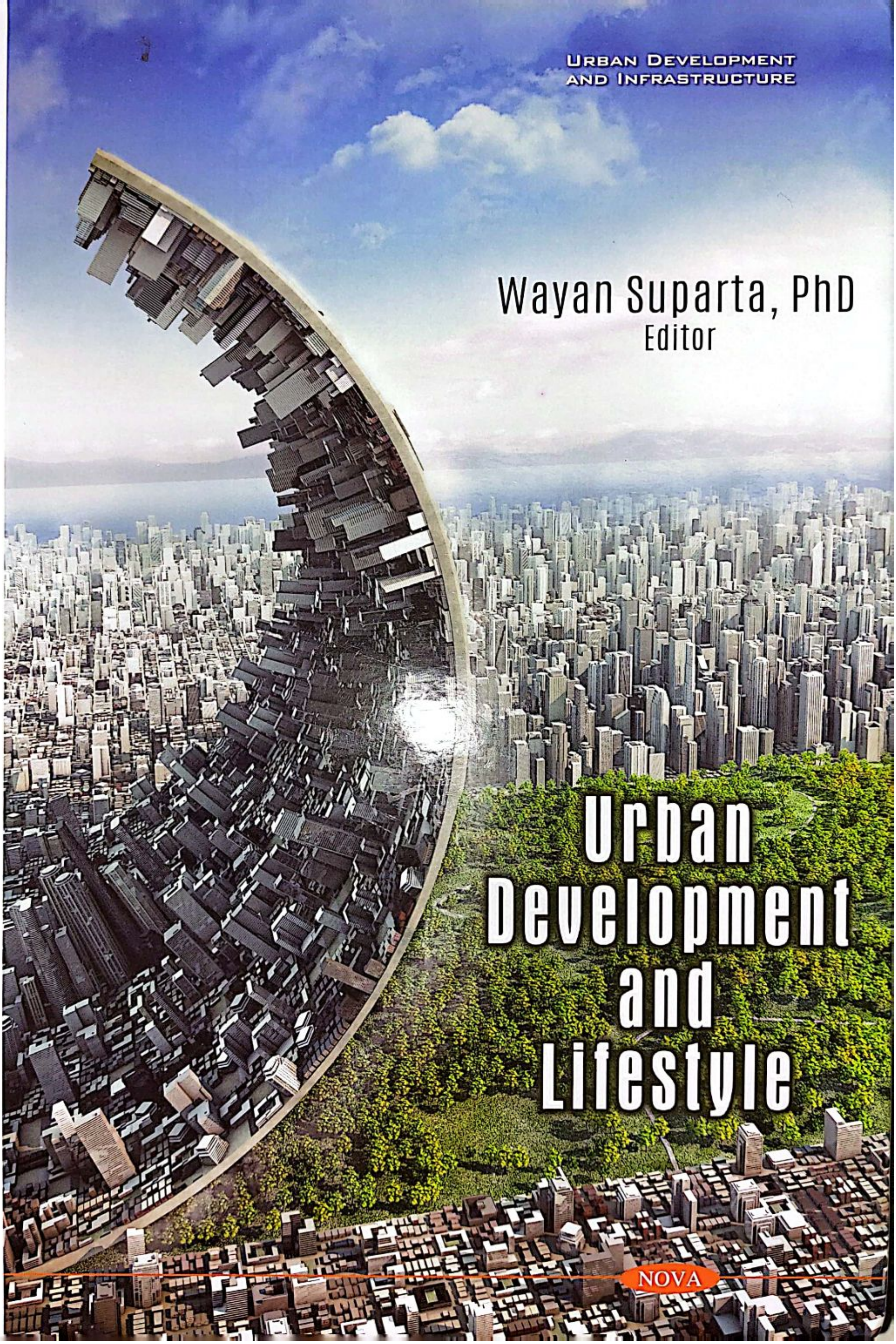

URBAN DEVELOPMENT AND INFRASTRUCTURE

Wayan Suparta, PhD
Editor

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As Professor at the Universitas Pembangunan Jaya, with daily activities in lecturing, doing research, as well as water resources development planning, I really praise the Nova Science Publishers for publishing selected papers from "2020 International Conference on Urban Sustainability, Environment, and Engineering (CUSME 2020)". Hence, this publication would be useful for professionals, reseachers, scholar, policymakers, and NGO. I believe that currently, many professionals would like to give more attention on development of sustainable urban. In addition, this publication could be used as reference for City authorities to make appropriate policy choices to protect the provision of equitable housing, health, and transportation services.

Prof. Ir. Frederik Josep Putuhena M.Sc., Ph.D
Center for Urban Studies – Universitas Pembangunan Jaya

Urban Development and Lifestyle are trend issues for the cities around the world. Learning from experiences is the most effective way to support the cities to be sustainable developed. This book offers the knowledge sharing among countries which covers variety of cities' issues. It also provides the great lessons for researchers, officers and policy makers on coping with several urban problems.

Associate Professor Sarintip Tantanee, Ph.D.
Director
Center of Excellence on Energy Technology and Environment (CETE)
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CONTENTS

PREFACE

One of the issues of urban development and urban lifestyle, which can be studied from the sea to space, has posed important challenges for humanities, environmental management of cities and urban areas, and the economy. This field is one of the pillars of sustainable development from urban studies towards sustainability welfare. Research and development (R & D) in this part plays a crucial role where urban problems are always alive and increasing every year because of changing customer preferences and needs. City authorities must make appropriate policy choices to protect the provision of equitable housing, health, and transportation services in the future. The megatrends 2030 triggered by the Industrial Revolution 4.0 estimates urbanization will increase sharply, massive move from rural to urban areas, and the land is getting narrower, especially in Asia. New directions and developments in this field and discussion of future priorities must be well anticipated, meticulous, dignified, and innovative.

This book highlights the latest views and solutions to technological innovations adapted to achieve prosperity in urban sustainability. For instance, adapting new buildings for urban needs with low-cost and modern design materials, the housing environment and the layout of city space, weather changes to disaster, and smart transportation systems are also taken into account. It also involves electricity, environmental management, and ways to use agricultural land to increase income. The ease of technology produced will change the business model.

This contributed volume presents solicit selected papers of the 2020 International Conference on Urban Sustainability, Environment, and Engineering (*CUSME 2020*) with the theme "Urban Life and Technology". The book covers the point of view in urban architectures with green technology, sustainable environmental, management, agrotechnology, and smart transportation systems. The impact of urban development such as psychological and cultural influences, communication and social complexity, information systems and technology is also discussed with various solutions offered. The outcomes of the conference will certainly support government policy, stakeholders, policymakers, scientists, and engineers by bringing together their latest findings towards achieving a sustainable economy, improved quality of life, and protecting the environment. The findings of this study will create opportunities for further collaboration and are expected to improve the welfare of humanity.

The conference committee and all our contributors wish to pleasantly thank for their efforts and cooperation in finalizing this volume. We wish to acknowledge and gratitude

Nova Science Publishers Team for supporting our book proposal and for granting the opportunity to publish these conference proceedings and for their cooperation and support.

Wayan Suparta
Chairperson of CUSME 2020
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Chapter 35

FUZZY TIME SERIES TO PREDICT THE VOLUME OF YIELD OF ARROWROOT

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ABSTRACT

Arrowroot is a superior plant in Kadireso village, Pajangan sub-district, Bantul, Yogyakarta. Arrowroot can produce several processed products, such as arrowroot flour and arrowroot chips. The high demand for arrowroot from various regions causes the need for accurate calculations related to the volume of the yield of arrowroot. Cheng's Fuzzy time series is a method that can be used to predict the volume of arrowroot yields in each period to meet the market demand.

The parameters used in this system are based on environmental data (temperature humidity, climate, altitude), genetic data (age and variety), and cultivation technique data (seed quality, fertilization, planting media). This research aims to predict the volume of the yields of arrowroot.

The result of this study is in the form of application to predict the volume of arrowroot yields based on the aforesaid parameters. From the results of MAPE, the percentage of 11.7% indicates that the level of accuracy using Cheng's Fuzzy time series is useful in predicting the yields of arrowroot.

Keywords: Cheng's Fuzzy Time Series, Arrowroot, Prediction, Yields

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The FLR can be symbolized with $A_i \rightarrow A_j$, where A_i is called the current state and A_j is called the next state [7].

Determining the weight of FLR to be a Fuzzy Logical Relationship Group (FLRG) is carried out by including all relationships and assigning weights based on the same sequence and iteration. FLRs which have the same current states (A_i) are combined into one group into a weighting matrix when there is a similar FLR sequence [7].

(t = 1) $A_1 \rightarrow A_1$, given 1

(t = 2) $A_2 \rightarrow A_1$, given 1

(t = 3) $A_1 \rightarrow A_1$, given 2

(t = 4) $A_1 \rightarrow A_1$, given 3

(t = 5) $A_2 \rightarrow A_1$, given 2

which state time. Then, the weight obtained in the Fuzzy Logical Relationship (FLR) is entered into a weighting matrix (W) whose equation is written as follows:

$$W = \begin{bmatrix} w_1 & w_2 & \cdots w_{1p} \\ w_2 & w_2 & \cdots w_2 p \\ w_{p1} & w_{p2} & \cdots \ w_p \end{bmatrix} \quad (6)$$

where W is a weighting matrix; w_i is the weight of the matrix in row i and column j with i = 1, 2, ..., p, j = 1, 2, ..., p.

Next is to transfer the weight of the FLRG to a standardized weighting matrix (W*) whose equation is written as follows:

$$W = \begin{bmatrix} {w_1}^* & {w_1}^* & \cdots {w_{1p}}^* \\ {w_2}^* & {w_2}^* & \cdots {w_{2p}}^* \\ {w_{p1}}^* & {w_{p2}}^* & \cdots \ {w_p}^* \end{bmatrix} \quad (7)$$

Where, W* is a standardized weighting matrix with ${w_i}^* = \frac{w_i}{\sum_{j-1}^{p} wi}$ defining the prediction defuzzification.

To produce the prediction value, the standardized weighting matrix (W*) is multiplied by m_i. Standardized weighting equation can be used to find the median (m_i) at fuzzy set intervals (Karasan et al., 2017). Therefore, the prediction calculation becomes:

$$F_1 = {w_1}^*(m_1) + {w_2}^*(m_2) + \ldots + {w_p}^*(m_p) \quad (8)$$

If the fuzzification result of the period i is A_i, and A_i does not have an FLR on FLRG with the condition $A_i \rightarrow \emptyset$, where the maximum value of the element is at U_i, then the prediction value (F_i) is the median of (F_i), or is defined with (F_i) [8].

Table 1. MAPE values for evaluation of prediction

MAPE Values	Accuracy of Prediction
MAPE ≤ 10%	High
10% < MAPE ≤ 20%	Fair
20% < MAPE ≤ 50%	Reasonable
MAPE > 50%	Low

Table 2. Data frequency and median

Interval	Frequency	Median		Condition
U_1= (112, 129.6)	2	m_1	120.8	First
U_2= (129.6, 147,2)	3	m_2	138.4	First
U_3= (147.2, 164.8)	2	m_3	156	First
U_4= (164.8, 182.4)	3	m_4	173.6	First
U_5= (182.4, 200)	4	m_5	191.2	First

The general standards of measurement of prediction errors use Mean Absolute Percentage Error (MAPE) for the percentage of accuracy [9].

MAPE values are used to analyze the performance of the prediction process as shown in Table 1.

Results and Discussions

Application of Cheng's Fuzzy Time Series Logic

Universe Set

After getting data of harvest in the last few years, the next step is to find the data value with the smallest and biggest amounts, which are (Max = 200, Min = 112). Then, the universe set is as follows:

U = [112, 200].

Determining Interval Length

- Calculating the range based on formula two as follows:

R = (Max - Min) = (200 - 122) = 88

- Calculating the interval value based on formula three as follows:

K = 1 + 3.3 × log (n) = 1 + 3.3 × log (14) = 4.78 rounded to 5

- Calculating the width of the interval based on formula four as follows:

$$I = \frac{Data\ Range\ (R)}{Interval\ Value\ (K)} = \frac{88}{5} = 17.6$$

Next is to determine the frequency of each interval. The frequency is obtained from the amount of harvest data located within each interval. Table 2 presents the result of the frequency and median of each frequency.

Data Fuzzification

Fuzzification can be formed based on pre-formed intervals, i.e., A_1 for U_1 interval, and so on. The following table is the result of data fuzzification.

Weighting is done based on the fuzzy relation process on the whole data in the fuzzification process, so that the weighting will be known. Then, it is entered into the matrix which will then be normalized. From the results about fuzzification in Table 3 above, then grouped by the similarities that arise. The following Table 4 shows that there are five groups that appear due to previous fuzzyficaton stages. The groups will be used for the normalization process.

Weighting

The weighting in Table 5 is carried out using the calculation of the opportunity to appear vector in that line.

Table 3. Data Fuzzyfication

Periods	Harvests (Kg)	Fuzzification	Relation
2014- quarter1	134	A_2	–
2014- quarter 2	176	A_4	$A_2 \rightarrow A_4$
2015- quarter 1	200	A_5	$A_4 \rightarrow A_5$
2015- quarter 2	186	A_5	$A_5 \rightarrow A_5$
2016- quarter 1	155	A_3	$A_5 \rightarrow A_3$
2016- quarter 2	187	A_5	$A_3 \rightarrow A_5$
2017- quarter 1	142	A_2	$A_5 \rightarrow A_2$
2017- quarter 2	122	A_1	$A_2 \rightarrow A_1$
2018- quarter 1	112	A_1	$A_1 \rightarrow A_1$
2018- quarter 2	156	A_3	$A_1 \rightarrow A_3$
2019- quartet 1	192	A_5	$A_3 \rightarrow A_5$
2019- quarter 2	166	A_4	$A_5 \rightarrow A_4$
2020- quarter 1	143	A_2	$A_4 \rightarrow A_2$
2020- quarter 2	166	A_4	$A_2 \rightarrow A_4$

Table 4. Fuzzy logic relationship group

Group 1	$A_1 \rightarrow A_1, A_1 \rightarrow A_3$
Group 2	$A_2 \rightarrow A_1, A_2 \rightarrow A_4$
Group 3	$A_3 \rightarrow A_5$
Group 4	$A_4 \rightarrow A_2, A_4 \rightarrow A_5$
Group 5	$A_5 \rightarrow A_2, A_5 \rightarrow A_3, A_5 \rightarrow A_4, A_5 \rightarrow A_5$

Table 5. Normalized weighting

	A_1	A_2	A_3	A_4	A_5
A_1	1/2	-	1/2	-	-
A_2	1/2	-	-	1/2	-
A_3	-	-	-	-	1/1
A_4	-	1/2	-	-	1/2
A_5	-	1/4	1/4	1/4	1/4

Many vectors are compared to the number of vectors in the variables. The results are shown in the following table.

Calculating Prediction Value

After the weighting process, the prediction value is calculated using formula eight. The value is as follows:

$F_1 = [m_1, m_3] * [A_1, A_3]$
= [120.8, 156] * [1/2, 1/2]
= 60.4 + 78 = 138.4

$F_2 = [m_1, m_4] * [A_1, A_4]$
= [120.8, 173.6] * [1/3, 2/2]
= 40.266 + 115.733
= 155.9

$F_3 = [m_5] * [A_5]$
= [191.2] * [2/2]
= 191.1

$F_4 = [m_2, m_5] * [A_2, A_5]$
= [138.4, 191.2] * [1/2, 1/2]
= 69.2 + 95.6
= 164.8

$F_5 = [m_2, m_3, m_4, m_5] * [A_2, A_3, A_4, A_5]$
= [138.4, 156, 173.6, 191.2] * [1/4, 1/4, 1/4, 1/4]
= 34.6 + 39 + 43.4 + 47.8
= 164.8

From the results of the calculation using the formula shown above, it can be completed until the prediction to n period yield. After the calculation is completed, then the result of the prediction is presented in Table 6 below.

Table 6 shows that arrowroot has a two-time harvest period in a year. Predictions are made using the previous data. The data used are taken from 2014 to the present time. The following Figure 1 shows the comparison chart of predicted results with the actual harvest data.

Table 6. Harvest prediction table

No.	Periods	Harvests	Fuzzification	Prediction Results
1	2014- quarter 1	134 Kg	A_2	-
2	2014- quarter 2	176 Kg	A_4	164.8 Kg
3	2015- quarter 1	200 Kg	A_5	164.8 Kg
4	2015- quarter 2	186 Kg	A_5	164.8 Kg
5	2016- quarter 1	155 Kg	A_3	191.2 Kg
6	2016- quarter 2	187 Kg	A_5	164.8 Kg
7	2017- quarter 1	142 Kg	A_2	155.9 Kg
8	2017- quarter 2	122 Kg	A_1	138.4 Kg
9	2018- quarter 1	112 Kg	A_1	138.4 Kg
10	2018- quarter 2	156 Kg	A_3	191.2 Kg
11	2019- quarter 1	192 Kg	A_5	164.8 Kg
12	2019- quarter 2	166 Kg	A_4	164.8 Kg
13	2020- quarter 1	143 Kg	A_2	155.9 Kg
14	2020- quarter 2	166 Kg	A_4	164.8 Kg
	Prediction Results			173.6 Kg

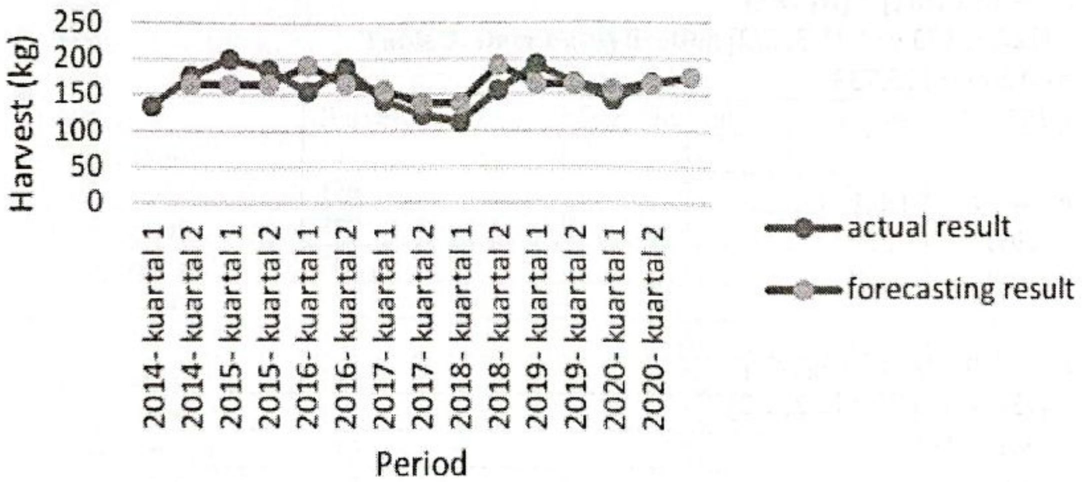

Figure 1. Comparison chart of prediction results.

Accuracy Level (MAPE)

It measures this accuracy as a percentage and can be calculated as the average absolute percent error for each period, minus actual values divided by actual costs.

Prediction values that have been obtained are placed on each fuzzy set, and error values are calculated using Cheng's Fuzzy Time Series Algorithm. Table 7 presents the result of MAPE accuracy.

From Table 7, the average error is 0.117 and the percentage of MAPE values is 11.7%. Therefore, it can be concluded that the accuracy of prediction using Cheng's fuzzy time series logic is relatively high.

Table 7. MAPE table

No.	Periods	MAPE	Accuracy Levels
1	2014- quarter 1	-	-
2	2014- quarter 2	6.3%	High
3	2015- quarter 1	17.6%	Fair
4	2015- quarter 2	11.3%	Fair
5	2016- quarter 1	23.3%	Reasonable
6	2016- quarter 2	11.8%	Fair
7	2017- quarter 1	9.7%	High
8	2017- quarter 2	13.4%	Fair
9	2018- quarter 1	23.5%	Reasonable
10	2018- quarter 2	22.5%	Reasonable
11	2019- quarter 1	14.1%	Fair
12	2019- quarter 2	0.7%	High
13	2020- quarter 1	9.0%	High
14	2020- quarter 2	0.7%	High
	Prediction Results	11.7%	Fair

CONCLUSION

Cheng's fuzzy time series method can be used as a method for predicting harvest yields of arrowroot. Based on data used from 2014 to present, the prediction results show that the accuracy of the MAPE is less than 11.7%, which can be concluded that predicting the volume of harvest yields of arrowroot by using fuzzy time series method provides good prediction values.

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