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The Prediction of Subsidized Fertilizer Stock Using Least Square Support Vector Machine on The Kartu Petani Berjaya Aplication

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ABSTRACT – Agriculture is one of the biggest commodities in Lampung, so that this also causes a lot of use and allocation of subsidized fertilizers. In terms of this it is very important to know how much amount of subsidized fertilizer needed in the future to prepare subsidized fertilizer stocks. The data needed was the time series data from subsidized fertilizer redemption data, using Least Square Support Machine and Autoregressive Integrated Moving Average methods to make a prediction model for subsidized fertilizer redemption. The result was hoped that we can find out how many harvests are in Lampung and the future subsidized fertilizer rations. This research was expected to provide benefits to the relevant parties.

Keywords: LSSVM, Kartu Petani Berjaya, Subsidized Fertilizer Prediction.

1. PENDAHULUAN

The industrial revolution 4.0 is a new era in which all aspects of human life will be dominated by technology and changed the existing patterns in society, this era has also given birth to the concept of agriculture 4.0 in which this sector is one of the largest sources of the economy in Indonesia [1]. Every agricultural activity, especially in the cultivation of food crops. Food crops include rice, corn, beans, and tubers.

Agriculture 4.0 pushes the agricultural sector in new directions that were previously unthinkable. In this case, of course, it has an impact not only on farmers but also has an impact on agricultural companies or agricultural commodity-producing entrepreneurs who have to adjust when agriculture 4.0 produces standards that are applied to agricultural policies [2].

The Kartu Petani Berjaya (KPB) application is here as a solution to increase agricultural production in Lampung. KPB is a flagship program from the Governor of Lampung for the 2019 – 2024 period. In the KPB application, farmers can make Farming Business Plans, view subsidized fertilizer quotas, and make subsidized fertilizer redemptions [3].

Agriculture cannot be separated from the use of subsidized fertilizers. Fertilizer is one of the factors that determine yields. The government provides subsidized fertilizers to support the needs of underprivileged farmers. The use of subsidized fertilizers must be given to farmers who need them. This should be considered in the future so that the use of subsidized fertilizers is right on target and the number of subsidized fertilizers must meet the needs of farmers. The fact is that the government has prepared fertilizer allocation data for farmers, but what happens is that many farmers don't make redemptions, this causes the fertilizer stocks that have been prepared to be less efficient. Fertilizer stocks that are not redeemed will be reallocated to other areas in need.

Regarding the problem of fertilizer efficiency, it is, therefore, necessary to research to predict the amount of subsidized fertilizer using machine learning. The methods used are Least Square Support Vector Machine.

2. RESEARCH METHODOLOGY

Least Squares Support Vector Machine

Least Squares Support Vector Machine is the development of the Support Vector Machine method, the difference is that the least squares support vector machine has better performance. Least Squares Support Vector Machines are a reformulation of the standard Support Vector Machine aimed at solving linear systems [4].

The performance of the Least Square Support Vector Machine can support annual data and evaluate the relative errors of 0.91%, 1.86%, and 0.93% [5]. In another study conducted by Fahteem and Ahmad, the predicted results of solar irradiance were able to prevent an imbalance in electricity production caused by uncertain radiation [6]. This shows that the Least Square Support Vector Machine is accurate for forecasting.

The use of LSSVM is the same as SVM. LSSVM is also used to solve regression and classification problems in linear or non-linear cases. Kernel techniques can also be performed using LSSVM in non-linear cases with RBF, MLP, linear, and polynomial kernels.

The Data

The data needed in this study is data on subsidized fertilizer redemption transactions.

In the table below, it can be seen that the number of datasets is 524 rows, the data was taken from 2021 to 2022. For the original data before the group-by-date query was carried out there were 6274 rows.

Tabel 1. Subsidized Fertilizer Transaction Data (2021 – 2022)

No	Date	Urea	NPK	SP-36	ZA	Organic
1	18-01-2021	2766	3017	0	0	0
2	19-01-2021	22566	24679	0	0	0
3	21-01-2021	53099	57861	0	0	0
4	25-01-2021	11850	12738	275	475	525
5	26-01-2021	5314	5627	0	0	0
...	...	...	...	...	...	...
524	19-12-2022	20438	27183	0	0	0

Data Normalization

Data normalization is a process of transforming values to change data values. Normalization is used to equalize the scale of data attributes into a specific range [7]. This process is carried out because some data have different value ranges. Data normalization will produce a balance of comparative values between data before and after processing [8].

$$x = \frac{(x - x_{min})}{(x_{max} - x_{min})}$$

(Formula 1)

The data normalization equation above will produce a new value x' which has a range from 0 to 1, or in other words, the lowest value is now 0 and the highest value is 1.

Evaluation Model

a. Mean Square Error (MSE)

Mean square error is another approach to test the level of forecast error. Each error is squared. This approach determines the magnitude of the forecast error due to the squared error. MSE is a second way to measure the magnitude of the overall forecast error. MSE is the average of the differences between the predicted values and the actual values. The MSE formula used in the following equation [9]:

$$MSE = \sum_{t=1}^{n} \frac{(X_t - F_t)^2}{n}$$

(Formula 2)

b. MAD

Mean Absolute Deviation (MAD) IS a method for evaluating or testing forecasting methods using the absolute amount of error. The formula used to calculate MAD is shown in the following equation [9]:

$$MAD = \frac{\sum_{t=1}^{n} |Yt - Ft|}{n}$$

(Formula 3)

c. MAPE

MAPE is calculated by using the absolute error in each period divided by the actual observed value for that period and then the values are averaged [10]. MAPE indicates how much error there is in the forecast compared to the actual value. MAPE is obtained using the following equation [9]:

$$MAPE = \frac{100\%}{n} \sum_{t=1}^{n} \left| \frac{X_t - F_t}{X_t} \right|$$

(Formula 4)

3. RESULT AND DISCUSSION

In this research, forecasting uses LSSVM assisted by Matlab 2021a software using 524 lines of data for each subsidized fertilizer.

Figures 1 - 5 below contain a comparison of the original data with the predicted fertilizer redemption data using LSSVM. The movement of the forecast results is shown by the red line, while the original data is shown by the blue line.

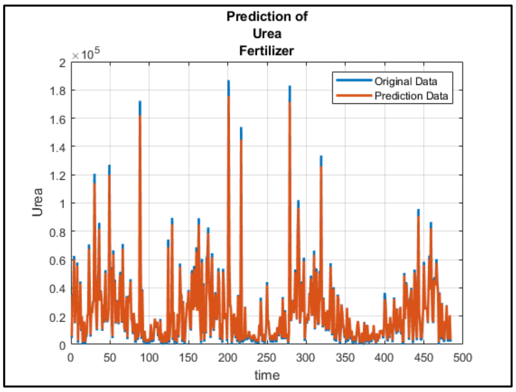

Figure 1. Prediction Urea Fertilizer

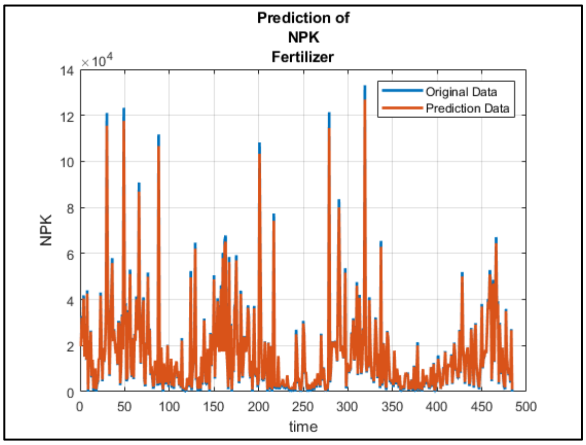

Figure 2. Prediction NPK Fertilizer

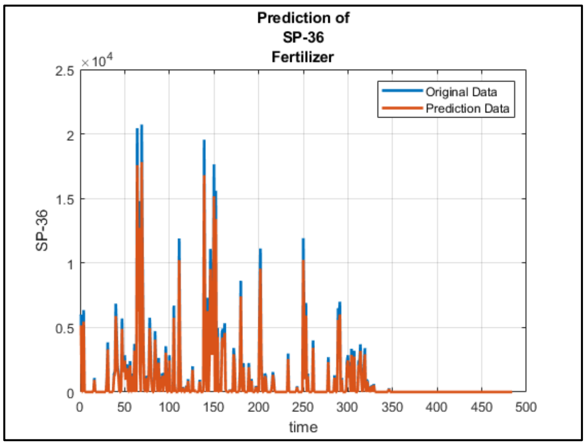

Figure 3. Prediction SP-36 Fertilizer

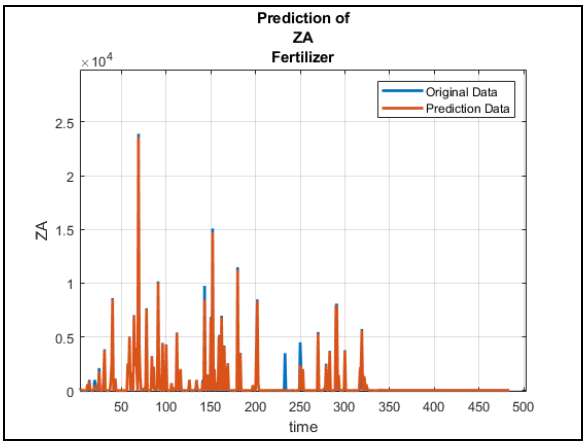

Figure 4 Prediction ZA Fertilizer

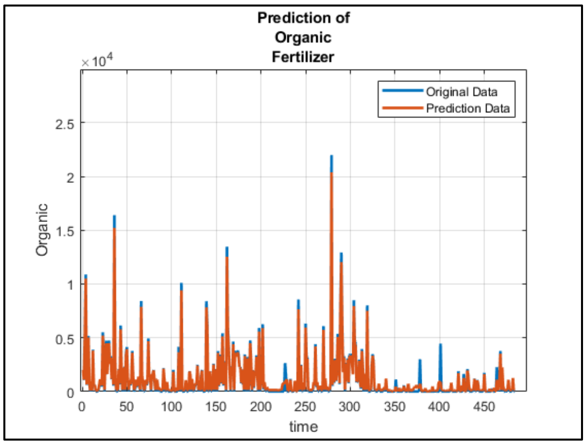

Figure 5. Prediction Urea Fertilizer

The forecasting carried out produces an evaluation value as shown in the following table.

Tabel 2. Evaluation Model

Fertilizer	MSE	MAD	MAPE (%)
Urea	0.107	0.2935	1.20
NPK	0.0883	0.2532	0.00139
SP-36	0.0000000064792	0.000043369	0.0000032
ZA	0.000078935	0.0034	4.4532
Organic	0.00039217	0.0172	2.26

In a forecasting the smaller the resulting error value indicates how well the model performs; this is reinforced by previous research. In a forecasting the smaller the resulting error value indicates how well the model performs; this is reinforced by previous research [11]. Error value testing is done by looking at the MSE, MAD and MAPE values resulting from forecasting using LSSVM.

In previous research [12] produced MSE value of 0.00025248, this value is below the MSE value in UREA fertilizer forecasting (0.107) and NPK (0.883) and higher than other fertilizer forecasts. For MAD value in previous research [13] 0.02, for SP-36 fertilizer (0.000043369) and ZA (0.0034) in this research the value is smaller than previous research but for other fertilizers it is higher. MAPE value in previous research 7% [14], this value is higher than all fertilizer forecasts in this research.

Forecasting using time series data is a process of estimating future values using historical data. In research using data on the number of subsidized fertilizer redemptions from 2021 to 2022, it shows several different results for each type of subsidized fertilizer. For related agencies, the forecasting results in this study can be used to prepare subsidized fertilizer stocks in warehouses or kiosks subsidized fertilizer in Lampung.

4. CONCLUSION

Based on the analysis in the previous chapter, this study aims to forecast the redemption of subsidized fertilizers in Lampung Province using historical data on the redemption of subsidized fertilizers from 2021 to 2022. Forecasting using LSSVM on Urea fertilizer produces MAD values of 0.000029649, MSE 0.000029649 and MAPE 0.1426. NPK fertilizers produce MAD values of 0.005, MSE 0.000029649 and MAPE 0.1509. SP-36 Fertilizer produces a MAD value of 0.000043369, MSE 0.0000000064792 and MAPE 0.7288. ZA Fertilizers produced MAD values of 0.0034, MSE 0.000078935 and MAPE 0.8998. Organic Fertilizers produce MAD values of 0.0172, MSE 0.00039217 and MAPE 0.6442.

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