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ENVIRONMENTAL LITERACY AND BEHAVIOUR OF AGRICULTURAL PRODUCERS – PILOT STUDY

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Abstract: The environmental literacy of agricultural producers is extremely important for sustainable agriculture and environmental protection. In this paper, we examined the knowledge, education and environmental and agricultural literacy of individual farmers as well as their influence on their work in agricultural practice. The study was performed in an agricultural region in Vojvodina, Serbia. We used a self-designed questionnaire. The questionnaire was completed during an interview and personal visits to farmer's households. All agricultural producers in the examined region had 8 years of formal education and more than half had higher education; more than half also attended additional informal education in the field of agriculture and had very good knowledge of pesticide toxicity and its environmental impact. However, their behavior in managing waste and pesticide-contaminated water is inadequate. After rinsing spray tanks at home, more than half of farmers reported pouring contaminated water from the tank with pesticide residues into the yard or into the sewage system, without being aware of the environmental hazard. In addition, 74% of farmers knew the name of the active ingredient in a pesticide and 76% of them always read the instructions for use. However, more than 37% of respondents believe that using a slightly higher concentration is the only way to control pests. The level of education, as well as the knowledge on environmental threat of pesticides did not significantly affect the behavior of agricultural producers. Although they have a high level of knowledge about the pesticide management, they do not always apply it adequately in everyday practice. Additional environmental education on the implementation of theoretical knowledge in everyday practice is needed.

Key words: environmental literacy, agricultural producers, pesticide handling, implementation.

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Introduction

In recent years, the intensive use of pesticides has significantly increased the impact of pesticide residues on nature and on humans (Narayanan et al., 2022). The amount, improper selection of pesticides applied, and suboptimal pesticide handling are some of the current major issues associated with pesticide use, particularly in underdeveloped and developing countries (Aktar et al., 2009; Bhandari, 2014; Melanda et al., 2022). Several pesticides used in agriculture cause health problems in humans, the most serious being cancer and congenital malformations (Shah, 2021). The main sources of contamination are food, water, or exposure during agricultural work. Agricultural environmental pollution is particularly prevalent in countries, where pesticide management and safety measures do not follow intensive agricultural development (Sarkar et al., 2019). One of the principal reasons for the improper use of pesticides and the handling of pesticide residues is the insufficient knowledge (Endalew et al., 2022) or the inadequate implementation of knowledge into practice (Sai et al., 2019), meaning that agricultural behavior is inadequate from the perspective of environmental literacy. Environmental literacy is the knowledge of environmental concepts and issues; the attitudinal dispositions, motivation, cognitive abilities, and skills, and the confidence and appropriate behaviors to apply this knowledge to make effective decisions in a range of environmental contexts (Hollweg et al., 2011). Relevant studies have confirmed that environmental literacy could promote individuals to adopt responsible environmental behavior (Asteria, 2019; Biswas, 2020). Environmental literacy had a significant positive impact on individuals' environmental behavior (Yu et al., 2022).

From the perspective of agricultural production, agricultural literacy is a term that has been gaining popularity recently. According to Spielmaker et al. (2014), "an agriculturally literate person understands and can communicate the source and value of agriculture as it affects our quality of life". What does it mean to be agriculturally literate? It is an understanding of the relationship between agriculture and the environment, food, fiber, technology, and the economy (Nutrient for life, Canada, 2022). Frick et al. (1991) identified eleven concepts that encompass agricultural literacy: Environment, processing, policy, natural resources, animal production, societal significance, plant production, economic impact, marketing, distribution, and globalization (Frick et al. 1991).

Agricultural literacy is most often related to the citizens (Trexler, 2000; Hess and Trexler, 2011). Individual agricultural producers are assumed to have enough professional knowledge in the field of agricultural production and the environment. However, individual agricultural producers are not always professionally trained in agriculture, and their environmental literacy, i.e., the development of knowledge, attitudes, and skills necessary to make informed decisions concerning the

relationships between natural and urban systems, is most often at the level of the general population. Nevertheless, they cultivate most of the agricultural land and use the largest amount of pesticides.

In our study, we therefore investigated the environmental/agricultural literacy of individual agricultural producers in the agricultural area in Serbia based on the level of knowledge and appropriate behaviors to apply such knowledge to make effective decisions. We tried to analyze how familiar the farm workers are with the environmental toxicity of pesticides, to what extent they implement the general rules for the pesticide waste management in everyday practice, and to what extent their opinions, and probably also their actions agree with the claims for use.

Material and Methods

The study was performed among the agricultural products of the Bački Petrovac municipality, situated in South Bačka district in the Vojvodina region in 2019–2020. The municipality consists of 4 villages, three of which participated in the study – Bački Petrovac, Kulpin and Gložan. In recent years, in Bački Petrovac, similar to other Serbian regions, the number of small (up to 5 hectares) agricultural households has declined, and most family farmers have around 25 hectares. The number of registered agricultural households is 1313 (Republika Srbija, 2020). Traditionally, experts from the pharmaceutical industry and professors from the Faculty of Agriculture from nearby universities, mainly in Novi Sad, organize educational meetings attended by most farmers (additional education) every winter.

Questionnaire development and delivery

We used a self-designed questionnaire. The questionnaire consisted of 24 questions related to four sections. The first section was related to the sociodemographic characteristics of farmers, including sex, educational level, amount, and farming duration. The second section focused on farmers' knowledge on the influence of pesticides on wildlife. The third section included questions regarding pesticide residue management reading and following the label instructions, and ecological practices relating to storing and disposing of pesticides and empty containers. In the fourth section, we asked the farmers about the knowledge of the generic name of the active ingredient in the pesticide, reading the instructions and implementing them in the practice, and finally about the knowing the meaning of pictograms as the signs of danger.

The inclusion criteria for participants were willingness to participate, age between 20 and 70 years (the active age group of farm workers in the given region), and full-time or part-time farm workers. The exclusion criterion was the unwillingness to participate in the study. The questionnaire was completed in the

form of an interview and personal visits to the farmer's households. A total of 80 questionnaires were submitted. The questionnaires not completely fulfilled were not included in the analysis.

Data analysis

All data were coded, entered, and analyzed using SPSS version 20 (SPSS Inc) and Microsoft Office Excel 2010 (Microsoft Corporation, Redmond, WA, USA). Results, expressed as frequencies and percentages, were conducted for all parameters obtained, and the chi-square test ($\chi 2$) was used to measure the possible association between nominal variables (level of education, farming years vs knowledge, attitudes and behavior of agricultural producers in practice) with Yates' correction for small samples. We used $\alpha \leq 0.05$ as a criterion for statistical significance.

Agricultural producers' attitudes, knowledge and behavior about pesticide knowledge influence on the environment, handling the pesticides, disposal practice, and equipment wash area were compared with formal and additional voluntary education about the safety and ecological aspects of handling the pesticides, amount and duration of land farming.

The ethical committee of the University of Health and Social Work of St. Elizabeth in Bratislava, Slovakia, and the Management of Local Associations of Agricultural Producers in the municipality of Bački Petrovac approved the study.

Results and Discussion

Seventy-eight out of 80 farmers fulfilled the questionnaire, indicating a full response rate of 97.5%. Most of the farmers were involved in the cultivation of corn, wheat, and soybeans.

Socio-demographic characteristics of the farmers

The respondents were mostly male (94.6%). There were no illiterate participants. All agricultural producers had at least eight years of formal education, 58.7% of them had 12 years, and 7.7% had 16 years of schooling at various universities. Of all participants, only 16 (13 with secondary school diploma and 3 with high school diploma) or 20.5% completed secondary or high school in agriculture. The majority of producers have been cultivating the land for more than ten years (83. 4%). Most of the agricultural producers cultivate between 5 and 25 hectares of the land (66.7%), 23% cultivate less than 5 hectares, 6 (7.69) cultivate between 25 and 50 hectares, while only two agricultural producers (2.56%) cultivate more than 50 hectares (Table 1).

Table 1. Demographic factors of respondents.

Gender	No.	%
Males	73	94.6
Females	5	6.4
Education		
Primary school	26	33.3
Secondary school	46	58.7
University/College	6	7.7
Field of education		
Agriculture	16	20.5
Other	62	79.5
Length of farming		
1–5 yr(s) of farming	5	6.4
6–10 yrs	8	10.2
> 10 yrs	65	83.4
Farming area (ha)		
Up to 5	18	23.07
Up to 25	52	66.7
Up to 50	6	7.69
> 50	2	2.56

The majority (70.2%) of the farm workers received further training in agriculture organized every winter in the form of educational meetings. The farmers with the lowest amount of farming land (up to 5 hectares) had the lowest ratio of attendance to the educational meetings (55.6%), farmers with up to 25 hectares had a participation rate of 78.8% while 21.1% of farmers did not attend additional educational activities. Furthermore, 83.3% of farmers with up to 50 hectares attended the additional educative meeting while farmers cultivating more than 50 hectares had 100% attendance at educational meetings (Table 2). The difference is statistically significant (X^2 7.99, $p<0.018$).

Table 2. Additional educational activities according to the farming area.

Additional education/ Amount of farming land							
5 ha		>25 ha		>50 ha		<50 ha	
Yes	No	Yes	No	Yes	No	Yes	No
No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
8 (44.4)	10 (55,6)	41 (78.8)	11 (21.1)	5 (83.3)	1 (16,16)	2 (100)	-
Total:		Yes 56 (71.8%)			No 22 (28.2%)		

Statistical significance: amount of farming/attendance (λ^2 4.73, X^2 7.99, $p<0.018$).

Environmental literacy – knowledge and behavior of farm workers

Farm workers' knowledge on environmental toxicity of pesticides

Farmers' interest and knowledge about pesticide environmental toxicity is shown in Table 3. When buying pesticides, 57.7% of farmworkers were interested in their environmental toxicity, 35.9% lacked the interest, while 6.4% answered "other". When asked about the length of time that pesticides can remain in the soil or water, 88.4% of farm workers knew that pesticides can remain in the soil and water for an extended period of time. Moreover, 94% of farm workers thought that pesticides were toxic to domestic and wild animals. The duration of farming significantly influenced this general awareness ($\lambda 2$ 4.73 $p \leq 0.05$). In addition, 91.0% of the farmers thought that pesticides can reach watercourses, while 6.4% believed that they remained on the surface. Furthermore, 97.6% of farmers believed that the pesticides entering the surface water could destroy fish and other wildlife, while only 2.4% were not concerned about it.

Table 3. Farmworkers' knowledge on the environmental toxicity of pesticides.

Question/variables	Yes No. (%)	No No. (%)
	No. (%)	
When buying pesticide do you ask about environmental toxicity?		
Yes, always, or read the instructions for use	45 (57.7)	
Mostly no	28 (35.9)	
Other	5 (6.4)	
Do you know that some pesticides can remain on soil and in water for > 1 yr**?**	69 (88.4)	9 (11.6)
Pesticides are toxic to domestic and wild animals (λ^2 4.73, $p \leq 0.05$) x farming years	79 (94)	5 (6.0)
Pesticides spilled on the ground		
Remain on the surface	5 (6.4)	
Reach a watercourse	71 (91)	
This is a small amount that is not harmful	0 (0.0)	
Other	2 (2.6)	
Pesticides that reach the surface water		
Can destroy fish and other wildlife	76 (97.6)	
Do not affect fish because only safe products are used	0 (0.0)	
Have not considered toxicity to fish and other wildlife	2 (2.4)	

P=0.8; 1.68; 0.79; 0.24; 0.2; NS. The level of education did not influence the answers (p=0.28, NS).

Pesticide residue management

The practice of farm workers in pesticide residue management is shown in Table 4. Most farmworkers did not spill pesticide residues after spraying at all (91%) or rarely (7.7%) in the field or watercourses. If they had leftover in spraying tanks, they usually sprayed it on the plants. All of them flushed tanks after spraying, 41% of farmers in the field, and 59% of farmers at home. Of the farmers who flashed the tank at home, 19.6% of farmers discharged the wastewater into the sewage system (down the drain), while most farmers throw out the wastewater in the yard (76%).

The empty pesticide packaging was thrown away in household waste by 16.7% of farmworkers (almost twice as many of them with primary than secondary education), while 82.1% of farmers put it in special containers.

Table 4. The practice of farm workers in disposal of pesticide residues.

Question	Variables	No. (%)
Do you spill unused pesticide in the surrounding watercourses (ditch, channel)?	Usually	1 (1.3%)
	Sometimes	0 (0.0%)
	Rarely	6 (7.7%)
	Never	71 (91 %)
Do you flush the tank after spraying?	Yes, in the field	32 (41%)
	Yes, at home	46 (59%)
	No	0 (0.0%)
Where do you discard the wastewater after flushing at home?	Down the drain	9 (19.6%)
	In the yard	35 (76%)
	Other	2 (4.4%)
Disposal of empty pesticide packaging	To garbage	13 (16.7%)
	Storage and transportation in special containers	64 (82.1%)
	Other	1 (1.2%)

p=0.1; 0.1; 0.057; 0.1; NS. The level of education did not influence the answers.

Knowledge of the generic name of the active ingredient in the pesticide, reading the instructions for use and implementing them into practice.

Only 74% of farmers know the name of active ingredient of a pesticide. When preparing the solution, 76% of farmers always read the instructions for use, 24% of farmers did not read the instructions for use, regardless of their education level. The reason: small letters (1), not understandable (1), boring (1), because I have already read it (3) (Table 5). Farmers who had been farming for more than ten years were significantly more likely to read the instructions than farmers who had been farming for less than five years (X^2 16.42 $p < 0.05$).

More than 37% of participants agreed with the claim that slightly higher concentrations than recommended were the only way to destroy pests. Formal or additional education did not significantly influence this statement.

Table 5. The knowledge of the generic name of the active ingredient in a pesticide, reading the instructions for use and implementing them into practice.

Topics	Yes	No
Farmers know the name of the active ingredient in the pesticide preparation	58 (74%)	20 (26%)
Farmers read the instructions for use before preparing the solution (λ^2 16.42, p.< 0.05 farming years)	59 (76%)	19 (24%)
Is using slightly higher concentrations than recommended the only way to destroy pests and weeds?	Strongly agree	17 (21.8%)
	Agree	12 (15.4%)
	Do not agree	38 (48.7%)
	Do not agree at all	7 (9.0%)
	Do not have an opinion	4 (5.1%)

P=0.8; 0.28; 0.14; NS. The level of education did not influence the answers.

In this study, we examined the knowledge of farmworkers on environmental toxicity, pesticide waste management practices, and willingness of the farmers to apply existing knowledge about pesticides in order to make effective decisions from the perspective of environment.

Some studies have revealed that environmental literacy has a significant positive impact on the environmental behavior of individuals (Yu et al., 2022). Nevertheless, the level of environmental literacy among individual, smallholder farmers, who cultivate most of the land in most countries, and who often do not have appropriate professional education in agriculture and ecology is not well known. However, they are the ones who use most of the pesticides and dispose of their residues and used packaging. The degree of their environmental literacy and the implementation of their knowledge are extremely important for sustainable agriculture. We therefore consider it very important to investigate the agricultural and ecological knowledge of these people.

In Serbia, family farms account for over 90% of agricultural land (Bogdanov, 2007; FAO, 2020). Most farmers cultivate 5–25 hectares of land, that is, most of them have developed small-scale family farming. An area of 25 hectares is enough to support a family in Serbia. In the majority of published studies, farmers cultivated from 5 to 25 hectares of land (Jallow et al., 2017; Adesuyi et al., 2018; Mubushar et al., 2019).

In our sample, all participants were formally literate, having completed primary school, and almost half of them had both secondary and tertiary education, although only 20% from the field of agriculture, indicating that agriculture was probably not their first career choice. The level of education is similar to the results from Greece, but much higher than the trials conducted among the farmworkers in some Asian or African countries (Damalas et al., 2017). A significant percentage of

our respondents also attended additional lectures in the field of modern agriculture. This was reflected in a good knowledge of the toxicity of pesticides to both living organisms and nature, and, based on their own statements, many of them showed concern for the environment.

As many as 57% of farmers were interested in the environmental toxicity of pesticides when purchasing pesticides, which is slightly more than half of the respondents. However, more than 90% of them were aware of the environmental toxicity of pesticides and their impact on wildlife. This is a better result than the result obtained in Malaysia, where about 74–76% of respondents with a similar level of education as in our survey gave correct answers to similar questions about the impact of pesticides on wildlife (Sabran and Abas, 2021).

In our survey, 91% of respondents stated that they never poured the remaining pesticide solution into the surrounding waterways. Although this is a high, and, in our opinion, satisfactory percentage, in neighboring countries, such as Greece, this percentage is even higher – 95%. While in Greece 49.3% of farmers dispose of unused pesticides on uncultivated land, in our survey as many as 59% of farmers washed out the tanks at home, and discharged the contaminated water into the sewage system or into the yard. In both cases, the pesticides reach groundwater and pollute it (Karasmanaki et al., 2021). Pesticides spilled in the yard most often end up in underground watercourses and pollute them. The situation is similar for spills into the sewage system, where the pesticides reach surface waters (Novaković et al., 2018). Although 90% of farmers stated that pesticides can enter the surrounding watercourses via the land, this practice shows that they do not sufficiently apply the existing knowledge. The probable explanation is that they are not completely aware that spilling in the yard or in the sewerage system is associated with the pollution of underground watercourses, because the handling of used packaging is very responsible, and more than 80% of farmers keep the used packaging and take it to special containers.

In our survey, 76% of agricultural producers regularly read the instructions for the use of pesticides. This is especially important for the preparation of the corresponding concentrations. However, only 57% of them agreed that the proposed concentrations were sufficient to achieve the effect and 37.2% believed that a higher concentration should be used. Although this is still not optimal, it represents a significant improvement compared to 2004. A group of authors led by Strubenhoff (2004) participated in a project on the use of pesticides in the Danube basin, in which it was found for the farmworkers from Serbia “they do not respect the proposed time of application of pesticides, apply pesticides later than it is proposed one, even 2–3 times higher in some cases”. This is the consequence of insufficient knowledge and education in the field of pesticides. Our study has shown that the education and a satisfactory level of knowledge can change the behavior of farmers in this field.

It is interesting to note that the level of additional education in the field of pesticides did not significantly affect the behavior of farmers. This is consistent with Karapandžin (2018). He has claimed that the adoption of environmental measures by farmers in Vojvodina does not depend on the level of education, nor on additional education, but contrary to Šarković et al. (2016), who have found that the level of formal education has a direct impact on the reduction of harmful environmental practices, provided that any infrastructure allows it. However, when talking about environmental literacy, it is an outcome of environmental education, not only formal education or education from the field; and only in this way can it provide a solid foundation for future environmental responsiveness and help in the transition towards more sustainable societies and healthy living (Usha Shri and Tiwari, 2021). According to Gifford and Sussman (2012), the environmental attitudes vary by age, gender, socio-economic status, ethnicity, degree of urban areas, personality, experience, education and knowledge about the environment, and education is one of the most important factors influencing the environmental awareness. In our study, only the length of farming experience had a significant impact on farmers' knowledge, showing that, in addition to education, experience in this branch is of crucial importance for acquiring knowledge.

Conclusion

In this paper, we investigated the knowledge and environmental literacy of farmers from Serbia, an agricultural region. We concluded that the farmworkers were familiar with the environmental toxicity of pesticides, and that they had good environmental and agricultural knowledge. They applied some of the knowledge well – particularly in terms of the application of recommended doses and dealing with empty pesticide packaging and pesticides, but not with pesticide-contaminated water. After rinsing the spray tank at home, the waste water was spilled into the yard, from where it entered the underground watercourses. In addition, 74% of farmers knew the name of the active ingredient in a pesticide, and 76% of them always read the instructions for use. However, more than 37% of respondents believed that using a slightly higher concentration was the only way to control pests. There is still a lack of fully applying the knowledge into practice that would be environmentally friendly. Additional environmental education in the form of repeated courses and lectures is needed to better understand water flows and environmental pollution so that people are able to navigate the environment and agriculture.

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EKOLOŠKA PISMENOST I PONAŠANJE POLJOPRIVREDNIH PROIZVOĐAČA – PILOT STUDIJA

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R e z i m e

Ekološka pismenost poljoprivrednih proizvođača je izuzetno važna za održivu poljoprivredu i zaštitu životne sredine. U radu smo ispitali znanje, obrazovanje i ekološku i poljoprivrednu pismenost kod individualnih poljoprivrednika kao i njihov uticaj na rad u poljoprivredi. Studija je sprovedena u poljoprivrednom regionu, u Vojvodini, Srbija u opštini Bački Petrovac, sa značajnim udelom poljoprivrednih proizvođača, putem upitnika. Svi poljoprivredni proizvođači u ispitivanom regionu imali su 8 godina formalnog i više od polovine visokoškolskog obrazovanja; više od polovine je takođe pohađalo dodatno neformalno obrazovanje iz oblasti poljoprivrede, i imalo je veoma dobro znanje o toksičnosti pesticida i njihovom uticaju na životnu sredinu. Međutim, njihovo ponašanje u upravljanju otpadnim, pesticidima zagađenim vodama je neadekvatno. Nakon ispiranja rezervoara za prskanje kod kuće, više od polovine farmera je prijavilo da prosipa zagađenu vodu iz rezervoara sa ostacima pesticida u dvorište ili u kanalizaciju, a da nisu bili svesni opasnosti po životnu sredinu. Pored toga, 74% poljoprivrednih proizvođača zna ime aktivne supstance u pesticidu, i 76% njih uvek čita uputstvo za upotrebu. Međutim, više od 37% ispitanika smatra da je korišćenje malo više koncentracije jedini put za suzbijanje štetnika. Nivo obrazovanja, kao i znanja o ekološkoj ugroženosti pesticida nisu značajno uticali na ponašanje poljoprivrednih proizvođača. Iako imaju visok nivo znanja o upravljanju pesticidima, ne primenjuju ga uvek na adekvatan način u svakodnevnoj praksi. Potrebno je dodatno ekološko obrazovanje o primeni teorijskih znanja u svakodnevnu praksu.

Ključne reči: ekološka pismenost, poljoprivredni proizvođači, primena pesticida, implementacija.

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