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IMPACT OF SELF-SUFFICIENCY FISH FEED PROGRAM ON THE FISH FARMING BUSINESS PERFORMANCE

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ABSTRACT

High feed prices and a high proportion of feed costs cause the profitability of fish farming businesses to decline. One of the government's efforts to reduce feed costs is encouraging fish farmers to produce their feed using local raw materials through Self-Sufficiency Fish Feed Program. This study aims to analyze program's impact on the fish farming performance using the Propensity Score Matching (PSM) method. Performance is measured by cost, revenue, profit, R/C ratio, Feed Conversion Ratio (FCR), and technical efficiency which estimated using Data Envelopment Analysis (DEA). The results show that program implementation at the fish farmer's level has not positively impacted the fish farming business's performance. The results of the PSM analysis show that the program significantly impacts on costs, revenue, profit, R/C ratio, FCR, and technical efficiency. Farmers with programs have a higher average cost and FCR than farmers without programs. The fish farmers with program have a lower revenue, profit, R/C ratio and technical efficiency than fish farmers without program. From the results of this study, it can be concluded that the main cause the program has not had a positive impact on the fish farming businesses performance is the quality of self-sufficiency fish feed. Therefore, the recommended policy is to create a system for supplying local raw materials with good quality, increasing feed formulation training and need specialize by forming group of self-sufficiency fish feed producers separated from the fish farming group.

Keywords: *data envelopment analysis, impact evaluation, propensity score matching, self sufficiency fish feed program*

BACKGROUND

In the last few decades, the aquaculture sector has developed significantly compared to capture fisheries. Global aquaculture production increased by 527%, while production from capture fisheries only increased by 14% (Figure 1). Aquaculture production in Indonesia increases by an average of 10.25% annually (DJPB, 2020). The increasing need for public fish consumption by 2.9% annually, demands fulfillment from the production of the aquaculture sector. This is because production from the capture fisheries sector is relatively stable which is affected by the declining availability of fish in nature due to overfishing.

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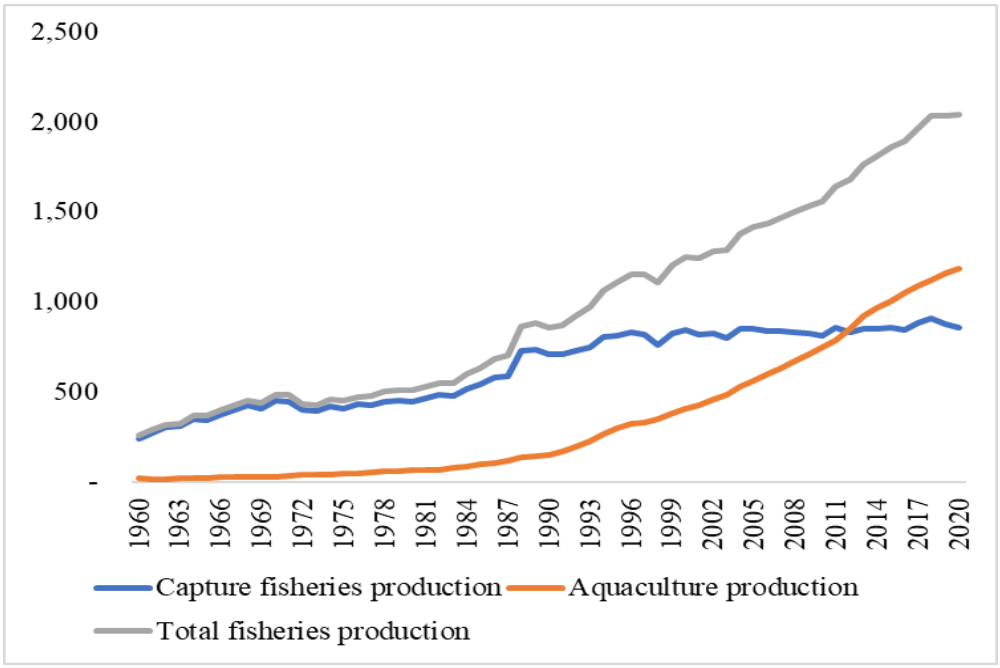

Figure 1. World Production of Aquaculture and Capture Fisheries (MT)
Source: FAO, 2020

The development of the aquaculture sector has implications for increasing demand for aquafeed as an important input in fish farming. Aquafeed in 2023 is estimated at 9.6 million tons (DJPB, 2020). So far, demand for aquafeed has been met by commercial feed produced by feed industry, both by national and multinational companies. In producing aquafeed, feed industry uses imported raw materials.The most imported raw materials of commercial feed ingredients are fish meal and soybean meal (Figure 2).

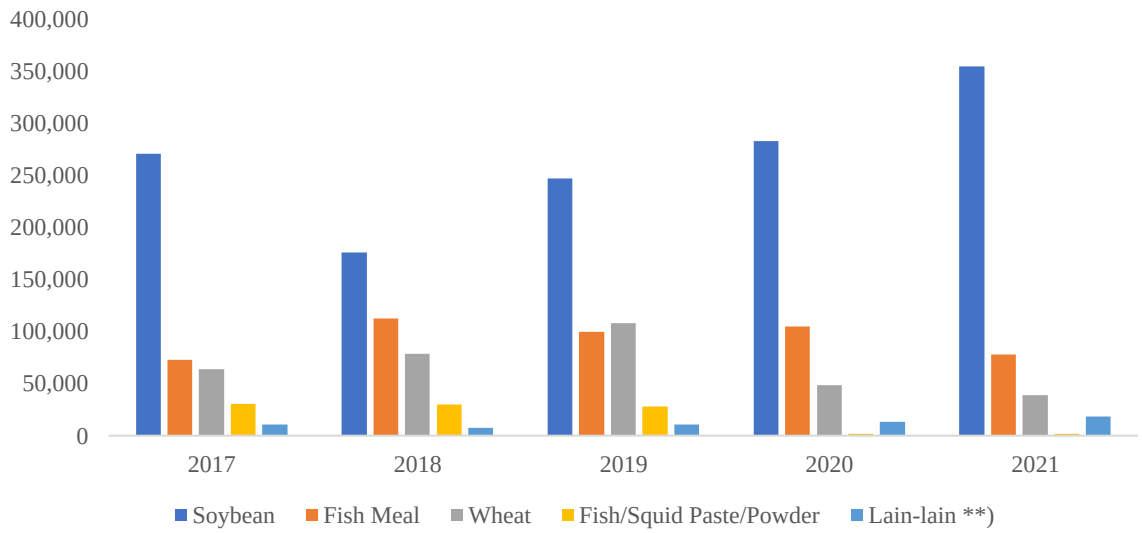

Figure 2. Volume Import of Raw Materials by Feed Industry in 2017-2021 (MT)
Source: DJPB, 2022

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The use of soybean and fish meal is relatively high because these raw materials are the primary source of protein in the manufacture of fish feed. The use of imported raw materials has an affect on fluctuations in commercial feed prices because the prices of imported raw materials tend to increase (Figure 3). According to data from GPMT, the price of feed raw materials in 2022 will increase by 25-50% (Grahadyarini 2022).

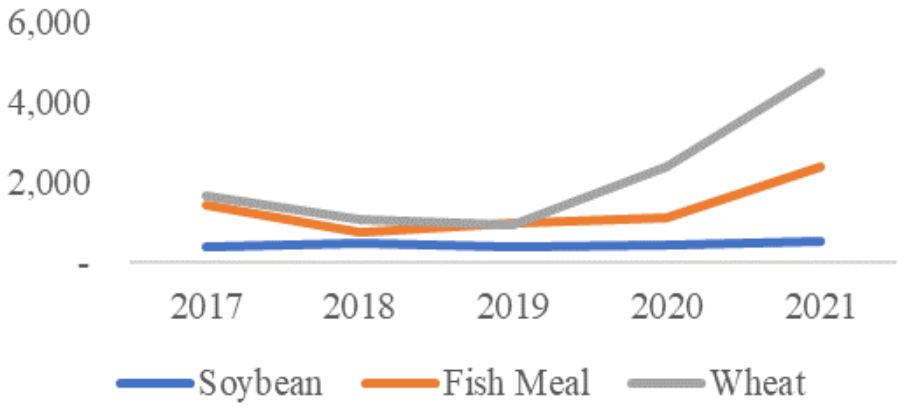

Figure 3. Prices of imported raw materials by feed industry (USD)
Source: DJPB, 2022

High demand for aquafeed with an increase in the price of raw materials causes the price of commercial feed increase. The increase in feed prices will significantly affect the profitability of fish farming, especially for small-scale fish farming. Feed is the largest component in the production cost structure between 40-60% (Central Bureau of Statistics 2016). Feed prices increase will significantly affect on feed cost. The solution for these problems is the government, through the Ministry of Maritime Affairs and Fisheries (MMAF) made a policy to reduce feed costs through the Self-Sufficiency Fish Feed Program. This program aims to provide feed made from local raw materials, which is expected to reduce feed prices so as to reduce production costs and increase farmer income. Local raw materials can be used to substitute the use of imported raw materials so as to reduce feed production costs (Samuel et al. 2021; Limbu et al. 2022). With good feed manufacturing techniques, the use of local raw materials can reduce feed costs by 30% (Wardono dan Prabakusuma 2016; Limbu 2020).

This program has been implemented since 2015, by developing feed production business units at the fish farmer level, which are members of groups. Implementing this program, the group acts as a feed producer by utilizing local raw materials, so it is expected that feed is available at the group level at low prices. However, the implementation of the program still faces obstacles. The use of local raw materials affects the quality of aquafeed (Amankwah et al. 2018), causing fish farming to become more inefficient, with a lower efficiency score (Yuan 2007). This is because farmers have not mastered feed production technology, the varying quality of local raw materials and the limited availability of local raw materials (FAO 2020b). These constraints will affect the performance of fish farming business.

Implementing the Self-Sufficiency Fish Feed Program must also be linked to agribusiness concepts. Since the agribusiness concept was initiated by Davis dan Goldberg (1957), production

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development at the on-farm level needs to be linked to development in the upstream subsystem, including feed, seeds, fertilizers, and the like. The upstream subsystem is carried out by a separate producer so that there is a specialization to increase business efficiency. The self-sufficiency fish feed program will encourage specialization in supplying inputs (feed) at the farmer group level, which will later be developed into self-sufficiency fish feed producing groups. The mechanism for implementing the independent feed program by providing feed inputs at the group level aims to bring feed production businesses closer to fish farming businesses to reduce transaction costs. However, it is suspected that this will also affect the feed quality because implementing this program will eliminate specialization in providing inputs.

Increasing feed quality will affect farmers' feeding choices in fish farming activities. If the quality of self-sufficiency fish feed is lower than commercial feed, farmers will prefer better quality feed because feed quality will affect the production and productivity of fish farming (Amankwah et al. 2018). Referring to the economic theory of production in Debertin (2012), farmers can choose a combination of inputs used in fish farming. The selection of input combinations minimizes costs by finding the optimal combination of inputs. The optimal combination of inputs in economic theory is done by selecting a combination of inputs with minimum costs to produce a certain number of outputs. Therefore, farmers will choose to use self-sufficiency fish feed at a lower price than commercial feed, assuming the quality of self-sufficiency fish feed is the same as commercial feed.

The quality constraints of the self-sufficiency fish feed will affect the fish farming business performance, so this research wants to answer how the impact The Self-Sufficiency Fish feed Program has on the performance of the fish farming business. The Self-Sufficiency Fish Feed Program has a positive impact on the fish farming businesses performance, which is measured by reducing production costs and increasing the welfare of farmers as program goals (Wardono dan Prabakusuma 2016; Asmaida 2018; Asmaida dan Rogayah 2019). Program implementation through technological interventions can increase farming performance, measured in production, income, and efficiency (Manevska-Tasevska et al. 2011; Mondal et al. 2012; Amankwah et al. 2018; Cordanis et al. 2019; Ayuba et al. 2020). Implementing The Self-Sufficiency Fish Feed Program is one of the adoptions of small-scale fish feed manufacturing technology. The implementation of this program is expected to improve the fish farming business performance, measured based on farm economics analysis and program goals to reduce feed costs and increase income.

Based on the description above, the purpose of this research aims to analyze the impact Self-Sufficient Fish Feed Program on fish farming performance. The contribution of the results of this study is as literature in analyzing the impact of a policy or program on the performance of fish farming businesses. Although several studies have analyzed the program's impact, the program's impact has yet to be analyzed using the PSM method. Limited resources lead to a limited number of respondents because they are only taken from one area, which may not be able to represent the impact of the program nationally. Finally, the implication for policymakers is to consider alternative strategies for the sustainability of program implementation.

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RESEARCH METHODS

Study Area

This research was conducted in Bogor Regency, West Java Province. The choice of location was determined purposively (purposive). Consideration for site selection, Bogor Regency is one of the leading commodity development areas (catfish), where the implementation of the Self Sufficiency Fish Feed Program is to support the development of aquaculture areas. This research was conducted in September - December 2022.

Sampling and Data Collection Procedure

The sampling method to be used in this study is purposive sampling. Determination of the sample selected stratified, that sample is classified based on fish farmer who uses self-sufficiency fish feed (with program as a treatment group) and fish farmer who does not use self-sufficiency fish feed (without program as a control group). Samples from the treatment group were taken as a whole because of the limited number of farmers using self-sufficiency fish feed. Meanwhile, samples from the control group were selected with similar criteria to the treatment group, namely fish farmers who carry out catfish farming, are members of the group and carry out fish farming activities using the same technology. The technique used to collect data is observation and interviews. Based on observations and interviews, the number of respondents in this study was 107 fish farmers, consisting of 22 fish farmers as treatment group, with program and 85 fish farmers as a control group, without the program.

Conceptual Framework

The conceptual framework of this study is based on the theory of production described by Debertin (2012) and the concept of efficiency described by Farrel (1957) dan Coelli et al. (1998). Fish farming's performance is measured based on farm economic analysis with cost, revenue, profit, R/C ratio, Feed Conversion Ratio (FCR), and technical efficiency indicators. Previous studies on the program's impact on the performance of fish farming businesses showed positive results. However, the impact analysis was measured using a different test, so there is potential bias. The PSM method reduces the potential bias due to other factors so that the impact result is only from the program.

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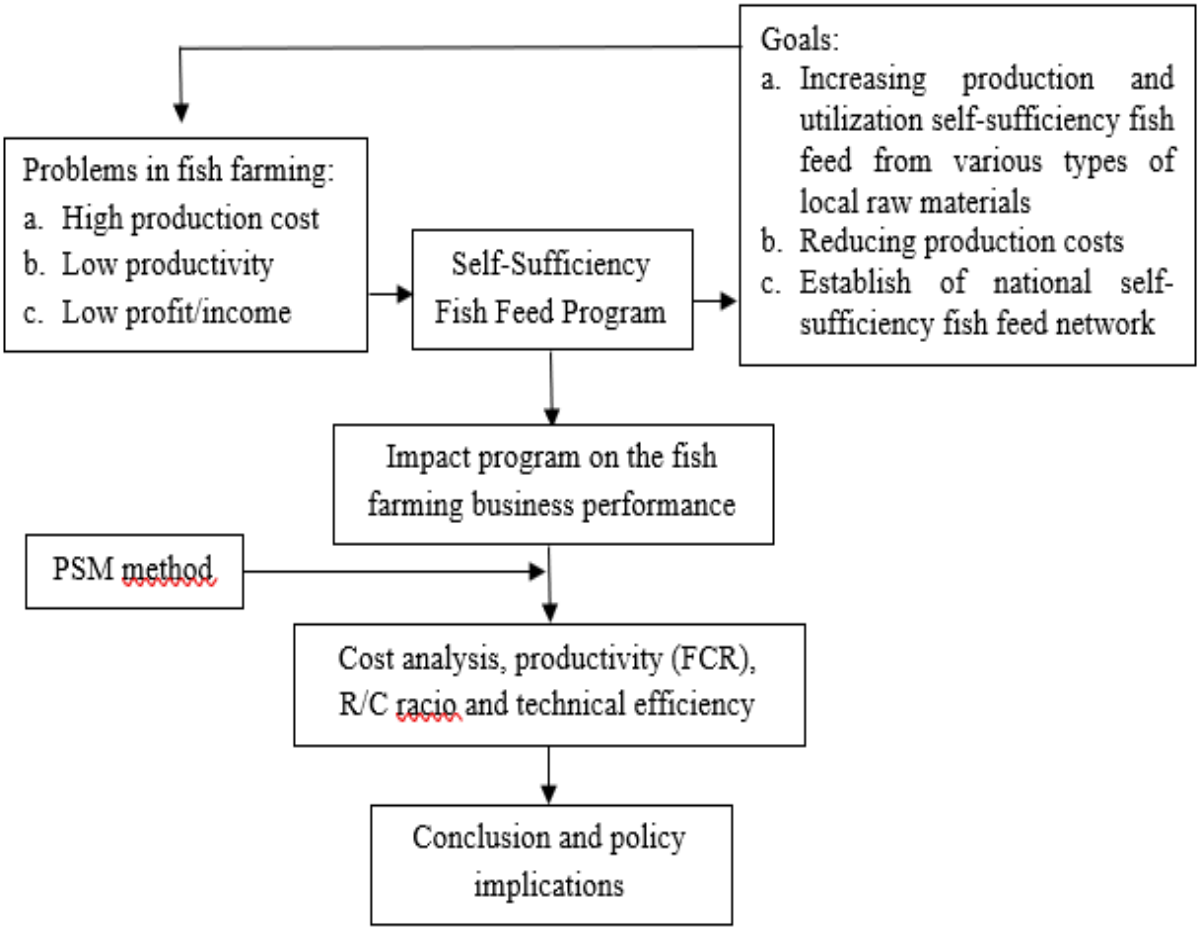

Figure 4. Conceptual Framework

Based on the conceptual framework in Figure 4, if the quality of self-sufficiency fish feed is the same as commercial feed, farmers will choose to use self-sufficiency fish feed because the price is lower so that the program goals of reducing production costs and increasing income can be achieved. Considering several obstacles in program implementation, it is necessary to analyze the impact program on the fish farming business's performance so that they can advise policymakers on the sustainability of program implementation.

Estimating The Impacts of Self-Sufficiency Fish Feed Program on The Fish Farming Business Performance

The impact program on fish farming performance was analyzed by Propensity Score Matching (PSM). This method is a non-experimental method that is recommended to reduce the potential for bias in socioeconomic research. The PSM approach estimates the program's impact by forming a group of participants (treatment) and a control group by observing similar characteristics (Khandker et al. 2010; Gertler et al. 2016). In the PSM analysis, the variables are grouped into outcome and confounding variables. Fish farming performance is an outcome variable as indicator of program impact. In contrast, the confounding variable is a variable that can cause potential bias, which comes from observable characteristics of the respondents.

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Outcome variables in this study include costs, revenue, profit, FCR, R/C ratio, and technical efficiency. Costs are analyzed using the size of the farm by calculating the total variable costs of fish farming. Profits are analyzed using the concept of income with the principle of profit maximization. Farming income calculated in fish farming consists of components of cash receipts and expenses. Productivity in fish farming is measured based on the calculation of the feed conversion ratio or FCR. The FCR value indicates how much feed is needed to increase fish's weight by 1 kg. R/C ratio analysis is a comparison between revenue and costs. Costs calculated in this study are cash costs. Meanwhile, to estimate technical efficiency. Data Envelopment Analysis (DEA) model with Variable Return to Scale (VRS) approach was used. Analyzing the impact program with PSM using the Average Treatment on Treated (ATT approach). The ATT model equation can be written as follows:

$$ATT = E\,[Y_{1i} \mid D_i=1] - E\,[Y_{0i} \mid D_i = 0]$$

For any fish farming household, the impact of program on fish farming performance is the difference between the potential outcomes $Y_{1i} - Y_{0i}$. This assumes that we know the participant's outcome if they are not participants because fish farmers can only be in one participant category. Y_{1i} represent the outcome if fish farmer adopts the program with using self-sufficiency fish feed, and Y_{0i} denotes the outcome otherwise. The impact of program was measured using the Nearest Neighbor Matching (NNM) method to match the treatment and control groups with the closest propensity score to minimize the absolute difference in the estimated propensity score.

RESULT AND DISCUSSION

The impact of Self-Sufficiency Fish Feed Program on the fish farming business performance was analyzed using the PSM method. In the PSM analysis, outcome variables are measured in cost, revenue, profit, productivity (FCR), R/C ratio, and technical efficiency. The confounding variables are pond area and the proportion of commercial feed used, which is determined based on results of logistics regression. Based on logistic regression, the confounding variable significantly affects the fish farming business performance. Pool area significantly affects costs, production, revenues, and profits. The larger pond area affects higher the production costs because of the use more inputs, and it also affects higher household income and may also give rise to economics of scale in production (Panayotou et al. 1982). The proportion of commercial feed also significantly affects the fish farming business performance because both treatment and control farmers still use commercial feed. The proportion of use of commercial feed affects the production and efficiency of feed (Aderolu et al. 2010; Hasan et al. 2022). The descriptive statistics of the variables used in the PSM analysis are presented in Table 1.

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Table 1. Descriptive Statistics Variable Used in PSM Analysis (Per Output Unit)

Variable	Fish farmers with Program (Treatment)		Fish farmers without Program (Control)	
	Mean	**Std Dev**	**Mean**	**Std Dev**
Pond area (m^2)	102.6	79.3*	566.1	554*
Proportion of commercial feed (%)	41.63	14.41*	72.7	17.56*
Proportion of self-sufficient fish feed (%)	30.11	29.28*	0	0*
Cost (Rp per kg)				
a. Feed	8,641.58	2,902.76*	10,391.15	2,156.5*
b. Nonfeed (seed, fertilizer, labor)	7,688.09	3,062.27*	5,078.08	1,871.23*
c. Total cost	16,329.67	3,423.82	15,469.23	3,409.27
Revenue (Rp per kg)	18,181.82	2,038.58*	20,383.27	627.22*
Profit (Rp per kg)	1,852.15	3,171.64*	4,914.04	3,491.43*
R/C ratio	1.14	0.15*	1.38	0.29*
FCR	1.75	0.23*	1.44	0.30*
Technical efficiency[a]	0.889	0.12	0.885	0.13
Observation (n)		22		85

[a]predicted by the DEA method, *represent significant at 5% respectively

By determining the confounding, a significant equal match is obtained, so that the program's impact as measured by the difference in performance between the control and treatment groups can be ascertained because of the program. The results of the complete PSM analysis are presented in Table 2.

Table 2. Result of PSM Analysis (Per Output Unit)

Variabel outcome	ATT		ATT diff	t-stat
	Fish farmers with Program (Treatment)	**Fish farmers without Program (Control)**		
Cost (Rp per kg)				
a. Feed	8,641.57	6,726.87	1,914.704	1.63*
b. Nonfeed	7,688.09	4,292.93	3,395.15	4.43***
Revenue (Rp per kg)	18,181.81	20,300	-2,118.18	-4.87***
Profit (Rp per kg)	1,852.15	9,280.18	-7,428.03	-7.73***
R/C rasio	1.14	1.84	-0.87	-6.54***
FCR	1.74	1.25	0.49	10.24***
Technical efficiency[a]	0.889	0.993	-0.027	-2.38**

[a]predicted by the DEA method, *represent significant at 10%, **represent significant at 5%, ***represent significant at 1%

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The average production cost of the treatment group is a higher than control group, both the average cost of feed and non-feed. Feed costs for treatment group are higher because fish farmers use a combination of commercial, self-sufficiency fish feed and alternative feed. The price of alternative feed is the lowest among other feed. Fish farmers use commercial feed as a starter to stimulate fish growth at the start of the enlargement stage (Ragasa et al., 2022). Meanwhile, average non-feed costs for the treatment group are also higher due to an increase in seed costs because fish farmers with program prefer to use seeds with a larger size (10-12 cm in size). The size and quality of fish seeds will affect the growth rate, disease resistance, and survival rate (Panayotou et al. 1982). Larger seed sizes will increase seed prices so production costs will also increase. Based on the result, the program's goal of reducing costs, especially feed costs, has yet to be revealed. So, it is necessary to improve quality of self-sufficiency fish feed to make its use more efficient by providing standardized local raw materials.

The program had a significant impact on fish farmer's revenue. Intervention of this program significantly impacted to revenue, profit and R/C ratio of the treatment group, which were a lower than control group. Fish farming households using self-sufficiency fish feed (treatment group) generates lower revenue (Rp 18,181.81) than control group (Rp 20.300). Fish farming households using self-sufficiency fish feed (treatment group) generates lower profits (Rp 1,852.15) than control group (Rp 9,280.18) (Ahmed et al. 2010; Yakubu et al. 2014). Fish farming households using self-sufficiency fish feed showing lower R/C ratio than using commercial feed. R/C ratio of the treatment group is 1.35, showed that every Rp 1 of costs incurred will generate revenue of Rp 1.35. while the control group was 2.23, indicating that every Rp 1 cost spent would generate revenue of Rp 2.23. But, fish farming with self-sufficiency fish feed is still feasible or profitable with an R/C ratio of more than 1.

This program significantly impacts the average FCR of treatment group (1.74), which is higher than control group (1.25). Increasing FCR indicates that the productivity of fish feed is lower with using of self-sufficiency fish feed. FCR reflects the nutritional content in feed, which indicates feed quality. Self-sufficiency fish feed has lower quality than commercial feed with a higher FCR. This causes catfish farming costs to become more expensive with more feed used, resulting in higher production costs (Mustapha et al. 2014). This quality difference influences farmer's choice to prefer using commercial feed over on-farm feed produced (Amankwah et al. 2016).

The program has a significant impact on technical efficiency. Based on the PSM analysis, the average score of technical efficiency in the treatment group was lower than a control group. Using self-sufficiency fish feed causes fish farming to become more inefficient, with a lower efficiency score (Yuan 2007). Based on the technical efficiency score, fish farming is efficient if the efficiency score is equal to 1 (Cooper et al. 2006). So that the lower technical efficiency score shows that fish farming using self-sufficiency fish feed is not efficient technically.

This program had a negative impact on fish farming performance. This is due to the need for more time for adoption of technology both in the production process and in selecting local raw materials that according to fish farming technic prosedure (Hall dan Khan 2016; FAO 2020b; Aung et al. 2021). Based on field data in the study area, obstacles faced by self-sufficiency fish feed producers consist of the quality of local raw materials that need to be standardized and change over time so that the quality of feed fluctuates (Limbu et al. 2016; Limbu 2020; Wachira et al. 2021; Limbu et al. 2022). Another obstacle is the limited availability of local raw materials and capital to buy raw

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materials in large quantities (Aung et al. 2021). As a result, 4 out of 7 group of participants in Bogor no longer produce feed, even though economically, small-scale fish feed businesses are feasible and profitable (Darman et al. 2015). Referring to a concept of agribusiness (Davis dan Goldberg 1957), provision inputs require specialization to improve the input quality. Providing inputs at the fish farming group level on a small scale will increase costs, so it does not meet the criteria for economies of scale.

The proximate test results showed that the protein content of self-sufficiency fish feed was under 30%, so the quality was lower than commercial feed. In catfish farming, using feed with a high protein is more economically profitable than feed with a low protein (Morenike dan Akinola 2010). So, feed with contained a low percentage of protein is not suitable for catfish farming but is more suitable for other freshwater commodities (Mustapha et al. 2014; Joshi et al. 2021). Therefore, program's impact on fish farming performance in other commodities may give different results. Such as, using on-farm produced feed on tilapia and pangasius farming shows positive impact with lower feed costs and higher R/C ratio (Asmaida 2018; Ash-shufi dan Hariati 2019).

CONCLUSION AND SUGGESTION

Impact evaluation using the PSM method shows that Self-Sufficiency Fish Feed Program did not positively impact on the fish farming business performance, especially on catfish farming. The results of the PSM analysis show that average production cost of the treatment group is a higher than control group, both the average cost of feed and non-feed. Fish farming households using self-sufficiency fish feed (treatment group) has a lower revenue (Rp 18.181,81) than control group (Rp 20,300). Treatment group has a lower profits (Rp 1,852.15) than control group (Rp 9,280.18). Treatment group has a lower R/C ratio (1.35) than control group (2.23). This program significantly impacts the average FCR of treatment group (1.74), which is greater than control group (1.25). The program has also a significant impact on technical efficiency. Based on the PSM analysis, the average score of technical efficiency in the treatment group (0.889) was lower than a control group (0.993). This is due to the lower quality of on-farm feed produced than commercial feed. Adopting technology needs more time and quality of local raw materials that have not been standardized have resulted in lower feed quality. So, this research recommends making a system for supplying locally available raw materials with good quality, scaling out feed formulation training and need to specialize by forming group of self-sufficiency fish feed producers separated from the fish farming group for the sustainability programs and increasing feed quality.

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