Farmer exchange rate category A Prediction analysis using ANN back propagation

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Abstract. The Farmer Exchange Rate (FER) is one of the indicators in determining the welfare level of farmers. Every month this large FER has a change especially at the end of each season during harvest, the price game especially from producers often occurs so that not a few farmers complain and suffer losses. Therefore, there need to be efforts from the government is looking at past data trends to find the amount of FER in the future so that policies can side with farmers. Artificial Intelligent with a multilayer Back Propagation method is very good for modeling and forecasting of data series in the past with data input in the form of a matrix *mxn*. The simulation results show that in 2020 in NTB there is an average increase in the exchange rate of farmers of 118.76%, this means that farmers are experiencing a surplus or farmers' incomes are rising more than their expenditures. However, it appears that from June-August and October-November there was an average decrease of 2%, although overall there was increase of 2.076%. This result was obtained by the construction of a network architecture of two hidden layers where theMSE of 0.12, and MAPE of 0.23.

1. Introduction

Human development and well-being is one of the main indicators of the success of the implementation of national development [1]. Human development can be seen from the level of the Human Development Index as measured through education, health, and living standards [2]. One indicator of improving living standards is that agriculture business is improving well. The measure in question is the high farmers exchange rate (FER). The farmer exchange rate (FER) is the ratio between the price index received by the farmer and the price index paid by the farmer stated in percentage [3, 4]. The exchange rate of farmers is one of the indicators in determining the welfare level of farmers [5]. FER is a comparison between the price index received by farmers and the price index paid by farmers [6]. The price index received by farmers is a price index that shows the development of producer prices on farmers' produce. While the price index paid by farmers is a price index that shows the development of the price needs of farmers households, both the needs of consumption in the daily life of the community and the need for the planning and implementation of agricultural production [7].

From the Statistics Central Bureau of Nusa Tenggara Barat (called NTB) Province obtained information that over the past six years, the average farmer exchange rate increased in January by 3.97%,

February was 3.67, March was 3.68, April was 3.75, May was 3.71, June was 3.81, July was 4.01, August was 4.26, September was 4.67, October was 4.68, November was 4.67, and December was 4.45. Of course this result that the more years the welfare level of farmers in NTB the better but not very significant. The research results of Dewi Retnasari (2015) show that FER that is too high is not good for the growth of human development index, because FER continues to increase which shows that farmers' incomes are also increasing. This will have an impact on inflation which causes the price of public goods including educational and health goods to increase, so that farmers have not been able to prioritize their spending on spending to improve the quality of human resources [9, 10]. Unique welfare indicators for farm households are practically none, so FER is the only option for agricultural development observers in assessing farmers' welfare levels. Thus, FER is one of the indicators of the relative level of welfare of farmers. The higher the FER, the more prosperous the farmer's life level [11].

From this information, there needs to be control on the part of the government to maintain economic stability in the community. All forms of policy must be data-driven and fact-based. Therefore, the need for future information regarding the size of FER to determine the selling price and purchase price of food crop production. One good prediction method with compound data is Artificial Neural Network (ANN). ANN work systems are adaptive that can change the structure of the network formed to recognize and solve problems based on input data or information received both externally and internally flowing through the network [12]. One type of ANN with multilayer is Back Propagation (BP). BP is a supervised learning method with a multi-layer network and has the special feature of minimizing errors in the output generated by the network [13, 14]. Isa Irawan (2013) said that ANN Back Propagation is a machine learning that has a high level of accuracy in recognizing the pattern or trend of a data even the accuracy rate reaches an average of 99.76%.

From the above discussion, there needs to be a mathematical strategic step to determine the direction of policy through the forecasting activities of farmers' exchange rate data in the future. Therefore, the goal that this research wants to achieve is to build a suitable ANN Back Propagation architecture through training and data testing, further used to find out the results of future farmer exchange rate predictions through a known mathematical model.

2. Method

This research is a quantitative study that begins with the construction of network models and analyzes and predicts data using the Artificial Neural Network (ANN) Back Propagation method with two hidden layers. The data used at the training and testing stage is the last 6 years from the Farmer Exchange Rate (FER) of NTB Province. The data source is taken from the official website of the Central Statistics Agency, namely https://ntb.bps.go.id/. Here are the steps in the process of network construction, data training, and simulation.

a. Develops an ANN Back Propagation network architecture with two hidden layers, primarily indicators of the parameters of each network layer.
b. Choose the best training method based on the smallest MSE and MAPE values, then use that architecture to predict upcoming data.
c. Perform data analysis as fair as the interpretation of prediction results based on the resulting error parameters.
d. Conduct a literature analysis related to government policies based on predicted results for reference in planning and development in agriculture.

In general FER produces 3 categories:

a. FER > 100, meaning FER in a given period is better than FER in the base year, in other words farmers are experiencing a surplus. Production prices rose more than the increase in consumption prices. Farmers' incomes go up and become bigger than they spend.
b. FER = 100, means FER at a certain period equals FER in the base year, in other words farmers break even. The increase/decrease in production price is equal to the percentage increase/decrease in the price of consumer goods. The farmer's income is the same as his expenses.

c. FER < 100, meaning FER in a given period decreases compared to FER in the base year, in other words farmers run deficits. The increase in production price is relatively smaller compared to the increase in the price of consumer goods. Farmers' incomes are down and smaller than their spending.

3. Results and Discussion

The data obtained from the Statistics Central Bureau of NTB province according to Table 1 follows.

Table 1. NTB Provincial Farmer Exchange Rate 2014-2019

Month/Years	2014	2015	2016	2017	2018	2019
January	97,14	100,34	100,34	107,08	112,72	117,87
February	97,86	100,72	100,72	105,77	110,58	117,09
March	97,21	101,89	101,89	104,72	110,8	116,34
April	95,16	98,31	98,31	103,41	107,84	114,25
May	94,91	99,87	99,87	104,14	108,54	113,77
June	96,04	101,08	103,66	104,98	108,83	115,68
July	97,01	101,63	104,6	104,56	110,06	117,93
August	96,71	102,07	106,06	104,77	110,66	118,91
September	96,41	103,07	105,83	107,26	113,46	120,98
October	97,4	105,69	107,2	110,05	116,31	122,27
November	97,98	108,07	108,12	111,47	117,05	122,77
December	98,31	107,04	108,3	111,7	117,55	122,01

From Table 1, information is obtained that the amount of input data for training data is 55 data taken from 2014-2018 and testing data as much as 12 data taken from 2019. Furthermore, the data training simulation is carried out to determine the best architecture. The results of training data according to Table 2.

Table 2. Simulation Result of Training & Testing Data

Learning Rate	Iteration	MSE	MAPE
0.7	215	0.0793879	0.173413
0.8	190	0.0790414	0.182035
0.9	188	0.0783667	0.19105

From Table 2 it is obtained information that the least number of iterations and the least MSE uses a learning rate of 0.9. These results are obtained using architectures with components:

Number of Neurons:
- Layer Input : 55
- Layer Hidden 1 : 10
- Layer Hidden 2 : 5
- Layer Output : 1

Activation Function : LOGSIG, LOGSIG, LOGSIG
Algorithm Training : TRAINRP
Setting Parameter:
- Max. Epoch : 1000
- Error (Goal) : 0,0001
- Learning Rate (LR) : 0,9
- Momentum : 0,9
- Decrease ratio LR : 0,7
- Increase ratio LR : 1,05

As for the network architecture for predictions seen in Figure 1 below.

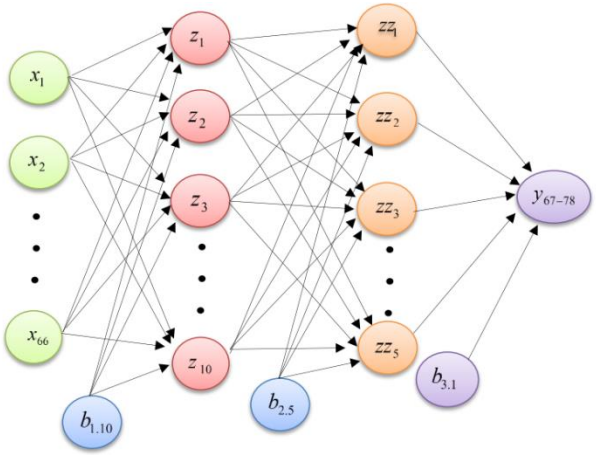

Figure 1. ANN Architecture for Data Prediction

Furthermore, using the architecture is done predicting the farmers exchange rate with input data as much as 66 data. The predicted results are seen in Figure 2 below.

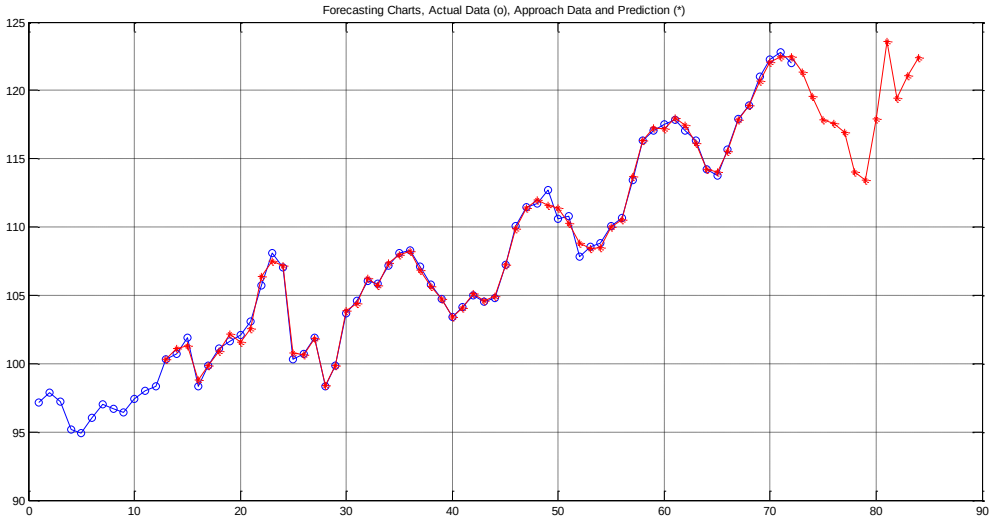

Figure 2. Farmers Exchange Rate Prediction Results

From Figure 2, there is a very good data pattern between the actual data and the prediction data with an iteration of 187, a regression of 0.99862 or an accuracy rate of 99.72%, an MSE of 0.12, and a MAPE of 0.23. Predicted result in January of 121.37%, February at 119.57, March at 117.85, April at 117.58, May was 116.92%, June at 114.05%, July at 113.45%, August at 117.91%, September at 123.59%, October at 119.42%, November at 121.09%, and December at 122.38%. Based on this data it can be known that the FER value in each month is more than 100, it can be said thatmeaning FER in a given period is better than FER in the base year, in other words farmers are experiencing a surplus. Production prices rose more than the increase in consumption prices. Farmers' incomes go up and become bigger than they spend.

However, it appears that from June-August and October-November there was an average decrease of 2%, although overall there was an increase of 2.076%. The decline in June-August and October-November is generally due to this month's abundant crop of farmers' food crops so that the purchase price of producers decreases even beyond the predictions of farmers. Here the economic law remains that the more goods the cheaper the purchase price of the manufacturer.

4. Conclusion

The exchange rate of farmers is one of the indicators in determining the Human Development Index (HDI) because it shows the level of welfare of farmers. The policy needs to be done in a structured and watched way towards the process of buying and selling food crops. At least a mathematical review is needed for future data to see data trends based on past data. ANN Back Propagation delivers good results with an accuracy rate of 99.72%. The results showed that in NTB Province, there was an increase of 2.076%% in January-May, September, and December, while in June-August and October-November there was an average decrease of 2%. Despite the decline in the farmer exchange rate, it remained above the standard of 118.76%.

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