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DEMAND FOR PESTICIDES ON SHALLOT FARMING IN SANDEN SUB-DISTRICT BANTUL REGENCY

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ABSTRACT

Sanden Sub-district is one of the shallots producing centers in Bantul Regency. The research objectives are: (1) to identify the type of pesticides used by shallot farmers and to calculate the cost structure of shallot farming; (2) to measure the variation of pesticide usage based on the growing season; (3) to analyze determinants of the demand for pesticides (4) to calculate the own price and cross-price elasticities of the demand for pesticides. The location and respondents of the research are chosen purposively and the research involves 35 shallot farmers. The descriptive method is used to identify the type of pesticide usage. Paired Sample t-test is used to test the pesticide usage difference between seasons. The ordinary Least Square (OLS) method is employed to analyze the factors affecting the demand for pesticides. The own-price and cross-price elasticities are determined based on regression coefficients. The result of the analysis shows that the type of pesticides consists of insecticide and fungicide, and the pesticide cost contributes 8-10% of the total production cost. The pesticide usage between seasons is statistically different. The results also show that the determinant factors of the demand for pesticides are the price of pesticides, the price of shallot, land size, and the wage of labor. Both insecticide and fungicide demand are elastic to price change.

Keywords: Demand for pesticides, pesticides usage, shallot, own price elasticity, cross price elasticity.

INTRODUCTION

Horticulture is one of the agricultural sub-sectors that can play a role in realizing the prosperity and welfare of the people, as well as in building the country's economy. Horticulture also plays a role as a source of food in everyday life, such as vegetables, fruits, medicinal plants, and others. One of the horticultural commodities that has a fairly high economic value is shallots.

According to Yanuarti and Afsari (2016), shallot production from 2006 to 2015 tended to increase with an average growth of 5.41% per year. The largest contribution from shallot production in Indonesia comes from the island of Java. Onion production in Java from 2006-2015 contributed 77.4% per year, and the remaining 22.6% came from outside Java.

Yogyakarta Province is one of the producers of shallots in Indonesia, although it is not as high as production in central areas such as Central Java, West Java, East Java, South Sulawesi, and West Nusa Tenggara. Yogyakarta Province contributed 13,980 tons of the total shallot production in Indonesia in 2017 (BPS, 2017). The area that is the center of shallot production in DIY Province in Bantul Regency. Onion production in Bantul accounts for more than 50% of DIY production.

Bantul has the largest harvest area and the contribution of shallot production in DIY. Bantul has several production centers, including Sanden, Kretek, Srangkan, Pundong, and Imogiri sub-districts which contribute quite a lot to shallot production in Bantul. Sanden District is one of the biggest red onion contributors in Bantul Regency. This high production will have an impact on the use of production inputs, one of which is pesticides. Another research conducted by Fauzan (2016) regarding shallot farming in the production center of Bantul Regency shows that shallot farmers in Bantul Regency use various kinds of pesticides quite intensively. In addition, according to the Head of the Bantul Agriculture, Food, Maritime and Fisheries Service, the use of pesticides by farmers, especially rice and shallot farmers in the southern region of Bantul is very high (Nursalikah, 2017).

The use of pesticides in shallot farming is very important because besides having an effect on crop production, pesticides can also affect human health if used in excessive doses. According to Hudayya and Jayanti (2012). It is known that 44.4% of farmers used a dose exceeding the recommended dose, while 36.4% used the recommended dose, and some even used a dose of up to 2 times the recommended dose as much as 12.1%. This is due to the concern that the use of the recommended dosage is not sufficient to control Plant Pest Organisms (OPT) so that it can threaten production.

Agriculture Minister Andi Amran Sulaiman stated that in 2017 Indonesia was able to export shallots to Thailand because of its abundant production, but this high production was inseparable from the use of pesticides by farmers. This is due to the high threat of pests in shallots (Samudra, 2018). Given the large role of pesticide regulation in controlling shallot pests and diseases and to obtain maximum production, the authors are interested in researching the need for pesticides in shallot farming. The high need for pesticides will certainly increase the demand for pesticides in shallot farming.

METHODS

The location was determined purposively, Srigading and Gadingharjo village, which are the largest shallots producers in Sanden District. Sampling was also carried out by the purposive sampling method. The population is shallot farmers in Sanden District. From this population, 35 samples were taken. The selected farmers are those who plant shallots for 2 growing seasons.

The data collected consisted of 2 types, namely primary data and secondary data. The primary data used are farmer identity, land ownership data, input use data, and input price data. Shallots for 2 planting seasons in 2018. Secondary data used were obtained from institutions such as the Central Statistics Agency (BPS), namely Yogyakarta Province data in Figures, Bantul Regency in Figures, Sanden District in Figures, and horticultural statistics of Yogyakarta Special Region. The data analysis methods used in this study include:

1. **Analysis of the Types of Pesticides Used and the Structure of Farming Costs**

   The analysis of various types of pesticides used and their structure was carried out by descriptive analysis, which is based on data obtained in the field. Pesticides are classified based on their active ingredients and trademarks. The cost structure of pesticides is known from the percentage value of expenditure on pesticides of the total cost.

2. **Comparative Analysis of Pesticide Use in MT I and MT II**

Comparison of pesticide use in the two growing seasons was carried out using the paired sample t-test. The t-test formula for paired samples is:

$$t = \frac{\overline{Xa} - \overline{Xb}}{\sqrt{\frac{Sa^2}{na} + \frac{Sb^2}{nb} - 2r\left[\frac{Sa}{na}\right]\left[\frac{Sb}{nb}\right]}}$$

In which:
$\overline{Xa}$ = average of sample a
$\overline{Xb}$ = average of sample b
Sa = standard deviation of sample a
Sb = standard deviation of sample b
Sa^2 = variances of sample a
Sb^2 = variances of sample a

The analysis hypothesis of pesticide use in MT I and MT II is as follows:

Ho : $X_1 \leq X_2$: the average use of pesticide input in MT I is less or the same as the average pesticide use in MT II

H_1 : $X_1 > X$: the average use of pesticide inputs in MT I is greater than the average use of pesticides in MT II

3. **Analysis of Factors Affecting the Demand for Pesticides**

   Analysis of the factors that influence the demand for shallot pesticides in Sanden District was carried out by using multiple linear regression analysis. Multiple regression analysis was performed to test the demand for insecticides and fungicides. The multiple regression model for the demand for the chlorfenapyr insecticide is as follows:

$$Y_1 = \beta_0 + \beta_{1.1}X_{1.1} + \beta_{1.2}X_{1.2} + \beta_{1.3}X_{1.3} + \beta_{1.4}X_{1.4} + \beta_{1.5}X_{1.5} + D + e$$

In which:
Y_1 = Demand for chlorfenapyr insecticide (liter)
β_0 = Constant
$X_{1.1}$ = Price of chlorfenapyr insecticide (Rp / liter)
$X_{1.2}$ = Price of thiodicarb insecticide (Rp / kg)
$X_{1.3}$ = Labor wages (IDR / HKO)
$X_{1.4}$ = Land area (m^2)
$X_{1.5}$ = Price of shallots
D = Dummy attack
e = Residual

While the regression model for iprodion fungicide demand :

$$Y_2 = \beta 0 + \beta_{2.1}X_{2.1} + \beta_{2.2}X_{2\cdot 2} + \beta_{2\cdot 3}X_{2\cdot 3} + \beta_{2\cdot 4}X_{2\cdot 4} + D + e$$

In which:
Y_1 = Demand for iprodion fungicide (kg)
β_0 = Constant
$X_{1.1}$ = Price of iprodion fungicide (Rp / kg)
$X_{1.2}$ = Price of propinep insecticide (Rp / kg)
$X_{1.3}$ = Labor wages (Rp / HKO)
$X_{1.4}$ = Land area (m^2)
D = Dummy attack
e = Residual

4. **Price Elasticity of Demand and Cross Demand Elasticity**

   The value of price demand elasticity and cross elasticity can be seen in the results of the regression analysis. This value is obtained from the regression coefficient value of the natural logarithmic model. If the regression used is a linear model, then the elasticity calculation can be done using the following formula:

$$Ec = (\Delta Y/\Delta X) * (\bar{X}/\bar{Y})$$

In which:
Ec = Cross elasticity value
$\Delta Y/\Delta X$ = The value of the regression coefficient in the linear model

RESULTS AND DISCUSSION

1. Types of Pesticides Used and Farming Cost Structure

Farmers generally use insecticides and fungicides to treat plant pests in shallot farming. The insecticides and fungicides used vary widely when viewed by trademark or active ingredient. The insecticides used by farmers have different active ingredients and brands. The insecticide is used by farmers to treat armyworm pests. The most widely used insecticides contain the active ingredient chlorfenapyr.

The average use of fungicides by farmers is still above the recommended limit and farmers admit to having spent quite a lot on pesticides. This is done by farmers with the aim that the onions are not attacked by pests which can damage crops and cause losses. The cost structure of shallot farming can be seen in Table 1.

Table 1. The cost structure of shallot farming per Ha

Cost Farming	MT I		MT II	
	Cost (Rp / ha)	Percentage (%)	Cost (Rp / ha)	Percentage (%)
Insecticide	2.398.642	4,37	2.745.827	4,14
Fungicide	2.310.064	4,21	4.068.353	6,14
Seed	14.036.680	25,58	18.788.282	28,34
Fertilizer	5.514.037	10,05	5.808.806	8,76
Labor	23.136.626	42,16	24.598.900	37,10
Engine Power	990.087	1,80	1.527.243	2,30
Transport	492.480	0,90	511.938	0,77
Adhesive	444.423	0,81	392.180	0,59
Fuel	575.170	1,05	3.034.071	4,58
Miscellaneous expense	4.984.069	9,08	4.821.041	7,27
Total	54.882.278	100,00	66.296.642	100,00

Source: Primary Data Analyzed in 2019

When viewed from the expenditure on pesticides, the percentage of costs for pesticides is quite high. The total cost for all insecticides and fungicides used in the two growing seasons is 8% to 10% of the total cost. Pesticides are a basic necessity for farmers. Farmers stated that without the use of pesticides, shallot farming would not be successful, so the use of pesticides was mandatory for farmers.

2. Comparison of Pesticide Use in the Two Planting Seasons

a. Comparison of Insecticide Use

Comparison of insecticide use in the two growing seasons can be seen in the following table:

Table 2. Different test results of the average use of Chlorfenapyr insecticide per hectare in the two planting seasons

	Use of Insecticides			
	Mean	t-value	t-sig	p-value
MT-I	1,61	-0,265	1,691	0,396
MT-II	1,71			

Source: Primary Data Analyzed in 2019

The two mean test results show that the p-value is greater than 5% alpha or by looking at the t-value is smaller than the t-sig, so that Ho fails to be rejected, meaning that the use of insecticides in MT-I is smaller or the same as the use of MT-II. The high use of insecticides during MT-II was caused by the inconsistent planting of shallots and wider use of land, which resulted in pests being able to move from one place to another and have a longer life phase. A small proportion of farmers have planted refugia plants to reduce pest attacks on shallots. This method was successful in reducing pest attacks, but when there was a pest explosion in the second planting season, refugia did not really help reduce these pests.

Farmers have also been introduced to and given assistance with a device called a light trap by the Agriculture Service. Light traps are light traps that are used at night to attract pests that will trap them in the appliance. This tool is quite capable of reducing pests, but the aid of this tool is still very minimal, so not all farmers can feel the benefits of this tool. In addition, there are also farmers who do not know at all how the tool works and the benefits of this tool.

b. Comparison of Fungicide Use

The fungicides used by farmers to treat pest problems have a variety of active ingredients. The most widely used fungicides are fungicides containing the active ingredient iprodion. Comparison of fungicide use in the two growing seasons can be seen in the following table:

Table 3. Different test results of the average use of Iprodion insecticide per hectare in the two planting seasons

	Use of Insecticides			
	Mean	t-value	t-sig	p-value
MT-I	1,84			
MT-II	2,55	-1,523	1,691	0,069

Source: Primary Data Analyzed in 2019

Table 3 shows that the p-value is greater than alpha 5% so that Ho fails to be rejected, meaning that the use of fungicides in MT-I is smaller or the same as that of MT-II. The higher use of fungicides during MT-II was due to farmers' anticipation of leaf spot disease. This makes the intensity and volume of spraying higher. Farmers admit that the rate of leaf spot attack is higher during the second growing season due to high humidity in the morning.

3. Factors Affecting Pesticide Demand

a. Use of Insecticides

The results of the regression analysis displayed must meet the classical assumption test to get BLUE (Best Linear Un] Estimator) properties. The tests included normality test, multicollinearity detection, heteroscedasticity test, and autocorrelation test. The analysis results obtained have passed the classical assumption test. After the classical assumption test, tests are carried out to determine the factors that influence the demand for insecticides.

Table 4. Regression Test Results Factors Affecting Demand for Chlorfenapyr Insecticide

Variable	Expected Sign	MT I Double Log Model			MT II Linear Model		
		Coef.	t-stat	Prob.	Coef.	t-stat	Prob.
Contant		0,142**	2,312	0,028	4,782	1,564	0,129
Chlorfenapyr Insecticide Price	-	-75.951***	-2,814	0,008	-7,70E-06**	-2,584	0,015
Thiodicarb Insecticide Price	+	-16.374^{ns}	-0,867	0,393	7,13E-07 ^{ns}	0,220	0,827
Labor Wage	-	2,518 ^{ns}	0,985	0,333	6,32E-06**	2,386	0,024
Land Area	+	-2,046 ^{ns}	-1,594	0,122	9,03E-05**	2,176	0,038
Price of Shallots	+	9,592*	2,010	0,054	-6,62E-5^{ns}	-1,367	0,182
Dummy Attack	+	2,372 ^{ns}	1,364	0,184	0,002 ^{ns}	0,016	0,987
R-squared		0,383			0,415		
Adj. R-squared		0,251			0,290		
F-statistic		2,896**			3,316**		
Prob F-statistic		0,025			0,014		

Source: Primary Data Analyzed in 2019

1) Chlorfenapyr Insecticide Prices

The thiodicarb insecticide is the second-largest insecticide used by farmers. The price of the chlorfenapyr insecticide has a significant effect on the demand for this insecticide. The price of the insecticide with chlorfenapyr content in MT-I has a probability value of t of 0.008 which is smaller than the alpha of 10% indicating that Ho is rejected, so the independent variable price of the chlorfenapyr insecticide has a significant effect on the demand for the chlorfenapyr insecticide.

The t probability value of the chlorfenapyr insecticide price at MT-II has a value of 0.015 which is smaller than the 10% alpha indicating that Ho is rejected, so the independent variable price of the chlorfenapyr insecticide has a significant effect on the demand for the chlorfenapyr insecticide.

2) Labor Wages

Labor wages at MT-II have a probability value of t of 0.024 which is smaller than alpha 10%, so that Ho is rejected. This means that labor wages significantly influence the demand for the insecticide chlorfenapyr. The labor wage regression coefficient has a positive sign in both growing seasons. This means that an increase in labor wages leads to an increase in the use of the pesticide chlorfenapyr. The results obtained did not match the expected signs, because labor and pesticides were complementary items. In MT-II, the labor wage given is higher than in MT-I. Onion cultivation in MT-II usually provides higher production, so that some farmers are willing to provide higher wages than in MT-I.

3) Land Area

The land area in MT-II has a probability value of t of 0.038 which is smaller than the alpha of 10%, so that Ho is rejected. This means that the variable of land area has a significant effect on the demand for the chlorfenapyr insecticide. This result is in accordance with Saputra's research (2010) that land area has a positive effect on the demand for fertilizer input.

4) Price of Shallots

The price of shallots has a probability value of t of 0.054 which is smaller than the alpha of 10%, so that Ho is rejected. This means that the price of shallots has a significant effect on the demand for the insecticide chlorfenapyr.

b. Use of Fungicides

Hypothesis testing to determine the factors that influence fungicide demand is as follows:

Table 5. Regression Test Results Factors Affecting Demand for Iprodion Fungicide

Variable	Expected Sign	MT I			MT II		
		Double Log Model			Linear Model		
		Coef.	t-stat	Prob.	Coef.	t-stat	Prob.
Contant		0,161**	2,243	0,033	6,196	1,616	0,117
Iprodion Fungicide Price	-	-48,913***	-2,868	0,008	-55,315***	-3,035	0,005
Propinep Fungicide Price	+	9,47^{ns}	0,562	0,578	18,035^{ns}	0,656	0,517
Labor Wage	-	3,649^{ns}	1,363	0,183	3,572^{ns}	1,296	0,205
Land Area	+	-1,698^{ns}	-1,242	0,224	-1,925^{ns}	-1,698	0,100
Dummy Attack	+	-0,492^{ns}	-0,177	0,861	-2,617^{ns}	1,621	0,116
R-squared		0,270			0,292		
Adj. R-squared		0,144			0,169		
F-statistic		2,146*			2,388*		
Prob F-statistic		0,088			0,062		

Source: Primary Data Analyzed in 2019

Iprodion Fungicide Price

Iprodion fungicide is a solid fungicide that is mostly used by farmers. The fungicide contains the active ingredient iprodion. The propinep fungicide is the second most widely used solid fungicide. Iprodion fungicide at MT-I has a probability value of t of 0.0076; smaller than alpha 10% so that Ho is rejected. This means that the price of the iprodion fungicide significantly affects the demand for this fungicide. In MT-II, probability t has a value of 0.005; smaller than alpha 10%, so Ho is rejected. This means that the variable price of the iprodion fungicide has a significant effect on the demand for the fungicide. Similar to MT-I, the price of iprodion fungicide at MT- II had a negative effect on the demand for this fungicide, seen from the regression coefficient value of -55.315. Pest attack dummy has no significant effect. This is due to the habit of most farmers spraying before the attack.

4. Pesticide Demand Elasticity

a. Insecticide Demand Elasticity

The elasticity of demand for shallot insecticides can be seen from the regression coefficient value of the regression model. The value of the elasticity of the demand for Chlorfenapyr insecticide can be seen in the following table:

Table 6. Price Elasticity Factors Affecting Demand for Chlorfenapyr Insecticide

Variable	Value of the elasticity of demand	
	MT- I	MT-II
Chlorfenapyr Insecticide Price	-75,95	-35,32
Thiodicarb Insecticide Price	ns	ns
Labor Wage	ns	4,73

Source: Primary Data Analyzed in 2019

The result of the regression coefficient of the chlorfenapyr insecticide value is -75.95, which means that an increase in the price of the chlorfenapyr insecticide by 1% causes a decrease in the demand for insecticide to decrease by 75.95%. This means that the demand for chlorfenapyr insecticides is elastic. In MT-II, the regression coefficient value of the insecticide chlorfenapyr is -35.32 which also indicates that the demand for insecticides is elastic. Even though it contains active ingredients that are considered good by farmers, some farmers who know the price of chlorfenapyr insecticides are high, prefer not to use these insecticides and use other types of insecticides at quite affordable prices.

The regression coefficient value for labor wages at MT-II is 4.73. The value of positive elasticity means that the increase in labor wages increases the demand for the insecticide chlorfenapyr. In theory, complementary goods have negative elasticity. This positive sign is because farmers expect higher production, so that the labor and wages used are greater.

b. Demand Elasticity of Fungicides

The elasticity of demand for iprodion fungicide can be seen in the following table:

Table 6. Price Elasticity Factors Affecting Demand for Iprodion Fungicide

Variable	Value of the elasticity of demand	
	MT- I	MT-II
Iprodion Fungicide Price	-48,91	-55,32
Propinep Fungicide Price	ns	ns
Labor Wage	ns	ns

Source: Primary Data Analyzed in 2019

The elasticity of demand for Iprodion fungicide at MT-I was -48.91, which means that an increase in the price of Iprodion fungicide by 1% resulted in a decrease in demand for the fungicide by 48.91%. As with insecticides, Iprodion fungicides also have a fairly high price compared to other fungicides, so the increase in the price of Iprodion fungicides causes farmers to reduce their use of these fungicides or even not use these fungicides at all and choose to use other types of fungicides. In MT-II, the regression coefficient value of the Iprodion fungicide price was -55.32, which means that an increase in the price of Iprodion fungicide by 1% caused a decrease in demand for the fungicide by 55.32%.

CONCLUSIONS

The use of pesticides has a percentage of 8-10% of the total cost of farming and the use of pesticides is still above the recommended limit. The average use of insecticides and fungicides in MT-II was higher than in MT-I. Factors that influence pesticide demand include pesticide prices, shallot prices, land area, and labor wages. The amount of insecticides and fungicides is elastic to price changes. Labor wages in MT-II have a substitution relationship with the amount of insecticide used.

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