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Analysis of fresh fruit bunches production based on oil palm bioenvironmental factors

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Abstract

Oil palm plantations are a source of foreign exchange for the country. Good management really determines the production of Fresh Fruit Bunches (FFB) of Oil Palm. Sustainable management must take into account all the factors that affect FFB production and have a model that can be used as a guide in oil palm plantations. This study aims to analyze all the factors that affect the production of oil palm FFB and create a model for managing FFB production in oil palm plantations. This study uses survey and observation methods. Observation parameters are the results of interviews, afdeling and research blocks, planting age (year), land area (ha), number of principal production (palm), SPH (space per hectare, palm/ha), type of weeds attack, type of pest attack, type of disease attack, biological agent, number of shoots per tree, average weight (kg/plant), FFB production (tone/ha), fertilization (kg/palm, weed control, pest control, disease control, soil conservation), water conservation, rainfall and rainy days, landscape, area and slope shape, soil family, soil pH, base saturation, slope and land suitability. Data were analyzed by Cobb-Douglas Multiple Linear Regression, SPSS 18. The results showed that the management model of oil palm plantations includes ten bioenvironmental factors, namely bio-physical, bio-agent, topography, climate, fertilization, soil conservation, water conservation, weeds, pests, and diseases. The increase and decrease in the management process affect the production of FFB.

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Introduction

Oil palm plants are in the form of trees, fibrous roots, trunks covered with midribs, compound leaves, and fruit clustered in bunches that emerge from each midrib. The most popular part for processing from oil palm is the fruit known as fresh fruit bunches (FFB). High FFB production with sustainable management is an important solution in the development of oil palm plantations. Based on a long life cycle, oil palm plantations require management starting from seedling, planting, canopy management, fertilization, plant protection, and harvesting. Oil palm is an important crop in the world, but its impact on the economy and the environment has always been questioned (Pahan, 2023).

FFB production is influenced by many factors. Bioenvironmental factors have very complex and interdependent relationship. Several studies have been conducted in the management of oil palm plantations. Ferrianta *et al.* (2017) designed the development of palm oil agroindustry with empowerment strategy. Development of a Spatial Multi Criteria Decision Support Tool for Palm Oil Plantation Management during the replanting period (Safriyana *et al.*, 2020). Improving the performance of agro-industry in state-owned oil palm plantations with a simulation model developed by Farida (2012). However, none of these studies have used bioenvironmental factors focused on FFB production. Many modeling studies on oil palm plantations have been carried out. The large prospect of oil palm in the future makes it important to have a management model for the factors that affect its growth and sustainable productivity.

Materials and methods

Oil palm plantation PT. Sari Lembah Subur is located in Pelalawan Regency, Riau Province, Sumatra-Indonesia. The method used is survey and observation method. The data used are primary and secondary data on mature plants (MP). Primary data taken in oil palm plantations are observation data in the plantation as well as interviews, and land surveys. The secondary data used are monthly reports and company annual reports. The data used is the data from 2021 - 2023. Secondary data includes data: Afdeling and research blocks, planting age (year), land area (ha), total production base (palm), SPH (space per hectare, palm/ha) , type of weeds attack, type of pest attack , type of diseases attack, Biological agents, number of stumps per tree, average weight (kg/plant), FFB production (tonne/ha), fertilization (kg/palm), weed control, pest control, disease control, soil conservation, water conservation, rainfall and rainy days, landscape, area and slope shape, soil family, soil pH, base saturation, slope slope, and land suitability. Based on the type of data collected, the samples taken were grouped into 2 types (Wardani and Dewi, 2021), namely samples of Bio plantation data and samples of Environmental plantation data.

Statistical analysis used is simple regression can be used to predict how far the change in the value of the independent variable on the dependent variable. To determine the effect of independent variables on the dependent variable, a statistical analysis tool is used, namely multiple linear regression with the Cobb-Douglas production function model (Ioan and Ioan, 2015). To determine the effect of variable X on variable Y simultaneously, the F test is used.

To partially test the effect of the independent variable on the dependent variable, a partial regression coefficient test (t test) is used.

Results and discussion

The results of correlation analysis and simple linear regression

The initial stage of statistical analysis in this study is to test the hypothesis of each bio-environmental factor on FFB production. Based on the correlation obtained from the results of the study, it was continued by using a simple linear regression test (Schwarz, 2015). The results of the statistical analysis are shown in Table 1.

The aim is to determine the magnitude of the relationship between variables and the form of the relationship function of each bioenvironmental factor with FFB production and to determine the variable at a constant level as the value increases or decreases (Salmiyati *et al.*, 2017) described in Table 2.

Table 1. Correlation of factors affecting FFB production

Variable	Pearson correlation	Sig. (2 tailed)
Bagworm	-.344**	0.00
Age	.515**	0.00
AntigononPlant	.253**	0.01
FormArea	.271**	0.001
Caterpillar	-.260**	0.001
Nephrolepis	.337**	0.004
Mucuna	.454*	0.017
Herbisida	.278**	0.00
Nfertilizer	.158*	0.044
Pfertilizer	.362**	0.00
Kfertilizer	.507**	0.00
BaseSaturate	.568**	0.00
SlopingLand	.358**	0.00
Area	.888**	0.00
Rat	-.235**	0.005
Palmwaste	.430**	0.00
PHSoil	.856**	0.00
Manure	.306*	0.011
Sph	.557**	0.00
TitoAlba	.395**	0.00
TreatmentWC	.442**	0.00
Orycties	-.600**	0.00
C. curvignathus	-.425**	0.00
BSR	-.388**	0.00
USR	-.427**	0.00
Spear Root	-.326**	0.00
Turnera	.121*	0.00

Factors that have been analyzed based on literature review, influence, nature, results of statistical analysis are grouped. There were 10 groups obtained, namely, bio-physical group, bio-agent, water conservation, soil conservation, fertilizer, topography, climate, herbicide, pest, and diseases. These ten groups are called bioenvironmental factors. The group of biophysical factors is always used as a reference for the development of oil palm plantations, which consists of Age and SPH (Abram *et al.,* 2014). Biological control which is widely used in oil palm plantations to control caterpillar and bagworm pests are beneficial plants, namely *Turnera subulata*, and *Antigonon leptopus*. Meanwhile, to control rat pests, natural predators are used, *Tyto alba* (Quality-RSPO, 2014). Improvement activities in oil palm plantations to optimize water use are water conservation applications. Water conservation activities can increase the optimal production life of oil palm by more than 25 years (Harefa *et al.,* 2024).

Table 2. Analysis results and simple linear regression function between each bioenvironmental factor and FFB production

Model	R^2	Standard Error	F	Sig.	Regression equation
Bagworm	0.118	5.6119	22.893	.000ᵃ	Y =18.926 - 1.719 bagworm
Age	0.265	5.1217	61.789	.000a	Y = 14.483 + 1.318 age
Antigonon plant	0.064	4.6351	10.778	.001a	Y = 22.974 + 0.257 antigonon
FormArea	0.073	3.2398	12.21	.001a	Y = 24.848 + 0.785 formarea
Caterpillar	0.068	7.2614	12.422	.001a	Y = 29.828 - 0.872 caterpillar
Nephrolepis	0.113	3.1857	8.948	.004a	Y = 19.449 + 2.260 nephrolepis
Mucuna	0.206	2.5919	6.484	.017a	Y = 20.704 + 1.347 mucuna
Herbisida	0.077	5.7456	13.116	.000a	Y = 22.551 - 1.044 herbisida
Nfertilizer	0.025	5.5807	4.14	.044a	Y = 21.916 + 0.016 Nfertilizer
Pfertilizer	0.131	2.7693	21.267	.000a	Y = 20.918 + 1.731 Pfertilizer
Kfertilizer	0.257	3.4408	36.58	.000a	Y = 19.876 + 1.353 Kfertilizer
BaseSaturate	0.322	3.1475	71.258	.000a	Y = 16.883 + 1.783 basesaturate
SlopingLand	0.128	2.9767	26.719	.000a	Y = 24.938 + 1.699 SlopingLand
Rat	0.055	5.79286	8.201	.005a	Y = 24.792 - 0.160 rat
Palmwaste	0.185	4.0249	19.093	.000a	Y = 19.499 + 1.367 palmwaste
pHSoil	0.734	2.3325	253.255	.000a	Y = 8.068 + 5.748 pHSoil
Manure	0.093	2.7573	6.796	.011a	Y = 24.022 + 0.246 manure
Sph	0.311	2.725	55.875	.000a	Y = 18.227 + 1.984 sph
TitoAlba	0.156	2.0805	24.066	.000a	Y = 18.310 + 2.799 TitoAlba
Treatment WC	0.196	5.3848	18.01	.000a	Y = 18.995 + 1.559 TreatmentWC
Land suitablity	0.557	2.4273	140.664	.000a	Y = 12.512 + 4.200 land suitability
Orycties	0.36	5.2456	169.66	.000a	Y = 25.579 + (-0.488) orycties
C. curvignathus	0.181	5.933	66.689	.000a	Y = 24.817 + (-0.868) curvignathus
BSR	0.151	6.0427	53.575	.000a	Y = 25.281 - 1.721 BSR
USR	0.182	5.9288	67.368	.000a	Y = 24.764 - 1.143 USR
Spear Root	0.106	6.1996	35.806	.000a	Y = 24.795 - 0.829 spearR
Turnera	0.015	6.7517	4.48	.035a	Y = 23.759 + 0.336 Turnera

The contribution of soil conservation really needs to be a highlight for every oil palm plantation because in addition to increasing FFB production, it can also reduce nutrient loss, store it, and be taken up by oil palm plants without the need for additional fertilizer (Sung, 2016). In the factor fertilizer group, the largest percentage that increased FFB production was P compared to N, K and other nutrients. Topography is a very decisive factor in determining a land to become an oil palm plantation because it is related to the production of FFB and its management (Salmiyati *et al.*, 2017).

Pests and diseases are the most considered factors in oil palm plantations because of their effects that can reduce FFB production (Murphy *et al.*, 2021). Disease actually has a relationship with pests, because in general the causes of disease in oil palm are caused by pests. Herbicide is a chemical control on the presence of weeds in oil palm plantations. The higher the herbicide applied, the greater the weed development in an oil palm plantation. Although the use of herbicides causes pollution when used repeatedly, herbicides are controlling weed development (Verwilgen, 2015).

Bio-physic sub-model

Based on the results of the joint analysis of each group with statistical analysis of multiple linear regression Cobb Douglas functions. The Cobb Douglas function is used to analyze the production of FFB caused by many bio-environmental factors. The results of the analysis of factors that affect the production of FFB from the biophysical group with Cobb Douglas function regression are shown in Table 3, as follows:

Based on the SPSS output in Table 3 above, mathematically it can be written a regression model between the biophysical variables and the variables that influence it in the following equation:

Ln Bio Phisic = 1.213 + 0.764 ln A + 0.455 ln SPH

The resulting model is quite good, as evidenced by a model that is free from classical assumptions, namely normality, autocorrelation, multicollinearity and heteroscedasticity. The results of the model regression analysis show that the coefficient of determination (R2) is 0.962, meaning that together the variable age and SPH affect the production of FFB by or 96.2% while the rest is influenced by other factors that have not been included in the model (Kisman and Restiyanita, 2015). This shows that every decrease and increase in age and SPH greatly affects the production of FFB.

Table 3. Regression model of Cobb Douglas function in the bio-physic group

Variable dependent	Coefficient	t statistics	Sig.	VIF
Constant	1.213	17.608	0.00	
LnAge	0.764	77.88	0.00	1.00
LnSPH	0.455	34.41	0.00	1.00

Table 4. Cob Douglas regression model in the bio-agent group

Variable dependent	Coefficient	t statistics	Sig.	VIF
Constant	2.996	62.525	0.00	
LnAntigonon	0.018	2.97	0.00	1.00
LnTitoA	0.024	4.00	0.00	1.04
LnTurnera	0.028	3.05	0.00	1.04

Agent bio sub model

Bio agents are a group of bioenvironmental factors that affect the production of FFB. The results of statistical analysis of the bioenvironmental factors of the Bio Agent group are shown in Table 4, as follows:

Based on Table 4 above, it can be written mathematically a regression model between the bio agent variable and the variables that influence it in the following equation:

Ln Bio Agen = 2.996 + 0.018 ln AP + 0.024 ln TA + 0.028 ln T

Application The results of the regression analysis of the model show that the coefficient of determination (R2) is 0.265, meaning that together the variables *Antigonon leptosus* plate, *Tyto alba* and *Turnera subulate* affect the production of FFB by or 26.5% while the rest is influenced by other factors that have not been included in the model. *Tyto alba* application in oil palm plantations was effective in controlling rats and increasing FFB production (Primananda *et al.,* 2024).

Water conservation sub-model

Water conservation is an improvement activity in oil palm plantations that is most widely applied because it can improve soil fertility as well as increase FFB productivity (Mohsen *et al.,* 2014). Several water conservation activities and their magnitude of effect on FFB production are described in Table 5, as follows:

The Cobb-Douglas production function is able to describe the state of return to scale, whether it is increasing, constant or decreasing (Ioan and Ioan, 2015). Based on Table 5 above, it can be written mathematically a regression model between the water conservation variable and the variables that influence it in the following equation:

Ln water conservation = 2.442 + 0.16 ln Tr + 0.115 ln ID + 0.133 ln RS + 0.119 ln FM + 0.119 ln Cv

Table 5. Cob Douglas regression model in the water conservation group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	2.442	36.66	0.000	
LnTrench	0.16	4.98	0.000	1.09
LnInfieldDrain	0.115	3.45	0.001	1.09
LnRainSlot	0.133	3.17	0.002	1.07
LnManualFurrow	0.119	3.24	0.002	1.05
LnCelvorts	0.119	3.74	0.000	1.11

Table 6. Cob Douglas regression model in the soil conservation group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	2.936	141.237	0.000	
lnNephrolepis	0.084	4.39	0.000	1.04
lnMucuna	0.052	3.43	0.001	1.10
lnManure	0.049	3.13	0.002	1.04
lnSolid	0.06	4.20	0.000	1.14
lnEFB	0.065	4.22	0.000	1.06
lnBoilerAsh	0.052	3.27	0.001	1.10
lnOrgSlot	0.053	3.29	0.001	1.03

The resulting model is very good as evidenced by a model that is free from classical assumptions, namely normality, autocorrelation, multicollinearity and heteroscedasticity.

Application of water conservation is more effective in increasing FFB production (Ishak, 2015). The results of the regression analysis of the model in this study indicate that the coefficient of determination (R^2) is 0.437, meaning that together the variables trench, infield drain, rain slot, manual furrow, and celvorts affect FFB production by 43.7% while the rest is influenced by other factors which have not been included in the model.

Sub-model soil conservation

The bioenvironmental activity of factor soil conservation aims to improve soil fertility, and prevent loss of soil nutrients, which are used in a fairly long cycle by oil palm plants (Satriawan *et al.,* 2017). Table 6 shows the magnitude of the effect of each soil conservation activity on FFB production. Based on Table 6 above, it can be written mathematically a regression model between the soil conservation variable and the variables that influence it in the following equation:

Ln Soil Conservation = 2.936 + 0.084 ln NL + 0.052 ln Mu + 0.049 ln Ma + 0.06 ln S + 0.065 ln EFB + 0.052 ln BA + 0.053 ln OS

Table 7. Cob Douglas regression model in the nutrient of fertilizer group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	1.523	10.641	0.00	
LnN	0.084	5.10	0.00	1.28
LnP	0.08	6.24	0.00	1.21
LnK	0.111	4.55	0.00	1.08
LnMg	0.033	2.24	0.03	1.04
LnCa	0.024	2.05	0.04	1.02
LnCl	0.067	2.23	0.03	1.11
LnB	0.069	2.29	0.02	1.11

Table 8. Multiple linear regression models in topographical groups

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	0.85	0.436	0.66	
FormArea	0.642	2.85	0.01	2.77
pHSoil	4.914	3.38	0.00	2.75
BaseStr	0.847	4.22	0.00	1.18
SlopingLnd	0.967	2.66	0.01	2.49
LandSuitability	2.117	3.34	0.00	2.94

Table 9. Cob Douglas regression model in the climate group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	0.505	0.505	0.626	
LnRainfall	0.868	3.579	0.006	2.555
LnRain Day	0.571	3.375	0.008	2.555

The results of the model regression analysis show that the coefficient of determination (R^2) is 0.297, meaning that together the *Nephrolepis*, *Mucuna*, Solid, EFB, Boiler ash, and Organic slot variables affect the production of FFB by or 29.7% while the rest is influenced by other factors that have not been identified, included in the model. Palm waste applications (EFB, solid, Pome, and boiler ash) were able to increase FFB productivity by 3.8%/ha (Abdullah and Sulaiman, 2013). The resulting regression model can predict the FFB productivity of palm oil plantations (Huth *et al.,* 2014).

Sub model nutrient of fertilizer

In this sub-model, what is analyzed is the nutrient content in the given fertilizer. Each recommends fertilization that must be in the right dose, it is the nutritional content needed by the oil palm. The following are the results of the analysis on the nutrient of fertilizer group:

Based on Table 7 above, it can be written mathematically a regression model between the nutrient of fertilizer variable and the variables that influence it in the following equation:

$$\text{Ln Nutrient of fertilizer} = 1.523 + 0.084 \ln N + 0.08 \ln P + 0.111 \ln K + 0.033 \ln Mg + 0.024 \ln Ca + 0.067 \ln Cl + 0.069 \ln B$$

The results of the model regression analysis show that the coefficient of determination (R^2) is 0.414, meaning that together the variables Nitrogen, Phosphate, Potassium, Magnesium, Calcium, Chlorine, and Boron affect oil palm production by 41.4% while the rest is influenced by other factors not yet included in the model. Nitrogen, phosphorus, potassium, magnesium and boron are very important in influencing FFB production although Calcium has not been reported to affect it. If there are symptoms of lack of nutrients, it will significantly reduce the yield of the plant (Sugianto *et al.*, 2023). Nitrogen, phosphorus, and potassium are most needed by oil palm because their deficiency affects plant growth, reproductive organ development, carbohydrate metabolism and enzyme activation (Verheye, 2010).

Topographic sub-models

Topography is not a factor that can be improved by oil palm plantations, but all of these factors greatly affect the production of FFB. Following are the results of the analysis that show the magnitude of the influence of topographic factors on the production of FFB.

Based on Table 8 above, it can be written mathematically a regression model between the topography variable and the variables that influence it in the following equation:

$Y = 0.85 + 0.642\ FA + 4.914\ pH + 0.847\ BS + 0.967\ SlL + 2.117\ StL$

The results of the model regression analysis show that the coefficient of determination (R^2) is 0.452, meaning that together the variables of form area, soil pH, base saturation, sloping land, and land suitability affect oil palm production by or 45.2% while the rest is influenced by other factors that have not been included in the model. Soil pH greatly affects the composition of fertilization, soil pH significantly affects N-fertilizer and reduces crop production (Huts *et al.,* 2014). Texture or form area affects the formation of soil pores, soil iron and organic content, cation exchange capacity (CEC), soil fertility, and soil nutrient content. Base saturation affects soil fertility so that it has an impact on crop yields (Paramananthan, 2015). Sloping land and land suitability determine the process of planting and maintaining plantations otherwise the plantations are not at the set standards greatly affecting FFB production, harvesting processes, and transportation of crop yields (Anwar *et al.,* 2014).

Climate sub-models

Climate is a sub-model after analyzing only rainfall and rainday which significantly affect the production of FFB. Table 9 shows the relationship between rainfall and rainfall on FFB production:

The climatic condition that most influences oil palm production in Indonesia is rainfall (Syaukat, 2011). Based on Table 10 above, it can be written mathematically a regression model between the climate variable and the variables that influence it in the following equation:

$Ln\ Climate = 0.505 + 0.868 \ln Rf + 0.571 \ln Rd$

The results of the regression analysis of the model show that the coefficient of determination (R^2) is 0.908, meaning that together the rainfall and rainday variables affect oil palm production by 90.8% while the rest is influenced by other factors that have not been included in the model. Water from rainfall is very much needed by oil palm for the development of generative organs so that it greatly affects FFB production, because an average of 1 ton/ha/year an increase in FFB yield will require an additional 300 mm of annual rainfall (Sung, 2016).

Sub model pests

Based on the results of statistical analysis, only caterpillar, bagworm, rat, orycties, and Copoterme significantly affected FFB production, although there were many other pests. Table 10 shows the magnitude of the influence of pests on FFB production.

Based on Table 10 above, it can be written mathematically a regression model between the pest variable and the variables that influence it in the following equation:

$Ln\ Pest = 3.456 - 0.049 \ln CP - 0.016 \ln BW - 0.028 \ln R - 0{,}203 \ln O - 0.018 \ln C$

The results of the model regression analysis show that the coefficient of determination (R^2) is 0.807, meaning that together the variables Caterpillar, Bagworm, Rat, Orycties, and Curvignathus affect palm oil production by or 80.7% while the rest is influenced by other factors that have not been included in the model. The presence of pests in oil palm plantations gives a negative response such as on leaves, stems, roots, and fruit, even at dangerous levels of attack causing plant death so that it tends to reduce FFB production (Stenek and Connell, 2011).

Sub-model diseases

Disease in oil palm plantations is one of the factors to be avoided in oil palm plantations, because it can reduce FFB production. The results of the Regression analysis with Cob Douglas in Table 11 show the magnitude of the effect of disease in reducing FFB:

Table 10. Cob Douglas regression model in pest group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	3.456	140.078	0.00	
LnCaterpillar	-0.049	-4.72	0.00	1.52
LnBagworm	-0.016	-2.62	0.01	1.12
LnRat	-0.028	-4.16	0.00	1.13
LnOrycties	-0.203	-21.25	0.00	1.57
LnCurvignathus	-0.018	-2.48	0.01	1.20

Table 11. Cob Douglas regression model in disease group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	3.468	52.642	0.00	
LnBSR	-0.039	-2.13	0.04	1.03
LnUSR	-0.012	-2.06	0.04	1.00
LnSpearR	-0.013	-2.09	0.04	1.03

Table 12. Cob Douglas regression model in the herbicide group

Variable dependent	Coefficient	t statistics [a]	Sig.	VIF
Constant	3.315	72.524	0.00	
LnGliphosate	-0.038	-2.21	0.03	1.12
LnParaquate	-0.025	-2.13	0.03	1.05
LnMetasulfuron	-0.071	-2.02	0.05	1.12

The results of this study indicate that the percentage of BSR disease affects the production of FFB more than other diseases. The results of the analysis based on Table 11 above can mathematically be written a regression model between the disease variable and the variables that affect it in the following equation:

Ln Diseases = 3.468 - 0.039 ln BSR - 0.012 ln USR - 0.013 ln SR

Based on the results of the regression analysis of the model in this study, it shows that the coefficient of determination (R^2) is 0.068, meaning that together the variables BSR, USR and spear rot affect palm oil production by or 6.8% while the rest is influenced by other factors that have not been included in the model. . The nutritional content of oil palm plants is closely related to the development of diseases in oil palm plantations (Sheil *et al.,* 2009; Verheye, 2010).

Herbicide sub model

Herbicides are chemical compounds to control weeds. The application of herbicides in oil palm plantations indicates the presence of weeds, which means that the more herbicides applied, the wider the plantation area covered with weeds (Mohamad *et al.,* 2010). The results of the regression analysis in this study showed that the application of herbicides due to the presence of weeds reduced the production of oil palm FFB. Table 12 describes these relationships.

Based on Table 12 above, it can be written mathematically a regression model between the herbicide variable and the variables that influence it in the following equation:

Ln Herbicide = 3.315 - 0.038 ln Gly - 0.025 ln Prq - 0.071 ln Mms

The results of the regression analysis of this research model indicate that the coefficient of determination (R^2) is 0.068, meaning that together the variables glyphosate, paraquate, and methyl metasulfuron affect oil palm production by or 6.8% while the rest is influenced by other factors that have not been included in the model. Glyphosate is most effective in eradicating weeds in juveniles, although glyphosate is also effective at any age of oil palm without showing any symptoms of phytotoxicity in oil palm plants (Ekhator *et al.,* 2018). The presence of weeds in oil palm plantations is both beneficial and detrimental. Adverse weeds can reduce FFB production (Anwar *et al.,* 2014).

Conclusion

The results showed that the production management model of oil palm FFB can be grouped into ten bioenvironmental factors, namely bio-physical, bio-agent, topography, climate, fertilization, soil conservation, water conservation, weeds, pests, and diseases. The increase and decrease in the management of each group of bioenvironmental factors affect the production of oil palm FFB.

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