ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

IJETMR
International Journal of Engineering Technologies and Management Research
A Knowledge Repository

FORECASTING OF AGRICULTURAL PRODUCTION RESULTS IN SOUTH DENPASAR USING QUADRATIC TREND METHOD BASED GIS

Ni Nyoman Supuwiningsih[*1], PaulaDewanti [*2], Ni KadekSukerti [*3], I Made AgusWirahadi Putra [*4]
[*1, 2] Computer System, STMIK STIKOM Bali, Indonesia
[3, 4] Information System, STMIK STIKOM Bali, Indonesia

Abstract:
Agriculture is an activity of exploiting natural resources performed by humans to meet their needs, especially as staple food. Agricultural activities can produce foodstuffs, raw materials for industry, energy and also can balance the natural ecosystems. People may have forgotten the function of agriculture for several factors. Mentioning one, the population growth, with the result that land conversion is done to housing. Another, an economic concern that being a farmer does not guarantee the future, so that people have turned to other livelihoods that are considered promising, and other factors. Based on these facts that there has been a decline in agricultural land from 2011-2014 in Denpasar area, especially South Denpasar District, which can affect the amount of agricultural production as staple food. Total production of staple crops, especially rice plants, has decreased significantly in 2014.It became great concern to government and people in finding a solution. Due to lack of information on the impact of agricultural land conversion that affects the production, so that food needs are not met. Based on those problems, it is necessary to forecast the number of agricultural production using Quadratic Trend Method based on GIS (Geographic Information System) application using ArcView software. The results of this forecast that are implemented with a digital map can be used as a reference to the government in making decisions and create people awareness how important it is to preserve agriculture.

Keywords: *Geographic Information System; Agriculture; Quadratic Trend Method; Digital Map.*

Cite This Article: Ni Nyoman Supuwiningsih, PaulaDewanti, Ni KadekSukerti, and I Made AgusWirahadi Putra. (2018). "FORECASTING OF AGRICULTURAL PRODUCTION RESULTS IN SOUTH DENPASAR USING QUADRATIC TREND METHOD BASED GIS." *International Journal of Engineering Technologies and Management Research*, 5(2), 170-180. DOI: 10.5281/zenodo.1186523.

1. Introduction

Agriculture is one of the main sectors in Indonesia economy as well as a source of ancestral livelihood in the past. Agriculture is an activity in exploiting the natural resources undertaken by humans, to meet human needs, especially staple food [1]. Agricultural activities can produce foodstuffs, raw materials for industrial enterprises, energy and can balance natural ecosystems.

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

People may have forgotten the function of agriculture for several factors. Mentioning one, the population growth, with the result that land conversion is done to housing. Another, an economic concern that being a farmer does not guarantee the future, so that people have turned to other livelihoods that are considered promising, and other factors.

Based on these facts that there has been a decline in agricultural land from 2011-2014 in Denpasar area, especially South Denpasar District, which can affect the amount of agricultural production as staple food. The primary crops observed are staple crops grown in South Denpasar region such as rice plants, soybeans, green vegetables, spinach, red onion, water spinach and long beans. The total production of staple crops, especially rice plants, has decreased significantly in 2014. It became great concern to government and people in finding a solution. Due to lack of information on the impact of agricultural land conversion that affects the production, so that food needs are not met.

Based on those problems, it is necessary to forecast the number of agricultural production using Quadratic Trend Method based on GIS (Geographic Information System) application using ArcView software. This forecasting calculation starts from 2015, 2016, 2017, 2018 and 2019. Forecasting method used is Quadratic Trend Method. This method is a trend method that is short and medium term; the possibility of trend will follow the pattern of linear [6]. The results of this forecast that are implemented with a digital map can be used as a reference to the government in making decisions and create people awareness how important it is to preserve agriculture using modern technology methods of agriculture as one of the solutions.

2. Materials and Methods

2.1. Forecasting Concept

Previous data analyzing is very important because human behavior is influenced much by the earlier condition or time [7]. A company, a person or a particular agency made their decisionbased on previous data and conditions. Periodic series can be used to predict future statuses. Periodic series have four components: trends (tendencies), season variations, cyclical variations, and irregular variation.

Trend is a long-term tidal movement that is obtained from the average change over time and its value is quite flat or smooths [6]. Periodic data trends may take the form of a steadily increasing and declining. A trend whose value increases is called a positive trend and a downward trend is called a negative trend. Trends show relatively long and stable time changes. Potency that can influence trends is population change, price, technology and productivity. Quadratic Trend Methods for short and medium term trends; chances are those trends will follow a linear pattern. However, in the long run, the pattern may change to not be linear. Therefore, if the pattern is not linear and predicted by a linear equation, the result of the prediction will be different or unsuitable. One of the nonlinear methods is the quadratic method. The equation of quadratic trends is formulated as follows:

$$Y' = a + bX + cX2$$

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

Description of the Formula
Y' : Trend value
a : Constant value
b : The value of the inclination is the additional value of Y, when X increases one unit
X : Year period value

2.2. The Concept of GIS (Geographic Information System)

Geographic Information System (GIS) consists of three terms, namely system, information and geography, is a set of components or elements that are interconnected between components/elements to achieve goals [3]. Information concept is the result of data processing and geography of the Earth's surface study. The concept of GIS is a collection of components that interact with each other in data processing to produce geographical information that implemented in the form of digital maps. GIS can also be defined as an information system that can analyze, store, update, integrate and display all forms of information related to the earth's surface.

Considering efficiency of Geographic Information System and its capability in managing data with a complex and large-scale structures, can be a help for decision-making process. There are several reasons why the concepts of GIS and its applications are attractive to use in various disciplines [4]:

- Geographic Information System (GIS) is very effective in helping the process of forming, developing or improving the map and always co-exist with the real-world physical environment filled with visual impressions.
- Geographic Information System (GIS) can be used as an interactive, interesting and challenging tool or tutorial to improve understanding, learning and education on ideas or concepts of location, space, population, and elements geographically located on the surface of earth and an attribute data attached to it.
- Geographic Information System (GIS) using spatial data and non-spatial data (attributes) in an integrated manner so that the system can answer spatial and non-spatial questions.
- Geographic Information System (GIS) has ability to decipher the elements contained on the surface of earth into a layer that can model real shapes.
- Geographic Information System (GIS) application can be customized using scripting language commands owned by relevant Geographic Information System (GIS) software to meet user needs automatically, at fast, more attractively, informatively and user friendly.

Method used in this research consists of several stages as follows:

- Literature Study

At this stage, researcher conducts a literature study from various supportive references comprising of books and supporting journals.

- Agricultural Land Observation in South Denpasar District

Conduct direct observation to South Denpasar District; see the remaining agricultural land due to agricultural land transform.

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

- Data Collection

Collecting data of agricultural land coverage in South Denpasar District and the amount of crop production from 2011-2014. This data is used as a reference to forecast the amount of crop production from 2015-2019. The main agricultural crops are rice, soybeans, green vegetables, spinach, red onions, water spinach and long beans.

- Forecasting Calculation Process

Forecasting calculation using Quadratic Trend Method is performed at this stage.

- Analyzing Spatial Data and Non-Spatial Data

At this stage, spatial data analysis for South Denpasar District is done, geographically along with non-spatial data in the form of attributes, total production of agricultural products in 2011-2014.

- Layer Identification Process

Identifying each layer for digitization.

- Digitized Map Process

Digitized map is done using ArcView desktop software, at this stage.

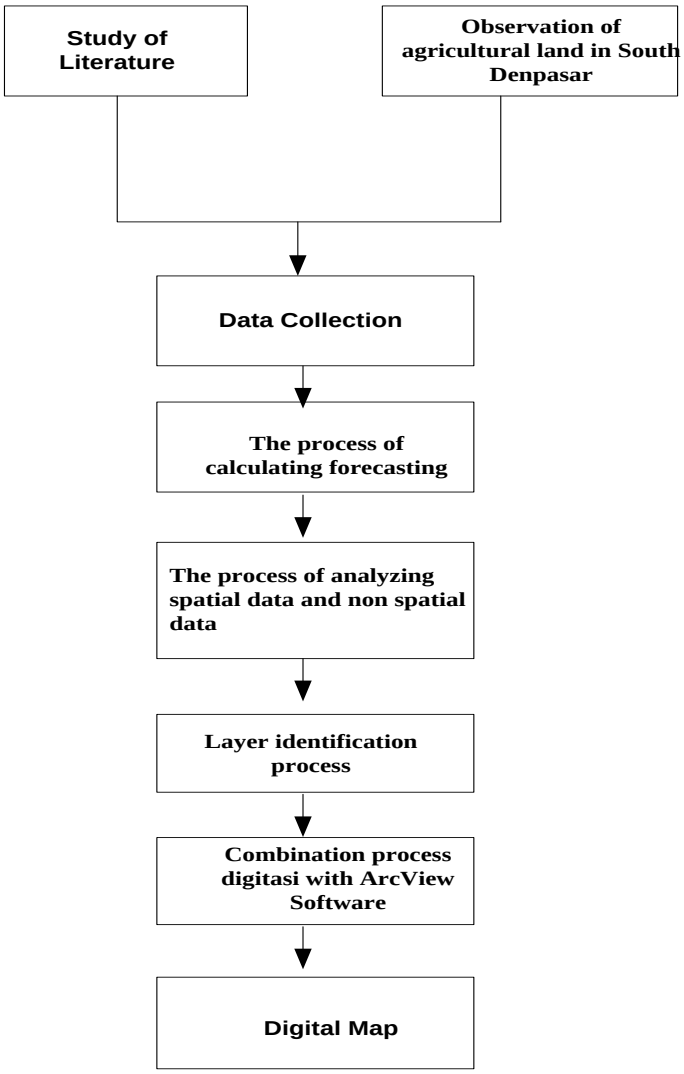


Figure 1: illustrates the flow of systematics writing

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

3. Results and Discussions

South Denpasar District with 49.99 km2 coverage areas and total agricultural land reach 8.96 km2 in 2011, 8.47 km2 in 2012, 2,843 km2 in 2013 and 1,353 km2 in 2014. Data of staple production for South Denpasar District from year 2011-2014 is on table 1.

Table 1**:** Number of South Denpasar District Crop Production Year 2011-2014

No	**Main Crops**	**Total Production (ton)**			
		2011	2012	2013	2014
1.	Rice	9308	9878	9955	9940
2.	Soybean	1628	371	328	277
3.	Green Vegetable	1946	1946	1948	900
4.	Spinach	1027	1025	1020	1018
5.	Red Onion	109	108	102	100
6.	Water Spinach	1415	1412	1410	1300
7.	Long Bean	36	30	36	20

The data of agricultural crops production that grown in South Denpasar District will be processed and predicted 5 years after the last data year of 2014, forecasting the amount of agricultural production for year 2015, 2016, 2017, and 2018, up to 2019. Forecasting is done by Quadratic Trend Method.

Below is the calculation for Forecasting of production of staple crops numbers that grown in the area of South Denpasar District:

Rice Plant Forecasting Calculation
Rice crops are the main agricultural crops grown in South Denpasar District. 2011-2014 data are used as reference, with forecasting calculation as follows:

Table 2: Calculation Table of Forecasting Number for Rice Plant Production in South Denpasar District

Year	**Y**	**X**	**XY**	$\mathbf{X^2}$	$\mathbf{X^2Y}$	$\mathbf{X^4}$
2011	9308	-1.5	-13962	2.25	20943	5.0625
2012	9878	-0.5	-4939	0.25	2469.5	0.0625
2013	9955	0.5	4977.5	0.25	2488.75	0.0625
2014	9940	1.5	14910	2.25	22365	5.0625
Total	39081		986.5	5	48266.25	10.25

Quadratic Equation

$$= \frac{(\sum Y)(\sum X^4)-(\sum X^2Y)(\sum X^2)}{n\,(\sum X^4)-(\sum X^2)^2}$$
$$= \frac{(39081)(10.25)-(48266.25)(5)}{4(10.25)-5^2}$$
$$= \frac{(400580.25)-(241331.25)}{41-25}$$

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

$= \frac{159249}{16}$
= 9953.1

$= \frac{\sum XY}{\sum X^2}$
$= \frac{986.5}{5}$
= 197.3

$= \frac{n(\sum X^2Y)-(\sum X^2)(\sum Y)}{n(\sum X^4)-(\sum X^2)^2}$
$= \frac{4(48266.25)-(5)(39081)}{4(10.25)-5^2}$
$= \frac{(193065-195405)}{41-25}$
$= \frac{-2340}{16}$
= -146.25

Therefore, the quadratic equation is $9953.1 + 197.3X - 146.25X^2$

Forecasting the amount of rice production in 2015 (X = 2.5)
$= 9953.1 + 197.3X - 146.25X^2$
$= 9953.1 + 197.3(2.5) - 146.25(2.5)^2$
= 9953.1 + 493.25 – 914.0625
= 9532.3

Forecasting the amount of rice production in 2016 (X = 3.5)
$= 9953.1 + 197.3X - 146.25X^2$
$= 9953.1 + 197.3(3.5) - 146.25(3.5)^2$
= 9953.1 + 690.55 – 1791.5625
= 8852.1

Forecasting the amount of rice production in 2017 (X = 4.5)
$= 9953.1 + 197.3X - 146.25X^2$
$= 9953.1 + 197.3(4.5) - 146.25(4.5)^2$
= 9953.1 + 887.85 – 2961.5625
= 7879.4

Forecasting the production of rice crops in 2018 (X = 5.5)
$= 9953.1 + 197.3X - 146.25X^2$
$= 9953.1 + 197.3(5.5) - 146.25(5.5)^2$
= 9953.1 + 1085.15– 4424.0625
= 6614.2

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

Forecasting the production of rice crops in 2019 (X = 6.5)
$= 9953.1 + 197.3X - 146.25X^2$
$= 9953.1 + 197.3(6.5) - 146.25(6.5)^2$
$= 9953.1 + 1282.45 – 6179.0625$
$= 5056.5$

Table 3 shows the results of forecasting calculations for all basic crops grown in the South Denpasar District ranging from rice crops, soybeans, green vegetables, spinach, red onions, water spinach and long beans.

Table 3**:** Results of All Basic Plants Forecasting in South Denpasar District

Year	**Forecasting Amount of Crop Production (ton)**						
	Rice	**Soybean**	**Green Vegetable**	**Spinach**	**Red Onion**	**Water Spinach**	**Long Beans**
2015	9532.3	1134.5	-409	1014.5	81.2	1163.8	176.8
2016	8852.1	2533.9	-2294.6	1011.3	62.9	968.6	363.1
2017	7879.4	4536.3	-4704.2	1008.1	85.2	541.7	145.2
2018	6614.2	7141.7	-7637.8	1004.9	79.4	417.7	912.1
2019	5056.5	10350.1	-11095.4	1001.7	73.1	61.96	1274.8

Further, the forecasting amount of agricultural production in South Denpasar District implemented in the form of digital maps. Below is the implementation of forecasting production of South Denpasar District.

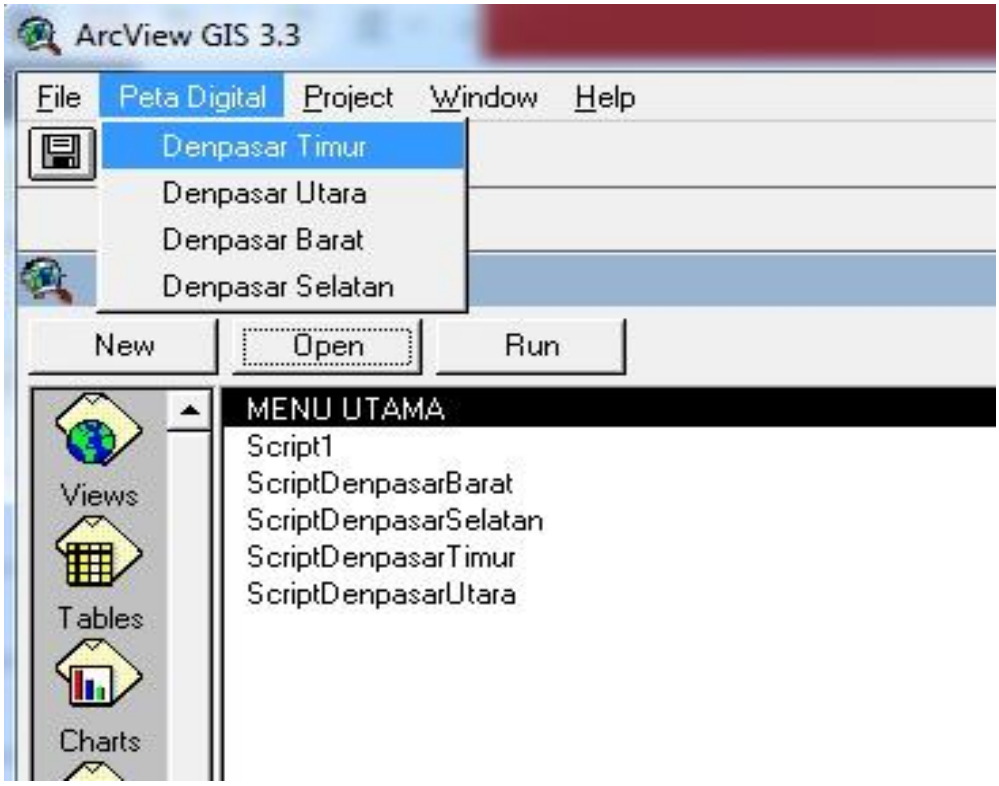


Figure 2: Implementation to ArcView

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

Digital Mapping of Region Area Coverage:
Denpasar Timur (East Denpasar)
Denpasar Utara (North Denpasar)
Denpasar Barat (West Denpasar)
Denpasar Selatan (South Denpasar)

Spatial data from South Denpasar District is the result of digitization of each village that consistof 4 villages and 6 sub-districts namely Pemogan Village, Sidakarya Village, Sanur Kaja Village, Sanur Kauh Village, Pedungan, Sesetan, Panjer, Renon, Sanur and Serangan.

Non Spatial Data for South Denpasar District implemented in Avenue GIS, in the form of tables, is the area of each Village, data of agricultural land area, data of production quantity and data forecasting of agricultural production amount. First thing to be implemented is the area covered in the following table:

Tablee 4: Area Coverage of South Denpasar District

No.	**Villages**	**Area Coverage (km^2)**
1.	Pemogan Village	9.71
2.	Pedungan	7.49
3.	Sesetan	7.39
4.	Sidakarya Village	3.89
5.	Panjer	3.59
6.	Renon	2.54
7.	Sanur Kaja Village	2.69
8.	Sanur Kauh Village	3.86
9.	Sanur	4.02
10.	Serangan	4.81
Total Luas Wilayah Kecamatan Denpasar Selatan		49.99

Figure 3 shows the spatial data of South Denpasar District' digitization, completed with the division of each village.

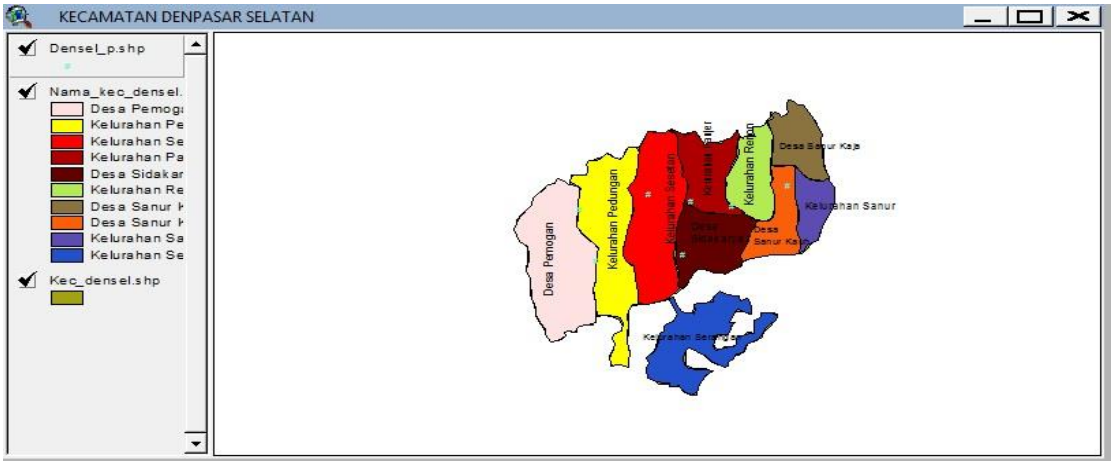


Figure 3: Digital Map Display of South Denpasar District

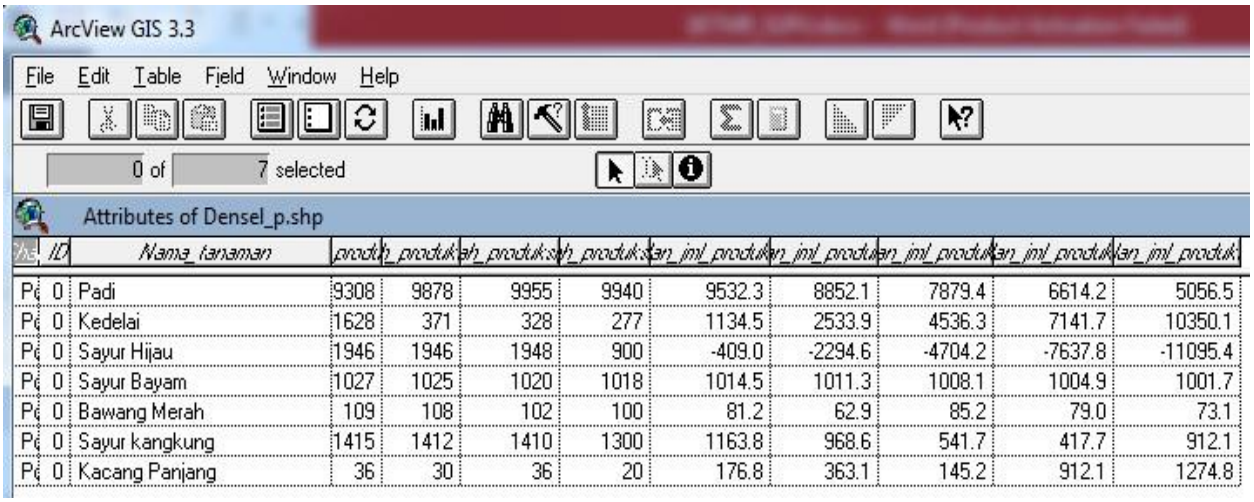
ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

Attributes of Nama_kec_densel.shp

Shape	ID	nama_wilayah	Luas_Wilayah
Polygon	1	Desa Pemogan	9.71
Polygon	2	Kelurahan Pedungan	7.49
Polygon	3	Kelurahan Sesetan	7.39
Polygon	4	Kelurahan Panjer	3.59
Polygon	5	Desa Sidakarya	3.89
Polygon	6	Kelurahan Renon	2.54
Polygon	7	Desa Sanur Kaja	2.69
Polygon	8	Desa Sanur Kauh	3.86
Polygon	9	Kelurahan Sanur	4.02
Polygon	10	Kelurahan Serangan	4.81

Figure 4: Area Coverage of South Denpasar District

Figure 4 shows the result of non-spatial data capture from South Denpasar District. While in figure 5, contain of non-spatial data capture forecasting result of agricultural production amount from 2015-2019.



	ID	Nama_tanaman								
Pe	0	Padi	9308	9878	9955	9940	9532.3	8852.1	7879.4	6614.2	5056.5
Pe	0	Kedelai	1628	371	328	277	1134.5	2533.9	4536.3	7141.7	10350.1
Pe	0	Sayur Hijau	1946	1946	1948	900	-409.0	-2294.6	-4704.2	-7637.8	-11095.4
Pe	0	Sayur Bayam	1027	1025	1020	1018	1014.5	1011.3	1008.1	1004.9	1001.7
Pe	0	Bawang Merah	109	108	102	100	81.2	62.9	85.2	79.0	73.1
Pe	0	Sayur kangkung	1415	1412	1410	1300	1163.8	968.6	541.7	417.7	912.1
Pe	0	Kacang Panjang	36	30	36	20	176.8	363.1	145.2	912.1	1274.8

Figure 5: Forecasting Number of Agricultural Crop Production in South Denpasar District

Types of agricultural crops:
Padi (Rice)
Kedelai (Soybean)
Sayur Hijau (Green Vegetable)
Bawang Merah (Red Onion)
Sayur Kangkung (Water Spinach)
Kacang Panjang (Long Bean)

The graph of agricultural production in South Denpasar District is shown in Figure 6. It can be seen that the largest number of plants is rice, the decrease in rice plants from 2011-2014 is not as significant as other plants.

ISSN: 2454-1907
DOI: 10.5281/zenodo.1186523

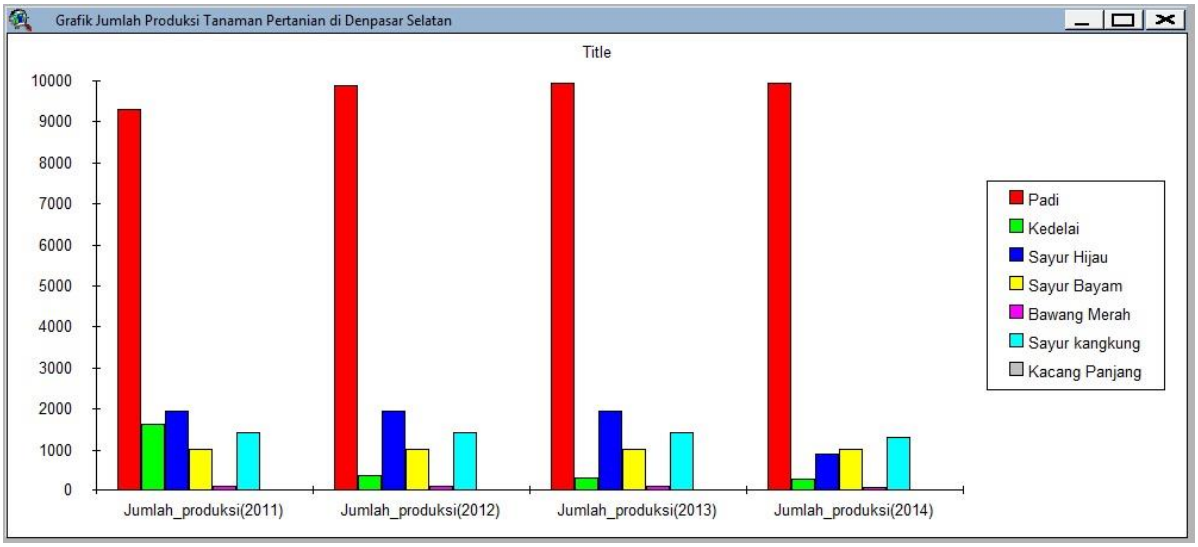


Figure 6: Agricultural Production Graph in District of South Denpasar

Figure 7 shows forecasting number of agricultural production graph in District of South Denpasar using the production figures for 2011-2014. Forecasting is for 5 years from 2015-2019.

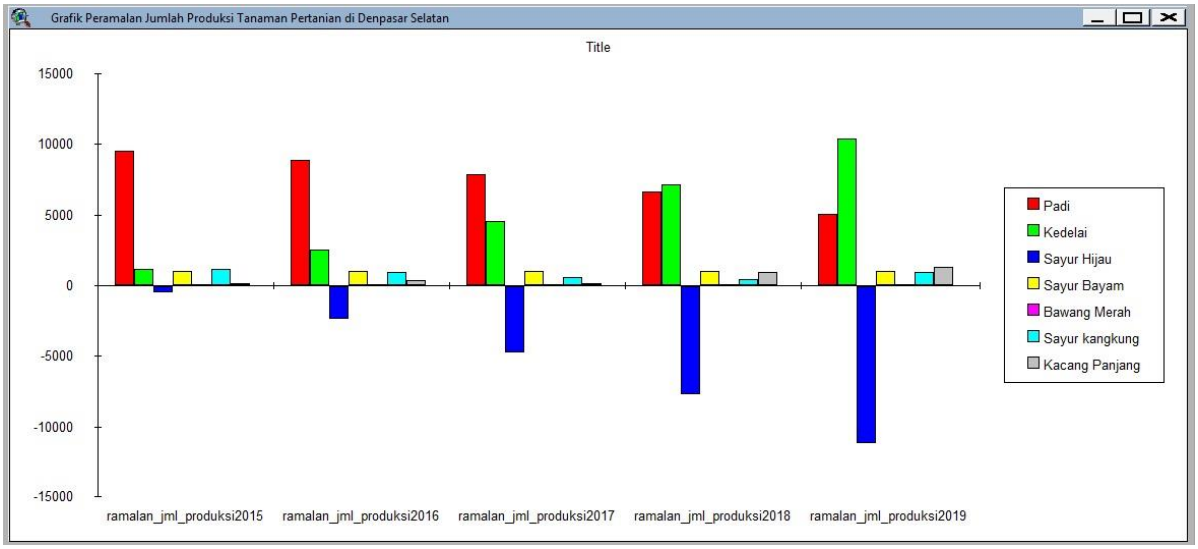


Figure7: Forecasting Number of Agricultural Production Graph inSouth DenpasarDistrict

Based on the graph in figure 7, it can be seen that significant decrease were green vegetables whose value was negative.

4. Conclusions and Recommendations

Results shows number of staple production from 2014 data to the results of the calculation of forecast in the last year of 2019 on each staple crop of rice decreased 4883.5 tons, soybean increased 10073.1 tons, green vegetables decreased 11995.4 tons, spinach decreased 16.3 tons, red onion decreased 26.9 tons, water spinach decreased 1238.04 tons and long bean increased 1254.8 tons. According to the forecast in 2019, several staple crops in South Denpasar District

will experience a decrease, among others, rice, green vegetables, spinach, red onions and water spinach, while the staple crops that are increasing are soybean and long bean plants. This should be a concern for government and society enable to save agriculture, especially in South Denpasar District as the amount of agricultural production of most staple crops has decreased the amount of production.

Acknowledgements

This research has been supported by STMIK STIKOM Bali: encompass the Chairman along with its management team, providing its support and resources. Hope the result of this work can be useful for community.

References

[1] Denpasar, P. K., 2016, Profil Kota Denpasar, www.denpasarkota.go.id, accessed on June 23, 2016
[2] Statistik, B. P. (2017, Mei 23). Badan Pusat Statistik Provinsi Bali. Retrieved from BPS Web site: http://www.bps.go.id/
[3] Martin J. Bunch, T.Vasantha Kumaran, R.Joseph, Using Geographic Information System (GIS) for spatial planning and environmental management in India, International Journal of Applied Science and Technology, 2012, 40-54
[4] Ibrahim Shaker, Hala Effat, Ayman Ragab, Asmaa Hamdy, Multi Criteria Geographic Information System Analysis for Sustainable Development in North Sinai-EGYPT, American Journal of Geographic Information System, vol 6 No.4, 141-155
[5] Sonti SH, Application of Geographic Information System (GIS) in Forest Management, Geographic & Natural Disasters, vol 5 issue 3.
[6] Irum Raza, Sobia Naheed, Muhammad Zubair Anwar, Muhammad Asif Masood, Trend Analysis of Tea Import in Pakistan, Global Journal of Researches in Engineering:G Indistrial Engineering, vol 15 Issue 3, 2015
[7] Nigel Meade , Evidence for the Selection of Forecasting Methods, Journal of Forecasting, 2000, 515-535
[8] Ni Nyoman Supuwiningsih, Muhammad Rusli, Prediction of Decreasing Agricultural Land Based on Geographic Information System Case Study: Denpasar City, International Journal of Computer Application, vol 162 No.9, March 2017, 30-34

*Corresponding author.
E-mail address: comank2002@ yahoo.com/pdewanti@ gmail.com/dektisamuh@ gmail.com/wirahadi@ stikom-bali.ac.id