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Abstract

Nowadays, the concept of sustainable and circular bio-economy is completely acceptable. Increasing demand for safe food for growing human population, biodiversity management, water quality, sustainable development under new challenged climatic changes and the progress of the animals' status are in the center of the researchers' interest as well as EU policies. Animal production provides high protein components of humans' diet with essential amino-acids and micronutrients. The time has come for the change of the attitude that livestock production is a polluter and pollutant of the environment, and hopefully it is ending with partial research of greenhouse gases production. The prerequisites for a rational and purposeful observation of animal production as part of a holistic and sustainable development, in the service of environment protection, biodiversity preservation and vitality of the area maintenance, are described within the project "Implementation of cross border cooperation toward environment protection-IMPACT-ENVI". The need for the use of manure in keeping the soil fertility and raising the content of organic matter has been demonstrated. At the same time, there was no overfeed by protein in animal rations, so there is no danger of excessive nitrogen excretion into the environment.

Key words: livestock production, circular economy, sustainability

Introduction

Although research and market demand for interconnected production have long existed, better interconnection between producers and consumers of agricultural products is demonstrated by current EU documents seeking sustainable circular bio-economics. The bio economy encompasses the production of renewable biological resources and the conversion of these resources, residues, by-products and side streams into value added products, such as food, feed, bio based products, services and bioenergy. From 2005 number of public citation with the terms bio-based and bio economy raised rapidly (Staffas et al., 2013). The term is defined as: "a bio-based economy integrates the full range of natural and renewable biological resources—land and sea resources, biodiversity and biological materials (plant, animal and microbial), through to the processing and the consumption of these bio-resources" (EC 2011). This is confirmed by many European documents in which is pointed that the emerging bio economy is moving from research niche to market norm and Europe needs to maintain its current global leadership (COM 2012, COM 2016, SWD 2017, COM 2018). A recent conference in Brussel (Sustainable and circular Bioeconomy, the European way, 22. 10. 2018) had the focus on the "neediness for establishing a sustainable and circular bio economy to enhance the transition in a changed EU policy context and towards a new environmental, social and economic reality. It also started the discussion about synergetic actions across different priority areas:

- support strategic research and innovation, and strengthen support for education and training,
- upscale the bio-based sectors, mobilize investments, support the creation of markets, develop better monitoring,
- encourage the adoption, update and coherence of national and regional Bioeconomy Strategies throughout Europe with citizens' engagement,
- strengthen the understanding and resilience of land and sea ecosystems,
- monitoring and assessment of bioeconomy development."

In the spirit of listed items, the role of livestock production in the whole eco bio systems has a crucial role. There is an awareness that the circular economy will boost the EU's competitiveness by protecting businesses against scarcity of resources and volatile prices, helping to create new business opportunities and innovative, more efficient ways of producing and consuming. It will create local jobs at all skill levels and opportunities for social integration and cohesion. At the same time, it will save energy and help avoid the irreversible damages caused by using up resources at a rate that exceeds the Earth's capacity to renew them in terms of climate and biodiversity, air, soil and water pollution. A recent report also points at the wider benefits of the circular economy, including in lowering current carbon dioxide emissions levels. Action on the circular economy therefore ties in closely with key EU priorities, including jobs and growth, the investment agenda, climate and energy, the social agenda and industrial innovation, and with global efforts on sustainable development.

Many farmers are not only commodity producers but also providers of quality food and managers of the eco-system. A public goods-oriented bio-economy emphasizes agro-ecological methods, organic and low (external) input farming systems, ecosystem services, social innovation in multi-stakeholder collective practices and joint production of knowledge. The potential of farmers and SMEs to contribute to innovation must be fully recognized. This approach recognizes the importance of local knowledge enhancing local capabilities, while also accommodating diversity and complexity. Therefore, the bio-economy concept should have a much broader scope than the dominant one in European Commission innovation policy (Schmidt et al., 2012). The first step in involving animal production in a positive way is a fact that using manure, as a bio-resource and the ecological cycle regulator, maintains soil organic matter content and fertility. Animal manure is a source of nutrients and organic matter and it is irreplaceable. The livestock production should be also the initiator for vitalization of rural areas, rising employment, preserving biodiversity and landscapes, protecting cultural heritage. The future task for each country would be to push integration processes in crops-livestock-(others) plant productions and new technologies for application.

In addition to growing food needs, the agronomist industry is faced with finding new final products, environmental protection and competitive agriculture involving both public and private actors (Herpin and Charley, 2008). There is a demand for reconciliation between the animal breeding and the environment protection. Every research in the future should include and integrative approach. There is a large potential of progress and innovation. The most prominent organizations take care about animal health, according to the European Commission's recently published proposal for a new common agricultural policy (CAP). They were debating what innovations are needed in terms of animal health to support future livestock farming, and how food production will develop in the future, the consensus was that complimentary actions focusing on resource efficiency, integrated animal health management, responsible farming systems and knowledge exchange can all contribute to ensuring the implementation of new techniques, tools and practices to deliver.

The IMPACT-ENVI project

From 2017 Faculty of agrobiotechnical sciences Osijek (FAZOS) runs the Interreg IPA CBC project under the title "Implementation of cross border cooperation toward environment protection-IMPACT-ENVI". Four partners (FAZOS, University Educons from Sremska Kamenica, Institute of Field and Vegetable Crops Novi Sad and Trade-industrial high school in Županja) from two countries (Croatia-Serbia) tries to find out critical points in soil and plant management, crop and vegetables production and livestock production. The aim is to raise the awareness of influence of agricultural activities on the environment and humans' life. The main objective of the project is to enforce integrated cross-border monitoring/management systems for key existing risks and environmental and biodiversity protection. Both project areas (Vojvodina and Slavonia) are high-risk areas, mainly because of the intensive agricultural production challenged with the climate changes. Croatia is a member of the EU and so it must meet the obligations of the EU Regulations and Directives as well as goals of European strategies in terms of reducing climate changes, water conservation, management of environmental risks and protecting biodiversity, landscapes and air and soil quality. Serbia, as a future EU member, has opportunities for creating preconditions for establishing good agricultural practice, in terms of environment preservation and protection. In order to achieve the EU objectives, activities which will result in developing awareness of pollutants originating from agricultural production, developing knowledge on natural values and protecting environment and health of population, need to be carried out. Carrying out those activities will, in the end, result in risk reduction. Joint cross-border initiative is used for raising awareness and interest of the community for revitalizing and improvement of agricultural production, environmental protection and food quality. Therefore, the on-going project will provide a knowledge platform about

the impact that sustainable agricultural production has on protecting the environment and quality of life. It will also educate the community about sustainability of agricultural production and its role in preserving environment and biodiversity, through various scientific and professional educational materials.

Material and methods

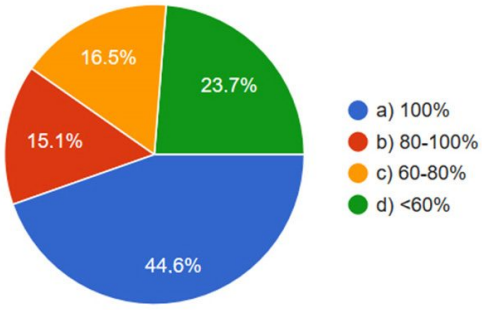
Project activities are divided in several groups according to main outputs they carry out:

1. Survey research on awareness of agricultural producers with the risk of environmental pollution by agricultural activities
2. Establishing joint screening on soil, water, livestock, diseases, pests, invasive species and crop and vegetable production status in project area
3. Implement education of good agricultural practice
4. Improve skills and knowledge in agricultural sector.

Chemical analysis of soil was performed used different methods: organic C according to HRN ISO 142351998, hydrolytic acidity, Ca CO3, AL P2O5 and total nitrogen by Lončarić et al. (2015). The nitrates and nitrites from water are determined by semi-quantitatives Quantofix® languettes (Macherey-Nagel, Germany). The analyses of the diets were carried by AOAC (2000) methods in order to determine the dry matter (934.01), the nitrogen content and the crude protein content by destruction in block (992.23), the crude fibre by a Ceramic fibre filter method (962.09) and fat by the Soxhlet method (991.36 AOAC, 1995).

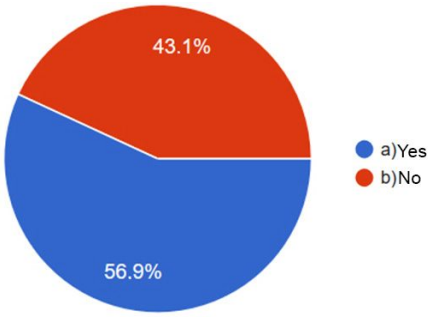
Results

The Nitrate Regulation was adopted in 1991 to reduce or prevent further water pollution from nitrates of agricultural origin. The Regulation requires a new approach to agriculture, both by competent institutions and by agricultural producers. Until now, new Regulation (EU 2018) on organic production was established which confirm the effort of the whole community to protect the soil and the environment. The decision on the determination on vulnerable regions in the Republic of Croatia was established in 2012 (NN130/2012) and Action program of water protection from nitrates pollution from agriculture origin (NN 15/2013). In that framework our work has sense. In our research only 44.6% family farms have enough area of agricultural land for animal production, other have some, in different percentages (Graph 1).

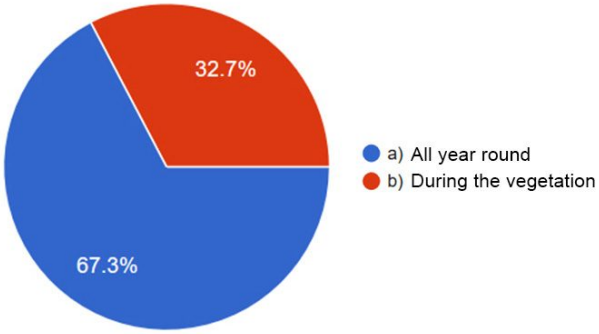


Graph 1 The share of farmers that have enough land for animal feed production within program area of IMPACT-ENVI project

Only 56.9% of farms have a manure management system (Graph 2). Only 32.7% of farmers know time which is proper for export manure to the soil, and 67.3% export it during the whole year (because of lack of adequate space).

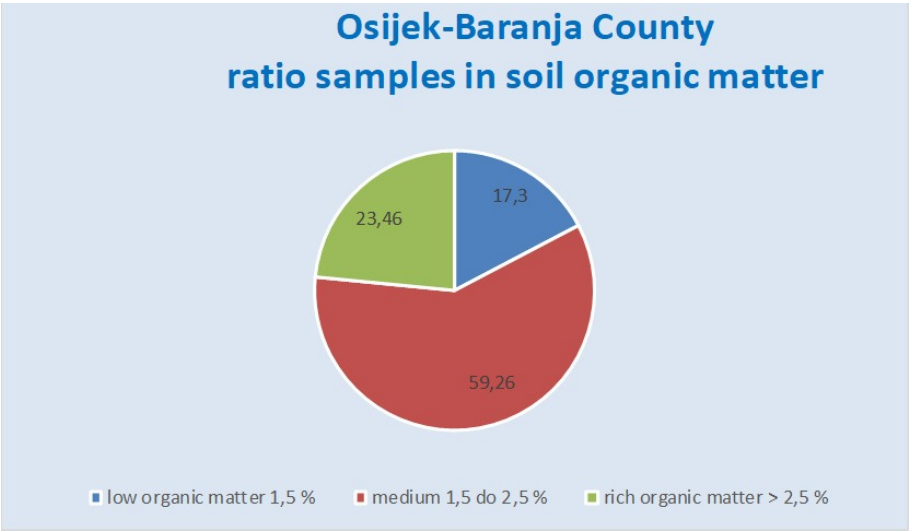


Graph 2 Percentage of farms within program area of IMPACT-ENVI project that has developed manure management system

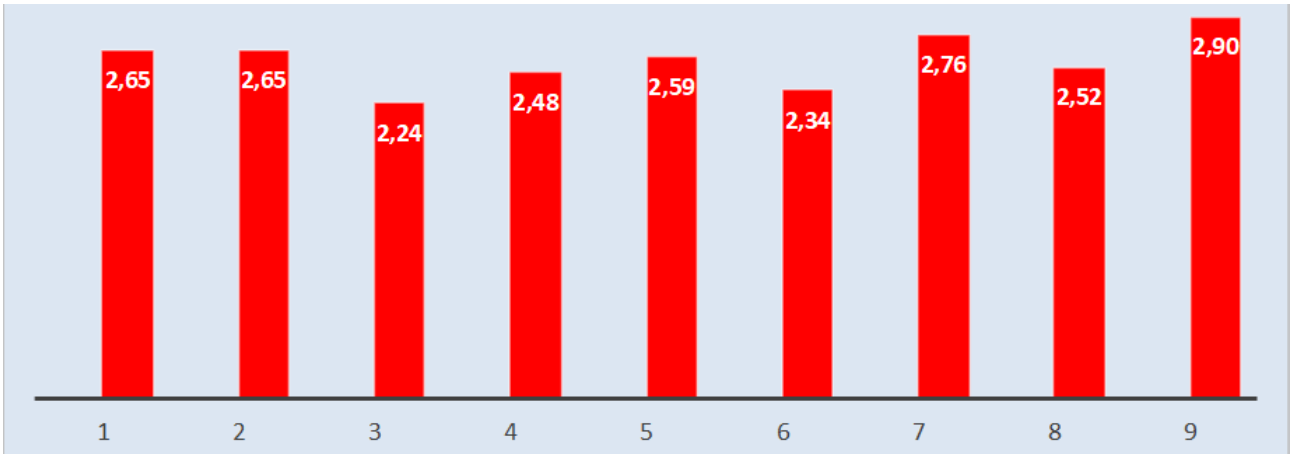


Graph 3 Percentage of farmers within program area of IMPACT-ENVI project which export manure on the agricultural land all year round

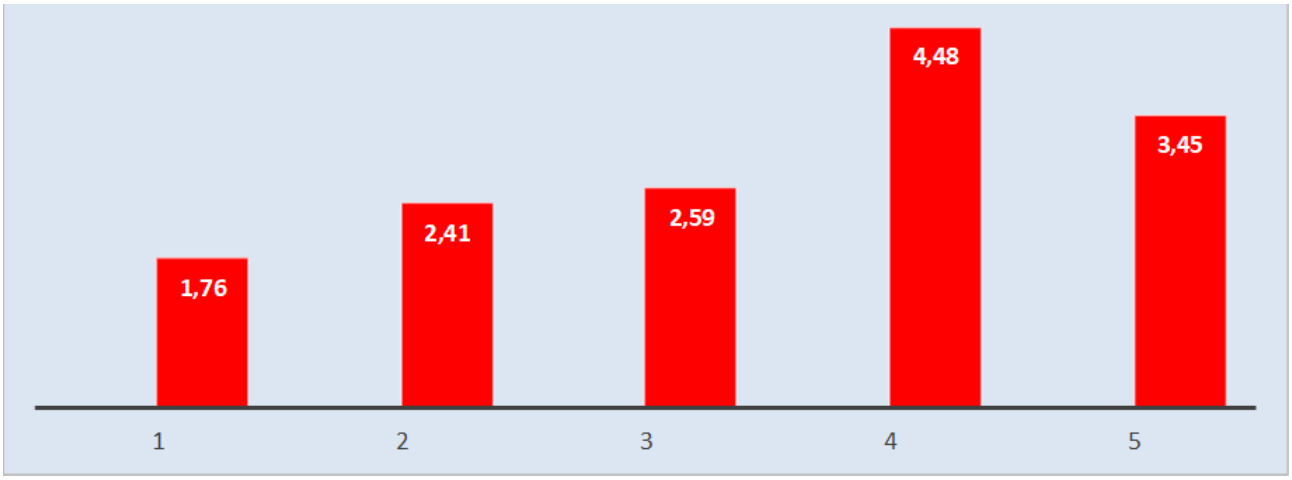
In the Osijek-Baranja County, a total of 105 soil samples were analyzed, of which more than 59% belonged to the class of humorous soil, 23.46% medium humorous class, and 17.3% to poor humus soil class (Graph 4). In other counties we analyzed less samples, so next graphs show individual results from each region. Surprisingly, all soil samples from the Vukovar-Sriem County belonged to the soil poor in organic metter, but in Požega-Slavonian County we found huge differences, depending on soil management and agricultural orientation (ecological vs. conventional productive system). Similar situation we found in Brod- Posavina County.



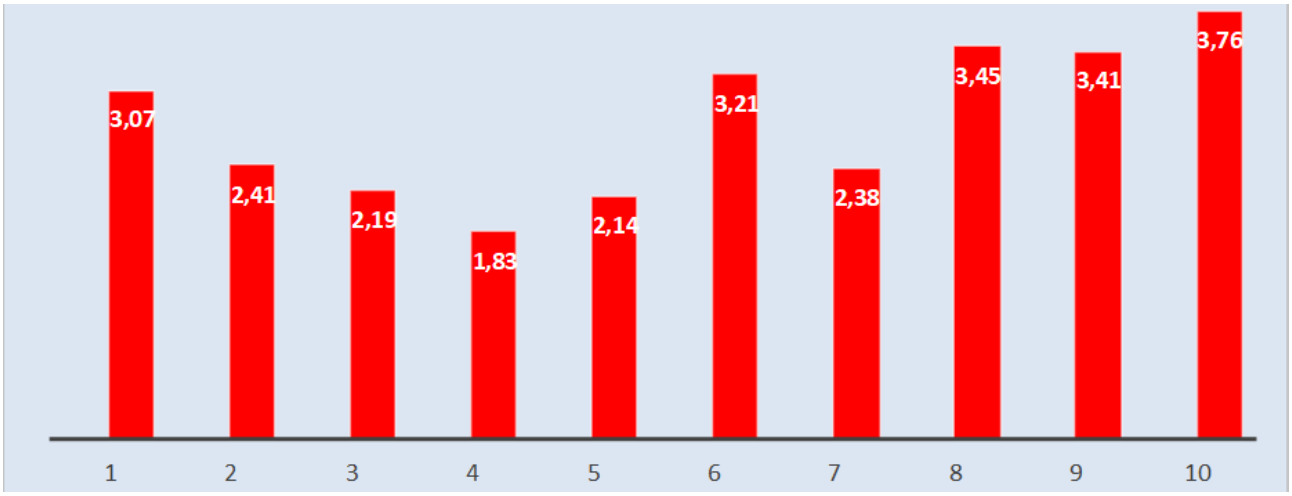
Graph 4 Share of soil samples collected within program area of IMPACT-ENVI project with different organic matter percentage



Graph 5 Share of organic matter in samples collected within Vukovar-Srijem County area of IMPACT-ENVI project

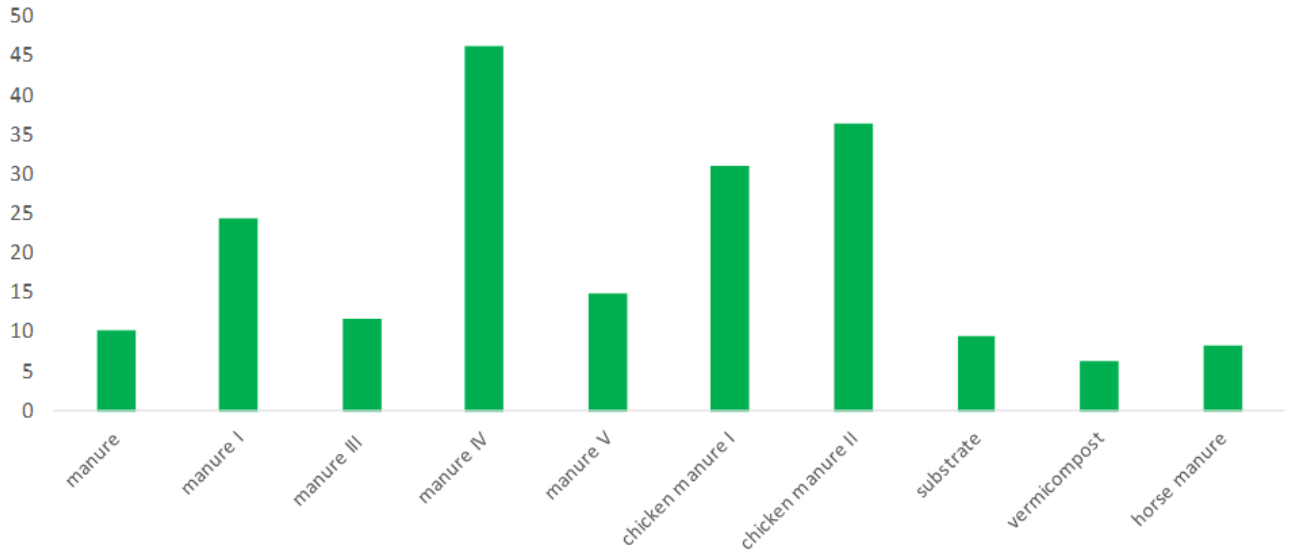


Graph 6 Share of organic matter in samples collected within Požega-Slavonia County area of IMPACT-ENVI project



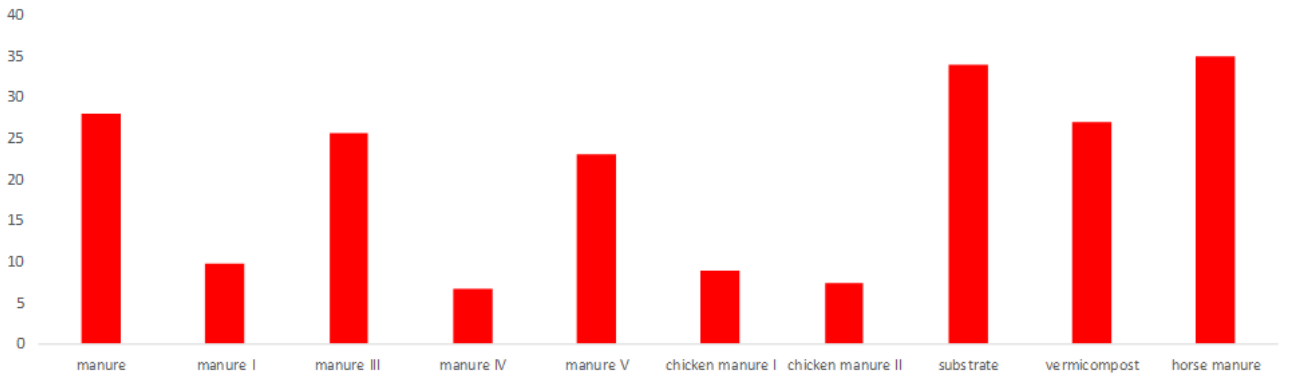
Graph 7 Share of organic matter in samples collected within Brod-Posavina County area of IMPACT-ENVI project

A total of 10 organic fertilizer samples were analyzed, and they were of different origin and degree of maturity. Most of the samples were either unfermented or not completely fermented, resulting in an unfavorable C/ N ratio and/or a lower nitrogen content.



Graph 8 Nitrogen amount in different fertilizer samles collected within program area of IMPACT-ENVI project (N total g/kg ST)

Organic fertilizers with a nitrogen concentration above 20 g/kg are categorized as most favorably with good fertilizer effect. Based on the obtained results, only two samples had a higher nitrogen content of 20 g/kg ST while the others had a lower nitrogen content.



Graph 9 C/N ratio in different fertilizer samples collected within program area of IMPACT-ENVI project

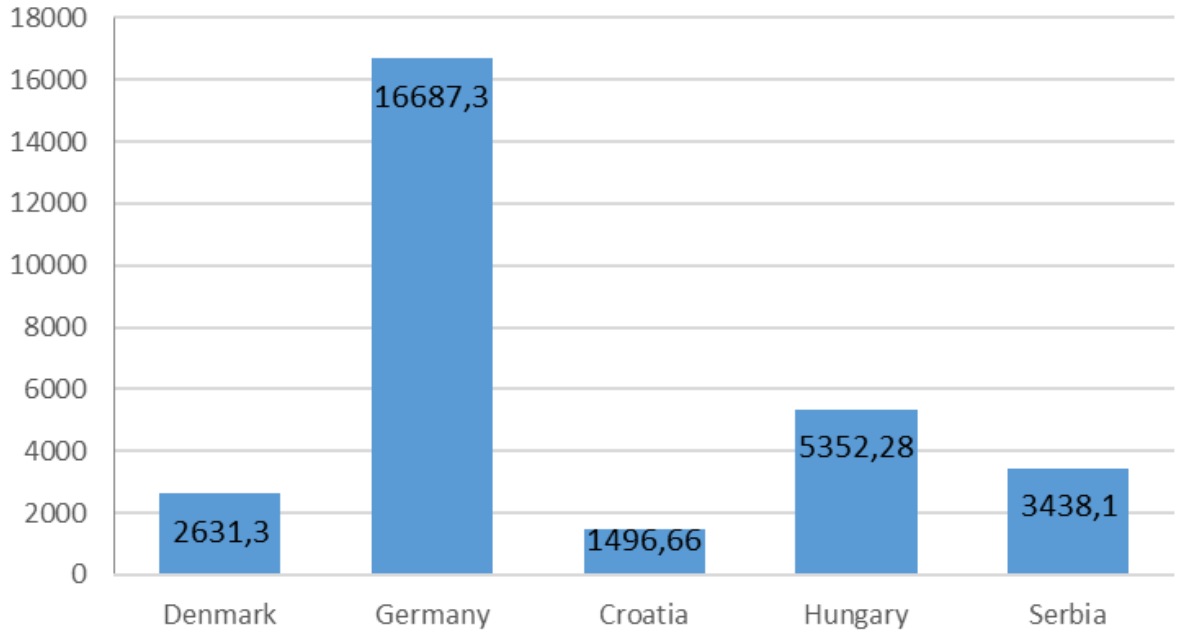
If the C/N ratio in the organic fertilizer is 10:1 or lower, this indicates the stability of the organic fertilizer and its prolonged activity in the soil. Increasing the C/N ratio to 40:1 results in reduced fertilizer stability, which reduces its supplemental fertilization value.

In our investigated organic fertilizers, the C/N ratio ranged from 7:1 to 35:1 so that only two samples belonged to a group of fertilizers with a reduced additional fertilization value, and no fertilizer did belong to a group of fertilizers with a limiting fertilization value.

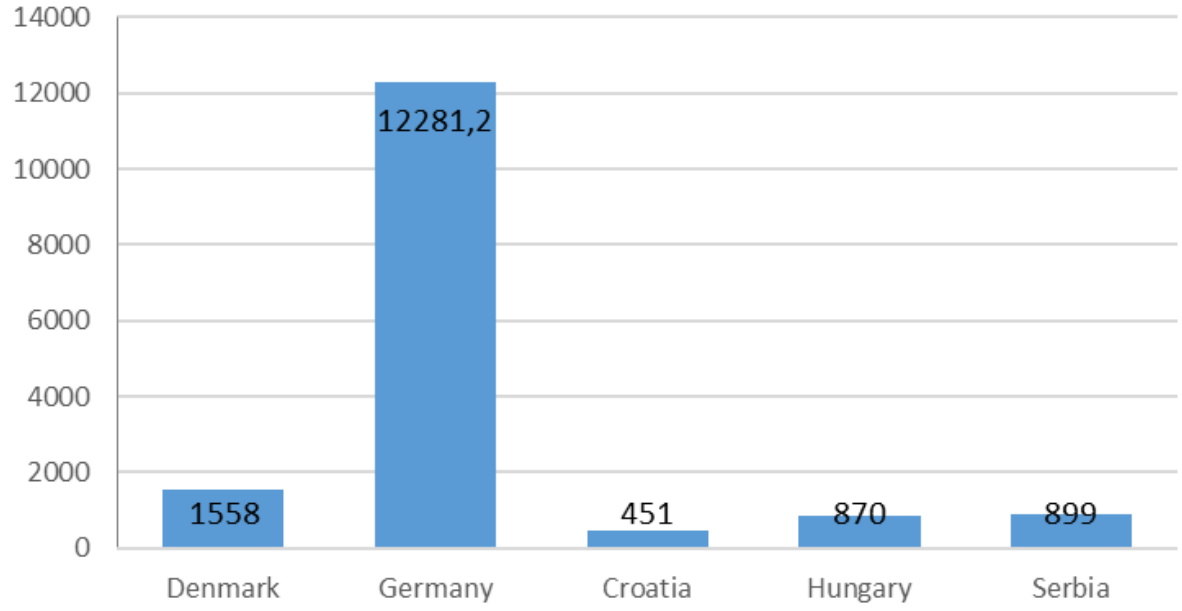
As can be seen from Graph 9 only 40% of the manure samples had C/N ratio under 10:1 which is indicator of high quality fertilizer. In addition to this many of the manure samples were not even considered to be analyzed because they were unfermented. This is the consequence of inappropriate manure management, which was detected during

farm visits within IMPACT-ENVI project. Manure is not manipulated according to EU BAT (2017) techniques. Low capacity for on farm manure storage means that it has to be transported on field before maturation time has passed, and all year round (Graph 4) On field deposition and lag of application time means that lot of nutrients from manure piles ends up either in the air (ammonia) or in the underground water. This causes pollution of water with nitrates, as determined with well water analyses within IMPACT-ENVI project as scattered contamination. Some of the well water within program used for the crop and vegetable production was heavily polluted with nitrates (150-200 mg/L).

Despite similar population in Denmark, Croatia has the lowest agricultural area (Graph 10) and last year it produced the lowest number of swine and bovine animals (Graph 11).



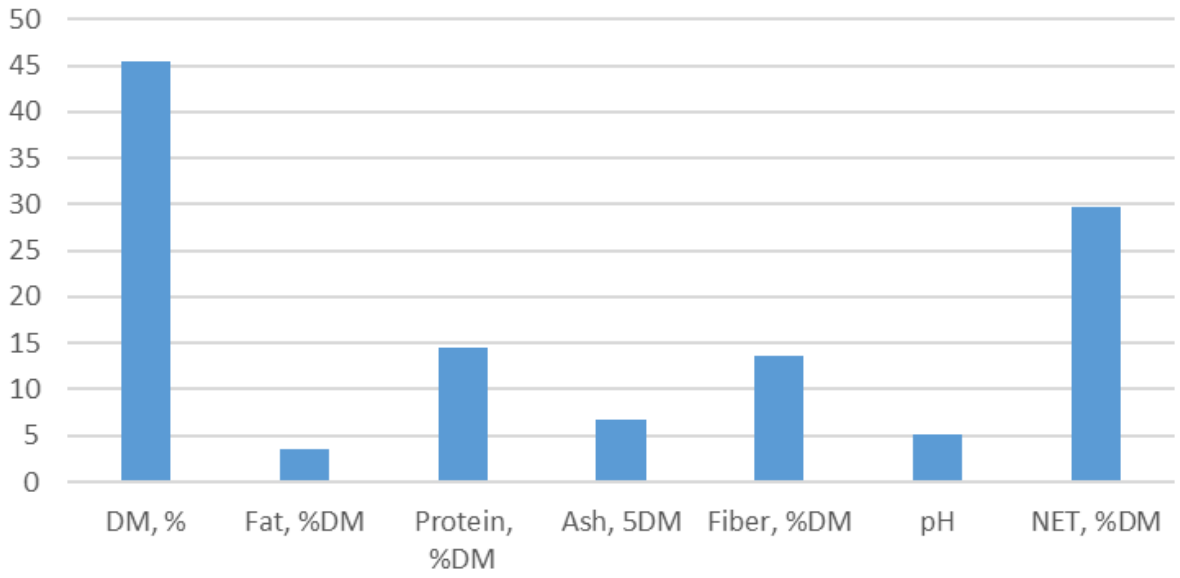
Graph 10 Utilized agricultural land in Croatia and selected European countries (in thousand hectares; Eurostat, https://ec.europa.eu/eurostat)



Graph 11 Number of bovine animals in Croatia and selected European countries (in thousands animals; Eurostat, https://ec.europa.eu/eurostat)

The main problem with manure management in Croatia is not the high number of animals (Graph 11) and consequent lack of utilized agricultural land (Graph 10) to apply manure on, but rather unorganized manure market or distribution system which could adequately distribute it. Focal points with high animal production concentrate manure distribution on small areas, producing risk for soil and ground water pollution. At the same time there are areas lacking nutrients and organic matter in soil (Graph 4, 6).

One of the possible problem related to the animal production is overfeeding with protein in animal ration and consequential load of nitrogen to the environment. Within IMPACT-ENVI project among other feed constituent's protein content of feed on dairy farms was analyzed. Determined values showed that protein content was not above recommended limit but rather adjusted to the milk production level (Graph 12). During the project we collected and determined chemical content of total mixed rations for dairy cows to check whether the nutrition is optimized for the animals' needs and milk production. Unfortunately, statistical analysis and mean of observed parameters did not show the real situation. Every farm has some disturbances (protein content, fat content, NET) which means that every productive unites need individually approach. Still, summarized results show low protein and fat content for this production type (Graph 12).



Graph 12 Chemical composition of total mix ration from dairy farms within program area of IMPACT-ENVI project

Conclusion

Republic of Croatia carries out procedures for harmonizing regulations with EU regulations and directives for environmental protection from livestock production. It is necessary to establish a sustainable manure management system as an irreplaceable soil improver in areas where soil fertility is impaired due to the long-term use of mineral fertilizers. There are scattered points of poor humorous soil, as well as those overloaded with nitrates. By comparing animal production per unit area with developed countries, the Republic of Croatia has the potential to increase animal production without negative environmental impacts by applying the best available technics (BAT) in agriculture.

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Uloga stočarske proizvodnje u održivoj kružnoj bioekonomiji

Sažetak

U današnje vrijeme prihvaćen je koncept održive cirkularne biokonomije. Povećani zahtjevi za sigurnom hranom za rastuće stanovništvo, održavanje bioraznolikosti, kvaliteta vode, održivi razvoj u uvjetima klimatskih promjena i podržavanje dobrobiti životinja u središtu su brojnih znanstvenika, ali i politike EU. Namirnice animalnog podrijetla izvorom su vrijednih proteina, esencijalnih aminokiselina i mikronutrijenata. Došlo je vrijeme kritičkog promišljanja o stočarstvu kao zagađivačima okoliša i kraj parcijalnim istraživanjima proizvodnje stakleničkih plinova. Preduvjeti za racionalnom i učinkovitom procjenom stočarske proizvodnje kao dijelom holističkog i održivog razvoja, u službi zaštite okoliša i preduvjeta očuvanju vitalnosti područja opisana je u projektu "Utjecaj dobre proizvođačke prakse u zaštiti okoliša IMPACT-ENVI". Pokazana je potreba korištenja stajskog gnoja u održavanju plodnosti tala i podizanju sadržaja organske tvari. Istovremeno, nisu nađena prekoračenja uporabe proteina u hrani za životinje, pa nema opasnosti od pretjeranog izlučivanja dušika u okoliš.

Ključne riječi: stočarstvo, cirkularna bioekonomija, održivost