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MODEL OF PRODUCTION FUNCTION AND PRODUCTION RISK OF CATFISH (*Clarias* sp) FARMING IN KEDIRI DISTRICT

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ABSTRACT

One of the risks which is faced by catfish farmers frequently is production risk. The existence of production risk encourages farmers to make decisions to allocate production inputs. The behavior of farmers in facing production risk will be the basis for making decisions related allocation of production inputs to be used in catfish farming. This study aimed to analyze the effect of the use of production factors on production and production risk of catfish farming in Kediri District. Data in this study used primary data which is obtained from observations and structured interviews. The type of cross section data is gained from 40 catfish farmers. Descriptive and inferential statistical analysis method is used to analyse the data in this study. Analysis of production function data and production risk with the Just and Pope model approach. This study depicts that feed use and years of farming experience have a significant influence on catfish farming production. Increasing farming experience has a significant effect in terms of reducing production risk of catfish farming. Catfish farmers should use good quality of catfish seeds, improve their skills in cultivation techniques continuously, and communicate horizontally with fellow catfish farmers in order to be perceptive in exchanging experiences. Farmers must increase their experience to mitigate production risks.

Keywords: *catfish farming, just and pope, production factors, production inputs, production risk*

BACKGROUND

Agriculture, forestry and fisheries sector in 2021 provided the largest contributor to the calculation of the Gross Regional Domestic Product (GRDP) of Kediri District, which amounted to 23.33% (BPS Kabupaten Kediri, 2022). One of the freshwater aquaculture sectors in Kediri District is catfish. Catfish is one of freshwater fish that has been commercially cultivated by the society. Catfish has good prospects and is growing very rapidly, due to its cultivation that can be done on limited land and water sources with high stocking density, cultivation technology that is relatively easy to accomplish by the community, and the capital required is relatively affordable (Sunarma, 2004).

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Catfish farming is a growing business in the freshwater fisheries sector in Kediri District. In 2021, the number of catfish farming households in Kediri District reached 1,149 people or 47.88% of the total freshwater fish farming households (BPS Kabupaten Kediri, 2022). Catfish is the highest production of fish commodity in Kediri District compared to the production of other types of fish, which the number of productions in 2021 reached 16,279.88 tons and catfish production in Kediri District tends to grow, which can be seen in Table 1.

Table 1. The Development of Fish Consumption Production in Kediri District (2017-2021)

No.	Freshwater Fish	Production (ton)				
		2017	2018	2019	2020	2021
1	Tombro/Goldfish	288.12	108.12	65.50	11.41	11.80
2	Silver Barb	113.14	60.58	25.20	9.20	4.18
3	Parrot	1,451.53	642.76	668.25	790.70	798
4	Carp	1,464.09	1,518.10	1,683.70	1,715.80	1,893.28
5	Catfish	11,825.31	14,570	14,980	15,948.10	16,279.88
6	Catfish	50.40	533.73	1,016.40	1,218	1,417.75
7	Pomfret	1,590.78	1,351	1,883	1,860.50	1,950.05
		16,783.37	18,784.29	20,322.05	21,553.71	22,354.94

Source: BPS Kabupaten Kediri, 2022

As show in Table 1, the growth rate of catfish production in Kediri District from 2017 to 2021 is 37.67%, This is due to the large number of catfish cultivators scattered throughout the sub-district which is balanced by the high public consumption of catfish. The catfish farming business in Kediri District is one of the freshwater aquaculture businesses which is preferred by some people and has good business prospects, due to high amount of interest on catfish, its simplicity, and short time of cultivation. Therefore, farmers profit gain can be earned sooner by the sale. However, the possibility of experiencing business production risks may occur. Business risks that frequently occur in catfish farming in Kediri District are production risks. According to Ulfah (2020), states that risk is uncertainty that causes losses or deviates from expected goals. Risk is the probability of an event that will occur during a certain period and bring adverse consequences (Wastra & Mahbubi, 2013; Melly et al., 2019; Ramadhan et al., 2018). Catfish farming cultivation business must face production risks in its operations. This is in accordance with research Prahestin & Harahab (2018), Firdausya & Fauziyah (2021), Marlina et al. (2021), Supriyadi & Efani, (2021), Munsiarum & Setyarini (2022) which state that the risks often faced by catfish farmers are production risk and price risk.

Production risks which are identified on catfish enlargement business consists of weather/climate, seed quality, water quality, pests and diseases, cannibalism, and human resources. Production risks consist of natural conditions, pond cleanliness, feed type, fish seed quality, pests and diseases, and human resources (Fauziyah et al., 2019; Offayana et al., 2016). The results of research conducted Sari et al. (2020) reveals that the usage of broodstock reduces production risk, whilst the usage of drugs rises production risk. The results of research Wahyuni et al. (2020), the usage of hired

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labor, family labor, and other costs are able to cut the risk significantly, whilst feed and fish seeds rise the risk

The existence of production risks encourages farmers to make decisions to allocate production inputs (Fanani et al., 2015). These production risks need to be managed in order to lower the impact caused (As Sajjad et al., 2020). The slightest risk must be addressed immediately to prevent greater losses (Ernawati et al., 2015). According to Oluwatayo & Timothy (2015), risk cannot be eliminated as a whole, by proper management it can bring to a minimum risk level and able to be accepted by the company.

The novelty of this research is to analyze production factors and production risks using the just and pope model. The difference between this research from prior research lies in the object of research, location of the research, and the usage of several production factors. The determination of production factors is based on inputs that are used by farmers such as pond area, seeds, feed, medicines, and length of cultivation business. The behavior of farmers in facing production risks will be the basis for making decisions on how much allocation of production inputs to be used in catfish farming. Hence, this study aims to analyze the effect of the use of production factors on productivity and productivity risk of catfish farming in Kediri District.

RESEARCH METHODS

The research was conducted in Kediri District. The selection of research location was done purposively by considerating the area as a producer of catfish in East Java, and catfish is a prime commodity in Kediri District with the amount of production tending to soar. This research was conducted from June to August 2022.

The data in this study used primary data obtained from observations and structured interviews. Data on the condition of the cultivation business was gained from observations on catfish enlargement businesses in Kediri District. In addition, characteristics of respondent farmers were obtained from structured interviews and questionnaires distributed to selected respondents. The type of data is in the form of cross section data which consist of production data, prices, revenues, and expenditures of catfish farming businesses. The sample selection method uses snowball sampling, which is based on information from one cultivator to the next cultivator as many as 40 people. According to Cooper & Emory (1995) that the sample size (n> 30) in a relatively homogeneous population will be distributed close to normal.

The data analysis method used is descriptive and inferential statistical analysis. The use of descriptive statistics can be used to describe the characteristics of catfish farmers. Inferential statistics are used to test hypotheses and interpret the relationship or influence between variables (Ghozali & Wibowo, 2019; Wekke, 2019).

Hypothesis testing regarding the variance (risk) of catfish farming production uses a model developed by Just & Pope (1979), where the model has accommodated the risk in the production equation by including the variance of the production equation. Asche & Tveterås (1999), explained that the production function in the Just and Pope model that uses a two-step procedure is the Cobb-

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Douglas production function in the form of natural logarithms. The production function mode by including the element of risk in it is as follows (Just & Pope, 1979):

$$Y = f(x) + g(x)\,\varepsilon$$

Information:

1. y : Output
2. x : The vector of input variables
3. f(x) : The catfish output function
4. g(x) : The variance function (risk) of catfish production
5. ε : The error term.

Production function:

$$LnY = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + \varepsilon$$

Risk production:

$$\sigma^2 Yi = (Y_i - \hat{Y}_i)^2$$

Where the production risk in this study is the residual of the regression model (production variance) obtained from the difference between actual production and regression result production.

Production variance (risk) function:

$$g(x) = Ln\sigma^2 Yi = \theta_0 + \theta_1 LnX_1 + \theta_2 LnX_2 + \theta_3\, LnX_3 + \theta_4\, LnX_4 + \theta_5\, LnX_5 + \varepsilon$$

Information:

1. Yi : Catfish production (kg/m^2)
2. $\hat{Y}$: Estimated catfish production based on capital (kg/m^2)
3. β : Estimated parameter coefficient in the production function
4. θ : Presumptive parameter coefficient in the production risk function
5. X_1 : Pond area (m^2)
6. X_2 : Catfish fry ($tail/m^2$)
7. X_3 : Feed (kg/m^2)
8. X_4 : Drugs (ml/m^2)
9. X_5 : Cultivation experience (years)
10. ε : Error term
11. Hypothesis for production function: $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 > 0$
12. Hypothesis for risk production function: $\theta_1, \theta_5 < 0, \theta_2, \theta_3, \theta_4 > 0$

Statistical model testing can be done with the classical assumption test, the coefficient of determination test (Adjusted R^2), the F test, and the t test. Econometric testing is carried out in order

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to obtain the value of the estimated production function which is said to be the Best Linear Unbiased Estimation using the Ordinary Least Square method (Rama et al., 2016; Asmara et al., 2019).

RESULT AND DISCUSSION

Characteristics of Respondents

The characteristics of respondents in this study provide an overview of the diversity of catfish farmers. The characteristics of respondents in this study are based on gender, age, latest education, number of ponds, pond ownership, and experience in catfish farming. Characteristics of respondents in the study area are presented in Table 2. The results showed that almost all respondents in the study area were male, with a total of 39 people or 97.5% of the total respondent farmers. The age of respondent farmers in the study area varied. The average age of farmers is still at a productive age with 35 people or 87.12% of the total respondent. According to Ukkas (2017) and Sutikno (2020), productive age is in the range of 15 to 64 years. Generally, catfish farmers who cultivate this cultivation business are farmers who are still in their productive age. This is because this cultivation business requires strong physical energy, particularly for seed stocking, seed sorting and harvesting. The average age of respondents of catfish farmers in Kediri District in terms of physical age can still increase their work ability in order to increase fish production.

Table 2. Characteristics of Respondents

Variable	Category	Total	Percentage (%)
Gender	Male	39	97.5
	Female	1	2.5
Age (years)	15-24	2	5
	25-34	4	10
	35-44	7	17.5
	45-54	15	37.5
	55-64	7	17.5
	≥ 65	5	12.5
Education	Elementary	6	15
	Junior High school	9	22.5
	Senior High School	18	45
	Bachelor	6	15
	Master	1	2.5
Ponds number (unit)	1-5	22	55
	6-10	10	25
	11-15	6	15
	≥16	2	5
Ponds ownership	Personal ownership	32	80
	Non-personal ownership	8	20
Years of experience	1-5	25	62.5
	6-10	3	7.5

	11-15	4	10
	≥16	8	20

Source: Primary Data, 2022

Almost all respondent farmers in the study area have received formal education at the senior high school level, with 18 people or 45% of the total respondent farmers. The level of education taken by respondent farmers is quite good, thus farmers will be able to seek and obtain information and adopt new technological innovations regarding good fish farming techniques. Pond ownership by catfish farmers varies with the largest number of ponds at 55%, farmers own 1-5 ponds and almost all ponds in the study area are personal ownership with 32 people or 80%. Ownership of a small pond remarkably influences the number of seeds that can be stocked, as the result respondent farmers will produce small number of catfish. Pond ownership also reflects the size of the business scale. Self-owned ponds are the most common form of ownership system in the study area, apart from ponds owned by village officials that are managed by farmers without rent as part of the village food security program.

The length of time in the catfish farming business can influence the success of cultivation, the longer the catfish farming business, the more experience the farmers have. The average experience of catfish farming in the study area is 1-5 years with 62,5% of the respondent farmers. Most of the experienced of catfish farmers in the study area is also still relatively young, namely 1-5 years or 62.5% of the total number of respondent farmers. This is because respondent farmers mostly considerate catfish farming as a side business in addition to the agricultural business which is the main livelihood.

Classical Assumption Test

According to Razali & Wah (2011), the normality test with a sample size of less than 50 can be used Shapiro-Wilk normality test. Based on the analysis results, the normality test using the Shapiro-Wilk normality test obtained a probability value of 0.4053 (p-value> 0.05) therefore it can be concluded that the model is normally distributed. In line with the research results Nizar & Haryati (2017) and Manurung et al. (2021) that the number of normality test results greater than 0.05 means that the data is normally distributed.

The autocorrelation test can be known from the Durbin Watson (DW) value, if the p-value is more than the real level of 0.05, it does not cause autocorrelation problems. Based on the analysis results, the autocorrelation test obtained a probability value of 0.4329, it means that the model is not autocorrelated. Based on Nada & Kariyam (2019), Azizah et al. (2021), Supriyadi et al. (2022) state that the p-value of the regression model analysis is greater than 0.05 (p-value> 0.05) Hence the data is assumed as not autocorrelated.

The Breusch Pagan Godfrey test can be used to determine the presence or absence of heteroscedasticity symptoms with a real level of 5% using R software (Effendi et al., 2019). Based on the results of the analysis, the heteroscedasticity test with the Breusch-Pagan test obtained a probability value of 0.2479 so it can be concluded that the model does not contain symptoms of

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heteroscedasticity. The findings of Wahab et al. (2021), Wahyuningtias (2021), and Aisyah et al. (2021) state that the Breusch-Pagan Godfrey test results with a probability value morer than 0.05 indicate that the regression model is free from heteroscedasticity symptoms.

The Variance Inflation Factor value can determine the multicollinearity symptoms of each explanatory variable on the response variable. According to Hanke & Wichern (2009), symptoms of multicollinearity in a model can be detected using the Variance Inflation Factor (VIF). The model with the assumption of non-multicollinearity is fulfilled, if the VIF value for the explanatory variables is <10 (Retnowati et al., 2017). Based on the results of the analysis, the multicollinearity test on each variable can be seen from the Variance Inflation Factor (VIF) value as shown in Table 3.

Table 3. Number of Variance Inflation Factor (VIF)

Variable	Variance Inflation Factor (VIF)
Size of Pond	6.103822
Fish seed	8.144377
Feed	1.971398
Drug	4.168583
Experience in fish farming	1.378501

Source: Primary Data, 2022

Based on Table 3, each variable has a Variance Inflation Factor (VIF) value> 0.1 and < 10 thus the data is not multicollinearity. The findings of Masitah et al. (2019), Sutarni & Berliana (2019), Maringka et al. (2021), and Elinur et al. (2020) state that all variables with a VIF value> 0.1 and VIF < 10 can be said that the model used does not experience multicollinearity symptoms.

Production Function and Production Risk Function of Catfish Farming

Estimation results on production factors that influence the production and production risk of catfish farming as shown in Table 4.

Table 4. Estimation Result of Production Function and Production Risk Function of Catfish Farming

Variable	Coefficient	Pr (>|t|)
Production function		
Intercept	-2.15109	0.000333 ***
Size of pond	-0.07304	0.296306
Fish Seed	0.82478	2.63e-13 ***
Feed	0.02520	0.785278
Drug	-0.03096	0.661594
Experience in fish farming	0.13126	0.025873 *
Adjusted R-squared: 0.9717		
p-value: < 2.2e-16		
Production risk function		
Intercept	4.04358	4.37e-11 ***
Size of pond	0.01494	0.7853

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Fish Seed	-0.03212	0.5734
Feed	0.10355	0.1625
Drug	0.04575	0.4148
Experience in fish farming	-0.10706	0.0218 *
Adjusted R-squared: 0.3227		
p-value: 0.002229		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ',' 0.1 ' ' 1
Source: Primary Data, 2022

Table 4 reveals that the estimation results on the production function of catfish farming obtained the equation:

$$LnY = - 2{,}15109 – 0{,}07304 \ln X_1 + 0{,}82478 \ln X_2 + 0{,}02520 \ln X_3 – 0{,}03096 \ln X_4 + 0{,}13126 \ln X_5$$

The results of the estimation of the catfish production function can be seen that the value of R^2 (adjusted R-square) is 0.9717 so it can be concluded that 97.17% of the diversity of catfish farming production can be explained by the size of the pond, fish seeds, feed, drug, and the experience of the cultivation business, the remaining 2.83% is described by other variables outside the model. Based on Table 4, the F-count probability value of the estimated production function of catfish farming is < 2.2e-16. The independent variables used simultaneously have an influence on the dependent variable. This is indicated by the p-value which is in the range ≤ 0.05. Pond area, fish seeds, feed, medicines, and farming experience simultaneously influence the productivity of catfish farming. If the significance value of the F test is less than 0.05, then the regression model used is a feasible model (Nanincova, 2019).

The parameter estimate value for the fish seed variable (X_2) has a positive value of 0.82478 and is significant at the 99.9% trust level. This case means that as the number of fish seeds increases, the production yield is relatively rising. It is suspected that this is because farmers already have a standard stocking density that refers to a number of references as well as based on their own experience. The stocking density used is 100-400 fish/m2 with different seed sizes. By increasing the number of fish fry, the fish population increases in a fixed pond area, which means that the density of fish cultivated increases so that the relative production yield increases. Respondent farmers use quality seeds so that fish can grow quickly and are immune to disease or death. The use of quality seeds by respondent farmers is the right strategy in increasing catfish production, one of the superior catfish seeds used by respondent farmers is pearl catfish seeds which have longer survival, shorter enlargement time, higher feed efficiency, and high taste so that crop productivity increases. The results of these findings are in line with Fitriani & Zaini (2012), Chineze et al. (2014), Antwi et al. (2017), Setiawan & Oktarina (2017), Ibeun et al. (2018), Elinur & Heriyanto (2019), Gbigbi (2021), Ramadani et al. (2022) if the number of fish seeds increases, additional number of production will be gained.

The success of a catfish aquaculture business cannot be separated from the availability of fish seeds. The availability of catfish seeds in Kediri District is approximately 1.3 billion with the number of cultivators reaching 1,500 people. According to Husen (2012), fish seeds are the initial phase of a cultivation process and therefore the quality of fish seeds must be really good. In other words, it is

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necessary to have a written or certified guarantee stating that the condition of seeds quality when they will be used. Regarding catfish seeds used by farmers in Kediri District, the majority come from local Kediri District. The majority of catfish seeds used in the enlargement business in Kediri District are obtained from local catfish seed farmers. The type of seeds they obtain are pearl catfish seeds, which are superior seeds in Kediri District. According to Burnasir (2014), superior catfish seeds come from the best broodstock, catfish seeds are also healthy characterized by agile movement, uniform size, reddish black or shiny brown skin color, brightly colored snout, not hanging, free of wounds or defects.

The parameter estimate value for the cultivation business experience variable (X_5) has a positive value of 0.13126 and is significant at the 95% trust level. This case means that by the increasing experience of catfish farmers, the production will grow relatively. Each respondent farmer has different experience, the average experience of catfish farmers in Kediri District is approximately 8.2 years. Cultivation experience provides the best information in cultivation activities so that respondent farmers can make choices on how to manage cultivation appropriately. In addition, horizontal communication among catfish farmers makes respondent farmers more perceptive in exchanging experiences. The findings show that the average production for experienced farmers 1-5 years is 0.8 tons/cycle, while experienced farmers > 6 years have an average production of 1.94 tons/cycle. These findings are in line with (Sudarmadji et al., 2011); (Khan et al., 2021) that fish production results relatively raise by increasing experience in fish farming.

One of the internal supporting factors for the success of catfish cultivation is increasing the creativity of work and hard work of human resources by learning from their experiences with the aim of increasing catfish production (Riska et al., 2015). The statement is reinforced by research Chowdhury et al. (2014) that a person's productivity is influenced by work experience, and work experience influences the average amount of income earned. Table 4 relates that the estimation results on the variance function of catfish farming production obtained equation:

$$LnY = 4.04358 + 0.01494 \ln X_1 - 0.03212 \ln X_2 + 0.10355 \ln X_3 + 0.04575 \ln X_4 - 0.10706 \ln X_5$$

The parameter estimate value for the cultivation experience variable or experience (X5) has a negative value of 0.10706 and is significant at the 95% trust level. This case illustrates that the more experience of farming, the risk of production of catfish farming will decrease. Catfish farming experience is one of the production inputs that minimize risk factors (reduce production risk) because farmers who have a lot of knowledge and experience about catfish farming techniques can develop their business easily. Therefore, the development of catfish farming in Kediri District still requires an increasement in the experience of farmers to mitigate production risks. Older and more experienced respondent farmers who have gained managerial skills over time tend to utilize inputs more wisely and are therefore technically more efficient than new and inexperienced respondent farmers. In addition, the more experience a farmer has, the greater level of courage to take the risks. Experience allows farmers to see all the opportunities and obstacles that must be dealed with in catfish farming. The results of research Herminingsih & Rokhani (2014) depicts that farmer experience has a positive and significant influence on farmer behavior in farming. The more farming experience a farmer has, the more courageous he is in taking risks to do business. This is in accordance with the opinion of

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Nyanga et al. (2011) which states that educated and experienced farmers have more knowledge and information about the sources of production risk and the steps needed to anticipate it.

CONCLUSION AND SUGGESTION

The results of the analysis reveals that fish seed and farming experience are significant to the productivity of catfish farming in Kediri District. The estimated values of all parameters are positive indicating that an increase in production inputs will increase the productivity of dumbo catfish seeds, cateris paribus. The highest influence of inputs on catfish farming is farming experience of 0.026. The results of the production risk function analysis reveal that the experience of cultivation is able to decrease the risk of catfish farming production (risk reducing factor).

An increasement in the usage of fish seed and farming experience influence the productivity of catfish farming in Kediri District. Therefore, catfish farmers should use quality catfish seeds, and improve skills in aquaculture management continuously and establish horizontal communication with other catfish farmers to exchange ideas and experiences. To reduce production risk in catfish farmers can be done by increasing the experience of the cultivation business. The government needs to build competence and knowledge as well as cultivation techniques for farmers through training and mentoring, therefore farmers will be more competent in managing catfish farming businesses to reduce the level of production risk experienced, moreover support catfish farming business is needed through the provision of superior technology (e.g. superior fish seeds that are resistant to pests and diseases), institutional consolidation of fish farmer groups and the development of fisheries insurance for small fish farmers in order to minimize production risks.

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