



## Producers' Behaviours and Their Information Source in Pesticide Use

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**Abstract:** Producer's behaviour is critical factor for human health and safe environment. This study aims to investigate the effects of tomato producers' behaviours in pesticide use and the source of information they use as the basis for this use. Simple random sampling method was used to estimate the sample size and 121 producers were interviewed in Aksu Township (Antalya-Turkey) to collect data for analyses. Analyses show producers' pesticide use to be correlated to their socio-economic background such as level of education and general knowledge. Age and education level affect the number of pesticide applications. We found that not using protective equipment, pesticide containers being left randomly in the environment, and some containers being used for other purposes. As well, producers expressed thoughts that these behaviors did not result in any contamination and did not affect human health. This study determines the behaviours of the producers that negatively affect human and environmental health. So, it will provide data for the policy- decision makers and extension programs (training activities) to change farmers' harmful behaviours.

**Keywords:** Pesticide, behaviour, producers, information sources, tomato

### Pestisit Kullanımında Üreticilerin Davranışları ve Bilgi Sitemleri

**Öz:** Üreticinin davranışı, insan sağlığı ve çevre güvenliği için kritik bir faktördür. Bu çalışma, domates üreticilerinin pestisit kullanımındaki davranışlarını ve temel olarak kullandıkları bilgi kaynağını incelemeyi amaçlamaktadır. Örnek büyüklüğünün hesaplanmasında basit tesadüfi örnekleme yöntemi kullanılmış ve Aksu İlçesinde (Antalya-Türkiye) 121 üretici ile görüşülmüştür. Analizler, üreticilerin pestisit kullanımının, eğitim düzeyi ve genel bilgi düzeyleri ve sosyo-ekonomik geçmişleriyle ilişkili olduğunu göstermektedir. Yaş ve eğitim düzeyi pestisit uygulama sayısını etkilemektedir. Koruyucu ekipman kullanılmadığı, pestisit kaplarının çevreye rastgele bırakıldığı ve bazı kapların başka amaçlarla kullanıldığı tespit edilmiştir. Ayrıca üreticiler, bu davranışların herhangi bir kirliliğe yol açmadığını ve insan sağlığını etkilemediğini ifade etmişlerdir. Bu çalışma, üreticilerin davranışlarının, insan ve çevre sağlığını olumsuz etkilediğini belirlemektedir. Bu nedenle, çalışmanın bulguları çiftçilerin zararlı davranışlarını değiştirmek için politika belirleyiciler ve yayım programları (eğitim faaliyetleri) için yararlı olabilecek veriler sağlamaktadır.

**Anahtar Kelimeler:** Pestisit, davranış, üreticiler, bilgi kaynakları, domates

#### 1. Introduction

Tomatoes are grown widely as a greenhouse agricultural product in Turkey, and are very important products both for export and domestic consumption. Tomatoes constituted about 57% of the vegetable exports made by Turkey in 2014 (964 thousand tonnes and 591 million dollars) (FAO, 2015). The 2018 world tomato production is 182256458 tonnes. About 33.75% of the world's tomato production comes from China, 10.63% from India, 6.92% from United

States, Turkey, 6.67% from, 3.63% from Egypt, and the remaining 38.4% is made up by other countries (FAOSTAT, 2020). The 2018 Turkish tomato production is about 12 150 000 tonnes and tomato export revenue is 289 827 000 dollars (TUİK, 2019; TRADE MAP, 2019).

One of the most important concerns in tomato production is about the fight against diseases and harmful pesticides. Agricultural yields have a direct relationship with the crop protection processes that often rely on the use of pesticides.

Pesticides have many undesirable effects such as adversely affecting human health, changing environments by altering natural balance, contaminating products, soil, water and air with residues, causing disease, and developing resistance in harmful weeds. The misuse/overuse and residues of pesticides has been shown to have many unwanted consequences to humans and environment as well as causing large economic losses (Pimentel et al., 1992; Delcoura et al. 2015; Hou et al., 2013; Bulut and Tamer, 1996). Nevertheless, pesticide use is on the rise in both developed and developing countries (De et al., 2013; Zhang et al., 2015; Skevasa et al., 2014).

Serious acute health problems and local and global environmental contamination has been created as a result of the extensive use of older, more toxic, often non-patented, environmentally persistent, and inexpensive chemicals in developing countries (Ecobichon, 2001). Every plant disease requires a different and specific set of information for cure. A wrong source of information used by a producer leads to the use of the wrong pesticide, and this results in a decline in yields and income.

Antalya province is an extensive tomato producing and exporting province where problems like environmental pollution, change of natural balance, and contamination of products, soil, water and air with residues, causing disease, and developing resistance in harmful weeds are faced as a result of uninformed use of agricultural pesticides. This creates a background for damaging human and environmental health, as well as damaging the economy as a result of significant decreases in export income (Ozkan et al. 2002; Demircan and Aktas, 2004).

The study seeks answers to the following questions: What are the producer's behaviours when using pesticides? And what sources of information do the producers use to fight disease?

This study aims to investigate producers' pesticide usage behaviours and sources of information they use as the basis for these behaviours. The study is based on a hypothesis that producers can solve their pesticide-related problems only if they are able to reach the right

information sources and the right tools to obtain the information.

## 2. Materials and Methods

There are about 7000 tomato producers in Antalya, planting in an area of 201.255 decares and producing 2.332.073 tonnes of tomatoes. In Aksu Township, where this specific research was done, there are 1436 producers planting in area 31.191 decares, and 400.718 tonnes of tomatoes are produced annually (Antalya Directorate of Provincial Food Agriculture and Livestock, 2015). Simple random sampling method was used to estimate the sample size for the research and 121 producers were interviewed in (June 2016) Aksu Township to collect data for analyses.

$$n = \frac{N \times S^2 \times t^2}{(N-1)d^2 + (S^2 \times t^2)}$$

n: sample size

S: standard deviation

N: population size

t: confidence level at 90% (standard value of 1.65)

d: margin of error at 5%

(Sumbuloglu and Sumbuloglu, 2005)

The data were analyzed using SPSS program, frequency tables were produced, and Multiple Correspondence Analysis (MCA) was undertaken on the collected data. Only a few selected MCA analyzes have been presented here since it is not possible to give all of them here.

## 3. Results and Discussions

### Pesticide use behaviours of producers and sources of information

It is established through surveys that producers in the region have the following average socio-economic characteristics: 51 years of age, married, low education (primary school graduates), and low monthly income (791.65USD – Exchange rate 2015, 1 USD = 2.91 TL (Central Bank of Turkey)), 15 years of farming experience, and have a household population of 4.

Pesticides are being used in agricultural production processes to improve the yield and

quality of various products. Although there are various cultural, biological, and physical methods available to fight plant diseases, chemical methods commonly dominate in practice. However, chemical methods require a very careful application to preserve the environment and human health. Table 1 shows the data on how producers use these pesticides.

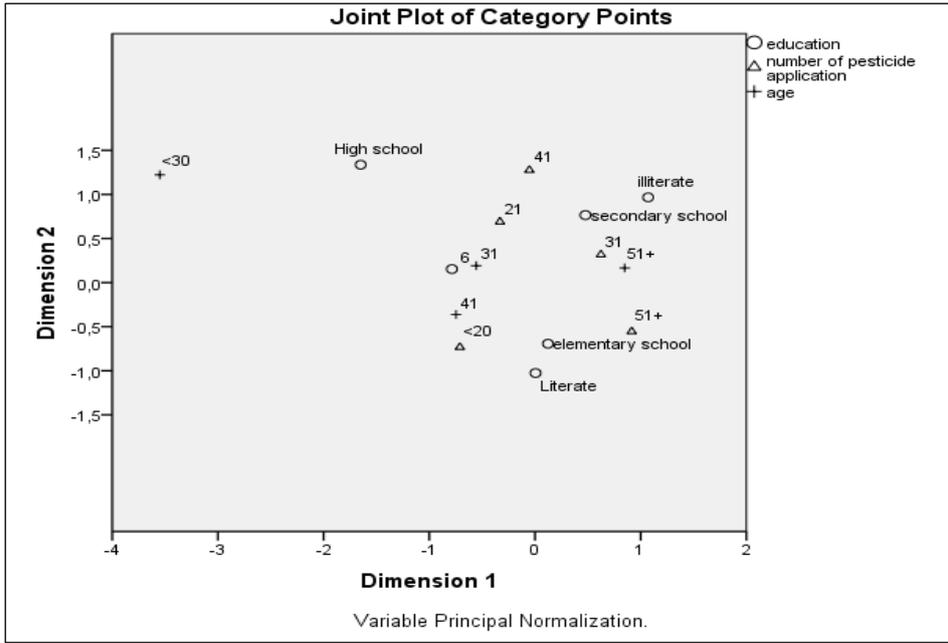
**Table 1.** Pesticide use behaviour among tomato growers

*Çizelge 1. Domates yetiştiricilerinin pestisit kullanım davranışı*

Pesticide use behaviour	Numbers	Percentage (%)
Pesticide use		
Use	110	90.9
Don't use	11	9.1
Total	121	100.0
Average number of pesticide use(per year)		
<20	42	34.7
21-30	9	7.4
31-40	14	11.7
41-50	28	23.1
51+	28	23.1
Total	121	100.0
Situations of pesticide usage		
When they see the disease	90	74.4
For protection purposes	31	25.6
Total	121	100.0
Source of their information/training about how to use pesticide		
Family elders	7	5.8
Neighbours	2	1.7
Agricultural engineers working in the provincial / district organization	18	14.9
Research institutions	3	2.5
Pesticide dealer	76	62.8
Advisor	12	9.9
Internet	3	2.5
Total	121	100.0
Factors of considered when buying pesticides		
Expiration date	15	12.4
Types of pesticide it is effective on	58	47.9
The price	34	28.1
Brand name	3	2.5
Toxicity level	3	2.5
Side effects	8	6.6
Total	121	100.0

All producers in the research area grow tomatoes from tomato seedlings, and almost all of them (90.9%) use pesticides in their growing processes. They use pesticides an average of 36 times per year. A large majority of these producers (74.4%) apply pesticides when they notice a sign of disease (Table 1). According MCA (Multiple Correspondence Analysis), producer group aged 51 and older and having primary or middle school educational level are spraying 31-40 times in a year; whereas, those at ages 31-40 with higher education level apply

pesticides 21-30 times in a year. Thus, age and education level affect the number of pesticide applications. As the age decreases and the level of education increases, the number of sprays decreases (Figure 1). Besides the educational level, it is also determined that the pesticide application frequency is related to income level, with younger and low-income producers applying pesticides less frequently than their older and high-income counterparts.



**Figure 1.** Education level, number of pesticide application and age  
<sup>△</sup> 1: illiterate, 2: literate, 3: elementary school, 4: secondary school, 5: high school, 6: university  
<sup>○</sup> 1 :< 10, 2:11-20, 3:21-30, 4:31-40, 5:41+  
<sup>+</sup> 1 :< 20, 2:21-30, 3:41-50, 4:41-50, 5:51+

**Şekil 1.** Eğitim seviyesi, pestisit uygulama sayısı ve yaş

These results are similar to the research done by Karlsson (2004) and Ríos-González et al. (2013). They are also concluded that education plays a significant role in changing farmers' lifestyles. According to these researchers, literate farmers have a better understanding of the effects of pesticides on human health and the environment compared to less literate farmers. Lechenet et al. (2017), have shown that reduction in the use of pesticides in farms rarely reduces the yield and profitability. They predict that a 42% reduction in pesticide use will not result in any negative effects on profitability for 59% of farmers in their national network. According to another research in China (Chen et al. 2013), use of pesticides can be reduced by about 15% with increased farmer awareness. A study based on primary household surveys in the North China Plain shows that farmers' lack of knowledge of pest management and pesticide use is noticeably related with overuse of pesticides. The authors concluded that improving farmers' awareness and knowledge could potentially reduce pesticide use by 10–15%.

Protection is the basic principle of the chemical control against plant diseases. At the same time, by taking into account current ecological conditions, it is necessary to anticipate which disease may be imminently seen and take preventive measures before the disease affects the plants (Yigit and Boyraz, 2003). Even in cases of a newly-discovered disease, 62.8% of producers ask pesticide dealers to provide information about which pesticide to use and how to use it. Another study (Avcı, 2007) also determined that pesticide and seed dealers are among the top main sources of information for producer in choosing a pesticide for their use. Since profit is the main reason of establishment and survival for commercial establishments like pesticide dealers, leaving them as sole information sources for producers is not an appropriate choice. Indeed, a research in China (Zhang et al. 2015) established that commercial extension organizations contribute to the increase in pesticide usage.

Pesticide dealers are also among the top sources of information used by producers in the preparation of pesticide mixtures. Thus, the

influence of pesticide dealers on the producers' selection of pesticides can easily be understood. In this case, it becomes essential that the technical capacity as well as the quality of service at these establishments, which can be so influential on directing farmers' choices, be maintained at a high level and necessary precautions for this to be taken (Avcı, 2007). When purchasing a pesticide, producers pay attention to what pathogens it is most effective against (47.9); but, to be effective, the dosage and timing of application is extremely important. Another research done on tomatoes in the region (Yiğit ve Boyraz, 2003) determined that greenhouse producers do not pay attention to these factors, and use pesticides randomly based on neighbor's advice or their previous experiences of using the same group of pesticides; thus, resistance problems have arisen for some pathogens. Success has not been attained in the chemical warfare against plant diseases either. This has resulted in more frequent pesticide applications using more than necessary amounts of pesticides. Also, the producer does not consider paying attention to the frequency and proper choice of pesticide until a definite sign of disease is seen. Because the choice of pesticides are done without considering ecological conditions, it becomes extremely difficult to control the disease once it has already begun. At this stage, the producers may panic and reduce the application interval to 5 days. Due to concerns about large economic losses, producers unwillingly resort to trying various random pesticides in hopes of controlling these losses. As a result, producers are faced with more costs and losses (Yiğit ve Boyraz, 2003). Kariathi et al. (2016) found that eighteen percent of farmers overdosed pesticide in tomato treatment. This is partly due to the presence of resistant pests and diseases. The use of pesticide in higher dosage than recommended might be the cause for pest resistantancy and high accumulation of residues in tomatoes which increased risk of exposure.

The percentage of producers using the dose amounts written on the package (54.5%) and those using greater than the written amounts (25.6%) is noticeably high (80.1%). These

amounts show the overuse in the per-use amounts in addition to frequency of use. At the same time, producers have an opinion that the pesticide residue from their use is not harmful (28.9%) and there will not be any residue if they use the suggested amounts (36.4%). The percentage of producers who believe the pesticides are not harmful for human (21.5%), and those who do not know if they are harmful at all (20.7%) is also high (42.2%). In a study done in Pakistan (Khana et al. 2015) it was found that, despite the high frequency (overuse) and amount of use per dose (overdose), the risk perception of producers was too low.

According our MCA analyses, the number of producers knowledgeable about an integrated and biological fight against pesticides increases as the level of education increases. Producers without writing and reading abilities have no idea about such methods at all. On the contrary, those with a university level of education know the biological fighting method against pesticides; they learned these methods from an agricultural engineer in their township or in the city. These findings show that producers need awareness and training in spraying and pathogen-fighting methods. These training and extension education activities should be given by reliable sources such as non-commercial, public or producer organizations. Any increase in the average frequency or amount per use of pesticide applications raises the hazard potential on environment and human health even further (Ecobichon, 2001; Koutros et al., 2013; Lebov et al. 2015; Starling et al. 2014). Producers get their information about dosing from pesticide dealers (66.1 %) (Table 2). These dealers appear to be an important source of information for producers. However, pesticide dealers are commercial establishments motivated by higher profits; thus, their information should be double-checked. As seen in Table 2, the majority of producers use only masks (40.5%) as protective material, followed by gloves (22.3%). This is a risky situation for practitioners, particularly with high frequency and heavy dose applications. Due to the inadequate use of protective masks and gloves, the producers must be informed of the benefits of using protective equipment, and

encouraged to also use other materials (boots, goggles etc.). This information and training should include topics on mode and dose of pesticide applications as well as their effects on human health. These training and extension activities can be done by local extension organizations and consultants.

**Table 2.** Certain behaviours about pesticide application  
*Çizelge 2. Pestisit uygulamasıyla ilgili belirli davranışlar*

Behaviours about pesticide application	Numbers	Percentage (%)
<b>Number of doses of pesticide used</b>		
As instructed on the package or prescription	66	54.5
A bit more than instructed	31	25.6
As instructed by consultant	13	10.7
As instructed by pesticide dealer	11	9.1
Total	121	100.0
<b>Source of information about what dose should be used</b>		
Family elders	5	4.1
Neighbours	4	3.3
Agricultural engineers in province/town	4	3.3
Research establishments	5	4.1
Pesticide dealers	80	66.1
Consultants	21	17.4
İnternet	2	1.7
Total	121	100.0
<b>Time of day for pesticide application</b>		
Early morning	56	46.3
Late in the evening	65	53.7
Total	121	100.0
<b>Stage of application</b>		
Before a pesticide observed	97	80.2
After a pesticide has been observed	24	19.8
Total	121	100.0
<b>Use of protective equipment</b>		
Can use	86	71.1
Cannot use	35	28.9
Total	121	100.0
<b>Used protective equipment</b>		
Mask	49	40.5
Gloves	27	22.3
Boots	3	2.5
Goggles	7	5.8
Total	86	71.1
<b>Potential for residue</b>		
All pesticides leave a residue	11	9.1
No harmful effect at all	35	28.9
Residue occurs only with excessive usage	25	20.7
Washing takes away residue	6	5.0
No residue if recommended dose is used	44	36.4
Total	121	100.0
<b>Potential harm to people from residues</b>		
Harmful	70	57.9
Not harmful	26	21.5
No idea	25	20.7
Total	121	100.0

**Table 3.** Some behaviours related to pesticide use and environment

*Çizelge 3. Pestisit kullanımı ve çevre ile ilgili bazı davranışlar*

Qualifications	Numbers	Percentage (%)
<b>What is done with expired or unused pesticides</b>	24	19.8
Burning	60	49.6
Throwing into garbage	14	11.6
Dumping to a nearby creek	6	5.0
Disposing	10	8.3
Burying	7	5.8
Returning to dealer	121	100.0
<b>Total</b>		
<b>Where and how are the pesticides stored</b>		
Warehouse, cool place	75	62.0
Open shelves, cool place	16	13.2
Pesticide cabin, cool place	18	14.9
Open air	2	1.7
Pesticide room, cool place	10	8.3
<b>Total</b>	121	100.0
<b>Reuse of fertilizer and pesticide containers</b>	40	33.1
Used	81	66.9
Not used	121	100.0
<b>Total</b>		
<b>If fertilizer and pesticide cups are reused, how?</b>		
to carry soil/dirt	8	6.6
to carry water	22	18.3
use as fruit pail	5	4.1
use as flower pots	5	4.1
<b>Total</b>	40	33.1
<b>How are pesticide packages discarded</b>		
Burned	25	20.7
Thrown into garbage	47	38.8
Thrown into a creek	22	18.2
Buried	14	11.6
Returned to dealer	13	10.7
<b>Total</b>	121	100.0
<b>Potential damage to soil from pesticides used</b>		
Harmful	34	28.1
Not harmful	46	38.0
Does not know	41	33.9
<b>Total</b>	121	100.0
<b>Potential damage to water from pesticides used</b>		
Harmful	41	33.9
Not harmful	38	31.4
Does not know	42	34.7
<b>Total</b>	121	100.0
<b>Potential damage to other seeded or planted products</b>		
Harmful		
Not harmful	71	58.7
Does not know	19	15.7
<b>Total</b>	31	25.6
	121	100.0

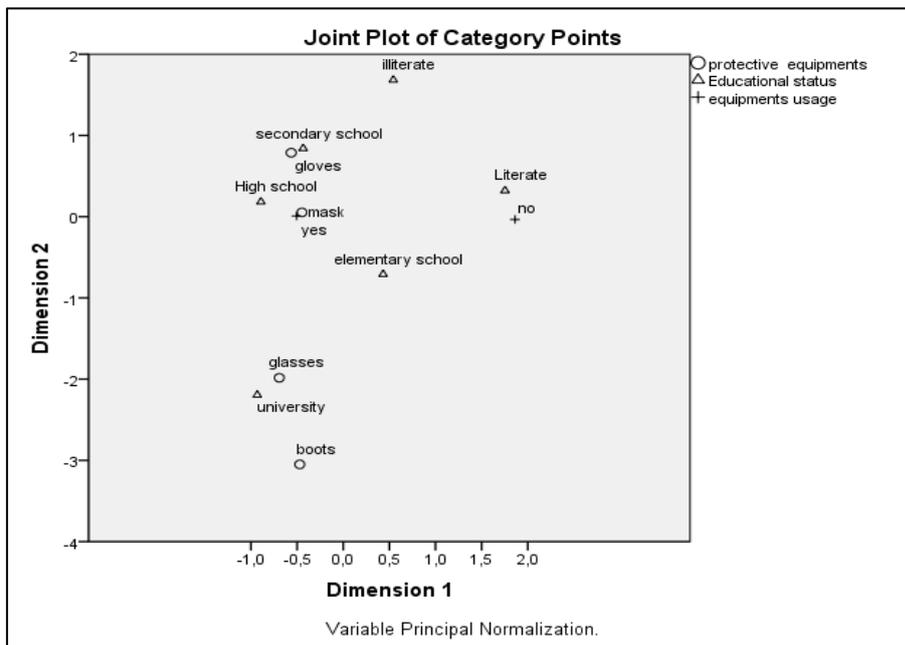
It has been determined that producers discard obsolete or unwanted pesticides in normal garbage containers (49.6%), and some (11.6%) even dump them into nearby creeks (Table 3). Both behaviours constitute an important risk to the environment because it is well known that garbage remains uncollected for days, which results in seepage into the environment. Similar behaviours exist for waste amounts and pesticide packaging. Another concern is about using fertilizer and pesticide package for unrelated purposes (33.1%); among them, using as water containers being the most common (18.2%) (Table 3). It is clear that these behaviours

generate undesired results primarily on human health, and in soil, water, and other organisms. Lack of information as well as incorrect or unsatisfactory information sources appear to be the root cause of these producer behaviours, because there is a significant producer segment (71.9%) who either believe pesticides are not harmful to soil (38%), or have no information on the this case at all (33.9%) (Table 3). MCA analyses show producers aged 31-40 do not use pesticide containers for other purposes, but those over 51 do use them for other purposes, particularly as water-carrying containers. This behaviour is also related to the level of education.

While illiterate producers use the pesticide containers for other uses, those with at least middle school education do not. Young and well-educated producers have more mindful behaviours and do not use pesticide containers for other uses, unlike older-aged and less educated producers and decreasing level. As well, according to the MCA analyses, producers who believe there is no residue also believe that there is no harm to humans (because there is no residue) but believe there is harm to other components (soil, plants, seeded, plant products) and not sure if there is a harm to water. Those producers who believe there is a residue, also believe there is a harm from residues to humans and water; but are not sure if they effect other components (soil, planted, seeded, plant products).

These results indicate that the producers' use of pesticides and their behaviour afterwards stem from the lack of information. Other researchers (Mengistie et al 2017; Engindeniz et al., 2010;

2012; Karaturhan et al. 2005) obtained similar results, showing that producers did not follow recommended doses, did not pay attention to residue on products, and did not use protective equipment during pesticide applications. We noted, during our studies, acute effects on humans as a result of not using protective equipment, pesticide containers being left randomly in the environment, and some containers being used for other purposes. As well, producers expressed thoughts that these behaviors did not result in any contamination and did not affect human health. According to the MCA test, producers not using protective equipment at all have the lowest education level (read and write only). Middle school graduates use gloves, high school graduates use masks in addition to gloves, and university graduates use goggles, boots, and gloves. The number of protective equipment used increases as the level of education increases (Figure 2).



**Figure 2-**Protective equipment, education level

*Şekil 2. Koruyucu ekipman, eğitim seviyesi*

\*Engindeniz and Cosar 2013, Uskun, 2015; Peker,

#### 4. Conclusion

Producers' socio-economic characteristics affect their behaviours about pesticide use. Number of sprays and dose are related to

producer's age, education and income level. As the level of income and education decrease, the number of sprays and overdoses increase. The reverse relationship exists with age; older

producers applying pesticides more often and at a higher dose. The producers decide the number of sprays and dose based on information they obtain from commercial pesticide dealers; who constitute their most important source of information. This creates a conflict of interest, because increasing profit levels is a top priority of commercial pesticide dealers that can override farmer interests. Thus, accessing the right source of information is critical in deciding the right number of applications and the appropriate dose which are safe both for their health and health of overall environment.

Producers also show a behavioral tendency to risk human and environmental health by not using proper safety equipment, leaving empty pesticide containers around haphazardly, and more importantly, reusing pesticide containers to carry water. Such producers, as a result of self-ignorance and using unreliable information sources, jeopardize their own health, public health, as well as environmental health and environmental sustainability and pose overall risk. Further, many producers do not think that excessive spraying can adversely impact human health, soil or water.

Producer behaviours can be changed with reliable information obtained from local extension agents and government agencies. Thus, local extension agents or farmer organizations should provide training about safe use of pesticides and effects of pesticides on human and environmental health. State should facilitate this by appropriate policy/legal changes.

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