Farmers' Preferences in Implementing the Six Right Principles of Pesticide Application During the Covid-19 Pandemic in Sumedang Regency

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Abstract. A study on the tendency (preference) of farmers in the application of the six proper principles (P6T) in the application of pesticides to conventional farming communities has been carried out in several villages in Tanjungsari Sumedang District. The research objectives were (1) to describe the level of farmers' tendency in implementing P6T, (2) to find factors that influence the tendency of farmers to apply P6T, and (3) to find strategies to increase the tendency of farmers to apply P6T. This study applies a survey method to farming communities that have participated in the Integrated Pest Management Field School (SLPHT) program with 63 respondents from 105 farmers, determined using the Slovin formula with an error of 10%. The data collected were independent variable (X) consisting of: internal factors (X_1) and external factors (X_2), while the dependent variable (Y) is preference. Data collection was carried out by direct interviews with respondents using a questionnaire that was first tested for validity and reliability. The results showed that the respondents' internal factors had a significant effect ($p < 0.01$) on preferences, while external factors significantly ($p < 0.05$) on farmers' preferences in the application of P6T.

Keywords: Preference · Principles of six right pesticides · Covid-19 pandemic · Multiple regression

1 Introduction

The COVID-19 pandemic has had an impact on people's lives around the world. The impact is not only on the health of hundreds of thousands and even millions of people, but it also affects the social sector and people's lives which are limited by the Large-Scale Social Restrictions (PSBB) format that limits transportation flows, shuts down the tourism and entertainment sectors, thus has a direct impact on the economy. A further impact is the stagnation of national economic growth, that almost all sectors show negative growth. However, when other sectors did not experience growth, the agricultural sector showed positive growth, for example, the agricultural sector grew 2.59% in the 4th quarter of 2020 and increased in the 1st quarter of 2021 to 2.95% [1].

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This condition proves that the agricultural sector is still active in carrying out agricultural development to meet national food needs.

In the development of the agricultural sector, many innovations and technological packages have been found, even several technology and innovation packages have been applied massively to agricultural communities, including fertilization technology, superior seeds, and control of plant pest organisms (PPO). In controlling pests, since 1989 various communities in Indonesia have developed Integrated Pest Control technology, better known as IPM. Pest control is an important part of plant protection to maintain productivity. As stated in Government Regulation of the Republic of Indonesia Number 5 of 1995 concerning Plant Protection Chapter 3 Article 10 Paragraph 2 that plant control measures are carried out through: physical, mechanical, cultivation or farming, biological methods, genetic methods, chemical methods, and other methods according to technological developments. Based on the recent study, farmers tend to use chemical pesticides because they think chemical pesticides work faster and the results are immediately visible, another reason; farmers still consider it as a guarantee of success in farming activities as a special example for shallot farmers in Brebes [2, 3]. Moreover, some farmers have perceived chemical pesticides as insurance, without considering the possible adverse effects.

The results of interviews with agricultural extension workers showed that pest control in Tanjungsari subdistrict still relies on the use of chemical pesticides because it is considered more practical and effective. Moreover, farmers also find it easier to apply chemical pesticides with instructions for use listed on the packaging. However, this does not guarantee that the behavior of farmers in applying pesticides is correct. It is feared that the use of chemical pesticides will have adverse effects on the environment and farmers' health, especially if they are used excessively and continuously. In the application of pesticides, most farmers pay less attention to the instructions for using pesticides that are available on each package of pesticide products such as dosage, time, technical, and so on related to the application or use of pesticides called the six right principles (P6T). Consequently, it will not only have an impact on human health but also damage the physical and biotic environment. Thus, the focus of the problem related to the application of chemical pesticides is the inappropriate use of proper procedures due to neglecting to pay attention to the instructions listed on the packaging, so it is necessary to conduct in-depth research to find solutions to the problem, namely: (1) what are the preferences of farmers towards the application of P6T, (2) what are the factors that influence farmers' preferences, and (3) what are the strategies to increase farmers' preferences in the application of P6T of pesticide applications. Thus, this study aimed to: (1) describe the level of farmers' preference for the application of P6T of pesticide application, (2) analyze the factors that influence farmers' preferences, and (3) find the right strategy to increase farmers' preferences for implementing P6T of pesticide application.

2 Literature Review

According to Effendi [3], good cultivation will cover some activities related to pest control, such as the assessment of methods used both in the short and long term, to the

production system and implications for the environment to minimize the use of chemicals in agriculture.

Thus, it is necessary to apply the concept of IPM through the six correct principles (P6T) of pesticides Application as conveyed by the Director-General of Horticultural Production Development (2002) in Moekasan and Prabaningrum [4], including (1) right on target, (2) right on quality, (3) right type of pesticide, (4) right time, (5) right dose or concentration, and (6) right method of use to minimize the use of synthetic pesticides and reduce chemical residues in the environment.

As we know that the application of IPM technology in lowland rice farming has a positive impact, especially behavioral changes from excessive use of pesticides [3]. The same information source said that IPM socialization in Indonesia had started in 1989 when the IPM master trainer (ToT) training was held at the Bogor Agricultural Extension Academy (APP). Furtherly, socialization was held through the Field School of Integrated Pest Control (SL-PHT) in several regencies in West Java Province. Through field schools, it is hoped that farmers will not only accept IPM technology as a technique for controlling plant pest organisms (OPT) but are also expected to preserve the natural enemies of pests that were in the crop ecosystem. However, the implementation of IPM still competes with past behavior which still relies on pesticides as a means of controlling pests. Not to mention with these conditions, the use of pesticides tends to be excessive and without paying attention to the principles and procedures in their use, in fact, in every pesticide product, there is a manual or standard procedure for its use. Based on the mentioned problems, it is necessary to conduct an assessment regarding the preferences of farmer group members towards the implementation of the six right principles (P6T) of pesticide application in Tanjungsari Sub-District, Sumedang Regency.

2.1 Preference

Preference is a person's choice or interest in choosing a product, either goods or services [5]. Preference itself is an English word that means the tendency of a person to choose an item that can be measured by a scale of needs from the desired item. Consumer behavior can be explained by several existing models, but course institutions can use the Kotler Model to answer the response of buyers or consumers in making decisions. Kotler & Keller model reveals that consumer decisions are influenced by two factors, namely external and internal factors [6]. This model explains that a person's characteristics and all influences from outside the consumer can influence consumers in responding and determining product choices. Kotler & Keller [6] divide external factors into two factors, namely marketing stimuli (product, price, distribution, and communication) and macro environment (economic, technological, political, and cultural), while internal factors include cultural, social, personal, and psychological. Seeing the complexity of the factors that influence consumer preferences in deciding the use of goods and services, a course institution company must prepare several choices of attributes to attract and meet consumer satisfaction. In addition, course institutions must be able to understand and analyze the attributes that are considered by consumers.

2.2 Covid-19 Pandemic

The Covid-19 pandemic in Indonesia, not only has an impact on the health of the population which has killed hundreds, thousands, and even millions of people from various groups, layers, and countries, but also has an impact on various other sectors, such as transportation, employment, trade, tourism, entertainment, and others. WHO health experts stated, the possibility of Covid-19 is difficult to disappear in the earth's atmosphere, so humans must be able to coexist with the virus that causes this deadly disease with a new order known as the New Normal. New Normal is an order of life that is adapting and living alongside Covid-19. Thus, during this Covid-19 pandemic, humans are required to adapt and live along with Covid-19 [7].

The Covid-19 pandemic has also affected the economic growth of many countries, including Indonesia. With a population of no less than 276 million people, the agricultural sector is required to ensure national food availability, therefore various agricultural development programs that have been launched by the government of Republic of Indonesia must be carried out properly and must continue. The main agricultural sector development programs that have been launched are: (1) Development of the Strategic Command for Agricultural Development (KOSTRATANI), (2) Facilitation of Financing, Infrastructure, and Agricultural Machinery Equipment (KUR), (3) Increasing Production of Food Crops through Area-Based Development Corporations (PROPAKTANI), (4) Development of Competitive Horticultural Areas (GEDOR-HORTI), (5) National Movement for Increasing Plantation Productivity, Production, and Competitiveness (GRASIDA), (6) Increasing Population and Productivity and Genetic Quality of Beef Livestock, Poultry = Cattle integrated cattle-palm, and upstream-downstream poultry industry (SIKOMANDAN), (7) Acceleration of Utilization of Technological Innovation and Propagation/Production of Seeds/Seeds from Research and Development, (8) Alleviation of Food Vulnerable Areas through Family Farming = School Enrollment Agriculture (PMS), distribution, control of staple food prices and food diversification, (9) Strengthening quarantine and acceleration services exports through the Triple Export Movement Program (GRATIEKS), and (10) Management Support (Employee Spending and Supervision). The question is, will the Covid-19 pandemic affect agricultural activities in the field? Therefore, this study can provide some answers.

2.3 Sustainable Agriculture

Dahuri states that sustainable development is an integral part of the economic development of a nation or the world's peoples [8], so to understand the meaning of sustainable agricultural development, it is necessary to first recognize the concept (paradigm) of sustainable development. Since the early 1980s coinciding with the issuance of the World Conservation Strategy) by the IUCN (International Union for the Conservation of Nature), various definitions of sustainable development have been raised by experts and scientific organizations. However, the definition generally accepted by the international community is the definition by the Brundtland Commission, namely: Sustainable Development is the development that meets the needs of the present, without compromising or impairing the ability of future generations to meet their own needs.

The definition does not prohibit activities related to economic development, but recommends it with the condition that the pace of development activities does not exceed the carrying capacity of the current environment. Thus, future generations will still have the same natural resources and environmental services (Environmental Services) assets, or if possible better than the current generation. Agricultural development is declared sustainable if the activity is economically, ecologically, and socially sustainable [9]. Economically sustainable means that a development activity must be able to produce economic growth, capital maintenance and efficient use of resources and investment. Ecologically sustainable means that development activities must be able to maintain the integrity of the ecosystem, maintain the carrying capacity of the environment and conserve natural resources, including biodiversity. Socially sustainable should be able to create equitable distribution of development outcomes, social mobility, social cohesion, community participation, community empowerment, social identity, and institutional development.

2.4 Six Right Principles (P6T)

Integrated pest control (IPM) using pesticides is the last step in controlling pests because IPM prioritizes agroecosystem management by combining environmentally friendly pest control techniques. Decision-making is important in pesticide use; wrong decision-making may be detrimental to the environment and from an economic point of view because of the costs involved. Observation of the suspected plot is the first step that must be taken to decide whether to use pesticides in controlling Plant Destruction Organisms (OPT). Observation is a process to determine the intensity of pest attack or population on farming land and climate change. If the observation results show that the intensity of the pest attack exceeds the economic threshold/control threshold, the decision taken is to use pesticides. Until now, most of the farmers assume that pesticides are a guarantee of production, especially shallot farmers in Brebes [10].

Even though pesticides must be used, there are 6 principles of proper use of pesticides that must be considered: (1) the right type; based on differences in the effectiveness (selectivity) of pesticides against target pests (OPT); (2) right on target; based on various types of pests (bacteria, fungi, mites, nematodes, herbs, etc.); (3) right on dosage; which is several active ingredients of pesticides that can kill pests; (4) right on time; suitability of time and conditions for pesticide application; (5) right on application method, namely the suitability of the right pest conditions for application (soaking, sowing, composting, greasing, etc.), because not all pesticides are sprayed, and (6) right quality; the pesticides to be used are of good quality, has a permit from the pesticide commission, is registered with a consumer agency, has no expiration date, and is guaranteed to be authentic.

2.5 Thinking Framework

Based on the problem background and the study purpose, there are several factors that are thought to influence farmers in implementing P6T. These factors, among others, come from within the individual (internal), namely: the age of farmer, the level of education, farming experience, the farming area, and the family dependents. In addition, there are also factors that come from outside the individual (external) consisting of: the

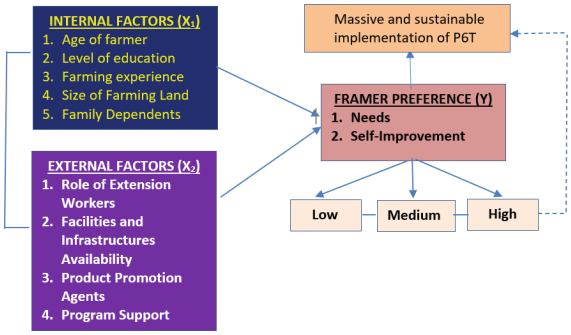

Fig. 1. Thinking framework.

role of extension workers, facilities and infrastructure availability, promotion agents for agricultural input products, and program support. Thus, the research framework was built to provide an overview of the relation and or influence of the independent variables of internal factors (X1) and external factors (X2) on the dependent variable (Y), as presented in Fig. 1.

3 Research Methods

This research is an *ex-post facto* research, which means research to observe the influence given in the past, with a quantitative approach supported by qualitative data and information. Based on the data analysis technique, this research is classified as descriptive and inferential research. The research was carried out for four months (April to July 2021), in several villages in Tanjungsari Subdistrict, Sumedang Regency. The location selection is based on the consideration of the commodity to be studied and the number of farmers carrying out farming activities (purposive). The population of three villages and six groups was 105 people. Sample determination using Slovin formula with a sampling error rate of 10% (*gallat*) obtained a sample of 55 farmers.

The data collected consists of; primary data directly obtained from respondents through interviews and secondary data obtained from documents and reports of Agricultural Extension Center Office (BPP), village offices, and local sub-district offices. Data collection was done by using a closed questionnaire containing questions and statements of variables, indicators, parameters, and types of measurement. Before being used as a data collection tool, the questionnaire was first tested for its validity and reliability on a farming community that almost resembles the farming community that will be used as research locations, namely in Cibungbulang Subdistrict, Bogor Regency. The research instrument grid is presented in Table 1.

Data analysis used were descriptive and inferential methods. Descriptive analysis was in the form of frequency distribution, while statistical inference analysis used multiple regression. Multiple linear regression analysis was used to determine how great the influence of relation between Internal Factors/Farmers Characteristics (X_1), External Factors (X_2) and the dependent variable Preference (Y) had on the dependent variable. The regression equation used was: $Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$.

Table 1. Variables, indicators, parameters and measurement scale

No	Variable	Indicator	Parameter	Measurement Scale
1	Internal Factors (X_1)	Age of farmer	Number of years	Ordinal
		Level of education	Number of years	Ordinal
		Farming experience	Number of years	Ordinal
		Farming area	Land size in m^2	Ordinal
		Family dependents	Number of family members	Ordinal
2	External Factors (X_2)	Role of extension workers	Facilitator: a. The ability to provide information b. The accuracy of providing information c. The accuracy of innovation selection Motivator: a. Distribution of innovation information b. The ability to provide innovation information Communicator: a. The clarity of information to farmers b. The completion of information c. Information Linkage	Interval
		Facilities and Infrastructure Availability	Adequacy level of facilities and infrastructure	Interval
		Promotion Agents	Innovation intermediaries, trend accompanist, farmer assistants and agricultural consultants	Interval
3	Preference (X_3)	Needs	The level of farmers need in using the Six Right principles (6T) of pesticides	Interval

Description:
Y = Preference.
b_1 = Regression coefficient of variable X_1.
(Internal Factors).
X_1 = Internal Factors/Farmers Characteristics.
B_2 = Regression coefficient of variable X_2.
(External Factors).
X_2 = External Factors

Processing and transforming data using Microsoft Office Excel 2010 program, while multiple regression analysis was processed by using Statistical Package for the Social Services (SPSS) version 26 program.

4 Results

4.1 Regional Profile

Tanjungsari Subdistrict is located in the western part of Sumedang Regency. Covering an area is 3.462 Ha with a distance to the capital city of Sumedang Regency of ±18 km and a distance to the provincial capital of ±24 km. The area topography is mostly hills with an altitude between 500–2000 m above sea level (asl). Most of the area is dry land or fields and forests. The rice fields area of 634,52 Ha, yard 745,68 Ha, and others around 166,61 Ha. The average rainfall is quite high, reaching ±185 mm per year, with an effective amount of rain between 20–146 days. This area has moderate duration of solar radiation with an average of 62,5% and moderate air temperature with an average of 21,5–25 ºC.

4.2 Variable Description

4.2.1 Internal Factors

The results of the descriptive analysis showed that the 55 respondents had individual characteristics, among others: majority (65.4%) were aged between 40–67 years, under 40 years were 9.1%, and over 67 years were 25.5%. The majority of respondents (81.4%) have a junior high school education (SMP), only 14.6 percent received higher education. Furthermore, majority (50.9%) have more than 30 years of farming experience, majority (81.8%) have farming area of more than 12,200 m^2. In addition, related to family responsibilities, it was found that majority of the respondents (69%) had family dependents of 3–4 people. A detailed description of the respondents' characteristics is presented in Table 2.

4.2.2 External Factors

External factors include the role of extension workers, facilities and infrastructure availability and promotion agents. The results of the descriptive analysis showed that the role of the extension worker (56.4%) was in the medium category, 45.5% of the respondents agreed that the role of the chemical product promotion agent was in the low category, and 41.8% of the respondents admitted that facilities and infrastructure availability

Table 2. Internal factors performance of respondents

No	Age	Total Respondent (person)	Percentage (%)
1	>68	14	25,5
2	55–67	15	27,3
3	40–54	21	38,1
4	<27	5	9,1
	Level of education	**Total Respondent (person)**	**Percentage (%)**
1	SD (Elementary School)	2	3,6
2	SMP (Junior High School)	45	81,8
3	SMA (Senior High School)	0	0
4	PT (College)	8	14,6
	Farming experience	**Total Respondent (person)**	**Percentage (%)**
1	<10	3	5,5
2	10–20	13	3,6
3	20–30	11	20
4	>30	28	50,9
	Farming area	**Total Respondent (person)**	**Percentage (%)**
1	<4.100	2	3,6
2	8.100–4.200	2	3,6
3	12.100–8.200	6	11
4	>12.200	45	81,8
	Family Dependents	**Total Respondent (person)**	**Percentage (%)**
1	>4	18	32,7
2	3	20	36,3
3	2	1	2
4	1	16	29

was in the high category. Details of the respondents' external factors are presented in Table 3.

4.2.3 Preference

The results of the descriptive analysis showed that respondent farmers' preferences agreed that farmers' preferences or tendencies in implementing P6T were in the moderate category, both for reasons of need (78.2%) and reasons for self-development (69.1%). Details of the results of the preference descriptive analysis are presented in Table 4.

Table 3. Diversity of respondents' external factors

NO	Variable	Level (100%)		
		Low	Medium	High
1	Role of Extension Workers	9.1	56.4	34.5
2	Infrastructure Availability	29.1	29.1	41.8
3	Promotion Agents	45.5	32.7	21.8

Table 4. Preference of respondent farmers

NO	Variable	Level (100%)		
		Low	Medium	High
1	Needs	10.9	78.2	10.9
2	Self-Development	20.0	69.1	10.9

Table 5. Results of multiple regression analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
R-Square	(0.544)				
(Constant)	48.629	10.497		4.633	0.000
Farming area	−4.369	1.030	−0.529	−4.243	0.000
Role of extension workers	0.204	0.094	0.258	2.159	0.036

4.3 Factors Influencing Respondent Farmer Preferences

The results of the regression analysis showed that the factor that had a significant effect on farmers' preferences in the application of P6T ($p < 0.01$) was the farming area with a negative coefficient of 4.369, while the role of extension workers had a significant effect ($p < 0.05$) with a coefficient of 0.202. Meanwhile, the value of R Square is 0.544 and the constant is 48.629. From these results, the regression equation obtained is $Y = 0.544 - 4.369\ X1 + 0.204\ X2 + \varepsilon$. Details of the results of factor analysis are presented in Table 5.

The regression equation above can be further explained as: (1) if the farming area and the role of the extension worker has a value of 0 (zero), then the preference of farmers in applying P6T is 48.63, (2) the value of farming area is negative 4.369, which mean that it is inversely proportional to the P6T application preferences. Furthermore, it can be explained that if the role of the extension worker has a value of 0 (zero) then

every increase of one unit of farming area will decrease the preference by 4.37 units. (3) the role of the extension worker has a positive value of 0.204, which means that it is directly proportional to the P6T application preferences; thus, if the farming area is 0 (zero) then each increase of one unit of the role of the extension worker will increase the P6T application preferences by 0.204 units. In addition, the termination coefficient (*R-square*) obtained is 0.544, which means that the contribution of the selected variables in this study that contributes to the research results is 54.4%, while the remaining 45.6% comes from outside of the study.

5 Discussion

In general, the results of this study can be emphasized, that the age of farmers belongs to less productive group because the majority (65.4%) are over 40 years old, with a relatively low level of education with 81.4% received junior high school level (SMP), very experienced in farming experience including with the majority (50.9%) have more than 30 years of experience and own extensive farming area with the majority (81.8%) own farming area of more than 12.200 m^2 and with family dependents of 3–4 people (69%). This condition strengthens the statements of experts and proves the growing issue that Indonesia is currently facing a farmer crisis due to the existing farmers are elderly with relatively low levels of education. These results are in line with Effendy *et al.* [10], that the current average age of farmers is relatively old, with a low level of formal education which can be graduating and not even completing elementary school. The results of the analysis of external factors indicate that most farmers agrees facilities and infrastructure availability needed was in the high category, the role of farmer extension workers was in the medium category, and the role of promotion agents was considered low. These results can be interpreted that external factors also influence farmers in accepting or rejecting an innovation. This situation is in line with Effendy *et al.* [11], Effendy *et al.* [12], external factors such as extension activities and business scale significantly influence the tendency to adopt Cross Rice technology.

The results of study also indicate that the level of tendency or farmers' preference in the P6T application was in medium category (unsatisfactory). If it is related to the results of the descriptive analysis above, it can be explained that the farmers' tendency to apply P6T is still unsatisfactory due to the high availability of infrastructure facilities, relatively large farming area owned, and elder age. When someone experienced convenience because everything is available, they tend to no longer try to fulfill it, as well as when it is associated with a relatively large farming area, they feel it is sufficient to meet all needs. On the other hand, at old age, they may think the efforts expended since youth is enough and after become elderly they just enjoy the results. This result is in accordance with Maslow [13], in his book on the hierarchy of needs explaining that a person will move to look for other needs when one need has been met. Jeffrey *et al.* stated that every consumer has various needs to achieve his goals or self-development; thus, individual needs are diverse from one another [14]. Effendy and Leilani stated that the characteristics of innovation, individual characteristics, and farmer capacity also determine the adoption of a technological innovation [15].

5.1 Strategy Increasing the Preference of P6T Application

The strategy to increase farmers' tendency to apply P6T was formulated based on the results of regression and descriptive analysis, namely the role of extension and the farming area. Therefore, extension activities must begin to identify needs; hence, the material presented is a solution to the problems faced by farmers, the media and methods used must consider the efficiency and effectiveness of achieving learning objectives, time and place should follow or at least be adjusted and agreed by the farmers, as well as the intensity and continuation of the activities should obey the health protocols need during the Covid-19 pandemic; thus, aspects of control and supervision become all parties responsibility. All activities related to the extension must always be carried out on farm lands and involve farmers own larger than average farming area.

6 Conclusion

The conclusions of the study are: (1) the general characteristics of respondent farmers are (a) internal characteristics: having an age ranging from 40–67 years including in the old category, the level of education is low, namely junior high school, has very adequate farming experience more than 30 years, has farm land relatively large area of about 12,000 m^2, with a family of 3–4 people; (b) external support consisting of the role of extension workers and promotion agents is in the medium category, but the availability of facilities and infrastructure is considered high; (c) the tendency of farmers in implementing P6T has not been satisfactory (including moderate); (2) the area of arable land and the role of the extension worker are factors that influence the tendency of farmers to apply P6T; (3) the strategy to increase preference for P6T application is to optimize the role of extension in the implementation of extension activities and involve farmers who have sufficient arable land to become demonstrators (motivators).

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