

Behavior of Shallot Farmers in Probolinggo Regency on The Use of Chemical Pesticides

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ABSTRACT

This research was conducted based on the conditions for controlling shallot pests in Probolinggo Regency, which still uses chemical pesticides, far from sustainable agricultural practices. Therefore, this study aims as follows: 1. To identify the knowledge of shallot farmers on chemical pesticides; 2. Identify farmers' responses to pests and diseases of shallots; 3. Knowing the pattern of chemical pesticides used by farmers; 4. Develop academic plans on reducing the use of chemical pesticides. This research was a type of descriptive research; the research looked at the phenomena in the research location symbols in society that are considered essential. The approach used in the research was quantitative. In this study, observations were made first to see the initial conditions of the research location, then continued with direct observations of the research location area to collect data according to the results obtained from the intended respondents. The results showed that shallot farmers' knowledge level in Probolinggo Regency was still in the medium category. Meanwhile, the attitudes and actions of farmers in using chemical pesticides were included in the poor level.

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1. Introduction

Adoption Shallot is a plant that has a high risk in agricultural cultivation activities. Among the existing risks, pest attacks (plant pest organisms) on this plant are a factor that often haunts farmers because the effects of attacks are very destructive and can even fail to harvest (Moekasan *et al.*, 2013). Production failures are usually caused by important pests commonly found in onion cultivation, such as *Spodoptera exigua*, *Fusarium*, and *Alternaria*. In the dry season, the level of pest attack will be difficult to control, while in the rainy season, the level of attack of disease-causing pathogens becomes higher, so the risk of crop failure is also higher. Crop failure is the effect of higher humidity in the rainy season than in the dry season, so the intensity of disease attacks is higher (Duriat *et al.*, 1997; Rosmahani *et al.*, 1998).

Farmers' need for knowledge in effective, efficient, and environmentally friendly pest control exacerbates the potential for significant crop failures. This condition certainly makes pest control still far from sustainable agricultural principles. Farmers can do many things as preventive measures in pest control, including the proper planting time, crop rotation, use of

resistant varieties, seed selection, use of traps, good soil management, and sanitation. Unfortunately, the reality of the common knowledge of farmers regarding variations in pest control has resulted in shallot farmers relying solely on pesticides as the only effective way to deal with pests and plant diseases (Ameriana, 2008; Oluwole & Robert, 2009; Suharjono, 2011; Sulistiyono *et al.*, 2008).

Farmers' response to the high level of pest attacks is excessive use of pesticides, which adds to farmers' need for more knowledge about pesticides. It is almost inevitable for farmers, and pesticides are the primary option to prevent pest attacks and act as "helping angels" when an attack occurs. This will undoubtedly have a harmful and unsustainable impact in the long term. (Schumacher & Schreiber, 2015) Schreinemachers *et al.* (2015) describe that there are three main challenges in overcoming the pesticide problem in Southeast Asia, namely the rapidly increasing pesticide trade, farmers still highly dependent on pesticides, and the lack of control over pesticide risk, which then affects the relevant parties in making rational decisions in the field.

The use of pesticides in the crop protection system in Indonesia is one of the permitted pest control methods. However, it must be following the recommendations that have been determined. Law 12 of 1992 concerning crop cultivation systems and government regulation no. 6 of 1995 has established a basic policy for plant protection with an integrated pest control system (IPM). According to the law in the IPM system, the use of pesticides is the last alternative. For farmers, pesticides are very beneficial; they can eradicate pests easily, reduce pest populations quickly, and reduce yield losses due to pests. By using pesticides, farmers also only require a little energy and do not require a long time.

Pesticides have a positive impact on increasing agricultural products and harm the surrounding environment (Sofia, 2001). Andriyani (2006) states that the impacts of using these pesticides include water and soil pollution, air pollution, the emergence of resistant pest species, new pests, secondary pest explosions, resurgence, damage to the balance of ecosystems, and can harm human health. The destructive effects are caused when the use of pesticides by farmers is not under the recommended use. On this basis, research on the behavior of Shallot Farmers in Probolinggo Regency towards pesticide use must be carried out so that it becomes the basis for agricultural development and development programs in particular and the environment in the general Probolinggo Regency area.

2. Methodology

2.1. Research Types and Approach

This research was descriptive. The researcher looked at the phenomena in the research location symbols in society that were considered necessary. In addition, the study saw farmers' level of knowledge, attitudes, and actions toward using pesticides to control shallot pests. After the data was obtained, a researcher described it as the beginning of writing the results.

While the approach used in the research was quantitative, the researcher will make observations first to see the initial conditions of the research location. After that, the researchers entered the research area directly, intending to collect data under the results obtained from the intended respondents.

2.2. Research Time and Location

The research was conducted from May to August 2021 in the shallot production center area of Probolinggo Regency, covering Dringu District, Tegalsiwalan District, and Gending District. These three research locations have the largest shallot area and have high productivity compared to other sub-districts as shallot production centers.

The method of determining the location of the research was to use a purposive method, namely in Mranggon Lawang Village (Dringu District), Sumberbulu Village (Tegalsiwalan District), and Sumberkerang Village (Gending District). The determination of the location of this research was based on the consideration that the three sub-districts are the largest shallot production centers in the Probolinggo area, and the three selected villages (Mraggon *et al.*) were the largest shallot production centers in each of these sub-districts (BPS, 2020)

2.3. Respondent Determination Method

Purposive sampling was the method of respondent selection at the research location. Purposive sampling was one method of intentionally selecting respondents with several criteria the researcher has determined. The number of respondents was set at 20 farmers in each selected village. The criteria chosen by the researchers were: (a) Shallot farmers who have been farming for two years; (b) Farmers who own land or determine what actions will be taken on shallot fields (not working farmers or labor farmers).

2.4. Data Collection Technique

2.4.1 *Primary Data*

Primary data were sourced directly from research respondents, namely shallot farmers in the research area (Dringu District, Tegalsiwalan District, and Gending District). This primary data can be obtained through observation, in-depth interviews, and questionnaires.

2.4.2 *Secondary Data*

Secondary data was data that describes the state of the research location's physical environment, the community's socio-economic conditions, and other data to support research results, both at the village, sub-district, and other relevant agencies. The secondary data included: (1) The research location's general condition, including the location and physical condition of the environment and the socio-economic conditions of the community; Population condition: age, gender, and livelihood; (2) Data on the number of farmers; (3) Data on institutions engaged in agriculture.

2.5. Data Analysis

The analytical method used was the descriptive quantitative method. This method is a method that emphasizes the aspect of measuring objectively social phenomena. The measurements utilize problem components, variables, and indicators. Each determining variable is measured by giving different number symbols according to the category of information related to the variable. By using these numerical symbols, quantitative mathematical calculation techniques can be carried out to produce a generally accepted conclusion in a parameter (Moleong, 1994).

Data from interviews with questionnaires were collected and processed using Microsoft Excel 2013 into a graph or table form to see the concentration and distribution of data. The

measurement results were not shown in the study results, but it was noted that the questionnaire submitted to farmers is feasible to use in similar research.

3. Results and Discussion

3.1 Overview of research Sites.

The Probolinggo Regency is one of the regencies in East Java Province, which is located at a position of 7°40' - 8°10' South Latitude and 111°50' - 113°30' East Longitude. Probolinggo Regency has an area of 1,696.16 km², including the Giliketapang Island area with an area of 0.6 km². Probolinggo Regency is located on the slopes of mountains stretching from west to east, namely the Tengger Mountains, Lamongan Mountains, and Argopuro Mountains.

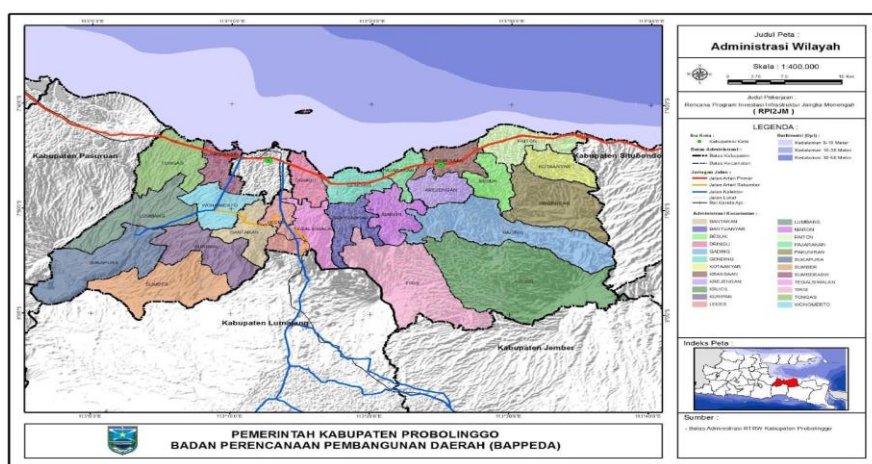


Figure 1. Probolinggo Regency Administration Area

The agricultural and agro-complex sectors have a very close relationship with the socio-economic conditions of the people in the Probolinggo Regency. The natural potential that supports the agriculture-animal husbandry sector is the primary source of people's livelihoods. The relationship between farmers, collectors, and markets is not only a representation of the supply chain, which is only seen from an economic perspective. However, the relationship between these roles is so ingrained that it can also be represented as an identifier of the prevailing social class. Therefore, until now, the agricultural sector is still the primary source of livelihood for the people of the Probolinggo Regency. The long history of agriculture in this region has been identified as having spawned many developed farming models. In reality, the current modernization is still quite challenging to accept. Agricultural institutions, cultivation systems, cooperatives, financial institutions, and small to medium-sized industries are essential elements that exist and continue to develop today.

At an altitude of 750 - 2500 m above sea level, it is suitable for vegetable crops, and at an altitude of 150 - 750 m above sea level stretching from west to east in the southern part at the foot of Mount Argopuro, very suitable for coffee cultivation, fruits such as durian, avocado, and other fruits, for example in Tiris and Krucil sub-districts. Meanwhile, shallots are centered on the north side in Dringu, Tegalsiwalan, Leces, and Gending Districts.

Table 1. Production of Vegetable Crops by Plant Type (Tons) in Probolinggo Regency 2018-2019

Plant Types	Years	
	2018	2019
Shallot	560.059	660.000
Garlic	1.737	12.070
Chili	119.186	204.125
Potatoes	230.576	219.412
Cabbage	221.031	269.945
Petsai	9.703	9.703
Tomatoes	5.747	9.605

Source : BPS (2020)

The land used as rice fields in Probolinggo Regency is 37,222 ha (BPS, 2020). This means that Probolinggo Regency has considerable potential to develop processes for modifying agricultural land use, such as intra-sectoral crop diversification, organic farming, etc. The increasing trend in vegetable commodities proves this great potential. For example, in vegetable commodities, Probolinggo Regency is recorded to have a significant amount of shallot production compared to other commodities, which amounted to 660,000 tons in 2019 (BPS, 2020)

3.2 Number of Conidia of *Trichoderma* sp.

The productivity of shallots in Probolinggo Regency tends to increase yearly from 2015 to 2019. 2019 was the year with the highest productivity, reaching 660,000 tons. This increase is also in line with the harvested area of shallot commodities, which continues to increase. This data shows that Probolinggo Regency has a high potential for red onion production, mainly concentrated in 5 sub-districts: Dringu, Tegalsiwalan, Leces Gending, and Banyuanyar Districts. The production is, of course, not only caused by the extent of agricultural land but also by many factors that affect the increase and sustainability of shallot cultivation in Probolinggo Regency. Several factors that affect the high productivity of shallots in Probolinggo Regency are the area of harvested land, climatic and environmental conditions, soil types, springs, and the shallot wholesale market.

3.3 Characteristics of Respondent Farmers

Farmers' decision-making is based on several factors. These factors will determine farmers' decisions in deciding something in their farming. Some of these factors are education level, age, farming experience, and experience as a member of a farmer group.

3.4 Shallot Cultivation Practices in Probolinggo Regency

Shallots in Probolinggo Regency are usually planted throughout the year, although with different planting times and patterns. Therefore, shallot cultivation in the Probolinggo district differs significantly from onion cultivation in general. It is just that farmers here have their techniques and patterns in farming to adapt to the times and environmental challenges.

The cropping pattern commonly used by shallot farmers in Probolinggo Regency is to plant shallots throughout the season. Other commonly grown crops such as rice, corn, chilies, or cucumbers are only planted when onion cultivation is less profitable. Farmers believe the soil has a saturation point if only one commodity is planted. However, this will only last for a

while. Therefore, the planting pattern other than shallots is usually only in the form of an interlude and is only planted once, which will continue to plant shallots. Such a cropping pattern is a cropping pattern that does not break the life cycle of pests and diseases.

3.5 Pesticides in Probolinggo Regency

3.5.1 *Pesticide Formulation Used*

Based on the formulation, respondent farmers in Probolinggo Regency used 104 pesticide formulations consisting of 12 fungicide active ingredients, seven herbicide active ingredients, and 24 active insecticide ingredients. The formulation is a trading name of a formulation registered by the holder of a pesticide registration number, and a trading name stated to have been used by the respondent farmer. These data indicate that some pesticide formulations used by respondent farmers contain the same active ingredients. There are more insecticides and fungicides than herbicides, and farmers change the types of insecticides and fungicides used more often.

3.5.2 *Pesticide Active Ingredients Used*

There are three types of pesticides used by respondent farmers: insecticides, fungicides, and herbicides. The dose and frequency of use depend on the incidence and intensity of pest attacks in the field. The data used in this discussion are pesticides used by respondent farmers and registered with the Ministry of Agriculture with the consideration that these pesticides have gone through a registration process according to procedures (valid). The results showed that insecticides were the most widely used pesticide by respondent farmers in Probolinggo Regency. The high use of insecticides in shallot production centers indicates that pests, especially from the insect group, are still essential pests for shallot cultivation and are pretty tricky to control, so farmers tend to use several types of insecticides in their use.

The formulation and the active ingredient of the pesticide are inseparable. Based on Table 6, the active ingredient of insecticides in the registered pesticide formulations most widely used by respondent farmers in Probolinggo Regency is chlorfenapyr. In contrast, the active ingredient of fungicides in Probolinggo Regency is mancozeb. Compared with previous data, there is a difference between the active ingredients in the most widely used pesticide formulations and the active ingredients contained in registered pesticide formulations that respondent farmers have used. The data shows a habit of trying or using pesticide formulations with the same active ingredients on the land managed by the respondent farmers. In addition, it also shows the number of companies that register and market pesticide formulations with the same active ingredients.

Table 2. Five Most Active Ingredients in Listed Pesticide Formulations Used by Respondent Farmers

No	Active Ingredients	User	
		Amount	%
1	<i>Klorfenapir</i>	44	73%
2	<i>Mankozeb</i>	41	68%
3	<i>Abamektin</i>	40	67%
4	<i>Klorantraniliprol</i>	40	67%
5	<i>Indosakarb</i>	39	65%

Source: Primary data (2021), Processed.

3.6 Knowledge, Attitudes, and Actions of Respondent Farmers on The Use of Pesticides

3.6.1 *Respondent Farmer's Knowledge of Pesticide Use*

The questions posed to farmers covered several prominent issues, including some general terms about pesticides, the impact of using pesticides, regulations related to pesticides, and the concept of Integrated Pest Control. From this point of view, the extent of knowledge of shallot farmers in Probolinggo Regency regarding pesticides will be explored.

The general term pesticide is the first subject to be explored. This includes farmers' knowledge about the meaning of pesticides, active ingredients, trademarks, properties, spectrum, formulations, precise concepts, and types of pesticides. Unfortunately, the research that shallot farmers in Probolinggo Regency have carried out is still lacking. It can be seen in Figure 2 that respondent farmers who understood the general term pesticide, only 13% answered doubtfully 28%, and dominated by farmers who do not know about the general term pesticide as much as 58%.

The general impact of pesticides is also a topic of discussion to determine the extent of farmers' knowledge. This subject includes questions regarding personal protective equipment (PPE), toxins to humans and animals, resurgence, pollution, and poisoning symptoms. Figure 2 shows that the majority of farmers already know the impact caused by the use of pesticides. 58% of farmers already know, 8% are unsure, and 38% do not. The level of knowledge about the impact of pesticides knowledge can also indirectly affect farmers' use of pesticides. Therefore, it will be a consideration if farmers understand the impact of their use.

In the use of pesticides, there are also several rules for agricultural sustainability. The regulations, of course, are also a subject to measure the extent of farmers' knowledge. In this subject, several questions will be asked, including regulations on plant protection, the concept of Integrated Pest Management (IPM), packaging labels, dosages, and guidance on the use of pesticides. Figure 18 shows that most farmers need to learn about the regulations on the use of pesticides. As many as 62% of farmers answered that they did not know, 20% answered that they knew, and 18% were unsure.

The last question to measure farmers' knowledge level is about the IPM system and other forms of identification besides pesticides. Questions on this topic include the definition, control methods, natural enemy impacts, and control thresholds. Figure 2 shows that most

farmers do not know the concept of IPM, where 14% answered they knew, 7% were unsure, and 79% answered they did not know. The plant protection system in Indonesia is inseparable from the IPM system, a program launched by the government to control the use of pesticides so that they are more targeted and sustainable for the environment. The knowledge of respondent farmers about pesticides still needs to be improved. Figure 2 shows that many farmers still need to understand the general terms of pesticides. These terms include spectrum, formulation, pesticide properties (contact/systemic), persistence, precise concept, and resurgence. In addition, about 80% of respondent farmers need to learn that some regulations/regulations address the issue of crop protection (particularly regarding the use of pesticides), and the use of pesticides is entitled to guidance, both from the government and pesticide companies. Respondent farmers also need to improve their understanding of IPM and control methods other than pesticides. It is proven (figure 2) that only 5% of farmers know about the concept of IPM. The lack of pesticide knowledge certainly needs to be handled seriously, considering the IPM system is one of the programs from the government that can be the answer to the problem of pesticides in this modern era.

The low level of knowledge of farmers is caused by several factories that adapt to influence—both from the internal factors of individual farmers and from external factors of farmers. The internal factors of farmers that can affect the level of knowledge of farmers are education level, age, and membership experience as a member of a farmer group.

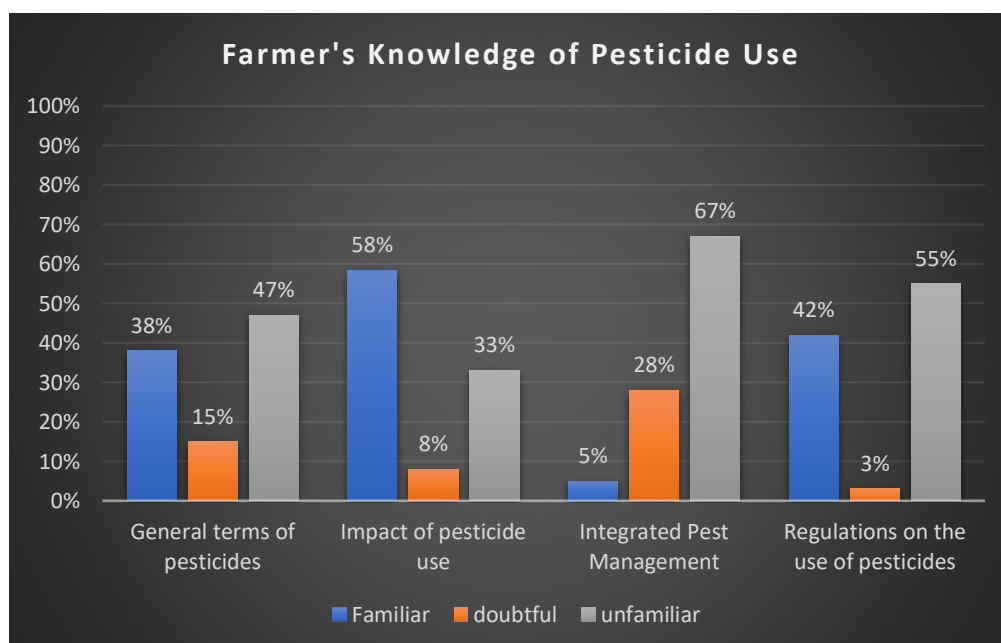


Figure 2. Farmers' Knowledge of Pesticide Use

Apart from the internal factors of individual farmers, factors that can affect the level of knowledge of farmers are also external factors. Farmers receive information about pest control from several sources. Shallot farmers mostly get pest control information from agricultural kiosks, where they buy pesticides and their families. The data shows that these two sources are the most accessible information for farmers in developing knowledge to overcome pest problems on their land. In addition, there is a significant role in pesticide sales, explaining the usefulness of the products offered by the problems experienced by farmers and the role of

neighbors who have experience in handling the latest problems in shallot plants. The rest of the farmers also gained knowledge from farmer groups, the internet, and extension workers, but not very intensively.

3.6.2 Respondent Farmer's Attitudes Against the Use of Pesticides

Shallot cultivation is inseparable from pesticides. Therefore, the thought arises that pesticides must be used when planting shallots. Figure 3 shows that 78% of respondents stated that pesticides should be used in pest control, 2% answered doubtfully, and 20% disagreed. The number is inseparable from the higher level of pest attacks on shallots. Some important pests often complained about by farmers are armyworm attacks, Fusarium, and *Alternaria porri*. The attack rate of armyworms is very high in the dry season, and attacks by Fusarium and *Alternaria porri* are challenging to control in the rainy season. This forces farmers to use pesticides to control pests.

In addition, the attitude of farmers as above can harm environmental sustainability because pesticides contain chemically active ingredients that harm the environment and humans. Most shallot farmers in Probolinggo Regency understand that pesticides are dangerous poisons. As many as 100% of respondent farmers agreed with the statement. The answer means that farmers realize it or not. They already know the terrible effects of pesticides, but because of the high level of attack and lack of knowledge, farmers have no choice but to use pesticides. So, in the use of pesticides, farmers tend to be excessive and not by the recommended use. It is proven by the statement of farmers as much as 58% disagree that pesticides must be by the recommended dose. Gerungan (2004) states that an open attitude to innovation will facilitate the implementation of the innovation. The statement is reinforced by Sarwono (2005) opinion, which states that a positive attitude will occur if there is a tendency to accept the recommended behavior. Conversely, a negative attitude occurs if a tendency to reject a particular object exists.

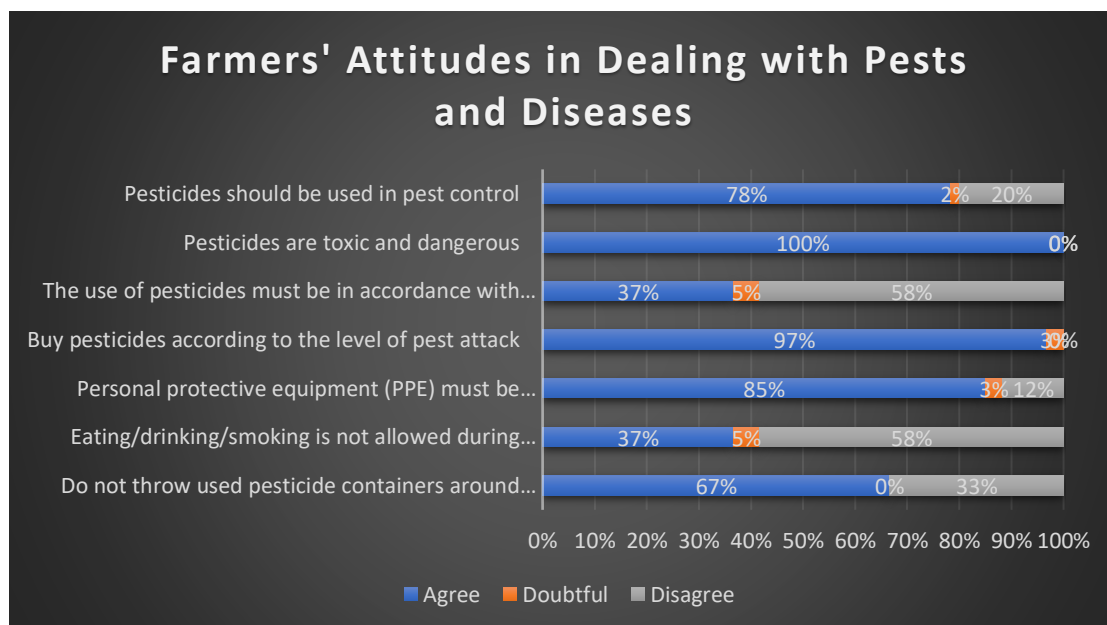


Figure 3. Farmers' Knowledge of Pesticide Use

In total, 85% of farmers agreed with PPE when spraying pesticides. However, good knowledge is only sometimes good practice. It is proven that farmers know the pesticides used

compared to the general public. In fact, on their farms, they do not use personal protective equipment for their safety. (Salameh *et al.*, 2004; Oluwole & Robert, 2009). Since many farmers have experience with the length of time they have been doing the shallot cultivation business (figure 12), some farmers still need to be made aware of inappropriate activities such as not using PPE and eating/drinking when spraying. Under the pretext that they are used to it and do not cause symptoms, farmers ignore their safety by underestimating the use of PPE. Likewise, during spraying activities, in Figure 3, it can be seen that farmers do not use PPE when spraying, have short sleeves, wear gloves, or wear masks. In addition, some farmers used to smoke. The bad behavior is hazardous because the hands of farmers can also be contaminated with active pesticide ingredients.

Attitudes will not respond directly to a change, realizing that knowledge and attitudes are influenced by experience (Rambe & Honorita, 2011). Purwanto (2005) said that experience could also shape attitudes to increase the knowledge possessed by farmers, including the experience of using new technology. At the same time, knowledge is the initial stage of perception, which then gives birth to attitudes and, in turn, to actions or actions so that the attitude of farmers in responding to the situation will impact the actions to be taken in their farming business. Suhardi (2004) argues that the most dominant factor influencing the behavior of farmers in the use of pesticides is their attitude.

3.6.3 *Actions of Respondent Farmers on The use of Pesticides*

The use of pesticides is still quite massive, with the purchase of pesticides every planting season by all shallot farmers in Probolinggo Regency. Farmers always feel the need to use pesticides as first aid in handling pest attacks. Farmers do not understand that there are other ways to control other pests. Most farmers do not consider the price of pesticides because it is considered an investment to get abundant harvests later.

Errors in their use still dominate the actions of shallot farmers in the Probolinggo Regency. Pesticides in Probolinggo Regency are carried out throughout the season, both in the dry season and the rainy season. Based on the research results in the field, 100% of respondent farmers stated that using pesticides was carried out every planting season. It is almost certain that onion farmers in Probolinggo Regency are already very dependent on pesticides. In practice, farmers are aware of buying labeled pesticides; 100% of respondents said that buying labeled pesticides. This is also influenced by the dominance of agricultural kiosks and pesticide sales in providing information to farmers about the products they market.

The price of circulating pesticides also varies, depending on the brand, type, active ingredient, and concentration. However, the increasing price of pesticides is not considered by farmers. 80% of respondents said that farmers did not consider the price of buying pesticides. This is, of course, because the farmers trusted in what recommendations were obtained. Meanwhile, in its application, based on trust and recommendations from the environment, farmers who buy pesticides do not see the label anymore. Farmers already feel that what is recommended is based on the needs of their land.

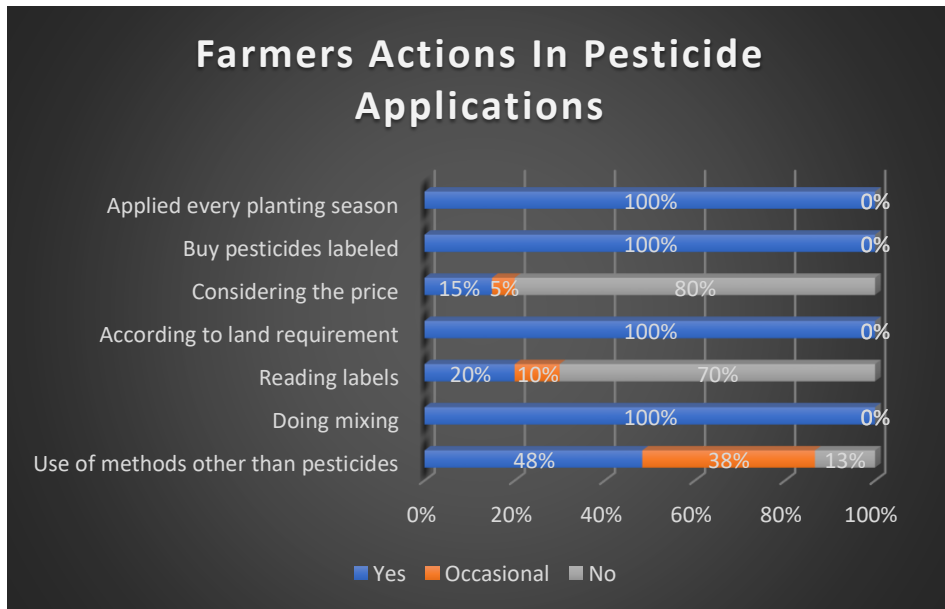


Figure 4. Farmers' Knowledge of Pesticide Use

Pesticide spraying is carried out by the farmers or farm laborers employed by the landowners. This means that pesticide spraying is carried out by humans, which needs to be considered in several aspects to maintain their safety and the surrounding environment. Given that pesticides are substances that contain toxins if exposed to the body or inhaled by humans. Therefore, when spraying pesticides, it is necessary to use personal protective equipment (PPE) as a protector in order to reduce the risk of danger from pesticides. Although from the study results (figure 5), 23% of farmers stated that they used PPE, in practice, showed different actions. Almost all shallot farmers in Probolinggo Regency do not use PPE when spraying pesticides on their land (figure 5). This is because they are used to doing this and feel it has no impact on them now.

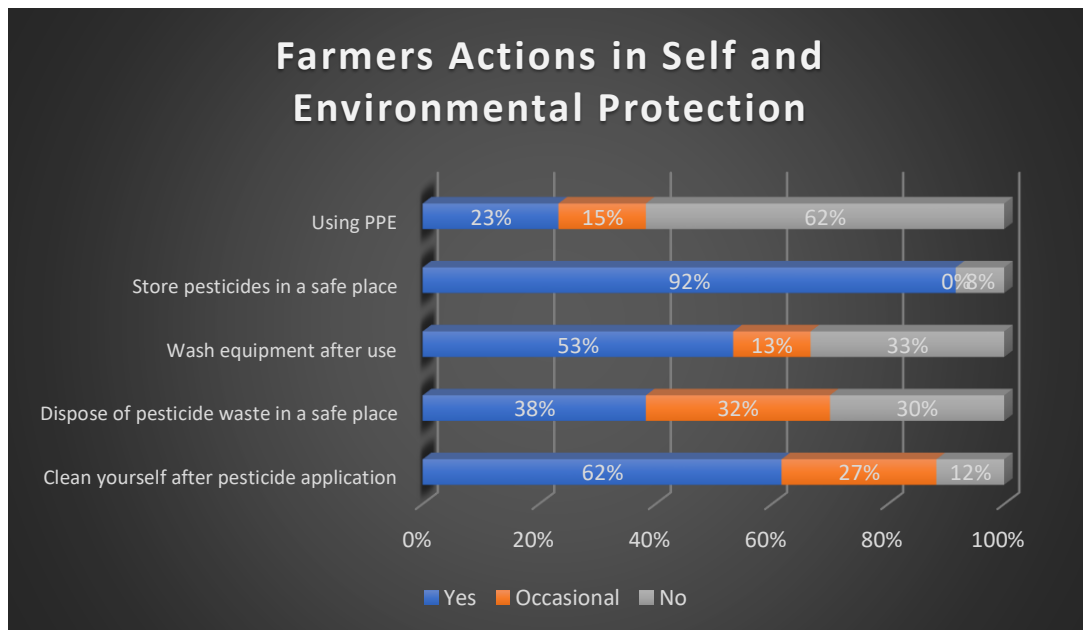


Figure 5. Farmers Actions in Self and Environmental Protection

After applying pesticides, some farmers have understood that remnants of toxic chemicals stick to clothes on the skin's surface, so they need to clean themselves before doing other activities. In addition, most shallot farmers also clean the equipment that has been used, as much as 53%. Furthermore, 95% of farmers have stored the remaining pesticides safely, are not close to food, and are not easily accessible to children. However, not all farmers dispose of used pesticide containers properly. Only 38% of farmers do this, while the rest sometimes need to do it. This can be dangerous because it can pollute the surrounding environment and poison organisms that accidentally eat food contaminated with pesticides.

Safety, health, and environmental aspects in the entire production process to marketing are assessed by the International Standardization Organization (ISO), which is known for its quality system approach and food safety, including the ISO 9000 Management System on Quality Management, ISO 14000 on Environmental Management, and Hazard Analysis Critical Control Point (HACCP) on Food Safety Management System. A quality product must have four criteria, namely: (1) meet the sensory properties, which include taste, appearance, smell, and color; (2) fulfill the nutritional value concerning the content of nutrients and vitamins, and there are no unwanted things such as substances that cause allergies; (3) meet the quality of health (hygienic quality) concerning cleanliness, freshness, no insects, not disgusting; and (4) fulfill food safety aspects which involve the absence of disease-causing microorganisms, no toxic substances such as pesticides, heavy metals, mycotoxins, and no deception (Frost, 2001).

4. Conclusion

Shallot farmers in Problinggo Regency need access to information regarding integrated pest management. This is because the information comes only from pesticide agents rather than agricultural experts. Shallot farmers ignore safety and environmental sustainability. This is reflected in the actions of farmers who mix chemical pesticides without looking at the usage label and not considering the price. The attitude of shallot farmers in Probolinggo Regency is in the wrong category. Even though farmers know that pesticides are toxic and dangerous, they still use sprays that do not comply with the recommended use, eat/drink/smoke when spraying, and still consider the pesticides used in pest control.

So, based on the points above, five essential things can be done as a first step to reduce the use of pesticides in Probolinggo Regency, namely:

1. Improving land function by collaborating with several farmers/farming group members in one area to implement various technologies that can reduce chemical pesticides.
2. Reactivate the role of farmer groups in accommodating farmers' needs.
3. Improve meeting routines and optimize materials, media, and extension methods according to farmers' needs.
4. Improve farmers' skills in reducing the use of chemical pesticides.

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