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Analisis Interpretasi Antara Hujan dan Jumlah Tandan Terhadap Produktivitas Dua Varietas Tanaman Kelapa Sawit (*Elaeis guineensis* Jacq.) di PT. Perkebunan Nusantara IV Kebun Laras

Interpretive Analysis Between Rainfall and Number of Fruit Bunches on the Productivity of Two Oil Palm (Elaeis guineensis Jacq.*) Varieties at PT. Perkebunan Nusantara IV Kebun Laras*

Desi Riantika Br Gurusinga[1], Irsal[*2]

[1]*Program Studi Agroteknologi, Fakultas Pertanian USU,20155, Medan*

[2]*Program Studi Agroteknologi, Fakultas Pertanian USU,20155, Medan*

[*]Corresponding Author: irsal@usu.ac.id

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ABSTRACT

This study aims to understand and analyze the effect of rainfall, rainy days, and the number of fruit bunches on the productivity of two oil palm varieties (Elaeis guineensis Jacq.), namely PPKS DxP 540 NG and Socfindo MT Gano, at PT. Perkebunan Nusantara IV Kebun Laras Regional II. The study uses secondary data from 2016–2025, covering productivity, number of fruit bunches, rainfall, and rainy days. Multiple linear regression and correlation analyses were conducted using SPSS v.31. The results show that rainfall and the number of rainy days do not significantly affect productivity in either variety. The number of fruit bunches significantly affects productivity for both varieties. Simultaneously, the three variables have a significant impact on oil palm productivity. The strength of the correlation ranges from fairly weak to strong for both varieties.

Keyword: number of fruit bunches, oil palm productivity rainfall, rainy days, varieties

ABSTRAK

Penelitian ini bertujuan untuk mengetahui dan menganalisis pengaruh curah hujan, hari hujan, dan jumlah tandan terhadap produktivitas dua varietas kelapa sawit (*Elaeis guineensis* **Jacq**.), yaitu varietas PPKS DxP 540 NG dan Socfindo MT Gano di PT. Perkebunan Nusantara IV Kebun Laras Regional II. Penelitian menggunakan data sekunder tahun 2016–2025 meliputi data produktivitas, jumlah tandan, curah hujan, dan hari hujan. Metode analisis menggunakan regresi linier berganda dan korelasi dengan bantuan SPSS v.31. Hasil penelitian menunjukkan bahwa curah hujan dan hari hujan berpengaruh tidak nyata secara parsial terhadap produktivitas kelapa sawit pada kedua varietas. Jumlah tandan berpengaruh nyata terhadap peningkatan produktivitas pada kedua varietas. Secara simultan, curah hujan, hari hujan, dan jumlah tandan berpengaruh nyata terhadap produktivitas kelapa sawit. Analisis korelasi menunjukkan tingkat keeratan yang bervariasi dari agak lemah hingga kuat pada kedua varietas.

Kata kunci: *jumlah tandan, produktivitas kelapa sawit, curah hujan, hari hujan varietas*

1. Introduction

Oil palm (Elaeis guineensis Jacq.) is one of the plantation commodities that plays a significant role in the economy of Indonesia because it is capable of producing vegetable oil that is highly needed by the industrial sector. Indonesia is the largest producer of palm oil in the world. The productivity of oil palm in Indonesia is a major concern because this commodity is the largest foreign exchange contributor for the country (Arsyad and Maryam, 2017).

In 2023, Indonesia produced 47.08 million tons of palm oil, while in 2024, total CPO production reached 45.44 million tons. Riau Province became the main production center with a total output of 9.136 million tons or about 20.11 percent of the national total production (BPS, 2024). Despite having great potential, there are challenges in improving this productivity. The growth and productivity of palm oil are influenced by various interrelated factors, including environmental factors, cultivation techniques, and resource management (PPKS, 2006).

Rainfall is one of the most important climatic factors in the growth of oil palm plants. Ecologically, oil palm is a plant that requires the most water during its growth process and will grow well if groundwater is sufficiently available. Rainfall can limit the potential yield of oil palm as well as its productivity (Harahap *et al*., 2021).

Oil palm plants can grow well on land with adequate rainfall of 1,750–3,000 mm/year, with evenly distributed rainfall throughout the year. Excessive rainfall can cause several problems, including a decline in the quality and quantity of the harvest. Changes in the number of bunches due to climate variability usually have the greatest impact on the harvest cycle (Junaedi *et al.,* 2021).

PTPN IV Regional II Kebun Laras is one of the oil palm plantation areas located in a region with a relatively high annual rainfall. The average annual rainfall in this area over 9 years (2016–2024) reached 2,511 mm, with an average of about 125 rainy days/year. The number of oil palm bunches is influenced by various complex environmental and agronomic factors. The interaction between rainfall, rainy days, and the number of bunches, along with the superior varieties used, is an important aspect of oil palm cultivation that affects plant productivity.

Based on the description, this study aims to determine the relationship between rainfall, rainy days, and the number of bunches with the productivity of two varieties of oil palm (*Elaeis guineensis* **Jacq**.) at PT. Perkebunan Nusantara IV Kebun Laras.

2. Research Method

This research was conducted at PT. Perkebunan Nusantara IV Kebun Laras Regional II, located in Bandar Huluan District, Simalungun Regency, North Sumatra Province, at an altitude of ±130 meters above sea level. This study used a quantitative descriptive method.

The sources of research data were TM 2011 Socfindo MT Gano variety and TM 2012 PPKS DxP 540 NG variety in Afdeling III of PT. Perkebunan Nusantara IV Kebun Laras. The secondary data used include rainfall data and rainy days from 2016–2024 as well as productivity data and the number of bunches from 2017–2025 obtained from the plantation office administration.

The analysis methods used are multiple linear regression and correlation analysis. The model feasibility test was conducted through classical assumption tests, which include the normality test (Kolmogorov-Smirnov), heteroscedasticity test (Glejser), multicollinearity test (VIF/tolerance), and autocorrelation test (Run Test) with the assistance of SPSS software version 31. The regression equation model used is:

$$\mathbf{Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \varepsilon}$$

Description:

Y : oil palm productivity

a : intercept

b : regression coefficient

X_1 : monthly rainfall

X_2 : monthly rainy days

X_3 : number of bunches

ε : error

The criteria for interpreting correlations refer to the following table:

Table 1. Interpretation of R values in correlation analysis

R Value	Interpretation
0,00	No correlation
0,01-0,20	Very Weak
0,21-0,40	Weak
0,41-0,60	Somewhat Weak
0,61-0,80	Fair
0,81-0,99	Strong
1,00	Very Strong

3. Results and Discussion

The average data of FFB productivity (kg/ha), bunch count (bunches/ha), monthly rainfall (mm/month), and monthly rainy days (days/month) during the research period can be seen in the following tables.

Table 2. Average Productivity of PPKS Oil Palm Varieties at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2017–2025)

Month	Year									Average
	2017	2018	2019	2020	2021	2022	2023	2024	2025	
	..……..……kg/ha……..……									
Jan	1.246	1.103	1.739	1.521	628	1.110	1.491	2.058	2.031	1.436
Feb	404	556	1.198	1.283	1.252	1.009	2.150	2.632	1.617	1.344
Mar	798	648	915	1.620	1.904	1.591	2.584	2.505	1.715	1.587
Apr	1.729	993	1.367	2.678	2.600	1.837	2.779	2.556	2.133	2.075
May	2.119	1.783	1.472	2.219	1.483	2.099	2.206	2.594	1.899	1.986
Jun	2.314	1.734	1.491	2.621	4.055	2.707	2.030	3.268	2.513	2.526
Jul	2.767	1.298	2.287	1.778	2.708	2.289	2.200	2.527	2.161	2.224
Aug	2.163	2.205	2.044	1.894	2.579	3.260	2.255	2.417	2.194	2.335
Sep	1.786	1.908	2.204	1.933	2.930	2.400	2.346	3.001	2.626	2.348
Oct	1.805	2.022	2.750	1.859	2.647	2.916	3.040	2.225	2.481	2.416
Nov	1.660	2.051	1.887	1.569	2.329	2.950	2.711	1.247	2.219	2.069
Dec	1.592	1.754	1.876	1.384	1.735	2.766	1.545	1.367	2.454	1.830
Total	20.382	18.055	21.231	22.360	26.849	26.935	27.336	28.398	26.042	

In Table 2, it can be seen that the average productivity of PPKS palm oil varieties is highest in June (2,526 kg/ha) and lowest in February (1,344 kg/ha).

Table 3. Average Productivity of Oil Palm Plants in Socfindo Varieties at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2017–2025)

Month	Year									Average
	2017	2018	2019	2020	2021	2022	2023	2024	2025	
	..……..……kg/ha……..……									
Jan	1.178	1.287	2.693	1.776	1.217	1.361	1.330	1.953	1.849	1.627
Feb	378	727	1.813	1.799	1.646	1.967	1.874	2.304	1.744	1.584
Mar	681	870	1.652	3.075	2.587	1.985	2.469	2.085	1.573	1.886
Apr	1.166	1.170	1.457	2.778	2.518	2.023	2.094	2.692	1.896	1.977
May	1.427	1.218	2.191	1.043	2.335	1.659	2.194	2.625	2.065	1.862
Jun	2.148	1.001	1.661	1.257	2.285	1.664	2.262	3.107	2.118	1.945
Jul	1.866	1.582	1.977	1.756	1.913	1.887	1.755	2.962	2.062	1.973
Aug	2.496	2.480	2.086	2.209	2.260	2.246	2.916	3.146	2.654	2.499
Sep	1.540	2.160	1.357	2.338	3.623	2.518	2.494	2.680	2.145	2.317
Oct	1.526	2.281	2.453	2.629	2.767	2.820	2.550	2.527	2.034	2.399
Nov	1.633	2.135	1.304	1.962	2.904	3.195	2.955	1.815	2.104	2.223
Dec	1.249	1.868	1.595	2.005	2.850	3.404	1.932	2.305	2.648	2.206
Total	17.289	18.780	22.239	24.627	28.903	26.729	26.826	30.200	24.893	

In Table 3, it can be seen that the highest average productivity of Socfindo palm oil variety occurs in August (2,499 kg/ha) and the lowest in February (1,584 kg/ha).

Table 4. Average Number of Bunches of Oil Palm Plants of PPKS Varieties at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2017–2025)

Month	Year									Average
	2017	2018	2019	2020	2021	2022	2023	2024	2025	
	..……..……. bunches/ha…….……									
Jan	276	151	198	129	40	65	72	89	93	128
Feb	81	76	128	113	85	59	101	116	79	95
Mar	159	85	101	135	139	86	119	115	84	117
Apr	336	121	148	216	174	91	132	121	107	167
May	410	216	146	181	101	103	103	117	91	172
Jun	386	197	131	207	253	129	94	152	121	193
Jul	459	151	192	143	163	103	95	123	105	179
Aug	358	245	168	136	148	155	92	116	113	177
Sep	295	208	173	137	163	115	99	142	129	166
Oct	298	235	223	134	156	138	129	106	121	177
Nov	273	222	154	113	136	142	117	66	105	153
Dec	227	200	151	99	100	145	65	67	123	132
Total	3.557	2.106	1.913	1.743	1.657	1.332	1.218	1.331	1.272	

In Table 4, it can be seen that the highest average number of bunches for the PPKS variety occurs in June (193 bunches/ha) and the lowest in February (95 bunches/ha).

Table 5. Average Number of Bunches of Oil Palm Plants of the Socfindo Variety at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2017–2025)

Month	Year									Average
	2017	2018	2019	2020	2021	2022	2023	2024	2025	
	..……..……. bunches/ha…….……									
Jan	168	128	205	119	81	76	58	80	83	111
Feb	46	71	134	115	96	109	88	91	84	93
Mar	84	82	129	199	143	100	112	85	74	112
Apr	144	105	122	167	129	99	97	111	99	119
May	177	108	165	77	143	78	97	110	105	118
Jun	242	89	114	88	135	80	101	134	101	120
Jul	209	134	124	109	108	89	75	124	102	119
Aug	267	195	135	133	121	100	117	141	128	149
Sep	161	153	79	132	178	120	98	129	102	128
Oct	159	174	144	147	144	128	99	121	99	135
Nov	171	174	85	116	151	149	120	82	101	128
Dec	125	150	102	124	152	163	78	106	119	124
Total	1.952	1.564	1.537	1.526	1.581	1.288	1.140	1.314	1.197	

In Table 5, it can be seen that the highest average number of bunches of the Socfindo Variety occurs in August (149 bunches/ha) and the lowest in February (93 bunches/ha).

Table 6. Average Rainfall at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2016–2024)

Month	Year									Average
	2016	2017	2018	2019	2020	2021	2022	2023	2024	
	……..…mm/month ……									
Jan	114	247	261	197	87	281	96	85	73	160
Feb	130	165	149	73	62	74	301	58	156	130
Mar	15	219	64	75	33	153	262	78	72	108
Apr	7	228	202	374	206	145	97	102	151	168
May	179	231	174	222	300	299	177	102	168	206
Jun	173	165	212	187	471	252	282	81	105	214
Jul	218	148	277	134	226	225	178	82	145	181
Aug	196	287	174	209	158	364	236	305	316	249
Sep	268	444	408	130	304	216	210	301	171	272
Oct	227	226	339	297	202	327	408	298	431	306
Nov	135	308	394	280	382	433	358	144	373	312
Dec	170	311	93	228	309	99	294	128	207	204
Total	1.832	2.980	2.747	2.405	2.739	2.868	2.899	1.763	2.368	

In Table 6, it can be seen that the highest average rainfall occurs in November (312 mm/month) and the lowest in March (108 mm/month). The total average rainfall over 9 years is 2,511 mm/year.

Table 7. Average Rainy Days at PT. Perkebunan Nusantara IV Kebun Laras over 9 Years (2016–2024)

Month	Year									Average
	2016	2017	2018	2019	2020	2021	2022	2023	2024	
	……..…days/month ……									
Jan	7	13	12	8	5	13	6	6	8	9
Feb	11	9	4	4	5	2	9	3	9	6
Mar	2	10	5	5	6	9	7	7	6	6
Apr	2	12	9	9	12	12	7	5	7	8
May	10	10	10	12	14	13	9	8	6	10
Jun	8	7	12	9	16	12	15	3	7	10
Jul	9	9	12	8	12	8	9	9	10	9
Aug	11	17	12	10	9	18	11	18	12	13
Sep	16	17	15	13	16	10	10	16	7	13
Oct	11	3	19	16	16	13	18	13	16	14
Nov	10	12	15	11	19	20	18	11	17	15
Dec	13	11	8	11	12	5	13	9	14	11
Total	110	131	132	116	142	135	133	108	120	

In Table 7, it can be seen that the highest average number of rainy days occurs in November (15 days/month) and the lowest in February and March (6 days/month). The total average number of rainy days over 9 years is 125 days/year.

3.1 Analysis of PPKS Varieties

Table 8. Average Productivity, Rainfall, Rainy Days, Number of Bunches of PPKS Varieties at PT. Perkebunan Nusantara IV Kebun Laras

Month	Average			
	Productivity	Rainfall	Rainy Days	Number of Bunches
	kg/ha	mm/ month	hari/ month	Bunches /ha
January	1.436	160	9	124
February	1.344	130	6	93
March	1.587	108	6	114
April	2.075	168	8	161
May	1.986	206	10	163
June	2.526	214	10	185
July	2.224	181	9	170
August	2.335	249	13	170
September	2.348	272	13	162
October	2.416	306	14	171
November	2.069	312	15	148
December	1.830	204	11	131
Total	24.177	2.511	125	1.792

Table 8 shows that the total average productivity of the PPKS oil palm variety over 9 years was 24,177 kg/ha, the total rainfall was 2,511 mm/year, rainy days were 125 days/year, and the number of bunches was 1,792 bunches/ha.

3.1.1 Classical Assumption Test for PPKS Varieties

Table 9. Classical Assumption Test of rainfall, rainy days, and bunch number on the productivity of PPKS oil palm varieties

One-Sample Kolmogorov-Smirnov Normality Test		
Asymp. Sig. (2-tailed)		0,200
Glejser Heteroskedasticity Test		
Model		Sig.
(Constant)		0,609
Rainfall		0,140
Rainy Days		0,155
Number of Bunches		0,620
Multicollinearity Test		
Model	Tolerance	VIF
Rainfall	0,909	1,100
Rainy Days	0,900	1,112
Number of Bunches	0,946	1,058
Autocorrelation Test		
Asymp. Sig. (2-tailed)		0,762

Based on Table 9, the research data has met all classical assumptions. The normality test indicates that the data is normally distributed (sig. 0.200 > 0.05). There is no heteroscedasticity (all sig. > 0.05), multicollinearity (VIF < 10; tolerance > 0.1), or autocorrelation (sig. 0.762 > 0.05), thus the model is feasible to use.

3.1.2 Correlation Analysis of PPKS Varieties

Table 10. Correlation Analysis Test of Rainfall, Rainy Days, and Bunch Number on the Productivity of PPKS Varieties

Variables	Test Statistics	Variables			
		Productivity	Rainfall	Rainy Days	Number of Bunches
Productivity	Pearson Correlation	1	0,703*	0,649*	0,946***
	Sig. (2-tailed)		0,011	0,022	< 0,001
	N	12	12	12	12
Rainfall	Pearson Correlation	0,703*	1	0,979***	0,602*
	Sig. (2-tailed)	0,011		<,001	0,038
	N	12	12	12	12
Rainy Days	Pearson Correlation	0,649*	0,979***	1	0,563
	Sig. (2-tailed)	0,022	< 0,001		0,057
	N	12	12	12	12
Number of Bunches	Pearson Correlation	0,946***	0,602*	0,563	1
	Sig. (2-tailed)	< 0,001	0,038	0,057	
	N	12	12	12	12

Table 10 shows the correlation coefficient between rainfall and the productivity of the PPKS Variety at 0.703 (moderate relationship, significant, p= 0.011). The correlation between rainy days and productivity is 0.649 (moderate relationship, significant, p=0.022). The correlation between the number of bunches and productivity is 0.946 (strong relationship, highly significant, p<0.001). All coefficients are positive, which means that an increase in the independent variables tends to be followed by an increase in productivity.

3.1.3 Multiple Linear Regression Analysis of PPKS Varieties

Table 11. The coefficient values of the multiple linear regression equation for rainfall, rainy days, and the bunch count of PPKS varieties

Model Summary			
Model	R	R Square	Adjusted R Square
1	0,965[a]	0,931	0,905

From the table above, it is found that rainfall, rainy days, and the number of bunches in the productivity of PPKS oil palm varieties have a correlation coefficient (R) of 96.5%, a coefficient of determination (R^2) of 93.1%, and an adjusted coefficient of determination (Adjusted R^2) of 90.5%. The coefficient of determination

(R^2) indicates that 93.1% of the productivity of PPKS oil palm varieties can be explained by the variables of rainfall, rainy days, and the number of bunches, while the remaining 6.9% is explained by other variables not included in this model.

Table 12. Partial t-Test of Rainfall, Rainy Days, and Bunch Number on Oil Palm Productivity of PPKS Varieties

Productivity	Variables	t-count	Significance Value	t-table
9 years	Rainfall	1,339	$0,217^{tn}$	2,201
	Rainy Days	-0,928	$0,381^{tn}$	2,201
	Number of Bunches	6,808	$< 0,001^{n}$	2,201

Note: ^{tn} = not significantly different

^{n} = significantly different

The results of the partial t-test above indicate that the significance value of the rainfall variable on oil palm plants of the PPKS variety over 9 years (2017-2025) is greater than 5% (Sig. > α 0.05), namely 0.217 > 0.05. The t-table value obtained is 2.201, thus the calculated t-value < t-table value, i.e., 1.339 < 2.201. Therefore, it can be concluded that the calculated t-value is not significantly different at the 95% confidence level (Ho is accepted). Thus, the rainfall variable has an insignificant effect on increasing the productivity of PPKS oil palm varieties.

The results of the partial t-test above indicate that the significance value of the rainy days variable on the PPKS palm oil variety over 9 years (2017-2025) is greater than 5% (Sig. > α 0.05), which is 0.381 > 0.05, and the calculated t-value is less than the table t-value, which is -0.928 < 2.201. It can thus be concluded that the calculated t-value is not significantly different at a 95% confidence level (H0 is accepted). Therefore, the rainy days variable partially has an insignificant effect on increasing the productivity of the PPKS palm oil variety.

The results of the partial t-test above indicate that the significance value of the bunch number variable in oil palm plants of the PPKS variety over 9 years (2017-2025) is less than 5% (Sig. < α 0.05), namely < 0.001 < 0.05, and the t-calculated value > t-table value, which is 6.808 > 2.201. Therefore, it can be concluded that the calculated t has a significant effect at the 95% confidence level (H0 is rejected). Thus, the number of bunches variable has a significant partial effect on increasing the productivity of the PPKS variety oil palm.

Table 13. Analysis of variance for the multiple linear regression equation in oil palm plants of the PPKS variety

Productivity	Sources of Diversity	F-count	Sig.	F-table
9 years	Regression	36,019	$< 0,001^{n}$	4,066

Based on the variance table above, it shows that for the productivity of PPKS palm oil varieties over 9 years (2017-2025), the calculated F value is greater than the table F value, namely 36.019 > 4.066, and the significance value in this test is less than 5% (Sig. < α 0.05), specifically < 0.001 < 0.05. So, it can be concluded that the calculated F has a significant effect at a 95% confidence level (H0 is rejected). This means that the variables of rainfall, rainy days, and the number of PPKS bunches in the regression model simultaneously have a significant effect on the productivity of PPKS palm oil varieties over 9 years (2017-2025).

Table 14. Multiple Linear Regression Testing Model for PPKS Varieties

Productivity	Variables	Regression coefficient	Sig.
9 years	Constant	106,199	0,639
	Rainfall	3,823	0,217
	Rainy Days	-56,378	0,381
	Number of Bunches	11,326	< 0,001

The regression equation obtained is:

$$\hat{Y} = 106,199 + 3,823 \text{ rainfall} - 56,378 \text{ rainy days} + 11,326 \text{ number of bunches} + \varepsilon$$

3.2 Analysis of Socfindo Varieties

Table 15. Average Productivity, Rainfall, Rainy Days, Number of Bunches of Socfindo Varieties at PT. Perkebunan Nusantara IV Kebun Laras

Month	Average			
	Productivity	Rainfall	Rainy Days	Number of Bunches
	kg/ha	mm/ month	hari/ month	Bunches /ha
January	1.627	160	9	111
February	1.584	130	6	93
March	1.886	108	6	112
April	1.977	168	8	119
May	1.862	206	10	118
June	1.945	214	10	120
July	1.973	181	9	119
August	2.499	249	13	149
September	2.317	272	13	128
October	2.399	306	14	135
November	2.223	312	15	128
December	2.206	204	11	124
Total	24.498	2.511	125	total 1.455

In Table 15, it can be seen that the total average oil palm productivity over 9 years (2017 – 2025) was 24,498 kg/ha, the total average rainfall over 9 years (2016 – 2024) was 2,511 mm/year, the average number of rainy days over 9 years (2016 – 2024) was 125 days/year, and the total average number of bunches of Socfindo variety oil palm plants over 9 years (2017 – 2025) was 1,455 bunches/ha.

3.2..1 Classical Assumption Test for PPKS Varieties

Table 16. Classic assumption test of rainfall, rainy days, and bunch count on the productivity of Socfindo variety oil palm

One-Sample Kolmogorov-Smirnov Normality Test	
Asymp. Sig. (2-tailed)	0,200
Glejser Heteroskedasticity Test	
Model	Sig.
(Constant)	0,079
Rainfall	0,069
Rainy Days	0,075
Number of Bunches	0,165
Multicollinearity Test	
Model	Tolerance / VIF
Rainfall	0,909 / 1,664
Rainy Days	0,900 / 1,199
Number of Bunches	0,946 / 1,840
Autocorrelation Test	
Asymp. Sig. (2-tailed)	0,130

Based on Table 16, the research data has met all classical assumptions. The normality test indicates that the data is normally distributed (sig. 0.200 > 0.05). There is no heteroscedasticity (all sig. > 0.05), multicollinearity (VIF < 10; tolerance > 0.1), or autocorrelation (sig. 0.130 > 0.05), thus the model is feasible to use.

3.2.2 Correlation Analysis of Socfindo Varieties

Table 17. Correlation Analysis Test of Rainfall, Rainy Days, and Bunch Number on the Productivity of Socfindo Varieties

Variables	Test Statistics	Variables			
		Productivity	Rainfall	Rainy Days	Number of Bunches
Productivity	Pearson Correlation	1	0,790**	0,820**	0,930***
	Sig. (2-tailed)		0,002	0,001	< 0,001
	N	12	12	12	12
Rainfall	Pearson Correlation	0,790**	1	0,979***	0,749**
	Sig. (2-tailed)	0,002		< 0,001	0,005
	N	12	12	12	12
Rainy Days	Pearson Correlation	0,820**	0,979***	1	0,809**
	Sig. (2-tailed)	0,001	< 0,001		0,001
	N	12	12	12	12
Number of Bunches	Pearson Correlation	0,930***	0,749**	0,809**	1
	Sig. (2-tailed)	< 0,001	0,005	0,001	
	N	12	12	12	12

Table 17 shows the correlation coefficient between rainfall and the productivity of the Socfindo variety at 0.790 (moderate relationship, highly significant, p=0.002). The correlation between rainy days and productivity is 0.820 (strong relationship, highly significant, p=0.001). The correlation between bunch number and productivity is 0.930 (strong relationship, highly significant, p<0.001). All coefficients are positively signed.

3.2.3 Multiple Linear Regression Analysis of Socfindo Varieties

Table 18. The coefficient values of the multiple linear regression equation for rainfall, rainy days, and the number of bunches of the Socfindo variety

Model Summary			
Model	R	R Square	Adjusted R Square
0,944a	0,890	0,849	0,944a

From the table above, it can be seen that rainfall, rainy days, and the number of bunches in the productivity of Socfindo palm oil variety have a correlation coefficient (R) of 94.4%, a determination coefficient (R^2) of 89%, and an adjusted determination coefficient (Adjusted R^2) of 84.9%. The determination coefficient (R^2) indicates that 89% of the productivity of Socfindo palm oil variety can be explained by the variables of rainfall, rainy days, and the number of bunches that occur, while the remaining 11% is explained by other variables that are not included in this model.

Table 19. Partial t-Test of rainfall, rainy days, and number of bunches on the productivity of Socfindo variety oil palm

Productivity	Variables	t-count	Significance Value	t-table
9 years	Rainfall	0,946	0,372 tn	2,201
	Rainy Days	-0,624	0,550 tn	2,201
	Number of Bunches	3,962	0,004 n	2,201

Note: ^{tn} = not significantly different

^{n} = significantly different

The partial t-test results above show that the significance value of the rainfall variable on Socfindo variety oil palm over 9 years (2017-2025) is greater than 5% (Sig. > α 0.05), which is 0.372 > 0.05. The t-table value obtained is 2.201, so the calculated t-value < t-table, which is 0.946 < 2.201. It can be concluded that the calculated t-value is not significantly different at a 95% confidence level (H0 accepted). Thus, the rainfall variable does not have a significant effect on increasing the productivity of the Socfindo variety oil palm.

The results of the partial t-test above indicate that the significance value of the rainy days variable on Socfindo oil palm plants over 9 years (2017-2025) is greater than 5% (Sig. > α 0.05), which is 0.550 > 0.05, and the calculated t-value < the t-table value, which is -0.624 < 2.201. It can therefore be concluded that the calculated

t-value is not significantly different at the 95% confidence level (H0 is accepted). Thus, the rainy days variable partially has an insignificant effect on increasing the productivity of Socfindo oil palm.

The results of the partial t-test above indicate that the significance value of the variable for the number of bunches in Socfindo palm oil plants over 9 years (2017-2025) is less than 5% (Sig. < α 0.05), namely 0.004 < 0.05, and the calculated t-value is greater than the t-table value, i.e., 3.962 > 2.201. Therefore, it can be concluded that the calculated t has a significant effect at the 95% confidence level (H0 is rejected). Thus, the variable of the number of bunches partially has a significant effect on increasing the productivity of Socfindo palm oil plants.

Table 20. Analysis of variability in multiple linear regression equations on Socfindo variety oil palm plants

Productivity	Sources of Diversity	F-count	Sig.	F-table
9 years	Regression	21,644	< 0,001[n]	4,066

Based on the variance table above, it shows that for the productivity of Socfindo palm oil varieties over 9 years (2017-2025), the calculated F value is greater than the table F value, namely 21.644 > 4.066, and the significance value in this test is less than 5% (Sig. < α 0.05), specifically < 0.001 < 0.05. So, it can be concluded that the calculated F has a significant effect at a 95% confidence level (H0 is rejected). This means that the variables of rainfall, rainy days, and the number of Socfindo bunches in the regression model simultaneously have a significant effect on the productivity of Socfindo palm oil varieties over 9 years (2017-2025).

Table 21. Multiple Linear Regression Testing Model of Socfindo Varieties

Productivity	Variables	Regression coefficient	Sig.
9 years	Constant	-232,720	0,559
	Rainfall	2,578	0,372
	Rainy Days	-42,253	0,550
	Number of Bunches	17,897	0,004

The regression equation obtained is:

$$\hat{Y} = -232{,}720 + 2{,}578 \text{ rainfall} - 42{,}253 \text{ rainy days} + 17{,}897 \text{ number of bunches} + \varepsilon$$

3.3 Discussion

3.3.1 The Effect of Rainfall on Productivity

PT. Perkebunan Nusantara IV Kebun Laras has an average rainfall over 9 years (2016–2024) of 2,511 mm/year, which is within the optimal range (1,500–4,000 mm/year) for oil palm growth (Hartanto, 2011). The correlation coefficient between rainfall and productivity is positive for both varieties (PPKS: r=0.703; Socfindo: r=0.790), indicating that an increase in rainfall within the optimal range tends to increase productivity.

Even though there is a significant correlation, the partial t-test shows that rainfall does not have a significant individual effect on the productivity of both varieties (PPKS: sig.=0.217; Socfindo: sig.=0.372). This is thought to be because the rainfall conditions in Kebun Laras are generally within an optimal range and evenly distributed, so variations in rainfall do not make a significant difference to productivity on a partial basis. In the multiple regression model, the rainfall coefficient is positive for both varieties, confirming that moderate rainfall has a positive impact on productivity (Harahap *et al.,* 2021).

3.3.2 Effect of Rainy Days on Productivity

The average number of rainy days in Laras Plantation over 9 years was 125 days/year, below the critical threshold of 180 days/year recommended for oil palm cultivation (Hartanto, 2011). The regression coefficient for rainy days was negative in both varieties (PPKS: -56.378; Socfindo: -42.253), indicating that a high frequency of rainy days has an unfavorable impact on productivity.

Correlation analysis reinforces this finding, where the correlation coefficient between the number of bunches and the productivity of the PPKS Variety reached 0.946 and the Socfindo Variety 0.930, both falling into the category of a strong and highly significant relationship. The number of bunches is the main yield component that directly determines the total FFB production in oil palm plants (Depari *et al*., 2015).

3.3.4 Simultaneous Effect

Simultaneously, rainfall, rainy days, and the number of fruit bunches have a significant effect on oil palm productivity in both varieties (PPKS: F=36.019; Socfindo: F=21.644; both sig.<0.001). The R^2 value for the PPKS variety is 93.1% and for the Socfindo variety is 89.0%, indicating that the three independent variables are able to explain most of the variation in productivity. The regression equation pattern in both varieties is consistent, namely rainfall and the number of fruit bunches have a positive effect, while rainy days have a negative effect on productivity.

The comparison between the two varieties shows that the bunch number coefficient in the Socfindo Variety (17.897) is higher than in the PPKS Variety (11.326), indicating that the productivity responsiveness to the addition of bunches is higher in the Socfindo Variety. This can be a consideration in the selection of varieties and plantation management (Barcelos *et al*., 2015).

4. Conclusions and Recommendations

4.1 Conclusions

1. Rainfall partially has no significant effect on the productivity of oil palm plants in PPKS and Socfindo Varieties over 9 years (2017–2025).
2. Rainy days partially have no significant effect on the productivity of oil palm plants in PPKS and Socfindo Varieties over 9 years.
3. The number of fruit bunches partially has a significant effect on the productivity of oil palm plants in PPKS and Socfindo Varieties over 9 years.
4. Rainfall, rainy days, and the number of fruit bunches simultaneously have a significant effect on oil palm productivity in PPKS and Socfindo Varieties over 9 years.
5. The correlation of rainfall, rainy days, and the number of fruit bunches has varying strengths ranging from fairly weak to strong with respect to productivity in each variety.

4.2 Suggestions

Further research needs to be conducted by adding observational variables at several plant age levels as well as more varieties in different plantations so that the results obtained can be used as a broader reference for palm oil plantation management.

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