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Implementation of Adaptive Neuro-Fuzzy Inference System (Anfis) Method on Rice Price Prediction in Lubuklinggau City

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ABSTRACT

The problem behind this research is the imbalance between the capacity offered and the capacity demanded by the community, resulting in uncontrolled rice prices, so it is necessary to predict rice price in the future to monitor the stability of rice prices in the Lubuklinggau City area. In this study, the Adaptive Neuro-Fuzzy Inference System (ANFIS) method was used to predict future rice prices. The sample used in this study is data on rice price in Lubuklinggau City from January 2016 to December 2020. The result of the prediction of rice price in the Lubuklinggau City area for the next five years. With the accuracy value in rice price predictions based on MSE training, numely 99,9037% and based on the MSE test that is 99,8784%. While the accuracy values of rice price predictions based on MAPE training and testing are 93,2997% and 88,2782%, respectively. For the accuracy value of rice price prediction result based on the MSE and MAPE values respectively namely 99,8935% and 92,9212%. It can be concluded that the ANFIS method is very effectively used for the process of predicting a price or value in the future .

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1. Introduction

The agricultural sector is a provider of basic foodstuffs for industry as well as sources of foreign exchange in the country. Agricultural development aims to increase agricultural production to meet the food needs of national industries. Until now, the agricultural sector is still the main source of income for most people in Indonesia. Rice is an important commodity for most people in Indonesia in meeting their food needs [1] [2]. The position of rice commodities as raw materials for most of the Indonesian population is a staple food, because almost all Indonesians need rice as the main foodstuff. As well as an important food source in the structure of food, therefore the aspect of supply is very important to maintainthe large number of Indonesian people.

Rice price forecasting is needed to create price stabilization to achieve food security nationally. The increasing number of people in an area is a threat to the resilience of pangan. With a large number

of people, food supply needs at the national and regional levels continue to grow. To meet the rice needs of the Indonesian population and maintain the stability of rice prices. Therefore, we need a science that studies thepractices that will occur in the future. An activity aimed at predicting what will happen in the future is called forecasting. Food policy, especially rice is a major element in the state budget sector so that one commodity that controls the general price level (inflation). This can allow the government to establish certain food control guidelines. The imbalance between the quantity available and the quantity needed by consumers becomes a factor that can cause price volatility. The supply of rice that producers provide is insufficient throughout the year because it is related to the growing season. Meanwhile, consumer demand will continue throughout the year, because rice is consumed every day, because rice is the main food for the population. .

2. Research Methodology

2.1. Data Collection Methods

In the method of data collection there are several methods used by authors in finding and processing research objects at the research site, among others:

1. *Observation*

   Observation is an observation of the application studied and intended to produce an overview of the object of research. The author conducted a direct observation of the data collection of rice prices at the Office of theMinistry of Food Of Lubuklinggau City which became a research location to obtain the data and information needed. Such methods are used to collect documents that are a very important source of information that can help in the analysis.

2. Interview

   Interview be method Collection data with do tanya answer and methodical with party that Associated of office Resistance Food City Lubuklinggau, so that information that Retrieved from method this Form information about Ofhe price rice and Problems that become reason climb or Decline price rice.

3. Documentation

   In this method, the researcher makes observations by documenting objects related to the data needed by the researcher.

4. Library Studies

   In this method data collection is done by studying books related to rice price prediction and the use of selected methods. In addition, it can talk references from the internet and *e-books*, guidebooks, journals, referencesi from textbooks for the need to analyze and use methods that will be proposed.

2.2. Population, *Sampling* Techniques, and Research Samples

The population used in this study is all rice price data in the Food Security Office of Lubuklinggau City. Sampling technique in sampling is *Purposive Sampling* which considers *samples* that have the necessary information bagi researchers. The sample that the researchers considered was rice price data at the Lubuklinggau City Food Security Office from January 2016 to December 2020.

For rice price data itself is the result of a survey obtained by every sub-district in the city of Lubuklinggau. Where the price data from each sub-district is recorded by staff in each sub-district who conducted a survey to the stalls, then the data is given to the City Food Security Office Lubuklinggau, the thing that also causes the existing rice price data is relatively slightly higher than the price in the market, because the Food Security Office of Lubuklinggau City is only Monitor the price of rice at the consumer level only.

The implementation of the Adaptive *Neuro-Fuzzy Inference System* (ANFIS) method on rice price prediction in the city of Lubuklinggau, is a quantitative study. [3] Meanwhile, for data collection methods in the form ofliterature studies, documentation, interviews and observations with the aim of facilitate researchers in collecting data and references. related to research and for data development methods in this study using pseudocode and flowchart, with the aim to see the stages of each method of processing the method used.

Research on the implementation of the Adaptive *Neuro-Fuzzy Inference System* (ANFIS) method on rice price prediction in the city of Lubuklinggau, consists of several stages, namely:

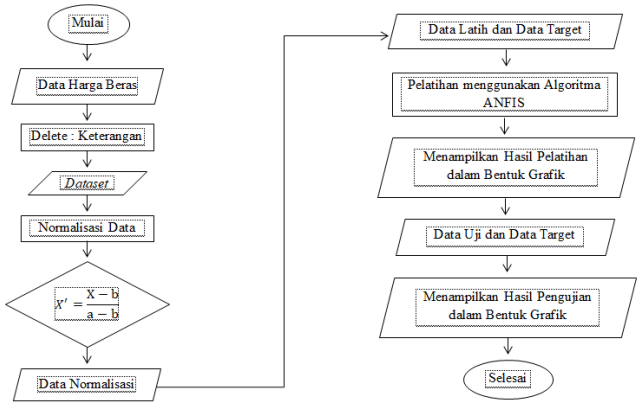

Figure 1. Flowchart Prediction System

The flow of the rice price prediction system using the ANFIS method can be seen in the picture above, with a description of each step, namely:

1. Enter original price data
2. Delete unnecessary columns
3. Showing Dataset
4. Perform data normalization, with formula X' = x-b/a-b
5. Display normalization data results
6. Perform training data process and target data
7. Conduct training with ANFIS algorithm
8. Show *training* results in diagram format
9. Perform ice prosdata test and targettest
10. Display test results in graphic form

3. Results and Discussions

3.1. Research Results

3.1.1 Preprocessing

In this prenelitian characteristics or features that will be used to predict the price of rice is the price of rice per week in the city of Lubuklinggau for 5 (five) years, from January 2016 to January 2016. with December 2020 predicted to use matlab application. Before the data mining process can be done, a preprocessing stage is needed. At this stage will be carried outa process of combining some data, then cleaning is done to get the appropriate dataset so that it can be used at the next stage. At that stage did not combine the data because the data taken came directly from the data design obtained from the Food Security Office of Lubuklinggau City.

Here is a sample from the Preprocessing of rice prices at the Department of Food Security of Lubuklinggau City:

Table 1 Rice Price Data of The Lubuklinggau City Food Security Office

Year		WEEK 1	WEEK 2	WEEK 3	WEEK 4
2016	JANUARY	9550	9875	9813	9938
	FEBRUARY	10000	9938	9938	10000
	MARCH	10500	10344	10563	10563
	APRIL	10188	10188	9563	9563
	MAY	9250	9313	9250	8938
	JUNE	9188	9250	9375	9063
	JULY	9250	9250	9313	9063
	AUGUST	9500	9500	9625	9500
	SEPTEMBER	9375	9438	8875	9438

	OCTOBER	8875	8875	8875	8875
	NOVEMBER	8875	9125	9375	9375
	DECEMBER	9375	9714	9500	9375
	JANUARY	9571	9714	9429	9875
	FEBRUARY	9813	9875	10063	9875
	MARCH	10063	9938	9938	9750
	APRIL	9688	9613	9375	9438
	MAY	9563	9688	9688	9688
2017	JUNE	9813	9563	9438	9646
	JULY	9313	9438	9313	9375
	AUGUST	9500	9563	9500	9688
	SEPTEMBER	10500	9688	9813	9875
	OCTOBER	9500	9750	9875	9938
	NOVEMBER	9500	10250	10563	10563
	DECEMBER	10750	11063	10188	10563
	JANUARY	11214	12750	11214	12071
	FEBRUARY	11214	11214	12071	12071
	MARCH	10714	10717	10875	10875
	APRIL	10875	10438	10875	10438
	MAY	10250	10256	10375	10063
2018	JUNE	10250	10063	10000	10438
	JULY	10188	10188	10438	10750
	AUGUST	10250	10250	10500	10188
	SEPTEMBER	10188	10188	10375	10375
	OCTOBER	10125	10125	10125	10125
	NOVEMBER	10375	10250	10250	10375
	DECEMBER	10375	10375	10406	10438
	JANUARY	10500	10313	10688	10438
	FEBRUARY	10438	10625	10250	10188
	MARCH	10250	10313	10313	10438
	APRIL	11125	10813	11313	10813
	MAY	10438	10313	9750	9625
2019	JUNE	10125	9875	9750	9625
	JULY	10125	9875	9750	9563
	AUGUST	9750	10000	9938	9525
	SEPTEMBER	9250	9338	9150	9188
	OCTOBER	9250	9250	9188	9125
	NOVEMBER	9275	9188	9250	9188
	DECEMBER	9313	9250	9125	9125
	JANUARY	9275	9188	9250	9188
2020	FEBRUARY	9313	9250	9125	9125
	MARCH	10063	9813	9813	10313
	APRIL	10063	10000	9875	10000

MAY	10188	10063	10250	10250
JUNE	10000	10000	9875	9938
JULY	9875	10000	10313	10313
AUGUST	10688	10625	10625	10625
SEPTEMBER	10313	10250	10250	10563
OCTOBER	10500	10375	10250	10438
NOVEMBER	10500	10375	10313	10313
DECEMBER	10313	10313	10625	10500

From the rice price data above can be seen the difference in price in each month, where the difference is caused by various factors, namely weatherfactors, pest disturbances, harvest, reduce rice fields, the presence of *imported* rice and *rice exports* and grain price factors.

3.1.2 Data Normalization

In this section is done data normalization [4], where the data used is the original data which is then applied using the formula of normalization of ANFIS data, using the following formula.

$$X'=(X-b)/(y-z)$$

Where:
X' = Data normalization results
X = preliminary data
y = the largest number of data
z = the smallest number of data

3.2. Application of Methods and Testing

The steps to implement the Adaptive *Neuro-Fuzzy Inference System* (ANFIS) method are:

1. Determination of Training Data and Training Targets *(Training)*

In this process, the price of rice is predicted to be sourced on rice price data 2 weeks before that. For data *trains* starting from the data of the 1st week of January 2016 to the 142nd week of December 2018, while for the training target starting from the data of the 3rd week of January 2016 until the 144th week of December 2018. Where to determine the training data using the formula *zeros* (numberof months × years of training - training week, training week). As for determining the training target using the formula *zeros* (numberof months × years of training - training week, 1). Then to determine the results of the prediction of the target train is to use the formula (output *training* × (maximal_data - minimum data)) + minimum data. This *zeros* disfunctionis to determine the data value of the range 0-1.

Table 2 *Training* Data Arrangements *and Training* Targets

Half	Training Data	Training Targets
1	Data in weeks 1-2	Week 3 data
2	Data in weeks 2-3	Week 4 data
3	Data in weeks 3-4	Week 5 data
4	Data in weeks 4-5	6th week data
5	Data in weeks 5-6	Week 7 data
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
139	Data in weeks 139-140	141st week data
140	Data in weeks 140-141	142nd week data
141	Data in weeks 141-142	143rd week data
142	Data in weeks 142-143	144th week data

2. Training using ANFIS Algorithms

In thisprocess, *training* is carried out with ANFIS algorithm with input in the form of data *trains* and target *trains* that have previously been obtained, then conduct ANFIS training with data *training.* using training data and training targets.

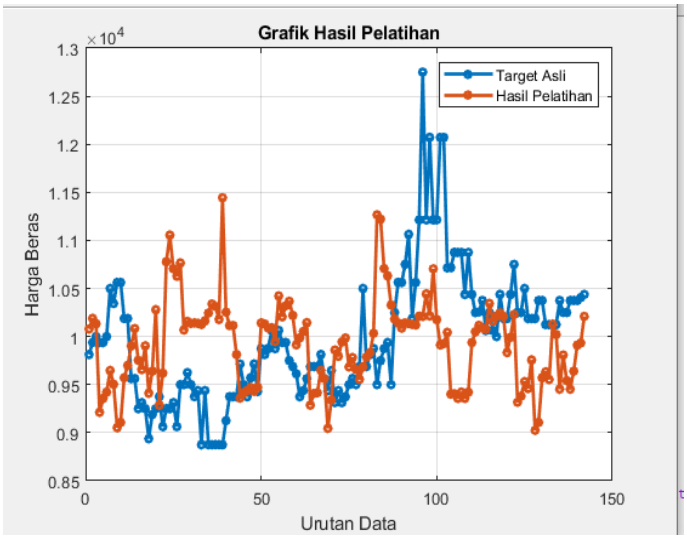

Figure 1 Training Results Graph

3. Determination of Test Data and Test Targets (Testing)

At this stage, the price of rice is predicted to be sourced on rice price data 2 weeks before that. For test data starting from the data of the 143rd week of January 2019 with the 238th week of December 2020, while for the test target starting from the data of the 145th week of January 2019 until the with the 240th week of December 2020.

Table 3 Test *Data Arrangement* and Test Targets

Half	Test Data	Test Target
1	Data in weeks 143-144	145th week data
2	Data in weeks 144-145	146th week data
3	Data in weeks 145-146	Week 147 data
4	Data in weeks 146-147	Week 148 data
5	Data in weeks 147-148	Week 149 data
6	Data in weeks 148-149	150th week data
7	Data in weeks 149-150	151st week data
8	Data in weeks 150-151	152nd week data
9	Data in weeks 151-152	153rd week data
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
92	Data in weeks 234-235	236th week data
93	Data in weeks 235-236	237th week data
94	Data in weeks 236-237	238th week data
95	Data in weeks 237-238	239th week data

96	Data in weeks 238-239	240th week data

Where to determine the test data using the formula *zeros* (numberof months × the test year, test week). As for determining the test target using the formula *zeros* (numberof months × the test year, 1). Then to determine the results of the test target prediction is to use the formula (output *testing* × (maximal data - minimum data)) + minimum data.

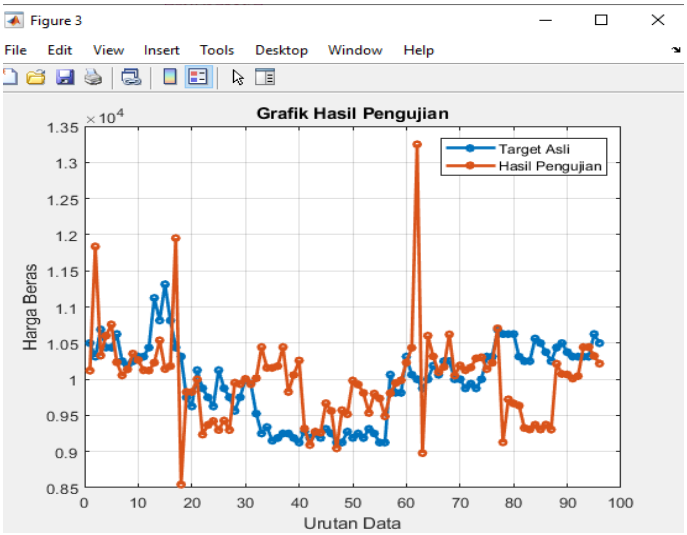

Figure 2 Test Results Graph

4. Determining prediction results

In this stage, the price of rice that will be predicted is sourced from rice price data 5 years earlier. The prediction data used is the price of rice from January 2016 to December 2020 (5 years). Then there will be an application on the matlab application. Where to determine prediction data using the formula *zeros* (numberof months × year prediction, prediction week). As for determining the prediction target using the formula *zeros* (numberof months × year prediction - prediction week, 1). Kemudian to determine the results of predictions is using formulas (out prediction × (max data - min data)) + min data.

Table 4 Prediction Results

No.	Original Data Prediction Target	Prediction Results	Information	Moon	Year
1	9813	10020	Prices Go Up	January	2021
2	9938	10260	Prices Go Up		
3	10000	10260	Prices Go Up		
4	9938	9328	Prices Are Down		
.	.	.	.	.	
.	.	.	.		
.	.	.	.		
.	.	.	.		
233	10313	10010	Prices Are Down	November	2025
234	10313	10310	Prices Are Down		
235	10313	10340	Prices Go Up		
236	10313	10380	Prices Go Up		
237	10625	10370	Prices Are Down	December	
238	10500	10410	Prices Are Down		

From the prediction results obtained the mse value prediction 0.1065% and the prediction MAPE value 7.0788%, with accuracy values based on MSE and MAPE values of 99.8935% and 92.9212%, of

99.8912% and 92.9212%, among them. Based on the results of the above predictions it can be concluded that the use of metode *Adaptive Neuro-Fuzzy Inference System* (ANFIS) on rice price prediction is very good and suitable for predicting rice prices. .

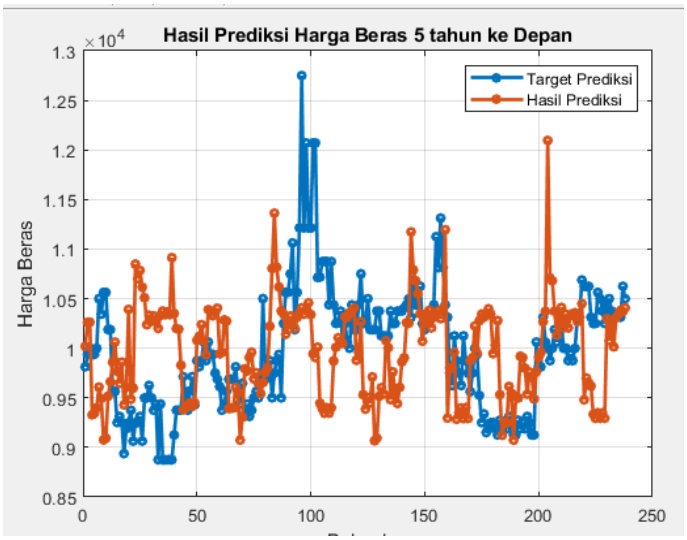

Figure 3 Graph *of* Rice Price Prediction Results

5. Data Validation

The need for data validation to ensure accuracy will level the level of variable-veriabel data in research that unites the period of research methods with research objects using existing data. The data used to validate the data is training data and testing data.

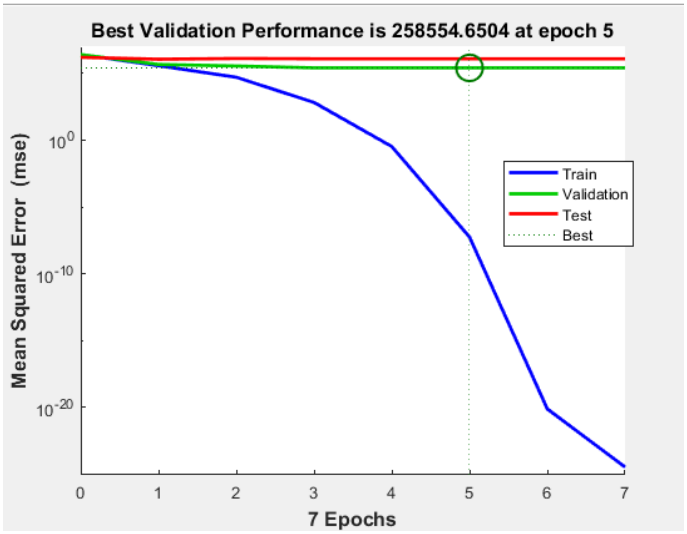

Figure 4 Best *Validation Performance Graph*

For each data validation check, the results obtained can vary due to the data used as random data or *random data.*

Validation performance values that have been done using training data and test data as the target, with Random 96 target timesteps data divided into 68 target timesteps data, 14 timesteps targets as *validation* and 14 targets *timesteps* as data tests. So get the best value is 258554.6504 in *epoch* 5.

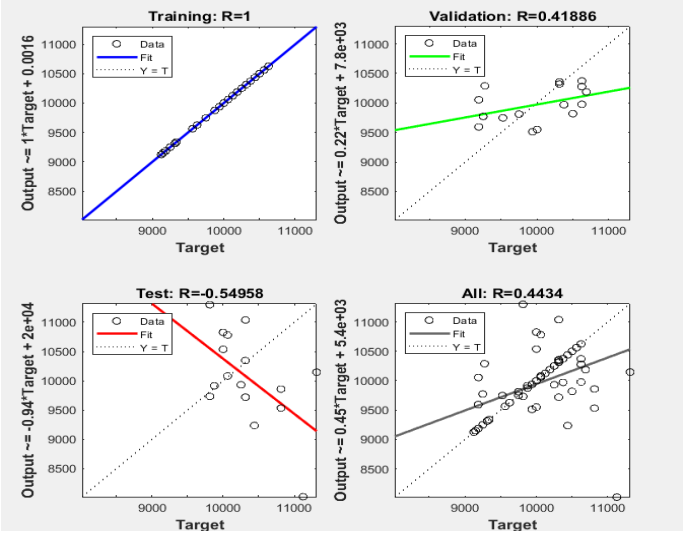

Figure 5 *Plot Performance Validation*

In the *performance validation* results show *regression* values that aim to measure the correlation value between *output* and target, where in *training* R = 1, in *validation* R = 0.41886, test R = 0.54958, and in all *performances* R=0.4434. If, the value of R is 1 indicates that *performance* has the closest relationship, while 0 is a random relationship. In the validation results above shows that the method listed is Regression because in the matlab application there is a *default tool* to perform a valid process of breast milk, namely *network time series tools* (ntstool) so that the validation results are *regression.* Adaptive *Neuro-Fuzzy Inference System* (ANFIS) is part of regression. For each time to validate data, the results obtainedn can vary because the data done for the validation process is random *data* taken from existing training and test data.

4 Conclusion

Based on the results and discussions that have been done, the conclusions obtained in this study are: Researchers can find out how to make predictions and how much accuracy predictions are obtained using the Adaptive *Neuro-Fuzzy Inference System* (ANFIS) method. MAPE*(Mean Absolute Percentage Error)* and MSE (MeanSquare*Error)* values from rice price prediction results in Lubuklinggau City using the ANFIS method, where for mape value training of 6.7003% and MSE value by 0.0963% while for testing mape values by 11.7218% and nilai MSE by 0.1216%.

For the accuracy value on rice price prediction based on MSE training which is 99.9037% and based on MSE testing which is 99.8784%. While the accuracy value of rice price predictions based on MAPE training and testing is 93.2997% and 88.2782% For prediction MSE values of 0.1065% and MAPE values of predictions 7.0788%, with accuracy values based on MSE and MAPE values of 99.8935% and 92.9212%, of 99.8212, are 99.8935% and 92.9212, years, of year.

The ANFIS method is an effective method for making price predictions in the future.

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