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Factor Affecting Catfish Production in Pasir Puteh, Kelantan

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Abstract
Catfish is one of the major fresh aquaculture species. Kelantan is one of the top producers of catfish in Malaysia, as stated by the Ministry of Agriculture and Food Security (MAFS). This can partly be attributed to the demand for the species. Nevertheless, its supply has also shown reduction, leading to a production deficit. Pasir Puteh is one of the main farming areas for catfish in the state of Kelantan, but research on its actual socioeconomic factors has not been well-explored. This research intends to analyze main factors that influence the production of catfish in Pasir Puteh. Close-ended questionnaires were administered to catfish producers through both face-to-face and online methods, yielding a total of 54 valid responses. Descriptive statistical analysis was employed to describe important socioeconomic variables including age, educational level, experience, size of pond, and scale of production. Pearson correlation analysis was employed to explore interconnections between variables relating to production and output levels for catfish. Multiple Regression Analysis was used to determine variables that are most influential in shaping production output. The result for MRA analysis indicated that marketing had a significant negative effect, whereas profit, price, cost, and incentives had significant positive effects on catfish production. The data shows that economic factors and investments are very influential in catfish production in Pasir Puteh. Further analysis is recommended to include larger sample sizes, additional production variables, and cross-sectional analyses between other districts in the state of Kelantan or other Malaysian states. It is also suggested that relevant authorities improve market access, price stability factors, and financial assistance to further enhance efficiency in small-scale catfish production.

Keywords: Catfish production, Aquaculture, Catfish production, Economic factors

1. Introduction

Catfish, particularly Clarias gariepinus (African catfish), represent a significant segment of Malaysia's freshwater aquaculture. Historically, Clarias species have been widely cultured due to their hardiness, rapid growth, and consumer acceptance (Khatib & Jais, 2021). Malaysians consume an average of 46.6 kg of fish per capita per year, indicating a strong preference for freshwater species including catfish, as a key protein source (Goh et al, 2023). The production of catfish in Malaysia has grown steadily over the past decade, contributing substantially to national aquaculture output. In 2023, the freshwater aquaculture sector produced approximately 39,815 metric tonnes of catfish, generating an estimated RM 3.9 billion in economic value (AGRIMAG, 2025). Even with the increased development of catfish aquaculture, there have been challenges associated with sustainable development. The nutritional requirements must be given keen attention to ensure such fish depend heavily on protein sources. Recent studies advocate the partial replacement of fish meal with plant-based protein to reduce production costs and improve environmental sustainability (Kari et al., 2023). Diseases such as Aeromonas and Edwardsiella have had adverse effects in catfish aquaculture. The development of diseases poses particular risks to intensive catfish farms where changes in water quality have increased risks of disease development. Variability in prices, feed sources, and wages may affect profitability. However high domestic demand and export market opportunities make it attractive to expand crops.

Catfish production employs diverse systems such as pond systems, cage culture systems, and small-scale canvas fish rearing systems which cater to local demands and limited inter-state trade (Dauda, 2017). This growth aligns with increasing consumer demand. Focusing on Kelantan, small-scale catfish farming is emerging as a promising rural livelihood. Entrepreneurs in these areas have started to cultivate the species Clarias gariepinus to meet both local market demand and broader consumption trends. The strategic positioning of farms with access to juvenile stock, and proximity to consumer markets give Kelantan-based producers a competitive advantage. Nevertheless, to scale up sustainably, farms in the state will likely need stronger support for feed innovation, biosecurity, and access to quality fingerlings. Previous research has focused largely on production techniques, growth performance, feed optimization, or induced breeding (Kari et al, 2020; Siti Nur Najwa & Othman, 2022), leaving gaps in understanding how production capacity aligns with local market demand. Additionally, although feed costs and fingerling availability are known to be major production constraints (Hasniyati et al., 2013), very few studies have explored how these issues affect farmers' ability to meet consumer demand in specific regions. Addressing these gaps, this study provides empirical evidence on the supply of catfish in Kelantan, integrating production constraints to offer actionable insights for farmers and policy makers. The objectives of this study are to observe the demographic of catfish producers in Pasir Puteh, Kelantan, and to identify the relationship and the most significant factors affecting catfish production. Such research can provide actionable insights to optimize production to enhance food security, supporting a sustainable and resilient catfish industry in Malaysia. Future studies should focus on optimizing production systems, enhancing feed efficiency, monitoring genetic and environmental impacts, and developing biosecurity measures to ensure that catfish aquaculture remains both profitable and environmentally responsible.

2.0 Literature Review

In Malaysia, the aquaculture sector's growing interest in Clarias gariepinus reflects both strong domestic demand and expanding production capacity. On the production side, despite being non-native, C. gariepinus now contributes significantly to Malaysian freshwater aquaculture, owing to its favorable production characteristics (Dauda, 2017). However, cost structure remains a challenge principally because feed constitutes a large share of production costs usually more than 50%, according to empirical studies (Kari et al, 2020). Rachmawati (2022) discovered that cost per unit gain is much reduced when feed efficiency is increased through nutritional modification. In a similar vein, Mundida et al. (2023) found that using black soldier fly larvae meal instead of fishmeal decreased feed costs and increased economic returns in catfish production. Farahiyah (2016) discovered that the application of locally prepared diets instead of commercial feeds can lower feed costs in Malaysia, Together, these studies demonstrate that the main factor influencing catfish farm profitability is production cost, especially feed price and efficiency which also directly affects farmers' capacity to satisfy growing market demand.

Proper farm maintenance is crucial In order to lower the possibility of disease in catfish aquaculture. Research continuously demonstrates that basic biosecurity procedures, vaccination, and effective water quality management greatly enhance survival and health. Agusta at al. (2022) discovered that adding carbon and probiotics to culture systems promoted growth, decreased physiological stress in catfish, and improved water quality. Vaccination against Aeromonas hydrophila has also been successful in reducing mortality rates and increasing relative percent survival after bacterial challenge (Mulia et al., 2022). Additionally, a recent biosecurity study by Khor (2024) showed that farms with improved husbandry practices such as routine pond cleaning, regulated stocking, and quarantine of young fingerlings will experience fewer disease outbreaks. In general, empirical evidence shows that consistent maintenance practices are a practical and cost-effective strategy for preventing disease and sustaining catfish production.

Price, profit, and marketing remain central economic dimensions shaping the viability of catfish aquaculture across developing regions, including Malaysia. Price plays a crucial role as one of the factors determining the profitability of the farm. Bovenkamp et al. (2021) showed that the economic returns of the producers can be greatly improved when the price of catfish increases slightly. Similarly, Sulem Yong et al. (2025) found that price competitiveness is strongly linked to production cost structures, where lower feed costs reduce the break-even price and improve farmers' ability to compete in domestic markets. This trend is also reflected in the results of the study by Sulem Yong et al. (2025) that showed both imported extruded feed and well-formulated local diets generate positive profitability though feed efficiency plays a decisive role in maximizing returns.

From a marketing perspective, effective distribution channels also determine the extent to which catfish producers capture value within the supply chain. Santosa et al. (2023) found that fewer middlemen increase producer revenue because simpler marketing channels result in a larger farmers' share of the final price. Demand-oriented market positioning is necessary since consumer preference studies demonstrate that marketing techniques that emphasize flavor, product quality, and availability have a substantial impact on purchase decisions (Obiero et al., 2014). Furthermore, value-chain analyses show that marketing performance is still hampered by inefficiencies like transportation and input prices, highlighting the need for more coordinated and economical market systems. The role of the government in enabling the culture of catfish in Malaysia through financial and technological support cannot be underestimated. Projects such as the development of the Integrated Cage System and smart aquaculture provide opportunities in the form of grants and advice to optimize production efficiency and minimize risks of investment (DOF, 2024; Haimid & Dardak, 2024). Historically, the provision of brood stocks and fingerlings through government initiatives has also served to ensure the sustainability of catfish production (FAO, 1993).

Collectively, key drivers that determine catfish production include input costs, market price, marketing channels, maintenance and maintenance practices, profitability, and government intervention. The conceptual framework positions these six variables as the principal determinants of catfish production, providing a structured approach to analyze how economic incentives, operational constraints, and institutional support collectively shape production outcomes. This framework underpins the study's investigation into the critical factors affecting catfish production and offers guidance for policy and management strategies in regions such as Kelantan, Malaysia.

3. Methodology

3.1 Area of Study

This study was undertaken in Kelantan, with Pasir Puteh identified as the principal research site due to its high concentration of catfish breeders. Field assessments indicated that Pasir Puteh exhibits highly favorable characteristics for catfish aquaculture supported by robust localized demand and its separation from major urban zones in Kelantan. Moreover, the district benefits from a reliable and sufficient water supply which constitutes a critical determinant of growth and production outcomes in catfish farming.

3.2 Sampling

Basic random sampling was employed to obtain the study sample, as this method ensures that every member of the population has an equal probability of selection (Lauren, 2020). The required sample size was calculated using the guideline proposed by Daniel (1999), which states that for a known population, the minimum sample size can be estimated using the formula $n = N / (1 + N(e^2))$, where N represents the population size and e the acceptable margin of error. A minimum sample size of 54 responders was obtained by applying this calculation with a 5% margin of error to the population of 62 catfish producers in Pasir Puteh, Kelantan.

3.3 Questionnaires

The questionnaire comprised a combination of multiple-choice items, closed-ended questions, and Likert-scale statements were designed to capture both factual and perceptual data from respondents in a structured manner. The instrument was organized into two main sections. Section A collected demographic characteristics of catfish producers, while section B focused on the key determinants contributing to catfish production such as maintenance, marketing, profit, price, cost and government incentives.

3.4 Data Analysis

This study adopted a quantitative research design because it allowed numerical measurement of production-related factors, facilitated objective comparisons, and enabled statistical testing of relationships between variables. The basic respondents' demographic characteristics were summarized using descriptive statistics. The initial linear associations between the independent variables and catfish production were examined using Pearson's correlation analysis. This step helped to determine the strength and direction of associations, ensuring that variables were suitable for inclusion in regression modelling. Multiple Regression Analysis was conducted to identify the factors that significantly influenced catfish production while controlling for other variables in the model. MRA enabled the estimation of each variable's independent contribution to production outcomes to provide robust evidence on which factors positively or negatively affected small-scale catfish production. The multiple regression equation for this study was expressed as follows:

$$Y = \alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + \varepsilon i \qquad (1)$$

Where: Y = Catfish production, X1 = Cost, X2 = Maintenance, X3 = Price, X4 = Profit, X5 = Marketing, and X6 = Incentives.

3.5 Pilot Test

The questionnaire was pre-tested with a small sample of target population to confirm content validity and improve item clarity and relevance. Cronbach's alpha was used to measure internal consistency; $\alpha \geq 0.70$ was considered acceptable. A pilot test (n = 20) was performed to verify the questionnaire's robustness and reliability. All constructs had a Cronbach's Alpha of 0.897, which above the 0.70 criterion suggested by Nunnally & Bernstein (1994) and indicates strong internal consistency and measurement stability. Consequently, the instrument was considered reliable and appropriate for use in the main study (n = 62).

4.0 Result and Discussion

This section presents the key findings from the survey of catfish producers involved in catfish farming in Pasir Puteh, Kelantan.

4.1 Demographic Profile of Respondents

Six items related to the characteristics of catfish producers were included in the questionnaire's demographic section. According to Table 1, 88.7% of respondents who involved in catfish farming were men, and only 11.3% were women. In terms of age, a greater percentage belonged to the age category of 31-40 years (40.7%), closely followed by the age category of 21-30 years (38.9%). Most of the respondents were married (75.9%). With regard to education, the majority of the respondents were Diploma qualified, which was 48.1%, followed by 46.3% who had completed secondary school, while only 5.6% were qualified with a degree. In terms of experience, more than half had less than 2 years of working experience (51.9%), followed by 35.1% with 2 to 4 years of experience. Lastly, most respondents had ponds smaller than 14.4 m² (62.0%), while only a small portion of the respondents managed ponds larger than 28.8 m² (7.4%).

Table 1: Respondent's Demographic Profiles

Item		**Frequency**	**Percent**
Gender	Male	48	88.7
	Female	6	11.3
Age	21-30 years	21	38.9
	31-40 years	22	40.7
	41-50 years	11	20.4
Marital	Single	13	24.1
	Married	41	75.9
Education Level	Secondary school	25	46.3
	Diploma	26	48.1
	Degree	3	5.6
Year of experience	<2 years	28	51.9
	2-4 years	19	35.1
	>4 years	7	13.0
Size of Pond	< 14.4 M²	34	62.0
	14.4 – 28.8 M²	16	39.6
	>28.8 M²	4	7.4

4.2 Correlation Coefficient Result

As shown in Table 2, the Pearson correlation analysis revealed several significant relationships related to catfish production. Cost (r=0.360, p=0.008), price (r=0.347, p=0.010), profitability (r=0.391, p=0.003), and incentives (r=0.395, p=0.003) were found to be moderated positively and significantly correlated with increased levels of these factors being related to increased levels of catfish production. The effect of maintenance on catfish production showed a weak, non-significant correlation with catfish production (r=0.163, p=0.239). However, marketing showed a non-significant negative correlation with catfish production, although other sectors related to marketing were indirectly related in the study. Overall, these observations manifest that economic factor influences catfish production significantly.

Table 2: Pearson Correlation Matrix

		Production	Cost	Mainte-nance	Price	Profit	Market-ing	Incen-tives
Produc-tion	Pearson Corr. Sig. (2-tailed)	1 -	0.360** 0.008	0.163 0.239	0.347** 0.010	0.391** 0.003	-0.609 0.618	0.395** 0.003

** Correlation is significant at the 0.01 level (2-tailed)

4.3 Multiple Regression Results

Multiple regression analysis is a statistical tool used for analyzing the link among numerous independent variables and a single dependent variable. The ANOVA result as shown in Table 3 demonstrates a significant value of p (< 0.05) with an F value of 6.58, indicating a statistically significant relationship between the independent variables and the dependent variable. It can be concluded from the results (Table 4) that the correlation is moderately strong with an R value of 0.676 because the model explained 45.7% of the variation in catfish production with an R-square value of 0.457 and an adjustment of 0.387. The value of standard error of the estimate showed that the regression model demonstrated moderate and acceptable in terms of accuracy.

The coefficient value of 0.325 for cost indicated that increased spending on critical inputs in fish production, such as feed, fingerlings, pond development, and water management quality had led to an increase in catfish output by 0.325 units as shown in Table 5. This result suggested that farms which allocated more financial resources to high-quality inputs tended to achieve higher yields due to improved feed conversion, better pond infrastructure, and more efficient farming practices. These findings were consistent with Adewumi and Adebayo (2020), who reported that feed investment was the strongest determinant of productivity among catfish farmers. Additionally, Asche et al. (2018) demonstrated that aquafarming facilities or enterprises that incurred greater expenditures in terms of cost performed much better than under-investing enterprises because cost-related investments played the role of drivers rather than expenses in terms of facilitating enterprises' or any organization's performance.

Table 3: ANOVA Result

Model	Sum of squares	Df	Mean Square	F test	Sig.
Regression	10.720	6	1.1787	6.58	.000
Residual	12.76	47	0.272		
Total	23.481	53			

Table 4: Coefficient of Determination Result

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.676	0.457	0.387	0.521

Table 5: Result of Regression Coefficient

Variable	Coefficient	t-stat	Sig.
Constant	-1.356	-1.338	0.187
Cost	0.325**	2.756	0.008
Maintenance	-0.124	-0.853	0.398
Price	0.320 *	2.660	0.011
Profit	0.349 *	2.520	0.015
Marketing	-0.292 *	-2.312	0.025

** Correlation is significant at the 0.01 level (2-tailed),
* Correlation is significant at the 0.05 level (2-tailed)

The positive coefficient of 0.320 with respect to price implied that when the market prices rose, there was an increase in the output of catfish by 0.320 units. It was apparent that when the market was favorable, farmers took positive actions to increase the output level through stocking and proper feeding programs. The observation was in line with other studies by Tveteras & Tveteras (2004), who found that aquaculture farmers increase output when prices are high due to positive expectations related to prices. Similar evidence was documented by Dey et al. (2010) and Kumar et al. (2018), who found that aquaculture fish price influences fish output significantly.

The coefficient value of 0.349 for profit showed that an increase in profit margins had raised catfish production by 0.349 units. This suggested that more profitable farms had reinvested additional earnings into technologies such as aeration systems, better feed, disease control measures, and water-quality monitoring tools, which collectively enhanced production efficiency. The finding resonates with the work by Asche & Roll (2013) who found that profitability was the most influential factor in reinvestment. Similar findings emerged in the works of Lem et al. (2014) and Pomeroy et al. (2006) who found that financially stable enterprises always invest in increased output performance. The marketing coefficient of -0.292 means that when there is an increase in marketing expenses, there would be a corresponding decline in catfish production of 0.292 units. In other words, an impractical allocation of marketing expenses or ineffective marketing activities leads to the diversion of critical funds away from where they are most needed. Indeed, the result obtained above confirms the observation by Tuu et al. (2010) that any impractical allocation of marketing expenses affects the profitability of farms negatively. In fact, both studies conducted by Shaikh et al. (2017) and Kumar & Quaddus (2011) suggested that imperfections in aqua marketing value chains have impacted negatively upon aqua performance in many developing nations.

The coefficient of 0.233 from the variable incentive shows that financial incentive support or technical aid increased catfish output by 0.233. It can be derived from this result that when farmers in the sample external support experienced lower cost burdens, thus enabling them to upgrade farm technology, purchase better feed, or improve management practices. The same result was discovered by Yahaya et al. (2022) who found that incentive mechanisms significantly improved aquaculture productivity in developing economies. Chen et al. (2021) and Tran et al. (2019) concluded that incentive-driven interventions enhanced technology adoption and strengthened production resilience among small to medium-scale farmers. Although the coefficient for maintenance was negative and statistically non-significant, it indicated that increases in routine maintenance activities had not contributed meaningfully to catfish production. This interpretation was broadly aligned with Huchette and Beveridge (2003), who reported that maintenance alone did not significantly enhance aquaculture performance. In addition, the role played by routine maintenance in productivity was considered less important than other factors, according to the research undertaken by Liti et al. in 2005.

5.0 Conclusion

Catfish production in Pasir Puteh, Kelantan was mainly driven by economic factors, with cost, price, profit, and incentives showing significant positive effects, highlighting the importance of investment, favorable market conditions, and external support. Meanwhile, maintenance had insignificant positive impacts and marketing had significant negative impacts, thereby suggesting inefficiencies in the allocation of resources and the absence of maintenance support without further enhancements in terms of technology or management. Data analysis using multiple regressions generally confirms the dominance of economic factors. In order to improve productivity, strategies should emphasize in feed efficiency through alternative protein sources and cooperative purchasing, stabilizing farm-gate prices via contract farming and transparent pricing, and expanding financial and technical support, including grants, subsidized inputs, and digital aquaculture technologies. High-quality fingerlings, improved biosecurity, and strengthened institutional support through public–private partnerships are essential to boost productivity, profitability, and sustainability of the catfish sector in Kelantan. This study guides the catfish industry by identifying key economic drivers, addressing marketing and maintenance inefficiencies, and providing recommendations on feed, fingerlings, biosecurity, and institutional support to improve productivity and sustainability.

Conflict of Interest:

The authors have no conflicts of interest regarding this investigation.

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