View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Repository of the Academy's Library

APPLICATION OF MEASURES OF GOOD AGRICULTURAL PRACTICE TO CONTROL DIFFUSE N POLLUTION ORIGINATED FROM LIVESTOCK MANURE

Hamid ČUSTOVIĆ – Mirha ĐIKIĆ – Melisa LJUŠA

Faculty of Agriculture and Food Science, University of Sarajevo, Zmaja od Bosne 8, Bosnia and Herzegovina, e-mail: custovic.hamid@gmail.com (corresponding author), m.djikic@ppf.unsa.ba, melisa.ljusa@gmail.com

Abstract

The polluting effects of organic farm wastes can occur in a number of different ways and therefore require a broad range of approaches to control. For example, all watercourses (notably lakes, ponds, rivers, streams and field ditches) adjacent to the production, storage or application of organic wastes are potentially at risk of point source pollution. This risk is different from the diffuse pollution that occurs when the microbial breakdown of manure applied to the soil occurs out of phase with the N uptake of a growing crop and leads to nitrate leaching. Bosnia and Herzegovina is divided into basic river basins as follows: Una, Vrbas, Bosna and Drina flow to the Sava River, which drains into the Danube, while the Neretva, Trebišnjica and Cetina flow to the Adriatic Sea. The biggest emission of organic pollution, then nitrogen and phosphorous is from the Bosna River basin (around 20%). This is followed by Una (15%), Sava (13%), Drina (12.5%), and Vrbas (around 10%). About 30% of above mentioned pollutants goes to the catchment of Adriatic Sea. The spatial distribution of emission is in accordance with the size of the river basin, and the size of the river basin is in accordance with other parameters (population, agricultural activities, cattle-breeding). Exceptions are the river basins of Sava and Ukrina with a bigger concentration of population and more intensive agricultural activities.

Keywords: manure, nitrogen, pollution, best agricultural practices, organic farming

Introduction

In the EU Countries various policy instruments and practical measures are currently used and/or are in preparation for implementation in the countries in order to promote the control of water pollution by agriculture (e.g. to implement national policy objectives, prepare for joining EU or comply with international conventions). These include: regulatory, economic and advisory/informative instruments and measures.

The current policy objectives and strategies of Bosnia and Herzegovina concerning the control of water pollution and other ecosystems caused by agriculture do not exist (red zone). This includes the point sources of pollution and diffuse sources of pollutions. When we talk about "water pollution by agriculture" we mean the presence of harmful substances in water which is caused by agricultural activity. This includes substances that are derived from: i) agrochemical inputs, such as mineral fertilizers and pesticides, that are used deliberately by farmers to improve crop and animal production, ii) farm wastes, such as silage effluent and animal manure, that are produced during usual agricultural activities, iii) natural processes, such as soil erosion, that are enhanced by usual agricultural activities.

Sustainable management of manure and organic matter in general could lead to the conclusion that the value of Soil Condition Index (SCI) could indicate negative, stable or improved organic matter trend condition in soil (Čustović et al., 2006). The implementation of pollution control measures at the farm level will only be successful and sustainable if the farmers can determine that it is in their economic interest to undertake such measures. While livestock manures were traditionally viewed as a valuable soil improver and important source of nutrients, changes in agricultural practices over the last 60 years have caused that manures are now regarded as a serious waste product. This is particularly the case where there is an imbalance between land suitable for livestock manure application and the rapid growth and intensification of confined livestock. Water is the primary medium for transporting diffuse pollution (Ćerić et al., 2003). Average number of rainy days in Bosnia and

Herzegovina is about 130 or 35%. Distribution of precipitation, characteristics of soil, phase of growth and development of crops and evapotranspiration are the main factors influencing the leaching of nitrogen (Mesić et al., 2007).

Materials and methods

Statistical data on livestock were analyzed and production of manure and quantity of nitrogen were calculated based on average values for all animal categories. Analysis was made for 2002 and 2011 according to the entities (Federation of BiH (FBiH) and Republika Srpska (RS)), and the aggregate values were interpreted for the entire Bosnia and Herzegovina (hereinafter BiH).The analyzed data were collected from statistical sources at the entity, cantonal and municipality levels. The values of total nitrogen in kg t^{-1} are the average values obtained by the Kjeldahl analysis.

Results and discussion

State of soil and production of manure in Bosnia and Herzegovina

By delimitation from 1985 BiH is divided into four agricultural regions: mountain region (57%); hilly (27%); flat (11%); and, Mediterranean region (5%). The huge heterogeneity of soil, relief, climate, geology, hydrology and hydrographic network in BiH, uncontrolled cultivation of sloped terrains, plowing of sloped grassland are just some of the very complex issues related to soil and water use and management.

BiH covers 51,129 km^2. In total area of BiH there are 2,533,000 hectares of agricultural land. Arable land takes up 1,593,000 ha or 62.9% of total agricultural area and non-cultivable plots take up 940,000 ha or 37.1%.

Table 1: Number of livestock in BiH in 2002 and 2011 (thousand)

Categories of livestock	BiH year		FBiH year		RS year	
	2011	2002	2011	2002	2011	**2002**
Cattle	455	459	213	223	236	235
Sheep	1,021	821	520	375	499	445
Pigs	577	168	87	81	483	88
Horses	19	22	649	13	12	9
Goats	65	50	38	40	27	10
Poultry	18,703	7,142	8,789	4,514	9,653	2,628

Table 2: Estimated Manure Production and Nitrogen in BiH in 2011

Type of livestock	Number of animals (thousand)	Fresh manure per animal in t/ year	Total manure production in t/ year	Quantity of N in kg t^{-1} of manure	Total N production from manure in t/year
Cattle	455	8.7	3,954,000	4.5	17,793
Sheep	1 021	0.53	540,360	10.0	5,404
Pigs	577	1.18	681,480	5.0	3,407
Horses	19	4.8	91,200	5.5	502
Goats	65	0.7	45,500	10.0	455
Poultry	18 703	0.006	112,218	15.0	1,683
Total			5,424,758		29,244

 DOI: 10.18380/SZIE.COLUM.2014.1.1.13

From a total of 1,009,000 hectares of ploughed fields and gardens, the sowed area in 2011 totaled 527,000 ha or 52.2%, about 4,000 ha was under nurseries, while 478,000 ha or 47.4% were fallow and uncultivated area (Agency for statistics, 2012).

Organic fertilizers – manure is a serious source of water pollution as well as pollution of environment in general, but on the other hand it is a considerable source of biogenic elements required by plants. Tables 1 and 2 show data on livestock numbers and quantity of produced manure and nitrogen.

In the past decade there has been an increase in number of sheep by 24%, pigs by 343% and poultry by 261%. Produced quantities of manure and nitrogen from it represent significant sources of diffuse pollution whose ultimate destination are the watercourses. In addition to manure, a lot of mineral fertilizers such as urea, 27% KAN and complex NPK fertilizers, usually 7:14:21 and 15:15:15 are used in BiH. However, the quantities of mineral fertilizers used in some crops are still very low, untimely applied and with inadequate NPK ratio.

According to some information, mineral fertilizers are applied on arable land, primarily ploughland, in the amount of 30 kg of P, 30 kg of K and about 50 kg of N per hectare, which is only 1/3 of the required dose. The reason is of an economic nature and has to do with poor position of the agrarian sector in society. Manure has been increasingly used in organic farming and production of vegetables in greenhouses and outdoors.

Emission of pollutants by catchments

BiH is divided into basic river basins as follows: Una, Vrbas, Bosna and Drina flow to the Sava River, which flows into the Danube, while the Neretva, Trebišnjica and Cetina flow to the Adriatic Sea. The biggest emission of organic pollution, then nitrogen and phosphorous comes from the Bosna River basin (around 20%). This is followed by Una (15%), Sava (13%), Drina (12.5%), and Vrbas (around 10%). About 30% of above mentioned pollutants goes to the catchment of Adriatic Sea. All watercourses should reach "Good Ecological Status" by 2015 with the exception of four water bodies on the Bosna River. All bodies under pressure were classified as "Exposed to risk in the first approximation". Because of this it is necessary to develop a strategy of sustainable soil and water management and make agriculture a generator instead of a victim of development. In such conditions, the issues of managing animal manure and other animal and human waste in rural areas will be not easy to solve.

The best practices of managing diffuse pollution can be grouped into structural, such as the construction of appropriate basins for the collection and storage of manure, change of method and timing of soil tillage, application of organic and mineral fertilizers, sowing structure (Šarić et al., 2004); and non-structural ones which pertain to the prevention of pollution through education, institutional measures etc. (Ćerić et al., 2003).

The application of measures of good agricultural practice aimed at preventing the formation of sources of diffuse pollution is necessary if we are to protect the water, soil and nature. In our circumstances this can be achieved by introducing the measures of good agricultural practice through integrated production and organic farming. At the state level of BiH, the area under organic farming, both certified and in the process of conversions, is 681 ha. This area is cultivated by 92 organic farmers (GIZ, 2012). Organic farmers try to be self-sufficient when it comes to crop nutrition and thus aim to ensure that as many nutrients as possible are recycled on the farm. Consequently, manure and slurry from housed livestock are carefully managed during storage and application to minimize nutrient losses.

Crop rotation is a fundamental measure suitable to maintain and improve soil fertility, stabilize humification and mineralization processes,

increase water and nutrient efficiency, microbial activity of soil and nitrogen intake. In organic farming a principle has been established "plough shallow, hoe deep". The principle is to turn soils as little as possible. This implies that the most suitable way of tilling the soil is through various soil-protecting methods, using cultivators and various attachables, rotating harrows, etc. Generally, on lighter soils and in wet conditions, farmyard fertilizer is applied deep, while on heavier soils and in drier conditions only shallow. It is advisable to fertilize with organic fertilizers more often, i.e. in intervals of 2-3 years and with smaller doses (Šarapatka et al., 2009). If the vegetation is seen as a barrier to surface and underground flows of nutrients, the role of vegetation cover in many strategies to control diffuse pollution sources becomes very important. Growing of cover crops of oat and rye in alternation with corn and soybean leads to the reduction of nitrate losses for more than 70% (Longsdon et al., 2002, cit. Oljača and Dolijanović, 2013).

Conclusions

Diffuse pollution from agriculture, especially from organic manures, poses a considerable problem in Bosnia and Herzegovina as it has never been addressed institutionally, and the increase in livestock can only contribute to an increase of diffuse pollution of water from agriculture.

The application of measures of good agricultural practice through organic farming can be the directions of agricultural development that will contribute to the reduction of such pollution, especially with regard to the fact that this type of production has been certified and that the protection of environment is one of the postulates on which it operates, and the possibilities for its expansion in the territory of BiH are there.

Diffuse pollution is a wide spread problem which affects the quality of surface and ground water in both rural and urban areas. Agricultural activities that cause diffuse pollution are mainly related to livestock farming. Livestock farming causes soil compaction, excessive grazing and overproduction of manure. The situation is further aggravated by the application of mineral fertilizers, protective and other chemicals, while the size of the load will depend on the type and amount of applied matters, type of soil and scale and intensity of precipitation. Diffuse pollution can be discharged into (or transported over) the land surface, atmosphere and rivers, lakes and ground waters.

Acknowledgements

Research has been support from the project "Agricultural Adaptation to Climate Change – Networking, Education", as a part of the Norwegian Programme in Higher Education, Research and Development (HERD) in the Western Balkans.

References

Agency for Statistics of Bosnia and Herzegovina (2013): First release, BiH ICPDR (International Commission for the Protection of the Danube River, 2012.

Čustović H., Mirza T. (2006): Soil Condition Index-(SCI) as an indicator of the soil organic matter dynamics at the farm Butmir near Sarajevo. Cereal Research Communications. 34: 1. 139-142. DOI: 10.1556/CRC342006.135

Ćerić, A., D. Selmanagić, D. Jabučar, B. Vučijak, A. Kalem-Perić, H. Čustović, N. Zerem, J. Bjelavac, R. Alić (2003): Upravljanje difuznim zagađenjem. Institut za hidrotehniku Sarajevo.

Oljača, S., Ž. Dolijanović (2013): Ekologija i agrotehnika združenih usjeva. Poljoprivredni fakultet Beograd.

Mesić, M., F. Bašić, I. Kisić, A. Butorac, Ž. Zgorelec, I. Gašpar, I. Vuković, K. Sabljo (2007): Rezultati znanstvenih istraživanja kao podloga za procjenu utjecaja poljoprivrede na onečišćenje vode dušikom. Proceeding 42nd Croatian and 2nd International Symposium on Agriculture, 11-20.

Study on the organic potential in South East Europe, GIZ, 2012.

Šarapatka, B., J. Urban (2009): Organic agriculture. Prague.

Šarić, T., Š. Muminović, M. Đikić, D. Gadžo (2004): Smanjivanje zagađivanja okoline stajskim đubrivima. Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu. 54. 15-25.

 DOI: 10.18380/SZIE.COLUM.2014.1.1.13