Production function model of African catfish hatchery business in Joho village, Wates, Kediri

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Abstract. The use of production inputs on African catfish hatchery business can cause production risks also can reduce production risks. This study aims to analyze the effect of production inputs cause on production risks faced by African catfish hatchery cultivators in Joho Village, Wates, Kediri. This study took 30 respondents conducted by snowball sampling and the data analysis method used Cobb-Douglas model. Data processing tools used Microsoft Excel 2016 and R-Studio 4.0.1 statistical software. The results showed production inputs of artificial feed, broodstock, and drugs significantly affect productivity. Increased of broodstock significantly decreases production risk, and increased of medicines significantly increase production risk. The policy recommendations of this study are limiting the use of production inputs that could pose production risk, and good fish farming implementation method based on the policy of Directorate General of Aquaculture (DJPB).

1. Introduction

The fisheries sector is all activities related to the management and utilization of fish resources and environment, pre-production, production, processing and marketing, which are carried out in a fisheries business system. The fisheries sector divided into two parts, namely the capture fisheries sector and aquaculture sector. Based on the map of potential for aquaculture from Ministry of Marine Affairs and Fisheries Republic of Indonesia (KKP), all islands in Indonesia have the opportunity to become a place for cultivation, both for freshwater, brackish, and marine aquaculture. One of areas in East Java that can be used as a development area for freshwater aquaculture sector is Kediri Regency.

Kediri Regency has a gross hatchery area both of fishery unit and UPR (People's Hatchery Units) of 211.70 hectares with a total of 2,551 hatcheries. Meanwhile, the level of need for catfish seeds in East Java is classified as high, namely 9,453,217,030 seeds [1]. This condition indicates that there is an opportunity to further develop catfish hatchery business [2].

The reason for doing catfish hatchery business is because it is technically easy and economically very profitable. Besides there are several advantages that are given, but in fact catfish hatchery business is more prone to high risk than catfish enlargement business if it is not managed properly. Factors that are indicated as sources of production risk so that they have a negative effect in producing production output are catfish seeds that are kept in a small condition, and are still vulnerable to sources risk of changes in water temperature, water quality, parasites and diseases, cannibalism and use of production inputs. According to [3], production risk factors can be classified into two, namely controlled risk factors that come from variations in the use of production inputs and uncontrolled factors that come from changes in seasons, diseases, and quality of human resources.

In the use of production factors or production inputs, there are production inputs that can pose a production risk, but there are also production inputs that can reduce production risk [4]. Therefore it is important to analyze the production inputs that exist in the African catfish hatchery cultivation. This is to determine the effect that occurs on each production factor that affects the productivity of the resulting African catfish seeds. Apart from that, output prices and input prices can also affect cultivator revenues
and production costs. Therefore, the size of the cultivator’s income and production costs affect the income received by the cultivator. This study aims to analyze the effect of production inputs on the production risks faced by African catfish seed farmers in Joho Village, Wates, Kediri.

2. Materials and Method
This research was conducted in Joho Village, Wates District, Kediri Regency. The location chosen purposively with consideration that Joho Village, Wates District is one of the villages that has a fish farmer group of African catfish hatchery business and also immigrant communities can visit this village with the application of health protocols during the Covid-19 pandemic. This research was conducted in “Pokdakan Berkah Lele” and “Pokdakan Sumber Rejeki” with the consideration that these two groups are still active in the African catfish hatchery business.

The method of taking respondents using snowball sampling method. This study took 30 respondents, the most active of the group. Sampling with this technique, because the population of African catfish seed cultivators has relatively the same behavior (homogeneous). In the central limit theorem, a relatively homogeneous population distributed close to normal with sample size (n ≥ 30) [5]. Processing and data analysis in this study carried out quantitatively. The quantitative data analysis used includes the analysis of production factors that affect the production of African catfish seeds using Just and Pope productions risk function model. The data and information that has obtained will be directly processed using Microsoft Excel 2016 tools and statistical software R-Studio 4.0.1.

The model of production and risk functions used is Cobb-Douglas function [6]. Systematically Production Function is:

\[ Y = f (x) \]
\[ \ln Y_i = \ln \beta_0 + \beta_1 \ln X_{i1} + \beta_2 \ln X_{i2} + \beta_3 \ln X_{i3} + \beta_4 \ln X_{i4} + \epsilon \]

To obtain the validity of the results of econometric testing using Ordinary Least Square (OLS) method to obtain an estimated value of the production function which is Best Linear Unbiased Estimation (BLUE) [7]. According [8], testing on deviations from classical assumptions is used to obtain the best model for estimating. Tests carried out for the production function model. Then performed the goodness of fit test such as the coefficient determination (R\(^2\)), F test, and t test.

Coefficient determination (R\(^2\)) to measure the ability of the model to explain the variation of the independent variables. Adjusted R Square used to determine the coefficient determination (R\(^2\)). The F test shows that all the independent variables (free) have a joint effect on the dependent variable (bound) if the value of F count> F table then. The t test shows that the independent variable (free) partially affects the dependent variable (dependent) if t count> t table.

3. Result and Discussion
The analysis of the factors affecting the risk of catfish seed production in Joho Village, Wates District, Kediri Regency was carried out using Just and Pope model combined with the Cobb-Douglas function. This Just and Pope model can explain how the influence of production inputs on production results.

This Just and Pope model will produce the average productivity function of catfish seeds. Production inputs used in this study as estimators, namely artificial feed, broodstock, labor and drugs. These factors will be analyze using the R Studio 4.0.1 program. The stages of the analysis is carried out, namely first performing the classical assumption test, testing the R2 value, testing the F value, testing the t value, and testing the sensitivity of each factor to the productivity level of catfish seeds and the risk of catfish seed production.

3.1 Classic assumption test
The classical assumption test was done before performing regression testing. According to [9], the classic assumption test includes the normality test, heteroscedasticity test, autocorrelation test, multicollinearity test, and linearity test if it is fulfilled then the estimation with Ordinary Least Square (OLS) will be Best Linear Unbiased Estimation (BLUE).
3.2 Normality test

According to [10], the linear regression model is mandatory using normally distributed data. This normality test is seen in the Q-Q normal graph and the Shapiro-Wilk normality test. This is confirmed by statement [11], the Shapiro-Wilk test is a normality testing method that is used in a limited manner for samples <50 in order to produce accurate decisions. [12,13] stated that the more efficient normality test for data <50 is the Shapiro-Wilk test. [14] stated that the Shapiro-Wilk showed the best normal distribution results followed by the Lilliefors test and the Kolmogorov-Smirnov test.

Based on the results of the analysis, it can be seen in Figure 1 that in the productivity function model and productivity variance the points spread around the line and follow the diagonal direction, thus it can be concluded that the residual value in the data analysis is normally distributed. The results of research [15] show that the normal probability plot (QQ-Plot) test carried out on the residual value in the regression model shows that the points are close to the diagonal line so that it can be concluded that the residual value is normally distributed. In addition, the normality test in this study can be confirmed by the results of the Shapiro-Wilk normality test with a p-value of 0.6352, which means that the p-value > 0.05 so that the data is said to be normally distributed. [16,15] added that the calculation of the data using the R-studio with an output p-value greater than the significance level of 0.05 means that the data has followed a normal distribution.

![Normal Q-Q chart](image-url)

**Figure 1.** Normal Q-Q chart

3.3 Heteroskedasticity test

According to [17], Heteroscedasticity testing is carried out to test whether the regression model has an error or constant variance from the residuals from one observation to another. [9] added that there are two ways to detect the presence or absence of heteroscedasticity, namely graphical methods and statistical tests. The statistical test methods used to detect the presence or absence of heteroscedasticity are the Park test and Pagan Godfrey's Breusch test [18,19]. Heteroscedasticity problem detection used the Breusch Pagan test [20,21]. According to [22], the method used to detect heteroscedasticity is the Breusch Pagan Godfrey (BPG) test method with a real level α = 0.05 using the help of R software.

From the analysis, it can be seen in Figure 2 that the productivity function model and productivity variance of the points spread evenly and there is no clear pattern, with the conclusion that heteroscedasticity does not occur. Meanwhile, based on the Breusch-Pagan test, the p-value is 0.9467, meaning that the p-value is > 0.05 so that the data is said to have no heteroscedasticity. [16] stated that the heteroscedasticity test used the Breusch-Pagan test with the resulting P-value greater than the significance level of 0.05, so there was no heteroscedasticity in the data. [15] added that the residual heteroscedasticity did not occur and the non-heteroscedasticity assumption was fulfilled because the p-value > the significance level of 0.05.
3.4 Autocorrelation test

According to [23] the autocorrelation test aims to test whether in the linear regression model there is a correlation between confounding error in period t and confounding error in period t-1 (previous). [24] added that the most widely used test to determine autocorrelation problems is the Durbin-Watson method.

The autocorrelation test is based on the DW value (Durbin Watson), if the p-value is> 0.05 then there is no autocorrelation. Based on the results of the analysis, it can be seen that the p-value in the analysis of the productivity function model and productivity variance is 0.2407, meaning that the p-value is> 0.05 so that the data is said to have no autocorrelation. The results of the study [15] indicated that the autocorrelation test with the Durbin-Watson test using statistical software R-studio resulted in a p-value > a significance level of 0.05 so that it could be said that the residuals did not occur autocorrelation.

3.5 Multicollinearity test

The method that can be used to test the occurrence of multicollinearity can be seen from the correlation matrix of the independent variables [25]. According to [26], multicollinearity is used to determine the linearity relationship between the independent variables. To detect multicollinearity in a model is done by looking at the Variance Inflation Factor (VIF) [27,20]. If a set of explanatory variables is uncorrelated, then the value of VIF = 1, if a set of explanatory variables is correlated at a high level then the VIF value is> 10, so that the VIF values 1 to 10 indicate the absence of multicollinearity [28].

Testing of the presence or absence of interference multikolinieritas disturbances can be done by looking at the Tolerance value dan VIF value. Tabel 1 is a Tolerance and VIF value from regression results of the average productivity function.

| Variabel         | Average Productivity Function |
|------------------|-------------------------------|
|                  | Tolerance | VIF              |
| $X_1$ (artificial feed) | 0.612082 | 1.633768         |
| $X_2$ (broodstock)     | 0.600689 | 1.664754         |
| $X_3$ (labor)           | 0.519502 | 1.924919         |
| $X_4$ (drugs)           | 0.543357 | 1.840411         |

Based on the results of the regression analysis on the productivity function in Table 1, it is known that the tolerance and Variance Inflation Factor (VIF) values in the variables $X_1$ (artificial feed), $X_2$ (broodstock), $X_3$ (labor), and $X_4$ (drugs) are each has a value> 0.1 and <10. Based on this it can be said that in the productivity function model and productivity variance there is no multicollinearity. [16] added that the calculation of the presence or absence of multicollinearity symptoms using R-studio with the
VIF output of all independent variables is less than 10, it can be concluded that there is no multicollinearity problem between independent variables.

3.6 Linearity test
According to [29], states that regression linearity test is used to determine whether a variable is linear or not against other variables. According to [26] the linearity test is used to determine the correlation between the independent variable and the dependent variable. The relationship between variables is said to be linear, which is a variable if there is a change in a variable, the other variables will follow the change. There are two techniques that can be used to test linearity, namely by using compare mean and scatter plot graph.

Testing the presence or absence of a linear relationship between the dependent and independent variables solved by looking at the position of two different colored lines (dotted line and connecting line) close together or not. Based on the results of the analysis, can be seen in Figure 3 that in the productivity function model and productivity variance it appears that the positions of two different colored lines are in close proximity, meaning that the independent variable has a linearity relationship with the dependent variable so that the linearity assumption of the regression model is fulfilled. Meanwhile, seen in a scatter plot graph, the plot formed spreads randomly or is not in the form of a pattern so that it meets the linearity requirements. The results of the study [30] stated that the plot that was formed spread randomly and was spread both above and below the zero on the Y axis, it can be concluded that it fulfilled the linearity requirements. [31] added that based on the Scatterplot graph, linearity is met if the plot between the standardized residual value and the standardized predictive value is not in the form of a specific or random pattern.

![Component + residuals plots chart](image)

Figure 3. Component + residuals plots chart

3.7 Factors affecting the productivity of African catfish seeds
The analysis factors that affect the productivity of African catfish seeds carried out by making productivity variable as dependent variable. Independent variables included in the multiple linear regression analysis for these two functions are variables: artificial feed ($X_1$), broodstock ($X_2$), labor ($X_3$), and drugs ($X_4$). Table 2 is the result of multiple linear regression analysis of the productivity function.
Table 2. Result of estimation production inputs of African catfish hatchery business

| Variable       | Estimate  | Pr (>|t|)     |
|----------------|-----------|--------------|
| (Intercept)    | 1.807577  | 0.01448 *    |
| X1 (artificial feed) | 0.179969  | 0.00164 **   |
| X2 (broodstock) | 0.144726  | 0.03096 *    |
| X3 (labor)     | 0.005542  | 0.94333      |
| X4 (drugs)     | 1.398119  | 0.00000 ***  |

*Significant **highly significant

Based on the results of the estimated productivity function of the African catfish hatchery business which is listed in Table 2, the following equation is obtained:

\[ Y = 1.806 + 0.180 \ln X_1 + 0.145 \ln X_2 + 0.006 \ln X_3 + 1.398 \ln X_4. \]

If returned in its original form, the equation will be as follows:

\[ Y = 6.096 + X_1^{0.180} + X_2^{0.145} + X_3^{0.006} + X_4^{1.398}. \]

Based on the estimation results of the productivity function model of the African catfish hatchery as shown in Table 2, it can be seen that the value of R2 (adjusted R-square) is 0.7846. This means that 78.46 percent of the variable variation of African catfish seed production can be explained by variations in the variables independent (artificial feed, broodstock, labor and medicines), while the remaining 21.54 percent is explained by variations from other variables outside the model.

The results of the F test (Table 2) obtained an F-statistic value of 27.41 with a significance value of 0.00000. The F-statistic value is greater than the T-table 1.39 at the α level of 0.05 and the F-statistic significance probability value is less than 0.05. This shows that all the independent variables (artificial feed, broodstock, labor and medicines) are simultaneously significant on the productivity of African catfish seeds.

The results of the t test in this study, the labor variable (X3) is not significant to the productivity results of African catfish seeds, this indicated by a probability value of 0.94333. Whereas for the number of artificial feed (X1), the number of broodstock (X2) and drugs (X4) were significant on the productivity of African catfish seeds, this was indicated by the probability values of X1 = 0.00164, X2 = 0.03096 and X4 = 2.66, respectively.

3.7.1 Artificial feed (X1). According to [32], the production inputs with value reaches 60 percent of total production cost is feed. Based on the results of regression analysis, estimated value for artificial feed parameters is positive with coefficient value of 0.180 and probability value of 0.00164. This value indicates that the additional use of artificial feed will increase the productivity of African catfish seeds, *cateris paribus*. The addition of artificial feed by 1 percent will increase the productivity value of African catfish seeds by 0.145 percent. Artificial feed is significant on the productivity of African catfish seeds produced by respondent cultivators, this can be seen from the probability value of artificial feed of 0.00164 which is smaller than the significant level of 0.05. The results of this study are in line with research [33,34] which states that the use of feed has a significant effect on the production of African catfish seeds. [35] added that the use of forage had a significant effect on the production of sangkuriang catfish seeds. The results of [36] revealed that pellets partially significant effect on catfish seed production. [37,38] stated that the feed dose has a significant effect on catfish production.

The artificial feed used by the respondent farmers consisted of seed feed in the form of FL-0, FL-1, PF-500, PF-800, LP-1 and PF-128 main feed. According to [39], the development of artificial feed is to find feed ingredients that can meet protein needs optimally for fish growth so that the addition of feed can properly increase fish production. [40] stated that fish growth is closely related to the availability of protein in feed, because protein is a nutrient and energy source needed by fish for growth.
3.7.2 Broodstock (X2). Broodstock is the main input and definitely used by catfish hatcheries in carrying out their production activities. Each African catfish hatchery has a different number of broodstock and the broodstock used by respondent cultivators has an average weight of 1.5 kg - 2 kg per head/ekor.

Based on the results of regression analysis, estimated value for broodstock parameter is positive with a coefficient value of 0.145 and a probability value of 0.03096. This value indicates that the additional use of broodstock will increase the productivity of African catfish seeds, *Cateris paribus*. The addition of broodstock by 1 percent will increase the productivity value of African catfish seeds by 0.18 percent. The broodstock is significant to the productivity of African catfish seeds produced by the respondent. The results of the t test in this study, the labor variable (X3) is not significant to the productivity results of African catfish seeds, this is indicated by a probability value of 0.94333. Whereas for the number of artificial feed (X1), the number of broodstock (X2) and drugs (X4) were significant on the productivity of African catfish seeds, this was indicated by the probability values of X1 = 0.00164, X2 = 0.03096 and X4 = 2.66, respectively. e-07., this can be seen from the probability value of broodstock of 0.03096 which is smaller than the significant level of 0.05. The results of this study are in line with research [33] which states that the use of broodstock has a significant effect on the production of African catfish seeds. In line with the results of research [36] that broodstock partially significant effect on the production of catfish seeds. Respondent cultivators get catfish broodstock from local fish cultivators such as the bitter melon and Blitar areas. The broodstock used by respondent cultivators has an average weight of 2 kg per head with a technical age of 3 years.

3.7.3. Drugs (X4). Based on the results of regression analysis, the estimated value for the drug parameter is positive with a coefficient value of 1.398 and a probability value of 2.66e-07. This value indicates that the addition of drugs will increase the productivity of African catfish seeds, *Cateris paribus*. The addition of drugs by 1 percent will increase the productivity value of African catfish seeds by 1.398 percent. The use of drugs is significant for the productivity of African catfish seeds produced by the respondent cultivators, this can be seen from the probability value of drugs of 2.66e-07 which is smaller than the real level of 0.05. The results of this study are in line with research [41], which showed that the use of drugs had a significant effect on the productivity of neon tetra fry at the 0.150 level. The results of the study [42] revealed that the cost of vitamins and medicines had a significant effect on the income of African catfish farmers at the significant level of 0.05. In line with the results of research [36] that probiotics partially significant effect on the production of catfish seeds. The results of the study [43] also re that the results of the drug variable test had a significant effect on the net income of Koi fish farming. The drugs used by the respondent farmers were booster inroflox-25 and furazolidone (yellow medicine). Medicines are important factors to support growth and increase the resistance of catfish seeds to bacteria and diseases.

4. Conclusion
Factors or inputs for the production of artificial feed, broodstock and drugs are significant for the productivity of African catfish seeds. The estimated value of all parameters is positive which indicates that the addition of production input will increase the productivity of African catfish, *Cateris paribus*. The artificial feed used by the respondent farmers consisted of seed feed in the form of FL-0, FL-1, PF-500, PF-800, LP-1. The use of artificial feed can fulfill protein requirements optimally for fish growth so that the addition of feed can increase the production of fish seeds. The broodstock used by the respondent cultivators has an average weight of 2 kg per head, the average technical age is under 3 years and the gonad maturity level is good enough so that the broodstock can increase the production of fish seeds. Meanwhile, the drugs used by the respondent farmers were booster inroflox-25 and furazolidone (yellow medicine). These drugs are used to support growth and increase the resistance of catfish seeds to bacteria and diseases.
Suggestions for African catfish seed cultivators are that restrictions on the use of production factors or inputs that can reduce production productivity should be implemented, the application of CBIB (Good Fish Cultivation Method) is based on the policies of the Directorate General of Aquaculture (DJPB) which are under the provisions of the Ministerial Regulation.

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References
[1] Dinas Perikanan dan Kelautan Jawa Timur 2014 Laporan Tahunan Statistik Perikanan Budidaya di Jawa Timur Tahun 2014.
[2] Adebayo O and Fagbenro O 2004 Induced ovulation and spawning of pond raised african giant catfish, heterobranchus bidorsalis by exogenous hormones. *Aquaculture* 242(1-4): 229-36
[3] Hartoyo K L and Fariyanti A 2018 Risiko dan strategi peningkatan produksi udang vannamei di kecamatan blanakan kabupaten subang. *Jurnal Sosek KP* 13(1): 99-110
[4] Asche F and Tvetereäs R 1999 Modeling production risk with a two-step procedure. *Journal of Agricultural and Resource Economics*, 24(2): 424-39
[5] Cooper D R and Emory C 1996 *Business Research Methods* (New York: Richard D Irwin)
[6] Just R E and Pope R D 1979 Production function estimation and related risk considerations. *American Journal of Agricultural Economics*, 61(2): 276-84
[7] Asmara R, Widyawati W and Hidayat A H 2019 Preferensi resiko petani dalam alokasi input usahatani jagung menggunakan model Just and Pope. *Jurnal Ekonomi Pertanian dan Agribisnis (JEPA)*, 3(2): 449-59
[8] Rama R N and Doloroza E 2016 Analisis risiko produksi usahatani padi lahan basah dan lahan kering di kabupaten melawi. *Jurnal Social Economic of Agriculture*, 5(1): 73-88
[9] Ghozali I 2009 *Ekonometrika Teori, Konsep, dan Aplikasi dengan SPSS 17* (Semarang: Badan Penerbit Universitas Diponegoro)
[10] Zuur A F, Ieno N Walker N, Saveliev A A and Smith G M 2009 *Mixed Effects Models and Extensions in Ecology with R*. (New York: Springer Science + Business Media)
[11] Shapiro S S and Wilk M B 1965 An analysis of variance test for normality (complete samples). *Biometrika*, 52(3/4): 591-611
[12] Ayuningtyas A D 2012 *Kekuatan Efisiensi Uji Normalitas Kolmogorov-Smirnov dan Shapiro-Wilk pada Sasaran Program KB di Provinsi Jawa Timur Tahun 2010*. (Surabaya: Universitas Airlangga)
[13] Dahlan M S 2009 *Statistik untuk Kedokteran dan Kesehatan* (Edisi 4 (Deskriptif, Bivariat dan Multivariat, dilengkapi Aplikasi dengan Menggunakan SPSS) ed.). (Jakarta: Salemba Medika)
[14] Razali N M and Wah Y B 2011 Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling Tests. *Journal of Statistical Modeling and Analytics*, 2(1): 21-33
[15] Azkia M W, Hitayuwana N, Khusna Z A and Widodo E 2019 Analisis Temperature Dan Kelembaban Terhadap Curah Hujan Di Kabupaten Sleman Provinsi Daerah Istimewa Yogyakarta (Studi Kasus: Temperature, Kelembaban, Dan Curah Hujan Di Kabupaten
Sleman). *Seminar Nasional Teknologi Creative and Innovative Education in the Industry 4.0: teh Current Trends* (Yogyakarta: UNY Press) pp 77-85.

[16] Ahsani F T and Ardian D 2020 Analisis Faktor yang Memengaruhi Swasembada Beras di Indonesia Tahun 2018. *Seminar Nasional Official Statistics 2019: Pengembangan Official Statistics dalam Mendukung Implementasi SDG’s. 2019 (1)* (Jakarta: Politeknik Statistika STIS) pp 196-201.

[17] Uthami I P Sukarsa I G and Kencana I E 2013 Regresi Kuantil Median untuk mengatasi Heteroskedastisitas Pada Analisis Regresi. *e-Jurnal Matematika*, 2(1): 6-13

[18] Andriani S 2017 Uji Park dan Uji Breusch Pagan Godfrey dalam Pendeteksian Heteroskedastisitas pada Analisis Regresi. *Al-Jabar: Jurnal Pendidikan Matematika*, 8(1): 63-72

[19] Winarno W W 2009 *Analisis Ekonometrika dan Statistika dengan Eviews.* (Yogyakarta: UPP Sekolah Tinggi Ilmu Manajemen YKPN)

[20] Thomas R L 1997 *Modern Econometrics an Introduction.* Harlow: Addison Wesley Longman.

[21] Verbeek M, Leuven K and University T 2000 *A Guide to Modern Econometrics.* (Chichester: Jonh Wiley and Sons Ltd)

[22] Effendi R, Maiyastri and Diana R 2019 Perbandingan Metode Regresi Kuantil dan Metode Bayes dalam Mengestimasi Parameter Model Regresi Linier Sederhana dengan Galat Heteroskedastisitas. *Jurnal Matematika Unand*, 8(1): 291-8.

[23] Ghozali I 2013 *Aplikasi Analisis Multivariat dengan Program SPSS* (7 ed.). (Semarang: Badan Penerbit Universitas Diponegoro)

[24] Yuwono P 2005 *Pengantar Ekonometri.* (Yogyakarta: CV. Andi Offset)

[25] Gujarati D N and Porter 2009 *Dasar-Dasar Ekonometrika.* (Jakarta: Salemba Empat)

[26] Alhusin S 2003 *Aplikasi Statistik Praktis dengan SPSS.10 for Windows.* Yogyakarta: Graha Ilmu.

[27] Hanke J E Wichern D W and Reitsch A G 2001 *Business Forecasting* (7 ed.). (Upper Saddle River, New Jersey: Prentice-Hall, Inc.)

[28] Hakim A 2004 *Statistika Deskriptif Untuk Ekonomi dan Bisnis* (Yogyakarta: Ekonisia)

[29] Sudjana 2005 *Metode. (Bandung: Tarsito)*

[30] Fitriyani H A 2019 Pengaruh Net Profit Margin (NPM) dan Biaya Operasional Pendapatan Operasional (BOPO) Terhadap Return on Assets (ROA) pada perusahaan transportasi yang terdaftar di bursa efek Indonesia Tahun 2013-2015 *Jurnal Bisis dan Akuntansi Unsurya*, 4(2), 94-106

[31] Sundarsih D and Andriati Y S. 2020 Analisis Ukuran Perusahaan Dalam Meningkatkan Profitabilitas (Survey pada PT Sekar Bumi Tbkg). *BanKu: Jurnal Perbankan dan Keuangan*, 1(1), 38-45

[32] Mahyudin K 2008 *Panduan Lengkap Agribisnis Lele.* (Jakarta: Penebar Swadaya)

[33] Pramono M D, Ferichani M and Rahayu E S 2017 The Analysis of Factors Influence Catfish Seed (*Clarias gariepinus*) Production in Wonogiri District. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, 28(1): 30-48

[34] Robby A N Arsyad A and Yusdiari A 2015 Analisis Pendapatan dan Faktor-faktor Produksi yang Mempengaruhi Usaha Budidaya Pembenihan Ikan Lele Dumbo di Kecamatan Ciseeng Bogor. *Jurnal Agribisnis*, 1(1): 30-7

[35] Sundari R S and Priyanto Y A 2016 Efficiency Of Production Factors Application on Catfish (*Clarias sp.*) Var. Sangkuriang Hatchery Technology. *Jurnal Teknologi Perikanan dan Kelautan*, 7(2): 200-07

[36] Kusumawati I H 2015 *Analisis Fungsi Produksi Cobb-Douglas pada Usaha Pembenihan Ikan Lele (*Clarias sp.*) di Kabupaten Kediri, Jawa Timur.* (Malang: Universitas Brawijaya)
[37] Dewi D K and Mulyo J H 2015 Production Analysis of Catfish (Clarias gariepinus) Farming: Cobb Douglas Production Function. Jurnal Perikanan (J. Fish. Sci.), 17(2): 54-60

[38] Sumartin 2017 Efisiensi Faktor Faktor Produksi Usaha Budidaya Ikan Lele Dumbo (Clarias gariepinus): Studi Kasus pada Alumni Peserta Pelatihan Budidaya Ikan di BPPP Banyuwangi. Samakia: Jurnal Ilmu Perikanan, 8(2): 6-16

[39] Khairuman and Amri K 2002 Membuat Pakan Ikan Konsumsi. (Jakarta: Agro Media Pustaka)

[40] Anggraeni N M and Abdulgani N 2013 Pengaruh Pemberian Pakan Buatan dan Pakan Alami Terhadap Pertumbuhan Ikan Betutu pada Skala Laboratorium. Jurnal Sains dan Seni Pomits, 2(1): 197-201

[41] Nauli M L 016 Analisis Faktor-Faktor yang Mempengaruhi Risiko Produksi Benih Ikan Neon Tetra di Kecamatan Bojongsari, Kota Depok. Institut Pertanian Bogor. (Bogor: Fakultas Ekonomi dan Manajemen)

[42] Fauziah A F, Agustina T and Hariyati Y 2016 Analisis Pendapatan dan Pemasaran Ikan Lele Dumbo di Desa Mojomulyo Kecamatan Puger. JSEP, 9(1): 20-36

[43] Ruby I and Sasongko 2017 Analisis Produksi Optimum Usaha Tani Ikan Koi (Studi pada Kecamatan Sanankulon, Kabupaten Blitar). Jurnal Ilmiah Mahasiswa Fakultas Ekonomi dan Bisnis, 5(2).