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Prediction of Black Soldier Fly Larva Sales and Production Using Linear Regression Method

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ABSTRACT

The waste problem is a problem that plagues the world. Various programs and methods have been carried out in processing waste. Until now, Bali has become the area with the most waste production in Indonesia, where every day the waste produced reaches 4,281 tons or in other words 1.5 million tons per year. In early 2021, a campaign on the separation of organic and non-organic waste has been initiated in several districts/cities in the province of Bali. The next problem is that people do not know how to process organic waste other than being compost for plants. Black Soldier Fly (BSF) or black soldier fly is an order of diptera whose physical characteristics are similar to wasps. BSF itself has an average life cycle from egg to adult of 45 days. Where the main consumption of BSF itself is organic waste. In Pelaga village, Petang sub-district, Badung district, there is an effort to breed BSF. Where in this effort, it can produce no less than 100 kg of BSF larvae within 15-20 days. The problems encountered by these entrepreneurs are often difficult to predict the amount of BSF larvae production, because around the area there are quite a lot of catfish and chicken farmers who need BSF larvae as feed. The use of linear regression method can overcome these problems. The results obtained between the application of this method include the accuracy value which reaches 62.5% for prediction of sales and 32.5% for prediction of production.

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INTRODUCTION

The waste problem is a problem that plagues the world. Various programs and methods have been carried out in processing waste (Satori et al., 2018). In Bali in particular, the growth in the amount of waste is directly proportional to population growth (Sutrisnawati & Purwahita, 2018). Until now, Bali has become the area with the most waste production in Indonesia, where every day the waste produced reaches 4,281 tons or in other words 1.5 million tons per year (Wijaya et al., 2021). This is due to the lack of education and knowledge possessed by the community about waste sorting.

At the beginning of 2021, a campaign on the separation of organic and non-organic waste has

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started in several districts/cities in the province of Bali. This activity has received a positive response from all residents who have received education and training on waste sorting (Suryawan et al., 2021). The next problem is that people do not know how to process organic waste other than being compost for plants.

The way to deal with piles of organic waste is to use the Black Soldier Fly (BSF) (Rancak et al., 2017). Black Soldier Fly (BSF) or black soldier fly is an order of diptera whose physical characteristics are similar to wasps. BSF itself has an average life cycle from egg to adult of 45 days. An adult female lays between 206 and 639 eggs at a time. BSF itself as a decomposer of waste from organic materials. Where the main consumption of BSF itself is organic waste. BSF larvae rapidly reduce the volume and weight of organic waste. Apart from being a decomposer of organic waste, BSF larvae are also used as animal feed.

In Pelaga village, Petang sub-district, Badung district, there is an effort to breed BSF. Where in this effort, it can produce no less than 100 kg of BSF larvae within 15-20 days. The problems encountered by these entrepreneurs are often difficult to predict the amount of BSF larvae production, because around the area there are quite a lot of catfish and chicken farmers who need BSF larva as feed. Not to mention a number of other farmers who are outside the village who need BSF larvae as their animal feed.

It is expected that the use of linear regression method can overcome these problems. One of the capabilities possessed by the linear regression method is being able to predict values that are quite accurate in the process of predicting future needs.

RESEARCH METHOD

Prediction

Prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information that is owned, so that the error (difference between something that happens and the predicted result) can be minimized. Prediction does not have to give a definite answer to what will happen, but tries to find an answer as close as possible to what will happen (Geni et al., 2019).

Black Soldier Fly

BSF is a fly (Diptera) which belongs to the family Stratiomyidae (Putra & Ariesmayana, 2020). This fly can be found in tropical and subtropical regions (46° N - 42° S). The life cycle consists of five phases namely egg, larva, prepupa, pupa and adult which lasts about 38-41 days. Adult female flies will lay eggs about five to eight days after exiting the pupa and generally can lay up to 500 eggs per head (Kaslam et al., 2022). The eggs will hatch into larvae in approximately 4.5 days (±105 hours).

BSF larvae have a high growth rate and optimal feed conversion and can make good use of various types of materials as food sources including organic materials that are considered useless such as household waste in general, and kitchen waste, vegetable waste, fruit waste, waste food processing, and livestock waste in particular. BSF larvae can consume food quickly ranging from 25 mg to 500 mg of fresh material per larva in one day and can reach a length of ±27 mm, a width of about 6 mm and a weight of up to 220 mg at the end of the larval stage (±14 days) (Sverguzova et al., 2021).

Source : https://distanpangan.baliprov.go.id/lalat-tentara-hitam-black-soldier-fly-serangga-yang-beragam-manfaat/ (2022)

Figure 1 Black Soldier Fly Animals and Black Soldier Fly Larva

A normal BSF female fly is able to produce eggs ranging from 1851235 eggs. Other literature states that a female takes 20-30 minutes to lay eggs with the number of egg production between 546-1,505 eggs in the form of egg mass. Egg mass weight ranged from 15.8-19.8 mg with individual egg weight between 0.026-0.030 mg. The peak time for laying eggs is reported to be around 14.00-15.00. Female flies are reported to only lay eggs once during their lifetime, after which the fly will die.

Larger larvae and prepupae are ideal for use in feed mixtures or pellets because they are able to meet the production quantity. Young larvae are more suitable to be fed directly to fish, because their small shape is suitable for the size of the mouth of livestock. Amino acids contained in BSF are similar to soybean flour which is one of the raw materials for making pellets. Giving BSF flour to an animal will meet the needs of these amino acids.

Linear Regression

Linear regression is a method to test the effect of the independent variable on the dependent variable, where the independent variable is only one variable. Linear regression is a statistical forecasting method used to model the relationship between the dependent variable (dependent; response; Y) and one or more

independent variables (independent, predictor, X) (Simbolon, 2021). The pattern shown by simple regression analysis assumes that the relationship between 2 variables can be expressed by a straight line. One of the uses of regression in research is to predict the dependent variable (Y) if the independent variable (X) is known. Simple regression is based on a functional or causal relationship between one independent variable and one dependent variable. The general equation for simple linear regression is (Saba'Pasinggi et al., 2022):

$$Y' = a + bX \quad \ldots\ldots\ldots (1)$$

Y'= Prediction value for variable Y (in research this is sales value)

a = constant number

b = Coefficient of direction or regression coefficient, which shows an increase or a decrease in the dependent variable based on the independent variable.

X = Independent Variable has a certain value. In principle, the existing techniques and methods base the analysis process on an attempt to obtain an exactstraight line through or approaching the scattered points (scatter) from the observation data. The values of a and b are calculated by the following formula (in this study as production values):

$$a = \frac{(\sum Yi)(\sum Xi^2)-(\sum Xi)(\sum XiYi)}{n\sum Xi^2-(\sum Xi)^2} \quad \ldots\ldots\ldots (2)$$

$$b = \frac{n(\sum XiYi)-(\sum Xi)(\sum Yi)}{n\sum Xi^2-(\sum Xi)^2} \quad \ldots\ldots\ldots\ldots (3)$$

State of the art

Research using linear regression for production and sales has been carried out a lot. Below are some of the following research results:

1 The implementation of linear regression for sales prediction in restaurant point of sales applications is one of the studies that uses linear regression as a prediction method. The result is that sales predictions using linear regression show accurate results.

2 Application of linear regression to predict rice production needs. In this study rice production as the main object, the data used in this study was carried out in the Tuban area. The results of this study resulted in the resulting value of rice production of 5347763 quintals and these results were in accordance with the predicted results that had been calculated in the previous 2 years.

3 Application of the Linear Regression Method for Predicting Property Sales at PT XYZ. This research resulted in property sales forecasting using the linear regression method which can be said to be in the pretty good category.

Research Conceptual Model

The types of research conducted are as follows:

a. This research is descriptive, where the results of this study are presented in the form of a description that is both qualitative and quantitative.

b. This research is exploratory, where this research was conducted by digging information for the use of information systems in predicting the production of BSF larvae with the regression method.

Research Time and Place

The process of observation and data collection in this study was carried out for 2 (two) months. The research location is in Pelaga village, Petang sub-district, Badung district. Bali province..

Data

This research requires a number of supporting data that will be used in the design process and the use of the regression method in the production prediction process.

Data Type

The types of data needed in this study are as follows:

a. Primary data

The primary data in this study were data on the production of BSF larvae produced before the application of the linear regression method.

b. Secondary Data

Includes other supporting data in the use of linear regression methods.

Research Flow

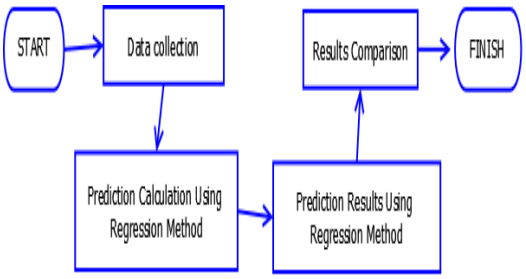


Figure 2 Research Flow

1 Data collection

At this stage, the data collection process was carried out by means of interviews with BSF business owners.

2 Prediction Calculation Using Regression Method

At this stage the prediction process is carried out using the linear regression method, where the data used is data obtained during the data collection process. In this process, a web-based system will be created which

uses the regression method in the calculation process.

3 Prediction Results Using the Regression Method

This process is more inclined to provide recommendations to business owners on the production and sales results calculated in the previous process.

4 Comparison of Results

The comparison of the results carried out at this stage is to compare the results of production and sales predictions using the linear regression method with the results of production and sales without the linear regression method

RESULTS AND DISCUSSION

Based on the results of observations that have been made, the following data were obtained:
Production data is shown in Table 4.1 below:

Table 1 BSF . Larva Production Data

Year	Month	Week	Production Quantity (Kg)	Sale (Kg)
2022	1	1	20	19
		2	20	19
		3	19	19
		4	30	28
	2	1	21	22
		2	27	27
		3	27	26
		4	25	26
	3	1	10	12
		2	28	26
		3	42	40
		4	71	65
	4	1	68	65
		2	44	44
		3	62	63
		4	68	67
	5	1	66	67
		2	49	48
		3	29	30
		4	47	45
	6	1	26	25
		2	42	42
		3	54	53
		4	111	112

Using formula (1), it must be determined in advance the value of the constant number (a), the regression coefficient (b) and the independent variable (X).
To calculate the constant number (a) the formula (2) is used, namely:

$$a = \frac{(\sum Yi)(\sum Xi^2)-(\sum Xi)(\sum XiYi)}{n\sum Xi^2-(\sum Xi)^2}$$

$$= \frac{-17452}{631544} = -0.027$$

To calculate the regression coefficient (b) formula (3) is used, namely:

$$b = \frac{n(\sum XiYi)-(\sum Xi)(\sum Yi)}{n\sum Xi^2-(\sum Xi)^2}$$

$$= \frac{622020}{631544} = 0.984$$

From the calculation above, the a value is -0.027 and the b value is 0.984. Furthermore, the calculation is continued using formula (1) as below:

Y'= a + bX ..... (1)

The value of X is determined at 41.91, it is obtained by the average value of production for 24 weeks. Then the calculation results are as follows:

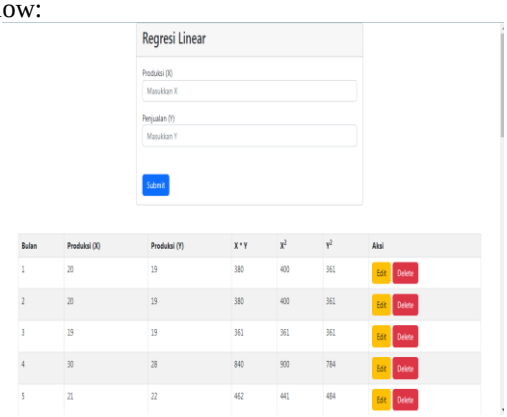
Y'= -0.027 + (0.984*41.91)
= 41.25

The predicted value of sales at week 25 is 41.25 Kg. Further testing was carried out for 8 weeks with the results in the table below:

Table 2 BSF . Larva Sales And Production Data

Year	Month	Week	Production Quantity (Kg)	Sale (Kg)	Production By System (Kg)	Sale By System (Kg)
2022	7	1	42	41.25	41.85	41.25
		2	54	54	50	54
		3	55	51	50	54
		4	55	45	50	54
	8	1	51	47	51	53
		2	51	53	51	53
		3	52	53	51	53
		4	51	52	51	52

To facilitate the calculation, a system has been built using a website-based regression method. Website results can be seen at the link http://regresi.epizy.com/.
The appearance of the website is shown in the image below:



Source : http://regresi.epizy.com/ (2022)
Figure 3 Website View

Table 3 comparison of production results without system and prediction system

Year	Month	Week	Production Quantity (Kg)	Production By System (Kg)
2022	7	1	42	41.85
		2	54	50
		3	55	50
		4	55	50
	8	1	51	51
		2	51	51
		3	52	51
		4	51	51

based on table 3 data, the same production value is obtained in week 1,2,4 in month 8. so if calculated with the percentage the result is

$$\frac{3}{8}\ x\ 100\% = 37.5\%$$

Table 4 comparison table of sales results without the system and with the prediction system

Year	Month	Week	Sale (Kg)	Sale By System (Kg)
2022	7	1	41.25	41.25
		2	54	54
		3	51	54
		4	45	54
	8	1	47	53
		2	53	53
		3	53	53
		4	52	52

based on table 4 data, the same sales value is obtained in week 1,2 in month 7 and week 2,3,4 in month 8. then if calculated with a percentage the result is

$$\frac{5}{8}\ x\ 100\% = 62.5\%$$

Based on the data in the table above, it is obtained for sales predictions 62.5% according to the system, and for production predictions 37.5% according to the system.

CONCLUSION

Based on the results of research from observations and data collection that has been carried out and comparative testing between prediction systems using linear regression methods with data in the field, the following conclusions can be drawn:

1 Accuracy for production prediction obtained a value of 37.5%.
2 Accuracy for sales prediction obtained a value of 62.5%.
3 The accuracy value is obtained by rounding the data input process.

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