFs. Funds can also be mobilized through the Fish Farmers Development Agency (FFDA) as a reward to increase their investment habit for getting more returns. The selected FFs, who are able to standardize the technology and who are able to explain their personal experience in fish farming methods to other farmers, may further be graduated as trainers in Farmers Field School (FFS). Extension professionals in consultation with such trainers may develop the syllabus for each FFS for its implementation, monitoring and evaluation. Fourthly, the issues related to fish marketing, need to be addressed (Jasbin and Radhika 2016), by organizing exposure visits of the farmers to different wholesalers and retailers, so that the network in the value chain can be strengthened. Fifthly, success stories in production and marketing can be documented (Searles *et al.*, 2018). These literatures may help in developing extension material in print and electronic media that can be effectively used through ICT. For developing such literature, some educated fish farmers can be designated as FFs and rewarded accordingly. Sixthly, there is a need to integrate extension programmes across the line departments like, agriculture and livestock to address the factor one. All the line departments may join together to conduct awareness programme at the district level. They can also empower the FFs with the knowledge on agriculture, livestock and fisheries. Further, they can monitor and evaluate such multipurpose FFs and FFSs, to see their impact on farmers' income.

FUTURE SCOPE

Future studies of the same research topic can be conducted in a different kind of location, subject matter or sample size. Prospective studies may even address the effects of various extension strategies proposed across varying locations.

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Conflict of Interest. None.

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