Scientific Journal of Informatics
Vol. 3, No. 2, November 2016
p-ISSN 2407-7658 http://journal.unnes.ac.id/nju/index.php/sji e-ISSN 2460-0040

The Implementation of Grey Forecasting Model for Forecast Result's Food Crop Agricultural

Asfan Muqtadir[1], Suryono[2], Vincensius Gunawan[3]

[1] Department of Informatics, FT, University PGRI Ronggolawe Tuban
[2,3] Masters of Information Systems, Graduate Schools, University of Diponegoro
Email : [1]asfanme@gmail.com, [2]suryono@undip.ac.id, [3]vgunawanslametk@undip.ac.id

Abstract

The increasing of the needs of food crops raised several issues related to land use. The problems of land used caused by the lack of information related to productivity and eligibility used of land. The goal of this research is to implementation a model of Grey forecasting GM(1,1) to forecast agricultural production, especially in food crops. GM(1,1) is used to built a model with limited data samples and generate good forecasts for short libertine forecasts. This research uses data from the production of food crops for the 2004-2013 it can be calculated by using the model of GM (1,1). The results showed the model GM (1,1) can produce highly accurate forecasts, from the experimental results for pattern trends generate value ARPE 5.74% or accuracy of forecasts reached 94.26% in crop production.

Keyword: Grey Forecasting, Forecast, Agricultural Products

1. INTRODUCTION

The forecasts are used to predict future events mathematically by looking at earlier data, so the forecasting methods can be provide an orderly way and directed processing that can be obtained using more advanced analysis techniques. The use of the techniques used for the analysis is expected to provide a level of confidence and greater accuracy because it can be tested with the deviations that occurred [1].

The forecasts will produce new information that will be happen in the future, this information is certainly beneficial for the business or policy-makers and decision-makers. But in terms of data collection is not any data is easily obtained so, the data are limited. The forecasts using Grey Forecasting Model as one of the approaches that can be used to build a model with limited data sample, with forecasts of short-term problems, to generate forecasting models are valid and does not require consideration of the statistical distribution [2].

In the previous research used the Grey Forecasting Model to determined the electrical load forecasting in developing countries, the rate of economic growth in developing countries is usually high and unstable so, not easy to get an accurate prediction using long-term data [3].

In Agriculture, especially in food crops, the main thing needed by the community, especially in Tuban district, the increasing need for food crops has caused some problems related of the land use [4]. It is caused a lack of information relating to productivity and feasibility of using the land.

Based on these problems required a forecast of crops to find out information about the productivity of land use, especially food crops, one method used to forecast is the Grey Forecasting or with another term called GM (1,1).

2. METHOD

2.1. Forecast Method

The Forecasting methods can be divided into two qualitative and quantitative forecasting methods. In Qualitative forecasting methods are predictions based on the opinions of a person and their data can not be represented explicitly be a number or value. In Quantitative forecasting methods based on quantitative data of the past and can be made in the form of numbers commonly referred to as data time series that have a relationship with one or more variables that influence [3].

2.2. Theory of Grey System

Grey system theory was first introduced in 1982 by Professor Deng Julong. The theory of Grey system is a system that is less-informed or have simply partially known parameters. The Name of Grey system was chosen based on the color of the subject being studied. For example, in control theory, the darkness of the color has been used to indicate the level of clarity of information. One of that is already well known is called a black box. This concept is used for objects with internal relationships or structure was not known. The word of black to indicated unknown information, white to information fully known, and Grey for most of the information is known and some unknown. Therefore, the information system that fully known is called white system, a system with fully unknown information is called black system, and the system with the most information is known and some not known called the Grey system.

2.3. Procedure Model of Grey System

The Grey forecasting is defined in the form of differential equations, in the model are the parameter values of a and b are to be sought in advance by applying techniques for generating Grey original data.

GM modeling procedures (1.1) can be summarized in the following steps [5]:

1) Building the original data series based on the sequence of time

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2),..., x^{(0)}(k)). \quad (1)$$

2) By taking the first order accumulated generating operation (1-previous) on $x^{(0)}$, can be obtained by a series of new data AGO :

$$x^{(1)} = (x^{(1)}(1), x^{(1)}(2),\cdots, x^{(1)}(k)), \quad (2)$$

Where

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i), \quad k=2,3,\ldots,n. \quad (3)$$

3) Calculate the value of the background $z^{(1)}$ formed by the generation method based on the average value of the two data $x^{(1)}(k)$ of adjacent.

$$z^{(1)}(k) = 0.5\left(x^{(1)}(k-1) + x^{(1)}(k)\right) \quad (4)$$

4) Furthermore, to each pair of values of $x^{(0)}(k)$ and $z^{(1)}(k)$ formed to implement the Grey differential equation in GM (1,1). Definition of differential equations first order Grey is a model $\frac{dx^{(1)}(k)}{dk} + ax^{(1)}(k) = b$, and the difference equation that is displayed as an image quation or whitenization:

$$x^{(0)}(k) + az^{(1)}(k) = b, \quad (5)$$

Where *a* is the coefficient of expansion, and *b* is a variable input Grey.

5) To get the value of parameters *a* and *b* are used the least squares method or the method of least squares estimate $\hat{a} = \left[\frac{a}{b}\right]$.

$$\hat{a} = (B^T B)^{-1} B^T Y\ , \quad (6)$$

Where

$$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix} \quad B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \quad (7)$$

6) Based on the time respone sequence to obtain an initial value, eg $x^{(1)}(1) = x^{(0)}(1)$, is the result of the grey *differensial* GM(1,1) :

$$\hat{x}^{(1)}(k) = \left(x^{(0)}(1) - \frac{b}{a}\right) e^{-a(k-1)} + \frac{b}{a} \quad (8)$$

7) Uses reverse techniques or restored accumulation value to generate approximate values $\hat{x}^{(0)}(k)$.

$$\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1). \quad (9)$$

2.4. Forecast Model Accuracy

Accuracy of forecast models can be seen from the difference between the original data and the results of such forecasts in Table 1 [5]. The results obtained from the calculation of forecasts by using Grey forecasting takes Relative Percentage Error, and Average Relative Percentage Error.

$$\in (k) = x^{(0)}(k) - \hat{x}^{(0)}(k) \tag{10}$$

$$\text{RPE}\ (k) = \frac{|\in(k)|}{x^{(0)}(k)} \text{x}\ 100\% \tag{11}$$

$$\text{ARPE} = \frac{1}{n-1} \sum_{k=2}^{n} \frac{|\in(k)|}{x^{(0)}(k)} \tag{12}$$

Description :

$\hat{x}^{(0)}(k)$ = forecast value

$x^{(0)}(k)$ = actual value

$|\in (k)|$ = Absolute residual value

Table 1. Classification accuracy of grey forecasting

RPE(k) and ARPE (%)	Forecasting power
< 10	Very accurate
10-20	Accurate
20-50	Less
> 50	Not Accurate

3. RESULTS AND DISCUSSION

After all the production data for districts and plants required previously stored, such of the data is the selected districts are District of Kenduruan and crops selected are rice fields. So after all stages of the electoral system passed will show the calculation results as in Figure 1 and Figure 2.

Prediksi Hasil Pertanian **PADI SAWAH**
di Kecamatan **Kenduruan**

NO	TAHUN	DATA ASLI	DATA PREDIKSI
1	2005	6245	6245
2	2006	8113	8692
3	2007	9722	8806
4	2008	8126	8921
5	2009	8733	9038
6	2010	10113	9157
7	2011	9498	9277
8	2012	9719	9399
9	2013	8789	9522

Figure 1. The results of the calculation grey forecasting

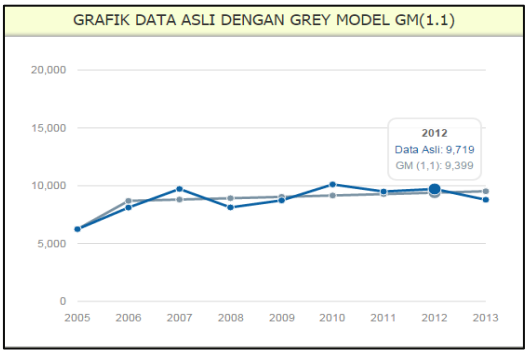

Figure 2. Graph of the calculation results of grey forecasting

The accuracy of grey forecasting models used to determine the level of accuracy of the forecasts that have been made. By using equation (11) for calculating the residual value or the difference between the initial value and the predicted value and equation (12) to calculate the relative error precentage. Table 2 shows the results of the calculation and the residual value of RPE..

Table 2. The accuracy of the grey forecasting model GM (1,1)

k	Year	Actual value $x^{(0)}(k)$	Model value $\hat{x}^{(0)}(k)$	Residual $\in (k)$	*RPE* (k)
1	2005	6245	6245	0	0
2	2006	8113	8692	-579	7,137%
3	2007	9722	8806	916	9,422%
4	2008	8126	8922	-796	9,790%
5	2009	8733	9039	-306	3,499%
6	2010	10113	9157	956	9,452%
7	2011	9498	9277	221	2,324%
8	2012	9719	9399	320	3,293%
9	2013	8789	9522	-733	8,342%

Furthermore, to determine the value of *ARPE (Absolute Relative Precentage Error)* used equation (12).

$$\text{ARPE} = \frac{1}{9-1}(53{,}26\%) = 6{,}66\ \%$$

The result of the calculation of rice crops in the District Kenduruan, forecasting error rate is 6.66% the accuracy of the results forecast using the model GM (1,1) reached 93.34%. Referring to Table 1 it can be seen that for ARPE value <10% categorized as very accurate and indicate the forecasts are not much different and even have a tendency value is almost the same as actual value.

The crop of products has very rarely shows activity results are constant and evenly distributed in a row. It is highly influential in the forecast results by using the method Grey forecasting. To handle the need of an evaluation system of the calculation results with the types of forecasting patterns, in order to know the level of accuracy that comes closest to the actual data. To determine the accuracy of the calculation of the system by the application of appropriate patterns, the evaluation the calculation of system with this type of pattern.

a) Trends Pattern (*Trend*)

If the data of agricultural production had increased the overall tendency is up or down, or flat do not go up and not down for long periods of time. For example, the production of rice crops in the District Singgahan. The result of the calculation of model of GM (1,1) pattern of the trend can be seen in Figure 3.

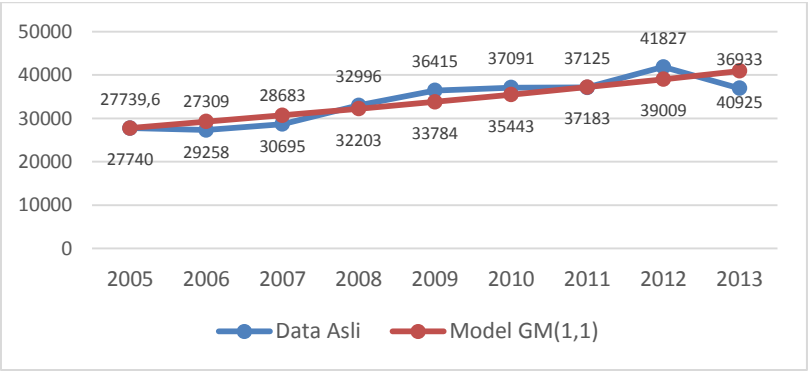

Figure 3. Graph of the calculation results with the trend pattern

The result of the calculation model of GM (1,1) with a pattern of crop production trends, providing improved accuracy of the ARPE 5.74%.

b) Random Pattern (*Random*)

The Erratic pattern seen in crop production. Most of the agricultural production data has a random pattern. For example, the production of sweet potato crops in the District Kenduruan. The result of the calculation model of GM (1,1) random pattern can be seen in Figure 4..

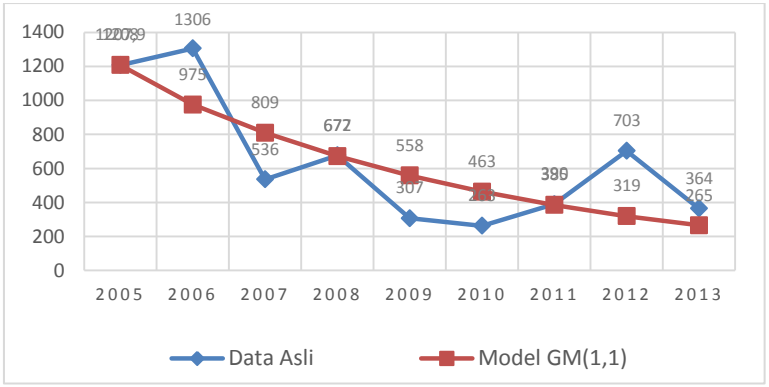

Figure 4. Graph the results of the calculation with random pattern

The result of the calculation model of GM (1,1) with a random pattern of crop production, produced a very low level of accuracy is 39.68%

c) Cyclical Pattern (*Cycle*)

The Cyclical pattern has a production output gradually rising and gradually fall over a longer time. The production of food crops in the district of Tuban has some production data with the cyclical pattern, for example, the production of maize in the District Kenduruan. The result of the calculation model of GM (1,1) the cyclical pattern can be seen in Figure 5.

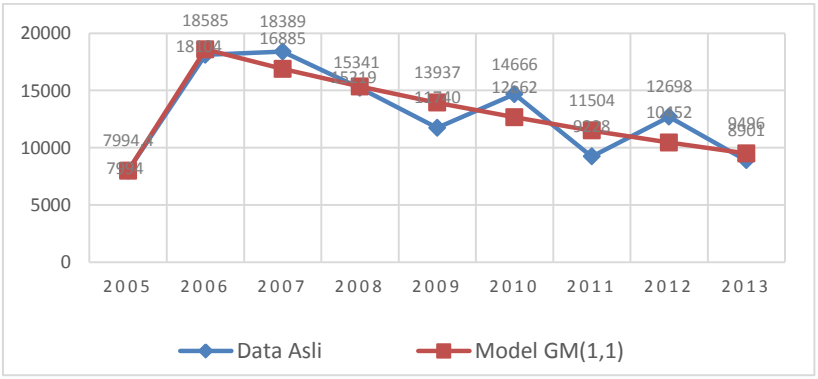

Figure 5. Graph of the calculation results with the cyclical pattern

The result of the calculation model of GM (1,1) with the cyclical pattern of crop production, produced a level of accuracy of the ARPE 11.63%.

4. CONCLUSION

From the research results implementation of Grey forecasting models for forecast the product of food crops, it can be concluded that Grey forecasting method implemented to produced a highly accurate forecast data for patterns of trends in crop production. Grey forecasting models applied linear equations for the calculation history data with incomplete data, so the results of calculations for pattern trends is highly accurate. The results of tests performed on several types of crop production, indicated the accurate prediction of data on agriculture with crops of rice paddies ARPE value are 5.74% or 94.26% accuracy of forecasts. The mentioned because of rice production patterns show up trend or down

5. REFERENCES

[1] Heizer, J., Render, B., 2005. *Operation Management, 7th Edition*. Manajemen Operasi Edisi 7, Buku I. Penerbit Salemba Empat, Jakarta.

[2] Sifeng, L., Yi, L., 2010. *Grey Systems: Theory and Applications.* Springer Science & Business Media, Berlin.

[3] Li, D.C., Chang, C.J., Chen, C.C., Chen, W.C., 2012. Forecasting short-term electricity consumption using the adaptive grey based approach an Asian case. *Omega.* Vol. 40(6): 767–773.

[4] BPS, 2013. *Tuban Dalam Angka 2013*. Badan Pusat Statistik Tuban, Tuban

[5] Shang, L. 2012. Forecasting agricultural output with an improved grey forecasting model based on the genetic algorithm, *Journal of Computers and Electronics in Agriculture*. Vol. 85: 33–39.