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Women's Role in Small-Scale Aquaculture Sector and its Implications for Technical Efficiency: Empirical Evidence in Myanmar

Yee Mon Aung[1], Manfred Zeller[1], Ling Yee Khor[1], Nhuong Tran[2]

[1]University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany
[2]WorldFish, Myanmar

Abstract

Efficient use of inputs is crucial for sustainably increasing aquaculture productivity and profitability as well as sustaining rural livelihoods in developing countries. A few studies have shown that women's participation in decision-making (WPDM) as a measurement of women empowerment can influence technical efficiency among crop farmers. However, rigorous empirical evidence on input use efficiency and the effect of WPDM on technical efficiency in small-scale aquaculture households is inadequate. Using data from 423 smallholder aquaculture households in the Delta region of Myanmar, this study: (*a*) measures technical efficiency and (*b*) examines the effect of WPDMI on technical efficiency. Two-stage double bootstrap Data Envelopment Analysis (DEA) was used to correct for bias and serial correlation of efficiency scores. Results reveal that most small-scale fish-farming households were not technically efficient, performing in a range of 45%-60% below the production frontier. All the inputs used contained slacks such that all of them are over-utilized in inappropriate ratios. Regarding the findings of the regression analysis, WPDMI has a positive and significant effect on technical efficiency. Moreover, we found that female family labor's contribution in fish production activities was associated with higher technical efficiency level. Additionally, aquaculture production practices and climate change adaptation strategies are also significant shifters to enhance the efficiency level. Together, the findings highlight the important need to promote interventions targeted at improving technical efficiency of small-scale aquaculture producers. Programs and policies aimed at increasing aquaculture productivity would benefit by including interventions to reduce gender inequality and promoting equity.

Keywords: *data envelopment analysis (DEA), bootstrap truncated regression, technical efficiency, slacks, women, small-scale aquaculture, Myanmar*

Introduction

The economic reforms in Myanmar that began in 2012, targeted at poverty reduction and rural development, introduced new agricultural policies promoting diversification of smallholder agriculture, including fish farming (NESAC 2016). Prior to the reforms, small-scale fish farming was almost non-existent (Driel and Nauta, 2014). The number of small and medium scale aquaculture producers has since then rapidly expanded (Belton et al., 2015). Most recently, Karim et al. (2020) showed that the entry cost of small-scale aquaculture is low because farmers can modify rice fields and or utilize unused backyard lands. Therefore, small-scale aquaculture development is important in meeting the growing fish demand and improving the livelihoods of poor and vulnerable households in rural Myanmar. Despite the potential of small-scale aquaculture for development in Myanmar, a relevant question for agricultural policy makers is whether and how the small-scale aquaculture sector can be made more technically efficient by achieving either the current output level with fewer inputs or more output with the current input level. Answering this question is imperative and requires a better understanding of farmers' current level of technical efficiency and the factors that influence efficiency. Conceptually speaking, technical efficiency of small-scale aquaculture is influenced by a combination of social, economic, and environmental characteristics of fish farming households. Although many previous studies have shown that socioeconomic characteristics of fish producers influence technical efficiency, the effect of the social aspect with a focus on gender perspective on technical efficiency has not been studied yet. This paper tries to measure the overall technical efficiency of small-scale aquaculture households through different DEA models and then investigate the implication of women's role on technical efficiency of small-scale aquaculture.

Analytical framework

Our analysis relied on data from 423 small-scale aquaculture households collected during an aquaculture performance assessment baseline survey in 2019 for the project "Scaling systems and partnerships for accelerating the adoption of improved tilapia strains by small-scale fish farmers (SPAITS)". The main institutions involved in the study are WorldFish, the Department of Fisheries (DOF) in Myanmar, and the University of Hohenheim in Germany. In this survey a combination of stratified purposive and random sampling techniques was used. First, the Ayeyarwaddy Delta Region was selected as the study area because it is the main fish producing region in Myanmar. Second, three townships in the region namely Dedaye, Kyaik Lat, and Pyapon were purposely selected for the study. In this study, an input-oriented approach DEA model was adopted with the aim of using minimum feasible amount of inputs while retaining at the given output level. To estimate the overall technical efficiency scores, this study moved towards applying both radial and non-radial or slack-based DEA models. In addition, due to the biased and serially correlated technical efficiency scores derived from the conventional DEA model criticized by Simar and Wilson (2007), a two-stage double bootstrapping DEA technique was also applied to estimate bias-corrected efficiency scores as well as the determinants consistently. WPDM index (WPDMI) was generated from seven decision variables related to input use, harvest use, quantity and type of food consumed, land allocation, fish income, crop income, and livestock income allocation through Principal Component Analysis (PCA) method. To generate an index using PCA technique, households were first assigned weights related to their respective decision domains based on women's participation in the decision-making processes. Following Sariyev et al. (2020), weights for each decision-making variable were calculated by the ratio of the number of women decision makers within the household to the total number of decision-makers in each decision domain.

Results and discussions

The average technical efficiency score under the radial CDEA analysis was 0.55, which implies that the fish farming households in this study could reduce approximately 45% of their input use without changing their output level. However, the magnitude of the non-radial efficiency score was at an average level of 0.40, so the feasible input reduction is 60%. Theoretically, the average TE derived from the radial model was 15% higher than that obtained through non-radial method, which means radial TE overestimates the efficiency level because it does not take into account the slacks in efficiency estimation and it lacks discriminatory power. The overall BCTE score was 0.44, which highlights that there is substantial potential for input reduction at 56%. These findings revealed that the radial CDEA model efficiency scores were overestimated if the sample bias is not adjusted.

Regarding the results related to WPDMI derived from PCA, all validity tests yielded the positive results, indicating that the predicted values referring to WPDMI present effectively the information included in the decision-making variables. We scaled WPDMI to range from 0, no female participation to 1, sole female decision-making. In Figure 1, we observed that in most of the sampled households, female participation in decision-making is not very low.

In this regard, bias-corrected technical inefficiency scores were used as the dependent variable; hence, a positive (negative) coefficient sign indicates a negative (positive) effect on technical efficiency in Table (1). WPDMI in model 1 was positively associated with technical efficiency and statistically significant at the 10% level. This finding is consistent with those of studies in the agricultural sector by Seymour (2017) and Bozoğlu and Ceyhan(2007). Women's participation in decision-making process within the household raise their voice within the households and increase their access to production resources, which in turn positively affects the agricultural productivity. In the model 2, the coefficient of the share of female labour in fish production activities was negative and statistically significant at 10% level, indicating it has a positive effect on the technical efficiency. The results reported by Rahman (2010) confirm this finding. Additionally, aquaculture production practices particularly integrated agriculture and aquaculture (IAA) and polyculture and climate change adaptation strategies are also significant shifters to enhance the efficiency level in both models.

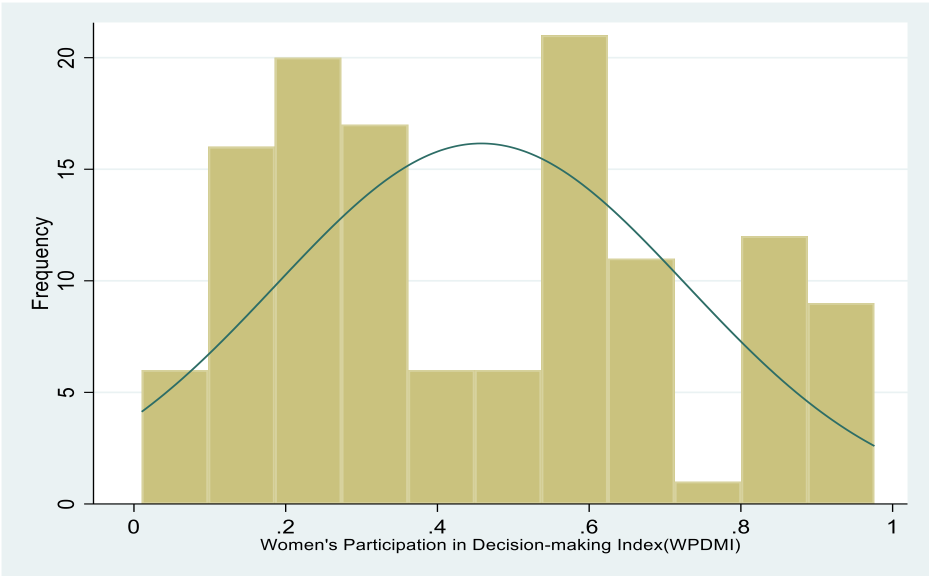

Figure 1 Histogram Women Participation in Decision-making Index (WPDMI)

Table (1) Bootstrapped truncated regression analysis in the small-scale aquaculture sector

Bias-corrected technical efficiency score	**Model 1 (WPDMI)**		**Model 2 (Share of female labor)**	
	Coef.	S.E.	Coef.	S.E.
Household head age (years)	0.004	0.004	0.004	0.004
Household head age squared (years^2)	-0.000	0.000	-0.000	0.000
Aquaculture experience (years)	0.001	0.003	0.001	0.003
Extension service (access=1, no access=0)	-0.028	0.021	-0.024	0.020
Average male education level (years)	-0.003	0.003	-0.003	0.003
Average female education level (years)	-0.001	0.003	-0.001	0.003
Log of total household expenditure (MMK)	-0.005	0.009	-0.005	0.010
Household head gender (male=1, female=0)	-0.090	0.040**	-0.074	0.036**
Women's participation in decision-making index	-0.015	0.008*		
Share of female labour (%)			-0.059	0.033*
Integrated farming system (yes=1, no=0)	-0.028	0.015*	-0.026	0.016*
Polyculture (yes=1, no=0)	-0.102	0.052*	-0.100	0.049**
Pond size - group 1 (<0.02 ha), group 2 (0.02 ha-0.04 ha), and group 3 (>0.04 ha)				
Group 2	-0.046	0.017***	-0.044	0.017**
Group 3	-0.063	0.018***	-0.063	0.018***

Climate change mitigation strategies (yes=1, no=0)	-0.046	0.021**	-0.039	0.021*
Climatic shocks affected fish farming (yes=1, no=0)	0.013	0.021	0.010	0.020
_cons	0.6423	0.147***	0.611	0.155***
Sigma	0.145	0.006***	0.145	0.006***
Observations		423		

Source: Own calculations. S.E. is the bootstrapped standard error.

Notes: P-values less than 0.1, 0.05, and 0.01 correspond to *, **, and ***, respectively.

Conclusions and Outlook

The results of the BDEA scores also revealed that the radial CDEA model efficiency scores are overestimated if the sample bias is not adjusted. Efficiency estimates revealed that sampled small-scale aquaculture households in Myanmar are operating their fish production below the production frontier, indicating that there is room for improvement if current input levels and technology are maintained. Therefore, small-scale aquaculture households need better pond management practices and quality fish seed to increase their profit by decreasing their production costs. Therefore, government should cooperate with local or international organizations and research institutes to develop a proper fish feeding formula with good feeding practices and produce good quality seed. In addition, we found that a higher participation of women in decision-making process and the contribution of female family laborers in fish production activities are associated with higher technical efficiency. To draw lessons from these research findings, WPDM and women involvement in the small-scale aquaculture sector are one of the crucial strategies for more efficient resource utilization that maximizes output. Therefore, programs and policies aimed at increasing small-scale aquaculture productivity would benefit by including interventions to reduce gender inequality and promoting equity.

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