Farmers knowledge on pesticide management practices: A case study of shallot growers in Palu, Indonesia

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Abstract. Pesticide is one of the most common methods of pests and diseases control applied in a developing country. Knowledge of pesticide management is significant for effective application. The purpose of the study is to determine the knowledge of farmers about pesticide management practices on shallot crops in Palu, Central Sulawesi, Indonesia. The study was conducted from October 2017 to February 2018. This quantitative and survey research was used respondents of 30 farmers in two locations: Duyu and Bayaoge in Tatanga District, Palu, Central Sulawesi, Indonesia. Commonly, the respondents working on the shallot field. The data quantification using the ordinal scale, then univariate analysis for frequency distribution and bivariate analysis to determine the correlation of two variables. The results were showed there no significant effect between farmers' knowledge about pesticides and the actions of farmers in the use of pesticides. Increasing knowledge about pesticides cannot be expected to change wise actions in using pesticides in pest control.

1. Introduction

Plant protection is an important part of the agricultural intensification program, related to the increasing level of pests and diseases attack crops. The one important and widely cultivated commodity in Palu city are vegetable crops. Vegetables are famous agricultural commodities and higher economic value in the community. Vegetable commodities have a wide diversity and their function as a source of carbohydrates, also vegetables added more variety, taste, color, and texture to food. Many types of vegetables are cultivated by farmers in Palu such as spinach, kale, mustard greens, long beans and shallots. For few decades, the shallot is a famous vegetable and contribute improve the income of farmers and the local government.

Efforts of increasing production often encounter obstacles in the form of the occurrence of pests and diseases caused by crop failures or reduced yields. The vegetable crop is highly susceptible to pests and diseases, resulting in the emergence habits of the farmers to continue applied pesticides on vegetable crops such as cabbage, spinach and others. Although the number of pests in the lowest level or nothing, the farmer still used pesticides such as fertilizer more than the recommended dose on their packaging [1, 2]. According to [3], the easy way increasing vegetable production is the one purpose of plant maintenance actions is the using of pesticides. Farmers believe that pesticide application on the plant will be protected from losses yield because of pests, diseases and weeds.
Sometimes shallot farmer’s behavior used pesticides not only maintain the presence of pest but improving environment pollution, such as used over of normal pesticides dosage. Also, the farmers often mix several types of pesticides with beliefs increasing toxicity control plant pests. In the long term, the behavior very harmful because leads to higher levels of environmental pollution [4, 5]. According to [6] state that farmers used the highest frequency of pesticides in horticultural and food crops. Commonly the frequency of the pesticide application reaches 3 - 5 times a week by using 2 - 7 types of pesticides. Every year, the increasing total pesticide concentration by farmers applied in crops reaches about 150 - 200%, higher than the recommended level by mixing two or three types of pesticides at a one-time application. The farmer habit still continues in every planting season to avoid attacks of pests and diseases on their crop. This is a very dangerous situation of crop yield used by consumers [2, 6, 7, 8].

Since a few years ago, the role of farmers as the main actor in managing natural resources, management and application of pesticides based the rules have been recommended. The purpose of the study is to determine the knowledge of farmers about pesticides and their management of pesticide application of vegetable crops especially in shallot at Palu, Central Sulawesi, Indonesia.

2. Materials and methods

2.1. Site of research
The research was conducted from October 2017 to February 2018. The type of research was used quantitative and survey research. The survey research used 30 respondents of shallot farmers at two locations: Duyu and Bayaoge in Tatanga District, Palu, Central Sulawesi, Indonesia. Commonly the respondents working on the shallot field. Primary data collection used test instruments, questionnaires and observation sheets containing structured questions through interviews. Secondary data was collected through a survey of the relevant agencies.

2.2. Data analysis
Data computation used the ordinal scale, then univariate analysis for frequency distribution and bivariate analysis to determine the correlation of two variables. Both of them used Statistical Product and Service Solutions (SPSS) Software.

3. Results and discussion

3.1. Results

3.1.1. Active Ingredients of pesticides. Based on the interview showed that massive pesticide applications very high in the area of research. The high number of pest attacks on vegetable crops force farmers to use pesticides irregularly, incorrectly and unsafely. The most common types of pests attacking vegetable plants in two research locations such as leaf caterpillars (Spodoptera sp. and Plusia sp.), aphids (Myzus persicae), leaf roller (Chrysodeixis chalcites). The diseases such as dumping off (Rhizoctonia sp.) and leaf spot (Cercospora sp.). The farmers still choose chemical pesticides in controlled plant pest organisms. Commonly the types of pesticides used by farmers in vegetable crops especially shallot as insecticides and fungicides. Active ingredients of pesticides that are generally used by shallot farmers in Duyu and Bayaoge was showed in table 1. It was showed generally vegetable farmers in Duyu and Bayaoge using fungicides and insecticides in moderate (II) and non-acute (U) classes based [9].

3.1.2. Characteristic of shallot farmers and education level. Based on the interview, many varieties the age of vegetable farmers as the respondents. The youngest respondent is 27 years and the oldest 57 years with an
average of 38.50 years. The other data was showed, based on the education level of the sample farmers in the past, most of them are still relatively low, an average of 36.67% in Elementary School, 50% in Junior High School and only 10% in Senior High School. The data means that the farmer's education level will affect farmers knowledge about pesticide management. Farming experience of farmers generally over 2 years (86%), only land ownership generally leases 76.66%. This information was showed the farmers really expect the farmers knowledge about pesticide management. Farming experience of farmers generally over 2 years (86%), only land ownership generally leases 76.66%. This information was showed the farmers really expect the results of their vegetable business especially shallot in areas of Central Sulawesi. The characteristics of farmers respondents were shown in table 2.

Table 1. Active ingredients of pesticides used by shallot farmers in Duyu and Bayaoge.

| Types of pesticides | Active ingredients | Group         | Class |
|---------------------|--------------------|---------------|-------|
| Fungicide           | Propineb           | Dithiocarbamate| U     |
| Fungicide           | Carbendazim        | Benzimidazole | U     |
| Fungicide           | Iprodione          | Dicarboximide | U     |
| Insecticide         | Chlorpirifos       | Organophosphate| II    |
| Insecticide         | Alpha-cypermethrin | Botanical     | II    |
| Insecticide         | BPMC               | Carbamate     | II    |
| Insecticide         | Chlorantraniliprole| Antranilic dinamide | U |
| Insecticide         | Emamectin Benzoat | Avermectin    | U     |

*II = Moderately hazardous; U = Unlikely to present acute hazard in normal use.

Table 2. Characteristic of shallot farmers as the respondent in two location in Palu.

| General information | Bayaoge (n = 15) | Duyu (n = 15) |
|--------------------|------------------|---------------|
|                    | Total (%)        | Total (%)     |
| Farmer age         |                  |               |
| >20 Years          | 3 20.00          | 2 13.34       |
| >30 Years          | 7 46.66          | 6 40.00       |
| >40 Years          | 3 20.00          | 4 26.66       |
| >50 Years          | 2 13.34          | 3 20.00       |
| Formal education level |                |               |
| Without formal education | 1 6.66   | 0 0           |
| Elementary school  | 5 33.34          | 6 40.00       |
| Junior high school | 8 53.34          | 7 46.66       |
| High school        | 1 6.66           | 2 13.34       |
| Farming experience |                  |               |
| <2 years           | 2 13.34          | 1 6.67        |
| 2 - 5 years        | 12 80.00         | 9 60.00       |
| 5 - 10 years       | 1 6.66           | 4 26.66       |
| >10 years          | 0 0              | 1 6.67        |
| Farmer’s status    |                  |               |
| Owner              | 3 20.00          | 4 26.67       |
| Tenant             | 12 80.00         | 11 73.33      |
3.1.3. Farmers knowledge of pesticides. Knowledge is very important in manage plant protection of the vegetable especially shallot. Farmers knowledge playing important role resulting safety food for consumers. Table 3 was showed shallot farmers knowledge of pesticides in Palu, Central Sulawesi.

| Knowledge category | Without formal education | Elementary school | Junior high school | Senior high school |
|--------------------|--------------------------|-------------------|-------------------|-------------------|
| Low                | 19.00                    | 8.50              | -                 | -                 |
| Moderate           | 56.23                    | 60.67             | 59.68             | 56.54             |
| High               | 24.77                    | 30.83             | 40.32             | 43.46             |
| Amount             | 100                      | 100               | 100               | 100               |
| Average Score      | 45.32                    | 52.56             | 61.50             | 65.56             |

Source: Primary data, 2018

Variable measures of respondents in two locations was showed low and moderate categories in table 4. There are no differences in the level of education in pesticide application in the field. The shallot farmers as respondents generally manage their vegetables according to their habits, although they know well the dangers of pesticides and negative impacts on the environment.

3.1.4. Farmers action of pesticides application. Based on Spearman Rank's analysis between knowledge and action was showed an insignificant correlation (0.26). Table 4 was showed the action of shallot farmers on pesticide.

| Knowledge category | Without formal education | Elementary school | Junior high school | Senior high school |
|--------------------|--------------------------|-------------------|-------------------|-------------------|
| Low                | 56.15                    | 57.68             | 55.90             | 49.98             |
| Moderate           | 43.85                    | 42.32             | 44.10             | 50.02             |
| High               | 0                        | 0                 | 0                 | 0                 |
| Amount             | 100                      | 100               | 100               | 100               |
| Average Score      | 28.98                    | 28.67             | 31.54             | 34.72             |

Source: Primary data, 2018

3.2. Discussion

Commonly in many developing countries, pesticide ingredients are divided into two groups such as active and inert (refer to other ingredients, adjuvants or co-formulants). Inert ingredients may be biologically or chemically active and labeled inert only because of their function in the formulated product. Most of the tests required to register a pesticide are performed only contain the active ingredient, not the full pesticide formulation. Inert ingredients are generally not identified on product labels [10]. According to [11] state that humans are exposed to complex chemical mixtures such as pesticides and their derivatives. The assessment of health and environmental hazard deriving from the interactions between various substances found in commercial pesticide formulation including active ingredients.
Based on table 1, although faster in reducing pest population, the continuing use of pesticides leading to the death of natural enemies, pest resistance, endophytic fungi, and environmental pollution [12, 13, 14]. All of these pesticides were used by vegetable farmers to control pests in Palu, Central Sulawesi. According to [15] state that failure to observe minimum intervals between pesticide application and sale is worrying because extremely hazardous (Carbofuran and Cadusaphos) or moderately toxic (Cypermethrin, Dimethoate, Endosulfan, Chlorpyrifos-ethyl, Fipronil) are the products currently used. The presented study indicates that pesticide application in the survey area represents a potential risk for the environment, farmers and consumers. According to [16] and [17] state that pesticides cause acute and chronic human health effects (especially farmer, worker and consumer), contamination of atmospheric, ground and surface water. According to [1] and [18] state that different pesticides have been implicated in neurotoxicity, endocrine disruption, immune impacts and mutagenicity.

More investigations are needed to quantify pesticides residues on the vegetables currently consumed and to determine the potential effect of those products on human and animals health [19, 20, 21] state that non-target organisms such as plants, earthworms, termites, ant colonies, snakes, birds, toads, lizards and other amphibians have been affected negatively by pesticide use. In general, determination of the environmental impact of pesticides depends on several factors such as pesticide active ingredient, dose rate, application frequency and method, environmental conditions (weather, soil type, geological formation) and site characteristics (available surface of water resources and presence of biological species). In a similar opinion, [11] reported their result of research recommended that all product pesticide formulations should be fully assessed during the authorization process for the safety of humans and the environment.

In general, farmers as the respondent has a moderate level of knowledge about pesticides in the medium category. Table 2 was showed a higher level of education has a strong relation to farmers knowledge of pesticides. According to [22] state that education influences the ability of reason and thought which is very important for building individual behavior. A similar reference by [23], states that education raising human capabilities and improvement of life, the higher education level has more capabilities in managing information. According to [24], knowledge is a major and important foundation for the formation of a person's actions, including farmers in conducting pest control technology. The initial stage required before a person of farmers adopting new behavior is knowledge. Based dynamic of the agricultural environment, farmers are required to know well in advance the meaning and benefits of the technology.

Several factors according to [25] and [26] which affect the weak relationship of knowledge, attitudes with farmers behavior are: anxiety, meaning that farmers feel anxious about very severe cases of crop failure that resulted in the value of investments are not back. Another aspect such as forecasting, poor farmers ability to predict the future of pests and diseases during the growing season; low awareness of farmers in IPM (Integrated Pest Management) implementation of these were driven by a lack of management and continuous monitoring by local government field service. Then, behavior intention meaning farmers have an intention to behave IPM because of the support of the cognitive aspects, but its implementation is strongly influenced by the surrounding situation. The desire to behave according to the rules to be blocked; finally, internal conflict, a factor between the fulfillment of needs and business constraints, severe pest disruptions cause concern which then causes extreme anxiety so that it encourages farmers to act out of control in pests, and ultimately use botanical pesticides. The research of [27] and [28] suggested that for reducing pesticides-use, farmers need to be educated about different non-chemical control methods. Farmer should be encouraged to adopt Integrated Pest Management practices.

Farmers knowledge and experience history were in agriculture very important in pesticide application in crops. According to [29] state that the habits of farmers in using pesticides adding the new dosage and often mix several types of pesticides with the reason increasing the toxicity of plant pests. According to [30] and [31] state that knowledge of pesticides in the right way is often responded to less positively by farmers because pesticides by farmers are considered as risk-reducing input because it is an input that increases the expected value of the probability of yield. The use of pesticides suppresses pest attacks and reduces yield losses. High beliefs on pesticides make it difficult for farmers to avoid the chemical product in managing their agricultural
land [24]. According to [32] state that the human productive age between 15 - 64 years, then all of farmers as respondents including in productive age.

Palu in Central Sulawesi as the central marketing of vegetable commodities from their own areas and another areas surrounding it. The research was showed there is no significant effect between farmer knowledge about pesticides and the actions or management of farmers in the use of pesticides. Commonly farmers do not use pesticides in pest control as recommended in the IPM concept, which limits the use of pesticides in pest control. Many factors outside the farmer more influence the actions of farmers in pest control, including the issue of anxiety about lost yield if they do not use pesticides and consumers demand a good vegetable performance. In contrast, the overdosage of pesticides caused environmental pollution and decreasing human health.

Increased knowledge of farmers about pesticides has not affected the actions of farmers in pest control in accordance with the expected stage of behavior change. According to [22] called the stages of behavior occur from knowledge, attitudes, and practices. This means that someone will practice or behave from what is known or acted. Research of [24] stated that the inappropriate actions of farmers in the use of pesticides are not only due to the lack of knowledge of farmers but also because of anxiety about crop failure when not using pesticides.

The results of research conducted by [31] and [33] reported the same thing that increasing knowledge about pesticides has not directly affected the use of pesticides at the level of vegetable farmers. Although the higher farmer knowledge about the dangers and impacts of pesticide use, farmers tend to reduce the quantity of pesticide use in the field. The same study was concluded by [34], that farmers have a positive attitude towards knowledge about the negative effects of pesticides but have not behaved well on the environment and generally farmers in many third world countries are illiterate and cannot read instructions on the label pesticides, lack of training on methods of applying safe pesticides, not wearing protective clothing, and not knowing about safe storage and disposal of residual pesticides.

4. Conclusion
Increasing knowledge of farmers about pesticides has not affected the actions of farmers in pest control following the expected stage of behavior change. There is no significant effect between farmer’s knowledge about pesticides by farmers in the use of pesticide action. Increasing knowledge about pesticides cannot be expected to change wise actions in using pesticides in pest control.

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