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IMPACT OF AGRICULTURE ON WATER POLLUTION

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ABSTRACT

The impact of agriculture on surface and groundwater is determined as negative. On the other hand, agriculture is negatively influenced by wastewater and polluted groundwater. The aim of the paper is to identify, analyze and assess the impacts of agriculture on water pollution and agriculture as a pollutant. The object of the survey is agriculture, and the subject of research is 1) the impact of water pollution on the agrarian sector and 2) the effects of agrarian activities on water pollution. The methodological framework of the paper includes: 1) literature review of impact of the water resources on agriculture and agriculture as a contributor to the water pollution; 2) analysis of impact of agriculture on water pollution based on statistical information and own survey; 3) conclusions and recommendations for mitigation of water pollution. The used method in the paper is survey method among agrarian, environmental and agroecological experts.

Keywords: *agriculture, water pollution, recommendations.*

INTRODUCTION

The impact of agriculture on surface and groundwater is determined as negative. Multiple farming activities as livestock breeding, pesticide use, fertilization and unsustainable land use lead to water pollution. Agricultural practices also damage aquatic ecosystems and river beds. The agricultural sector is responsible for water pollution due to plant and livestock activities. According some authors (Parris, 2011; Wiebe and Gollehon, 2007) pollutants can be classified as nitrate, phosphorus, pesticide, soil sediment, salt, and pathogen pollution. Ivanov (2015) considers agriculture has a negative impact on water resources through pressure on: 1) water quality - the use of fertilizers and pesticides, wastewater, 2) the water quantity through change and destruction of natural riverbeds, 3) water habitats – negative impact because of intensive agriculture, soil erosion and others. According UNEP (2016) agriculture pollutes water resources as a result of the use of agrochemicals, organic substances, saltwater drainage, and pollution threatens aquatic ecosystems and human health. The same opinion is shared by a working group set up by the Global food security programme (2015), considering that agriculture impacts on water quality by the release in water bodies of nutrients and

other chemicals, as well as changes of the physical habitat of rivers. According OECD (2012) water pollutants from agriculture are related to nutrients and pesticides, soil sediments, and other contaminants. The water pollution leads to negative impact on aquatic ecosystems, commercial freshwater and marine fisheries. The pollution also leads to decrease of social benefits of water resources as swimming and waterscapes and has negative impact on human health. Petkova (2012) considers that the main polluters of water from agricultural activities are: organic and mineral fertilizers, soil erosion, and wastewater from livestock farms. The author summarizes the reasons for water pollution with nitrates from agricultural sources such as: receiving of higher yields from cultivated crops, lack of knowledge of soil nitrogen storage, uneven soil fertilization, and improper storage of fertilizers. The other reasons for the negative impact of agriculture on water resources are connected with the population growth. Mateo-Sagasta et al. (2017) consider that water quality is negatively influenced by the intensification of production due to the increasing demand for food. Negative influence stems from cropping and livestock systems and aquaculture. The authors reveal that agriculture has a negative impact on water as a result of the population growth and changes in dietary patterns. The use of polluted water has also negative impact on agriculture because it affects the agricultural production. Sarathamani et al. (2014) make connection between wastewater and water springs. Polluted water springs have negative impact on agriculture and health of the farmers due to contact with the contaminated water. Ongley (1996) also considers that agriculture is a victim of water pollution, because polluted surface and ground water influenced negatively on crops and lead to different disease to consumers and farm workers. Wiebe and Gollehon (2007) consider that water pollution leads to additional costs. The presence of sediment, nutrients, pesticides, salts, and pathogens create costs for users of water resources. The authors stress on the fact that is very complicated to calculate the arised losses by poor water quality. The issue is due to the lack of physical monitoring and the difficulties in assessing the economic costs and benefits of environmental goods and services. An OECD study indicates that most of the costs due to the quality of water resources are related to removing pollutants from water resources, negative impact on ecosystems, fishing, etc. (Parris, 2011). The aim of the paper is to identify, analyze and assess the impact of agriculture on water pollution and agriculture as a pollutant. The conclusions could be used for policy making support and introduction of practices and mechanisms in agriculture that will contribute to the improvement of the environment and in particular the quality of the water resources.

MATERIAL AND METHODS

The methodological framework of the paper includes: 1) literature review of impact of the water resources on agriculture and agriculture as a contributor to the water pollution; 2) analysis of impact of agriculture on water pollution based on statistical information and own survey; 3) conclusions and recommendations for mitigation of water pollution. The object of the survey is agriculture, and the

subject of research is 1) the impact of water pollution on the agrarian sector, and 2) the effects of agrarian activities on water pollution. The analysis is based on national statistical data and own survey. The used method in the paper is survey method among agrarian, environmental and agroecological experts. The sample includes 24 expert interviews with closed and open questions. The survey was conducted in 2018. The respondents evaluate the impact of the agricultural sectors on water pollution and agriculture as a victim of water pollution. The main agricultural practices related to plant and livestock breeding are evaluated to find out their negative impact on water resources. Respondents shared a view about voluntary and restricting measures related to reducing the negative impact of agricultural activities on water.

RESULTS AND DISCUSSION

Statistical data present the increase of waste water from agriculture in Bulgaria for the period 2007-2016 (Table 1). Wastewater increased over 5 times. A large part of the wastewater from agriculture (from 93% to 99%) is discharged into water bodies. Insignificant part of total wastewater (from 2% to 18 %) is discharged of wastewater treatment plant. This reveals the importance of the problem and the need of solutions to reduce the amount of agricultural wastewater discharged into the water bodies without treatment. Table 2 presents a ranking of agricultural sector as a pollutant and affected by water pollution. Respondents consider that polluted water has a high impact on plant sectors (over 60% of experts). The relevantly high impact is supported by a different number of respondents for the plant sectors, their share ranges from 54% to 75%. The most affected sectors by water pollution are vegetables and perennials, and vines, followed by cereals, oil crops, industrial cultures, medicinal and aromatic crops. The highest pollutants according to respondents are grain sector and vegetables (54% and 50% support this statement). This could be explained by intensive agricultural practices and mechanization in grain sector and the high level of pesticide usage in vegetable sector. The experts consider that the low level of influence have the sectors - medicinal and aromatic crops (37.5%), and perennials and vines (25%).

Table 1. Generation and discharge of wastewater from agriculture in Bulgaria, mill. m³/year

| Year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| Wastewater from agriculture, of which: | 7.02 | 9.65 | 18.39 | 16.94 | 16.75 | 24.59 | 18.24 | 23.38 | 36.62 | 39.75 |
| Total wastewater discharged into water bodies | 6.52 | 9.18 | 18.14 | 16.66 | 16.31 | 24.29 | 18.05 | 22.00 | 36.42 | 39.40 |
| Wastewater discharged without treatment | 5.36 | 8.12 | 17.49 | 15.94 | 15.60 | 23.50 | 17.40 | 21.31 | 33.44 | 38.60 |
| Discharged in wastewater treatment plant | 1.16 | 1.06 | 0.66 | 0.73 | 0.72 | 0.79 | 0.65 | 0.69 | 2.98 | 0.81 |

*Source: NSI (2016). Generation and discharge of wastewater - total for the country, by Statistical Region and River Basin District. Statistical data.

Table 2. Sector ranking - Pollutants and affected by pollution - Crops

| Sector | Rank - Influenced by water pollution | Rank - Influence on water pollution |
|----------------------------|---|--|
| Grain production | 2 | 1 |
| Oil crops | 3 | 4 |
| Perennials and vines | 1 | 6 |
| Industrial cultures | 3 | 3 |
| Medical and aromatic crops | 3 | 5 |
| Vegetables | 1 | 2 |

*Source: Authors' elaboration based on the survey results.

Table 3 presents the ranking of stockbreeding subsectors of agriculture as pollutant and affected by pollution. Experts consider that beekeeping, rabbit breeding, horse breeding are the subsectors that have lowest negative impact on water resources, respectively 87%, 45%, 50 % consider they don't affect on water pollution.

Table 3. Sector ranking - Pollutants and affected by pollution - Livestock breeding

| Sector | Rank - Influenced by water pollution | Rank - Influence on water pollution |
|--------------------------------------|---|--|
| Cattle-breeding and buffalo-breeding | 3 | 3 |
| Sheep and goat breeding | 3 | 4 |
| Pig breeding | 4 | 1 |
| Poultry rising | 4 | 2 |
| Beekeeping | 1 | 7 |
| Rabbit breeding | 2 | 6 |
| Horse breeding | 4 | 5 |

*Source: Authors' elaboration based on the survey results.

Sectors as cattle-breeding and buffalo-breeding, pig breeding and poultry rising are considered by the experts with high negative impact on water (respectively 50%, 58%, 54%). Most respondents are on the opinion that stockbreeding sector is highly influenced by water pollution. The evaluations varied from 50% for pig and horse breeding and poultry rising up to 63 % for beekeeping.

Figure 1 presents the consideration of the experts of possible sources of water pollutions from agricultural activities. Wastewater from livestock breeding (75%), plant protection and pest control preparations and non-compliance with the Nitrate Directive (75%) and bad agricultural practices (71%) are pointed as practices with very high influence on water pollution. A third of the respondents (33%) considers that application of intensive agriculture to obtain higher yields of cultivated crops is a source with high influence. With the lowest impact on the water pollution is pointed soil erosion.

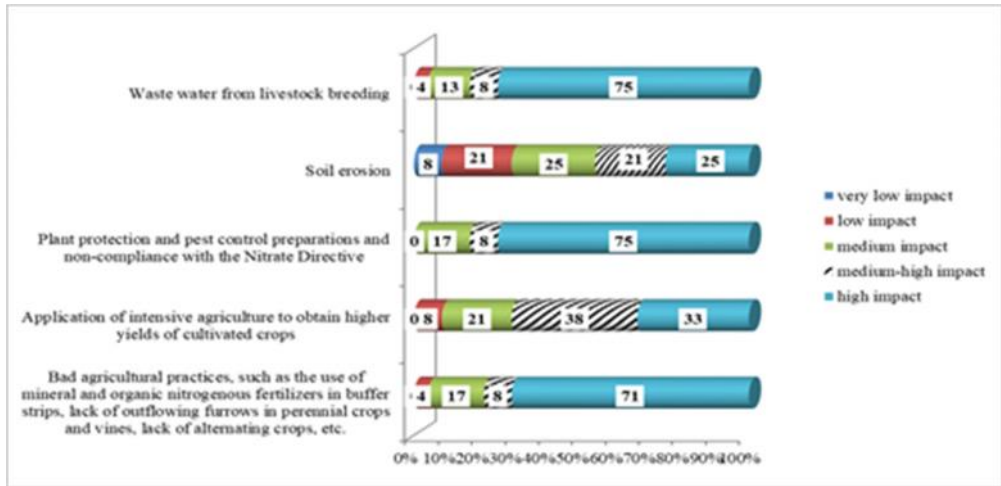


Figure 1. Practices related to water pollution connected with agricultural activities.
*Source: Author’s elaboration based on the survey results.

The experts had to evaluate the restrictive mechanisms which could be undertaken to reduce water pollution by agricultural activities. Most of the respondents consider that ecotax for non-compliance with the Nitrate directive and good agricultural practices, implementation of preparation ecotax, will contribute as mechanisms connected with reducing water pollution of agricultural activities (Figure 2).

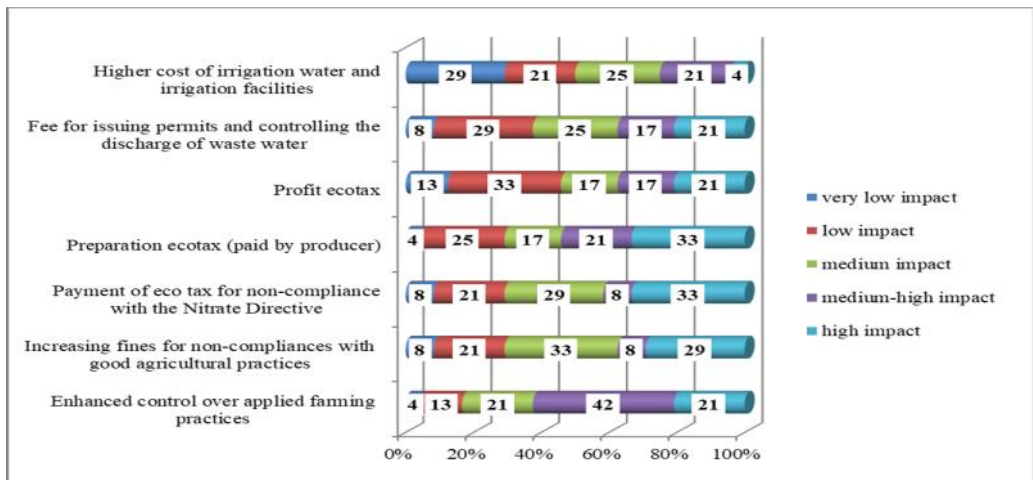


Figure 2. Restrictive mechanisms in agriculture related to reducing the impact of agricultural activities on water pollution
*Source: Authors’ elaboration based on the survey results.

Fee for issuing permits and controlling the discharge of wastewater splits the experts into two groups - 37% consider this mechanism would have low impact on water pollution and 35% are on the opinion that the impact will be high. According respondents' view, higher cost of irrigation water and irrigation facilities will have low impact on water resources and will not be helpful for reducing levels of pollution.

The respondents had to evaluate also the voluntary mechanisms for reducing water pollution, by implementing voluntary measurements. Investments in irrigation facilities is pointed as the highest possibility for reducing water pollution, followed by policies which motivate the application of ecological practices. The most of the respondents consider that different type of voluntary mechanisms in agriculture will have a positive influence on water pollution (Figure 3).

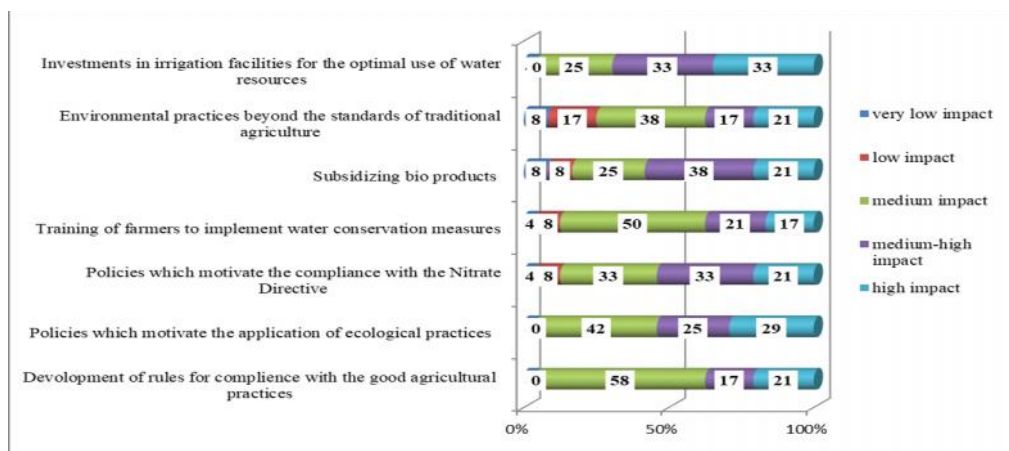


Figure 3. Voluntary mechanisms in agriculture related to reducing the impact of agricultural activities on water pollution.

*Source: Authors' elaboration based on the survey results.

The evaluation of mechanisms related to reducing the impact of polluted water on agriculture shows that construction of treatment facilities to prevent the entry of contaminated water is the measure with highest importance (58%), followed by informing farmers about contaminated water bodies (38%) (Figure 4). All mechanisms related to reducing the impact of polluted water on agriculture are with significant importance.

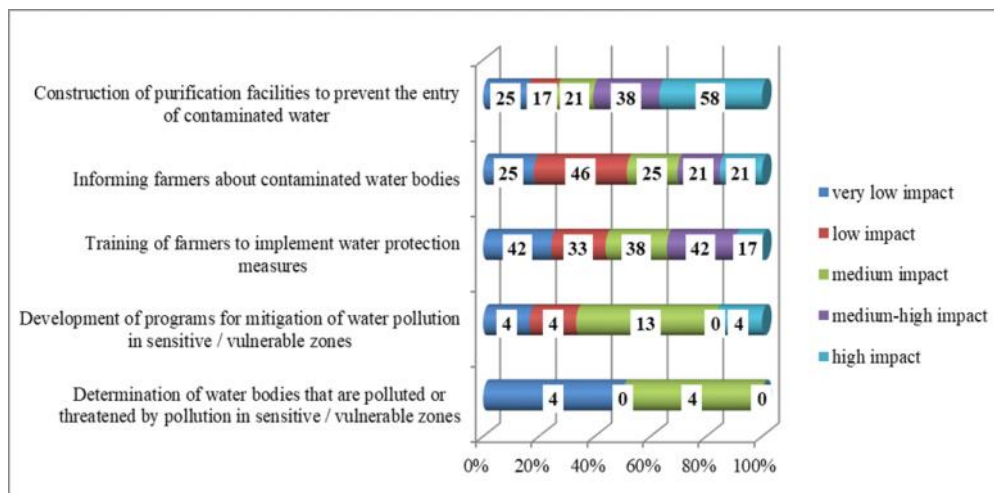


Figure 4. Mechanisms related to reducing the impact of polluted water on agriculture

*Source: Authors' elaboration based on the survey results.

CONCLUSIONS

In order to reduce water pollution, is necessary to develop policies encouraging farmers to apply good agricultural practices such as creating and maintaining buffer strips, creating run-off holding furrows in perennial crops and vines and planting crop strips as well as animal waste management. Technologies and innovation are a driving force and an opportunity to reduce water pollution and negative impact on agriculture. Farmers' attitude for applying more environmental friendly approach and implementation of the principles of sustainable development in their agricultural practices will reduce the negative impact of polluted water on agriculture and also the impact of the agrarian sector on water resources. In this connection, is necessary to stimulate projects in the water sector and for their successful realization to implement eco-innovative approaches and practices in the management of water projects. Reducing the negative impact of agriculture on water resources could also be achieved by increasing farmers' awareness and creating a culture of thinking about the environment and people. The impact of agriculture on water resources and the impact of water on agriculture will be positively influenced by the participation of farmers in training to implement good agricultural practices. This requires participation in specific trainings and awareness programs. They could be related both to mandatory practices as compliance with the national standards for good agricultural practices, Nitrate Directive requirements and to the voluntary mechanisms as erosion reduction activities, integrated pest management, irrigation water management, etc.

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