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BIOLOGICAL, ECOLOGICAL, SUSTAINABLE AND ORGANIC FARMING SYSTEMS ‐ COMPARISON, OPPORTUNITIES, CHALLANGES AND PROSPECTS

Marin YOSSIFOV

Department „Animal nutrition and feed technologies” Institute of Animal Science, Kostinbrod, Bulgaria
*Corresponding author: m_vet@abv.bg

Abstract

This paper provides a thorough picture of what Bulgarian producers are required to do to maintain compliance with different agroecological productive systems closing the soil-plant-animal cycle in a natural and integrated manner. Bulgarian farming activities in regards to sustainable agriculture and new farming systems have no a consistent policy. The country registered 1 054 organic farms (about 0.3 % of its total holdings) in 2011. There’re counted during the same year about 17 295 ha of certified organic land and more than 9 328 ha under conversion, but the total organic area (converted and in-conversion) amounted to just 0.7 % of total utilized agricultural area (UAA) in this country. On 6 521 ha of organic land are cultivated cereals, followed by 3 257 ha dedicated to industrial crops. Bulgaria had in 2011 a 4 764 ha of organic pasture and meadows (excluding rough grazing), while organic wild crops are cultivated on a surface of 543 655 ha. In 2011, there’re 6 443 ha with permanent crops and cultivated organic vegetables on an area of 670 ha in this country. In organic animal farming owned 58 855 beehives, 976 bovine, 6 648 sheep and 3 397 goat heads. The certified organic animal production is presented by 1 108 T organic honey, 118 T organic white brined cheese and 74 T organic yoghurt in 2011. The aims of this are 1./ to defined terms of biological (*BFS*), ecological (*EFS*), organic (*OFS*) and sustainable (*SFS*) farming systems, 2./ to be compared to each other and with conventional farming systems (*CFS*), 3./ to evaluate and draw opportunities and challanges, and 4./ to submit altermative options for eco-efficient livestock production systems based on agricultural renewable resources management in regards to biodiversity (intra- and interspecific diversity of pasture plants, feedstuffs, and animals).

Keywords: *Farming practices, productive systems, animals.*

Introduction

The European Union (EU) prepared the first steps to organic farming in 1991 and began reform of its Common Agricultural Policy (CAP) in 2005 (European Commission, 2003). Currently, the organic sector in the EU has been rapidly developing during the last years. According to Eurostat data, the EU_{27} had in 2011 a total area of 9.6 million ha cultivated as organic, up to 5.7 million ha in 2002 according to a recent report of the European Commission (www.ec.europa.eu). During the last decade, organic area in the EU improved by about 500 000 ha per year or 5.4 % of total UAA in Europe. Most of the organic farming area (78 %) and of organic farms (83 %) are situated in the EU_{15} (www.ec.europa.eu). The Bulgarian organic farming area (certified organic + in-conversion) amounted 25 022 ha in 2011 (MAF, 2014). So, the EU_{27} *UAA* amounted to an estimated 5.4 % of the *UAA* in 2011, but in Bulgaria only 0.7 % of its *UAA* was dedicated to organic farming (*see* fig. 1). The observation of the share of in-conversion area within the total area of the organic sector (in-conversion and certified organic areas) provides an indication of the growth potential of the sector for the next few years.

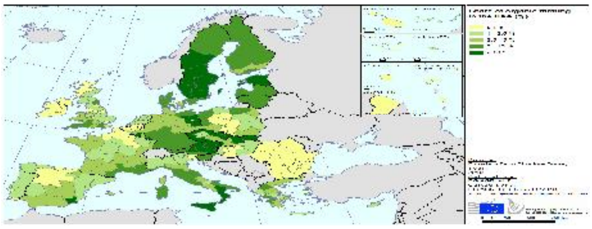

Figure 1. *Share of the organic area in total UAA (2010) at regional level* (Eurostat FSS data)

More than 270 050 organic operators, including 235 464 organic producers (87 %) were registered in the *EU27* in 2011 as compared with 1 054 organic producers, processors and importers in Bulgaria (www.ec.europa.eu; MFA, 2014). The table below gives detailed view on the average number of organic producers (entering, registered and leaving) for 2007–2011 period.

Table 1. *Stability in the number of organic producers (average 2007-2011)*

	Registered	New	Withdrawn
Bulgaria	527.2	218.8	64.6
			www.ec.europa.eu; MFA, 2014

In 2013 a total amount of 252 900 farms with total UAA of 3 708 330 ha or average 15.2 ha per farm (MAF, 2014). An animal farms number 183 300 (72 % of all) with UAA of 997 230 ha (27 % of all). At the same time, the number of agricultural holdings (as a sum of conventional and organic farms) and average surface (ha.holding^{-1}) are summarized in fig. 2. If for the *EU27* about 48 % of total holdings have a size lower than 2 ha, only 6.2 % of organic farms are situated in this category.

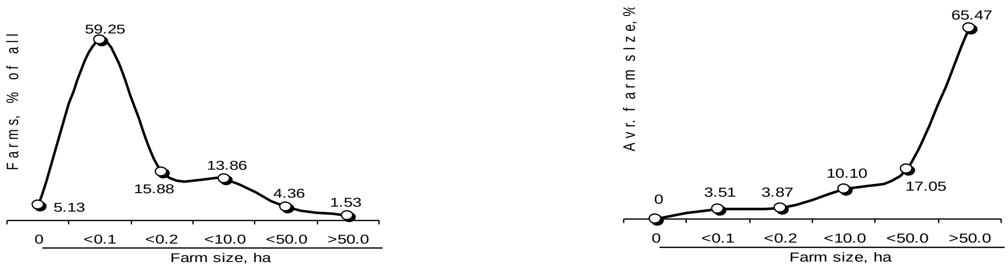

Figure 2**.** *Evolution of the area and number of holdings involved in Bulgarian organic sector*

Looking at the data about the level of the permanent pasture in the *EU27* in 2011 represents the biggest part of the organic area (45 %), followed by cereals (15 %), permanent crops (13 %), etc. Conversely, cereals cover 31.8 % of the total UAA of the EU, but only 2.5 % of organic UAA. One element of explanation lies in the fact that organic production systems are more extensive than in conventional agriculture (higher reliance on grazing on permanent pastures). At the same time, permanent pastures are often eligible for agri-environmental organic payments and easier and less risky to convert to the organic sector than the other types of crops (e.g. arable crops). The breakdown and share of the main categories of organic area (ha) as per cent of the total (%) and total *UAA* (%) in 2011 at *EU27* is presented in table 2. In regards to these data, the Bulgarian organic farming area (certified organic + in-conversion) indicated sustainable increment in 2011(3.8 %).

Table 2. Main categories of organic land in the EU_{27} (2011) [1]

	Organic land (ha)		% of total organic		% of TUAA per category	
	EU_{27}	*BG*	*EU_{27}*	*BG*	*EU_{27}*	*BG*
Total crops	9 613 500.0	25 022	100.0	100.0	0.49	5.4
Cereals	1 405 152.1	6 521	26.1	14.6	0.13	2.5
Dried leguminous	211 568.0	106	0.4	2.2	0.01	16.0
Industrial crops	183 804.0	3 257	13.0	1.9	0.06	1.4
Permanent grassland	4 317 285.0	4 764	19.0	44.9	0.09	7.5
Permanent crops	1 259 289.0	8 969	35.8	13.1	0.18	11.0

1 *Eurostat data land use statistics (code: apro_cpp_luse);* TUAA-total UAA (conventional and organic).

This makes 12 % reducing of the Bulgarian total fallow lands in 2011. Looking at the area under organic farming in 2011 available data (*see* table 3) shows that organic areas cultivated with cereal crops (wheat, corn, barley, rye) represent 22 % more than 2010 (6 521 ha). The share of industrial and oilseed crops registered increment. The organic sector amounts significantly decreased for fodders. Vegetable sector represents a minor part of the organic area,

Table 3. Breakdown and share of organic area per type of crop, 2011(MAF, 2014)

Items \ *Organic areas, ha*	*Certified*	*In-conversion*	*Total, % 2011/2010*
Cereal crops	4 980	1 541	+ 22.1
Industrial crops	3 350	2 495	+ 19.0
including rose oil	*516*	*329*	NA
Vegetables	467	203	+ 56.5
Permanent crops	5 087	1 356	+ 11.2
Permanent grassland	1 519	2 972	+ 24.4
Fodders	771	225	– 380.1
including alfalfa	*649*	*73*	NA
Fallow land	1 057	456	– 11.8
TOTAL	17 295	9 328	+ 3.8
Wild crops	22 600	521 055	– 0.5

but it’s under development in 2010/2011 (+ 56.5 %). At the Bulgarian level, the organic area of permanent crops amounts to 11 % enhance, i.e. 6 443 ha in 2011. So, the organic area of permanent pasture amounts 1.2 % of the total (organic and non-organic) area of permanent pasture. Statistics on the number of organic animals in the *EU_{27}* are presented in table 4. As shown,

Table 4. *Evolution of animals under organic production in the* EU_{27} *(2011)*

	Organic heads
Cattle	2 611 544
including dairy	719 408
Sheep	3 957 496
Goat	480 139
Pig	855 535
Poultry	26 185 341
including laying hen	12 746 588
	www.ec.europa.eu

the sheep and cattle production for the EU_{27} are the most important out of the total organic animal production. It make a strange impression that apart from sheep and goats, the ruminant sector (as a heads and per cent of total) would tend to develop faster than other livestock sectors at an equal parities of EU_{27} and national level (*see* table 5).

Table 5. *Heads and percentage of organic out of total animal heard (2011)*

	Organic heads		% organic out of total	
	BG	EU_{27}	*BG*	EU_{27}
Cattle	976	2 611 544	0.18	2.90
Small Ruminants	10 045	4 437 635	1.44	2.82
				www.ec.europa.eu; MFA, 2014

So, the importance of the organic sector in relation with the whole ruminant sector is the highest as % organic out of total heads. The evolution of animals under organic production (as heads and per cent) in our country are summarized in table 6.

Table 6. *Number of certified animal heads in Bulgaria (2011)*

	Organic heads	*2011/2010, %*	% organic out of total
Cattle	976	+ 268.13	0.18
Sheep	6 648	– 0.75	0.49
Goat	3 397	+ 22.50	0.95
Bee	58 855	+ 26.76	9.60
			MFA, 2014

In 2011 there were 976 heads of certified organic cattle in Bulgaria, near trice higher 2010 (364). The largest organic producers are bee farms with a total number of 58 855 beehives and about 27 % annual increment. The higher number of organic animals resulted in higher amounts of organic animal production. So, the data about the certified organic animal production (as T and per cent of total) are presented in table 7.

Table 7. *Animal production by certified organic animal production (2011)*

Item	Organic production (T)	2011/2010 (%)	% organic out of total
White brined cheese	118	+ 22.0	0.33
Yoghurt	74	+ 162.2	0.16
Honey	1 108	+ 14.0	13.17
			MFA, 2014

Unfortunately, like their conventional counterparts, many organic growers find marketing to be the hardest part of farming management chain. While demand for organic products has greatly increased since the late 90s, organic production has also increased. It’s inevitable that the rapid rise in production will eventually reduce or even eliminate the premium prices that have attracted many new growers to certified organic production. So, the market research company *Organic Monitor* estimated the global market for organic products in 2011 at 83 billion € (up from 78 billion €) or more than 45 billion € with leading position of US market (21 billion €) (www.fibl.org). The organic market in Europe increased in 2011 (by 9 %) and it’s now at 21.5 billion € – in the past years highest market shares were reached in Denmark, Austria, and Switzerland. The highest consumption of organic food (per capita) in 2011 was in Switzerland (177 €), followed by Denmark (162 €), Luxembourg (134 €), Austria (127 €), Sweden (94 €) and Germany (84 €). The obtained data for average consumption (27 € per capita) evaluate available 39 countries (Schaack et al., 2013). So, there exists challenge to emulation between social and envinronmental terms or system productivity and consumer desire for safety, nutritious, environmentally friendly functional foods (Pretty, 2008). So, current cropping systems proposed a kind of disturbance and disbalance stressed ecosystems as a result of poor managing nutrient cycles and energy flows. The input – output disharmony in cropping and livestock systems providing losses in organic matter and energy flows. Thus, using the agroecological paradigm, four essential system properties of agroecosystems have been determined: ***productivity*** (level of output); ***stability*** (constancy or persistence of output over time); ***sustainability*** (recovery from stress, disruptions); ***equitability*** (evenness of distribution among various groups). These properties are bounded by certain essential ecological laws or principles.

The interest in sustainable agriculture is driven by three main concerns: 1/. present agricultural practices are having a negative impact on environmental quality, and on resource availability and use; 2./ farming practices are contributing to a deterioration in human health; 3/. the economic situation for producers continues to decline. So, the negative environmental impacts of current conventional agricultural practices include: 1/. soil degradation; 2/. water depletion and contamination; 3/. inefficient energy use; 4/. loss of plant and animal genetic diversity; 5/. destruction of non-agricultural habitat, etc. Thereby, certain conventional products and practices are implicated in human health problems, including antibiotic resistance, nitrates in groundwater, pesticide exposure in an occupational setting, pesticide residues in foods, many food additives, and certain food processing techniques, such as removal of fibre from grains, addition of salt, refined sugar, and boiling in fat, oil or water. Although considerable scientific controversy remains, there’s some evidence to suggest that conventional soil management practices are contributing to declining nutritional value in foods. So, new farming systems are perceived in many circles to provide decisions for most of these problems.

Biological (*BFS*), ecological (*EFS*), organic (*OFS*) and sustainable (*SFS*) farming systems are some kind of alternative management practices at industrialized conventional farming systems (*CFS*) and conventional input intensive production ecosystems thinking. There’re different manners to maintain productivity at most natural way and to mitigate agro-ecologo-economy risks in ecosystems. Each one of this systems has its own principles and operations, set of rules and guidelines.

Ecological farming system (*EFS*) cover soil, plant, animal, human and environment interact as an alternative to the prevailing annual monoculture input-driven *CFS*. It reducing external inputs and mitigate agro-ecologo-economy risks based on: 1/. usage of ecological processes; 2/. coverage of economic stability under the existing circumstances of population; 3/. greenhouse gas emmissions; 4/. water and soil instability, etc. environmental issues. Such kind of ecological system health is founded on reduced mechanical or chemical practices, substances cycling through endogenous inputs, balanced producer/consumer/reducer organism inter-relationships, trophic links and foodwebs in regards to biogenic cycle of sutstances and ecosystem homeostasis (Darnhofer et al., 2010; Cabell and Oelofse, 2012). Main principles of *EFS* are: 1./ biodiversity maintaince; 2./ cultivate plants and animals adapted to local environment; 3./ wildlife habitat as biological pest controller and pollinator; 5./ soil biological activity, organic matter accumulation and protection; 6./ substances, materials and resources recycling practices; 7./ sustainable local nutrient and energy flows cycling; 8./ enhance productivity – water conservation, nitrogen (N) fixation, mineral cycling, soil organic matter formation, adaptable plants and animals; 9./ develop and adopt new technologies for eco–agro–socio–economic impact, etc.

Sustainable farming system (*SFS*) possess ability to continue a particular sustainable agriculture practices into the future to complex measures of biological and ecological function, social dynamics and its integrity. Therefore, its aimed to make the best use of environmental goods and services while not damaging these assets and minimizing the use of non-renewable inputs based on knowledge and skill and the capacity of people to work together (Pretty, 2008; Koohafkan et al., 2012; Malézieux, 2012). Thus, *SFS* are implemented in small farms which are self-sufficient by recycling all the farm’s waste to meet its fertility needs. The *SFS* involves: 1/. design and management procedures that work with natural processes; 2/. conserve all resources; 3/. minimize waste and environmental damage; 4/. maintaining or improving farm profitability. Working with natural soil processes is of particular importance. So *SFS* are designed to take maximum advantage of existing soil nutrient and water cycles, energy flows, beneficial soil organisms, and natural pest controls. Some of the main directions as the aspects of *SFS* are: 1/. crop rotations; 2/. crop residues; 3/. animal manures; 4/. legumes; 5/. green manures; 6/. off-farm organic wastes; 7/. appropriate mechanical cultivation; 8/. minimal tillage to optimize soil biological and natural pest control activity; 9/. maintaince soil fertility and crop productivity; 10/. usage of resistant varieties; 11/. biological, biorational, and cultural controls of pests, weeds and diseases; 12/. preventative health care strategies; 13/. dietary changes at animal and human level.

Organic farming system (*OFS***)** is based on: 1/. minimal use of off-farm; 2/. endogenous inputs oriented practices; 3/. biodiversity promoted; 4/. strict regulated and certificated by production standards in regards to restore; 5/. maintain and enhance environmental sustainability; 6/. provide ecological integrity and harmony. Overall, it’s a type of holistic system designed to optimize the productivity and to diverse communities into an agroecological whole – soil organisms, plants, animals and people. Thus, the principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment (CGSB, 2006). This system use materials and practices that manage: 1/. natural plant fertilization; 2/. natural pest; 3/. soil biological activity; 4/. fertility and 5/. health. All these is collaborated through: 1/. crop rotation; 2/. green manures; 3/. forages in rotation; and 4/. manure or compost applications. The weeds are generally managed through cultural means such as high seeding rates or mechanical means such as tillage (Nelson et al., 2010). *OFS* have lower ecological impact and enhance the ecological balance (Bavec et al., 2012), have increased energy efficiency (Hoeppner et al., 2006; Zentner et al., 2011) and enhance a number of soil and nutrient parameters such as organic matter, soil C and nutrient retention (Pimentel et al., 2005). *OFS* can’t ensure that products are completely free of residues, but methods are used to minimize pollution from air, soil and water. Also, *OFS* is implemented in different sized farms able to meet the organic certification requirements.

Biological Farming Systems (*BFS*) is based on scientific principles and common sense that microbes are the basis of all agricultural production systems. It’s a pursuit of agricultural practices that: 1/. create soil homeostasis at different level (nutrient, mineral, organic matter, organism balance); 2/. promotes organic soil carbon; 3/. increases healthy soil biota (earthworms, bacteria, fungi, etc.); and 4/. enhances micropores and humus-based substances to ensure better water holding capabilities and sustainably productive soils. *BFS* balanced producer/reducer organism interrelationships, trophic links and foodwebs in regards to sustainable microbial activity, recycle substances, carbon sequestration and capacity of organisms to work together. So, it turn back atmospheric carbon (CO_2) into soil through natural plant and soil conversions – photosynthesis, resynthesis, exudation and humification. Some of main directions as the aspects of *BFS* are soil and water quality, plant production and quality, animal health and economic viability. Healthy soil ecosystems, in regards to *BFS*, improved pasture production, provide the plants and animals with the necessary trace elements needed to develop healthy well balanced functional foods. And moreover, species found in healthy soil reducing system input (nutrients, energy, etc.). In regards to natural breakdown of organic matter and biogeochemical cycles, the picture below (**fig**. **3**) depicting the effect of soil management on soil fertility. So, by reducing tillage, soil isn’t inverted and exposed into the air. Less carbon is lost to the atmosphere resulting in more soil organic carbon (**B**). This has an added benefit of carbon sequestration which can reduce green house gases (*GHGs*) and aid in reversing climate change.

Figure 3. *Concentration of soil carbon (*www.sba.asn.au*)*

Some of the key characteristics of different farming systems are summarized in the table bellow (*see* table 8). Whereas the *OFS* is based on actual certification control in regards to strong and strict rules and norms (IFOAM, 2005), other systems are only a philosophy or way of life / thinking and mustn’t be adjusted to some rules and norms. The ecological impact of different farming systems isn’t environment–friendly in equal – *CFS* spread *N*, *P*, pesticide, etc. pollution. The same, water and food security are linked. So, water quality is worsen at *CFS*, followed by *OFS*, *BFS*, *SFS* and at least – *EFS*. Simultaneously, excepting *CFS*, water efficiency is being improved at all farming systems. In such manner energy flow efficiency passed and be negatively affected at *CFS* but in all balancing farming systems (*OFS*, *BFS*, *EFS*) efficiency increased up to 30 – 60 %. The *CFS* is having a significant and escalating impact on the biodiversity of world ecosystems, reducing both their resilience and biocapacity as a result of mass monoculture production. Also, loss of biodiversity as habitat loss and land fragmentation impact negatively biogeochemical cycles (N, C, etc.). Unlike, the organism genetic diversity is an important manner at sustainable ecosystems, so sustainable-friendling productive systems maintained rare crop cultivars and animal breeds. Although genetically modified organisms (*GMO*) are excluded from *OFS*, *SFS*, *EFS* and *BFS*, throughout *CFS* is available *GMO* pollen contamination. Animal welfare as a well-being of animals presume *OFS* to maintain "access" to outdoors and *BFS* to maintain a natural behaviors of animal species. At *CFS* a large number of animals are reared in confinement at high stocking densities producing abnormal behaviors (European Union Council Directive 1999/74/EC). Also, another major concern for the welfare of farm animals is the ritual of slaughter – to be designed in such manner to decrease suffering of animals. The discussion about farm size is available. There’s no limits for *OFS* and it can be involved large corporations as distinguished from the sustainable systems which are smaller, as a family farming model. The application and contamination with different unnatural substances is a big environmental problem. Some of the importest aspects are: 1/. in many countries, the intensive *CFS* don’t excluding the practices of antibiotic and artificial hormone use in livestock feed to promote faster growth contributing food contamination and increasing the risk of the public health (Ferber, 2002; Mathew et al., 2007). In *OFS* no antibiotics and hormones can be used, nor are they fed for sustainable farming; 2/. Application of pesticides in *CFS* and runnoff effects leaves residues with toxicological significance. The *OFS*, *BFS* and *EFS* not applied such chemicals but their products can contain amounts (significantly minimize exposure) as a persistent environmental contaminants; 3/. whereas *CFS* applied chemical fertilizers providing nitrogen, phosphorus, potassium, etc., the biofertilization by green (with cover crops) and animal manure is applied in *OFS*, *SFS*, *BFS*, *EFS*. In regards to food quality and safety, *CFS* decreased nutritional value of food products, either way *OFS*, *SFS*, *BFS*, *EFS* products are more nutritious, healthy and uncontaminated. As overall, based on listed key characteristics of different farming systems we can concluded that *CFS* is short term oriented system, while *OFS*, *BFS*, *EFS* are with long term oriented perspectives.

Table 8. *Comparison between different farming systems*

		F A R M I N G S Y S T E M S			
	CFS	*OFS*	*SFS*	*BFS*	*EFS*
Certification	– – –	+ + +	+ / + +	+ / + +	+ / + +
Input/ output balance	– – – / – –	+ / + +	+/ + +	+ / + +	+ + / + + +
Environmental impact	– – –	+ / + +	+ / + + +	+ / + + +	+ + / + + +
Water quality	– – –	+	+ / + + +	+ / + + +	+ + / + + +
Energy flow efficiency	– – –	+ / + +	+ + +	+ / + +	+ +
Organism genetic diversity	– – –	+ / + +	+ + +	+ + +	+ +
Animal Welfare	– / +	– / +	+ + +	+ +	+ / ++
Inputs					
Antibiotics	– – –	+ + +	+ / + +	+ +	– / +
Hormones	– – –	+ + +	+ / + +	+ +	– / +
Pesticides	– – –	+ + +	+ / + +	+ + / + + +	+ / + +
Fertilizers	– – –	– / +	+ / + + +	+ / + + +	+ / + + +
Production size	– – –	– / +	+ + +	+ / + +	+/++
Foods quality	– – –	+ / + +	+ / + + +	+ +	++
Human health	– – –	+ + +	+ / + + +	+ / + + +	+ / + + +
Price rate	+ + +	– / – – –	– / – – –	– / – – –	– / – – –
Handle	+ + +	– / – – –	– / – – –	– / – – –	– / – – –
Marketing monopol	+ / –	– / – – –	– / – – –	– /– – –	– / – – –
Distribution/Transport	+ + +	– / +	– / – – –	– / – – –	– / – – –
inputs/costs	+ + +	– / – –	– / – – –	– / – – –	– / – – –
Net farm income	+	+ + / + + +	+ + / + + +	+ + / + + +	+ + / + + +

FS-farming systems, *BFS*-biological FS, *EFS*-ecological FS, *OFS*-organic FS, *SFS*-*s*ustainable FS.
+++ strong possitive; ++ expressive possitive; + labile possitive; +/– jumpy changeable; – labile negative; – – expressive negative; – – – strong negative.

Conclusion

In regards to EU Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan agriculture must be more oriented about series of proposals on sustainable consumption and prouction to target EU goals for environmental sustainability, economic growth and being welfare. The life cycle of such kind of sustainable products provided a lot of environmental, social, economic, etc. profits with continuous improvements. Moreover, the modernity of this policy offers different subsidies and grands. So, Bulgarian producers are required to do to maintain compliance with different agroecological productive systems closing the soil-plant-animal cycle in a natural and integrated manner. The lack of farming activities in regards to sustainable agriculture and new farming systems with a consistent policy must be took an action on the decision adopted. In regards to definitions of biological (*BFS*), ecological (*EFS*), organic (*OFS*) and sustainable (*SFS*) farming systems producers must to submit altermative options for eco-efficient crop and livestock production systems based on agricultural renewable resources management in regards to biodiversity (intra- and interspecific diversity of pasture plants, feedstuffs, and animals) as an competative choice of their future development.

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