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Enhancing Tilapia Fry Business Management Capacity through a Smart Production System-Based Business Information System at Aquafarm Patommo

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Abstract: The tilapia hatchery business managed by the Aquafarm Patommo group continues to face several challenges, including unstructured production and financial recordkeeping, limited operational control, and a lack of data-driven decision-making. This community service program aims to strengthen the group's business management capacity through the implementation of a Business Management Information System integrated with a Smart Production System. The program adopts a participatory approach involving business condition assessment, training, system implementation, ongoing assistance, and evaluation. The system integrates production data, feed consumption, operational costs, mortality rates, and sales records to generate key business performance indicators, including costs, revenue, profit, cost of goods produced (COGP), and the revenue-to-cost (R/C) ratio. Program outcomes are evaluated by comparing pretest and posttest scores across four indicators: understanding of business management, production planning, recording of operational and feed costs, and documentation of production and seed sales. The data are analyzed descriptively by calculating the percentage of correct responses and the differences between pretest and posttest results. The findings demonstrate improvements across all four indicators, with the average level of partner understanding increasing from 30% at baseline to 82.5% after program implementation, representing a gain of 52.5 percentage points. The implementation of the system also strengthens the consistency of business recordkeeping, production monitoring, performance evaluation, and data-driven decision-making in the management of the group's tilapia hatchery business.

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Introduction

Aquaculture is a strategic sector that contributes to food supplies, provides protein, creates jobs, and strengthens local economies. The State of World Fisheries and Aquaculture report notes that global fisheries and aquaculture production reached 223.2 million metric tons in 2022, with aquaculture production of aquatic animals surpassing capture fisheries for the first time (FAO, 2024). In Indonesia, aquaculture production reached 6.37 million tons in 2024, a 13.64% increase from the previous year. Nile tilapia (Oreochromis niloticus) is one of the sector's leading commodities, with production reaching approximately 1.38 million tons in 2024, up from 1.36 million tons the previous year (KKP WEB, 2024). Tilapia has significant economic potential because of its rapid growth, economic value, and broad market

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demand (Hutauruk et al., 2026). These developments show that hatchery operations play a strategic role in supporting the sustainability of tilapia farming, particularly by ensuring the availability of high-quality seed. Seed quality is an important factor in determining the success of fish rearing, growth, and farm productivity.

The problem becomes more complex when the production process still relies on personal experience and lacks structured, systematic record-keeping. Without documented production data, business actors will struggle to monitor changes in fish growth, feed usage, survival rates, and the relationship between inputs and outputs. In fact, indicators such as growth, feed conversion ratio (FCR), survival rate, water quality, and feed usage are key parameters for evaluating tilapia production performance (Khalil & Nasr-Allah, 2025). This can make evaluation and decision-making less effective. Specifically, this condition was found at Aquafarm Patommo, where the production system is still conventional, measurements are not systematic, decision-making remains data-minimal, and operational efficiency is not yet optimal.

Aquafarm Patommo is a community-based business group focused on breeding Nile tilapia (Oreochromis niloticus), located in Watang Pulu District, Sidenreng Rappang Regency, South Sulawesi. The group has 12 members and is classified as an economically productive community group. Aquafarm Patommo has strong potential for business development because of demand for Nile tilapia fingerlings from grow-out operations in Sidenreng Rappang Regency and surrounding areas. A reliable supply of high-quality fingerlings is essential to the sustainability of Nile tilapia grow-out operations, making hatcheries strategically important in supporting the continuity of aquaculture production (Zulendra & Sektiana, 2022). However, optimal production and business management systems have not yet fully supported this potential. Preliminary observations suggest production challenges include uneven seed growth, low survival rates, and suboptimal feed utilization. Growth, survival rates, and feed efficiency are important indicators for evaluating tilapia production performance (Musa et al., 2025). In addition, economic aspects of production, such as production costs, production volume, survival rate, and revenue, are important indicators of the feasibility and sustainability of the hatchery business (Ansyari et al., 2025).

Another issue was inadequate recording and management of production and financial data. Information on feeding, production costs, mortality rates, seed growth, production cycles, and sales revenue has not been systematically documented and therefore cannot be used effectively to support business decision-making. As a result, production processes cannot be consistently and measurably controlled, costs and revenue cannot be accurately calculated, and input efficiency cannot be properly evaluated. Yet systematic production and financial recordkeeping enables business operators to monitor production performance, assess input efficiency, and compare business results across periods to determine what improvements are needed (Belova & Badina, 2025). With technological advances, information systems and digital dashboards can also integrate production data and present it in an easier-to-understand format to support monitoring, evaluation, and managerial decision-making (Ihsan et al., 2024). Therefore, Aquafarm Patommo needs to strengthen its capacity to manage production and business operations by implementing systematic production and financial recordkeeping, controlling operating costs, and using data to support evaluation and decision-making. These efforts are expected to improve production efficiency, strengthen business management, and support the sustainability of its tilapia hatchery operations.

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Given these conditions, a system is needed that not only records production activities but also integrates production and financial data into managerial information. This integration becomes increasingly important because fisheries involve various interconnected data types, ranging from input usage and production processes to production results and financial transactions. Studies on Aquaculture 4.0 indicate that digital technology and data integration can improve data-driven decision-making at the fisheries business level, although implementation still faces challenges in data integration and use (Kruk et al., 2024).

The Smart Production System implemented at Aquafarm Patommo is a web-based platform with a digital dashboard that supports management of a tilapia hatchery business. The platform includes features for managing groups, production cycles, operating costs, feed use, mortality, sales, and business reports. Users manually enter production and financial data, which the system stores and then processes automatically to generate management information, including total production costs, total revenue, profit, the R/C ratio (revenue-to-cost ratio), production cost per fish, the number of fingerlings stocked, the number of fingerlings that died, and the number of ponds. The digital dashboard presents this information as performance indicators and visual comparisons of costs and revenue. The system therefore helps partners record, monitor, and evaluate their business more systematically and provides information to guide production planning for the next period.

The novelty of this activity lies in integrating tilapia hatchery management with the Smart Production System, making production and financial data the basis for monitoring, evaluation, and decision-making at the community business group level. Unlike conventional record-keeping that serves only as documentation, the system implemented in this activity links production data with the business's economic indicators, giving partners a more structured overview of costs, revenues, profits, HPP (unit cost of production), and R/C Ratio. This integrative approach aligns with digitalization in the fisheries sector, which positions data and digital technology as tools to improve efficiency and support business decision-making (Kruk et al., 2024). Thus, implementing the Smart Production System is expected to improve the measurability of the production process, resource efficiency, business control quality, and professionalism in business management. Based on these issues, this activity aims to strengthen data-based tilapia hatchery management through the Smart Production System at Aquafarm Patommo.

Method

This community service program used a mentoring approach and technology implementation to strengthen the business management capacity of the Aquafarm Patommo group’s tilapia hatchery. The program’s success was evaluated using four indicators: understanding of business management, production planning, recordkeeping for operating costs and feed use, and recordkeeping for production output and fingerling sales. Data were collected using pre- and post-test questionnaires with true-or-false answer choices (1 point for a correct answer and 0 points for an incorrect answer), observation forms, reviews of business records, and activity documentation. The Smart Production System was implemented through a web-based platform featuring a digital dashboard and tools for recording group information, production cycles, operating costs, feed use, mortality, sales, and business reports. Users entered data manually, and the system processed it to generate information on total production costs, revenue, profit, the R/C ratio (revenue-to-cost ratio), production cost per fish, the number of fingerlings stocked, the number of fingerlings that died, and the number of ponds, providing a basis for business monitoring and evaluation.

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The pretest and posttest data were analyzed using a quantitative descriptive approach. Responses were scored by assigning 1 point for each correct answer and 0 points for each incorrect answer. The percentage of understanding was calculated by dividing the number of correct answers by the total number of questions and multiplying the result by 100%. The percentage was calculated using the descriptive percentage analysis formula (Sudijono, 2012), as follows:

$$\mathbf{P = (f / N) \times 100\%}$$

Notes:
– P = percentage of correct answers;
– f = frequency or number of correct answers;
– N = total number of questions; and
– 100% = fixed multiplier.

Calculate the increase in partners' understanding by finding the difference between the post-test and pre-test percentages. The increase is expressed in percentage points using the following formula:

$$\mathbf{\Delta P = Ppost - Ppre}$$

Notes:
– ΔP = increase in understanding percentage (percentage points);
– Ppost = percentage of correct answers on the post-test; and
– Ppre = percentage of correct answers on the pre-test.

The results of observations and reviews of business records were analyzed descriptively to describe partner involvement, the implementation of production and financial recordkeeping, and the use of system-generated information to support business management. The pretest and posttest results are presented as percentages and comparisons of conditions before and after the activities.

Result and Discussion

The community service program at Aquafarm Patommo used a participatory approach and hands-on support, actively involving the partner in identifying problems, planning, implementing technology, and evaluating business management. This approach was chosen because the partner's challenges involved not only technical aspects of fish hatchery operations but also production and financial recordkeeping, cost control, performance monitoring, and data-driven decision-making. Through a participatory approach and action learning, the empowerment process was conducted collaboratively so that the partner could take a direct role in solving problems and improving business management (Christanti et al., 2023). The activity began with an assessment of the business's current conditions through observation, interviews, discussions, and a review of production and financial records to identify the partner's priority needs (Alfalisyado, 2023). Next, capacity was strengthened through training and hands-on practice in business management, production and financial recordkeeping, petty cash management, cost control, profit calculations, and SOP development. The training, combined with ongoing support, is expected to improve partners' skills in managing business finances more systematically (Mariyah & Rerung, 2023).

The initiative's main outcome was implementing a Smart Production System that integrates records of production, feed use, operating costs, growth, mortality, and sales to monitor performance and support data-driven decision-making (Chatziantoniou et al., 2023). The system's implementation is reinforced through regular guidance and monitoring, particularly in recording transactions, managing petty cash, tracking production, calculating

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costs, and preparing reports to ensure consistent use (Jati et al., 2024). To support the program's sustainability, partners received recordkeeping templates and standard operating procedures (SOPs) they can use independently to evaluate production, control costs, and plan the next breeding cycle. This effort aligns with community service initiatives in the fisheries sector that combine training with ongoing support to help partners apply their knowledge and skills effectively (Patang, 2023; Junda et al., 2023). Accordingly, this initiative aims to establish more structured, well-documented, and data-driven management practices for fish hatchery businesses.

Stage 1. Identification and Mapping of Partner Business Conditions

The team assessed conditions at Aquafarm Patommo through field observations, interviews, and discussions with the partner. The assessment aimed to provide an overview of the tilapia hatchery's current management and identify the partner's needs for developing a business management system. Based on this process, the data needs identified included production cycles, feed use, operating costs, mortality, production output, and sales. This preliminary information served as the basis for designing system features, developing training materials, and establishing indicators to evaluate the partner's empowerment.



Figure 1. Field observation, interviews, and discussions with partners

At this stage, the team also identified the data needed to support decision-making, including production cycle data, feed usage, operating costs, mortality, sales, and production output. These findings established the initial baseline and provided a basis for determining system requirements, training materials, and program success indicators. Based on these findings, the Smart Production System was implemented by integrating manual financial recordkeeping into a digital system. Income and expense data were then processed into financial summaries and business reports, making it easier for partners to monitor costs, revenue, and profit. A comparison of manual recordkeeping and information presented through the digital dashboard is shown in Figure 2.

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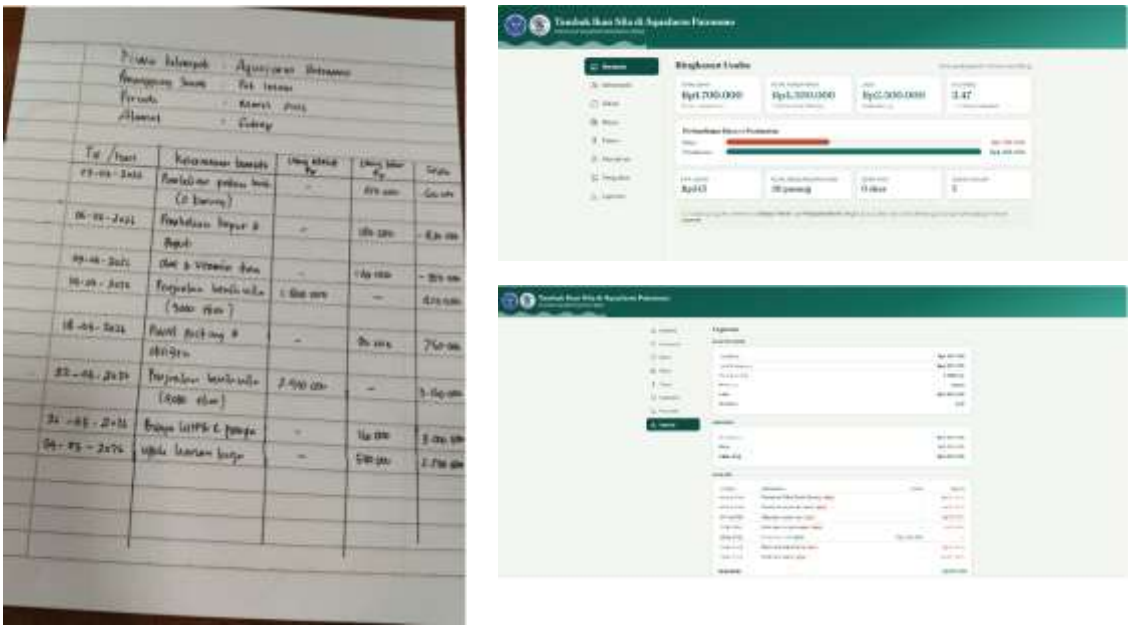


Figure 2. Comparison of Manual and Digital Financial Recordkeeping

The initial assessment showed that the partner business still kept records manually, so production and financial information was not presented in an integrated format. With the implementation of the Smart Production System, these records were developed into a web-based system that presents business information through a digital dashboard. This change is expected to help the partner monitor production, control costs, and evaluate business performance.

Stage 2. Strengthening the Partner Group's Business Management Capacity

The community service activities improved the Aquafarm Patommo group's capacity to manage its tilapia hatchery business through orientation, business management training, implementation of a Smart Production System–based Management Information System, and ongoing support. Before the activities, the business was managed informally, without structured production or financial records. The business did not systematically document information on feed use, operating costs, mortality, production output, and sales, limiting its use as a basis for business evaluation and planning.



Figure 3. Outreach and capacity building in business management for Aquafarm Patommo partners

The evaluation results before and after the activities showed improvements across all indicators of the partners' capacity. Understanding of tilapia hatchery business management increased from 35% to 85%. The ability to plan production based on business targets rose from 30% to 80%. In addition, the ability to record operating costs and feed use increased

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from 25% to 80%, while the ability to record production output and market fingerlings rose from 30% to 85%. Overall, the partners' average capacity level increased from 30% on the pretest to 82.5% on the posttest, a gain of 52.5 percentage points.

These improvements indicate a change in the partners' capabilities, particularly in planning, recordkeeping, and business information management. The largest absolute increase was in the indicator for recording operating costs and feed use, which rose by 55 percentage points. Keeping records of costs and feed use is important because this information can be used to track resource use and evaluate the efficiency of production activities. These results are consistent with the development of the Aquaculture 4.0 concept, which promotes the use of digital technology and production data to support decision-making and improve the efficiency of fisheries business management (Kruk et al., 2024).

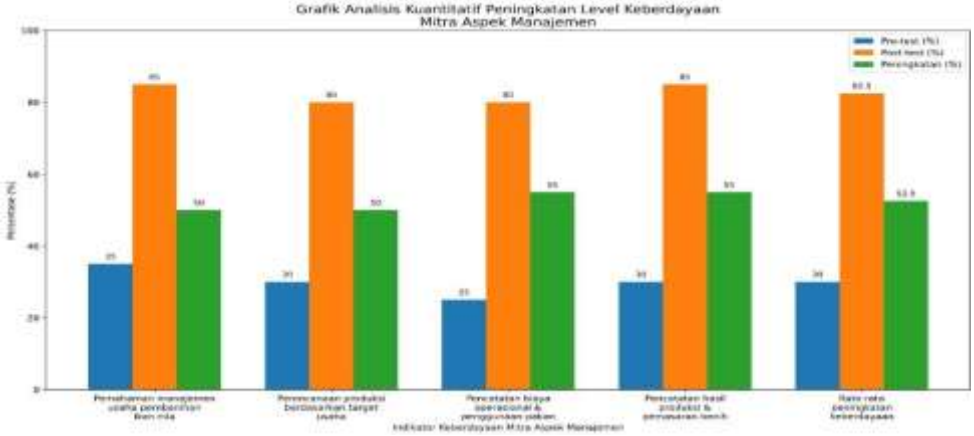


Figure 4. Comparison of partners' empowerment levels before and after the activities based on four indicators.

Stage 3. Smart Production System for Production and Financial Data Integration

One of the main outcomes of the community service program was implementing a Smart Production System–based Business Management Information System as a web-based platform with a digital dashboard. The system was designed to help the partner manage production and financial records for tilapia hatchery operations on a single platform. Its features include menus for groups, production cycles, costs, feed, mortality, sales, and reports. Using these features, the partner can regularly enter and update business data, documenting production and financial information more systematically. Users enter data manually, and the system stores it on the device being used; the system does not yet support data synchronization across devices.



Figure 5. Implementation of Business Management Information System based on Smart Production System

The data entered into the system is then processed to generate management information, including total production costs, total revenue, profit, the Revenue-Cost Ratio

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(R/C Ratio), and the cost of goods produced (HPP) per fish. The dashboard also displays the number of fish stocked, the number of fish that died, and the number of ponds. This information helps partners understand the condition of their business from both operational and financial perspectives. Thus, recordkeeping is no longer limited to documenting transactions; it also serves as a tool for evaluating input use, production output, and the business's economic performance.

Stage 4. Digital Dashboard for Business Monitoring and Evaluation

Implementing the Smart Production System helps partners understand their business conditions through a digital dashboard that displays information on costs, revenue, profit, the R/C ratio, cost of goods sold per fish, the number of fingerlings stocked, mortality, the number of ponds, and a comparison of costs and revenue. This information helps partners evaluate feed use, mortality rates, and financial performance during each production cycle. The dashboard therefore serves as a monitoring and evaluation tool that integrates production activities with the business's financial condition.



Figure 6. Smart Production System dashboard display at Aquafarm Patommo

In addition to the business summary page, the platform also provides interfaces for managing various record-keeping activities. The system interface documentation shows pages for managing groups, production cycles, costs, feed, mortality, sales, and reports. These interfaces demonstrate how the web platform supports record-keeping and information management for the Aquafarm Patommo business. Users enter data through the available features, and the system processes it into information used to evaluate the business.

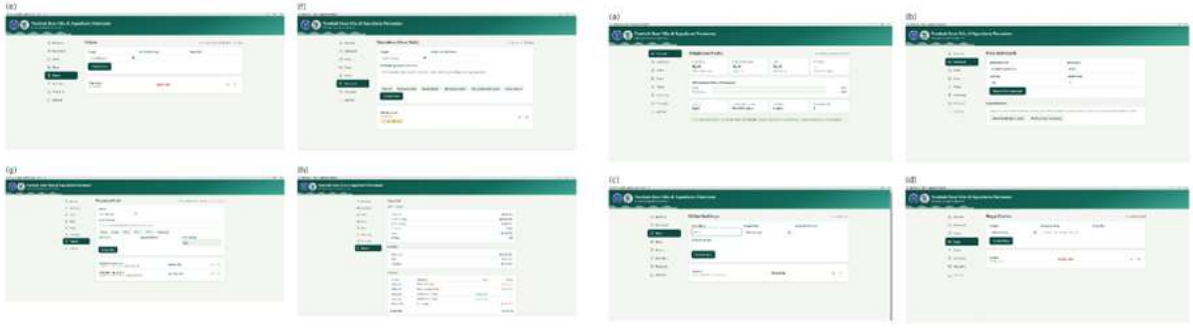


Figure 7. Documentation of the Smart Production System interface at Aquafarm Patommo

Stage 5. The Role of Mentoring in Technology Adoption

The successful implementation of the Smart Production System depends not only on the availability of a digital platform but also on partners' ability to operate and use it effectively. Therefore, the community outreach program included hands-on support for members of the Aquafarm Patommo group. The support covered an introduction to the

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system's features; practice entering production and transaction data; recording feed use; managing costs; tracking mortality; and using business reports.



Figure 8. Assisting partners with technology use and business activity recordkeeping

Through these activities, partners gained hands-on experience using technology to support business management. The assistance also aimed to build an understanding that routine data recording is an important part of business management. The system-generated information can be used to track production progress, identify operational issues, and assess the business's financial condition. Partners' improved ability to record expenses, feed use, production output, and seed marketing demonstrates that training and assistance are important parts of the system implementation process.

Stage 5. The Role of Smart Production System in Strengthening Business Management

Overall, the community engagement activities changed how the tilapia hatchery business at Aquafarm Patommo is managed, moving toward more structured recordkeeping. This is reflected in the increase in the partners' average empowerment level from 30% to 82.5%, covering their understanding of business management, production planning, records of operating costs and feed use, and records of seed production and sales.

The main contribution of these activities was implementing a Smart Production System–based Business Management Information System that integrates production and financial data through a web-based platform. The system helps the partners monitor input use, production, mortality, and sales, and access information on costs, revenue, profit, cost of goods sold (COGS), and the R/C ratio. The phased implementation of the system is an initial step toward building data-driven business management to support evaluation, production planning, group capacity building, and the sustainability of the tilapia hatchery business.

Conclusion

Implementing a Management Information System based on the Smart Production System at Aquafarm Patommo successfully improved the tilapia hatchery business's management capacity from a conventional pattern to more structured, data-driven management. Integrating data on costs, feed, production cycles, mortality, output, and sales produced managerial information for monitoring, evaluation, and decision-making in the business. Evaluation results showed increases across all indicators of management empowerment, with an average rise from 30% to 82.5% (52.5 percentage points). This improvement indicates that digital record-keeping, accompanied by training and mentoring, not only enhances skills in using the system but also strengthens partners' ability to plan, record, control, and evaluate their business. The main contribution of this activity is integrating business management functions with the Smart Production System, enabling operational data to be converted into economic and production information to support decision-making. This approach could serve as a model for strengthening data-based fish

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hatchery management and can be replicated across similar business groups with adjustments to production characteristics and partner needs.

Recommendation

To support the continued use of the Smart Production System, Aquafarm Patommo is encouraged to consistently record production and financial data, follow standard operating procedures (SOPs), and use the dashboard to evaluate costs and profits and plan the next production cycle. The community service team is expected to provide ongoing guidance and periodic evaluations to strengthen the partner's ability to operate the system independently and use data to make decisions. Meanwhile, technology developers and relevant government agencies are expected to improve the system by developing user-friendly, secure features and facilitating training, guidance, and access to technology so other fisheries businesses can adopt the digital system.

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