CHAPTER VII

EVALUATION OF ECOLOGICAL SUSTAINABILITY WITHIN THE AGRICULTURE OF THE DANUBE REGION IN THE REPUBLIC OF SERBIA[92]

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ABSTRACT

Specialization of production and intensive use of mechanization, energy, pesticides, mineral fertilizers, concentrated animal feed and newly established varieties and races imply serious consequences for the environment and agro-biodiversity. In order to ensure sustainable development, protection of agro-environment and preservation of food quality and food safety, imposes the need for renewal of the relations between agriculture and nature. According to that, sustainable agriculture (also known as bio-economics) is established and developing, and it includes: ensuring of food safeness (quantitatively, qualitatively and structurally); preservation of natural environment; valorisation and efficient use of agricultural resources; improvement of agriculture competitiveness (on domestic and foreign market) and realization of production surpluses; gaining of balanced and stable farmers' incomes and growth of living standard of population that live in rural areas.

Depending on regional specificities of production area, environmentally sustainable production systems and techniques in agriculture differ among themselves, but also they have a lot in common, which are before all related to ensuring and improvement of soil fertility and more rational application of pesticides and mineral fertilizers. Faced with the essential requirements of economic and ecological efficiency achievement, in other words production profitability with minimal risk of environment violation, Serbian agriculturalists strive to adjust their production as much as possible to the regulations of good agricultural practice.[93]

Using the methods for evaluation of the ecological sustainability on the agricultural husbandries, authors were directed their research to the selected family husbandries within the defined territorial units of the Danube region in Serbia, as are: the area of the Upper Danube region, within the

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[93] Codex of Good Agricultural Practice represents a minimal standard for management to agricultural husbandry, relating to: protection of natural resources; environmental management; manpower safety; health and welfare of animals; safety of food and feed; health care, etc.

Metropolitan area Belgrade – Novi Sad (also known as the Central Danube region) and in the Carpathians (also known as the Lower Danube region). The main goal of research is to express and compare the willingness of family husbandries in the Danube region within the Serbia toward respect of the current requirements that are imposed by environment-friendly production in agriculture.

KEY WORDS: ecological sustainability, agriculture, family husbandries, Danube region, Republic of Serbia.

INTRODUCTION

Under term *sustainable agriculture*[94] Food and Agriculture Organization of the United Nations (FAO) considers management and preservation of natural resources, as well as direction of technological and institutional changes towards achieving and continuous fulfilment of needs of current and future generations. According to definition, sustainable development (in agriculture, forestry and fishery) has the function of land, water, plant and animal resources conservation, it does not endanger environment, technically is applicable, economically viable and socially acceptable.[95]

Depending on regional specificities, or from production potential of available natural resources, different measures, systems and techniques of sustainable production in agriculture are applied.[96] In accordance with the rules of good agricultural practice, characteristics of sustainable production are expressed through their contribution to sustainable land management and preservation of agro-biodiversity.

Also, in previous years, many countries started with implementation of the support measures to the production of non-market goods in agriculture, as well as to combination of production activities in the agricultural sector and development of rural tourism and physical and social infrastructure within the multifunctional agriculture. Therefore, the FAO defines multifunctional character of agriculture as a function that contributes to food safety, and possesses different ecological, economic and social functions.[97]

Management under agricultural land based on the principles of sustainability considers measures and activities that have to be taken in order to pre-

[94] Sustainable Agriculture and Rural Development – SARD.

[95] Đekić, S. (2005): *Održivost i multifunkcionalnost poljoprivrede*, Ekonomika, Niš, vol. 51, no. 3, pp. 56-63.

[96] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11.

[97] Pingault, N. (2001): *Une évaluation multicritère pour des politiques multifonctionnelles*, Notes et études économiques, no. 14, pp. 51-69, UMR INRA-ENESAD CESAER, Dijon.

serve the natural functions of soil and its use, as well as in order to protect and improve it in line with its main purpose (FAO, 1998). Accordingly, protection, regulation and use of agricultural land are regulated by the Law on agricultural land.

When in focus is protection of agricultural land, by the Law are regulated measures that relate to:[98]

- change of use and fragmentation (atomisation) of arable agricultural land;
- ban for dropping and putting off of hazardous and harmful substances on agricultural land and within the irrigation and drainage canals;
- obligation for determination of the existence of hazardous and harmful substances into the agricultural land and irrigation water;
- undertake of anti-erosion measures (ban to plough the meadows and pastures, as well as other surfaces and their transfer into the arable land under annual crops; establishment of crop rotation; cultivation of perennial plants (fruits and vine); building of specific facilities; way of agricultural land cultivation; establishment and growing of agri-protection areas and perennial plants; ban of livestock grazing or limitation of number of animals within the certain areas; ban of deforestation over the endangered parcels; etc.);
- obligation to conduct the control of fertility, as well as to control the volume of injected industrial mineral fertilizers and pesticides into the arable land (from I to V class);
- field damages (including the ban to incinerate the organic residues after harvest, before all crops such are wheat, barley, corn, sunflower, etc.);
- protection from natural disasters (with special accent to damages caused by hail and floods).

In the area of agricultural land arrangement, by the Law are regulated the measures that relate to land consolidation and reclamation.

The area of use of arable land and pastures is also regulated by the Law. In this case are prescribed measures that oblige the owner (or user of parcel) to always cultivate the arable agricultural land and use the pastures in a sustainable way (transferring them to other culture only in certain circumstances), acting at that time as good host according to the Codex of good agricultural practice.

Agro-biodiversity considers diversity and variability of animals, plants and micro-organisms that are directly or indirectly used in nutrition and agriculture, including plant products, livestock, forestry and fishery. It includes diversity of genetic resources, species and agro-ecosystems, as well as organisms that support the production of biomass, fertility and productivity of agro-ecosystems (soil micro-organisms, predators, pollinators), (FAO, 1999).

Under the application of different systems and techniques of sustainable production in agriculture is considered an orientation toward local species, varieties and hybrids, combining of number of crops that are simultaneous-

ly or successively grown in surrounding of wild plant communities, combined plant-animal production, etc. Such sustainable production favours the preservation of soil biodiversity, genetic, species and ecosystem biodiversity in agriculture, it enables biological protection from diseases and pests and pollination, provides recycling of inputs, or increases the efficiency of agro-ecosystems and contributes to the protection of water, air and climate.[98]

Observing the geographical location, special reserve of nature *Upper Danube region* lies along the left bank of the Danube River in the Republic of Serbia (from 1,367 to 1,433 km of the overall flow), it is a part of a large marsh complex (which extends through the two neighbouring countries Hungary and Croatia) and like that represents one of the last large flood areas in Europe. For the purposes of this research, the Upper Danube region is observed in a broader context and includes administrative area of the Sombor city and the municipalities of Apatin, Bač and Bačka Palanka.

Since it includes two major administrative centres (Belgrade and Novi Sad), *Central Danube region* is an administrative area in the Republic of Serbia, which has a high population density. Observed territory is consisted from four cities Belgrade, Novi Sad, Pančevo and Smederevo, as well as seven local communities with the status of municipalities Beočin, Irig, Sremski Karlovci, Inđija, Ruma, Pećinci and Stara Pazova. Under the influence of Belgrade and Novi Sad, mentioned territory can be freely called as the Metropolitan area Belgrade – Novi Sad.

Having in mind the borders of the Carpathians within the Republic of Serbia, the area of *the Lower Danube region* covers administrative area of municipalities Golubac, Kučevo, Majdanpek, Kladovo and Negotin. It should be mentioned that across the largest part of the Lower Danube region extends the national park Đerdap and its protected zone.

In expectation of the codex of good agricultural practice and harmonization of national with EU legislation within the field of agriculture, this research is focused on the possibilities and willingness of family agricultural husbandries in the Danube region in Serbia to adjust their production to ecological requirements.

METHODOLOGY AND DATA SOURCES

According to character of the paper, during the writing was used IDEA (Indicateurs de Durabilité des Exploitations Agricoles) methodology. The methodology has been put into the practical use during 1999 after the request of the Ministry of Agriculture and Fishery of the Republic of France, who wanted to

[98] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11

adequately evaluate the sustainable development on agricultural husbandries. Mentioned methodology points out technical disadvantages and identifies directions for improvement of implemented methods of quantitative evaluation of agricultural practices that are considered suitable for certain biophysical and social environments. It is a reliable tool in decision-making process and can be used for every type of agricultural production system. It allows momentarily diagnosis for agricultural husbandry, by assigning of value for each set of criteria that correspond to the goals of sustainable agriculture. The method is consisted from three mutually independent scale of sustainability (economic, ecological and social) that also are not cumulative.[99]

According to Zahm et al., 2006,[100] the indicators have to apply the basic concepts taken from the definition of sustainable agriculture. *Economic viability* considers the efficiency of used production system as a way of income gaining within the unstable market and uncertainties surrounding direct payments. *Social livability* points out whether the taken activity on husbandry provides a decent professional and personal life for the agriculturalists and his family. It reconsiders relations between agriculturalists and certain social and community references. *Environmental reproducibility* of the ecosystems linked with the husbandries is analysed by the use of agri-environmental indicators that describes the impacts of applied practices on the environment.

Data that were used in this paper represent results of field research conducted in 2013 within the Danube region in the Republic of Serbia. Totally, 15 selected family husbandries were surveyed (5 from the territory of the Upper Danube region, 5 located in the Metropolitan area of Belgrade – Novi Sad and 5 from the Carpathians), where the developmental perspectives of mentioned husbandries are in the function of the ecological sustainability of agriculture.[101]

RESULTS WITH DISCUSSION

IDEA methodology is based on determination of few indicators that are often irreplaceable source of information during the decision making process. Accord-

[99] Subić, J., Arsenijević, Đ., Mihajlović, D. (2005): *Metode za ocenu održivog razvoja na poljoprivrednim gazdiunstvima*, Tematski zbornik sa međunarodnog naučnog skupa – Multifunkcionalna poljoprivreda i ruralni razvoj, Beograd, decembar 2005, IEP Beograd, pp. 253-267.

[100] Zahm, F., Viaux, P., Girardin, P., Vilain, L., Mouchet, C. (2006): *Farm Sustainability Assessment using the IDEA Method – From the concept of farm sustainability to case studies on French farms*, INFASA Symposium – From common principles to common practice, March 2006, Bern, Switzerland.

[101] It should be mentioned that according to the last agricultural census in Serbia (2012) dominate husbandries which are using up to 2 ha of agricultural land (47%), as well as husbandries that cultivate 2-5 ha (29%).

ing to beforehand defined task, the observed method for evaluation of sustainable development on agricultural husbandries generates four basic sets of indicators: a) for evaluation of economic effectiveness, b) for evaluation of economic viability, c) for evaluation of environmental sustainability, and d) for evaluation of social sustainability.[102] In this paper the focus is on methods for evaluation of environmental sustainability at selected agricultural husbandries located on the territory of the Upper Danube region, the Carpathians and the Metropolitan area of Belgrade – Novi Sad.

Diversity of animal species

Indicator *Diversity of animal species* considers number of different animal species and number of heads within the specific species on observed husbandries, primarily according to production activities that are carried out on the agricultural husbandries.

Generally, sustainable agricultural systems are leaning on three basic production lines animal, annual and perennial plant cultures. Valorisation of abundant and economise with rare (or non-renewable) resources imposes development of technical complexes that will support local productivity with a minimum of exogenous inputs, whereby animal breeding usually has unavoidable role for the sustainability of local ecosystems.[103]

Grown animals contribute to a better valorisation of local resources. They primarily converted grass mass and cereals, idle lands, hardly accessible terrains, by-products and labour into the value added.[104]

Livestock breeding has a long tradition in Serbia. On husbandries, before all depending of natural predispositions of the region in focus, different species and categories of domestic animals are present. From heads of heavy livestock usually are bred dairy cows and bullocks for fattening, pigs, sheep and goats, while in the group of small animals dominates poultry (broilers and laying hens). Livestock products can be in function of gaining of primary income or significant part of income at market-oriented agricultural husbandries. On other hand, in line with historical heritage in almost every commercial yard of farm can be find heads of certain species and categories of livestock that are

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[102] Subić, J., Arsenijević, Đ., Mihajlović, D. (2005): *Metode za ocenu održivog razvoja na poljoprivrednim gazdiunstvima*, Tematski zbornik sa međunarodnog naučnog skupa – Multifunkcionalna poljoprivreda i ruralni razvoj, Beograd, decembar 2005, IEP Beograd, pp. 253-267.

[103] Subić, J., Cvijanović, D., Marković, B. (2006): *Ocena ekološke održivosti na poljoprivrednim gazdinstvima u opštini Mali Zvornik*, Ekonomika poljoprivrede, IEP Beograd, br./N^0 TB (13-667), pp. 57-63.

[104] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11.

hold primarily for natural use of livestock products, in other words for preservation of food autonomy of the husbandries.

As it is known, level of overall development of agricultural production within certain country is under the great influence of the share of livestock in the structure of complete agricultural production. Aforementioned is more expressed by fact that the consumption of meat and meat products in the world increase faster than population growth.[105]

In next tables (Table 7.1, 7.2 and 7.3) are shown data about structure of livestock, gained from chosen agricultural husbandries from the territory of the Carpathians, the Upper Danube region and the Metropolitan area Belgrade – Novi Sad.

Table 7.1. Structure of livestock fund on the husbandries within the Carpathians

Husbandry	Animal species					
	milking cows	fattening bullocks	sheep	goats	pigs	poultry
I_c	4	6	25	-	12	25
II_c	2	-	53	11	-	15
III_c	4	5	22	-	15	26
IV_c	5	7	18	5	10	27
V_c	3	-	-	-	11	19

Source: According to survey of IAE, Belgrade, 2013.

According to data from Table 7.1, it can be concluded that husbandry IV_c possesses livestock fund with most expressed diversity, where the most presented are sheep and poultry. It is followed by husbandries I_c and III_c (they have also as the most presented animal species sheep and poultry). Husbandry V_c, according to number of animal species and total number of heads has on disposal the poorest livestock fund.

Since analysed territory has significant surfaces under meadows and pastures, on farms are often kept heavy animals, whose nutrition is based on grazing (sheep and cattle) or haylage during the winter period.

Generally, despite the favourable natural conditions livestock production within the Carpathians is underdeveloped, has an continuous fall in production volume and it is limited by unfavourable ambient for further development, as well as by low productivity in meat and milk production.[106]

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[105] Sarić, R., Roljević, S., Bekić, B. (2010): *Trends and developmental possibilities of meat industry*, Economics of Agriculture, SI-2, vol. LVII, IAE, Belgrade, Serbia, pp. 280-287.

[106] Paraušić, V., Mihailović, B., Kuzman, B. (2013): *Poljoprivreda, prehrambena industrija i razvijenost udruživanja u agroprivredi*, chapter in monograph – Stanje i mogućnosti razvoja održive poljoprivrede i ruralnog razvoja u Podunavlju, IAE Belgrade, pp. 120-141.

Table 7.2. Structure of livestock fund on the husbandries in the Upper Danube region

Husbandry	Animal species					
	milking cows	fattening bullocks	sheep	goats	pigs	poultry
I_u	3	-	20	8	33	47
II_u	4	20	12	4	23	46
III_u	10	6	7	-	18	42
IV_u	4	-	-	-	17	50
V_u	6	4	-	-	17	35

Source: According to survey of IAE, Belgrade, 2013.

Data from the Table 7.2 indicate that the husbandry II_u has on disposal the largest number of different animal species (mostly pigs and poultry). It was followed by husbandries I_u and III_u, while on the husbandry IV_u is present the poorest livestock fund (both, in terms of number of species and total number of animals).

How on analysed territory are significant surfaces under crops (source of energy and proteins in the feed), on farms are usually grown heavy animals in stable facilities, whose nutrition is mostly based on rations of complete forage mixtures and concentrates (dairy cows, bullocks in fattening, pigs and poultry).

It should be noted that during the previous period livestock production at national level was devastated, mostly by unstable and low support from the agricultural budget. Also, expressed oscillations of redemption prices of live animals and livestock products, presence of grey economy, problems of unstable and unorganized redemption channels, as well as low productivity on the husbandries affect quite a lot on the decrease of total livestock production.[107]

According to data from the Table 7.3, it can be concluded that husbandry II_m disposes with the highest number of different animal species (mostly pigs and poultry). It is followed by husbandry IV_m.

Within the Metropolitan area Belgrade – Novi Sad agriculture has an important role. Urban agriculture (intra-urban and peri-urban) implies the presence of different production systems (from low scale production systems in agricultural enclaves within the city core that mainly deals with vegetable, fruit and mushroom production, to intensive conventional agricultural production that includes broader palette of fresh food products (vegetable, fruit, milk,

[107] Paraušić, V., Mihailović, B., Kuzman, B. (2013): *Poljoprivreda, prehrambena industrija i razvijenost udruživanja u agroprivredi*, chapter in monograph – Stanje i mogućnosti razvoja održive poljoprivrede i ruralnog razvoja u Podunavlju, IAE Belgrade, pp. 120-141.

meat, etc.) for city green markets and retail chains in peri-urban zones) depending on ecological, social and economic capacities of certain micro area.[108]

Table 7.3. Structure of livestock fund on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Animal species					
	milking cows	fattening bullocks	sheep	goats	pigs	poultry
I_m	-	-	8	-	15	33
II_m	5	2	-	8	18	54
III_m	-	-	3	-	28	23
IV_m	4	1	-	-	9	30
V_m	2	-	-	-	17	22

Source: According to survey of IAE, Belgrade, 2013.

Although family agricultural husbandries are most often located in hinterland of bigger consumers' centres, they are more and more affected by urbanization trend (before all hygiene requirements) so on farms are usually grown just certain number of pigs and poultry. In other words, livestock production on husbandries is continuously transferring into the direction of plant production.

Generally, animal breeding on the husbandries IV_c, II_u and II_m provides the best effects on maintaining of ecosystems at local level, since it can greatly contribute to equilibration of the humus balance within the soil for a long period. In other words, growing of many animal species is of great importance for the preservation of local agro-ecosystems, as generated manure as a by-product of livestock production conduces a lot in achieving of higher yields in plant production.

Diversity of plant species

Indicator *Diversity of plant species* considers the number of different plant cultures grown on the observed husbandries, respecting the total surfaces on which they organize certain lines of plant production.

In following tables (Table 7.4, 7.5 and 7.6) are presented data about structure of arable land and structure of grown plant species, which are received from chosen agricultural husbandries from the territory of the Carpathians, the Upper Danube region and the Metropolitan area Belgrade – Novi Sad.

[108] Filipović, V., Popović, V., Subić, J. (2013): *Organic agriculture and sustainable urban development: the Belgrade – Novi Sad Metropolitan area case study*, Proceedings, II International Scientific Conference – Employment, education and entrepreneurship, 16-18 October, Belgrade.

Table 7.4. Structure of arable land (grown crops) on the husbandries within the Carpathians

Husbandry	Arable land (ha)		Grown crops – production (ha)			
	own	rented	corn	wheat	triticale	meadows
I_c	5.0	1.0	3.5	-	-	2.5
II_c	10.0	-	2.0	-	-	8.0
III_c	8.0	1.0	4.5	1.0	1.0	2.5
IV_c	6.5	2.0	4.0	1.0	-	3.5
V_c	3.0	-	2.0	-	-	1.0

Source: According to survey of IAE, Belgrade, 2013.

According to data from previous table it can be concluded that on husbandries from researched territory exist a relatively unfavourable picture of grown cultures diversity. In other words, assortment of grown plant cultures is very limited (only four cultures are present), while only at the husbandries III_c and IV_c is established any kind of sowing structure.

Table 7.5. Structure of arable land (grown crops) on the husbandries within the Upper Danube region

Husbandry	Arable land (ha)		Grown crops – production (ha)					
	own	rented	corn	sunflower	wheat	triticale	soya	alfalfa
I_u	20.5	5.5	15.0	5.0	3.0	-	-	3.0
II_u	25.0	10.0	17.0	8.0	3.0	3.0	2.0	2.0
III_u	17.0	7.0	13.0	1.5	2.0	-	2.5	5.0
IV_u	12.5	1.5	7.0	3.0	-	2.0	-	2.0
V_u	19.0	4.0	12.0	6.0	3.5	-	-	1.5

Source: According to survey of IAE, Belgrade, 2013.

Diversity of grown crops on chosen husbandries within the territory of the Upper Danube region is noticeably more complex (up to six cultures). Benefits also consider significantly larger surfaces of agricultural land that are cultivated. The most favourable sowing structure has husbandry II_u (6 cultures on 35 ha).

In addition to aforementioned should be noted that on the territory of the Upper Danube region (Sombor city and Apatin, Bač and Bačka Palanka municipalities) primary agricultural production is extremely developed (cereals and industrial crops), with a very high percentage of arable land and gardens within the ag-

ricultural land (from about 84% in Apatin to around 93% in Sombor and Bačka Palanka).[109]

Table 7.6. Structure of arable land (grown crops) on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Arable land (ha)		Grown crops – production (ha)					
	own	rented	corn	wheat	soya	triticale	vegetable	alfalfa
I_m	4.5	0.5	4.5	-	-	-	0.5	-
II_m	11.0	3.0	7.0	2.0	2.5	-	0.5	2.0
III_m	7.0	2.0	6.0	-	1.0	-	-	2.0
IV_m	4.0	2.0	3.0	1.0	-	-	2.0	-
V_m	9.0	4.0	7.0	-	-	2.0	3.0	1.0

Source: According to survey of IAE, Belgrade, 2013.

Guided by the data from previous table it can be concluded that on observed husbandries within the territory of the Metropolitan region is presented a broader assortment of grown crops (it is present more than six crops including vegetables). However, in relation to the Upper Danube region arable land surfaces managed by the individual husbandry are considerably smaller. The most suitable sowing structure has husbandry II_m (6 cultures on 14 ha).

In the structure of agricultural production in the Metropolitan area Belgrade – Novi Sad dominates production on arable land and into the gardens, with a high share of cereals (more than 60% of surfaces), then industrial crops (mostly in Novi Sad, on about 26%, Stara Pazova and Pančevo, around 20% of used surfaces), vegetables and forage crops.[110]

In all three observed sub-regions, in order to strengthen the presence of the biodiversity of plant species, to improve technical connectivity and management of fertilization in longer period, it would be necessary to favour the growing of several plant cultures on family husbandries.

Importance of perennial meadows

Since the length of exploitation, perennial meadows represent important element of ecological stability within the agro-ecosystems functioning. They have a

[109] Paraušić, V., Mihailović, B., Kuzman, B. (2013): *Poljoprivreda, prehrambena industrija i razvijenost udruživanja u agroprivredi*, chapter in monograph – Stanje i mogućnosti razvoja održive poljoprivrede i ruralnog razvoja u Podunavlju, IAE Belgrade, pp. 120-141.

[110] Paraušić, V., Mihailović, B., Kuzman, B. (2013): *Poljoprivreda, prehrambena industrija i razvijenost udruživanja u agroprivredi*, chapter in monograph – Stanje i mogućnosti razvoja održive poljoprivrede i ruralnog razvoja u Podunavlju, IAE Belgrade, pp. 120-141.

number of characteristics that affect the agricultural and ecological sustainability (preservation of soil fertility, erosion protection, preservation of water resources, landscape and biodiversity). This indicator of ecological sustainability represents the ratio between the grassland and agricultural land in use for each observed husbandry.[111]

Data that express the importance of perennial meadows for chosen husbandries within the mentioned territories are presented in Table 7.7, 7.8 and 7.9.

Table 7.7. Ratio between agricultural land and grassland surfaces on the husbandries within the Carpathians

Husbandry	Agricultural land in use (ha)			Surfaces under grassland (ha)			Ratio
	own	rented	total	natural*	sown**	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(3)
I_c	7.0*	1.0	8.0	2.0	2.5	4.5	0.6
II_c	10.0	4.0*	14.0	4.0	8.0	12.0	0.9
III_c	9.5*	1.0	10.5	1.5	2.5	4.0	0.4
IV_c	7.5*	2.0	9.5	1.0	3.5	4.5	0.5
V_c	3.0	-	3.0	-	1.0	1.0	0.3

Source: According to survey of IAE, Belgrade, 2013.

* Since in focus is agricultural land in use, surfaces under grass cultures also involves pastures which husbandries or possess or rent during the season of grazing.

** This category involves just surfaces under sown lawns (meadows) that are owned by husbandries or rented from other persons (defined by Table 7.4).

Based on gained results it can be concluded that the surfaces under grass cultures that possesses husbandry II_c contribute the most to the agricultural and ecological sustainability (value of the indicator importance of perennial meadows is 0.9). Less pronounced contribution of meadows is at husbandries I_c and IV_c, while in other cases their role is negligible.

Table 7.8. Ratio between agricultural land and grassland surfaces on the husbandries within the Upper Danube region

Husbandry	Agricultural land in use (ha)			Surfaces under grassland (ha)			Ratio
	own	rented	total	natural	Sown*	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(3)
I_u	20.5	5.5	26.0	-	3.0	3.0	0.1

[111] Subić, J., Popović, V., Cvijanović, D. (2006): *Mikromodeli za ocenu ekološke održivosti u poljoprivredi*, Ekonomika poljoprivrede, IEP Beograd, vol. 53, no. 4, pp. 987-997.

Husbandry	Agricultural land in use (ha)			Surfaces under grassland (ha)			Ratio
	own	rented	total	natural	Sown*	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(3)
II_u	25.0	10.0	35.0	-	2.0	2.0	0.1
III_u	17.0	7.0	24.0	-	5.0	5.0	0.2
IV_u	12.5	1.5	14.0	-	2.0	2.0	0.1
V_u	19.0	4.0	23.0	-	1.5	1.5	0.1

Source: According to survey of IAE, Belgrade, 2013.

* This category involves only surfaces under alfalfa owned by husbandries, or rented from other persons (defined by Table 7.5).

According to the value of indicator (Importance of perennial meadows) for observed husbandries can be concluded that, although the surfaces under alfalfa in possession of farm III_u give the largest contribution to the maintenance of agricultural and ecological sustainability, in general surfaces under grass crops have a negligible role.

Table 7.9. Ratio between agricultural land and grassland surfaces on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Agricultural land in use (ha)			Surfaces under grassland (ha)			Ratio
	own	rented	total	natural	sown	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(3)
I_m	4.5	0.5	5.0	-	-	-	-
II_m	11.0	3.0	14.0	-	2.0	2.0	0.1
III_m	7.0	2.0	9.0	-	2.0	2.0	0.2
IV_m	4.0	2.0	6.0	-	-	-	-
V_m	9.0	4.0	13.0	-	1.0	1.0	0.1

Source: According to survey of IAE, Belgrade, 2013.

Similar to the situation in the Upper Danube region, perennial grass cultures (alfalfa) generally have small contribution to the preservation of agricultural and ecological sustainability (if it is sown, alfalfa occupies relatively small surfaces within the used agricultural surfaces) on the observed husbandries within the Metropolitan area. According to this issue in the best position is husbandry III_m.

Crop rotation

Organization of plant production based on monoculture and simple crop rotation carries certain economic and ecological risks, and most often is in contrary to the fundamental principles of agriculture. As it negatively effects on the biologi-

cal functioning of the soil, as well as on the chemical surfeit of soil, implementation of complex crop rotations and calculative methods for their assessment were initiated.[112]

Application of crop rotation is necessary in order to preserve the soil structure and fertility, as well as to reduce the appearance of pests, diseases and weeds on the parcels under the grown cultures. Crop rotation is also one of the methods for evaluation of the ecological sustainability on agricultural husbandries. Mentioned indicator represents the ratio between main culture and agricultural land in use on the observed husbandries.[113] Data that describe on best possible way considered indicator, and which are gained from chosen husbandries located within the territory of the Carpathians, the Upper Danube region and the Metropolitan area Belgrade – Novi Sad are presented in next tables (Table 7.10, 7.11 and 7.12).

Table 7.10. Ratio between agricultural land in use and main culture on the husbandries within the Carpathians

Husbandry	Agricultural land in use (ha)			Main culture (ha)	Ratio
	own	rented	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_c	7.0	1.0	8.0	3.5	0.4
II_c	10.0	4.0	14.0	10.0	0.7
III_c	9.5	1.0	10.5	4.5	0.4
IV_c	7.5	2.0	9.5	4.0	0.4
V_c	3.0	-	3.0	2.0	0.7

Source: According to survey of IAE, Belgrade, 2013.

Assessment of the established crop rotation refers to the height of the calculated indicator (Crop rotation), where its lower values indicate better organization of crop rotation on the farm, while higher values lead to the conclusion of its dysfunction, or even absence (if its value strive to 1).

Based on the calculated values for the indicator on observed husbandries in the Carpathians it can be concluded that husbandries I_c, III_c and IV_c are leaders toward the established crop rotation, since they have established relatively good crop rotation. Unfortunately, at husbandries II_c and V_c situation is relatively worse.

[112] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11.

[113] Jeločnik, M., Nastić, L., Subić, J. (2011): *Evaluation of ecological sustainability on family farms in the Upper Danube zone*, XV International Eco-conference 2011, Proceedings, II book, Ecological Movement of the city of Novi Sad, Novi Sad, Serbia.

Table 7.11. Ratio between agricultural land in use and main culture on the husbandries within the Upper Danube region

Husbandry	Agricultural land in use (ha)			Main culture (ha)	Ratio
	own	rented	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_u	20.5	5.5	26.0	15.0	0.6
II_u	25.0	10.0	35.0	17.0	0.5
III_u	17.0	7.0	24.0	13.0	0.5
IV_u	12.5	1.5	14.0	7.0	0.5
V_u	19.0	4.0	23.0	12.0	0.5

Source: According to survey of IAE, Belgrade, 2013.

After appliance of mentioned criteria, it was come to the results which refer that all observed husbandries from the territory of the Upper Danube region have established functionally relatively equable crop rotation.

Table 7.12. Ratio between agricultural land in use and main culture on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Agricultural land in use (ha)			Main culture (ha)	Ratio
	own	rented	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_m	4.5	0.5	5.0	4.5	0.9
II_m	11.0	3.0	14.0	7.0	0.5
III_m	7.0	2.0	9.0	6.0	0.7
IV_m	4.0	2.0	6.0	3.0	0.5
V_m	9.0	4.0	13.0	7.0	0.5

Source: According to survey of IAE, Belgrade, 2013.

According to values of calculated indicators for the husbandries located within the researched sub-area of the Danube region in Serbia, it can be concluded that the husbandry I_m is in very bad position related to issue of established crop rotation (basically it does not have it).

Fattening

Indicator *Fattening* put into the relation total number of heads of heavy livestock with total surfaces under cultures for animal feed, which are on disposal to observed husbandries.

For the calculation of mentioned indicator, in next tables (Table 7.13, 7.14 and 7.15) are shown all needed data gained from the chosen agricultural husbandries that are located within the observed territories.

Table 7.13. Ratio between surfaces under fodder crops and number of heads of heavy livestock on the husbandries within the Carpathians

Husbandry	Surfaces under fodder crops (ha)	Heavy livestock					Ratio
		cattle	sheep	goats	pigs	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(1)
I_c	6.0	10	25	-	12	47	7.8
II_c	12.0	2	53	11	-	66	5.5
III_c	9.0	9	22	-	15	46	5.1
IV_c	8.5	12	18	5	10	45	5.3
V_c	3.0	3	-	-	11	14	4.7

Source: According to survey of IAE, Belgrade, 2013.

During the assessment of mentioned indicator, its higher values indicate on better utilization of the surfaces under crops that are used in animal feed (respecting the better organization of fattening process on the farm). Based on obtained results it can be concluded that relating to this indicator husbandry I_c is in the best position.

Table 7.14. Ratio between surfaces under fodder crops and number of heads of heavy livestock on the husbandries within the Upper Danube region

Husbandry	Surfaces under fodder crops (ha)	Heavy livestock					Ratio
		cattle	sheep	goats	pigs	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(1)
I_u	21.0	3	20	8	33	64	3.0
II_u	25.0	24	12	4	23	63	2.5
III_u	20.0	16	7	-	18	41	2.0
IV_u	11.0	4	-	-	17	21	1.9
V_u	17.0	10	-	-	17	27	1.6

Source: According to survey of IAE, Belgrade, 2013.

Gained indicators generally have a low value, what indicates that husbandries usually generate surpluses in cultures that in same time are animal feed. Within the group of observed husbandries, farm I_u exploits in the best possible way surfaces under plant cultures that are used as feed, while in the most unenviable position is husbandry V_u.

Table 7.15. Ratio between surfaces under fodder crops and number of heads of heavy livestock on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Surfaces under fodder crops (ha)	Heavy livestock					Ratio
		cattle	sheep	goats	pigs	total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6):(1)
I_m	4.5	-	8	-	15	23	5.1
II_m	11.0	7	-	8	18	33	3.0
III_m	8.0	-	3	-	28	31	3.9
IV_m	4.0	5	-	-	9	14	3.5
V_m	10.0	2	-	-	17	19	1.9

Source: According to survey of IAE, Belgrade, 2013.

In the group of husbandries from the territory of the Metropolitan area Belgrade – Novi Sad, fattening has weakest organization at the husbandry V_m.

Autonomy of husbandries according to availability of animal feed is one of the important principles of sustainable agriculture. Strengthening of the production line fattening on the husbandry on one hand can lead to external dependence of the farm from feed sources (purchase of the most of feed), while on other side may arise structural surpluses of by-products (e.g. manure). Also, in regions that have on disposal surfaces under pastures, lower level of grazing often is not in a line with the adequate use of pasture potentials, so eventually can endanger the level of desired fattening. Of course, insufficient use of pastures affects the growth of uncultivated surfaces.[114]

Managing the areas under fodder crops

Indicator *Managing the areas under fodder crops* is connected to animals keeping, and it expresses the ratio between surfaces under silage corn (or triticale) and total surfaces under forage crops on certain husbandry.

As they require relatively low level of inputs, perennial meadows represent real economic interest for agricultural husbandry. Besides, they may provide a many advantages related to biodiversity and groundwater quality. On the other hand, silage corn and triticale are usually in function of the intensive feeding that requires external procurement of proteins in order to better balancing of animal meals. Also, they are cultures that represent potential risks to the hu-

[114] Subić, J., Arsenijević, Đ., Mihajlović, D. (2005): *Metode za ocenu održivog razvoja na poljoprivrednim gazdiunstvima*, Tematski zbornik sa međunarodnog naučnog skupa – Multifunkcionalna poljoprivreda i ruralni razvoj, Beograd, decembar 2005, IEP Beograd, pp. 253-267.

man environment, as they required mineral fertilization, appliance of pesticides, etc.[115]

In next tables (Table 7.16, 7.17 and 7.18) are shown the data gained from the agricultural husbandries from the territory of the Carpathians, the Upper Danube region and the Metropolitan area Belgrade – Novi Sad, that on best possible way describe indicator in focus.

Table 7.16. Ratio between surfaces under the silage corn (triticale) and surfaces under the fodder crops on the husbandries within the Carpathians

Husbandry	Surfaces under fodder crops (ha)			triticale (silage corn) (ha)	Ratio
	natural	sown	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_c	2.0	2.5	4.5	-	-
II_c	4.0	8.0	12.0	-	-
III_c	1.5	2.5	4.0	1.0	0.3
IV_c	1.0	3.5	4.5	-	-
V_c	-	1.0	1.0	-	-

Source: According to survey of IAE, Belgrade, 2013.

As it can be noticed only husbandry III_c is growing triticale. Neither one farm grows silage corn, while all of them produce hay either from natural, or from sown surfaces.

Table 7.17. Ratio between surfaces under the silage corn (triticale) and surfaces under the fodder crops on the husbandries within the Upper Danube region

Husbandry	Surfaces under fodder crops (ha)			triticale (silage corn) (ha)	Ratio
	natural	sown	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_u	-	3.0	3.0	-	-
II_u	-	2.0	2.0	3.0	1.5
III_u	-	5.0	5.0	-	-
IV_u	-	2.0	2.0	2.0	1.0
V_u	-	1.5	1.5		-

Source: According to survey of IAE, Belgrade, 2013.

Results from Table above refer to conclusion that only husbandries II_u and IV_u are growing triticale. Neither one farm grows silage corn, while all of them grow alfalfa in order to produce hay for animal nutrition.

Table 7.18. Ratio between surfaces under the silage corn (triticale) and surfaces under the fodder crops on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Surfaces under fodder crops (ha)			triticale (silage corn) (ha)	Ratio
	natural	sown	total		
	(1)	(2)	(3)	(4)	(5)=(4):(3)
I_m	-	-	-	-	-
II_m	-	2.0	2.0	-	-
III_m	-	2.0	2.0	-	-
IV_m	-	-	-	-	-
V_m	-	1.0	1.0	2.0	2.0

Source: According to survey of IAE, Belgrade, 2013.

As like in previous table, only husbandry V_m is growing triticale. Neither one farm grows silage corn, while most of them grow alfalfa in order to produce hay for animal nutrition.

Fertilization

It is undisputed that the micro and macro elements of fertilizer (especially nitrogen) are very important for achieving of high yields in agriculture. However, by uncontrolled use of fertilizers a lot of by plant unused residues from mineral or organic fertilizers can have negative impact on the quality of ground and surface water, air and soil.

For example, it is known that all the quantity of applied mineral and natural fertilizers will not be used by plants (get into the biomass), as large volume is flushed in deeper soil layers or redirected to the aquatic basins. Surplus of fertilizers into the soils has negative effect over it. For instance, surplus of nitrogen accumulates under the form of nitrates, so how soil does not absorb the nitrogen under this form, it can be easily pushed (around 20% to 40%) to underground waters and nearby pounds.[115]

Indicator *Fertilization* represents a ratio between spent volume of fertilizers and agricultural land in use. Disposal of information about spent volumes of nitrogen (from purchased fertilizer, or animal manure) will allow the assessment of soil contamination, on the parcels that are cultivated on observed husbandries, by the agents of chemical and organic origin.[116]

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[115] Calugar, D., Morar, F. (2010): *Research regarding the impact of chemical fertilizers upon the soil*, Scientific Bulletin of the Petru Maior University of Targu Mures, Vol. 7, no. 1, pp. 50-53.

[116] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11.

Data obtained from mentioned family agricultural husbandries located in the observed territories that express on best possible way importance of fertilization for those farms are presented in Tables 7.19, 7.20 and 7.21.

Table 7.19. Ratio between used fertilizers and agricultural land in use on the husbandries within the Carpathians

Husbandry	Agricultural land in use (ha)	Mineral fertilizers (t)	Ratio	Manure (t)	Ratio
	(1)	(2)	(3)=(2):(1)	(4)	(5)=(4):(1)
I_c	8.0	1.6	0.20	112.5	14.1
II_c	14.0	1.5	0.11	120.0	8.6
III_c	10.5	3.1	0.29	190.0	18.1
IV_c	9.5	2.6	0.27	170.0	17.9
V_c	3.0	0.7	0.23	40.0	13.3

Source: According to survey of IAE, Belgrade, 2013.

According to data from table above it could be noted that husbandry II_c use the minimal volumes of mineral fertilizer (0.11 t/ha). Same husbandry also consumes the minimal volumes of manure (8.6 t/ha). On the other hand, husbandry III_c has the highest consumption of mineral fertilizers (0.29 t/ha) and manure (18.1 t/ha). The best ratio of mineral fertilizers and manure use has husbandry II_c (1:78).

Volume of applied manure and mineral fertilizers varies from husbandry to husbandry, depending primarily on need of grown crops (sowing structure), type (class) and condition of soil, chosen type of fertilizer or manure, used production technology, available financial assets, use of irrigation, etc. Within the applied fertilizers in Serbia mostly dominate NPK in different formulations and KAN, as well as cow manure. Unfortunately, applied dosages of manure and mineral fertilizers in previous few years are highly influenced by the lack of financial assets on many farms, so they are usually lesser in some volume than proposed agro-technical standards.[117]

[117] According to the data obtained from the surveyed husbandries within the complete Danube Region in Serbia, consumption of mineral fertilizers (NPK and KAN) per hectare of agricultural land under certain plant culture during the last production cycle at farms ranged: for corn 350-500 kg/ha (up to 600 kg/ha if it is irrigated), for wheat 400-500 kg/ha, for sunflower 400-550 kg/ha, for cabbage around 700 kg/ha, for potatoes about 800 kg/ha, for alfalfa around 400 kg/ha, etc. Along with mentioned, consumption of manure ranged: for corn 20-40 t/ha (up to 50 t/ha if it is irrigated), for wheat 15-20 t/ha, for sunflower around 20 t/ha, for alfalfa and meadows around 10 t/ha, for cabbage around 40 t/ha, for potatoes around 35 t/ha, etc.

Table 7.20. Ratio between used fertilizers and agricultural land in use on the husbandries within the Upper Danube region

Husbandry	Agricultural land in use (ha)	Mineral fertilizers (t)	Ratio	Manure (t)	Ratio
	(1)	(2)	(3)=(2):(1)	(4)	(5)=(4):(1)
I_u	26.0	12.7	0.49	625.0	24.0
II_u	35.0	19.5	0.56	1,180.0	33.7
III_u	24.0	10.3	0.43	665.0	27.7
IV_u	14.0	6.5	0.46	305.0	21.8
V_u	23.0	11.4	0.49	685.0	29.8

Source: According to survey of IAE, Belgrade, 2013.

As it was said earlier in this part of Danube region is presented much more intensive crop production, so the use of fertilizers is generally higher. Although the consumption of mineral fertilizers is almost equalized on observed husbandries, highest consumption per hectare was recorded on the farm II_u (0.56 t/ha). Same husbandry also consumed the maximal volume of manure (33.7 t/ha), what is mostly caused by serious corn production under irrigation. The best ratio of mineral fertilizers and manure use has husbandry V_u (1:61).[118]

Table 7.21. Ratio between used fertilizers and agricultural land in use on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Agricultural land in use (ha)	Mineral fertilizers (t)	Ratio	Manure (t)	Ratio
	(1)	(2)	(3)=(2):(1)	(4)	(5)=(4):(1)
I_m	5.0	2.4	0.49	105.0	21.0
II_m	14.0	6.7	0.48	305.0	21.8
III_m	9.0	4.0	0.44	170.0	18.9
IV_m	6.0	3.4	0.57	195.0	32.5
V_m	13.0	7.2	0.55	320.0	24.6

Source: According to survey of IAE, Belgrade, 2013.

More intensive use of fertilizers is also presented within the Metropolitan area Belgrade – Novi Sad, and it is mainly caused by vegetable production. In same time husbandry IV_m consumed the highest volume of mineral fertilizers (0.57 t/

[118] One of the principles of the Good agricultural practice put in foreground the fact that main crop nutrition has to be done by manure, while for later additional plant nutrition will be used lower doses of mineral fertilizers.

ha) and manure (32.5 t/ha). Mentioned husbandry also possesses the best ratio of mineral fertilizers and manure use (1:57).

Pesticides

Indicator *Pesticides* indicates the level of pesticides usage per unit of agricultural surface on the observed husbandry. Unfortunately, every level of pesticides use has more or less direct or indirect impact on natural and living environment. Agricultural husbandries with few lines of plant production in the sowing structure often feel the negative consequences on their own property in case of excessive use of pesticides.

As like fertilizers, preparations for crops protection and preservation significantly affect the environment in which are, so by entering into the food chain they are transferring their harmful effects even to remote ecosystems. Risks from some pesticides depend primarily on chemical character of active substance and methods of application. However, it must be said that most of the active substances have also harmful effects on non-targeted organisms. Information about environmental contamination caused by pesticides are often very limited and difficult to access.[119]

In next tables (Table 7.22, 7.23 and 7.24) are shown the data gained from the farms located in observed territories that properly describe indicator in focus.

Table 7.22. Ratio between used pesticides and agricultural land in use on the husbandries within the Carpathians

Husbandry	Agricultural land in use (ha)	Pesticides (l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_c	8.0	15.5	1.9
II_c	14.0	27.0	1.9
III_c	10.5	24.8	2.4
IV_c	9.5	25.3	2.7
V_c	3.0	9.5	3.2

Source: According to survey of IAE, Belgrade, 2013.

According to data from previous table, husbandry V_c is in the worst position towards excessive use of pesticides.

Volume of applied pesticides differs among observed husbandries, depending primarily on grown crops, climate and weather conditions over a production cycle, chosen set of preparations for plant protection (active substances), used production

[119] Cvijanović, D., Roljević, S., Kljajić, N. (2012): *Agrochemicals – factors restricting the quality of water*, Journal of society for development of teaching and business processes in new net environment in B&H, DRUNPP, Sarajevo, B&H, vol. 7(1), pp. 395-403.

technology (organic, controlled or conventional production), methods and time of pesticides application, elevation of parcels, adequate sticking to suggested dosages and concentration during the preparations application, available financial assets, etc.

Table 7.23. Ratio between used pesticides and agricultural land in use on the husbandries within the Upper Danube region

Husbandry	Agricultural land in use (ha)	Pesticides (l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_u	26.0	123.0	4.7
II_u	35.0	184.0	5.3
III_u	24.0	112.3	4.7
IV_u	14.0	51.0	3.6
V_u	23.0	94.3	4.1

Source: According to survey of IAE, Belgrade, 2013.

As this is the part of the Danube region in Serbia where are mainly grown cereals and industrial crops, but on more intense level in relation to the Carpathians, consumption of pesticides on observed husbandries is on relatively higher level. Negative effects of excessive use of pesticides possibly could be felt on the husbandry II_u, what is mostly caused by harder chemicals application within the production of corn under irrigation.

Table 7.24. Ratio between used pesticides and agricultural land in use on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Agricultural land in use (ha)	Pesticides (l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_m	5.0	28.0	5.6
II_m	14.0	70.0	5.0
III_m	9.0	41.5	4.6
IV_m	6.0	47.0	7.8
V_m	13.0	86.0	6.6

Source: According to survey of IAE, Belgrade, 2013.

Presented data can lead to conclusion that among observed husbandries farm IV_m can be endangered by excessive use of pesticides. In compare to other areas of Danube region, these husbandries have higher average consumption of pesticides, what is mostly caused by presence of by chemicals use more intensive agricultural production lines (vegetable production).

Energy dependence

It can be freely ascertained that the reduction of energy dependence is both a goal and a consequence of the functioning of sustainable agricultural systems. It is underlined goal as by it is contributed to the autonomy of the production system through the saving of stocks of non-renewable resources (e.g. oil), as well as it limits greenhouse effects. As a consequence it can be observed from the aspect that it arises from the use of technical solutions at a low input level which valorise before all local potentials.[120]

One more thing has to be discussed. As the petroleum reserves are not infinite, agriculture is directly requested to produce non-food biomass in large volume as a substitute for energy resources. Current agriculture is in some kind of opposed situation, when global food needs increase (caused by population growth) and when usable agricultural area does not stop to decrease, as well as when is justifiably to expect the preservation of agricultural ecosystems, physical, chemical and biological quality of soils which are the essential in agricultural production, appears new needs for biomass production as one of important energy resources in close future. In other words, agriculture has to find the way to increase the global production to satisfy the food needs, as well as new energy needs, along with reduction/elimination of greenhouse gas emissions and its energy consumption without penalising the results of its basic production.[121]

Indicator *Energy dependence* expresses the ratio between volumes of used energy per unit of cultivated area (agricultural land in use).

In tables 7.25, 7.26 and 7.27 are shown the data gained from the agricultural husbandries from the territory of the Carpathians, the Upper Danube region and the Metropolitan area Belgrade – Novi Sad, that are adequately explaining the indicator in focus.

Table 7.25. Ratio between used energy and agricultural land in use on the husbandries within the Carpathians

Husbandry	Agricultural land in use (ha)	Petroleum (D2/Euro diesel in l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_c	8.0	600	75.0
II_c	14.0	640	45.7

[120] Vasiljević, Z., Subić, J., Popović, V. (2010): *Ecological Sustainability of Production in Agriculture*, Proceedings from XII International Symposium – Organizational sciences and knowledge management, Zlatibor, Serbia, 9-12 June, Faculty of Organizational Sciences, Belgrade, CD1, total pages 11.

[121] Riedacker, A., Mousset, J., Bodineau, L., Racape, J., Theobald, O. (2006): *Energie et effet de serre: quelles évolutions pour l'agriculture?,* Journées AFPF – Prairies, élevage, consommation d 'énergie et GES, p. 14.

Husbandry	Agricultural land in use (ha)	Petroleum (D2/Euro diesel in l)	Ratio
	(1)	(2)	(3)=(2):(1)
III_c	10.5	940	89.5
IV_c	9.5	790	83.2
V_c	3.0	300	100.0

Source: According to survey of IAE, Belgrade, 2013.

Having in focus observed husbandries, it can be noted that husbandry V_c achieves the highest consumption of petroleum products per unit of used agricultural land. On the other hand holding II_c achieves minimal energy consumption, as it has relatively large surfaces under pastures and meadows which have lower requirements for petroleum products consumption.

It has to be mentioned that the fuel (energy) consumption on one farm in great depends from many factors on which husbandry has or has not influence. Primarily, this is the age and functionality of the driving machine and used working equipment, adequacy of the size and power of aggregate according to terrain characteristics, type (class) and state of soil, sowing structure (number of different species and area under certain cultures), number and type of production activities that are done, size of parcels, operator experience, use of irrigation, etc.[122]

Table 7.26. Ratio between used energy and agricultural land in use on the husbandries within the Upper Danube region

Husbandry	Agricultural land in use (ha)	Petroleum (D2/Euro diesel in l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_u	26.0	2,680	103.1
II_u	35.0	2,550	119.1
III_u	24.0	2,145	89.4
IV_u	14.0	1,380	98.6
V_u	23.0	2,190	95.2

Source: According to survey of IAE, Belgrade, 2013.

According to data from previous table it can be concluded that husbandry II_u has the highest consumption of petroleum products per unit of agricultural land in

[122] Potential examples of the ranges of fuel consumption per hectare of agricultural land under certain plant culture during one production cycle are: for corn 100-120 l/ha (up to 150 l/ha if it is irrigated), for wheat 90-110 l/ha, sunflower 100-120 l/ha, cabbage 260-280 l/ha, for potatoes 240-260 l/ha, etc.

use, where significant impact on total consumption on the farm has a large surfaces under corn that are irrigated. On the other hand, husbandry III_u achieves a minimal consumption of energy (petroleum) what is partly the result of the sowing of certain crops that require much less use of mechanisation.

Table 7.27. Ratio between used energy and agricultural land in use on the husbandries within the Metropolitan area Belgrade – Novi Sad

Husbandry	Agricultural land in use (ha)	Petroleum (D2/Euro diesel in l)	Ratio
	(1)	(2)	(3)=(2):(1)
I_m	5.0	625	125.0
II_m	14.0	1,320	94.3
III_m	9.0	780	86.7
IV_m	6.0	920	153.3
V_m	13.0	1,660	127.7

Source: According to survey of IAE, Belgrade, 2013.

After the focus on data from the observed farms, it can be ascertained that husbandry IV_m are accomplishing proportionally higher consumption of petroleum products per unit of used agricultural land than other husbandries from the Metropolitan area Belgrade – Novi Sad. On total consumption of petroleum (energy) at mentioned farm dominant influence have significant areas under vegetables (cabbage) that are irrigated. Similar situation is on husbandries V_m and I_m, which also have certain areas under vegetables (potatoes and cabbage) within their sowing structure.

CONCLUSIONS

Starting from the fact that agriculture and r*ural development* can be sustainable only in situation when they are environmentally friendly, economically viable and socially justified (directed towards humane and science), Landais (1998)[123] and Zahm et al. (2008)[124] step down to the farm level noting that sustainable farm has to be viable (economically efficient in income gaining), livable (it has to secure a decent life for the agriculturalists) and environmentally reproducible (with low impact on the close environment.). On the other words by use of IDEA meth-

[123] Landais, E. (1998): *Agriculture durable: les fondements d'un nouveau contrat social*, Courrier de l'Environnement de l'INRA, vol 33, pp. 5-22.

[124] Zahm, F., Viaux, P., Vilain, L., Girardin, P., Mouchet, C. (2008): *Assessing farm sustainability with the IDEA method – from the concept of agriculture sustainability to case studies on farms*, Sustainable Development, vol. 16(4), pp. 271-281.

odology it can be evaluated level of development of certain husbandry related to its economic, social and ecological sustainability.

Mentioned methodology represents the cornerstone for the evaluation of environmental sustainability on agricultural husbandries. Although it is based on relatively known indicators, the clarity and broadness of methodological approach is a good guideline to establishment of sustainable agriculture on the husbandry in accordance to the principles of Good agricultural practice. Hence it was appeared the idea of assessment of environmental sustainability on certain number of to development oriented husbandries that are located within the sub-regions of the Danube Region in Republic of Serbia. By analysis of gained data, it was come to concrete results about level of environmental sustainability at selected agricultural husbandries from the area of the Upper Danube region, the Carpathians and the Metropolitan area Belgrade – Novi Sad. Conducted research resulted following conclusions:

- On the surveyed husbandries is generally recorded a diversity of animal species, with that in the area of the Carpathians it is based on the species adapted to intensive grazing, while in the zone of the Upper Danube region it is mostly based on the breeding of heavy animals in stable facilities, whose nutrition are based on complete forage mixtures and concentrates, while in the Metropolitan area it is under expressed influence of urbanization, as livestock production on husbandries is continuously transferring into the direction of plant production;
- Agricultural land in use and arable surfaces that are on disposal to each husbandry is above national average, with significant advantage of farms from the territory of Upper Danube region which are mostly oriented towards intensive cereals and industrial plants production. Number and present species of grown plants differ from husbandry to husbandry, primarily depending from the present level of livestock breeding and animal species on disposal. Generally the worst diversity of grown plant cultures have the husbandries from the territory of the Carpathians;
- Presence of grassland surfaces is much expressed on the husbandries from the territory of the Carpathians;
- Territorially observed, appliance of crop rotation is the most pronounced on the husbandries within the Upper Danube region, while on micro level in some cases it has secondary importance;
- Surfaces under cultures for animal feed are generally much better utilized on husbandries within the zone of the Carpathians in compare to other observed farms;
- If it is talked about managing the surfaces under fodder crops situation in all observed sub-regions/husbandries is relatively unfavourable (except sporadic presence of triticale, grown of silage corn was not recorded);
- Ratio between use of manure and mineral fertilizers is on relatively good level in all observed zones, with slight advantage of the Carpathians,

where, depending from grown crops, is noticed generally lesser use of fertilizers;
- On the husbandries have not used large volumes of pesticides, although individually observed their the most pronounced appliance was recorded at the husbandries within the Metropolitan area Belgrade – Novi Sad;
- Energy dependence is much expressed in sub-regions of Danube region where are located more intensive plant production (Upper Danube region and the Metropolitan area).

Presented assessment indicates the critical elements of applied system of agricultural production at the husbandries from the aspect of environmental protection, in other words to necessary improvements of undertaken production activities and agro-technical measures. Shown methodology provides enough space for eventual methodological advancements in the assessment of ecological sustainability in agriculture.

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