Application of the NDVI and ARVI methods in measuring estimated productivity of oil palm plants using Landsat 8 Imagery at PT. Hindoli Cargill Indonesia

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Abstract. The NDVI (Normalized Difference Vegetation Index) method is one of the usually used vegetation index transformations in society. The NDVI value is used to evaluate the density and health conditions of oil palm plants. The ARVI (Atmospherically Resistant Vegetation Index) method is one of the vegetation index transformations that focuses on suppressing atmospheric influences. The ARVI method focuses on identifying the density level of vegetation despite atmospheric effects. The atmosphere plays a crucial role in vegetation data processing activities for oil palm plants. The issue addressed in this research is to compare and measure the accuracy of production estimation data generated using the NDVI and ARVI methods. The method we used in this research is to analyze Landsat-8 remote sensing data using ArcMap 10.4.1 software to produce various vegetation indices for which several tests. The final results that will be obtained in this research are production distribution data estimated using the NDVI index, ARVI index, and actual production in the field. Based on research using simple linear regression analysis, vegetation index value, the productivity obtained using the NDVI method is 2,122 tons/ha/month, and using the ARVI method is also 2,122 tons/ha/month. This corresponds to the actual field productivity value of 2,122 kg/ha/month.

1 Introduction

Palm oil is a plantation commodity has a key role in the agricultural sector as a producer of economically valuable oil [1]. The oil palm plantation sector provides opportunities for the community to develop and cultivate oil palm activities, to helping the economy people of the country, especially Indonesia. Indonesia ranks among the top palm oil producers in Asia and globally, boasting extensive plantation areas and high productivity levels. Given the rising demand for processed palm oil, there is a critical need

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to swiftly and accurately estimate oil palm production. This ensures proactive planning to meet future supply requirements and demands effectively.

The integration of technology significantly impacts various activities, particularly in oil palm cultivation, where it serves as a catalyst for accelerating processes. One such technological application is remote sensing, which employs optical and radar techniques for monitoring and forecasting oil palm growth [2]. Among remote sensing methods, NDVI (Normalized Difference Vegetation Index) stands out for its widespread use. NDVI measures vegetation density and health, providing insights into oil palm plant conditions and facilitating production estimates [3]. Another method, ARVI (Atmospherically Resistant Vegetation Index), minimizes atmospheric interference to focus on vegetation density assessment [7].

The NDVI and ARVI methods in estimating production and productivity of oil palm plants is very helpful in using technology. The NDVI method will focus on knowing the health level of plant leaves on oil palm trees so that it will affect the quality of production in terms of fertilization [4]. Beside that, the NDVI method is one of the uses of remote sensing technology that will monitor plant health quickly and comprehensively by taking into account the subjective nature of oil palm plants. This method will provide information on the range of oil palm plants from -1 to +1 which indicates the influence of health on plant production [5]. Production can be in the form of garden products obtained by harvesting in the field. The ARVI method focuses on identifying the density level of atmospheric vegetation. The atmosphere is key in data processing activities for oil palm plant vegetation. In the ARVI formula there is an additional channel used, there is a blue channel [2]. ARVI data is one of the data that has the ability to analyze the influence of plant production by eliminating the influence of air or the atmosphere. So the data will read the atmosphere around the experimental garden sample.

The connection between land mapping and production helps communities and companies in monitoring the results obtained in the field. The results of land mapping can be a production distribution map. This research will focus on several objectives: the application of remote sensing technology, analyzing the NDVI and ARVI levels to measure oil palm productivity estimation, and assisting companies in measuring oil palm production estimates. The outcome will include statistical modeling and production estimation maps. These maps will depict the distribution of production and serve as a basis for further actions by the company in cases where oil palm productivity declines, necessitating actions such as replanting. This map will be used in evaluating activities in the company such as adding fertilization processes, improving land quality by spraying weeds, pest control, and other activities that can provide the potential for increased production.

2 Materials and Methods

2.1 Times and location

The research was held from August to November 2023. The research location at Sungai Pelepah Estate, Sungai Lilin, Musi Banyuasin, South Sumatra (Fig. 1). Sungai Pelepah Estate is located at coordinates 104,054° east longitude and 2,450° south latitude. This oil palm plantation is planted with Verdant and Costa Rican varieties.

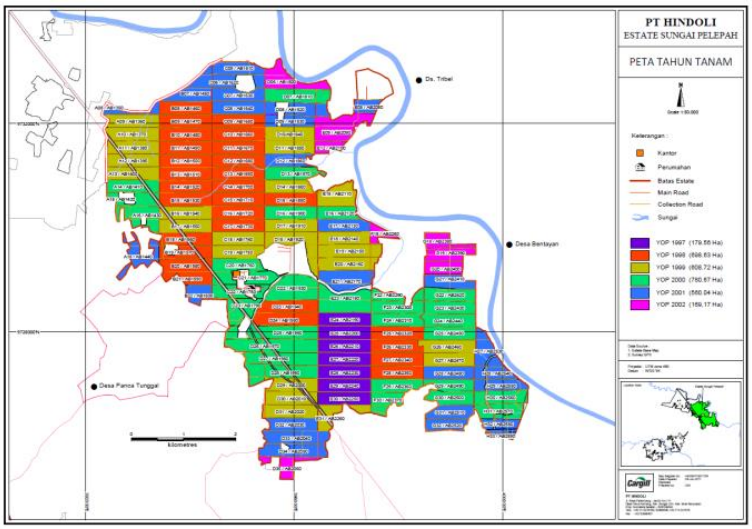

Fig. 1. The Research Location Map of Sungai Pelepah Estate, Sungai Lilin, Musi Banyuasin, South Sumatra.

Estate Sungai Pelepah is located in Mulyo Rejo Village, Sungai Lilin District, Musi Banyuasin Regency, South Sumatra. The research has been conducted at Estate Sungai Pelepah. The administrative boundaries of Estate Sungai Pelepah are:

North : Estate Sungai Tungkal
South : Panca Tunggal Village
West : Panca Tunggal Village
East : Tribel and Bentayan Villages

In terms of latitude and longitude, Estate Sungai Pelepah is situated between 97.32° to 97.82° S and 39.2° to 40.00° E. Additionally, the estate is located at an elevation of 8 to 12 meters above sea level (mdpl). The terrain at Estate Sungai Pelepah is generally flat with some areas being slightly hilly. The estate consists of 123 blocks and is managed by three plantation division assistants. The estate's location map shows two main land areas: mineral land and swamp land. Overall, mineral land occupies 55.00% of the total area, while swamp land occupies 45.00%.

2.2 Data collection

The preparation stage is the first stage in research activities. This stage is used to obtain and collect secondary company data, in the form of actual production data for August 2023 – October 2023, a map of the Sungai Pelepah Estate plantation location, and determining Landsat 8 imagery according to the sample location.

2.3 Pre-processing

The important thing that must be done for analyse NDVI and ARVI to estimate productivity is collecting Landsat 8 Satellite Imagery data. Landsat 8 satellite imagery can be accessed on the website https://earthexplorer.usgs.gov/. This file is needed in the Landsat 8 image processing process to overlay the Sungai Pelepah Estate location map with Landsat 8 image. After downloading the file, the file will be geometrically corrected for further data processing [8].

Table 1. The characteristic of Landsat 8 OLI

Band	Type (30 m)	Sprektral (µm)
1	Coastal/Aerosol	0.44 – 0.45
2	Blue	0.45 – 0.51
3	Green	0.53 – 0.59
4	Red	0.64 – 0.67
5	NIR	0.85 – 0.88
6	SWIR-1	1.57 – 1.65
7	SWIR-2	2.11 – 2.29
8	Pan	0.53 – 0.68
9	Cirrus	1.36 – 1.38

Landsat 8 Satellite Image data consists of Operational Land Manager (OLI) sensors which consist of 9 bands [6]. The NDVI method will use 2 main bands, there are Band 4 and Band 5. The ARVI method will use 3 bands, there are Band 2, Band 4, and Band 5 (Table 1).

2.4 Data Processing

The Processing Stage is the core stage in the research process including:

2.4.1 Correction

Image geometric correction is a method of processing image transformation results from remote sensing to produce images with various balanced scale and projection properties.

2.4.2 Image Design

Image design is a method of reading maps using established formulas. Image design is one method of measuring data to get the range of data read by land mapping applications [6]. This stage we will use the NDVI and ARVI methods. The NDVI and ARVI methods have a formulas:

$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})} \rightarrow \text{NDVI} = \frac{(\text{Band 5} - \text{Band 4})}{(\text{Band 5} + \text{Band 4})} \quad (1)$$

$$\text{ARVI} = \frac{\text{NIR} - [\text{RED} - \gamma(\text{RED} - \text{BLUE})]}{\text{NIR} + [\text{RED} - \gamma(\text{RED} - \text{BLUE})]} \quad (2)$$

Information:
γ (gamma) : Uses the value 1
NIR : Reflectance value of the near infrared band
RED : Reflectance value of the red band
BLUE : Reflectance value of the blue band

2.4.3 Linear Regression Analysis of Vegetation Index

Linear Regression Analysis of Vegetation Index involves measuring and processing data using statistical techniques. Regression analysis is utilized to predict unknown data values based on known and related data values. This study will employ both simple and multiple linear regression analysis methods using the Minitab application [7].

2.4.4 Map Research Result

Map estimate productivity is one of the final stages in describing the results of production estimates using linear regression analysis. Map making must prioritize the color of production estimates and actual production in the field, and supporting implementation contained in the map. The map will illustrate the production conditions at the company.

3 Result and Discussion

3.1 Analysis and result of NDVI and ARVI vegetation index transformation processing

The NDVI and ARVI index transformations were conducted using the ArcGIS 10.4.1 application. Landsat-8 satellite imagery data were sourced from https://earthexplorer.usgs.gov/, ensuring criteria such as minimal cloud cover and accurate coordinate alignment with the research location. The sample data utilized in this study consisted of a map of the Sungai Pelepah Estate, comprising 122 blocks.

Based on the algorithm processing results in ArcGIS 10.4.1 for NDVI and ARVI indices during the period from August to October [11], the following data were obtained In August, NDVI ranged from a minimum of 0.14 to a maximum of 0.38, with an average value of 0.26. ARVI ranged from a minimum of 0.08 to a maximum of 0.27, averaging 0.18. In September, NDVI varied from a minimum of 0.23 to a maximum of 0.49, averaging 0.36. ARVI ranged from 0.17 to 0.38, with an average value of 0.28. In October, NDVI ranged from 0.21 to 0.48, averaging 0.34. ARVI varied from 0.13 to 0.37, averaging 0.25.

3.2 Analysis and result of linear regression transformation NDVI and ARVI indexes with plant age

The processing after obtaining the NDVI and ARVI index values is getting a simple linear regression analysis. Simple linear regression analysis was carried out using two data, namely the NDVI and ARVI index values and plant age. The goal is to find out the level of correlation that describes relation between vegetation index and age of oil palm plants. R and R^2 are values that reflect the ability of a model to accurately project the value of Y. If the values of R and R^2 are close to 1, then the model can be used because the independent variables it is correct for projecting the value of Y.

In August 2023, the linear regression analysis of the NDVI vegetation index with plant ages ranging from 21 to 26 years showed a weak relationship, indicated by R and R-squared values of 0.0860 and 0.0074, respectively. Similarly, the linear regression of the ARVI vegetation index with the same plant age range resulted in a weak relationship, with R and R-squared values of 0.0141 and 0.0002. In September 2023, the linear regression analysis of the NDVI index with plant ages 21 to 26 years continued to show a weak relationship, with R and R-squared values of 0.0871 and 0.0076. The linear regression of

the ARVI index with the same age range showed slightly higher but still weak relationships, with R and R-squared values of 0.0911 and 0.0083. By October 2023, the linear regression analysis of the NDVI index with plant ages 21 to 26 years demonstrated a slightly stronger but still weak relationship, with R and R-squared values of 0.1030 and 0.0106. Meanwhile, the linear regression of the ARVI index with the same age range showed a similarly weak relationship, with R and R-squared values of 0.1192 and 0.0142.

The multicollinearity test in this research showed that the tolerance value between the NDVI and ARVI indices for plant age was 0.971. This value is greater than 0.10, meaning that multicollinearity does not occur. The multicollinearity test included an examination of the Variance Inflation Factor (VIF). The VIF measures how much the variance of the regression coefficient increases compared to independent variables that are orthogonal when linearly connected. The VIF yielded a value of 1.03 for the NDVI and ARVI indices, which is <10, indicating that these independent variables can proceed with multiple linear regression analysis. From this data, it can be concluded that the NDVI and ARVI indices, in conjunction with plant age, do not yet provide conclusive insights into the production and productivity of oil palm plants.

3.3 Analysis and results of multiple linear regression transformation NDVI and ARVI indexes with production data and plant age

The design of the estimation results was carried out using multiple linear regression analysis. Multiple linear regression analysis was carried out using environmental factors, genetic factors, and interaction factors between environment and genetics. The factors used as test samples were using the NDVI and ARVI index variables, plant age, and production data [7].

The results from multiple linear regression estimates of oil palm plant productivity in August showed R-squared (R2) and correlation coefficient (R) values of 0.28 and 0.53 for the NDVI algorithm. Similarly, in August, the ARVI algorithm yielded R2 and R values of 0.28 and 0.53. In September, these values improved to 0.37 and 0.61 for NDVI, and 0.37 and 0.61 for ARVI. By October, the R2 and R values were 0.25 and 0.50 for both NDVI and ARVI algorithms. On average, the R2 and R values were 0.41 and 0.64 for NDVI, and 0.39 and 0.62 for ARVI. Details of the formulation results using the Minitab application are provided in Table 2.

Table 2. Model Formulation of NDVI and ARVI Method

Month	Index	Formulation
August	NDVI	$y = -68847 + 4393x_1 + 5087x_2$
	ARVI	$y = -69204 + 5174\ x_1 + 5111\ x_2$
September	NDVI	$y = -101162 + 2827\ x_1 + 6480\ x_2$
	ARVI	$y = -105854 + 17524\ x_1 + 6517\ x_2$
October	NDVI	$y = -75627 + 14772\ x_1 + 4983\ x_2$
	ARVI	$y = -73054 + 5413\ x_1 + 5032\ x_2$
Average	NDVI	$y = -90947 + 41383\ x_1 + 5439\ x_2$
	ARVI	$y = -88632 + 38906x_1 + 5515x_2$

Based on Table 2, it can be inferred that the formulas derived from the NDVI/ARVI vegetation index variables, plant age, and production data are as follows: y = -90947 + 41383x1 + 5439x2 for the NDVI value, and y = -88632 + 38906x1 + 5515x2 for the ARVI value.

3.4 Statistical Test

The formulations obtained from the multiple linear regression test results will undergo several statistical tests. Some tests that need to be conducted are Heteroskedasticity test, Normality test, and Multicollinearity test. These three tests are used to analyze the variables used meet the criteria and to assess that the resulting formulation is highly suitable for use.

3.4.1 Heteroskedasticity test

Heteroskedasticity test is a regression model test to assess whether there is variance inequality in the residuals of each observation [13]. Based on the test results, the F-test value for this test is obtained at 23.93 with a significance value below 0.05 (Table 3). Furthermore, when conducting the t-test, it is found that the age constant obtains a t-value of 8.44 with a significance value below 0.05. Meanwhile, for the NDVI variable, the significance value is 0.759, and for the ARVI variable, the significance value is 0.884 (Table 4). Because the significance values of the NDVI and ARVI variables exceed 0.05, it can be concluded that there is no heteroskedasticity present in the linear regression model.

Table 3. Results of F-test for heteroskedasticity

	Model	df	F	Sig.
1	Regression	3	23,930	.000[b]
	Residual	118		
	Total	121		

Table 4. Results of partial t-test for heteroskedasticity

	Model	t	Sig.
1	(Constant)	-5.117	.000
	Age	8.449	.000
	NDVI	-.308	.759
	ARVI	-.146	.884

3.4.2 Normality Test

A normality test is a statistical assessment used to determine whether the regression method, dependent variable, and independent variable exhibit normal distribution characteristics. This test is conducted to evaluate whether the research data follows a normal distribution or approximates normality.

Table 5. Normality test Kolmogorov-Spirnov

No	Variable	*Tolerance*	VIF	Result of Multicolinierity test
1	NDVI	0,970	1,031	Non Multicolinierity
2	ARVI	0,970	1,031	Non Multicolinierity
3	Age of Plant	0,997	1,003	Non Multicolinierity

Based on the normality test results using the Kolmogorov-Smirnov method, it was found that the significance value (2-tailed sig) using the NDVI and ARVI index variables and age against production values is 0.196. This means that the variables have a significance level greater than 0.05. Therefore, it can be concluded that the research data with NDVI index, ARVI index, and plant age variables are evenly.

3.4.3 Multicolinierity Test

The multicollinearity test assesses correlations between independent variables in a regression model. Ideally, there should be no correlation among independent variables. The test examines Variance Inflation Factor (VIF) values, aiming for VIF values below 10, and it also considers tolerance values above 0.1.

Table 6. Multicolinierity test

Model		t	Sig.	Collinearity Statistics	
				Tolerance	VIF
1	(Constant)	-5,117	0		
	Age	8,449	0	0,997	1,003
	NDVI	-0,308	0,759	0,97	1,031
	ARVI	-0,146	0,884	0,97	1,031

Based on Table 15, it can be concluded that the tolerance values for the NDVI and ARVI index variables are 0.970, while the tolerance value for the age variable is 0.997. This means that these values are greater than 0.1. Meanwhile, the VIF values for the NDVI and ARVI index variables are 1.031, and for the age variable, it is 1.003. These values are smaller than 10. Therefore, it can be concluded that there is no multicollinearity issue in the regression model.

Based on several test values conducted in the linear regression analysis, it is found that the generated data is accurate and appropriate. Thus, the data can be accepted and used as a formulation to determine productivity values. This data provides an overview of the influence of NDVI index, ARVI index, and plant age on productivity. Next, data validation will be conducted by comparing the estimated data with actual field data.

3.5 Validation of palm oil production and productivity estimates using the NDVI and ARVI indexes

This stage is to analysis of accuracy and validation tests regarding the formula obtained from multiple linear regression analysis. Validation is measuring the level of accuracy and percentage of success of the designed model by comparing actual production. It is hoped that the resulting model will become a benchmark for assessing this data. The formulation used also includes RMSE (Root Mean Square Error) to determine the level of errors produced by the model. The results of validation of production estimates against actual production in Table 7 and Table 8, while the results of validation of plant productivity estimates can be seen in Table 9 and Table 10.

Table 7. Validation of production estimates and actual production by NDVI Index

Month	Production Average (kilograms/ha)		Dev	Acc (%)	RMSE
	Estimate	Actual			
August	51.831	51.829	2,21	80,20	0,20
September	52.140,	52.142	2,42	80,31	0,22
October	46.566	46.570	3,93	75,59	0,36
Average	50.179	50.180	2,85	78,70	0,26

Table 8. Validation of production estimates and actual production by ARVI Index

Month	Production Average (kilograms/ha)		Dev	Acc (%)	RMSE
	Estimate	Actual			
August	51.838	51.829	9,03	80,19	0,82
September	52.140	52.142	1,41	80,41	0,13
October	46.566	46.570	3,77	78,13	0,34
Average	50.181	50.180	4,74	79,58	0,43

Based on Table 7, the average actual production using the NDVI index is 50,180.47 tons, while the average production estimated using the NDVI index is 50,179.28 tons. The average production deviation resulting from estimated and actual results is 2.85 tons. The accuracy of the resulting data between estimated production and actual production is 78.70%. The research also measures RMSE. RMSE (Root Mean Square Error) is used to evaluate forecasting results in measuring the estimates of the processed forecast results. In this study, the RMSE value using the NDVI index was 0.26. The RMSE value provides information that errors in data processing are small in accordance with the definition of RMSE, the smaller the RMSE value, the more accurate the data produced.

Based on Table 8, the average actual production using the ARVI index is 50,180.40 tons, while the average production estimated using the ARVI index is 50,181.68 tons. The average production deviation resulting from estimated and actual results is 4.74 tons. The accuracy of the resulting data between estimated production and actual production is 79.58% with an RMSE level of 0.43.

Table 9. Palm Oil Productivity in Sungai Pelepah Estate (NDVI Index)

Month	Land area (ha)	Productivity (kilogram/ha)	
		Estimate	Actual
August	2.885,01	2.191,82	2.191,72
September	2.885,01	2.204,86	2.204,96
October	2.885,01	1.969,17	1.969,34
Average	2.885,01	2.121,95	2.122,01

Table 10. Palm Oil Productivity in Sungai Pelepah Estate (ARVI Index)

Month	Land area (ha)	Productivity (kilogram/ha)	
		Estimate	Actual
August	2.885,01	2.192,10	2.191,72
September	2.885,01	2.204,90	2.204,96
October	2.885,01	1.969,18	1.969,34
Average	2.885,01	2.122,06	2.122,01

Based on Table 9, it can be seen that the average productivity value using the NDVI index in the Sungai Pelepah Estate has an estimated productivity value of 2,121.95 kilograms/ha/month while the actual productivity value is 2,122.01 kilograms/ha/month. The resulting data difference between the estimated model and actual productivity is 0.06 tons/ha. The productivity estimation model for August 2023 has a difference that is close to actual productivity of 0.09 kilograms/ha/month. The productivity estimation model for October has a quite large difference compared to August and September, namely 0.17 kilograms/ha/month. So the productivity estimation model for August has a level of accuracy that is close to actual productivity.

Based on Table 10, it can be seen that the average productivity value using the ARVI index in the Sungai Pelepah Estate has an estimated productivity value of 2,110.06 kilograms/ha/month while the actual productivity value is 2.122,01 kilograms/ha/month. The resulting data difference between the estimated model and actual productivity is 0.05 tons/ha. The estimated productivity model for September 2023 has a difference that is close to actual productivity of 0.16 kilograms/ha/month. The productivity estimation model for August has quite a large difference compared to September and October, namely 0.38 kilograms/ha/month. So the productivity estimation model for October 2023 has a level of accuracy that is close to actual productivity.

Based on Table 9 and Table 10, it can be concluded that the productivity estimation model using the ARVI index has a high level of accuracy compared to the NDVI index, namely 0.05 kilograms/ha/month compared to 0.06 kilograms/ha/month. The productivity estimation model using the ARVI index is considered to be quite close to the productivity estimate in the period from August 2023 to October 2023.

3.6 Spatial area mapping estimated production and productivity of oil palm plants

Production and productivity estimation data using the NDVI and ARVI indices were used to create a map of the production area and productivity of the Sungai Pelepah Estate. The map was created after the data was plotted according to production and productivity. Spatial area mapping is reached by dividing production classes into 5, there are between less than 30,000 tons/month to more than 60,000 tons/month. Production distribution maps at Sungai Pelepah Estate can be seen in Figure 13, Figure 14, and Figure 15. This Production Map was obtained from the results of processing the NDVI and ARVI algorithms on average for the period August – October 2023. This map is a visual form of data distribution production that describes the production conditions of the Sungai Pelepah Estate. Apart from that, this map will provide information regarding the amount of production produced by each block or division based on the specified range [9].

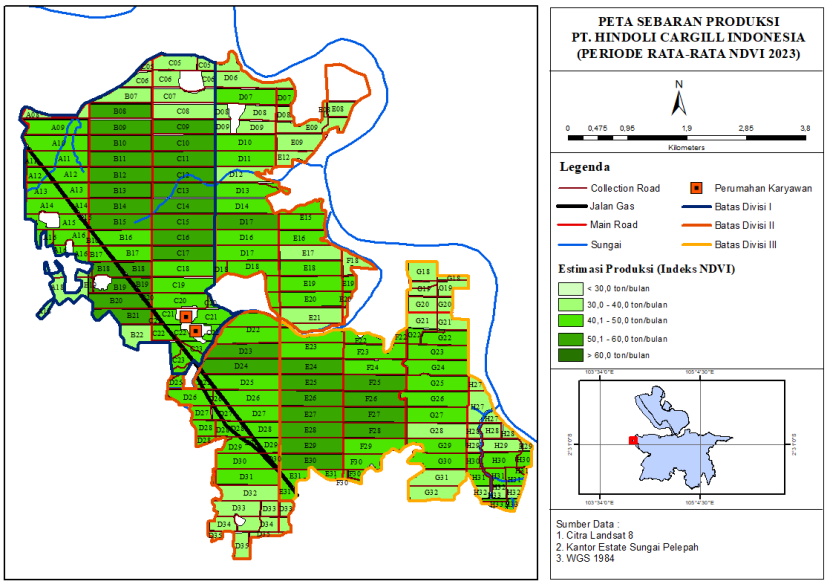

Fig. 2. Production distribution map at PT. Hindoli Cargill Indonesia Estate Sungai Pelepah based on the average NDVI index (period August – October 2023).

Figure 2 represents the map of the estimation results obtained using the NDVI method. In Figure 2, after performing calculations using the estimation model, the final outcome of the model represents the estimation model in the form of a production map for that month. Figure 2 provides information about the average production distribution map in the Sungai Pelepah Estate using the NDVI index [5]. The results of mapping using the NDVI index show that 15 plantation blocks have estimated production in the range of 30,00 to 40,00 tonnes/month, 52 blocks have estimated production in the range of 40,10 to 50,00 tonnes/month, 38 blocks have estimated production in the range of 50,10 to 60,00 tonnes/month. month, 17 blocks have an estimated production of more than 60,00 tons/month. The map also provides information that the largest distribution of production is dominated by division 1 and division 3 blocks.

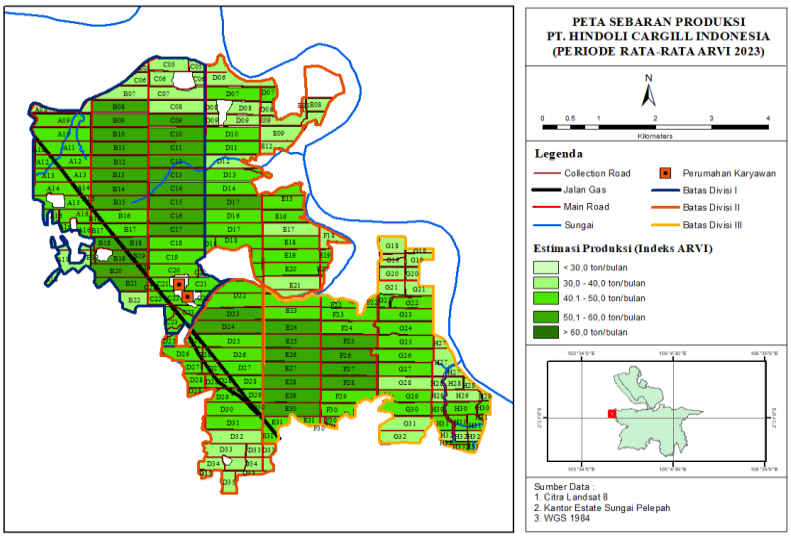

Fig. 3. Production distribution map at PT. Hindoli Cargill Indonesia Estate Sungai Pelepah based on the average ARVI index (period August – October 2023).

Figure 3 represents the map of the estimation results obtained using the ARVI method. In Figure 3, after performing calculations using the estimation model, the final outcome of the model represents the estimation model in the form of a production map for that month. Figure 3 provides information about the average production distribution map in the Sungai Pelepah Estate using the ARVI index [7]. From mapping results using the ARVI index, information was obtained that 17 plantation blocks had production estimates in the range of 30,00 to 40,00 tons/month, 49 blocks had production estimates in the range of 40,10 to 50,00 tons/month, 38 blocks had production estimates in the range of 50,10 to 60,00 tons/month. month, 18 blocks have an estimated production of more than 60,00 tons/month.

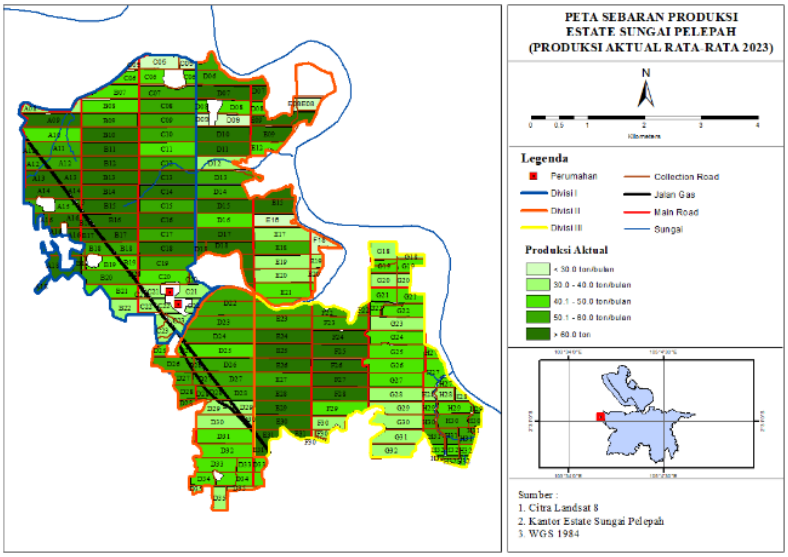

Fig. 4. Production distribution map at PT. Hindoli Cargill Indonesia Estate Sungai Pelepah based on average actual production (period August – October 2023).

Figure 4 is the actual production map in the field. This map is useful for observing and comparing with Figure 2 and Figure 3. The purpose of Figure 4 is to assess the estimation results obtained after performing model calculations and to compare between the estimation map and the actual production map of Estate Sungai Pelepah. Figure 4 provides information about the actual average production distribution map in the Sungai Pelepah Estate in the field. Based on field data obtained from August to October 2023, information was obtained that 8 plantation blocks had production of less than 30,00 tonnes/month, 21 plantation blocks had production in the range of 30,00 to 40,00 tonnes/month, 30 blocks estimated production in the range of 40,001 to 50,00 tons/month, 32 blocks have production in the range of 50,10 to 60,00 tons/month, 31 blocks have production of more than 60,00 tons/month.

Figure 4 has fundamental differences based on production mapping. Figure 2 and Figure 3 have differences in that there are no blocks that have an estimated production of less than 30,00 tons/month, whereas in Figure 4 there are 8 blocks that have production of less than 30,00 tons/month. Several things that influence the differences between estimated production and actual production include land conditions, work conditions, and different harvesting mechanisms between mechanical harvest blocks and manual harvest blocks. This situation is in line with the accuracy results carried out previously which resulted in better accuracy for the ARVI index transformation.

4 Conclusions

Implementation of PT research activities. Hindoli Cargill Indonesia Estate Sungai Pelepah provides benefits, related to production land mapping resulting from estimates using NDVI and ARVI index values. Based on the data obtained, the author arrived at the following conclusions that the correlation between actual production and estimated production is balanced according to the NDVI and ARVI index values. The results of the correlation values can be seen from the average NDVI R= 0.41 and R^2= 0.64 while the ARVI algorithm R=0.39 and R^2= 0.62. The use of Landsat 8 imagery in estimating production has an accuracy level of 78.70% using the NDVI index value and 79.58% using the ARVI method. The use of technology in oil palm plantations really helps the process of monitoring production in the field, especially in mapping production. This research is an example of the application of technology in oil palm plantations by assessing production estimates using Landsat 8 imagery with production data. The productivity produced using the NDVI method was 2,122 kilograms/ha/month and 2,122 kilograms/ha/month using the ARVI method. This is comparable to the actual field productivity value, which is 2,122 kilograms/ha/month. The level of accuracy of the data produced is based on productivity, namely 0.06 and 0.05 for the error value of the data produced. The ARVI method in this research is considered very good for use in the production estimation process compared to the NDVI method. This is in accordance with the level of accuracy of data produced from the ARVI method, namely 79.58%.

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