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THE PESTICIDE MARKET IN SERBIA



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SUMMARY

The use of plant protection products (PPPs) has become a social concern regarding food safety and quality, and risks to human health and the environment. Accordingly, the agricultural microbials market is a steadily growing sector of the global agriculture industry. This paper evaluates the market of basic groups of pesticides in Serbia (namely herbicides, fungicides and insecticides), as well as other collectively presented plant protection products, with a particular emphasis on the biopesticides segment. The official data of the Serbian Plant Protection Directorate for the period 2000-2020 served as a primary source of data. The movement of PPPs and active ingredients (AIs) imports into Serbia were analyzed separately. The average values of PPP quantities imported into Serbia were computed for the period under consideration. The time series variability was evaluated using the coefficient of variation, whereas the dynamics of PPP import movements was evaluated using the rate of change. In the overall structure of the imported pesticides in Serbia, herbicides remain the dominant product type (57.0%), followed by fungicides (27.5%), insecticides (10.5%), and other PPPs (5.0%). The import of AIs for the production of herbicides claimed a share of 79.8%, whereas the share of AIs for the fungicide production approximated to 12.8% (followed by AIs for the insecticide production (6.7%) and AIs for the other groups of pesticides (0.7%). Biopesticides comprise a small share of the total crop protection market in Serbia. Bioinsecticides were found to be imported into Serbia in largest quantities (followed by biofungicides, bioacaricides, and biobactericides). No imports of bioherbicides have been recorded. According to the official data on the import of PPPs in Serbia in the period 2000–2020, it can be concluded that there is a positive growth trend, which is expected to continue in the future. Although the import of AIs shows a positive rate of change, no significant growth trends were recorded.

Key words:

biopesticides,
pesticide market,
Serbia

Abbreviations:

FAO - Food and
Agriculture
Organization; PPD -
Plant Protection
Directorate; PPPs -
Plant protection
products

INTRODUCTION

Plant protection products (PPPs) are different preparations used in agricultural production for protecting cultivated plants from pests, diseases and/or weeds. The biological or chemical active substances of these preparations are

responsible for the pesticide effect on target organisms. Depending on the purpose, plant protection products are divided into the following groups: herbicides (used for weed control), fungicides and bactericides (used for the control of phytopathogenic fungi and bacteria), and insecticides (used for insect control) (Aktar et al., 2009). In addition to these basic groups of pesticides, the agrochemical sector comprises numerous products designed to kill, reduce or repel organisms interfering with the production, processing, storage and transport of agricultural commodities (rodenticides, nematocides, molluscicides, avicides, piscicides, etc.) and agricultural chemicals used for other purposes such as attractants (pheromones), defoliant, desiccants and plant growth regulators (Carolyn et al., 2013).

Biopesticides include a broad array of microbial pesticides which provide crop protection and offer a promising yield loss control without compromising the quality of the product (Kumar & Singh, 2015). Biopesticides have emerged as suitable alternatives to synthetic chemical pesticides, supporting sustainable agricultural production and minimizing adverse environmental repercussions caused by excessive chemical use (Gupta & Dikshit, 2010).

The agricultural microbials market is a steadily growing sector of the global agriculture industry. The use of PPPs has become a social concern regarding food safety and quality, and risks to human health and the environment. Therefore, the demand for organic food products and the rising importance of sustainable farming practices have been gaining prominence (Kirchmann, 2019). It is important to add that agricultural producers and consumers have been aware of the existence of aflatoxins in milk and maize (Krstović et al., 2018).

Organic agriculture has been thriving on novel microbial products, resulting in soil quality improvement, healthier chemical-free food, and more sustainable agricultural practices with regard to the circular bio-economy. This paper evaluates the market of basic groups of pesticides in Serbia (namely herbicides, fungicides and insecticides), as well as other collectively presented plant protection products (acaricides, nematocides, rodenticides, limacides, repellents, plant growth regulators and disinfectants), with a particular emphasis on the biopesticides segment.

MATERIAL AND METHODS

The official data of the Serbian Plant Protection Directorate (PPD) for the period 2000-2020 served as a primary source of data in this study. As the data obtained for certain years of the period under consideration are not complete, the results of the analysis performed were adjusted in accordance with the available time series.

The data on the import of pesticides into Serbia were processed using descriptive statistics. The total Serbian import of pesticides was analyzed for the period 2000-2020. The movement of PPPs and active ingredients (AIs) imports into Serbia, which are used as raw materials for further production of PPPs, were analyzed separately. The average values of PPP quantities imported into Serbia were computed for the period under consideration. The time series variability was evaluated using the coefficient of variation, whereas the dynamics of PPP movements was evaluated using the rate of change.

In addition to the movement analysis of the total PPPs and AIs imports into Serbia, the movement of certain groups of pesticides was also analyzed separately, i.e. herbicides, fungicides, insecticides and other groups of pesticides. Based on the available data, the analyzed time series for the basic groups of pesticides was somewhat shorter and referred to the time frame of 2004-2020. Furthermore, the value of the total import of pesticides for the period 2000-2018 was presented in USD. The official data of the Food and Agriculture Organization (FAO) were used as value indicators.

RESULTS AND DISCUSSION

According to the data of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia (2020), a total number of 1,076 plant protection products were registered in the Serbian market in 2020. The most numerous group among PPPs were herbicides (40.3%), followed by fungicides (35.3%), insecticides (16.8%), other chemicals (6.3%), and biopesticides (1.3%) (PPD, 2020).

At the global level, the total annual pesticide market value reached approximately \$ 24.3 billion in the 21st century, with a positive rate of change of 7.1%. The EU countries claim nearly a 46.3% share of the global pesticide market (FAOSTAT, 2021). The leading pesticide exporters in the world are China and the United States, followed by Germany, France, Brazil and Japan (Zhang et al., 2011). In the EU, Germany, France, the UK, Spain and Italy are the largest consumers of pesticides, accounting for more than two-thirds of the pesticide sales in the EU (Zhang, 2018). The average pesticide consumption in the EU amounted to 463,564.8 tons in the period 2000–2018, most of which were herbicides (38.8%) and fungicides (39.6%). Insecticides were used to the least extent, accounting for approximately 11.1% of the total pesticide consumption in the EU (followed by other pesticides (10.5%)) (FAOSTAT, 2021).

Most of the plant protection products and AIs found in the Serbian market are imported from the EU countries, especially in the period 2015–2020. The largest fungicide supplier was Germany, claiming a 25.6% share of the total fungicide import into Serbia. Although EU herbicide exporters supply most of the herbicides in the Serbian market, China is the largest individual supplier, claiming a 27.8% share of the total Serbian herbicide import. Conversely, the largest insecticide exporters to Serbia were Belgium, Switzerland, Spain and Germany, with a collective share of 60.9% of the total Serbian insecticide import (PPD, 2020).

The Chinese export of active ingredients used in PPPs production claimed the largest share of the Serbian AIs import, i.e. 70.9%. The active ingredients for the production of herbicides and insecticides imported from China accounted for 77.5 % and 82.9% of the total Serbian AIs import, respectively (whereas the average share of fungicides was 38.4%) (PPD, 2020).

Table 1 summarizes the value of pesticide imports into Serbia in the period 2000–2018. The average value of the total pesticides imported in the period under consideration was 77,840,991.9 USD. A positive rate of change of 21.1% and a coefficient of variation of 72.9% indicate significant changes in the value of imported pesticides in the period under consideration.

Table 1. Values of the pesticide import into Serbia in the period 2000–2018 (USD)

Period	Pesticide import value (USD)
Average	77,840,991.9
Minimum	3,459,093.4
Maximum	187,835,992.8
Coefficient of variation (%)	72.9
Rate of change (%)	21.1

Source: FAOSTAT, 2021

Figure 1 depicts changes in the value of imported pesticides in Serbia in the period 2000–2018 (FAOSTAT, 2021). It is noteworthy that a growing trend was recorded in the Serbian pesticide import from 2000 to 2008, followed by a two-year downward trend and then a rapidly growing trend until reaching its peak in 2014. The highest value of Serbian pesticide import (187.8 million USD) was recorded in 2014. In 2015 and 2016, the pesticide import into Serbia declined significantly, reaching the value recorded in 2016 by the end of the period under consideration, i.e. in 2017 and 2018.

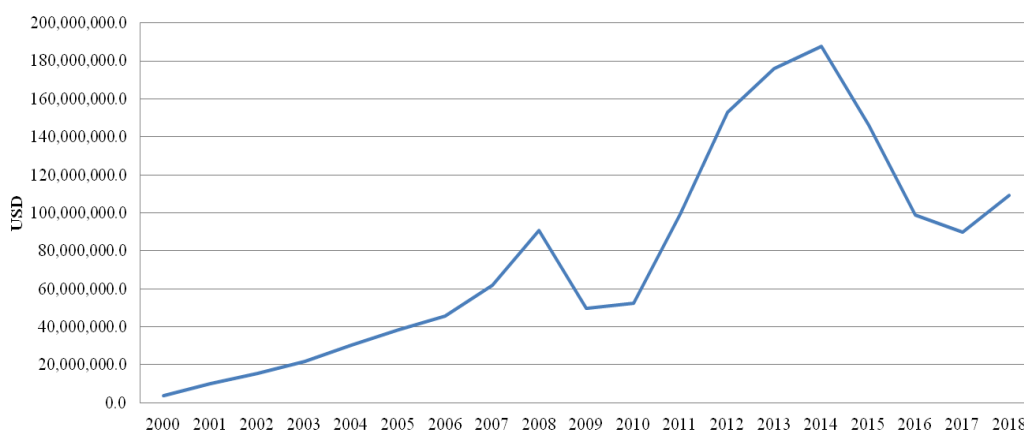


Figure 1. Values of the pesticide import into Serbia in the period 2000–2018 (USD)

The decrease in the Serbian herbicide import after 2014 can be accounted for by the pesticide market saturation and stockpiling in the previous period, associated with the changes in the structure of cultivated crops in the country. A significant decrease in the Serbian sugar beet production in 2015, which is mainly based on the use of herbicides, had an adverse effect on the import of herbicides. The increasing establishment of fruit orchards in the country after 2014, followed by a decrease in field crop production, also contributed to the reduction of Serbian pesticide import (particularly herbicides) because fruit crops do not require large quantities of herbicides, especially in the first years of production (Oliveira et al., 2016). Moreover, the reduced pesticide import was additionally caused by a withdrawal of certain types of PPPs from the market due to concerns about the impact of chemicals on the environment and human health (European Commission, 2007), transformation in global agrochemical markets, and

environmental and trade policy (which paved the way for the introduction of biopesticides as a suitable alternative against harmful pathogens) (Mishra et al., 2015).

The total imports of PPPs and AIs in Serbia in the period 2000–2020 were 119,580.7 t and 56,971.7 t, respectively. The average annual import value of PPPs was 5,694.3 tons, with an average annual rate of change of 12.7%. The high value of the coefficient of variation (55.5%) indicates significant annual changes in the PPP and AI quantities imported. On the other hand, the interval of variation of imported quantities of AIs was at a significantly lower level (a coefficient of variation of 19.7%), with a rate of change of 1.1%. The Serbian AIs import constancy reflects the fact that AIs are used as raw materials in pesticide production by domestic producer mainly oriented to the domestic market, in which the consumer behaviour is not changing significantly. The average annual imported quantity of AIs in the period 2000–2020 was 2,712.9 tons. Table 2 shows the basic data related to the PPPs and AIs import in Serbia in the period 2000–2020.

Table 2. Total import of PPPs and AIs in Serbia in the period 2000–2020 (tons)

Period	Pesticide import (tons)	
	PPPs	AIs
Average	5,694.3	2,712.9
Minimum	604.9	1,257.9
Maximum	10,798.9	3,400.8
Coefficient of variation (%)	55.5	19.7
Rate of change (%)	12.7	1.1

Source: PPD, 2020

Figure 2 summarizes the annual quantities of PPPs and AIs imported into Serbia in the period 2000–2020. A positive growth trend was recorded in the Serbian PPPs import quantities with significant annual changes. The highest value of imported PPPs quantities was recorded in 2014 (10,798.9 tons), whereas the lowest value was recorded in 2000, i.e. the initial year of the period under consideration (604.9 tons). Conversely, the import of AIs was permanent throughout the entire period under consideration, although it declined substantially in 2006, reaching the lowest imported quantity of 1,257.9 tons.

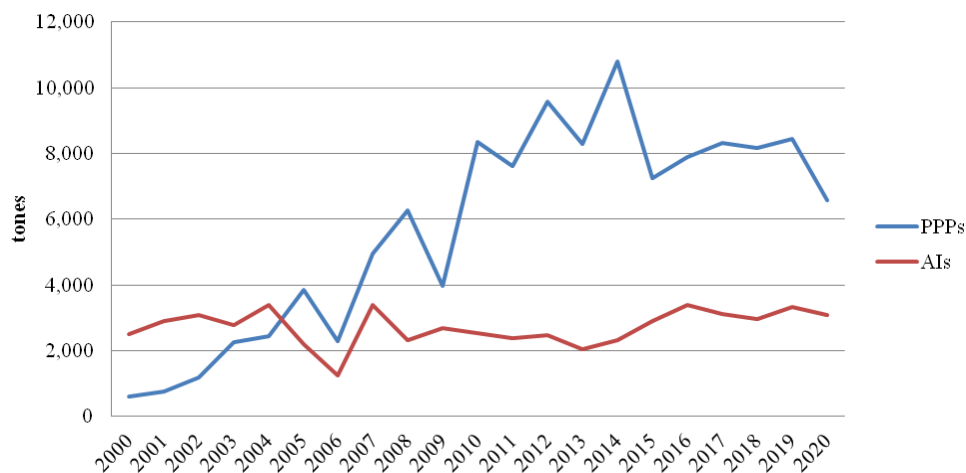


Figure 2. Total import of PPPs and AIs into Serbia in the period 2000–2020 (tons)

In the overall structure of the Serbian pesticide import in the period 2004–2020, herbicides remain the dominant product type (57.0%), followed by fungicides (27.5%), insecticides (10.5%) and other PPPs (5.0%). Figure 3 shows the structure of pesticides imported into Serbia in the period under consideration. The predominant share of herbicides in the total quantity of imported pesticides can be accounted for by the predominance of field crops in the total structure of agricultural production in the Republic of Serbia, as field crop production is heavily dependent on the use of herbicides.

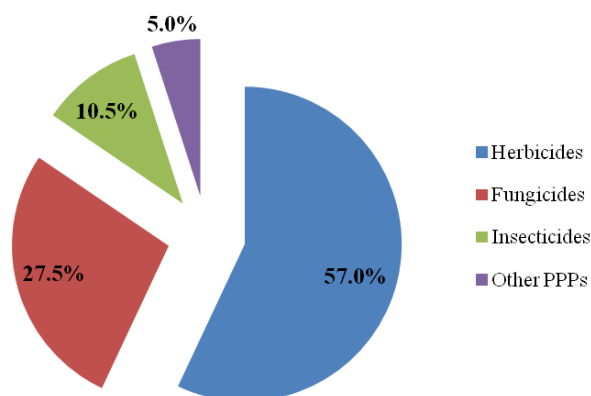


Figure 3. Average share of herbicides, fungicides, insecticides and other PPPs in the total Serbian pesticide import in the period 2004-2020 (%)

With regard to the quantities of PPPs imported into Serbia, all groups of pesticides considered showed an increasing trend in the period under consideration. The rate of change in all the pesticide groups was positive, ranging from 3.1% (other PPPs) to 7.2% (herbicides). The coefficient of variation was relatively high and comparable in all the pesticide groups. The average annual quantity of imported herbicides was 3,848.3 tons, followed by fungicides (1,884.3 tons), insecticides (699.2 tons), and other pesticides (332.4 tons). Table 3 shows the import of pesticides into Serbia in the period under consideration.

Table 3. Total import of PPPs into Serbia in the period 2004-2020 (tons)

Period	PPPs import (tons)			
	Herbicides	Fungicides	Insecticides	Other pesticides
Average	3,848.3	1,884.3	699.2	332.4
Minimum	1,323.1	608.8	224.6	69.9
Maximum	7,168.4	3,263.4	1,202.0	602.5
Coefficient of variation (%)	40.4	46.2	41.0	44.8
Rate of change (%)	7.2	6.4	4.1	3.1

Source: PPD, 2020

Figure 4 shows the quantities of PPPs imported into Serbia in the period 2004-2020. The most significant changes were recorded in the Serbian fungicide import, although the changes in other pesticide groups considered were at a similar level. Growing trends in the Serbian herbicide import were recorded in 2010 and 2014. The predominant import of herbicides in 2014 prompted a significant increase in the total pesticide import into Serbia in 2014 (as argued previously herein).

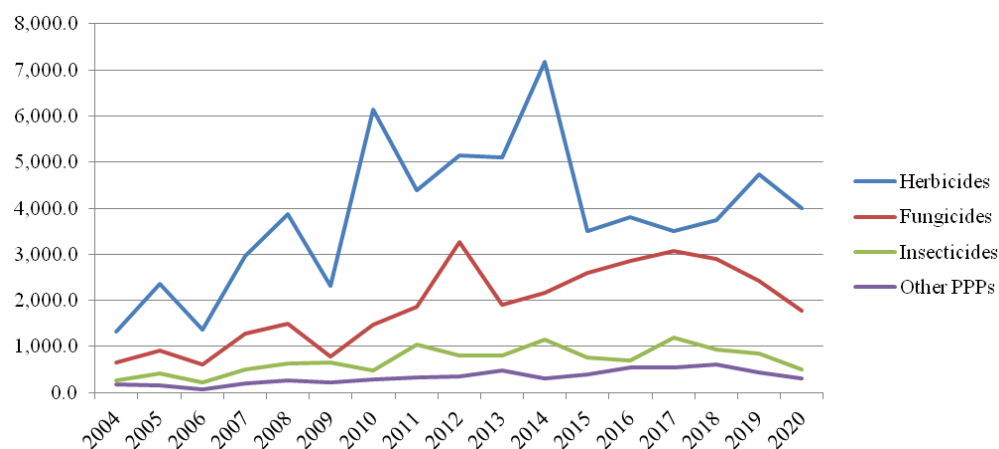


Figure 4. Total import of herbicides, fungicides, insecticides and other PPPs in Serbia in the period 2004-2020 (tons)

The imported quantities of AIs, used as raw materials for pesticide production, and imported quantities of the basic groups of PPPs followed somewhat similar patterns. However, the import of AIs for herbicide production was exceptional (79.8%), whereas the share of AIs for fungicide production was approximately 12.8%, followed by AIs for insecticide production (6.7%), and AIs for the production of other groups of pesticides (0.7%). Figure 5 shows the average share of AIs for the production of basic groups of pesticides in the period 2004-2020.

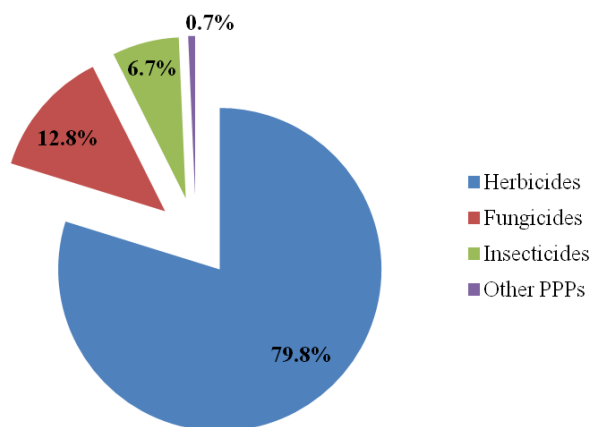


Figure 5. Average share of AIs for the production of herbicides, fungicides, insecticides and other PPPs in the total import of AIs into Serbia in the period 2004-2020 (%)

The predominant share of herbicides in the AIs imported into Serbia can also indicate a great demand for herbicides used in field crops production, as well as higher usage per unit area. The average import of AIs for the production of herbicides was 2,133.6 t in the period under consideration. The following average imports of AIs for the production of other groups of pesticides were recorded: AIs for the production of fungicides (354.2 tons), AIs for the production of insecticides (186.4 tons), and AIs for the production of other pesticides (17.9 tons). The AIs imported for the production of other pesticides showed greatest fluctuations (CV = 113.6%). As these AIs account for only about 0.7% of the total imported AIs, a more detailed analysis would not be of great importance. Conversely, the AIs for herbicide production showed the lowest level of change in the period under consideration (CV = 20.6%). A rate of change of only 0.1% indicates a stable import of AIs for the production of herbicides. For all other AIs groups considered, the rate of change was negative. Table 4 shows the import of AIs for the production of pesticides into Serbia in the period under consideration.

Table 4. Total import of active ingredients into Serbia in the period 2004-2020 (tons)

Period	AIs (tons)			
	Herbicides	Fungicides	Insecticides	Other pesticides
Average	2,133.6	354.2	186.4	17.9
Minimum	1,188.3	47.5	3.0	0.0
Maximum	2,790.8	724.4	290.1	55.3
Coefficient of variation (%)	20.6	42.2	42.6	113.6
Rate of change (%)	0.1	-3.2	-3.2	-26.0

Source: PPD, 2020

Figure 6 shows the annual Serbian import of AIs for the production of basic groups of pesticides in the period 2004-2020. It can be observed that the imported quantities of AIs for the production of fungicides, insecticides and other pesticides were at a significantly lower level than that of AIs for herbicide production. The smallest quantity of AIs for herbicide production was imported into Serbia in 2006, whereas sharp increases in AIs import were recorded in 2007, 2016 and 2019 (significantly exceeding the average AIs import in the period under consideration). This can be accounted for by the stockpiling of AIs in the previous period, followed by the increased import in the next year.

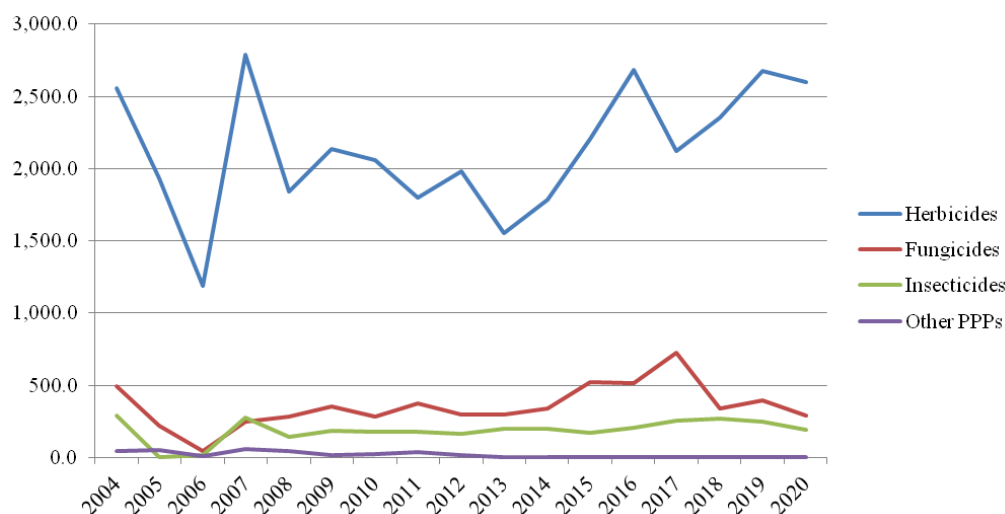


Figure 6. Total import of herbicides, fungicides, insecticides and other AIs into Serbia in the period 2004–2020 (tonnes)

At present, biopesticides claim a small share of the total crop protection market in Serbia with only a few officially registered products. Bioinsecticides were imported into Serbia in largest quantities, followed by biofungicides, bioacaricides and biobactericides. No imports of bioherbicides have been recorded. Table 5 summarizes the imported quantities of biopesticides into Serbia in the period 2015–2020.

Table 5. Biopesticide import into Serbia in the period 2015–2020 (tons)

Year	Bioinsecticides	Biofungicides	Other biopesticides
2020	8.00	-	-
2019	4.62	4.87	1.13
2018	2.00	-	1.00
2017	0.16	7.55	0.30
2016	-	0.04	0.14
2015	0.36	-	0.18
Total	15.14	12.46	2.75
Average	3.03	4.15	0.55

Source: PPD, 2020

The average biofungicide import into Serbia was approximately 4.15 tons in the period 2015–2020. Accordingly, the average share of bioinsecticides in the total Serbian import of insecticides was 0.40%. The share of biofungicides in the total Serbian fungicide import was 0.10% in the period under consideration, i.e. comparable to other biopesticides considered.

CONCLUSION

According to the official data on the import of PPPs in Serbia in the period 2000–2020, it can be concluded that there is a positive growth trend, which is expected to continue in the future. A positive growth trend in the Serbian import of all individual groups of PPPs (namely herbicides, fungicides, insecticides and other pesticides) was also recorded. The results obtained are consistent with the global growth trend in the use of plant protection product. Although the Serbian import of AIs shows a positive rate of change, a significant growth trend has not been recorded. Therefore, the import of AIs into Serbia is expected to remain steady and fairly comparable to that recorded in the previous period, which is a result of significantly lower domestic production of PPPs than the PPPs import. The global interest in biopesticides and biopesticide market can significantly increase the biopesticide market share in Serbia. A significant competitive advantage of biopesticides over chemical pesticides is reflected in their beneficial effects on the environment, human and animal health, and the effective control of plant pathogens and pests (Kumar & Kumar, 2019). Nevertheless, biopesticides have not yet reached the desired level of use. A future perspective on biopesticides is strongly influenced by the public awareness of the adverse effects of pesticides on food safety and the environment (Leccese et al., 2019). The co-operation between public and private sectors is required to facilitate the development, production, marketing and use of biopesticides. A proper set of regulations should be adopted to

promote the registration of low-risk compounds, regulate the biopesticide market, and encourage changes in the farmers' knowledge of and attitude towards the use of PPPs. Moreover, the long-term effect of the use of pesticides in agricultural production should also be considered from an economic perspective.

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Conflict of interest: The authors declare that they have no conflict of interest.

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