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THE CONSUMPTION OF MINERAL FERTILIZERS AND WATER RESOURCES' QUALITY IN THE EUROPEAN UNION AND THE REPUBLIC OF SERBIA¹

Svetlana Roljević², Aleksandra Nikolić³, Rajko Tepavac⁴

Summary

Its goal is to point out to a significance of tracking the nitrate emission in agricultural production, by which makes bases for undertaking adequate measures of water protection and other natural resources from agriculture effect. This paper is focused on analysis of mineral, i.e. nitrogen fertilizers consumption, and their effect on the environment, i.e. surface waters. Data from the relevant institutions in the EU on consumption of mineral fertilizers and loading of waters by nitrates, which origin from agricultural production, were collected by desk research method. Data on consumption of mineral fertilizers in the Republic of Serbia for the period 1985-2001. year are taken from official statistics for selected years, while the display of water quality data is given for research by local authors. As a general conclusion imposes a fact that in our country have been spent significantly less amounts of mineral fertilizers in relation to the community of 27 countries, but there is still a profound adverse impact on the environment owing to inadequate laws implementation and lack of infrastructure in the field of ecology.

Key words: *Agriculture, water resources, mineral fertilizers, nitrates.*

JEL: *Q25, Q53*

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- 2 Svetlana Roljević, B.Sc., Research Assistant, IAE Belgrade, Volgina Street 15, phone: +381 11 29 72 842, E-mail: svetlana_r@iep.bg.ac.rs
- 3 Aleksandra Nikolić PhD, The Faculty of Economics and Engineering Management, University Business Academy, Novi Sad, mob. +381 69 2000954, E-mail: aleksandranikolic.fimek@gmail.com
- 4 Rajko Tepavac PhD, The Faculty of Economics and Engineering Management, University Business Academy, Novi Sad, mob. 063-200910, Rajko.Tepavac@dunav.com

Introduction

According to FAO data, total resources of fresh water in the world are estimated at approximately 43,764 km³/per annum and are arranged in accordance with the climatic and physical-geographical conditions (FAO, 2003). Systematized data show that around the world consumes about 50% of available drinking water, and it was estimated that the consumption might reach even 80% of capacity, in next two decades. Globally, agriculture is the largest consumer of water. The need for a rational approach to the consumption of potable water on a global level is more and more pronounced because the water is considered as a strategic resource of the XXI century.

Agriculture is the main, but not the only, nitrates polluter of water. Of the total amount of nitrogen burdening water systems on Earth during last 30 years, arable land is releasing even 50-80%. As the nitrogen compounds are very mobile, the entire surplus that the plants do not adopt, is flushed to the water's surface, or gone into the deeper layers of soil thus reaching the groundwater. Basic indicators of increased concentrations of nitrogen compounds in the environment are acidic soil reaction (which affects the composition and abundance of species in the ecosystem), raising the level of nitrate in freshwater systems and their eutrophication. As a result of large amounts of nutrients (nitrogen and phosphorus) in water, algal blooms reducing water transparency are emerging. As well as reducing the transparency of water, algae secrete substances toxic to fish and people, and for their decomposition microbes consume large amounts of oxygen, leaving a dramatic impact on living things in the water and the ecosystem as a whole.

Mineral fertilizer consumption in the European Union and unfavorable effects on the environment

Intensive exploitation of existing agricultural land and "repairing" of soil fertility in today's conventional agricultural practice is inconceivable without the use of mineral fertilizers, integrated into the very notion of agricultural production and, thus, becoming an integral part of production and food supply chain.

Of the EU 27 (432,525,000 ha) total territory, 38% is covered with agricultural land (Eurostat database)⁵. The European Union countries, particularly those economically developed, are consuming large amounts of mineral fertilizers. For this reason, agricultural production in the European Union is regulated by a number of laws and directives which lay down the rules of plant and livestock production, in order to protect the environment, manage natural resources in a sustainable manner and produce sufficient quantities of food.

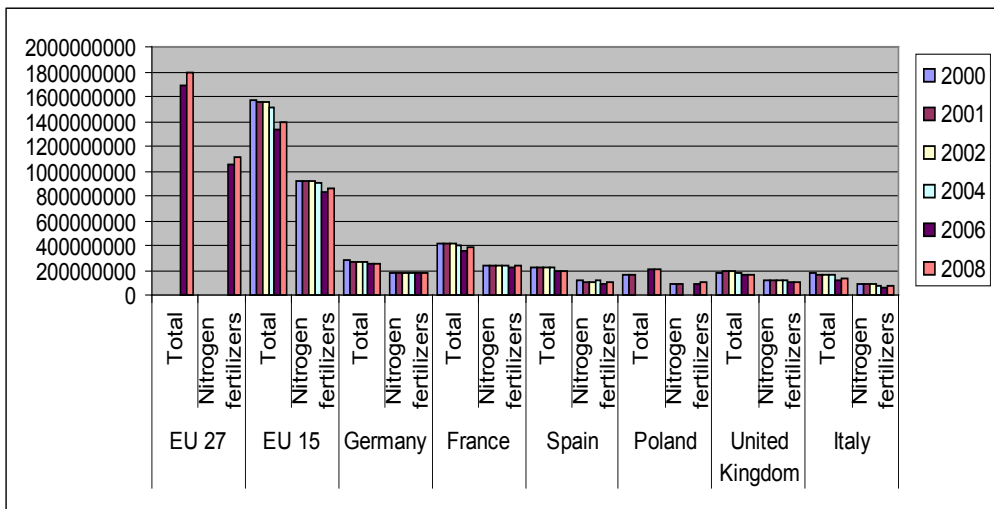
According to Eurostat data which shows a graph, the total amount of fertilizer consumed at the level of EU 27 in 2008 amounted to 17,897,623.29 tons of active ingredient, which is 965,073.04 tons more than in 2006 year. However, realized consumption in 2008 was approximately 5 million tones lower than the one in 1985, when countries in Western

⁵ Agricultural statistics, 2008-2009, pp. 98.

Europe consumed about 22 million tons of artificial fertilizers. Nowadays (2009), members of EU-27 spend an average 74 kg per ha of agricultural land, where average consumption is 59 kg nitrogen per ha, phosphorus 6 kg per ha, 11 kg potassium per ha⁶.

The largest consumers of artificial fertilizer among the 27 EU members are France, Germany, Spain, United Kingdom, Italy and Poland. Figure 1 shows a slight decline in total consumption of fertilizers in the period from 2000-2008 in all countries, and at the level of EU 15, too. Contrary to this fact, the community of 27 European countries recorded a growth in consumption of fertilizers between the 2006 and 2008, because the restrictions on the consumption of fertilizers, which are valid in economically strong countries of the European Union, do not apply in developing countries. Agricultural households in developing countries do not have enough funds to purchase the optimal amount of crops fertilizer, and therefore achieve less pressure on the environment, and in these conditions, limits concerning the use of fertilizers give superb performance without application.

Chart 1. Total consumption of mineral fertilizers and nitrogen share in total consumption of fertilizers in some of the 27 EU member states in the period 2000-2008.



The source: Eurostat database

Major problem in environmental policy of economically developed countries is consumption of nitrogen fertilizers, which in total consumption of mineral fertilizers account for more than 50%. So, at the EU-27 level nitrogen fertilizers covers 62% of the total mineral fertilizers consumption, while in Germany the participation of nitrogen in the total consumption of mineral fertilizers, is 70%. At the level of EU 15 member-countries, during the period of 2000-2008, there has been a stable consumption of nitrogen fertilizer, from about 9 million tons, while consumption in EU-27 level increased by about 6%

6 http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Fertiliser_consumption_and_nutrient_balance_statistics

In addition to fertilizer, an important source of nitrate is intensive livestock production. Intensive livestock breeding requires the use of stable higher capacity and more intensive crop production, which released large amounts of fertilizers into the environment thus undermining the stability of ecosystems. According to the European Commission report on implementation of Nitrates Directive for the period 2004-2007, the amount of nitrogen originating from livestock breeding, concerning the agricultural area is about 9.3 million tons per year in EU 27 and 7.7 million tons per year in the EU 15⁷. In Belgium and the Netherlands, as well as some parts of Italy, France, Spain and Portugal over 170 kg of nitrogen originating from manure per hectare of arable land is spent. Between 120 and 170 kg N per ha is spent in Denmark, UK, as in several districts in Ireland and northern parts of Germany.

How much the above mentioned nitrates emission trends in agriculture affected water quality it is shown in Table 1, where the results of two consecutive reports are shown, presenting the surface water condition for the period from 2000-2003 and from 2004-2007 in the EU15 countries.

Table 1. Nitrates concentration in surface freshwater in the EU15 countries⁸

Period	2000 – 2003			
Nitrates concentration	< 2 mg NO ₃ /l	2-10 NO ₃ /l	40-50 NO ₃ /l	> 50 NO ₃ /l
Gaging stations share	19 %	53 %	4 %	2,5 %
Total number of gaging stations	22.000			
Period	2004. – 2007. year			
Period	< 2 mg NO ₃ /l	2-10 NO ₃ /l	40-50 NO ₃ /l	> 50 NO ₃ /l
Nitrates concentration	24 %	30 %	4 %	4 %
Gaging stations share	22.000			

Source: “Report from the Commission to the Council and the European Parliament On implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources for the period 2000-2003“ and “Report from the Commission to the Council and the European Parliament On implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources for the period 2004-2007“

The data in Table 1 point out that water quality of surface water flows which had less than 10 mg/l was improved between the two observed periods, but, on the other side, the share of measuring spots, in which concentration was above 50 mg NO₃/l, was increased. According to the reports from the period from 2004-2007, France

7 Report from the Commission to the Council and the European Parliament on implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources for the period 2004-2007, pp. 3

8 Note: Monitoring stations in Great Britain represent 30% of the total number of gaging stations in the EU15, where water samples with nitrates concentration above 25 mg/l are most frequent. Because of such uneven disposition of gaging stations on the territory of EU15, final report showing surface water quality is not actually realistic.

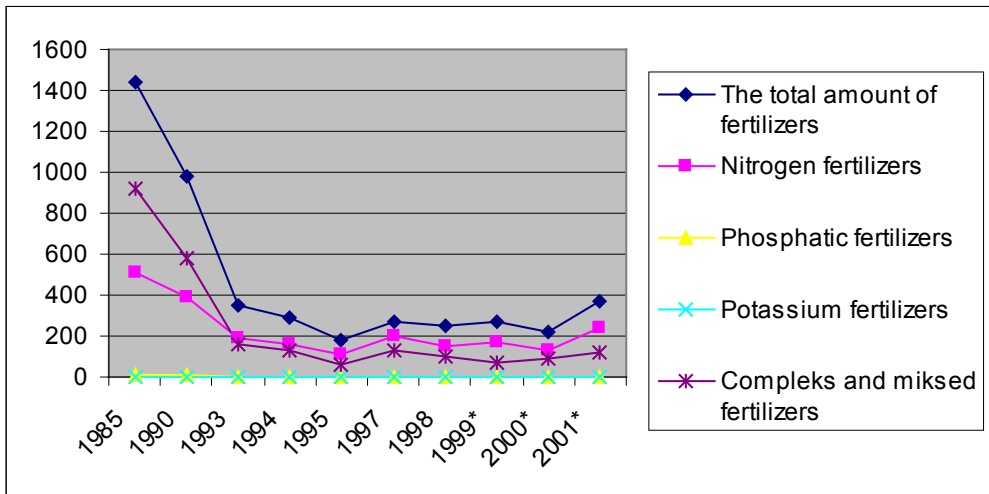
achieved significant positive results with gaging stations which recorded largest share of improvement in surface water quality, whereas in Greece and Luxembourg gaging stations recorded largest share of reduction in surface water quality.

As the main indicator of the environment condition in a community of 27 countries, European Agency for Environmental Protection is using the *gross nitrogen balance*, which refers to the excess nitrogen in agricultural areas. The gross nitrogen balance represents the difference between nitrogen ingested (mineral fertilizers, manure, atmospheric nitrogen, nitrogen adopted by the legumes) and adduced amount of nitrogen (nitrogen that adopt crops) per hectare of used area. According to European environmental standards, the gross nitrogen balance for the EU 15 in 2000 was 55 kg/ha, representing 16% less than in 1990. Surplus in gross income of nitrogen was reduced in all members of EU 15, except in Ireland and Spain. The largest national surpluses of nitrogen are in the Netherlands and Belgium and slightly lower in Spain, Italy and the UK

Consumption of mineral fertilizers in the Republic of Serbia

All up to 2001, the consumption of mineral fertilizers in the Republic of Serbia has been systematically tracked by the Republic Statistical Office, which has given a good ground also for evaluation of primary agricultural production influence on the environment. After 2001, the consumption has not being followed, but only the production of mineral fertilizers within the industrial production of chemicals and chemical products. According to data provided by the Statistical Office ran until 2001. consumption of mineral fertilizers in Serbia is characterized by a declining trend, particularly after the 1992. With 1.44 million tons (1985) consumption is reduced to approximately 220,000 tons (2000), showing the tendency to gradually increase, to 300,000 tons (2003). After 1992, oscillating of all types of mineral fertilizers consumption are noticed, as a consequence of the state's economic weakening and its productive potentials, as well as insufficient economic power of households to apply optimal amount of nutrients in crops. The largest share in total consumption during this period had nitrogen and mixed fertilizers, while their dominance changed from year to year (Figure 2). The average consumption of nitrogen fertilizers in the period 1985-1992 at the Republic of Serbia level, was amounted around 230 thousand tons annually, while in the period 1992-2001 that amount had decreased on 60 thousand tons of nitrogen fertilizers for totally arable land (5,058,000 ha). Over time, the threat to the environment and eutrophication of aquatic systems were reduced. According to the 2009 State Report of Environment in the territory of Vojvodina has been identified as the most polluted area of the Republic of Serbia, because 25% of the analyzed soil samples showed high content of phosphorus, while 56% of the analyzed territory believed to be still in the process of acidification. These results were expected since the Vojvodina region has the biggest agricultural production in Serbia, and therefore in the soil a large amounts of residues mineral fertilizer and pesticides are presented.

Chart 2: Consumption of mineral fertilizers in the Republic of Serbia in the period 1985-2001, in thousands tons



The source: Statistical Office of the Republic Serbia

Note: In 1999, 2000 and 2001, data for Kosovo and Metohija are missing

The data on consumption, which dispose within last decade, derive from export-import balance of mineral fertilizers in our country, which furthermore lead to data on mineral fertilizers consumption in the Republic of Serbia about 36 kg of active matter per a hectare of arable land (data from 2002), i.e. about 25 kg of nitrogen per a hectare of arable land (total arable land 5,058,000 ha). Such amounts of mineral fertilizers are minor in regard to fertilizers use in the EU, which means that the consequences for the environment are more delicate, but still miss better monitoring of these matters appliance on natural environment in Serbia.

Great potential in food production and environment protecting is to increase the efficiency of mineral fertilizers. Specifically, the average efficiency of applied nitrogen fertilizers is approximately 30-50%, which means that there is considerable scope for increasing efficiency and reducing loss of nitrogen, while the efficiency of phosphorus fertilizers is even lower, representing approximately 20 percent.

Balance quality of surface waters in the Republic of Serbia

Since 2010, the legal status of waters, integrated water management, water facilities and water land, resources and financing of water services, as well as other issues relevant to water management in the Republic of Serbia are defined by the Law on Waters (Official Gazette RS, No. 14/2010). Surface water quality is regularly monitored by the competent authorities of the Republic Hydro-meteorological Service of Serbia (RHSS) according to the program on an annual basis by the Government of Serbia. Network Monitoring Station includes 159 profiles of 84 watercourses.

According to Veljkovic and Jovicic research (2009), in 2007 the water area of Morava was the most loaded by nitrates with concentration of 1.78 mg/l ($\text{NO}_3\text{-N}$), than follows the water area of Sava 1.13 mg/l ($\text{NO}_3\text{-N}$) and according to our legislature the concentrations of nitrates are in limits, regulated for I and II class of water quality.

Regarding the burden of lakes and reservoirs by nitrates and phosphates in Serbia, based on analysis of samples collected in 2005-2009 period terms by the Bureau of hydro meteorology, one can say that the quality of water in reservoirs in 2009 has been improved since participation of indicators classified as "very good" increased and indicators as "bad" decreased compared to previous year. Contrary to improving the quality of surface water reservoirs, it was noticed in 2009 a weaker groundwater quality compared to 2005. because the concentration of nitrate increased, but is still below the maximum allowable concentration of (50 mg/l), which is prescribed in the Regulations on the hygienic quality of drinking water (Official Gazette, SRY no. 42/98).

Conclusion

In accordance to mentioned data on consumption of mineral fertilizers can be concluded that the consequences which agricultural production in our country leaves on the environment, primarily water and soil, is significantly smoother than the one the agricultural production leaves in economically developed countries of the EU, on what point out also concrete measurements mentioned in this paper. Although, the state of waters in Serbia is not satisfactory, the research on nitrate content in main watercourses in our country, from 2007, has shown that the most loaded are water areas of Morava, Sava and Danube. There is no institutional or legal framework, which would provide tracking nitrates and other nitrogen compounds emission, which derive from agricultural production, as well as their effect on waters, soil and air. In regard to the significance which agriculture has in the local economy, such researches should be a guideline of further agriculture development in our country.

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POTROŠNJA MINERALNIH ĐUBRIVA I KVALITET VODNIH RESURSA U EVROPSKOJ UNIJI I REPUBLICI SRBIJI

Svetlana Roljević⁹, Aleksandra Nikolić¹⁰, Rajko Tepavac¹¹

Rezime

Cilj rada je da ukaže na značaj praćenja emisije nitrata iz poljoprivredne proizvodnje čime se stvaraju osnove za preduzimanje adekvatnih mera zaštite voda i drugih prirodnih resursa od uticaja poljoprivrede. Težište rada čini analiza potrošnje mineralnih, tačnije azotnih đubriva i njihov efekat na okruženje, odnosno površinske vode. Desk metodom istraživanja prikupljeni su podaci relevantnih institucija u Evropskoj uniji o potrošnji mineralnih đubriva i opterećenosti voda nitratima poreklom iz poljoprivredne proizvodnje. Podaci o potrošnji mineralnih đubriva u Republici Srbiji za period 1985-2001. godine uzeti su iz godišnjaka zvanične statistike za odabrane godine, dok su za prikaz kvaliteta voda dati podaci istraživanja domaćih autora. Kao opšti zaključak nameće se činjenica da se u našoj zemlji troše značajno manje količine mineralnih đubriva u odnosu na zajednicu 27 zemalja, ali da je ipak prisutan dubok nepovoljni uticaj na životnu sredinu zbog neadekvatnog sprovođenja zakona i nedostatka infrastrukture u oblasti ekologije.

Ključne reči: *poljoprivreda, vodni resursi, mineralna đubriva, nitrati.*

9 Svetlana Roljević, B.Sc., IEP, Beograd, Volgina 15, tel: +381 11 29 72 842, E-mail: svetlana_r@iep.bg.ac.rs

10 Dr Aleksandra Nikolic, Fakultet za ekonomiju i inženjerski menadžment, Privredna akademija Novi Sad, mob. 069-2000954, E-mail: aleksandranikolic.fimek@gmail.com

11 Dr Rajko Tepavac, Fakultet za ekonomiju i inženjerski menadžment, Privredna akademija Novi Sad, mob. 063-200910, E-mail: Rajko.Tepavac@dunav.com

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