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Evaluation of Farmers' Knowledge Level in Pesticide Use: The Case of Central District of Yozgat Province

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ABSTRACT

In recent years, the economic return of pesticides as well as their negative effects on the environment and human health have been discussed. Ensuring sustainability in agriculture is possible with an increase in production and a decrease in environmental destruction. In particular, the conscious use of pesticides by farmers is very important in terms of both the environment and human health. This study aimed to measure the level of knowledge and sensitivity of farmers towards the use of pesticides. The main material of the study consists of primary data obtained through a questionnaire from farmers engaged in plant production in the Central District of Yozgat province. The sample volume was determined as 90 using the simple random sampling method. According to the findings, the majority of the farmers in the region used chemical pesticides in agricultural control, and they used herbicides more than pesticides for diseases and pests. Although 56.7% of the farmers stated that they had sufficient knowledge about pesticides, it was observed that they did not pay enough attention to the use and purchase of pesticides. Trainings on pesticide use affect the conscious use of pesticides. The fact that the majority of the farmers used pesticides based on their own experience made wrong practices inevitable. On the other hand, it can be stated that the economic concerns of the farmers and their desire to earn more income took precedence over their attitudes and behaviors towards the environment and human health. In this context, in order to ensure an accurate and effective use of herbicides, there is a need for improvements in training and consultancy services carried out by the relevant institutions and organizations for farmers, as well as market regulations in pesticide prices. In addition, provision of the pesticides based on prescriptions by experts, not on declaration by farmers, could increase the effectiveness of pesticide use.

1. Introduction

In the face of a rapidly increasing population, the demand for food increases considerably, putting a pressure on agricultural production. Considering the limits of agricultural lands, the way to increase production is directly dependent on the increase in yield and quality. Plant protection contributes enormously to the increase in the amount of product obtained from a unit area (Gün and Kan, 2009; Erdal et al., 2019). Cultural, chemical, biological and biotechnical control methods are extremely important in the control of agricultural pests (Özercan and Taşcı, 2022).

Pesticides are widely used in the fight against diseases, pests and weeds in crop production. The chemical pesticide, which is preferred due to its fast effect and ease of use, is also effective in saving labor, using fertilizers and reducing risk as well as increasing crop yields (Ghimire and Woodward, 2013). On the other hand, the intense increase in the use of pesticides and

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misuse over the years has led to a decrease in biodiversity, negative effects on animal and human health, and a decrease in soil, air and water quality (Levitan et al., 1995; van der Werf, 1996; Zhang et al, 2011; Schreinemachers and Tipraqsa, 2012; Ayyıldız, 2022). In terms of the sustainability of agricultural activities, it is necessary to consider agriculture and the environment as a whole (Kaya and Bostan Budak, 2022).

According to the data of the Food and Agriculture Organization of the United Nations (FAO), the use of pesticides in world agriculture in 2021 was 3.53 million tons. Brazil, the United States, and Indonesia are the countries where pesticides are used most intensively in the agricultural field, accounting for 41% of the total amount of pesticides (FAO, 2023). The fact that the use of pesticides in Turkey, which is 53,000 tons, lags behind many developed countries is considered important in terms of environmental impact (Anonymous, 2023). The use of pesticides is quite high in the Mediterranean and Aegean Regions of Turkey where intensive agriculture is widely practiced (Akar ve Tiryaki, 2018; Erdil ve Tiryaki, 2020; Aydın Eryılmaz ve ark., 2021; Durmaz ve ark., 2022). This situation differs in regions where rainfed agriculture is performed which needs less pesticide use.

It was stated in the previous studies that there were many errors in practice of pesticide use and that the farmers were insensitive in this regard (İnan and Boyraz, 2002; Kızılaslan and Somak, 2013; Çelik and Karakaya, 2017; Arslan and Çiçekgil, 2018). It was found that 385 million farmers and agricultural workers worldwide were poisoned in 2020 due to pesticides, approximately 11,000 of which resulted in death (Boedeker et al., 2020). Although there is no comprehensive data in Turkey, the results of a study conducted in Adana showed the seriousness of the situation. Çelik (2018) found that at least one agricultural poison was found in the hair and blood of 94% of the farmers.

While unconscious use of pesticides brings many of the abovementioned problems, it could also pose a threat to sustainable production in the coming years. For this reason, it is important to identify the problems in the practice and direct the farmers to the correct use, to create awareness of safe pesticide use and/or to develop alternative control methods. This study aimed to guide the extension activities to be developed on pesticide use by revealing the level of knowledge and awareness of farmers about the use of pesticides.

2. Material and Method

The main material of the study consisted of the primary data obtained through a face-to-face survey of the farms engaged in plant production in the central district of Yozgat province in 2023. Since the standard deviation of the population was unknown, the number of farms to be surveyed was determined by random probability sampling method (Çiçek and Erkan, 1996). In determining the sample volume, a 95% confidence interval and a 10% margin of error were used.

The number of questionnaires was determined as 90 using formula (1).

$$n = \frac{N.p.q}{[(N-1).(D)^2] + p.q} \quad (1)$$

$$(D)^2 = (d/t)^2 \quad (2)$$

It represents *n*: sample volume, *N*: number of agricultural enterprises, *p*: proportion of producers using pesticides.

In the distribution of the determined sample size, the farms were divided into three groups as small (40 farms, ≤ 10 hectares), medium (23 farms, 10.1-20.0 hectares) and large farms (27 farms, ≥ 20.1 hectares), taking into account the total operating lands of the farms. The information obtained from the farmers, such as chemical pesticide usage status, reasons for purchase, and points taken into consideration in application, was interpreted by creating cross-tables.

3. Results and Discussion

General information about farms and farm owners is given in Table 1. The average age of the farmers was 52.71 years and there was no significant difference between the size of the farms. In terms of the educational status, there was a significant difference among the groups. While the proportion of primary school graduates was higher in large-scale farms (40.7%), a large proportion of those with university degrees (35.0%) had small-scale farms. As the general average, the farmers had high school education. Considering that agricultural experience increases as the farm sizes increases and the rate of those with non-agricultural income decreases, it can be stated that small-scale farm owners take part in agricultural production in order to provide additional income. Similar results were also reached in studies on the use of pesticides. In a study conducted in Zonguldak province of Turkey, the average age of the farmers was 53.31 years (Aydın Eryılmaz et al., 2021). In another study carried out in Adıyaman province, the average age of the farm owners was 50.7 years, average experience with agriculture was 23.9 years and non-agricultural income was 41.1% (Aydoğan and Baran, 2023). Yüzbaşıoğlu and Topkaya (2022) found the average age of the farmers as 46 years and the duration of experience as 25 years in their study in the Central district of Tokat province. Agricultural income increases depending on the size of the farm land. The average size of the farm land was 19.03 hectares, the number of plots was 10.7 hectares and the average land size was 21.17 hectares. Kaya and Bostan Budak (2023) it was reported that environmental awareness is also higher in young farmers.

Table 1. General information about farms and farm owners

		Small	Middle	Large	General
Age	Year	52.90	54.17	51.19	52.71
Education					
Primary school	%	20.0	17.4	40.7	25.6
Secondary school		17.5	30.4	18.5	21.1
High school		27.5	43.5	25.9	31.1
University		35.0	8.7	14.8	22.2
Average annual agricultural income	000 ₺	85.400	262.217	795.593	348.089
Non-farm income status					
Yes	%	80.0	73.9	44.4	67.8
No		20.0	26.1	55.6	32.2
Agricultural production experience	Year	25.75	32.17	31.56	29.13
Social security					
Yes	%	95.0	100.0	96.3	96.7
No		5.0	-	3.7	3.3
Operating land (avg.)	Ha	5.8	14.5	42.5	19.0
Number of plots (avg.)		5.2	9.8	19.6	10.7
Plot area (avg.)	Ha	1.93	1.77	2.87	2.17

The general production pattern of the research region consists of wheat, barley, chickpeas and beets. There are differences in the types of diseases, pests and weeds according to crops. In terms of diseases, rust, septoria, root rot and mosaic virus were common in wheat, while leaf spot and yellow dwarf were common in barley, root rot and anthracnose in chickpeas, powdery mildew, fungus, Cercospora diseases in sugar beet. As plant pests, sunnpest was commonly observed in wheat, while sunn pest and stink bug were common in barley. On the other hand, chickpea leaf miner was common in chickpeas and wireworm, budworm and armyworm in sugar beets. As for weeds, wheat mustard and Canada thistle were common in wheat and barley fields, while wheat mustard, Chenopodium album and thorn were common in chickpeas, and thorn and Convolvulus arvensis in sugar beet fields.

Pest, disease and weed control increased in farms as the farm size increased (Table 2). It was observed that the farmers in the region used control more for weeds than for diseases and pests. For the controls, the use of chemical pesticides (80%) was widely preferred.

Table 2. Agricultural control status of farms and their use of chemical pesticides (%)

	Small	Middle	Large	General
Plant disease control*	45.0	56.5	74.1	56.7
Pest control*	22.5	39.1	66.7	40.0
Weed control*	62.5	73.9	77.8	70.0
Use of Chemicals				
Yes	72.5	82.6	88.9	80.0
No	27.5	17.4	11.1	20.0

*More than one marking has been made. In the percentage calculation, the share of the farmers who perform agricultural controls in the group total is given.

In general, 20% of farmers did not apply chemical pesticides. The reasons why the farmers did not apply chemical spraying are given in Table 3. In general, those who did not prefer chemical control against diseases, pests and weeds stated that they did not use chemical pesticides because they did not need it, that the practice increased production costs and that they did not find the practice beneficial. On the other hand, there were those who did not use chemical control but used smart seeds. Though at a low rate, small-scale farms used smart seeds for diseases (9.1%), pests (6.4%) and weeds (6.7%). In large-scale farms, smart seeds were mostly preferred among farm owners who did not engage in chemical control against weeds.

Table 3. Reasons why farmers do not apply chemical pesticides (%)

		Small	Middle	Large	General
Their cost is too high	D	31.8	20.0	14.3	25.6
	P	38.7	35.7	22.2	35.2
	W	21.4	50.0	33.3	30.8
I don't find them useful	D	27.3	20.0	14.3	23.1
	P	25.8	42.9	44.4	33.3
	W	26.7	33.3	16.7	25.9
I use different control methods	D	-	-	-	-
	P	3.2	-	-	1.9
	W	6.7	-	20.0	7.7
Because they are harmful to the environment and human health	D	-	-	-	-
	P	6.5	-	-	3.7
	W	6.7	-	-	3.7
I don't need them	D	40.9	70.0	71.4	53.8
	P	38.7	42.9	55.6	42.6
	W	33.3	33.3	50.0	37.0
I'm using smart seeds	D	9.1	-	-	5.1
	P	6.4	-	-	3.8
	W	6.7	-	16.7	7.4

D: Disease, P: Pest, W: Weed

When the farmers were asked about the level of knowledge about the use of pesticides, 56.7% stated that they had sufficient knowledge, 36.7% stated they had some knowledge, and 6.6% stated they did not have any knowledge (Table 4). While 7.8% of the farmers stated that they had taken a course on pesticide use before, 40.4% stated that they wanted to attend a course or seminar on the subject. In their study, Yüzbaşıoğlu and Topkaya (2022) and Arslan and Olhan (2022) concluded that 21 and 49% of the farmers had previously taken courses on pesticide use, respectively. In general, education on the use of pesticides appeared to be at a low level. Farmers mostly used pesticides based on their own experience (73.0%) and did this based on the instructions on the label (44.6%), dealer advice (40.5%), information from the provincial directorate of agriculture (13.5%) or other people around them (13.5%). Similar results were found in other studies. In a study carried out in Antalya, it was observed that 68% of the farmers used pesticides for diseases and pests based on their own experience while 20.2% consulted dealers (Özkan et al., 2002). In the study conducted in the central district of Tokat province, it was determined that 46.32% of farmers relied on their own experience while 51.58% received dealer advice in determining the timing of pesticide use (Yüzbaşıoğlu and Topkaya, 2022). In a study in Çelikhan district of Adıyaman province, it was stated that 59.6% of the farmers received advice from the pesticide dealers while 21% used them based on the label information, and 17% based on their experience (Aydoğan and Baran, 2023). Kaya and Salık (2023) reported that farmers mostly obtained information from relatives, leading farmers and courses. It was also stated that farmers should be informed about environment and health. According to the findings obtained, 89.2% of the farmers obtained pesticides from dealers. Besides, it was determined that pesticides were purchased from the chamber of agriculture, cooperatives and unions. Kaya and Bostan Budak (2023) it was said that farm size groups have an effect on the knowledge level and knowledge sources used by the farmers.

Table 4. Level of knowledge about pesticide use (%)

	Small	**Middle**	**Large**	**General**
I have enough knowledge	45.0	73.9	59.3	56.7
I have some knowledge	47.5	21.7	33.3	36.7
I don't know	7.5	4.3	7.4	6.6

Table 5 shows the considerations that farmers pay attention to when purchasing pesticides. The most prominent factor in pesticide purchasing was price (63.5%). On farm scale, this rate was 60.7, 81.0 and 52.0% in small, middle and large farms, respectively. Persistence period, effectiveness, active ingredient, and need for re-spraying gained importance as the farm size increased. Compared to other factors, it was noteworthy that the rate of those who attached importance to the level of impact on the environment and human health was quite low. In their study, Gözener et al. (2017) stated that the price of the pesticide, its efficacy and its brand were the factors considered most in purchasing. In their study, Aydın Eryılmaz et al. (2021) concluded that in the purchase of pesticides farmers paid attention most to the price, place of sale and expiration date while active ingredient, side effects in the plant and its environmental impact were less important.

Table 5. Pesticide purchase considerations (%)

	Small	Middle	Large	General
Price of the chemical	60.7	81.0	52.0	63.5
Persistence period of residues	10.7	28.6	44.0	27.0
Length of its activity	39.3	61.9	68.0	55.4
Active ingredients	17.9	33.3	56.0	35.1
Need for re-spraying	46.4	47.6	48.0	47.3
Impact on environment and human health	14.3	9.5	12.0	12.2
Other	3.6	-	-	1.4

More than one marking has been made. In the percentage calculation, the share in the size groups of the farms is given.

Failure to take the necessary precautions during pesticide application adversely affects the environment and human health. The farmers surveyed mentioned that they took precautions such as using protective clothing (75.4%), preferring a place away from children and animals (82.4%), using tools during preparation (86.5%), keeping windows closed during spraying with tractors (73.0%), choosing suitable weather conditions to reduce pesticide carryovers (66.2%), not consuming any food or drink during preparation and application of pesticides (31.5%) (Table 6). On the other hand, it was revealed that 1.4% of the farmers did not take any precautions. While the measures taken according to the farm scale differ proportionally, it was concluded that precautions were taken during preparation and application of the pesticide in general, but the measures taken were not at the desired level. In their study, Yüzbaşıoğlu and Topkaya (2022) reported that 71% of the farmers took protective measures during pesticide application, 44% used protective clothing, and 83% did not eat or drink during the process. Aydoğan and Baran (2023) stated that a very low proportion (16%) of the farmers used protective clothing, but they were careful about not to eat or drink (92%) during pesticide application. In their study, Durmaz et al. (2022) concluded that 18% of the farmers did not take any protective measures, but they had separate masks, gloves and specific clothes for pesticide application. Acıbuca et al., (2022) reported that chemical inputs used in agriculture should be reduced and used carefully.

Table 6. Precautions taken during pesticide preparation and application (%)

	Small	Middle	Large	General
Use of protective clothing	67.9	85.7	76.0	75.4
Doing the preparation away from others	78.6	81.0	88.0	82.4
Using tools during preparation	89.3	85.7	84.0	86.5
Keeping windows closed during spraying with tractors	57.1	90.5	75.0	73.0
Applying in suitable weather conditions to prevent carry-overs outside the intended area	50.0	76.2	76.0	66.2
Not consuming food, etc. during the application	25.9	33.3	36.0	31.5
Failure to take any precautions	3.6	-	-	1.4

More than one marking has been made. In the percentage calculation, the share in the size groups of the farm is given.

The extent to which the farmers paid attention to various issues during the preparation and application of pesticides gives information about whether the practice was appropriate. This information is given in Table 7. The farmers mostly read the instructions for use before the application (78.4%), paid attention to the expiration of the pesticides (86.5%), kept them in their own packaging (83.7%) and looked at the instructions about mixing of the pesticides (70.3%). There were farmers who stated that they did not start agricultural control (54.1%) when the disease was noticed in the region. Taking precautions in their own land as soon as the diseases were noticed could reduce the costs of controlling these diseases. Aydoğan and Baran (2023) reported in their study that 48% of the farmers stated that they started using pesticides when the disease was noticed. Use of pesticide rates higher than what was suggested in the instructions causes persistence period of pesticide residue in the crop. Although most of them paid attention to this fact, there were farmers who thought that high rates would protect the crop better (21.6%). Pesticides should be prepared fresh each time in the amounts to be applied and application preparations should not be made before and stored for the sake of ease of practice. It was determined that 62.2% of the farmers prepared more than sufficient amount of pesticides and the remaining preparation was stored ready for later use. In Turkey, empty pesticide packaging are collected and destroyed at common collection points in order to protect the environment. However, it was determined that 10.8% of the farmers left empty boxes in the field after use, and 74.3% of them destroyed them by burning. Similar results were found in studies on the use of pesticides among farmers. In a study conducted in Tokat province, it was stated that 46% of the farmers threw them away and 62% destroyed the pesticide packages by burning (Yüzbaşıoğlu and Topkaya, 2022). Çelik and Karakaya (2017) stated that 50% of the farmers destroyed packages by collecting

them in one place and then burning them while Akar and Tiryaki (2018) found that 55% of the farmers burned them. Similarly, Erdil and Tiryaki (2020) stated that 19% of them disposed of packages by throwing away, 6% by throwing them into the environment and 68.5% by burning. Aydoğan and Baran (2023), on the other hand, concluded that 90% of farmers they surveyed did not dispose of packages properly.

Table 7. Issues that farmers pay attention to in the use of pesticides (%)

		Small	Middle	Large	General
Before the application, I read the instructions for use of the pesticides	1	7.2	19.1	24.0	16.2
	2	3.6	-	12.0	5.4
	3	89.2	80.9	64.0	78.4
I look at the expiration date of the pesticide before the application	1	3.6	9.5	12.0	8.1
	2	7.1	4.8	4.0	5.4
	3	89.3	85.7	84.0	86.5
I apply pesticides by distinguishing them according to diseases	1	3.6	9.5	12.0	8.1
	2	14.3	9.5	12.0	12.2
	3	82.1	81.0	76.0	79.7
Even if it is not in my own land, if the disease is seen in the area, I apply the appropriate pesticide	1	53.5	52.3	56.0	54.1
	2	7.1	28.6	12.0	14.9
	3	39.4	19.1	32.0	31.0
During the application, I pay attention to the homogeneous distribution of the pesticide	1	3.6	13.3	8.0	8.1
	2	10.7	14.3	16.0	13.5
	3	85.7	72.4	76.0	78.4
I think that the use of high dosages makes the pesticide more effective	1	53.5	71.4	72.0	64.9
	2	14.3	14.3	12.0	13.5
	3	32.2	14.3	16.0	21.6
I mix pesticides to reduce the workload	1	42.9	57.1	40.0	45.9
	2	14.3	23.8	16.0	17.6
	3	42.8	42.9	44.0	36.5
I store pesticides in appropriate conditions and in their own packaging	1	10.7	14.3	12.0	12.2
	2	7.1	4.8	-	4.1
	3	82.2	85.7	88.0	83.7
I often use herbicides to protect plant	1	50.0	52.4	56.0	52.7
	2	17.9	23.8	8.0	16.2
	3	32.1	47.6	36.0	31.1
If there is any leftover from the pesticide I have prepared, I store it for reuse	1	39.3	19.1	36.0	32.4
	2	3.6	4.8	8.0	5.4
	3	57.1	80.9	56.0	62.2
I destroy pesticide packaging by burning	1	3.6	9.5	16.0	9.5
	2	10.7	9.5	28.0	16.2
	3	85.7	90.5	56.0	74.3
I leave the pesticide packaging in the area where I apply	1	89.2	90.5	64.0	81.1
	2	-	9.5	16.0	8.1
	3	10.8	9.5	20.0	10.8
I use some pesticides as mixed in accordance with the instructions	1	3.6	9.5	20.0	10.8
	2	14.3	28.6	16.0	18.9
	3	82.1	90.5	64.0	70.3

The data were collected on a 5-point Likert scale and presented in the study by combining them (strongly disagree and disagree-1, no opinion-2, agree and strongly agree-3).

Farmers' opinions on pesticides and their use are given in Table 8. It is known that the use of pesticides has a negative impact on the environment and human health. In another study conducted in Aydın province (Durmaz et al., 2022), it was concluded that less than half of the farmers had this awareness, unlike what was reported by Akar and Tiryaki (2018). 61.2% of the farmers thought that biological control methods should be disseminated in order to reduce the use of pesticides. Despite the opinion that the precautions taken for the disposal of pesticide packaging were insufficient prevailed, the farmers mostly destroyed packaging by burning. It was determined that the farmers did not pay attention to the persistence period of pesticides, and there was a common opinion that the inspections regarding the use of pesticides and their residues were not sufficient. Farmers thought that with the correct use of pesticides, an increase in yield would be achieved and even if it increased production costs, it would also increase the profitability as a result. Similarly, Durmaz et al. (2022) reported that most of the farmers (84.2%) used pesticides to increase crop productivity. Regarding the use of expired pesticides, 91.2% of the farmers were of the opinion that they should not be used. In a study by Aydoğan and Baran (2023), this rate was found to be 92%.

Table 8. Farmers' opinion on the chemicals and chemical use (%)

		Small	Middle	Large	General
Pesticide use adversely affects the environment	1	10.0	21.7	18.5	15.5
	2	10.0	17.4	11.1	12.2
	3	80.0	60.9	70.4	72.3
Pesticide residues adversely affect human health	1	7.5	4.3	11.1	7.8
	2	2.5	21.7	7.4	8.9
	3	90.0	74.0	81.5	83.3
The measures taken for the disposal of pesticide packaging are insufficient	1	10.0	8.6	11.1	10.0
	2	12.5	4.3	-	6.7
	3	77.5	87.1	88.9	83.3
Prescription procedure should be started about the use of pesticides	1	17.5	21.7	22.2	20.0
	2	17.5	13.0	18.5	16.7
	3	65.0	65.3	59.3	63.3
Training, seminars, etc. on pesticide use are insufficient	1	10.0	13.0	18.5	13.4
	2	10.0	13.0	18.5	13.3
	3	80.0	74.0	63.0	73.3
Widespread attention is not paid to persistence period of pesticides	1	2.5	4.3	7.4	4.4
	2	15.0	13.0	18.5	15.6
	3	82.5	82.7	74.1	80.0
As a result of the correct application, a yield increase is achieved	1	7.5	4.3	11.1	7.8
	2	-	8.7	3.7	3.3
	3	92.5	87.0	85.2	88.9
Inspections of pesticide use and residues are insufficient	1	7.5	13.0	11.8	10.0
	2	7.5	4.3	18.5	10.0
	3	85.0	82.7	69.7	80.0
Expired chemicals should not be used	1	2.5	4.3	11.1	5.5
	2	2.5	4.3	3.7	3.3
	3	95.0	91.4	85.2	91.2
Subsidies for pesticides would reduce the illegal use of pesticides	1	7.5	17.3	25.9	15.5
	2	22.5	26.1	18.5	22.2
	3	70.0	56.6	55.6	62.3
It is important to develop and disseminate biological control methods to reduce the use of pesticides	1	12.5	26.1	14.8	16.6
	2	17.5	21.7	29.6	22.2
	3	70.0	52.2	55.6	61.2
Even if the use of pesticides increases costs, their use also increases profitability	1	5.0	8.6	14.8	8.9
	2	7.5	21.7	3.7	10.0
	3	87.5	69.7	81.5	81.1

The data were collected on a 5-point Likert scale and presented in the study by combining them (strongly disagree and disagree-1, no opinion-2, agree and strongly agree-3).

4. Conclusion

Chemical pesticides are widely used in agricultural farms in the central district of Yozgat province. While pesticides are used to control diseases and pests, it was determined that they are mostly used against weeds. It was revealed that the farmers primarily considered the price of the pesticide, how long it would provide protection and whether it requires re-spraying. The persistence period of pesticide residue and the level of impact on human and environmental health were among the least important issues. These findings showed that economic factors, rather than environmental awareness, were effective in the purchase of pesticides.

The precautions taken during pesticide preparation and application are important for the health of the practitioners, other people, animals and the environment. Making applications according to their own knowledge may cause negative outcomes. Thus, considering the fact that most farmers used pesticides based on their own knowledge and only 7.8% of them received training on pesticide use, it would not be wrong to state that pesticide applications were not performed in appropriate ways. In this context, it is necessary to promote the farmers to participate in the courses on the subject.

It was found that used pesticide packages are usually destroyed by burning. In order to prevent this situation, it is recommended to impose more serious sanctions and switch to the practice of prescription-based sale of pesticides. With prescription-based sales, it is thought that sufficient amount of pesticide could be provided upon the observance of diseases or pests on the production site. In addition, it could be stated that the establishment of a deposit payment system, which can be effective in bringing the finished packaging to the collection points, would make a positive contribution to the environment.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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