IMPACTS ASSESSMENT REPORT

The impacts of GQSP Indonesia SMART-Fish 2 under Global Quality Standard Program (GQSP) on Selected Aquaculture Value Chains in Indonesia

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SUMMARY

This report presents a comprehensive assessment of the SMART Fish 2 Program implemented under the Global Quality Standard Program (GQSP) Indonesia and its impact on selected aquaculture value chains. The program aims to enhance domestic and international competitiveness of the Indonesian selected aquaculture value chains, focusing on shrimp, milkfish, pangasius, catfish, and seaweed value chains. The program's approach involved developing standard operating procedures (SOPs) for good aquaculture practices, piloting them, and subsequently scaling up their implementation through training and technical assistance for farmers. Data for the study were collected through surveys conducted before and after the program, involving 220 farmers out of 1981 assisted farmers across seven districts in four provinces. Additionally, focus group discussions (FGDs) were conducted with adopters and non-adopters in eight project locations, and interviews were conducted with key actors in the value chains. Both quantitative and qualitative methods were employed to analysis the program's impacts.

The results demonstrate that the program has been effective in increasing the adoption level of SOPs among farmers in most sectors. Specifically, the results indicate that out of the 1,981 assisted farmers, an estimated 1,265 have improved their management practices. This improvement in adoption level has proven instrumental in mitigating risks and enhancing farmers' resilience, thereby maintaining and improving production and revenue levels, even amidst challenging circumstances characterized by declining trends in aquaculture production. However, it is important to note that the adoption of SOPs alone does not guarantee improvements in production outcomes including productivity, SR, FCR, received price, and revenue. It is crucial to consider climate changes and market dynamics for a comprehensive understanding of the production outcomes. Furthermore, the study reveals that the program has facilitated 137 farmers in establishing business connections or linkages with 224 new fries/seed suppliers and supported 92 farmers in accessing 155 new market channels from our samples, resulting in an estimated total of 3,506 new business linkages created for all assisted actors along the selected value chains. The success of the SMART Fish 2 Program in promoting the adoption of SOPs and facilitating value chain inclusions underscores the significance of sustained support and investment in promoting best practices and standardized procedures within the aquaculture sector in Indonesia.

The study indicates the increase in SOPs adoption can increase revenue, particularly in pangasius, catfish, milkfish, and glacilaria. The improved practices also play a role in mitigating risks and reducing potential revenue loss, especially in shrimp and cottonii seaweed sectors. In

Tulungagung, pangasius farming saw a significant increase in revenue of IDR 4200 per square meter, while in South Lampung, the revenue boost for pangasius was even higher at IDR 4500 per square meter. Catfish farming in Kediri showed a substantial revenue gain of IDR 152,600 per square meter, while shrimp farming in South Lampung experienced an increase of IDR 6000 per square meter. Milkfish farming in Tarakan demonstrated noteworthy progress, resulting in a revenue gain of IDR 1 million per hectare. Additionally, cottonii farming exhibited positive outcomes, with IDR 26,000 per line in Jeneponto and IDR 16,000 per line in Pangkep. Lastly, the revenue increase for glacilaria farming in Maros amounted to IDR 80 per square meter. These encouraging results underscore the importance of implementing improved practices in aquaculture to enhance revenue and economic viability in the sector across various regions. Our projections indicate that the implementation of improved practices across all sectors assisted in the project will result in a substantial increase in revenue, estimated at around IDR 6.3 billion. This promising figure highlights the potential economic benefits that can be achieved by adopting these SOPs

In the aquaculture value chains, when farmers adopt Standard Operating Procedures (SOPs), various stakeholders, such as processors, Small and Medium Enterprises (SMEs), and middlemen, can experience significant benefits. Firstly, SOP adoption enhances the quality and quantity of aquaculture produce, ensuring a more reliable and consistent supply for processors and middlemen. This, in turn, improves the overall product quality and meets the demands of the market. Secondly, standardized practices lead to greater efficiency in the aquaculture process, reducing costs and optimizing operations for all involved parties. SMEs and processors can benefit from streamlined processes and reduced waste. Moreover, adherence to SOPs can enable access to premium markets that prioritize certified, high-quality seafood products, creating lucrative opportunities for processors and middlemen to tap into higher-paying customer segments and international export markets. By partnering with farmers who adhere to SOPs, these stakeholders may establish long-term relationships and secure a stable supply of aquaculture produce, mitigating supply chain disruptions. Additionally, supporting sustainable aquaculture practices can enhance the reputation of processors and middlemen as environmentally responsible entities, appealing to conscious consumers and investors.

INTRODUCTION

Background

The SMART Fish 2 Program under Global Quality Standard Program (GQSP) in Indonesia was implemented from July 2019 to June 2023 with the aim of enhancing the domestic and international competitiveness of Indonesian aquaculture in selected value chains, including shrimp, milkfish, pangasius, catfish, and seaweed. The program consisted of three main components: (1) National Quality Infrastructure, (2) Value chains, and (3) Quality awareness and policies.

The program has collaborated with multi-stakeholders to strengthen Good Aquaculture Practices (GAP) and promote an internationally recognized certification scheme to ensure quality, safety and sustainability called as IndoGAP. Standard Operating Procedures (SOPs) have been developed to practically implement the GAP for the selected value chains by involving experts, industry associations, and value chain actors in cooperation with MMAF. The SOPs serve as a set of guidelines and best practices for farmers in their aquaculture operations, aiming to improve the quality, safety, and sustainability of their production.

The implementation of the SOPs was scaled up from 2022 to 2023 to reach a broad base of farmers within the targeted aquaculture value chains. During such period, all assisted farmers across value chains have run production cycles several times (2-3 times for shrimp, catfish and seaweed; 1 time for pangasius) and produced the outcomes. Scaling up the implementation of SOPs involves extending the adoption and application of standardized practices beyond the initial pilot phase location? . The scaling-up process involved following steps:

1. Pilot Implementation: Initially, the SOPs were developed in collaboration with all stakeholders and piloted with a select group of farmers or farms in the programme's locations. This pilot phase allows for testing the feasibility, effectiveness, and adaptability of the SOPs by farmers in the local context.
2. Evaluation and fine-tuning SOPs: During the pilot phase, the implementation of the SOPs is closely monitored and evaluated to assess their impact and identify any necessary adjustments or improvements. Feedback from the farmers, technical experts, and other stakeholders is valuable in refining the SOPs and making them more applicable and relevant.
3. Training and Assistance: As the SOPs are finalized, the next step is to provide training and assistance to a broader group of farmers within the targeted value chains. Training sessions, workshops, and demonstrations are conducted to educate farmers about the SOPs and guide them on their implementation.
4. Upscaling Efforts: To achieve broad adoption, the GQSP employs various strategies to scale up the implementation of SOPs. These strategies include leveraging existing farmer networks or cooperatives, empowering local technical assistants, collaborating with

fisheries extension services, Jakarta Polytechnic through an internship programme and working closely with industry associations.

5. Technical Support and Extension Services: Alongside the scaling-up process, technical support and extension services are provided to assist farmers in implementing the SOPs effectively by GQSP Indonesia value chain experts. This support can be in the form of field visits, training, access to technical experts, and ongoing guidance to address any challenges or concerns faced by farmers during the adoption process.

However, such interventions faced various challenges and uncertainties during its implementation, including the COVID-19 pandemic, climate changes, and global market disruptions. For example, the pandemic led to restrictions on movement, disruptions in the supply chain, and impacts on market demand. Climate change poses significant challenges to the aquaculture industry, including changing water temperatures, increased frequency of extreme weather events, and the potential for disease outbreaks. These factors much affect aquaculture production and productivity. At the same time global market was disrupted by changes in trade policies, geopolitical tensions, and economic downturns. These disruptions affect market access, demand, and prices for aquaculture products, impacting the competitiveness and profitability of Indonesian producers. All these factors introduced additional complexities which may violate the program assumptions and influence the program's outcomes and overall effectiveness.

Considering all program interventions on one hand and all those disruptions on the other hand, conducting an impact assessment becomes crucial to understand how the program interventions addressed these challenges and their overall effectiveness. The assessment can shed light on whether the program successfully enhanced the competitiveness of Indonesian aquaculture and seaweed production in the face of market disruptions and changes of trade policies. It will also help to evaluate the resilience and adaptability of the aquaculture value chains in the face of pandemics and climate change. It can provide valuable insights into the strategies, policies, and support mechanisms needed to build a more robust and sustainable aquaculture sector that can withstand and overcome such challenges in the future.

Objectives

The impact assessment has overall objective to evaluate the effectiveness of SMART Fish Program II under GQSP Indonesia in delivering the long-run impact on the Indonesian aquaculture sector competitiveness and sustainability. The specific objectives are following:

a. To assess the effectiveness of the program assistance to improve farmer’s management practices through SOP adoption
b. To assess the effectiveness and outcome of the SOP adoption to improve farmer’s resilience in productivity, quality, sustainability and income during complex and uncertain circumstance
c. To assess the effectiveness of program intervention to increase value chain inclusion (business linkages)
d. To identify lessons learned and enhance accountability in order to support sound policy recommendations

Scope and Limitation

In this study, we focus on assessing the impact of the GQSP intervention, with a particular emphasis on Component 2, which aims to enhance value chain capacities to meet the required standards. The primary actors under consideration are those involved in grow-out farming. To complement our findings and gain a comprehensive understanding of the program's impact on grow-out farmers, we also include some middlemen and processors in the analysis.

However, it is important to note the scope and limitations of this study. We do not cover the impact assessment of Component 1, which pertains to quality infrastructure, as well as Component 3, which deals with quality policy and awareness. Our study is solely focused on the specific interventions related to enhancing value chain capacities.

Additionally, the assessment does not extend to hatchery farming, as we have confined our analysis to the grow-out sector. This limitation is crucial to keep in mind when interpreting the results, as the impact of the GQSP intervention on hatchery farming remains beyond the scope of this particular study. By acknowledging these boundaries, we aim to provide a clear and insightful evaluation of the program's effects on the targeted value chain actors in the grow-out farming segment.

METHODS

Conceptual framework

A conceptual framework on how the program works in delivering the expected results is presented in Figure 1. The expected long-term effect of the program is improving production, quality, sustainability, and farmers income in the selected value chains. Such impacts are delivered by introducing and promoting the adoption of Standard Operating Procedures (SOPs) of Good Aquaculture Practices (GAP). The success of farmers in achieving the outcomes will depend on to what extent they adopt the SOPs. It is important to analyze the effect of SOP adoption on the outcomes.

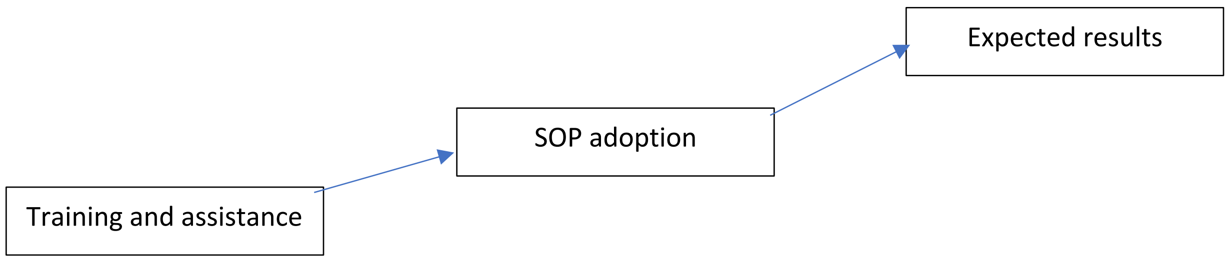

Figure 1. Conceptual framework of program mechanism to deliver the expected results

Hence, the first step on the impact assessment is assessing the adoption level of assisted farmers. This includes evaluating the degree to which farmers have adopted new practices that align with the SOPs and identifying any deviations or areas where current practices differ.

The adoption level may vary from one to another affected by a set of farmer and farm characteristics as well as their engagement in the program intervention. In order to increase the adoption level, the program implemented training sessions and provided technical assistance to targeted farmers, introduced them to the SOPs and supported their implementation. The training helped farmers understand and adopt the recommended practices, while technical assistance addressed any challenges or gaps encountered during implementation.

The standard operating procedures (SOPs) utilized in this study encompasses seven key sections: (1) location and preparation, (2) water control, (3) seeds/fries, (4) feed, (5) health and environment, (6) harvesting, and (7) biosecurity and (8) documentation. To evaluate farmers' implementation of the SOPs, an adoption score was employed. This score is a quantitative measure that calculates the percentage of SOP items implemented by farmers out of the total number of items on their to-do list, score weighting considering the relative importance of each section. Given that the contribution of each section to the key success factors varies across different value chains, the weight of each section was determined in consultation with value chain experts for each specific value chain. The adoption score ranges from 0 to 100, where 0 indicates no adoption of any SOP item, while 100 represents complete implementation of all SOP items. This scoring system allows for a comprehensive assessment of farmers' adherence to the

SOP, providing insights into the level of implementation achieved in different sections across the various value chains.

The conceptual framework of impact evaluation is presented in Figure 2. It emphasizes the importance of assessing the adoption level of SOPs among assisted farmers and evaluating the impact of increased adoption on the desired outcomes. By comparing the before-and-after data, the impact assessment provides insights into the effectiveness of the program in achieving its expected impacts.

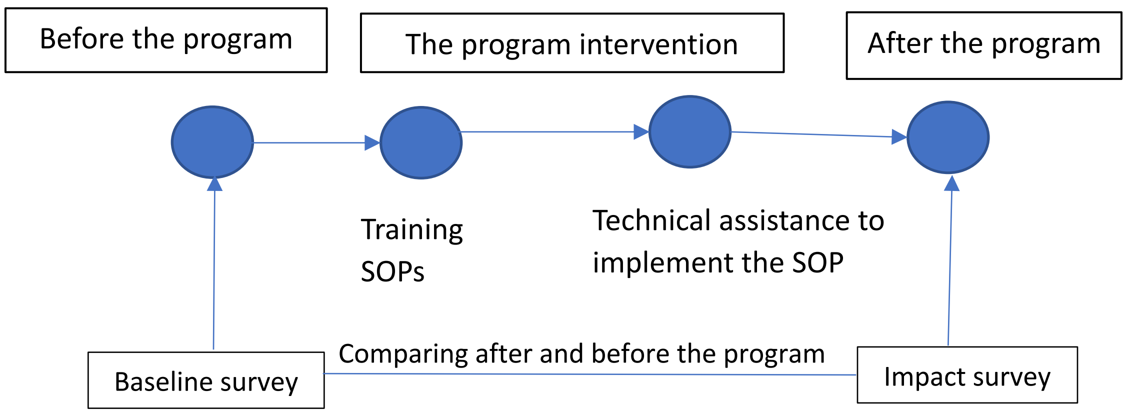

Figure 2. A conceptual framework of impact evaluation

Data collection

To assess the impacts of the programme, quantitative and qualitative approaches were combined Two surveys with structured instruments were carried out before and after program intervention to measure SOPs adoption score and outcomes. A set of FGDs and an in depth interview were also conducted to get feedbacks from SOPs adopters and non-adopters.

1. Baseline Survey:

The baseline survey was conducted in April 2022 before the program intervention implemented the up scaling phase. The targeted respondents were farmers who participated in training or received technical assistance. The survey aims to assess the initial level of adoption of Standard Operating Procedures (SOPs) and measure baseline outcomes such as production, productivity, survival rate (SR), and feed conversion ratio (FCR) and quality of commodity harvested (i.e size & meat texture).

Assisted farmers and their farm were visited and asked a structured questionnaire to assess their current adoption of SOPs and gather relevant data on outcomes. All data input were administered by using online platform. Total number of respondents was 1981 grow out farmers across value chains.

The collected data from the baseline survey is analyzed to establish a baseline adoption score and understand the initial outcomes achieved by the respondents.

2. Impacts' Survey:

The impacts' survey is conducted after the completion of the GQSP program, targeting the same respondents from the baseline survey. The survey asked the same questions and measures the same indicators as the baseline survey to allow for a direct comparison.

Differ from baseline survey that assessed all assisted farmers, the impact survey applied purposive sampling survey in particular locations taking into account budget and time constraints. Sample locations were determined in consultation with value chain experts to capture most represented characteristics of production sites. The impact survey was conducted of 223 farmer respondents in 8 districts across value chains including shrimp, milkfish, pangasius, catfish, glacilaria and Cottonii seaweed. This survey was carried out on March to April 2023, one year after the baseline survey. Detail sample and locations of baseline and impact surveys are presented in Table 1. The respondents were provided with the same structured questionnaire to assess their current adoption of SOPs and gather data on outcomes.

The collected data from the impact survey is analyzed to identify changes in the adoption scores and outcomes of the respondents compared to the baseline data. The analysis focuses on understanding the extent to which an increase in the adoption score correlates with improvements in outcomes such as production, productivity, SR, and FCR.

Table 1. Sampling and locations of baseline and impact surveys

No	Value chain	Location	Total assisted farmers	Impact (sampling)	Sampling proportion (%)
1	Pangasius	South Lampung	33	24	34
		Tulungagung	31	30	
		Kampar	61	0	
		Central Lampung	35	0	
2	Catfish	Kediri	43	29	67
3	Milkfish	Tarakan	15	15	19
		Pemalang	30	0	
		East Lampung	30	0	
4	Shrimp	South Lampung	31	28	20
		East Lampung	57	0	
		Tulang Bawang	43	0	
5	Glacilaria	Maros	340	32	9
6	Euchema	Pangkep	401	30	5
		Jeneponto	403	32	
		Bantaeng	11	0	
		Bulukumba	399	0	
		Maros	4	0	
	Total		1981	220	11

3. Focus Group Discussions (FGDs):

FGDs were conducted alongside the surveys to provide qualitative insights and a deeper understanding of participants' experiences with the GQSP program. FGDs can explore the factors influencing adoption, challenges faced, and perceived impacts.

The FGD was organized in the same impact survey locations, namely South Lampung, Tulungagung, Kediri, Tarakan, Maros, Pangkep and Jeneponto. In each location, the FGD invited 3 adopters and 3 non-adopters to provide feedbacks on cost and benefits of SOP adoption. FGDs enable to identify common patterns, challenges, success stories, and additional insights that may not be captured through quantitative surveys.

Figure 3. Focus group discussion with adopter and non-adopter farmers

Data analysis

The impact assessment involves comparing the changes in adoption scores and outcomes between the baseline and impact surveys. We compare the adoption score and the outcomes from the same farmers to measure the changes of each farmer. This analysis helps determine the relationship between increased adoption of SOPs and improvements in outcomes.

The assessment employed descriptive statistics to quantify the changes in adoption scores and outcomes, allowing for a more rigorous analysis of the program's impact. Regression models were further applied to analyze the effect of the changes on adoption score toward the changes on the outcomes. The changes in the outcome variable were entered as the dependent variable, while the changes in the adoption score were entered as the independent variable. Covariates were included in the analysis to control for their potential influence on the outcome variable. The analysis aimed to estimate the regression coefficient associated with the adoption score, indicating the direction and magnitude of the impact of SOPs adoption on the outcome variable.

$$Y_1 - Y_0 = a + b(X_1 - X_0) + c$$
$$\Delta Y = a + b\Delta X + c$$

Where

$Y1$ = Outcome after intervention

$Y0$ = Outcome before intervention

$X1$ = Adoption score after intervention

$X0$ = Adoption score before intervention

Please add the meaning of coefficient a,b and c

As we observed the same farmers and we assume no changes on farm characteristics in a year (before and after program intervention), the changes of the outcomes can be attributed to the changes of SOP adoption score.

To visualize the relationship between the changes in adoption score and changes in the outcome variable, a Cartesian graph was created. The x-axis represented the changes in adoption score, while the y-axis represented the changes in the outcome variable. Each participant/entity was represented by a data point on the graph, corresponding to their specific change scores.

A scatter plot was generated, with each data point plotted on the graph. The regression line was superimposed on the scatter plot to illustrate the overall trend and relationship between the changes in adoption score and changes in the outcome variable. The slope of the regression line represented the estimated regression coefficient, indicating the magnitude and direction of the impact of SOP adoption on the outcome variable.

Difference in Difference (DID) approach

The Difference-in-Differences (DID) model is commonly used in observational studies or quasi-experimental settings where a randomized controlled trial (RCT) is not feasible or ethical. It allows us to estimate the causal impact of a specific intervention or treatment by leveraging data from two groups over different time periods.

Figure 4 illustrates the fundamental concept underlying the Difference-in-Differences (DID) model, wherein the goal is to compare the pre- and post-intervention outcomes between the treated and control groups, followed by an assessment of the differences in those outcomes. In this study, the treated group comprises farmers who improved their adoption of Standard Operating Procedures (SOPs), while the control group consists of farmers who did not implement any enhancements in their SOP practices. Specifically, the treated group is technically defined as farmers with a positive adoption score change (Δ adoption score >0), while the control group is otherwise. By employing this approach, the model can effectively account for time-invariant unobservable factors that may influence both groups similarly, allowing for a focused analysis of the intervention's actual impact. This scientific approach ensures a rigorous examination of the treatment effect within the context of the study, enhancing the validity and reliability of the findings.

The Difference-in-Difference (DiD) approach with the Average Treatment Effect on the Treated (ATT) is a powerful method used in impact evaluation to estimate the causal effect of a treatment or intervention on a specific group of individuals. The steps in applying this method is following.

1. Define Treatment and Control Groups:
    - Treatment Group: Farmers who improved their SOP adoption score during the period of 2022 to 2023.
    - Control Group: Farmers who did not show any improvement in SOP adoption during the same period. These are considered as a comparison group.
2. Measure the Outcome Variable: The outcome variable we are interested in is revenue. For each farmer in both the treatment and control groups, we calculate their revenue productivity by dividing the revenue received by the farm size for each year in the study period.
3. Calculate the Pre-Intervention and Post-Intervention Differences: We calculate the average revenue productivity for both the treatment and control groups before the intervention (2022) and after the intervention (2023).
4. Compute the Difference-in-Difference Estimation: The DiD estimate is the difference between the post-intervention average revenue productivity of the treatment group and the control group, minus the difference between their pre-intervention averages. This will give us an estimate of the average treatment effect on the treated (ATT).
5. Interpret the Results: If the ATT estimate is positive, it suggests that the improvement in SOP adoption positively influenced farmers' revenue.

By using the DiD method with the ATT approach, we can better account for potential confounding factors and better isolate the causal effect of the improvement in SOP adoption on farmers' revenue, making the assessment more robust and reliable.

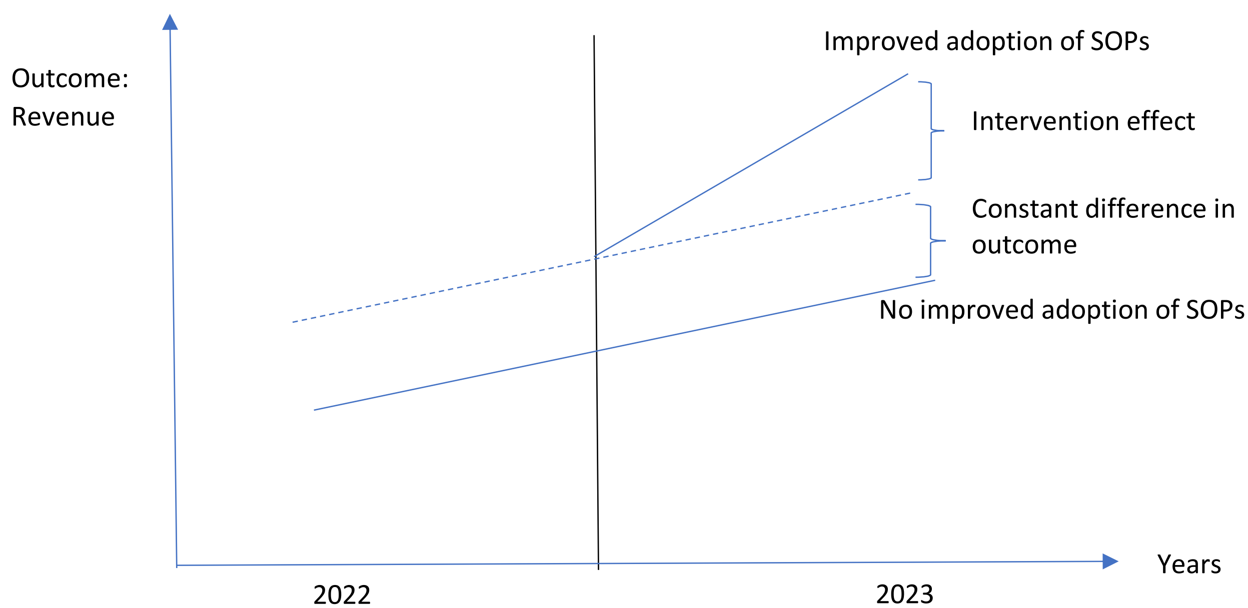

Figure 4. Difference in Difference model

RESULTS AND DISCUSSION

The impact on SOPs adoption

The effectiveness of the program intervention in increasing SOP adoption score among farmers is presented in Table 2. It shows that average adoption scores in most sectors excluding milkfish increased after the program intervention. Also, in most sectors more than a half of assisted farmers increased their SOP adoption score. The highest improvement is shrimp sector where more than 90% of farmers improved their practices while the lowest is catfish sector where only 45% of assisted farmers improved their practices. It is projected that 1265 of 1985 targeted farmers already improved management practices (increased adoption score) during the program intervention.

Table 2. The effectiveness of the program to increase SOP adoption

Value Chain	Average adoption score		Number of farmers improved adoption score (management practices)			
	2022	2022	# of sample with improved score	% farmers with improved score	# of total assisted farmers	# of estimated farmers with improved score
Pangasius	71,46	77,39	41	76	160	**121**
Catfish	53,10	55,52	13	45	43	**19**
Shrimp	48,11	67,21	26	93	137	**127**
Milkfish	72,47	70,13	7	47	79	**37**
Seaweed (Cottonii))	78,34	79,87	39	63	1222	**769**
Seaweed (Glacilaria)	89,6	92,6	18	56	340	**191**
Total			144		1981	**1265**

The Impact on value chain inclusions

Besides improving SOP adoption score, the program intervention is also expected to increase value chain inclusion or establish new business linkages among value chain actors. The program enhanced farmers' capacities to do a set of improvements in pond construction, seed selection, water quality, feed management, harvesting biosecurity and documentation. This led them to the needs of better inputs as well as better market price. Then, new business linkages might be established through two ways. First, UNIDO expert or local assistance directly facilitate or assist farmers to find and deal with new qualified suppliers or new market channels. Second, the training and assistance empowered farmers to find and make arrangement with new suppliers and new buyers in order to meet the standards. During impact survey targeted farmers were asked any new business linkages established to support SOP implementation. The results are presented in Table 3. From our impact survey, the program supported 137 farmers to deal with 224new suppliers and 92 farmers to access 155 new market channels. For example, the milkfish expert that work for this program facilitated milkfish farmers in Tarakan to directly access certified fries' suppliers in Bali. Pangasius farmers in Tulungagung improved the quality and sold their products to various processors. It is estimated that in total 3506 new business linkages were created.

Table 3. Value chain inclusions

Sector	Based on sample impact survey					Estimated # total new links
	# farmers linked to new supplier	# farmers linked to new buyers	# links to new suppliers	# links to new buyers	# total new links	
Pangasius	30	30	68	63	131	385
Catfish	24	9	27	9	36	**53**
Shrimp	4	3	4	4	8	**37**
Milkfish	20	0	20	0	20	**105**
Seaweed (Euchema)	28	28	53	54	107	**2108**
Seaweed (Glacilaria)	31	22	52	25	77	**818**
Total	137	92	224	155	379	**3506**

In addition, the program also assisted some processing companies to increase their exports. There are 5 of 11 assisted firms enabled to either access global market for the first time or increase export volume/ value during 2021-2023, namely: PT Sabindo Raya Gemilang, PT Tarakan Fisherindo Sipatuo, CV Sonya Nauli Putri in Tarakan, PT. Jala Lautan Mulia in Sidoarjo, and PT Ajaib Toha Putra in Pati, Central Java. The support were compliance with export requirement such as facilitation to obtain HACCP certificate and link to international buyer.

The impact of GQSP Program on additional economic gains

In this study, we have employed farmers' revenue as an indicator to measure their economic gains. Revenue is derived by multiplying the price received for their products with the total quantity of production sold. As shown in Table 4, we assessed gross revenue or gross sales of assisted farmers before and after program intervention. Table 4 shows that 4 of 6 sectors have lower average gross sales in 2023 than those in 2022. Only two sectors, namely pangasius and glacilaria generated higher sales. While pangasius farmers still suffered lower demand than they got before pandemics, the sector started to recover from the pandemic effects. It is noted that in 2021 and 2022 pangasius demand in global and domestic market significantly dropped and the supply chain was also disrupted due to pandemics and transportation restrictions. Glacilaria is another case where farmers in 2023 expanded their farms and benefited a lot from stable market and price.

It is noted that during the period of 2022 to 2023, the pandemic effect still remained and at the same time global market disruption and climate risks occurred. All those factors simultaneously affected supply and demand aquaculture products. Climate risks led to diseases outbreaks that hit aquaculture production especially in shrimp sector while global market disruption lowered fishery market price and increased feed price. Hence, majority of those sectors experienced declining production and sales which led to lower revenue. Such lower performance was mainly affected by external factors that beyond program intervention control where global and macroeconomic assumptions in the project's theory of changes were violated.

Table 4. The effectiveness of program intervention to increase economic gains

Sector	Average gross revenue (IDR/ pond/ cycle)		# of assisted farmers with additional economic gains (improved sales)		
	2022	2023	# sample	% assisted farmers with economic gains	# total estimation
Pangasius	42,922,019	55,971,146	38	70%	**113**
Catfish	13.721.194	7.744.924	15	52%	**22**
Shrimp	27.250.909	23.211.067	10	36%	**49**
Milkfish	38.267.000	34.795.267	8	53%	**42**
Seaweed (Cottonii) per line	174.452	56.752	5	8%	**99**
Seaweed (Glacilaria)	334.484	4.279.641	32	100%	**340**
Total				**49%**	**664**

Sector that most suffered from this disruption was Cottonii where almost all assisted farmers experienced price and production drop at the same time. They were exposed to climate risks that increased sea level and flooded their farms in the end of 2022. Another sector strongly hit by shocks was shrimp where shrimp farmers experienced diseases outbreak several times and declining prices while the price of production inputs (feed) increases. Only 36% of shrimp farmers were able to keep or increase their sales or gross revenue.

It is crucial to acknowledge that not all assisted farmers implemented improvements in SOP adoption between 2022 and 2023. Despite providing training and technical assistance, the effectiveness of the intervention varied from farmer to farmer. As a result, the degree of improvement in SOP adoption scores varied across different sectors and locations. By examining the performance changes of these assisted farmers during the specified period, we gain initial insights to further analyze the impact of improved SOP adoption on revenue across various sectors and locations.

Table 5 presents the impact of adopting Standard Operating Procedures (SOP) within the GQSP Program on the revenue of different sectors. To estimate the impact, we compare farmers who improved their adoption score (∆adoption score > 0) with those who did not improve (∆ adoption score <= 0).

We first categorized farmers into two groups based on their adoption score improvement and then calculated the average revenue differences per pond size for each group in 2022 and 2023. By comparing the results between farmers with improved adoption and those without, we estimated the effect of improved adoption on revenue per pond size.

As shown in Table 5 particularly row a and b, we observed that the results for pangasius, catfish, milkfish, and glacilaria were positive, indicating increased revenues in 2023 for farmers who improved their practices. However, for shrimp and cottonii, both the groups, with and without adoption improvement show negative results indicating they experienced a drop in revenue in 2023. This decline in revenue can be attributed to external factors such as global market disruptions impacting shrimp and cottonii prices, and climate changes increasing the risks of disease outbreaks in shrimp and floods affecting cottonii production.

Nevertheless, when examining the estimated effects of improved adoption score (as shown in row c), we found positive results for all sectors, including shrimp and seaweed. This suggests that the adoption of SOPs not only can increase revenue, particularly in pangasius, catfish, milkfish, and glacilaria but also play a role in mitigating risks and reducing potential revenue loss, especially in shrimp and cottonii sectors. The study reveals the revenue impact of improved practices in different regions as follows: For pangasius farming in Tulungagung, the revenue increase is IDR 4200 per square meter, while in South Lampung, it is IDR 4500 per square meter. Catfish farming in Kediri shows a revenue gain of IDR 152,600 per square meter, shrimp farming in South Lampung yields an increase of IDR 6000 per square meter, and milkfish farming in Tarakan results in a revenue gain of IDR 1 million per hectare. Additionally, for cottonii farming, the revenue gain is IDR 26,000 per line in Jeneponto and IDR 16,000 per line in Pangkep. Lastly, glacilaria farming in Maros demonstrates a revenue increase of IDR 80 per square meter.

To delve further into the impact of improved SOP adoption, we incorporated the average pond size or production area and estimated the revenue effect per farmer for each sector in row d. The revenue effects of improved adoption per farmer vary across different sectors and locations. Pangasius farmers in Tulungagung experienced an increase of IDR 1.07 million, while those in South Lampung saw a higher impact of IDR 1.89 million. Catfish farmers in Kediri observed a substantial revenue effect of IDR 4.3 million, and shrimp farmers in South Lampung saw an improvement of IDR 3.38 million. The most significant positive impact was witnessed among milkfish farmers in Tarakan, with a remarkable revenue effect of IDR 16.93 million. For Cottonii farmers, Jeneponto and Pangkep both benefited significantly, with revenue effects of IDR 6.19 million and IDR 6.96 million, respectively. Glacilaria farmers in Maros experienced a more modest increase in revenue, with an effect of IDR 560 thousand.

Moreover, the magnitude of the revenue effect in each sector and location is influenced by the scale of farming operations. For instance, let's consider the Cottonii sector: the effect of improved practices on revenue per line in Jeneponto is higher than that in Pangkep. However, Pangkep farmers have almost double the number of lines (stretch ropes) compared to Jeneponto farmers. As a result, the revenue effect of improved practices per farmer in Pangkep is higher than in Jeneponto. Moving on to the pangasius sector, the revenue effect in South Lampung surpasses that in Tulungagung, mainly due to the larger average pond size in South Lampung, allowing for higher yields and increased revenue. The variations in farm scale play a crucial role in determining the extent of the revenue effects observed across different sectors and locations.Considering the sampling proportion and assuming that SOP adoption in our sample accurately represents the entire project, we projected that the total estimated additional revenue generated by improved practices across all sectors would be IDR 6.3 billion. This amount includes IDR 173 million of pangasius farming, IDR 44.5 million of catfish farming, IDR 222.8 million of shrimp farming, IDR 173.4 million of milkfish farming, IDR 5.6 billion of Cottonii farming and IDR 63.4 million for glacilaria farming. This promising figure highlights the potential economic benefits that can be achieved by incraesing SOPs adoption.

In conclusion, the data from Table 5 demonstrates the positive impact of adopting SOPs in the GQSP Program on revenue for various sectors. It indicates that improved SOP adoption can contribute to revenue growth in pangasius, catfish, milkfish, and glacilaria farming while helping shrimp and cottonii farmers mitigate risks and minimize potential revenue losses. The findings emphasize the significance of SOP implementation in aquaculture practices to foster sustainable and profitable farming across different sectors and regions.

Table 5. The estimated impacts of improved SOP adoption score

No	Parameters	Pangasius		Catfish	Shrimp	Milkfish	Cottonii		Glacilari	Total
		Tulungagung	South Lampung	Kediri	South Lampung	Tarakan	Jeneponto	Pangkep	Maros	
	Average difference in revenue / pond size (IDR/ m2 for pangasius, catfish, shrimp, glacilaria; IDR/ ha for milkfish; IDR/ line for Cottoni)									
a	Farms with improved adoption score	45,980.28	7,932.27	264,657.10	-2,077.18	1,231,858.84	-114,752.03	-68,400.00	533.64	
b	Farms without adoption improvement	41,763.99	3,453.87	112,094.12	-8,123.86	173,577.21	-141,016.67	-84,500.00	453.06	
c	The effect of improved adoption per pond size (IDR/pond size) using ATT [c=a-b]	4,216.30	4,478.39	152,562.98	6,046.68	1,058,281.63	26,264.64	16,100.00	80.58	
d	Average pond size of farmers with improved practices (m2 for pangasius, catfish, shrimp, and glacilaria; ha for milkfish; number of lines for Cottonii)	253.04	422.56	28.18	558.64	16.00	235.55	432	6944	
e	The effect of improved adoption per farmer (IDR million/farmer) [e= c*d]	1.07	1.89	4.30	3.38	16.93	6.19	6.96	0.56	
f	Number of sample farmers with improved practices	23	18	13	26	7.00	29	10	18	
g	Number of sample farmers	30	24	29	28	15.00	32	30	32	
h	Total number of assisted farmers	160	160	43	137	79.00	1222	1222	340	
i	Estimated total additional revenue of all assisted farmers by improved practices (IDR million) [i=(f/g)*h*e]	72.71	100.93	44.50	222.82	173.40	4,060.07	1,573.94	63.41	6,311.77

The impact of GQSP Program on Pangasius farming

The results of baseline and impact surveys conducted to assess the changes in pangasius farming are presented in Table 6. These surveys compare the farming performances between two project locations, Tulungagung and South Lampung Districts, for the years 2022 (before the program) and 2023 (after the program).

In Tulungagung, the average production per cycle shows a positive trend, increasing from 3.8 tons to 4.7 tons. On the other hand, in South Lampung, the average production per cycle tends to decrease from 5 tons to 2.8 tons. It is interesting to note that farmers in Tulungagung are expanding their pond sizes, whereas farmers in South Lampung are reducing pond sizes for pangasius cultivation. This may be indicative of the varying levels of confidence and optimism among farmers regarding pangasius farming. In South Lampung, more farmers have opted to switch to other sectors, as they no longer consider pangasius farming financially viable in terms of benefits and costs.

Table 6. Changes on Pangasius farming from 2022 to 2023

	Tulungagung			South Lampung		
Parameters	2022	2023	Gap	2022	2023	Gap
Average Production (kg)/ farmer/cycle	*3815*	*4699*	*884*	5117.4	2831.32	-2286,08
Average pond size/ farmer (m2)	*1019*	*1213*	*194*	2989.2	2985.48	-3.72
Average productivity (kg/m2/cycle)	14.26	14.15	-0.11	*6.72*	*5.96*	*-0,75*
FCR	1.67	1.24	-0.43	*1.28*	*1.28*	*0,01*
SR (%)	92.53	92.53	0.00	*90.42*	*92.06*	*2*
Average received price per kg (IDR)	16.000	15.483	-517	*15,258*	*15,271*	*13*
Average sales (revenue)/ farmer (IDR million)/cycle	58.3	66.7	8.4	24.4	43.1	18.7
All assisted farmers revenue generated (IDR million)	1750	2001	252	585.6	1034.4	208.8

Furthermore, the results demonstrate that feed efficiency has significantly improved among farmers in Tulungagung, with the average feed conversion ratio (FCR) decreasing from 1.67 to 1.24, of which this decrease indicates the feed utilization is more efficient. In contrast, there was not much improvement in feed efficiency observed among farmers in South Lampung. This suggests that farmers in Tulungagung are more advanced in their farming practices. Notably, Tulungagung has been selected as one of the locations for the SMART Fish I program. Although the current assisted farmers in Tulungagung differ from those in the previous program (SMART Fish I), they have joined farmer groups and received more comprehensive technical assistance, enabling them to share knowledge and experiences among themselves.

Moreover, Tulungagung offers larger market opportunities and channels compared to South Lampung. For instance, PT Delta Mina Perkasa (DMP), a fillet processing company located in Tulungagung, positioned just behind the fisheries agency, can absorb 5-7 tons of pangasius per day from farmers. Additionally, there are other processing companies in Surabaya and Rembang that serve as potential markets for the farmers.

Overall, the data presented in Table 6 highlights the contrasting farming performances, feed efficiency improvements, and market opportunities between Tulungagung and South Lampung. These findings shed light on the different dynamics and factors influencing pangasius farming in these two project locations. The SOP adoption and its impact on each location are further discussed.

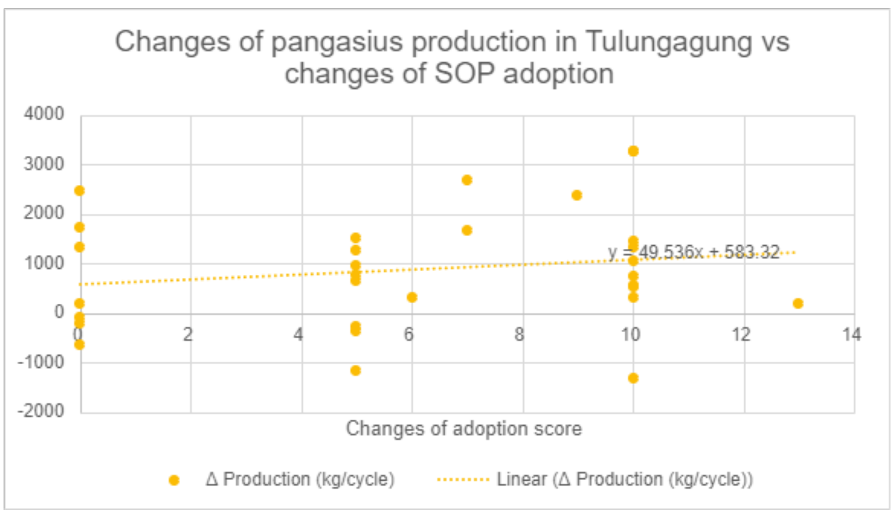

Figure 5. Changes of pangasius production and adoption score in Tulungagung

In Figure 5, the distribution of data points provides insights into the relationship between the changes in adoption score and the changes in production among the Pangasius farmers in Tulungagung. The majority of dots are positioned on the right side of the vertical axis, indicating that a large number of farmers in Tulungagung have already improved their adoption score. Conversely, only seven dots are observed on the Y axis, representing farmers who have remained at the same level of adoption. This suggests that the majority of farmers have made progress in terms of their adoption of Standard Operating Procedures (SOPs), while only a few have maintained their previous level.

Furthermore, when examining the distribution of dots with respect to the horizontal axis, the majority of them are located above the axis. This indicates that a significant number of farmers have experienced an increase in production. Conversely, only six dots are positioned below the line, suggesting a decline in production for a small subset of farmers. These findings suggest that the implementation of SOPs has had a positive impact on production levels for the majority of farmers, while only a few have encountered challenges leading to a decrease in production.

The regression line depicted in Figure 4 exhibits a positive trend, supporting the notion that there is a relationship between the changes in adoption score and the changes in pangasius production in Tulungagung. This suggests that, to some extent, correlation (r) an increase in the SOP adoption score tends to be associated with an improvement in production levels.

The above results are supported by our findings during the FGD with pangasius farmers in Pokdakan Mina Kendalbulur Lestari, Kendalbulur Tulunga Agung. The purpose of the FGD was to examine the advantages, drawbacks, and difficulties associated with implementing SOPs. The FGD pointed out following findings.

1. Farmers reported that there were 12 of 31 assisted farmers attending SMART Fish 2 / GQSP training. The training participants shared training materials and discussed the implementation of the SOP to the rest on farmer group meetings. They claimed that almost all training materials have been already known and applied before training.
2. In early 2020 the GQSP program has assisted and linked 4 farmers to sell their products to a fillet processor, PT Delta Mina Perkasa (DMP). Unfortunately, due to the pandemic, there was a significant drop in the fillet market, leading PT DMP to reduce its production by 70%. Presently, the company is still trying to recover its production levels and market share, utilizing only 30% of its production capacity. Although the assisted farmers are capable of meeting the requirements, the current demand has significantly declined, resulting in low prices. Consequently, the farmers are exploring alternative markets and looking for other factories in different cities. Pak Suyanto, one of the assisted farmers, has identified a potential market opportunity with a processing or exporting company in Rembang District (about 5-hours' drive from Tulungagung) and has proposed it as a potential option.
3. Aquaculture production faces significant costs, with feed expenses being a major component. Currently, farmers are paying IDR 308,500 per package for feed and they require 35 packages to support stocking of 1000 pangasius fingerlings ~~seeds~~. However, the poor quality of the feed results in a high feed conversion ratio (FCR), negatively impacting production cost efficiency because the more feed is required. On average, feed costs typically constitute the largest portion of the total production cost in pangasius farming, ranging from 50% to 70% of the overall expenses, therefore coupled with the low price and demand for pangasius, this leads to minimal or insufficient profit margins. It becomes a losing proposition for farmers if their FCR exceeds 1.4. To achieve a margin of around IDR 1500 per kilogram, the maximum tolerated FCR is 1.3.

During the evaluation process, the monitoring and evaluation (M&E) expert conducted an interview with the plant manager of PT Delta Mina Perkasa, a prominent processor company located in Tulungagung. It was revealed that the company currently procures a daily average of 5-7 tons of products from farmers, which is significantly lower compared to its production capacity in 2019, when it could handle up to 15 tons per day.

To ensure a secure supply chain, PT Delta Mina Perkasa provides feed credit to its partner farmers. Typically, the cost-sharing ratio between the processor and farmers for the feed is 60:40. Farmers are obliged to sell their products exclusively to the company, and the sales are then deducted by the corresponding feed credit.

According to the plant manager's perspective, producing fillets under the current circumstances is not economically viable. The demand for fillets remains low and has not fully recovered from the adverse effects of the pandemic. Consequently, the company is only able to utilize 30% of its production capacity, resulting in inefficient production costs. Despite these challenges, PT Delta Mina Perkasa strives to maintain production in the most efficient manner possible, as they have already made significant investments in feed credits for their partner farmers.

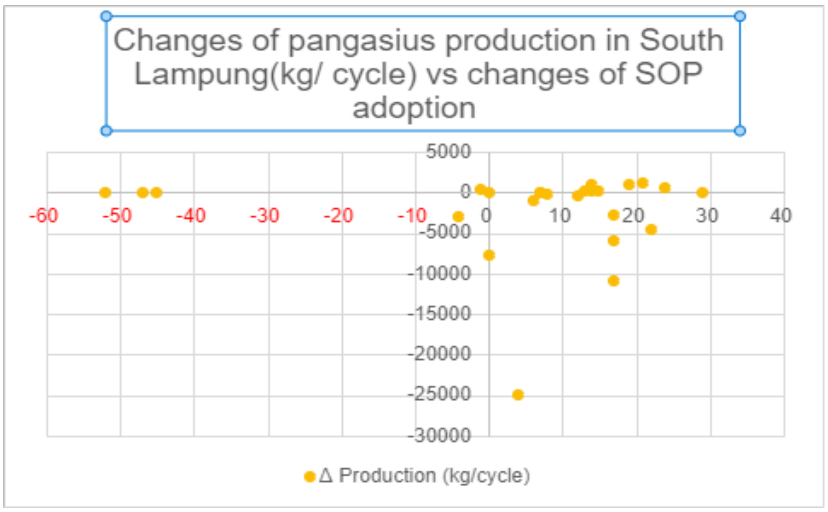

Figure 6. The changes of pangasius production and SOP adoption score in South Lampung

Figure 6 illustrates the changes in pangasius production and adoption score specifically for South Lampung. In this case, there appears to be less improvement among the pangasius farmers compared to the findings in Tulungagung. The figure reveals that five dots are plotted on the left side of the vertical axis, indicating a decrease in adoption score for these five farmers. Additionally, ten farmers are located below the horizontal axis line, suggesting poorer production outcomes, while six farmers are situated on the line, indicating no improvement in production. The relationship pattern between the changes in adoption score and the changes in production is not clearly discernible in the case of South Lampung. Farmers are confronted to the unfavorable market situation, increasing feed price, declining of feed quality, and limited access to certified seeds which beyond their capacity to control. In such circumstance, several farmers undermined the SOP practices to reduce costs which led to poor results.

During the FGD in South Lampung, farmers emphasized three key aspects of standard operating procedures (SOPs) that they found valuable and beneficial. These aspects include land preparation, probiotic application, and the use of water reservoirs (water tandons).

a. Land Preparation: Farmers expressed gratitude towards the GQSP program for teaching them how to apply calcium dioxide in land preparation, which improves water quality and stabilizes pH levels. To implement this procedure, farmers use 50 kg of calcium dioxide (equivalent to 1 pack) for a pond covering an area of 600 m2. The cost of one pack is IDR 75,000. This application has led to a decrease in mortality rates and the production of better-sized fish. Prior to using calcium dioxide, farmers reported a monthly fish death rate of 60-100, with an average harvest size of 250 grams. However, after implementing this procedure, the mortality rate decreased significantly to below 10%, and the average harvest size increased to 333 grams within three months. By following the SOP, farmers were able to reach a size of 500 grams within four months.

b. Probiotic Application: Farmers were already familiar with the use of probiotics before receiving training. However, the training provided them with more detailed and comprehensive understanding of probiotic application, enhancing their knowledge and techniques.

c. Reservoirs: One farmer shared their experience of using reservoirs, highlighting that fish grew faster when utilizing this method. The farmer claimed to have earned 2.6 tons from 5000 seeds in a span of four months. In comparison, another farmer, using the same density and production cycle but without a water reservoir, only earned 2.2 tons.

Overall, the farmers' accounts during the FGD demonstrate the practical benefits and positive outcomes associated with implementing SOPs in areas such as land preparation, probiotic application, and the use of reservoirs.

Farmers also raised several significant challenges they face in the pangasius farming during the FGD. These challenges include:

1. The increasing cost of feed and the declining quality of feed, as indicated by poor feed conversion ratios (FCRs). Farmers expressed concerns about the rising prices of feed and the adverse impact it has on the efficiency of their operations.
2. Limited access to certified or high-quality seeds. Farmers reported difficulties in obtaining seeds that meet the necessary standards or have proven quality, posing a challenge to their productivity and output.
3. The persistently low prices of pangasius in both local and industrial markets. Farmers expressed frustration over the low prices they receive for their products, whether sold locally or to the industrial market. This further contributes to their financial struggles and affects their motivation to invest in producing better quality or standardized-sized fish.

While standard operating procedures (SOPs) provide certain benefits for farmers as previously explained, they alone are insufficient to help pangasius farmers overcome these challenges and survive in the face of external disturbances. Given these circumstances, farmers have little incentive to implement standard operating procedures (SOPs) that require additional effort and potentially increase production costs. As a result, some farmers have decided to stop growing pangasius and have shifted their focus to other sectors. A local assistant reported four out of the 30 assisted farmers have already discontinued their involvement in pangasius farming and switched to other sectors, illustrating the severity of the situation.

The monitoring and evaluation (M&E) expert corroborated these concerns by interviewing a pangasius middleman named Pak Warto. He confirmed that there is currently no price difference between the local/traditional market and the industrial market in South Lampung. In fact, in some cases, the industrial market offers slightly lower prices for higher specification products compared to the traditional market. The only motivation for middlemen to engage with the industrial market is its significantly higher capacity to absorb products. This lack of market incentive further discourages farmers from focusing on producing better quality or standardized-sized fish that meet industrial requirements. These challenges underline the complex and difficult circumstances faced by pangasius farmers in the current market landscape.

The impact of GQSP Program on Catfish farming

The changes in catfish farming performance in Kediri from 2022 to 2023 are presented in Table 7, revealing several noteworthy findings. Notably, there has been a significant decline in the average production, productivity, and survival rate, resulting in lower average sales or revenue. This indicates a challenging period for catfish farmers during this timeframe.

Table 7. Changes on Catfish farming from 2022 to 2023

Parameters	2022	2023	Gap
Average Production (kg)/ farmer/cycle	872,72	418,10	- 454,62
Average pond size/ farmer (m2)	105,41	112,16	6,74
Average productivity (kg/m2/cycle)	168,14	17,99	-150,15
FCR	1,28	1,11	-0,17
SR (%)	83,69	72,21	-11,48
Average received price per kg (IDR)	15.924	18.517	2.592
Average sales (revenue)/ farmer (IDR million)/cycle	13.72	7.74	-5.98,-
Estimated revenue of all assisted farmers (IDR million)	590.01	333.03	256.98

Interestingly, despite the overall decline in performance indicators, we observed an increase in the average pond size used for growing catfish. This response by farmers can be attributed to a significant upward trend in catfish prices in the local market, rising from approximately IDR 16,000 to IDR 18,500 per kilogram. This suggests that farmers perceive catfish farming as a potentially lucrative business and are thus willing to invest more in larger pond sizes to accommodate increased production. However, it is unfortunate that the increase in pond size did not correspondingly lead to improved productivity, resulting in lower average production and sales.

On a positive note, our analysis revealed that farmers were able to reduce the Feed Conversion Ratio (FCR) by 0.17 points, indicating an improvement in feed efficiency. This success in achieving better feed management efficiency can be attributed to the adoption of Standard Operating Procedures (SOPs) by farmers. Specifically, the significant reduction in FCR suggests the effectiveness of the SOPs implemented, particularly in feed management practices.

Table 7 highlights a concerning observation of a significant drop in the Survival Rate (SR) from 83.69% to 72.21%. One of the main factors contributing to this decline is the exposure of farmers to climate risks, characterized by substantial fluctuations in air temperature over the past year. These unpredictable climate changes likely impacted the survival of catfish stocks. Additionally, farmers also faced challenges related to limited access to high-quality seeds, which further contributed to the decline in SR.

In summary, the findings from Table 6 shed light on the changes in catfish farming performance, revealing a decline in several key indicators, including productivity and SR. Such decline can be attributed to climate risks and limited access to high-quality seeds. Despite the challenging period, farmers displayed optimism by investing in larger pond sizes driven by the increasing trend in catfish prices. The successful adoption of SOPs in feed management is evident in the improved feed efficiency. These findings provide important insights into the dynamics and challenges faced by catfish farmers during the period under study.

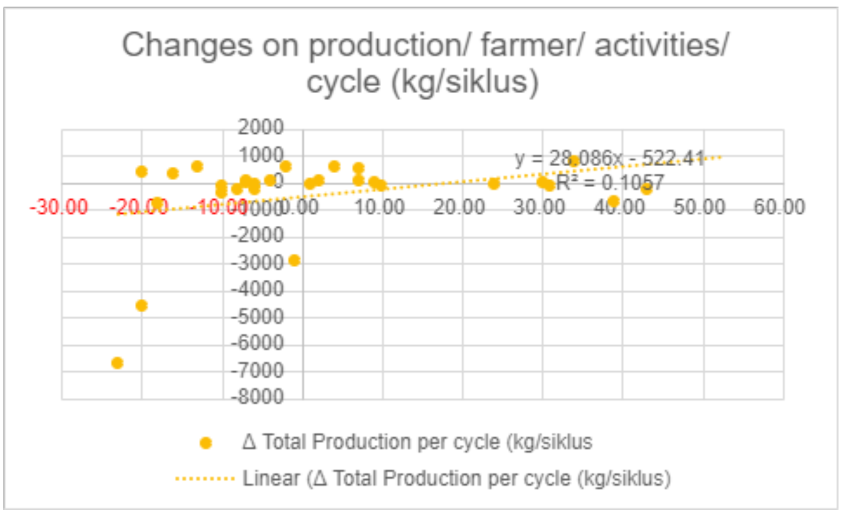

Figure 7. Changes of catfish production and SOP adoption score in Kediri

Figure 7 provides valuable insights into the relationship between changes in Standard Operating Procedure (SOP) adoption and production among farmers. Notably, half of the dots are positioned on the left side of the vertical axis, indicating that approximately half of the farmers reduced their SOP adoption during the period under study. Similarly, half of the dots are located below the horizontal axis line, suggesting that approximately half of the farmers experienced lower production levels.

Upon closer examination of the data presented in Figure 6, almost half of the farmers fall into the quadrant representing negative changes in both adoption and production. This finding suggests that farmers who reduced their adoption score also tend to experience a decline in production. This correlation between decreased SOP adoption and production drop emphasizes the importance of maintaining consistent adherence to SOPs for achieving favorable production outcomes.

Further analysis reveals a case where two farmers who reduced their adoption score by 20 points or more experienced an extreme production drop more than 4 tons. This substantial decrease underscores the significance of SOP adoption and its impact on production levels. The findings highlight that a significant reduction in the adoption score has a detrimental effect on production outcomes.

The regression line depicted in Figure 6 demonstrates a positive trend, indicating that improvements in SOP adoption are associated with corresponding improvements in production levels. This positive relationship further underscores the importance of maintaining and enhancing SOP adoption for optimizing production outcomes. The regression analysis estimated the changes in production using the equation

$$\Delta Y = 28.086\Delta X - 522.41$$

This equation provides valuable insights into the relationship between the changes in production (ΔY) and the changes in the adoption score (ΔX).

According to the regression equation, if there is no improvement in the adoption score (ΔX), the production in the same pond is likely to decrease by 522.41 kg. This negative intercept value suggests that without any improvement in the adoption score, a decline in production is expected. During the past year, farmers were confronted to climate risks which led to high mortality rate of catfish stock.

The regression coefficient of 28.086 represents the slope or the change in the production variable (ΔY) associated with a one-unit change in the adoption score (ΔX). This coefficient implies that for every 10-point increase in the adoption score, there is an estimated increase of 280 kg in production. Therefore, to maintain the production level above the previous year's level, a minimum increase in the adoption score of 18.6 points is required. This minimum increase is derived by dividing the intercept value of 522.41 by the regression coefficient of 28.086.

It is important to note that if farmers make improvements in production management practices but the increase in the adoption score is below 18.6 points, their efforts may not be sufficient to prevent a decline in production. This finding underscores the significance of achieving a certain threshold in the adoption score to effectively maintain or improve production levels.

By examining Figure 6, we gain valuable insights into the relationship between changes in SOP adoption and production among farmers. The findings emphasize the significance of consistent SOP adoption and its positive impact on production levels. Farmers who reduced their adoption score experienced a corresponding decline in production, with larger reductions resulting in more severe production drops. The results indicate that without any improvement in the adoption score, a decline in production is likely. Furthermore, the regression coefficient highlights the positive impact of increasing the adoption score on production levels. It is crucial for farmers to achieve a minimum increase in the adoption score of 18.6 points to prevent a decline in production and make significant improvements in their production management practices. These findings provide valuable guidance for farmers and stakeholders aiming to improve production performance through effective SOP adoption.

In order to complement the statistical analysis conducted, we conducted interviews and focus group discussions (FGDs) with various actors involved in the catfish value chain. As part of this process, our Monitoring and Evaluation (M&E) expert visited Kampung Lele Kediri and interviewed Mr. Maryani, a catfish middleman who plays a significant role in the local industry. Mr. Maryani not only operates a catfish-based culinary restaurant but also manages a small processing plant that offers a diverse range of approximately 15 catfish products.

Mr. Maryani has been involved in catfish trading since 1997, initially acting as a mediator between traders from outside cities in East Java and local farmers in Kediri. On a daily basis, he purchases and distributes around 400 kg of catfish, with 90% of the stock being sent to cities outside the region, while the remaining 10% is allocated for his restaurant and processing plant. To ensure a consistent supply, Mr. Maryani collaborates with 10-15 farmers who collectively own a varying number of fish ponds, ranging from 1 to 15 ponds. These farmers follow a production cycle that typically lasts 3-4 months, and the scheduling of these cycles is carefully coordinated to maintain a steady supply. Mr. Maryani procures a minimum of 50 kg of catfish per day from each farmer.

It is worth noting that the price paid to farmers differs based on the size of the catfish. For standardized-sized catfish (8 pieces per kg), the farmers receive a price ranging from IDR 19,500 to IDR 20,000 per kg. On the other hand, for oversized catfish (3-5 pieces per kg), the price ranges from IDR 13,000 to IDR 14,000 per kg.

These findings provide valuable insights into the dynamics of the catfish value chain, highlighting the role of middlemen like Mr. Maryani in facilitating the trade between farmers and external markets.

During the interviews and FGDs with farmers, the discussions revealed two critical issues in catfish farming and standard operating procedures (SOP): the availability of certified/high-quality seeds and feed efficiency. Farmers expressed concerns about the high mortality rate associated with the use of current seeds. In an extreme case, out of 35,000 stocked seeds, only 3,000 survived and produced a yield of 1,500 kg. Obtaining high-quality seeds has proven to be challenging for the farmers, who have to purchase them at a price of IDR 185 per piece from Desa Bendo, Pare, Kediri. Although farmers recognize the importance of using high-quality seeds, their access to such seeds is limited. Additionally, the drastic temperature changes in recent years have also contributed to the high mortality rate. The decline in feed quality and efficiency was another concern raised by the farmers. Currently, the feed efficiency stands at 24-25 kg of production per 30 kg feed package. However, farmers believe that this efficiency can still be improved to 27-28 kg per 30 kg of feed.

While farmers have made efforts to implement SOP, it appears that the existing procedures are not sufficient to address external factors such as climate change and feed-related issues. These circumstances pose additional challenges to the farmers' catfish farming practices.

The findings from these discussions shed light on the specific challenges faced by farmers in relation to seed quality and feed efficiency. Addressing these issues is crucial for improving the overall productivity and sustainability of catfish farming. Further research and interventions are needed to develop effective solutions that consider the impact of climate change and optimize feed utilization in the industry.

The Impact of GQSP Program on Shrimp farming

The changes in shrimp farming performance in South Lampung from 2022 to 2023 are presented in Table 8, providing insights into key parameters that have undergone variations during this period. The average production per farmer per cycle decreased from 477.9 tons in 2022 to 438.9 tons in 2023, indicating a decline of 38.9 tons. This decline suggests a challenging period for shrimp farmers, as they experienced a reduction in their overall production levels.

Additionally, the average pond size per farmer decreased of 78.3 hectares. This reduction in pond size further contributes to the overall decrease in production observed during the same period.

The Feed Conversion Ratio (FCR) increased from 1.39 in 2022 to 1.46 in 2023, indicating a decrease in feed efficiency by 0.07. This suggests that shrimp farmers may have encountered challenges in optimizing their feed utilization, resulting in a less efficient conversion of feed into shrimp biomass.

Furthermore, the Survival Rate (SR) showed an increase from 73.93% in 2022 to 77.86% in 2023, reflecting a positive change of 4%. This improvement suggests that shrimp farmers experienced a better survival rate for their shrimp stocks, indicating more favorable conditions for shrimp growth and health.

The average received price per kilogram of shrimp decreased from Rp 62,500 in 2022 to Rp 50,643 in 2023, resulting in a decrease of Rp 11,857 per kilogram. This decline in price may have contributed to the decrease in revenue for shrimp farmers. Finally, the average sales (revenue) per farmer per cycle decreased from Rp 28,966,760 in 2022 to Rp 22,057,321 in 2023, indicating a decline of Rp 6,909,439. This reduction in revenue per cycle further emphasizes the financial challenges faced by shrimp farmers during this period.

Table 8. Changes on Shrimp farming from 2022 to 2023

Parameters	2022	2023	Gap
Average Production (kg)/ pond/cycle	477,9	438,9	-38,9
Average pond size/ farmer (m2)	650,6	572,3	-78,3
Average productivity (kg/m2/cycle)	0,89	0,93	0,04
FCR	1,39	1,46	0,07
SR (%)	73,93	77,86	4
Average received price per kg (IDR)	62.500	50.643	-11.857
Average sales (revenue)/ farmer (IDR million)/cycle	28.97	22.06	6.91
Estimated revenue of all assisted farmers (IDR Million)	3,968.4	3,021.85	-946.55

In summary, the changes in shrimp farming performance from 2022 to 2023, as shown in Table 8, indicate a decline in production, pond size, and average sales. However, there were slight improvements in productivity and survival rate. The decrease in feed efficiency and the decline in shrimp prices contributed to the financial challenges faced by shrimp farmers. These findings highlight the complex dynamics and challenges within the shrimp farming industry during the specified period. The decline in those key parameters can be attributed to multiple factors, including climate risks and global market disruptions. Changes in weather patterns, such as temperature fluctuations and extreme weather events, can disrupt optimal farming conditions. These climate variations increase the vulnerability of shrimp to diseases and other stressors, ultimately leading to a decline in production and feed efficiency. Furthermore, global market disruptions can significantly impact shrimp farming performance. Factors such as changes in consumer demand, trade policies, and economic fluctuations can create uncertainties and affect market prices. The decrease in average received price per kilogram and average sales revenue per farmer per cycle observed in Table 7 may be indicative of the challenges posed by such disruptions. The disruption also leads to increasing feed price which is the major component of production costs.

It is crucial to acknowledge that these factors can have profound effects on the overall health, productivity, and profitability of shrimp farming operations. Addressing these challenges requires proactive measures to mitigate climate risks, adapt to changing market dynamics, and implement effective management strategies to ensure the long-term sustainability and success of the shrimp farming industry.

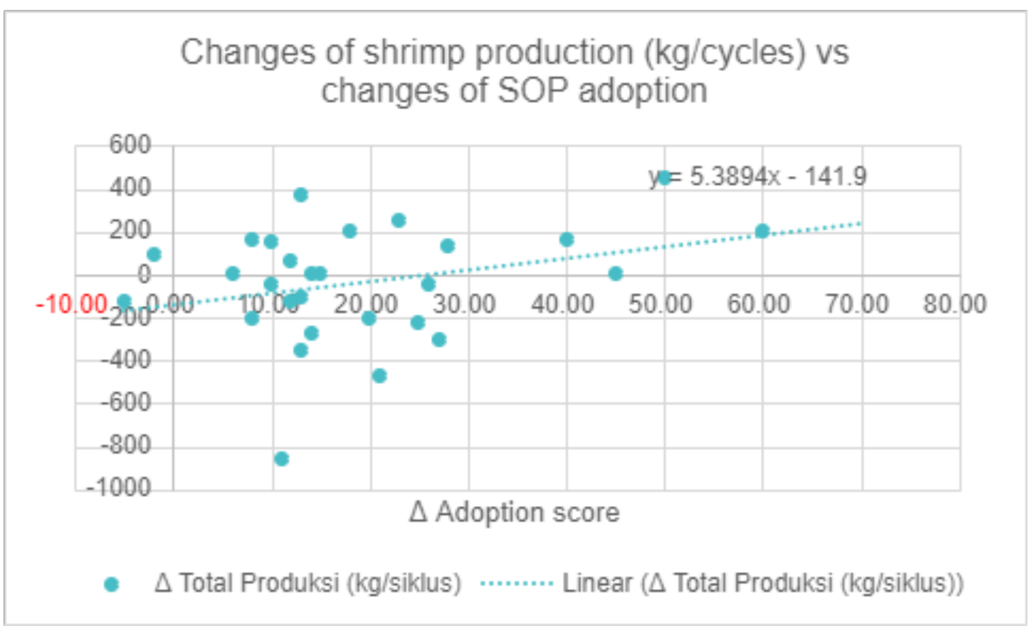

Figure 8. Changes of shrimp production and SOP adoption score

Figure 8 provides valuable insights into the relationship between changes in shrimp production and changes in adoption scores. Upon careful examination of the figure, a clear pattern emerges.

The majority of dots are clustered on the right side of the vertical axis, indicating that a significant number of farmers have successfully improved their adoption scores during the specified period. This highlights the farmers' commitment to implementing recommended Standard Operating Procedures (SOPs) and their dedication to enhancing their shrimp farming practices.

However, a contrasting observation is found below the x-axis, where more than half of the dots are plotted. This suggests that over half of the farmers experienced a decline in shrimp production during the same period. This decline in production raises concerns and calls for a deeper understanding of the factors influencing these outcomes.

It is important to recognize that the decline in production cannot be solely attributed to the farmers' capacity or implementation of SOPs. Rather, the profound effect of climate risks and disease outbreaks on shrimp production becomes apparent. These external factors, beyond the control of individual farmers, pose significant challenges to the industry as a whole. Climate variations, including temperature fluctuations and extreme weather events, coupled with disease outbreaks, can significantly impact shrimp health, growth, and overall production.

Moreover, the regression line depicted in Figure 9 exhibits a positive trend, indicating that an increase in the adoption score is associated with an improvement in production levels. This positive relationship underscores the importance of enhancing the adoption of recommended practices and protocols in shrimp farming for achieving favorable production outcomes.

To quantify the relationship between changes in production and changes in adoption score, the changes in shrimp production can be estimated using the following regression equation:

$$\Delta Y = 5.3894\Delta X - 141.9$$

In this equation, ΔY represents the changes in production, and ΔX represents the changes in adoption score. The equation provides a mathematical framework to estimate the impact of changes in the adoption score on production changes.

Interpreting the regression results, the coefficient of ΔX (5.3894) represents the expected change in production associated with a one-unit change in the adoption score. This coefficient implies that, on average, a ten-point increase in the adoption score leads to an estimated increase in production of 54 kg.

To determine the minimum increase in adoption score required to maintain the production level above the previous year, we can calculate the point where the production change (Y) does not fall below zero. In this case, we can set Y to zero and solve the equation:

$0 = 5.3894\Delta X - 141.9$

Solving for ΔX, we find that a minimum increase in the adoption score of approximately 26.36 points is needed to prevent a decline in production below the previous year's level.

In summary, the positive trend in the regression line highlights the importance of improving adoption scores to achieve favorable production outcomes. Additionally, the regression equation allows us to estimate the impact of adoption score changes on production changes. The calculated minimum increase in adoption score helps guide farmers in maintaining or surpassing production levels achieved in the previous year.

Overall findings underscore the complex and interconnected nature of shrimp production, where both the farmers' adoption of SOPs and external factors play crucial roles. While the farmers' efforts in improving their adoption scores are commendable, addressing climate risks and disease outbreaks necessitates collaborative efforts, such as industry-wide initiatives, technological advancements, and supportive policies.

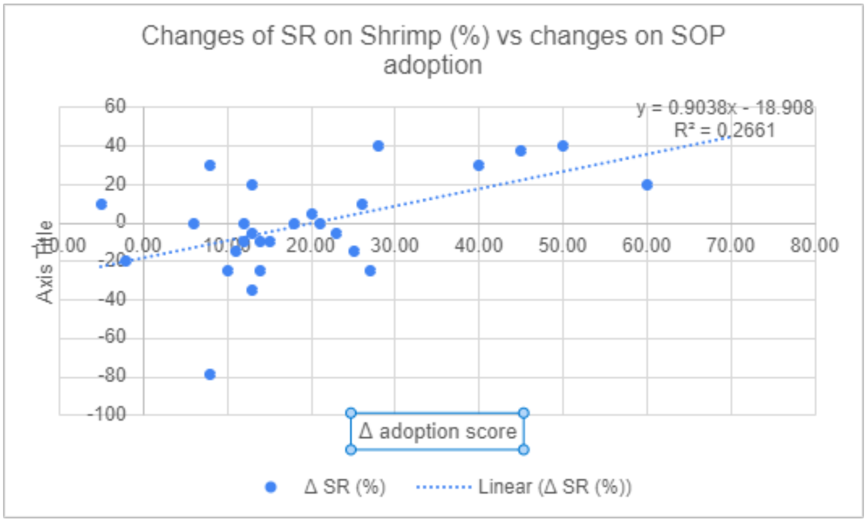

Figure 9. The changes of SR on shrimp farming and SOP adoption score

Figure 9 provides valuable insights into the relationship between changes in the survival rate (SR) and changes in the adoption score among farmers. A careful examination of the figure reveals a distinct pattern: approximately half of the dots are clustered below the x-axis, indicating that roughly half of the farmers experienced a decline in the survival rate. While external factors such as disease outbreaks and climate risks may contribute to this decline, it is important to explore the role of the adoption score as well.

Interestingly, despite the presence of external factors, we observe a positive trend in the regression line. This suggests that an increase in the adoption score may lead to an improvement in the survival rate. While it is crucial to acknowledge the influence of external factors on the survival rate, the positive relationship highlighted by the regression line underscores the potential impact of enhanced adoption scores on improving the survival rate among farmers.

To quantify the relationship between changes in the survival rate and changes in the adoption score, the changes in the survival rate can be estimated using the following regression equation:

$$\Delta Y = 0.9038\Delta X - 18.908$$

In this equation, ΔY represents the changes in the survival rate, and ΔX represents the changes in the adoption score. The equation provides a mathematical framework to estimate the impact of changes in the adoption score on changes in the survival rate.

Interpreting the regression results, the coefficient of ΔX (0.9038) represents the expected change in the survival rate associated with a one-unit change in the adoption score. This coefficient suggests that, on average, a ten-point increase in the adoption score leads to an estimated increase in the survival rate of 9 % point. Furthermore, the intercept of 18.908 indicates that on average, without any changes in the adoption score, there is an expected decrease in the survival rate by approximately 18.908 % point. This negative intercept value implies that there might be other factors or influences, beyond the adoption score, that contribute to a decline in the survival rate among shrimp farmers. This was confirmed by farmers during FGD that pointed out climate risks and limited access to high quality seeds for low salinity that they faced.

While it is important to acknowledge the potential influence of external factors on the survival rate decline, the positive coefficient in the regression equation implies that improvements in the adoption score can have a favorable impact on the survival rate. By implementing and adhering to recommended SOPs, farmers can enhance their farming practices and potentially mitigate the adverse effects of external factors on shrimp survival

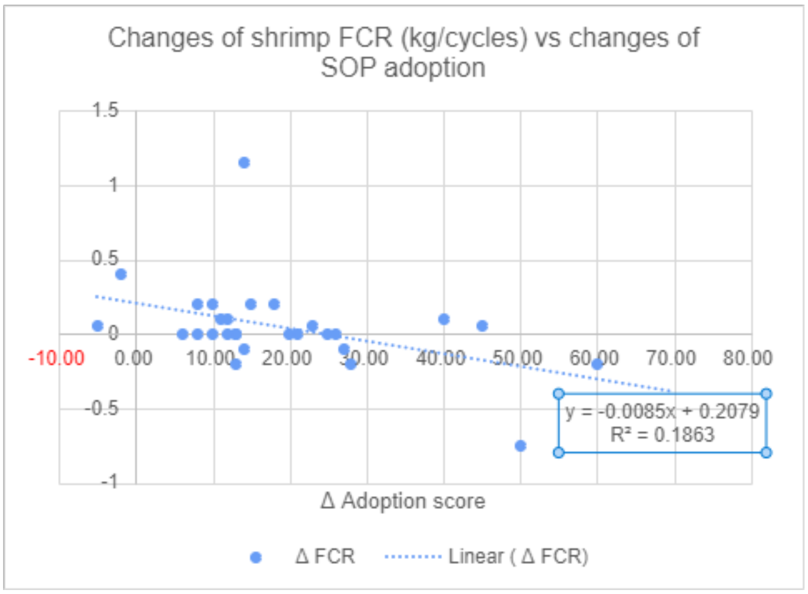

Figure 10. Changes of FCR and SOP adoption score in shrimp farming

Figure 10 sheds light on the relationship between changes in Feed Conversion Ratio (FCR) and changes in the adoption score among shrimp farmers. Upon closer examination of the figure, a noteworthy pattern emerges. Approximately half of the dots are clustered above the x-axis, indicating an increase in FCR or a decline in feed efficiency. This observation raises concerns about the efficiency of feed utilization within the industry.

One factor that could contribute to this phenomenon is the global market disruption, which has resulted in a rise in feed prices. The increased cost of feed might prompt some farmers to compromise their feed practices by opting for cheaper feeds with potentially lower quality. This compromise in feed quality can lead to an increase in FCR or a deterioration in feed efficiency.

However, the regression line depicted in Figure 11 reveals an interesting finding. It displays a negative trend, suggesting that an increase in the adoption score tends to reduce (improve) the FCR. This implies that a higher level of SOP adoption is associated with better feed utilization and improved feed efficiency.

To quantitatively assess the relationship between changes in FCR and changes in the adoption score, the changes in FCR can be estimated using the following regression equation:

$$\Delta Y = -0.0085\Delta X + 0.2079$$

In this equation, ΔY represents the changes in FCR, and ΔX represents the changes in the adoption score. The equation provides a mathematical framework for estimating the impact of changes in the adoption score on changes in FCR.

Interpreting the regression results, the coefficient of ΔX (0.0085) represents the expected change in FCR associated with a one-unit change in the adoption score. This coefficient implies that, on average, a ten-points increase in the adoption score leads to an estimated decrease in FCR of 0,085

These findings support the notion that an emphasis on SOP adoption and improved farming practices can contribute to a reduction in FCR and enhance feed efficiency. By implementing effective SOPs, farmers can optimize their feed utilization, improve feed conversion, and ultimately enhance the economic viability of their shrimp farming operations.

To determine the minimum increase in SOP adoption that would result in a reduction in FCR, we need to set Y to zero and solve for ΔX:

0 = -0.0085ΔX + 0.2079

Solving this equation, we find:

ΔX = 0.2079 / 0.0085

ΔX ≈ 24.47

Therefore, the minimum increase in SOP adoption required to reduce the FCR would be approximately 24.47 points. This means that shrimp farmers would need to increase their adoption score by at least 24.47 points to achieve a reduction in FCR.

By implementing and adhering to recommended SOPs and improving feed management practices, farmers can optimize their feed conversion and enhance feed efficiency, leading to improved shrimp farming performance and reduced FCR.

In order to complement statistical analysis above, results of FGD and interview with shrimp farmers are also discussed. During the FGD, farmers highlighted two important components of the standard operating procedures (SOP) that they had not previously implemented before undergoing the SMART Fish training: the use of reservoirs and the application of calcium dioxide in land preparation.

(a) Reservoir:

Farmers provided testimonies regarding the effectiveness of reservoirs in controlling water quality, which resulted in better shrimp adaptation and improved survival rates (SR) and size. Ponds with reservoirs had an SR of 80%, while those without reservoirs had an SR of 50%, indicating a significant gap of 30%. For example, in a 1800 m2 pond, this gap translates to a potential benefit of IDR 17,400,000 or IDR 9,666.7 per m2 of pond area. Additionally, reservoirs allowed for longer harvest periods and larger shrimp sizes. Ponds with reservoirs produced shrimp sized 60-80 pieces/kg in 3 months, while similar ponds without reservoirs mostly yielded shrimp sized 95 pieces/kg in 2.5 months. The price difference between these sizes (IDR 60,000/kg for size 60 and IDR 48,000/kg for size 95) further contributed to the benefits of using reservoirs.

Although farmers incurred additional costs to build reservoirs (e.g., IDR 10,000,000 for a 10m x 25m x 2m reservoir) and spent more on feed for an additional 15 days, the hypothetical benefits for a 1800 m2 pond with 200,000 seeds showed a net benefit of IDR 11,300,000. The return on reservoir adoption was calculated to be 48%.

(b) Land preparation:

The application of calcium dioxide in land preparation was found to stabilize pH levels, resulting in better shrimp molting processes. By utilizing 6 packs of calcium dioxide at a price of IDR 75,000 per pack, a farmer spent IDR 450,000 for this application. The improved SR of 10-20% (equivalent to 150 kg production) led to a benefit of IDR 8,700,000. After deducting the operational cost of application, the net benefit was IDR 8,250,000.

Despite the benefits derived from these SOP components, farmers faced several constraints in their aquaculture development. Limited land availability hindered their ability to build reservoirs, forcing them to focus on improving aquaculture treatment instead of making investments. Access to high-quality or certified seeds, particularly for low salinity shrimp, was also limited. Additionally, the increasing cost of feed, which accounted for approximately 75% of total costs, posed a challenge for farmers.

In conclusion, the implementation of reservoirs and the application of calcium dioxide in land preparation proved to be beneficial for farmers, improving survival rates, shrimp size, and overall profitability. However, constraints such as land limitations, limited access to high-quality seeds, and rising feed prices continue to impact their aquaculture practices.

The Impact of GQSP Program on Milkfish farming

A comprehensive overview of the changes in milkfish farming parameters in Tarakan from 2022 to 2023 is presented in Table 9. The observed alterations highlight the importance of understanding and addressing the various external factors that influence milkfish farming outcomes.

Table 9. Changes on Milkfish farming from 2022 to 2023

Parameters	2022	2023	Gap
Average Production (ton)/ pond/cycle	3,06	2,68	-0,38
Average pond size/ farmer (ha)	19,93	15,20	-4,73
Average productivity (ton/ha/cycle)	2,09	1	-1,09
FCR	No feed used	No feed used	-
SR (%)	75,67	67,33	-8,33
Average received price per kg (Rp)	14.400	15.733	1.333,-
Average sales (revenue)/ farmer (IDR million)/cycle	38.27	34.8	- 3.47

Estimated total revenue of all assisted farmers (IDR million)	3,023.09	2,748.83	-274.26

Firstly, there was a notable decline in average production, with a decrease from 3.06 tons per pond per cycle in 2022 to 2.68 tons per pond per cycle in 2023, resulting in a negative gap of -0.38 tons. This decline in production could be attributed to a range of factors, including climate risks such as changes in temperature, water quality, and extreme weather events, which can significantly impact farming conditions and productivity. Additionally, external disruptions, such as market fluctuations or supply chain challenges resulting from global events like pandemics, may have contributed to this decline.

The average pond size per farmer also experienced a substantial reduction, declining from 19.93 hectares in 2022 to 15.20 hectares in 2023, indicating a negative gap of -4.73 hectares. This decline in pond size could be influenced by changes in farming practices, resource availability, or economic considerations. The decision to reduce the pond size may reflect adjustments made by farmers to optimize resource utilization or adapt to changing market conditions.

Moreover, the average productivity witnessed a significant decrease from 2.09 tons per hectare per cycle in 2022 to 1 ton per hectare per cycle in 2023, resulting in a negative gap of -1.09 tons. This decline in productivity underscores the complex interplay of various factors, including suboptimal farming practices, changes in water quality, disease outbreaks, and other environmental influences.

The survival rate (SR) experienced a notable drop of 8.33%. This decline in SR could be attributed to external factors, such as climate risks, diseases, or suboptimal farming conditions. Changes in water quality, disease outbreaks, and shifts in environmental conditions can significantly impact the health and survival of milkfish, thereby influencing SR outcomes.

In terms of market dynamics, the average received price per kilogram of milkfish increased from Rp 14,400 in 2022 to Rp 15,733 in 2023, resulting in a positive change of Rp 1,333. This increase in price may reflect market fluctuations, demand-supply dynamics, or changes in consumer preferences.

Consequently, the average sales per farmer per cycle decreased of -Rp 3,471,733. This decline in revenue can be attributed to a combination of factors, including changes in production levels, market conditions, and external disruptions such as global market disruptions.

Understanding the underlying causes of these changes in milkfish farming parameters is essential for developing effective strategies to mitigate their impact. Adaptation to climate risks, implementing disease management protocols, optimizing resource utilization, and staying informed about market dynamics are crucial considerations for the milkfish farming industry. By addressing these factors, stakeholders can enhance the resilience and sustainability of milkfish farming practices, ensuring the long-term viability of this vital sector.

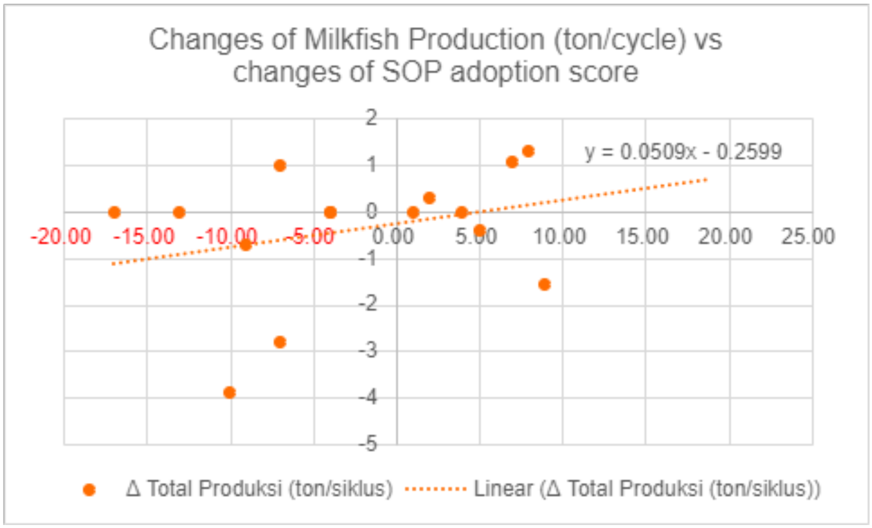

Figure 11. The changes of milkfish production and SOP adoption score

The relationship between the changes in production and adoption score in milkfish farming was investigated and depicted in Figure 11. It reveals that approximately half of the data points are clustered on the left side of the vertical axis, indicating that a significant proportion of farmers did not maintain their level of adoption. Furthermore, more than half of the farmers experienced a decline in production, suggesting the challenges faced in the industry. Notably, there were two farmers who reduced their adoption score encountered a substantial drop in production, highlighting the importance of maintaining a strong commitment to adopting recommended practices.

The regression analysis resulted a positive trend line, indicating that an improvement in the adoption score has the potential to increase production levels. This implies that a higher level of commitment to adopting standardized operating procedures (SOPs) and best practices could result in improved production outcomes for milkfish farmers.

The regression equation, $\Delta Y = 0.0509\Delta X - 0.2599$, provides a quantitative representation of the relationship between the changes in production (ΔY) and the changes in adoption score (ΔX). The coefficient 0.0509 indicates that, on average, for every 10 points increase in the adoption score, there is an expected increase in production by 0.5 tons. The intercept term, -0.2599, represents the starting point for production changes. It means that when there is no improvement in adoption score, farmers are more likely to experience production decline by 0.26 tons during the period with difficult circumstance.

These findings emphasize the importance of maintaining and enhancing the adoption of recommended practices in milkfish farming. Increasing the adoption score, through the implementation of SOPs, training programs, and knowledge sharing, may lead to improved production outcomes and overall success in the industry. It is crucial for farmers and stakeholders to recognize the positive relationship between adoption score and production and strive to continuously improve their adherence to best practices. By doing so, the milkfish farming sector can enhance its productivity, sustainability, and competitiveness in the market.

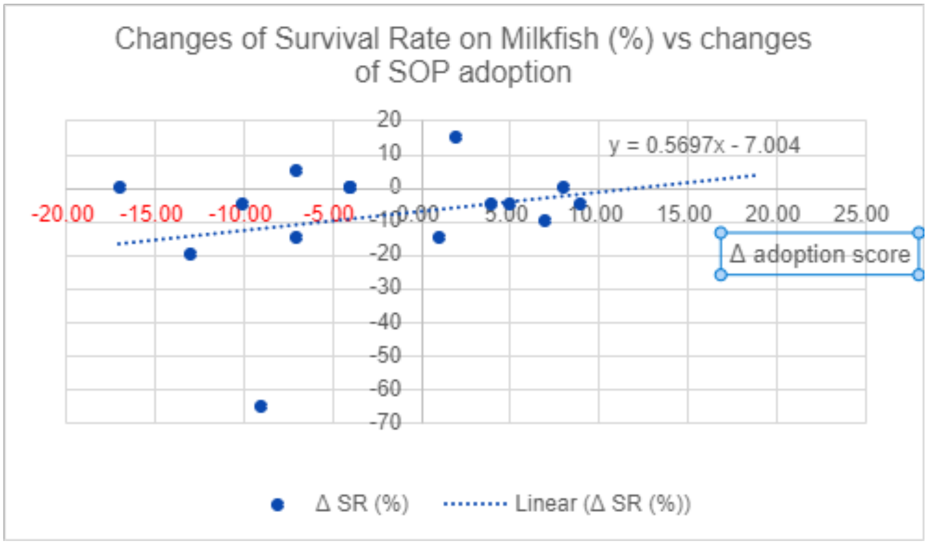

Figure 12. The changes of SR and SOP adoption score in milk fish farming

The relationship between the changes in survival rate (SR) and adoption score in milkfish farming in Tarakan was examined, as presented in Figure 12. The majority of data points were observed to cluster below the x-axis, indicating that a significant number of farmers experienced a decline in SR. This suggests that maintaining a consistent SR in 2023 was a major challenge faced by milkfish farmers in the region.

However, the regression analysis revealed a positive trend line, implying that an improvement in the adoption score can have a positive effect on SR. This suggests that by enhancing their commitment to adopting standardized operating procedures (SOPs) and best practices, farmers may have the opportunity to improve SR outcomes in their milkfish farming operations.

The regression equation, $\Delta Y = 0.5697\Delta X - 7.004$, provides quantitative insights into the relationship between the changes in SR (ΔY) and the changes in adoption score (ΔX). The coefficient 0.5697 indicates that, on average, for every ten-points increase in the adoption score, there is an expected increase in SR by 5,7% point. The intercept term, -7.004, indicates when the adoption score remains unchanged farmers are more likely to decline in SR by 7% point.

The challenges in maintaining a satisfactory SR in milkfish farming in Tarakan may be attributed to various factors. Environmental factors such as water quality, temperature fluctuations, and disease outbreaks can significantly impact the survival of milkfish. Inadequate disease management practices, limited access to high-quality fry or fingerlings, and suboptimal farming conditions can further contribute to the challenges faced by farmers in maintaining a consistent SR.

To address these challenges, it is crucial to promote the adoption of effective disease management strategies, improve access to high-quality seedstock, and enhance overall farming practices. Training programs, technical assistance, and knowledge sharing initiatives can play a vital role in equipping farmers with the necessary skills and information to improve SR outcomes. By boosting the adoption score through the implementation of best practices, the milkfish farming industry in Tarakan can enhance its resilience, productivity, and overall success.

To supplement the statistical analysis mentioned earlier, the findings from the focus group discussion (FGD) and the interviews conducted with milkfish farmers are also elaborated. During the FGD, it was revealed that most farmers lacked sufficient extension services on good aquaculture practices. The participants raised several important problems, including the lack of natural feed in the pond and the poor quality of seeds with high mortality rates after one month. Additionally, the farmers expressed a lack of access to extension services and information, relying on learning from other farmers and social media platforms like YouTube.

In a separate session, H. Muhyidin, a leader of a farmer group who participated in the training was interviewed. H. Muhyidin has been involved in milkfish grow-out since 2018 and milkfish hatchery since 2023. He owns three ponds of different sizes: 10 ha, 15 ha, and 5 ha. The 10 ha pond produced 3 tons from 50,000 grade B seeds, the 15 ha pond produced 5 tons from 50,000 grade A seeds, and the 5 ha pond produced 300 kg from 15,000 seeds. H. Muhyidin purchased grade A seeds from Bali at a price of IDR 85 per piece for cultivation. Although he attended the training and received an SOP book, he was unable to present the book during the interview as it was lost.

While H. Muhyidin benefited from the training, he argued that certain parts of the SOP were not suitable and needed adjustments to fit the field situation in Tarakan. The most valuable training material for him was learning how to select and use excellent/qualified seeds. The program has connected two farmer groups, including H. Muhyidin's group and H. Masykur's group, with high-quality seed suppliers from Bali. Each group consists of 10-12 members, and H. Muhyidin has been selling 300,000 seeds to each member every six months over the past year. He offers two grades of seeds with different prices based on size and quality.

In conclusion, the results obtained from the farmers' experiences and feedback shed light on several important aspects of aquaculture practices. The lack of extension services and information, coupled with challenges related to natural feed availability and seed quality, emerged as significant hurdles for farmers. However, the engagement of farmer groups in training programs and the establishment of connections with high-quality seed suppliers showcased the potential for collaboration and networking to enhance aquaculture practices.

The need to adjust standard operating procedures (SOPs) to suit local field conditions emphasizes the importance of flexibility and adaptation in implementing best practices. Additionally, the limited access to reliable information sources highlights the significance of improving knowledge dissemination channels for farmers.

Overall, these findings emphasize the need for continuous learning, support, and innovation in the aquaculture sector. By addressing the identified challenges and implementing appropriate solutions, stakeholders can work towards improving productivity, sustainability, and the overall well-being of farmers in the aquaculture industry.

The Impact of GQSP Program on Milkfish Processing Industry

In addition to evaluating the impact of the GQSP program at the upstream level, it is crucial to assess its influence at the downstream level, particularly in milkfish processing industry. This evaluation focuses on the success stories of GQSP Program in supporting milkfish processing plants in Tarakan, emphasizing the positive outcomes resulting from program interventions. Two prominent companies, CV Sonya Putri (CV SNP) and PT Tarakan Fisherindo Sipatuo (PT TFS), have directly benefited from the assistance provided by GQSP Indonesia. These success stories shed light on how the program has effectively increased the capacity and competitiveness of these processing plants within the global market context.

CV SNP, established 13 years ago, faced limitations in exporting due to capacity constraints and insufficient required documents. With the support of GQSP Indonesia, CV SNP was able to directly export to an international buyer in Malaysia and received financial assistance for exporting. The program also provided training on Hazard Analysis and Critical Control Points (HACCP), resulting in higher revenue and quality improvement for CV SNP. However, CV SNP needs to upgrade its HACCP grade to access markets like Dubai, Russia, or China.

UNIDO trained CV SNP staffs on HACCP on-site, but the certificate issued was not recognized by the local authority. Willy, the owner of CV SNP, recommended better coordination between UNIDO and the local authority to ensure recognition of the training certificates. Additionally, CV SNP faces challenges in securing an adequate supply of raw materials, competing with traders who offer higher prices for fresh fish.

PT TFS, established in 2016, has a production capacity of 30 tons of milkfish per day. With GQSP Indonesia's assistance, PT TFS was connected to international buyers in Malaysia, received financial support, and underwent capacity building in traceability and HACCP. However, similar to CV SNP, PT TFS faces difficulties in obtaining sufficient raw materials due to competition with traders, particularly from Malaysia.

Lessons learned from these success stories highlight the importance of program interventions in improving market access, revenue, and product quality for milkfish processing plants. Strengthening HACCP certification processes and coordinating with local authorities are essential to ensure the recognition and acceptance of training certificates. Additionally, securing raw materials and enhancing competitiveness against traders will be crucial for the sustained growth. By addressing all these factors, milkfish processors can position themselves better in the global market, maximize their revenue potential, and contribute to the growth and development of the local fishery sector.

The Impact of GQSP Program on Seaweed farming

Eucheuma Cottonii farming

A comparison of seaweed (Eucheuma) farming performance in Pangkep and Jeneponto, highlighting the differences in changes between 2022 and 2023 is presented in Table 10. In Pangkep, there was a decrease in average wet production per stretch rope per farmer from 29.10 kg in 2022 to 25.60 kg in 2023, resulting in a gap of -3.50 kg. Similarly, the average dry production per farmer per stretch rope decreased from 3.83 kg to 3.08 kg, with a gap of -0.75 kg. On the other hand, in Jeneponto, there was also a decrease in average wet production per stretch rope per farmer from 45.78 kg in 2022 to 40.94 kg in 2023, resulting in a gap of -4.84 kg. The average dry production per farmer per stretch rope showed a more significant decrease from 6.22 kg to 1.56 kg, with a gap of -4.66 kg. These declines in production in both locations were attributed to various factors such as changes in environmental conditions and flood disaster.

Table 10. Changes on Cottonii farming from 2022 to 2023

Parameters	Pangkep			Jeneponto		
	2022	2023	Gap	2022	2023	Gap
Average Wet Production (kg)/ stretch rope/farmer	29,10	25,60	-3,50	45,78	40,94	-4,84
Average Dry Production (kg)/ farmer/stretch rope	3,83	3,08	-0,75	6,22	1,56	-4,66
Average stretch ropes	288,00	319,67	31,67	230	229	-1
Average wet productivity (kg/m)	1,17	1,06	-0,11	1,65	1,52	-0,13
Average dry productivity (kg/m)	0,15	0,13	-0,03	0,22	0,06	-0,17
Average Received Price for dry product per kg (Rp)	41.833	28.143	13.690	32.433	29.917	2.516
Average sales (revenue)/ stretch rope/farmer	160.333	81.200	79.133	187.688	33.833	153.855

The average number of stretch ropes increased slightly in both areas, with a gap of 31.67 in Pangkep and a negligible decrease of -1 in Jeneponto. This could indicate efforts to expand seaweed farming or changes in farming practices.

Both Pangkep and Jeneponto experienced decreases in average wet and dry productivity per meter. In Pangkep, the average wet productivity decreased by -0.11 kg/m, while the average dry productivity decreased by -0.03 kg/m. Similarly, in Jeneponto, the average wet productivity decreased by -0.13 kg/m. However, the average dry productivity showed a more significant decrease, dropping from 0.22 kg/m to 0.06 kg/m, with a gap of -0.17 kg/m. These declines in productivity could be attributed to various factors, including changes in farming techniques, nutrient availability, or environmental conditions.

The average received price for dry seaweed per kilogram also varied between the two areas. In Pangkep, the price decreased from Rp 41,833 to Rp 28,143 per kilogram, resulting in a gap of 13,690 Rp. In Jeneponto, the price decreased from Rp 32,433 to Rp 29,917 per kilogram, with a smaller gap of 2,516 Rp. These changes in prices could be influenced by global market dynamics.

Overall, the differences in changes in seaweed performance between Pangkep and Jeneponto indicate variations in production, productivity, and prices. These differences could be attributed to a range of factors, including environmental conditions, climate risks, farming practices, and market dynamics. Understanding these variations is crucial for identifying areas of improvement and implementing targeted interventions to enhance seaweed farming in both regions.

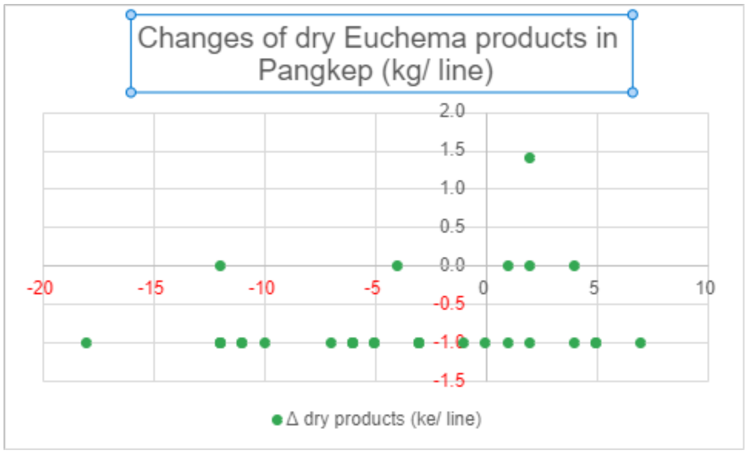

Figure 13. The changes of dry Cottonii production and adoption score in Pangkep

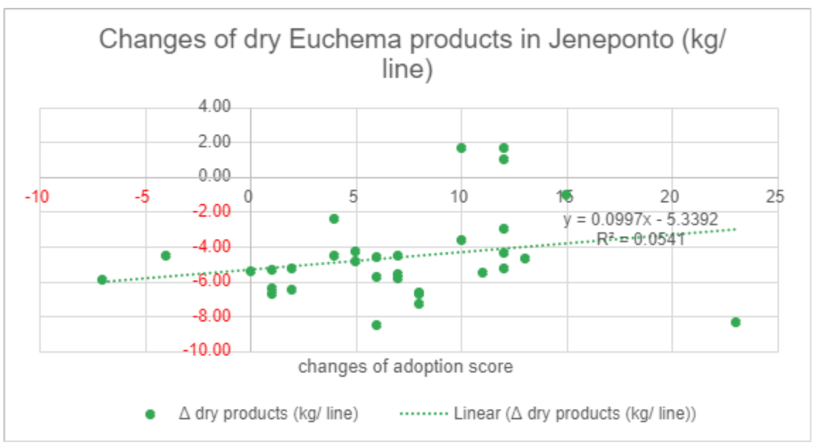

Figure 14. The changes of dry Eucheuma production and adoption score in Jeneponto

The effect of SOP adoption on production in Pangkep and Jeneponto was examined, and the results are presented in Figures 13 and 14. In Pangkep (Figure 13), the data points are mostly clustered below the x-axis, indicating that the majority of farmers experienced a decline in production compared to the previous year. The figure does not show a clear pattern, suggesting a weak or no relationship between the changes in adoption score and production. This implies that an improvement in adoption score may not necessarily lead to an increase in production. It suggests that external factors such as climate and environmental conditions play a more significant role in seaweed production. It is worth noting that the seaweed farms in Pangkep were also affected by a significant flood at the end of 2022, which could have contributed to the decline in production.

In contrast, Figure 14 illustrates the relationship between the changes in adoption score and production in Jeneponto. Similar to Pangkep, the majority of farmers in Jeneponto also experienced a decline in production. However, a positive trend can be observed in the regression line, indicating a potential positive effect of an improvement in adoption score on production improvement. This suggests that in Jeneponto, there is a stronger association between the adoption of SOPs and an increase in production compared to Pangkep.

These findings highlight the importance of considering location-specific factors when assessing the impact of SOP adoption on production. While external factors such as climate and environmental conditions may have a more significant influence on production outcomes, the relationship between adoption score and production improvement can vary between different locations. Understanding these variations is crucial for developing targeted interventions and strategies to enhance seaweed production in each specific area. The regression equation is following.

During the focus group discussions (FGDs), seaweed (Eucheuma cottonii) farmers in Jeneponto expressed their gratitude to the GQSP for introducing useful and beneficial SOPs. They highlighted several important points regarding the benefits of SOP implementation:

1. Change in line distance: The SOP introduced wider spacing between lines, increasing the distance from 30 cm to 50 cm. This change resulted in a significant improvement in productivity. Under the old practice, farmers produced only 50 kg of wet seaweed in one month, whereas with the SOP, they were able to produce 100 kg, double the previous amount. The reduced number of lines, from 100 to 70, also resulted in higher productivity. Comparing the total seed production in one month, the old practice yielded 5,000 kg, while the SOP practice achieved 7,000 kg. Thus, the new SOP practice demonstrated a 2,000 kg higher yield than the old practice.
2. Drying process: The SOP and training encouraged farmers to use "para-para" or drying pedestals, which significantly improved the quality of dried seaweed. In the old practice, some farmers did not use para-para, resulting in higher water content and dirt in the seaweed. Collectors or middlemen differentiated prices or net weights based on drying and dirt levels when purchasing seaweed from farmers. Seaweed dried using para-para accounted for an additional 4 kg per sack of 100 kg, compared to not using para-para. Consequently, farmers earned IDR 128,000 more per sack of seaweed by using para-para. Although there is a cost associated with making para-para (approximately IDR 3,000,000 for a size of 8m x 4m), it lasts up to 5 years and can be used multiple times.
3. Seeds cutting and selection: The training recommended a single cutting of seeds instead of multiple cuttings, which proved effective in stimulating faster growth. Farmers preferred to use young seeds instead of old ones. Additionally, farmers observed that if the tied seeds stayed overnight on land before being placed in the sea, the mortality rate was higher (40% for cottonii and 70% for spinosum).
4. Identification and selection of suitable seaweed types: Farmers learned to identify and select suitable types of seaweed based on location, conditions, and seasons. To minimize risks, some farmers, like Pak Kahar, grew multiple types of seaweed simultaneously (e.g., Sakol, Cottonii, and Spinosum) in different locations.

In interviews with collectors in Jeneponto, namely Dewi and Sunarti, it was revealed that they provided working capital to farmers and required their members to sell their products exclusively to them. The collectors were familiar with the specifications required by buyers/exporters, such as a maximum water content of 35% with minimal impurities. However, farmers typically provided seaweed with a water content of 37%. Consequently, collectors needed to dry the seaweed again using para-para and adjust the price accordingly. Collectors typically waited 2-3 days to collect up to 2 tons of seaweed before transporting them to larger traders, exporters, or processing plants.

To gain a comprehensive understanding of seaweed productivity and quality, an interview was also conducted with Amir Nashir, the Head of Processing Plant at PT Bantimurung Indah (PT BI), a reputable processing plant in Maros. During the interview, several challenges faced by processing plants in obtaining raw dried seaweed that meets the required specifications were highlighted. This emphasizes the importance of increasing quality awareness and production practices among seaweed farmers according to standard operating procedures (SOPs).

PT BI, established in 1985 as a cracker factory using shrimp as raw material, has shifted its focus to processing cottonii-based products, specifically Semi Refined Carrageenan (SRC). The company currently has a production capacity of 4.8 tons per day, with a yield of 27%. They trade approximately 2 containers (50 tons) of SRC per month to the international market, particularly the UK, and have served markets in Russia, Argentina, and Chile in the past.

The company's specifications for raw materials require a maximum water content of 37% and impurities below 3%. The origin of the raw material also plays a crucial role for the processing plant, as buyers often require traceability to ensure quality. Specific origins, such as NTT, NTB, and Maluku, may be requested by buyers.

PT BI purchases seaweed from Jeneponto and Bone at a price of IDR 34,000 per kilogram, while seaweed sourced from outside South Sulawesi is priced at IDR 35,000-36,000 per kilogram (including transportation costs). Consequently, seaweed from outside the province is priced IDR 1,000-2,000 per kilogram higher than local seaweed. However, currently, only 30% of the raw material comes from within the province (Jeneponto, Bone, Pangkep, and Maros), while the remaining 70% is sourced from outside. The company has identified a significant decline in the quality of seaweed from within South Sulawesi, particularly in terms of gel strength, which falls below the required minimum of 700 and averages between 500-600. Harvest age has been identified as a key factor affecting gel strength, as high demand from raw material exporters has led farmers to harvest seaweed prematurely. Exporters focus primarily on the dryness level and are willing to purchase seaweed as long as it meets that requirement, overlooking gel strength. Furthermore, poor handling practices by collectors, who mix seaweed from various origins and harvest ages, and attempts to accelerate drying with salt further deteriorate the quality of the raw material.

Previously, the company had a partnership scheme with farmers to support working capital. However, this scheme is no longer effective, and PT BI now prefers to collaborate with collectors to secure raw materials. This highlights the need for seaweed stakeholders to come together and agree upon standards to ensure the quality and sustainability of the industry.

Glacilaria farming

The changes of glacilaria farming from 2022 and 2023 is presented in Table 11. As shown in Table 11, there was a remarkable increase in average production of wet weight (WW) per cycle per farmer, rising from 201.88 kg in 2022 to 2,184.38 kg in 2023. This indicates a substantial improvement in production, with a gap of 1,982.50 kg. Similarly, the average production of dry weight (DW) per cycle per farmer experienced a significant increase from 51.25 kg to 628.59 kg, resulting in a gap of 577.34 kg. These changes suggest a substantial boost in productivity and output.

Table 11. The changes on Glacilaria farming from 2022 to 2023

Parameters	2022	2023	Gap
Average Production WW (kg)/ cycle/farmer	201.88	2184.38	1982.50
Average Production DW (kg)/ cycle/farmer	51.25	628,59	577.34
Average production area (m2)	6,775.00	8.093.75	1,318.75
Average productivity WW (ton/ha)	0.41	3.05	2.63
Average productivity DW (ton/ha)	0.10	083	0.73
Average received price per kg DW (Rp)	6,596.9	6,825.0	228.1
Average sales (revenue) IDR million / cycle/farmer	10.7	136.95	126.25
Estimated total revenue of all assisted farmers (IDR million)	3,639.19	46,562.49	42,923.3

The average production area also witnessed an expansion, growing from 6,775.00 m2 in 2022 to 8,093.75 m2 in 2023, with a gap of 1,318.75 m2. This increase in production area indicates the expansion of Glacilaria farming activities in Maros.

Furthermore, the average productivity of Glacilaria in terms of wet weight (ton/ha) showed a substantial improvement, increasing from 0.41 tons/ha in 2022 to 3.05 tons/ha in 2023, resulting in a gap of 2.63 tons/ha. Similarly, the average productivity of dry weight (ton/ha) also experienced a significant increase from 0.10 tons/ha to 0.83 tons/ha, with a gap of 0.73 tons/ha. These improvements in productivity highlight the enhanced efficiency and effectiveness of Glacilaria farming practices.

In terms of financial aspects, the average received price per kilogram of dry weight (DW) remained relatively stable, with a slight increase from Rp 6,596.9 to Rp 6,825.0 per kilogram, resulting in a gap of Rp 228.1. This indicates a consistent market value for Glacilaria in Maros. Additionally, the average sales revenue per cycle per farmer showed a significant increase from Rp 10,703,500 to Rp 136,948,500, with a gap of Rp 126,245,000. This substantial increase in sales revenue reflects the improved profitability and economic viability of Glacilaria farming in Maros.

Overall, the changes observed in Glacilaria farming in Maros from 2022 to 2023 demonstrate significant improvements in production, productivity, and financial performance. These positive developments can be attributed to various factors, including advancements in farming techniques, increased production area, and stable market prices. These findings indicate the potential for further growth and success in Glacilaria farming in Maros.

Glacilaria and Eucheuma Cottonii are two different types of seaweed used for different purposes. Glacilaria is primarily used to produce agar, while Eucheuma Cottonii is used to make carrageenan. These different end products result in variations in characteristics, required environmental conditions, and market dynamics, including price.

The difference between Cottonii (Eucheuma cottonii) and Glacilaria also lies in their farming or cultivation locations. In the context of farming, Eucheuma cottonii is typically farmed in the sea, while Glacilaria, as studied in this program, is farmed inside ponds. Cottonii, is a type of red seaweed that is primarily cultivated in coastal areas and marine environments. It is grown in floating seaweed farms or rafts that are anchored to the seabed. These seaweed farms allow the Cottonii to absorb nutrients from the seawater and receive sunlight necessary for photosynthesis. On the other hand, Glacilaria is also a type of red seaweed, which is farmed in ponds in our study. These ponds are usually constructed on land and filled with seawater to create a controlled environment for cultivating Glacilaria. The seaweed is grown within these ponds and carefully managed to ensure optimal growth conditions, including temperature, water quality, and nutrient supply.

Compared to Cottonii, the price of Glacilaria is generally lower but more stable. This stability in price may be one of the reasons why some farmers prefer to cultivate Glacilaria. Additionally, the suitability of the location and weather conditions for Glacilaria farming also plays a roleg in farmers' decision-making process.

Figure 16 illustrates the changes in dry production and SOP adoption score in Glacilaria farming. In 2022, it is observed that most farmers already had a high SOP adoption score, averaging around 90 points. This indicates that farmers had already implemented standard operating procedures in their farming practices. However, many data points are clustered on the right side of the vertical axis, suggesting that farmers continued to make improvements in their adoption scores. Furthermore, the majority of data points are located above the x-axis, indicating that most farmers were able to improve their production. Even for those who did not improve or reduced their adoption scores, they still managed to increase their income. This could be attributed to the stable price of Glacilaria and the relatively suitable production sites available.

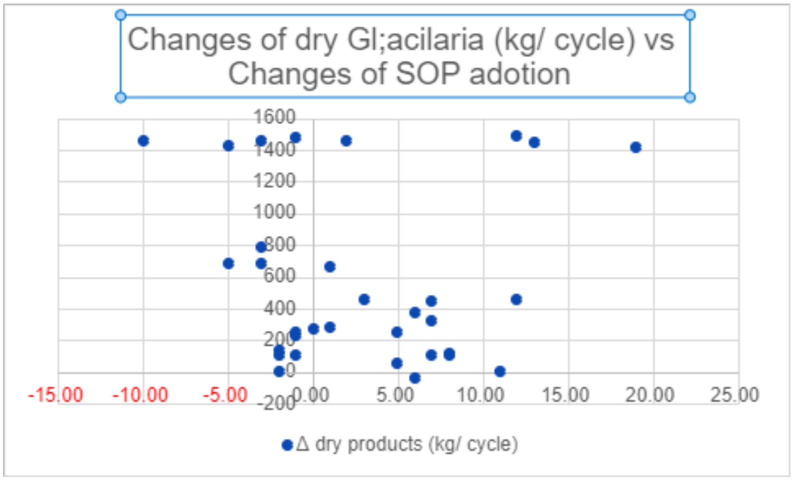

Figure 15. The changes of dry production and SOP adoption score in Glacilaria farming

The lack of a clear pattern between SOP adoption score and dry production in Glacilaria farming suggests that external factors, such as global market dynamics and environmental conditions, have a significant impact on production outcomes beyond the level of adoption.

Based on the data, it can be inferred that the increasing production of Glacilaria in 2023 was driven by the rising market price. Additionally, although SOP adoption score did not appear to have a direct impact on production, it is possible that the training and assistance provided to farmers played a role in encouraging them and instilling confidence to engage in more intensive Glacilaria cultivation.

To gain a broader perspective on glacilaria production, we also conducted an interview with a collector, Syamsir (26 years old). Syamsir has been involved in the glacilaria trading business since 2019, operating in Pangkep. With a daily trade volume of 2000 kg, he purchases glacilaria from farmers at a price of IDR 6,600 per kilogram (dry weight). However, if he determines that the seaweed is not adequately dried, he adjusts the price to IDR 6000 per kilogram. Collectors face the risk of rejection from buyers if the quality of the seaweed is compromised due to high humidity or exposure to rain. Syamsir sells the glacilaria to Sutrako, a warehouse in an industrial park in Maros, earning a margin of IDR 800 per kilogram. This provides insight into the collector's role within the glacilaria supply chain, highlighting the challenges they face in ensuring the quality of the product and securing a profitable trade.

The GQSP has addressed the challenges faced by collectors and farmers in ensuring product quality. The program's emphasis on proper drying techniques and adherence to specifications has helped collectors avoid rejection from buyers due to poor-quality seaweed. By implementing SOPs and adjusting pricing based on seaweed dryness, farmers and collectors have been able to maintain profitability and market demand for glacilaria

KEY FINDINGS, LESSONS LEARNED AND RECOMMENDATIONS

Based on the comprehensive analysis of the results, this report highlights several key findings, valuable lessons learned, and essential recommendations. These findings shed light on the effectiveness of the SMART Fish 2 Program in enhancing the competitiveness of aquaculture value chains in Indonesia, with notable improvements observed in the adoption of standard operating procedures (SOPs) among farmers.

Key Findings

1. The program intervention has been effective in increasing the adoption score of standard operating procedures (SOPs) among farmers in most sectors. The average adoption scores in most sectors improved after the program intervention, indicating a positive impact on farmers' management practices.
2. The shrimp sector showed the highest improvement, with over 90% of farmers enhancing their practices, while the catfish sector had the lowest improvement, with only 45% of assisted farmers improving their practices.
3. It is projected that during the program intervention, 1,265 out of 1,981 assisted farmers have already improved their management practices by increasing their adoption score.
4. The impacts survey results showed that the program supported farmers in dealing with 224 new suppliers and accessing 155 new market channels, resulting in an estimated total of 3,506 new business linkages created.
5. Five processing companies assisted by the program were able to increase their exports, accessing global markets or increasing export volume/value.
6. An increase in SOP adoption leads to revenue growth, especially in the pangasius, catfish, milkfish, and glacilaria sectors and serves as a crucial risk mitigation strategy to reduce revenue loss, particularly for the shrimp and cottonii. Improved practices have led to the following revenue increases:
   - Pangasius (Tulungagung): IDR 4,200 /m2
   - Pangasius (South Lampung): IDR 4,500 million/m2
   - Catfish (Kediri): IDR 152,600/m2
   - Shrimp (South Lampung): IDR 6000/m2
   - Milkfish (Tarakan): IDR 1,058,000/ha
   - Cottonii (Jeneponto): IDR 26,000/line
   - Cottonii (Pangkep): IDR 16,000/line
   - Glacilaria (Maros): IDR 80/m2
7. Our projections indicate that the implementation of improved practices across all sectors will result in a substantial increase in revenue, estimated at IDR 6.3 billion.
8. External factors such as climate, environmental conditions, and market dynamics play a significant role in influencing production outcomes, beyond the level of SOP adoption.
9. During the difficult circumstance and trend of production decline, 637 of 1981 assisted farmers are estimated still can keep and even gain better income.

Lessons Learned:

1. The program intervention can effectively enhance the adoption of SOPs among farmers, leading to improved management practices.
2. Different sectors may respond differently to program interventions, highlighting the need for tailored approaches and strategies for each sector.
3. Location-specific factors should be considered when implementing interventions and strategies to enhance value chains. Different regions may have varying suitability for specific crops or products.
4. The adoption of SOPs alone may not guarantee improvements in production. External factors and market dynamics need to be taken into account for a comprehensive understanding of production outcomes. Most sectors experienced declining production and sales due to lower demand, supply chain disruptions, diseases outbreaks, and climate-related challenges.
5. The program's theory of changes and macroeconomic assumptions were violated by these external factors, highlighting the need for flexibility and adaptability in program design and implementation.
6. Increasing adoption level is required to mitigate risks and improve farmers resilience in dealing with external shocks. Farmers who did practice as usual (no improvement in adoption score) are more likely to experience decline in production and revenue. A certain threshold in increasing the adoption score is needed for each sector to effectively maintain or improve production levels in dealing with climate risks, global market
7. disruption and remain effects of pandemics.
8. Training and assistance programs can play a crucial role in encouraging farmers and instilling confidence in adopting new practices and technologies.
9. The impact assessment study faced limitations in terms of time and allocated budget. The time constraints imposed limitations on the comprehensive coverage of the project areas. Sampling was conducted in selected areas with a relatively small number of samples in each location. This may have reduced the representativeness of the assessment, potentially missing out on capturing the overall characteristics of the project areas.

Recommendations

1. The program's success in increasing SOP adoption highlights the importance of
2. continued support and investment in promoting best practices and standardized procedures in aquaculture sectors. Continued support and investment in the development and implementation of SOPs in value chains can lead to improved production, productivity, and profitability.
3. Tailored interventions and strategies should be developed for each sector, taking into account their specific needs, challenges, region characteristics and potential for improvement.
4. Training and assistance programs should be expanded to provide farmers with the necessary knowledge and skills to adopt best practices and technologies. Project local assistants need to be empowered to support the implementation of SOPs in the fields.

4. Market access should be further facilitated by promoting certification programs that ensure sustainable and responsible farming practices. This will enhance the marketability of products and encourage farmers to adopt sustainable practices.
5. Efforts should be made to address external factors such as climate change and market dynamics through policies that promote resilience and adaptability in value chains.
6. Monitoring and evaluation should be an integral part of program interventions to track progress, identify areas for improvement, and ensure the effectiveness of interventions.
7. Collaboration between government, industry stakeholders, and research institutions is essential for the successful implementation and monitoring of value chain development programs.
8. Flexibility and adaptability should be incorporated into program design and implementation to mitigate the effects of external shocks.
9. Sufficient budget and time for the impact assessment process should be allocated. Committing to integrating monitoring and evaluation (M&E) budget and planning from the beginning of the project is crucial. This ensures that resources are allocated appropriately to conduct comprehensive and thorough impact assessments. Sufficient budgetary provisions enable the engagement of qualified professionals, the implementation of rigorous data collection methodologies, and the utilization of advanced analysis techniques.