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Abstract

In Bulgaria, like in most countries, the comprehensive assessments on agrarian sustainability are mostly at sectoral or farm levels while there is practically no in-depth study on sustainability at sub-sector (industry) level. This paper tries to fill the gap and assess the sustainability of different sub-sectors in Bulgarian agriculture. First a holistic hierarchical framework for assessing integral, economic, social and ecological sustainability of Bulgarian agriculture is suggested including 17 principles, 35 criteria, and 46 indicators and reference values. After that, an assessment is made on the overall and aspects sustainability of major crop, livestock and mixed subsectors of Bulgarian agriculture. The assessment is based on first-hand information collected though in-depth interviews with the managers of "typical" farms in analysed industries.

The study has found out that there is a considerable differentiation in the level of integral and aspects sustainability in individual sub-sectors in Bulgaria, with mixed livestock-breeding, mixed crop-growing, and perennial crops sub-sectors having the highest integral sustainability, while pigs, poultry and rabbits; vegetables, flowers and mushrooms, and mixed livestock-crops subsectors the lowest one. There are also substantial variations in the levels of economic, social and ecological sustainability of different agricultural sub-sectors and individual indicators with the highest and lowest values showing (critical) factors enhancing and deterring particular or overall sustainability of evaluated agro-industries. Results on the integral agrarian sustainability level of this study based on the micro sub-sector (farm) data are similar to the previous assessment based on the aggregate sectoral (statistical, etc.) data.

Key words: sub-sectors, agriculture, sustainability, economic, social, ecological, Bulgaria

Introduction

The issue of assessment of level of agrarian sustainability and its economic, social and ecological aspects is among the most topical in developed and developing countries alike (Bachev, 2010, 2018; Bachev et. al., 2016, 2017; Bachev and Terziev, 2018, Bohlen and House, 2009; Candido et al., 2018; De Oliveira, 2018; FAO, 2013; Hayati et. al., 2010; Ikerd, 2015; Ivanov et al, 2009; Gliessman, 2016; Gemesi, 2007; Gitau et al., 2009; Jalilian, 2012; Irvin et. al., 2016; Lopez-Ridauira et. al. 2002; Ramírez-Carrillo et. al., 2018; Sauvenier et al., 2005; Terziev et al., 2018; Todorova and Treziyska, 2018; VanLoon et al. 2005; Zvyatkova and Sarov, 2018). Despite enormous progress in the theory and practice of this new evolving area, still there is no consensus on how to assess agrarian sustainability due to diverse understandings, approaches, methods, employed data, etc. In Bulgaria (like in most countries), comprehensive sustainability assessments are mostly on sectoral (Bachev et. al., 2017) or farm (Bachev, 2016, 2017; Bachev and Terziev, 2017) levels while there is practically no in-depth study on sustainability at subsector (industry) level.

The goal of this paper is to assess the sustainability of different subsectors in Bulgaria.

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Methodological framework

In order to assess agrarian sustainability of agricultural subsectors in Bulgaria a hierarchical system is developed including 17 principles, 35 criteria, and 46 indicators and reference values (Table 1). Principles are the highest hierarchical level associated with the "universal" functions of agricultural system and represent the state of sustainability in 3 main pillars/aspects of sustainability (economic, social, and ecological). Criteria represent a resultant state when the relevant principle is realized. Indicators are quantitative and qualitative variables of different types (behaviour, activity, input, effect, impact), which can be assessed allowing the measurement of compliance with particular criteria. Reference Values are the desirable levels for each indicator according to the specific conditions of each subsector which assist the assessment giving guidance for achieving (maintaining, improving) sustainability. The approach for formulating and selecting principles, criteria and indicators for assessing sustainability level are presented in details in our previous publications (Bachev, 2016, 2017, 2018).

Table 1. System of principles, criteria, indicators, and reference values for assessing sustainability level of sub-sectors of Bulgarian agriculture

Principles	Criteria	Indicators	Reference values
Economics aspect			
Financial stability	Reducing dependence on subcidies	Share of direct payments in Gross Value Added	Experts estimate/ Trend
	Sufficient liquidity	Ratio of overall liquidity	Experts estimate/ Trend
		Ratio of quick liquidity	Experts estimate/ Trend
	Minimizing dependence on external capital	Share of owned in total capital	Experts estimate/ Average for the sector
Economic effectiveness	Positive or high profitability	Cost - effectiveness	Experts estimate/ Average for the sector
		Profitability of capital	Experts estimate/ Average for the sector
	Maximize or increase labour productivity	Labour productivity	Experts estimate/ Average for the sector
	Maximize or increase land productivity	Productivity of land	Experts estimate/ Average for the sector
	Maximize or increase livestock productivity	Livestock productivity	Experts estimate/ Average for the sector
Competitiveness	Support or increase of marketed output	Share of marketed output	Experts estimate/ Trend

	Support or increase of sales	Sales growth in the last 3 years	Experts estimate/ Trend
Adaptability to economic environment	Sufficient adaptability to market environment	Ratio of gross income to fixed costs	Experts estimate/ Trend
	High investment activity	Investment growth	Average for the sector/ Trend
Social aspect			
Welfare of employed in agriculture	Equality of income with other sectors	Ratio of farm income to the average income in the region	Experts estimate/ Trend
	Fair distribution of income in agriculture	Ratio of payment of hired labour in the farm to average income in the region	Average for the sector/ Trend
	Sufficient satisfaction from farm activity	Degree of satisfaction from farm activity	Farmers assessment
	Satisfactory working conditions	Correspondence to official norms	Official norms
Conservation of farming	Preservation of the number of family farms	Existence of a heritor ready to take over of the farm	Experts estimate/ Trend
		Number of family workers	Experts estimate/ Trend
		Age of the manager	Farmers assessment/ Trend
	Increasing the knowledge and skills	Level of participation in the training programs	Experts estimate/ Trend
		Level of education of the manager	Experts estimate/ Trend
	Maintaining and increasing of agrarian education	Number of employed with special agricultural education	Experts estimate/ Trend
Gender equality	Equality in men-women relations	Degree of participation of women in farm management	Half/Trend
Social capital	Participation in professional associations and initiatives	Number of participations in professional associations and initiatives	Experts estimate
		Level of hired labour membership in labour unions	Experts estimate/ Trend
	Participation in public management	Public position	Experts estimate/ Trend

	Contribution to the development of regions and communities	Participation in local initiatives	Experts estimate/ Trend
Adaptability to the social environment	Sufficient ability to respond to the ceasing farming activity and the demographic crisis	Vacant job positions in the farms to the total number of employed	Experts estimate/ Trend
Ecological aspect			
Air quality	Maintaining and improving air quality	Growth of carbon emissions for the past three years	Trend
Land quality	Minimizing soil losses	Soil erosion index	Scientific norm/ Trend
	Preservation and improvement of soil fertility	Amount of nitrogen fertilization	Scientific norm/ Average for the sector
		Amount of potassium fertilization	Scientific norm/ Average for the sector
		Amount of phosphorus fertilization	Scientific norm/ Average for the sector
	Maintaining a balanced land use structure	Share of arable land (without fallow) in total agricultural areas	Scientific norm/ Average for the sector
	Preservation of landscape features	Amount of area covering the requirements for "green" direct payments through maintaining landscape elements	Experts estimate/ Trend
Water quality	Maintaining and improving water quality	Index of groundwater pollution	Scientific norm/ Average for the sector
Effective energy consumption	Minimizing the use of conventional energy	Fuel consumption per unit area	Experts estimate/ Average for the sector
		Cost of conventional electric energy per unit of gross output	Trend/ Average for the sector
Biodiversity	Maintaining or enhancing natural habitats	Change in the number of habitats	Trend/ Average for the sector
		Share of agricultural land in NATURA 2000 and other protected areas	Planed target Trend/
	Preserving and improving the biodiversity	Number of cultivated plant species	Trend/ Average for the sector
Animal welfare	Compliance with the	Level of compliance with	Official norms

	principles of animal welfare	the principles of animal welfare	
Implementation of organic production	Increasing the organic production	Share of areas under conversion or certified for organic production	Experts estimate/ Trend
Adaptability to the environment	Sufficient adaptability to climate change	Variation in the yield of main crops	Average for the sector/ Trend
		Death rate in livestock farms	Average for the sector/ Trend

Source: author

In Bulgaria, like in most countries, there are no official aggregate data for calculating most of the socio-economic and ecological sustainability indicators at sub-sector level. In order to assess the level of sustainability of major agricultural industries (sub-sectors) in-depth interviews with the managers of 80 commercial farms of different types and locations in 4 major administrative and geographical regions of Bulgaria (North-Central, South-Eastern, South-Central and South-Western) were held in 2017. “Typical" farms for different regions and industries were identified with the assistance producers’ professional associations, National Agricultural Advisory Service, Executive Agency for Vine and Wine, processing, bio-certification and service organizations, and local government. Farmers of different types were surveyed -: different legal entities (natural persons, sole traders, cooperatives, companies); farms of different sizes (semi-market, small size for the sector, average size for the sector, large sizes for the sector; and farms in different production specialization (arable crops, vegetables, flowers and mushrooms, perennials, grazing livestock, pigs, poultry and rabbits, mixed crops and mixed livestock breeding).

The survey includes many questions in 4 major areas: general characteristic of farms; primary information for calculating economic indicators for agrarian sustainability; primary information for calculating social indicators for agrarian sustainability; and primary information for calculating environmental indicators for agrarian sustainability. Calculated quantitative and qualitative levels for each indicator are further transformed into a unitless index of sustainability. After than the integral index for a particular criterion, principle, and aspect of sustainability, and the integral sustainability index for each surveyed farm is calculated as arithmetic average applying equal weight for each indicator in a particular criterion, of each criterion in a particular principle, and each principle in every aspect of sustainability. The composite sustainability index of a particular sub-sector is an arithmetic average of the indices of relevant farms belonging to that industry.

For assessing the level of sustainability of agricultural sub-sectors the following scales defined by the experts in the area are used: 0,85-1 - a high level of sustainability; 0,50-0,84 - a good level of sustainability; 0,25-0,49 - a satisfactory level of sustainability; 0,12-0,24 - an unsatisfactory level of sustainability; 0-0,11 - non-sustainable level.

General characteristic of the questionnaired farms

The survey was conducted in the period April-November 2017 and covered 80 farmers from five administrative districts of the country - Pazardjik, Plovdiv, Kjustendil, Blagoevgrad, Bourgas and Veliko Tarnovo (Table 2).

Table 2. Geographical and ecological location of agricultural holdings surveyed (number)

Location of farms	North-Central Region	South-western region		South-Central Region		South-eastern region	General number * and%
	Veliko Tarnovo	Kjustendil	Blagoevgrad	Pazar-dzhik	Plovdiv	Bourgas	
Mostly plane area	2	4	4	14	0	8	80
Plane-mountain area	8	4	2	8	2	6	37,5
Mostly mountain area	0	6	2	4	6	0	22,5
Land in protected areas and territories	0	0	0	0	2	4	7,5
Mountain area with natural restrictions	2	6	0	4	0	2	17,5
Non-mountainous area with natural restrictions	0	0	2	2	0	0	5
Western Thracian Lowland	0	0	0	22	0	0	27,5
Middle Danube Plain	6	0	0	0	0	0	7,5
Dupnitsa valley	0	4	0	0	0	0	5
Sandanski-Petrich valley	0	0	6	0	0	0	7,5
The valley of the Maritsa river	0	0	0	14	0	0	17,5
The valley of the Yantra river	6	0	0	0	0	0	7,5
The valley of the Struma River	0	4	6	0	0	0	12,5
South-Black Sea	0	0	0	0	0	8	10
Middle Forest mountain	0	0	0	6	6	0	15
Western Rila mountain	0	4	2	0	0	0	7,5
Total number	**10**	**14**	**8**	**26**	**8**	**14**	**80***
Share of all (%)	12,5	17,5	10	32,5	10	17.5	100

Source: survey with managers of farms, 2017

The majorities of the surveyed holdings are unregistered farms of individuals, mostly small in size, and specialize in mixed plant-animal farms and perennial farms (Table 3). Most of the studied farms are located in South Central and South-West geographical and administrative regions, and in mostly plane and plane-mountain areas of the country. One quarter of the farms surveyed is in the Thracian Lowland. Each fifth is located in valleys of different kind - Danube plain, Dupnitsa valley and Sandanski-Petrich valley. In riverside ecosystems of different types (Maritsa, Struma and Yantra) there are about 36% of the farms surveyed and in the seaside area - every tenth farm.

Table 3. Legal status, sizes and production specialization of the surveyed agricultural farms (number)

Type of farms	North-Central Region	South-western region		South-Central Region		South-eastern region	Share in total number (%)
	Veliko Tarnovo	Kjusten dil	Blagoev-grad	Pazar-dzhik	Plovdiv	Bourgas	
Legal person	6	6	2	6	6	4	37,5
Sole trader	2	4	4	6	0	0	20
Cooperative	2	2	0	4	0	4	15
Commercial company, etc.	0	2	2	10	2	6	27,5
Companies mostly for self-sufficiency	0	2	0	0	4	0	7,5
Companies rather small for the industry	4	6	2	14	2	2	37,5
Companies average for the industry	4	4	4	10	0	6	35
Companies big for the industry	4	0	2	2	2	6	20
Field crops	2	2	0	2	0	4	12,5
Vegetables, flowers and mushrooms	0	2	2	4	0	0	10
Perennial plants	4	0	4	6	2	4	25
Grazing animals	2	0	0	2	2	0	7,5
Pigs, birds and rabbits	0	2	0	2	0	0	5
Mixed plant-animal farms	2	4	2	4	4	4	25
Mixed plant farms	0	2	0	6	0	2	12,5
Mixed livestock farms	0	2	0	0	0	0	2,5

Source: survey with managers of farms, 2017

The owners or managers of the majority of farms surveyed are men and in active working age from 41 to 65 years. Such gender and age structure of managers (owners) will manage the majority of Bulgarian farms in the near 10-15 years and will contribute to one or other level of their sustainability. The majority of respondents are between age from 56 to 65, which is an indicator of both their life and professional experience and the worrying aging of the employed in our agriculture.

Most of the farms surveyed have a relatively long life - over 15 years and only 10% with a short development period from 2 to 5 years. This is an indicator that the majority of farms have sufficient effective management experience and sustainability. Most of the farmers surveyed indicate that the period they are taking care of improving the sustainability of the farm is over 6 years, the majority of them are in the group with long experience over 15 years. There is a correlation between the duration of the existence of the farms and the period during which the farms take care to improve their sustainability. Moreover, with the increase in the duration of the existence of the farm, the proportion of farms with an effective care to improve their sustainability increases. All this shows that the practical problem of "agrarian sustainability" is not new. However, the question is whether farms know and to what extent they respect the principles of sustainable agriculture.

The kknowledge of the main socio-economic and environmental challenges and the basic principles of sustainable agriculture is the basis for effective management of agrarian sustainability. Our large-scale survey found that according to the majority of farms in the country, they are located in areas with "normal" economic, social and environmental problems. However, a significant part of them is in the areas with "big" or "extreme" economic, social and environmental challenges. One third of the managers say that their farm is located in an area with "small" or "no" ecological problems, while the share of farms with similar economic and social problems is smaller. The share of managers who are not familiar with the character or cannot assess the level of socio-economic and environmental problems in the area where their farm is located is not low. The greatest concern is farmers' competence with regard to the ecological problems in the area, followed by social and economic challenges.

Our study found that the majority of the managers of the surveyed farms know "well" and "very well" the principles of economic, social and environmental sustainability (. At the same time, a large proportion of farmers recognize that their knowledge of the principles of social and environmental sustainability is "satisfactory" or lacking at all. The low lack of competence concerns almost half of the holdings in terms of social sustainability principles, almost every third farm in terms of environmental sustainability and about one fifth of farms for economic sustainability.

Only a small proportion of the farms surveyed increase their sustainability management capacity by hiring a consultant, and this is all about getting to know the principles of environmental and economic sustainability. The relatively high (internal) potential for managing the different aspects of sustainability are cooperative farms, where everyone knows "well" or "very well" the principles of economic and social sustainability, and a significant part of them know the principles of environmental sustainability (Figure 6). At the same time, 16.67% of these farms "use a consultant" to improve their environmental sustainability competence.

All of the sole traders know well or very well the principles of economic sustainability and three-quarters of them - the principles of environmental sustainability. About 12% of these types of farms hire a consultant in order to improve the economic sustainability. The majority of sole traders also know well or very well the principles of social sustainability. However, 37.5% of them report that their knowledge about the principles of social sustainability is not good. The majority of commercial companies know well or very well the principles of economic and environmental sustainability, but only slightly more than half of them have a similar level of competence with respect to the principles of social sustainability. Every tenth of this type of farms also use an external consultant to enhance its environmental sustainability competence. Two thirds of individuals are highly competent in terms of economic sustainability principles, and 40% of them are also competent in terms of

environmental sustainability. At the same time, nearly three quarters (73.33%) of this type of farms are not well aware of the principles of social sustainability.

Competence of sustainability principles grows together with farm size and, as a rule, larger farms are better acquainted with economic, social and environmental sustainability. At the same time, 7.69% of medium-sized farms hire a consultant to increase their knowledge of economic sustainability and 15.38% of environmental sustainability. At the same time, it is worrying that none of the farms that are primarily for self-sufficiency know well the principles of economic, social and environmental sustainability. This group of producers represents a significant part of all farms in the country and is an important factor in improving the socio-economic and environmental sustainability of agriculture. There is also a differentiation of competence with respect to the principles of sustainability and depending on the production specialization of farms. In all categories of farms, a high level of knowledge of the principles of economic sustainability is typical of all or a majority of them. Exceptions are only farms with plant breeding specialization, where each second farm is not well aware with the principles of economic sustainability. Half of pig, poultry and rabbit farms also have a consultant to improve their competence in terms of economic sustainability.

Knowledge of the principles of ecological sustainability is high in farms specializing in field plants, perennial crops, mixed crops, mixed crops and grazing livestock, while in farms with other specialization the share of those with low ecological competence is significant. Each fifth of field plants farms improves their ecological sustainability capacity by hiring a consultant, similar to 11.11% of those in perennial crops. Knowing the principles of social sustainability is good in most of the farms specializing in field plants, mixed plant growing and perennial crops. For farms in other production specialization, the share of highly competence in social sustainability is low, and for farms with vegetables, flowers and mushrooms, and those in mixed livestock farming, their share is zero.

Farms located in predominantly plain and plain-mountain areas and those in non-mountainous areas with natural constraints have a better knowledge of the principles of economic, social and environmental sustainability. On the other hand, farms located in predominantly mountainous areas, in mountainous areas with natural constraints and those with landscapes in protected areas and territories have a relatively small part highly competence in the principles of sustainability. Some of the farms located in mountainous regions improve their economic and ecological sustainability by employing a consultant - respectively 6.67% and 13.33% of all farms in this group.

Finally, all the farms surveyed in the South-East region know well or very well the economic, social and ecological principles of agrarian sustainability. Competence for economic sustainability is high in most of the farms in the other studied regions of the country. Most of the farms in the North-Central region are well informed about environmental sustainability while in the South-West region they are a minority. Also, knowing the principles of social sustainability is not good at the majority of farms in the South-Central and South-West regions of the country. Consultants in order to improve the knowledge of sustainable agriculture use 13.5% and 6.25% of farms in the South-West and South-Central region in terms of ecological aspects and 6.25% of farms in the South Central Region in terms of economic sustainability. Therefore in the future, greater efforts should be made in order to improve the farmers' competence in low-culture groups with regard to the principles of agrarian sustainability through training, counselling, advices, exchange of positive experiences, etc.

Competence about the principles of agrarian sustainability is necessary but not a sufficient condition for its effective management. Due to incomplete knowledge and various other economic, technological, agronomic, behavioural, etc. reasons, and at different times, farmers do not always strictly apply the principles of sustainable agriculture. Our study found

that, according to the majority of farm managers, they comply "strict" or "good" principles of economic, ecological and social sustainability (Bashev 2016). However, a significant part of the farms respect the principles of social, economic and environmental sustainability only "satisfactory". Moreover, some farms point that they do not "follow" such principles (which reach 6% of the total number of farms in terms of social sustainability), or "only follow if there are sanctions" (up to 8% ecological sustainability).

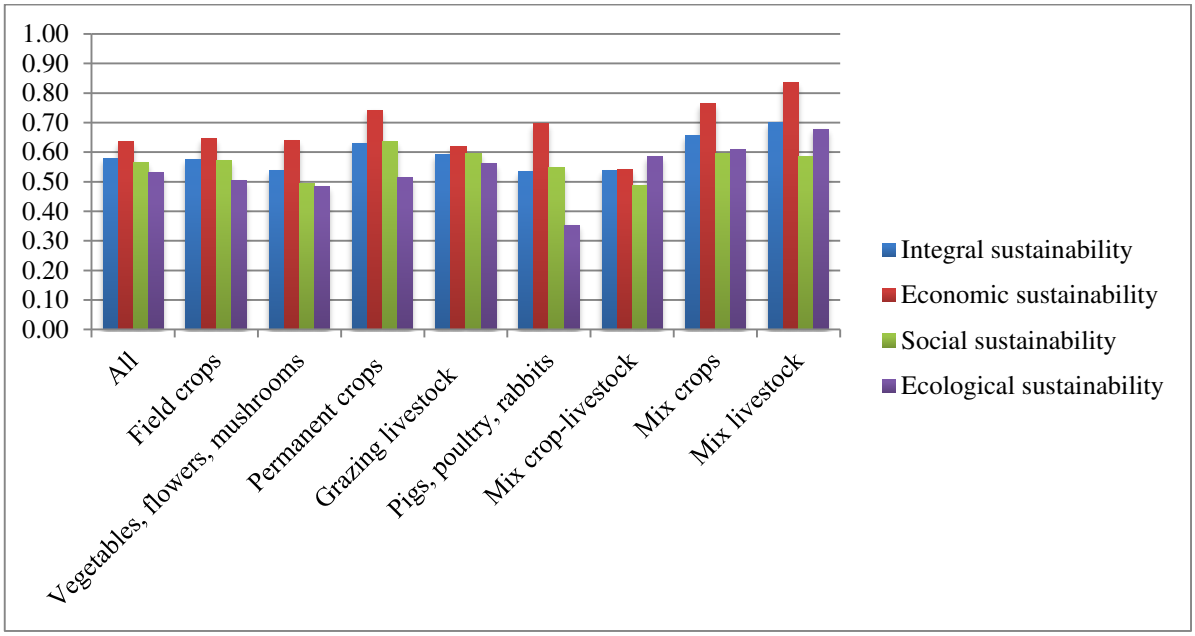
The principles of agrarian sustainability are applied to the greatest extent in the general management of farms in cooperatives and commercial companies. Around 8% of cooperatives apply the principles of environmental sustainability only if there are sanctions. A comparatively smaller proportion of sole traders and natural persons apply the principles of social sustainability to a high degree. Many natural persons follow the principles of sustainable agriculture only if there are sanctions - 9% for environmental sustainability, 5% for economic sustainability and 5% for social sustainability. These data show that sanctions by the state, local authorities, owners, members, etc. generate economic behaviour to improve environmental sustainability in certain groups of farms such as cooperatives and natural persons.

The application of sustainability principles grows with farm sizes and as a rule, larger farms are better of economic, social and environmental sustainability. Compliance with the diversity of sustainability principles is the most common among farms specializing in field plants, grazing livestock and mixed plant breeding and mixed plant growing farms. However, the quoted study also found that for all groups of holdings, the proportion of those who respect well or strictly the principles of agrarian sustainability exceeds the proportion of those who know well or very well these principles. Therefore, the question is how much some of the farms apply effective principles that they themselves do not know well.

Integral, economic, social and ecological sustainability in different sub-sectors

The assessment has found out that with the highest integral sustainability is the mixed livestock-breeding (0,7) and mixed crop-growing (0,66) sub-sectors, followed by the perennial crops (0,63). (Figure 1). Therefore, the mixed livestock-breeding and crop-growing farms and the farms with perennials contribute in highest degree for improving the integral sustainability of Bulgarian agriculture. From the other hand, the farms specialized in pigs, poultry and rabbits (0,53); vegetables, flowers and mushrooms (0,54) and mixed livestock-crops (0,54) have the lowest integral sustainability. This means that these subsectors decrease to the biggest extent the agrarian sustainability in the country.

Figure 1. Sustainability level in different sub-sectors of agriculture



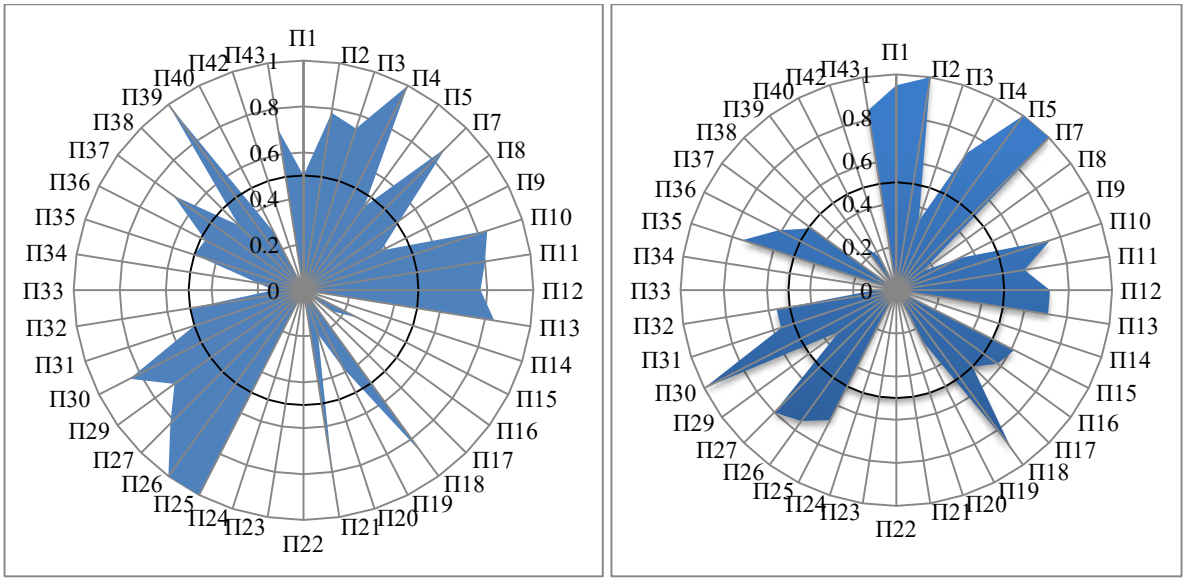
Source: survey with managers of farms, 2017 and author's calculations

Similar to integral sustainability, the sub-sectors with the highest economic sustainability are: mixed livestock breeding (0,84), mixed crop growing (0,76) and perennial crops (0,74). The mixed crop-growing production has the highest ecological sustainability (0,61) and one of the best social sustainability (0,6). The perennial crops sector has high social sustainability (0,64), but lower than the average and almost satisfying ecological sustainability (0,51). The social sustainability of farms specialized in grazing livestock has comparatively high level of social sustainability (0,6). The social sustainability in mixed crop-livestock farms has satisfying level (0,49). The pigs, poultry and rabbits' farms have lowest and satisfying level (0,35), like the farms for vegetables, flowers and mushrooms (0,48). The field crops farms have good, but relatively low ecological sustainability (0,5), close to the satisfying level.

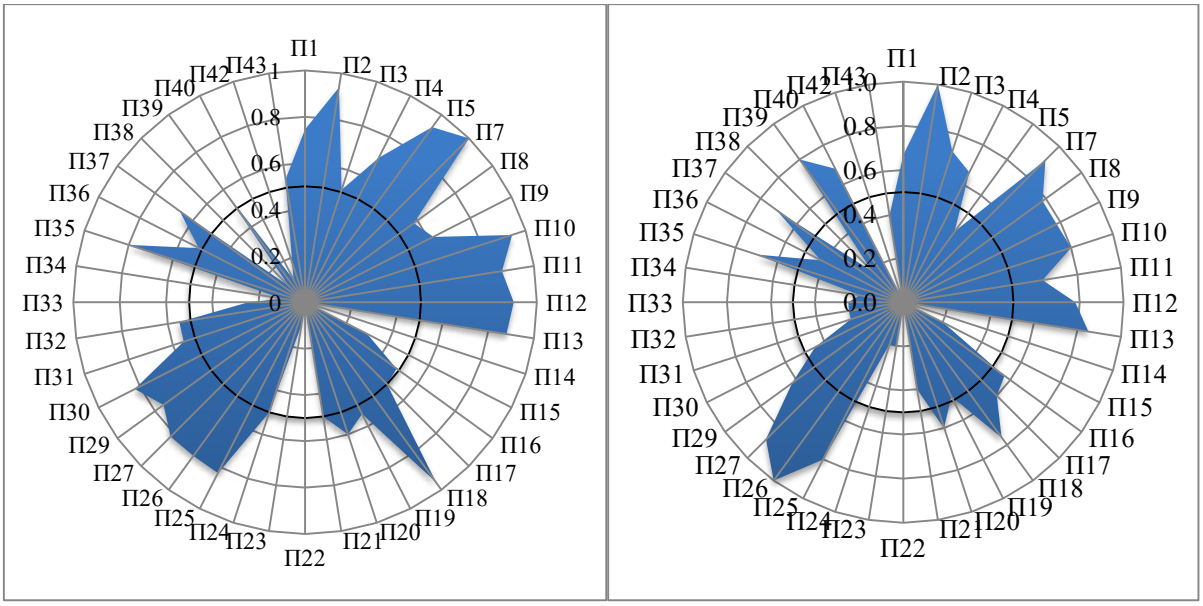
The different agricultural sub-sectors are characterized by important variation of levels of indicators for agricultural sustainability. The productions specialized in field crops have high economic sustainability for: labour productivity (1) and share of sold output in the total (0,87); high social sustainability for net farm income/ average income in the region (0,84), degree of compatibility to normative labour conditions (0,84), education level of the manager (0,88), share of unoccupied permanent work positions in the total number of employed (1) and share of unoccupied seasonal work positions in the total number of employed (1); and high ecological sustainability for dynamics of used agricultural land in last 5 years (0,82), compliance to norms of nitrate fertilization (0,85) and protection of natural biodiversity (1) (Figure 2).

Figure 2. Sustainability indicators* in different crop-growing sub-sectors of agriculture

Field crops **Vegetables, flowers and mushrooms**



Perennial crops **Mixed crop-growing**



*П1-Direct payments in the net income; П2-Share of own capital in the total one; П3-Profit/production costs; П4-Labour productivity; П5-Land productivity; П6-Livestock productivity; П7-Share of sold production in the total one; П8-Sales growth in the last three years; П9-Investments growth in last 5 years; П10-Net farmer's income/ average income in the region; П11-Payment of hired labour/ average income in the region; П12-Degree of satisfaction from farmer's activity; П13-Degree of compliance to normative labour conditions; П14-Presence of a family member ready to take the farm; П15-Number of family members working in the farm; П16-Age of manager; П17-Participation of training programs in the last 3 years; П18-Education level of manager; П19-Share of occupied with special agricultural education / qualification; П20-Degree of participation of women in the farm management; П21-Number of participation in professional organizations and initiatives; П22-Share of hired workers, members of trade unions; П23-Public positions occupied from the farmer, manager and owner; П24-Participation in local initiatives; П25-Share of non-occupied permanent work positions in the total number of employed; П26-Share of non-occupied seasonal work positions in the total number of employed; П27-Change of UAA in last 5 years; П28-Change of livestock number in last 5 years; П29-Soil erosion; П30-Compliance of nitrate fertilization to norms; П31-Compliance of potassium fertilization to norms; П32-Compliance of phosphorus fertilization to norms; П33-Share of arable land

in the total UAA; П34-Keeping the practices of landscape maintenance; П35-Degree of pollution of underground waters with nitrates; П36-Level of fuel consumption; П37-Level of electricity consumption; П38-Presence of protected species on the farm territory; П39-Natural biodiversity protection; П40-Number of cultural species; П41-Respecting of animal welfare norms; П42-Implementation of principles for organic production; П43-Yield variation of main crops for 5 years; П44-Percentage of mortality of livestock for 5 years.

Source: survey with managers of farms, 201 7 and author's calculations

The sub-sector of field crops has satisfying economic sustainability for land productivity (0,45) and investments growth in last 5 years (0,38). The social sustainability of field crops productions has satisfying levels for number of family members working in the farm (0,27) and share of employed with special agricultural education/qualification (0,38); unsatisfying levels for manager's age (0,15) and degree of participation of women in the farm management (0,2). The field crops are socially unsustainable in relation to: presence of a family member ready to take the farm; participation in education programs in the last 3 years, share of hired workers, members in trade unions; public position of the farmer, manager or owner and participation in local initiatives. The ecological sustainability of field crops farms is satisfying for level of fuel consumption (0,48), presence of protected species on the farm territory (0,4) and number of cultural species (0,28); unsatisfying for share of arable land in the total agricultural land (0,13) and keeping of landscape maintenance practices (0,2); and unsustainable regarding the application of the principles for organic production.

Productions, specialized in vegetables, flowers and mushrooms have high levels of indicators for: economic – share of direct payments in the net income (0,95), share of own capital in the total (1), land productivity (1) and share of sold production in the total (1); social – education level of manager (0,9); and ecological – compliance to norms of nitrate fertilization (1) (Figure 2). At the same time these productions have satisfying levels of sustainability regarding the economic indicators profit/ production costs (0,34) and investment growth in last 5 years (0,33); social: for the share of employed with special agricultural education/qualification (0,26); and ecological: soil erosion (0,33) and level of electricity consumption (0,49). The sub-sector of vegetables, flowers and mushrooms has unsatisfying levels of economic sustainability regarding the sale growth in last 3 years (0,15) and for ecological sustainability: natural biodiversity protection (0,25) and number of cultural species (0,17). This production is unsustainable in relation to many social and ecological indicators: presence of a family member ready to take the farm, degree of participation of women in the farm management, number of participation in professional organizations and initiatives, share of hired workers, members of trade unions, public positions of the farmer, manager or owner, participation in local initiatives, share of arable land in the total agricultural land, keeping of practices for landscape maintenance, presence of protected species on the farm territory and implementation of principles for organic production.

The sub-sector of perennial crops has high economic sustainability regarding the share of own capital in the total (0,93), land productivity (0,93) and share of sold output in the total one (1) (Figure 2). The social sustainability of perennial crops is also high for some indicators: net farm income/ average income in the region (0,94), payment of hired labour/ average income in the region (0,86), degree of satisfaction from farm activity (0,9), compliance degree of normative labour conditions (0,88), education level of manager (0,96), share of unoccupied permanent work positions in the total number of employed (0,83) and share of unoccupied seasonal work positions in the total number of employed (0,82). This sub-sector is with high ecological sustainability only for the dynamics of the used agricultural land in the last 5 years (0,82) and the compliance to norms of the nitrate fertilization (0,82). Satisfying is the social sustainability in relation to the number of family members, working in

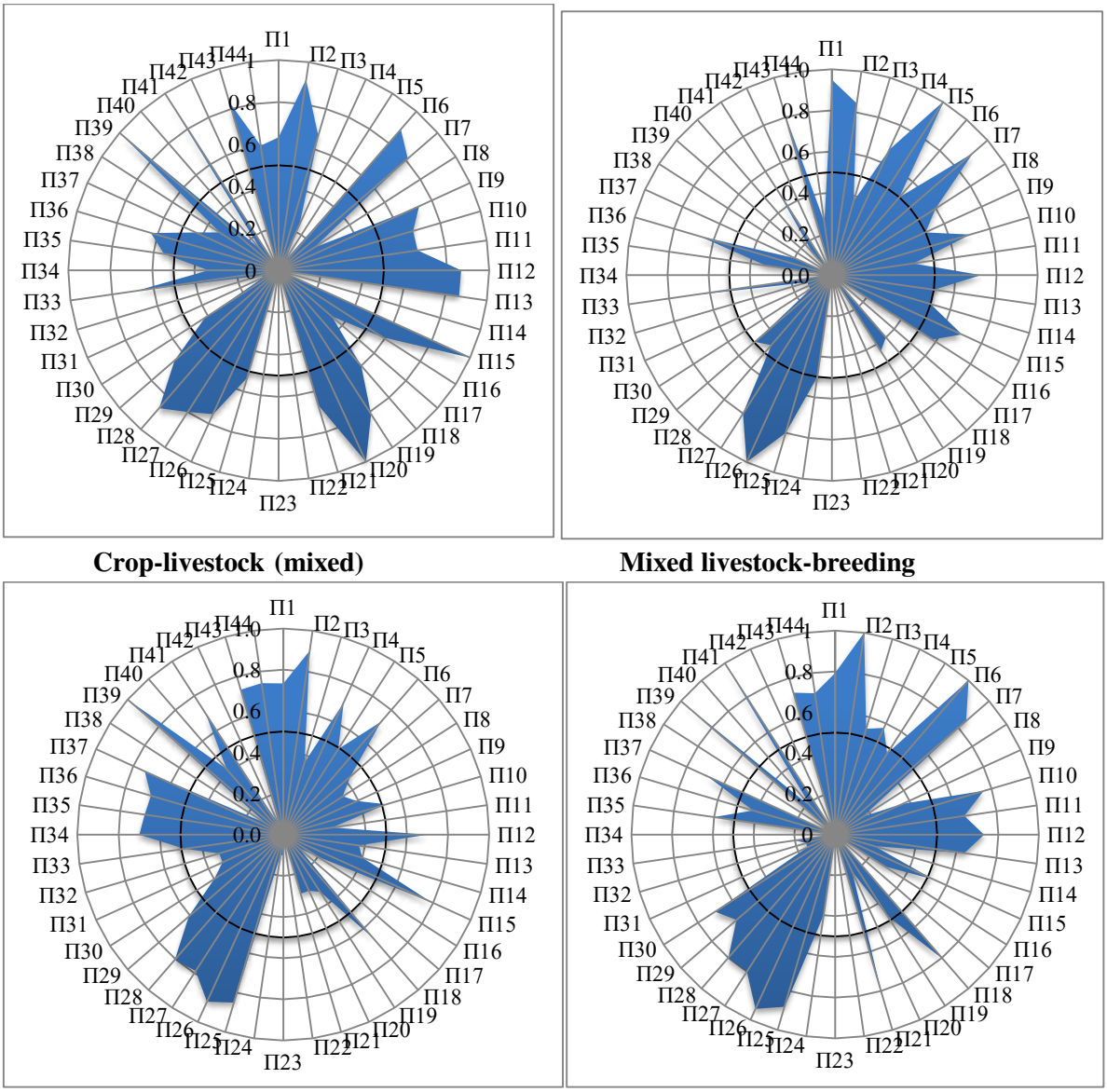
the farm (0,3) and manager's age (0,49), and socially unsustainable for: presence of a family member ready to take the farm, share of hired workers, members of trade unions and public position of the farmer, manager or owner. Unsatisfying is the ecological sustainability for share of arable land in the total agricultural land (0,24), number of cultural species (0,11) and implementation of principles for organic production (0,18). They are ecologically unsustainable regarding the keeping of practices for landscape maintenance and presence of protected species on the farm territory.

The mixed crop-growing productions have high sustainability for the following economic indicators: share of own capital in the total (1) and share of sold production in the total (0,91); the social indicators – degree of compliance to normative labour conditions (0,85) and share of unoccupied seasonal work positions in the total number of employed (1); and the ecological indicator – dynamics of UAA in last 5 years (0,88) (Figure 2). The mixed crop-growing productions have satisfying levels of sustainability for the economic indicator – land productivity (0,4); social indicators: share of employed with special agricultural education/ qualification (0,48) and number of participation in professional organizations and initiatives (0,4); and ecological indicators: compliance to norms of nitrate fertilization (0,45), level of fuel consumption (0,42) and variations of yield from main crops for 5 years (0,4). The level of sustainability is unsatisfying regarding some social and ecological indicators: number of family members working in the farm; public position of the farmer, manager or owner and participation in local initiatives (0,2 each); compliance to norms of the potassium fertilization , compliance to norms of the phosphorus fertilization and share of arable land in the total agricultural land (0,25 each), and keeping of practices for landscape maintenance and presence of protected species on the farm territory (0,2 each). This productions' type is socially and ecologically unsustainable for: presence of a family member ready to take the farm, share of hired workers, members in trade unions and implementation of organic production principles.

The sub-sectors with livestock productions also have big differences in the levels of indicators for agricultural sustainability. The herbivore livestock's productions have high economic sustainability for the share of own capital in the total (0,92), livestock productivity (0,89) and share of sold output in the total (0,81); high social sustainability for degree of satisfaction from farming activity (0,87), degree of compliance to normative labour conditions (0,87), number of family members working in the farm (1), share of employed with special agricultural education/ qualification (0,81) and degree of participation of women in the farm management (1); and high ecological sustainability for the dynamics of the number of raised animals in the last 5 years (0,87), natural biodiversity protection (1), meeting of norms for animal welfare (1) and variation of yield from main crops for 5 years (0,83) (Figure 3).

Figure 3. Sustainability indicators* in different livestock sub-sectors of agriculture

Grazing livestock **Pigs, poultry and rabbits**



Crop-livestock (mixed) **Mixed livestock-breeding**

Source: survey with managers of farms, 2017 and author's calculations

Specialized productions from herbivore livestock have satisfying social and ecological sustainability for: participation in education programs in the last 3 years (0,33), public position of the farmer, manager or owner (0,33), compliance to norms of nitrate fertilization (0,42), keeping of practices for landscape maintenance (0,33), level of consumption of electricity (0,43) and presence of protected species on the farm territory (0,33). The sustainability is unsatisfying in relation to the following economic, social and ecological indicators: labour productivity (0,24), land productivity (0,06), sales growth in last 3 years (0,2), compliance to norms of potassium fertilization (0,08), compliance to norms of phosphorus fertilization (0,08), number of cultural species (0,13). The productions of grazing livestock are socially unsustainable for: presence of a family member ready to take the farm; share of hired workers, members of trade unions; participation in local initiatives and ecologically unsustainable for the implementation of principles for organic production.

The production specialized of pigs, poultry and rabbits has high economic sustainability regarding the share of direct payments in the net income (0,95), the share of own capital in the

total (0,84), the land productivity (1) and the share of sold output in the total (0,91) (Figure 3). In social aspect this type of production is strongly sustainable for the share of unoccupied seasonal work positions in the total number of employed (1), and from ecological aspect, for: variations of the yields of main crops for 5 years (0,81). Satisfying degree of sustainability have the following indicators: payment of hired labour/ average income in the region (0,4), education level of the manager (0,4) and share of employed with special agricultural education/qualification (0,44). There is a social unsustainability for: participation in education programs in last 3 years, degree of participation of women in the farm management, number of participation in professional organizations and initiatives, share of hired workers, members of trade unions and public position of farmer, manager or owner. From ecological aspect the pigs, poultry and rabbits' productions have satisfying level of sustainability for: dynamics of the number of raised livestock in last 5 years (0,45), degree of pollution of underground waters with nitrates (0,33), and mortality percentage of animals for 5 years (0,26). This sub-sector has unsatisfying ecological sustainability for: compliance to norms of nitrate fertilization (0,13), compliance to norms of potassium fertilization (0,13), compliance to norms of phosphorus fertilization (0,13), level of consumption of electricity (0,2) and number of cultural species (0,15). These productions are unsustainable for: meeting of practices for landscape maintenance, presence of protected species on the farm territory, natural biodiversity protection and implementation of principles for organic production.

The mixed crop-livestock productions are economically sustainable only regarding the share of the own capital in the total (0,9); highly sustainable from social aspect for the share of unoccupied permanent work positions in the total number of employed (0,85) and share of unoccupied seasonal work positions in the total number of employed (0,89); and ecologically highly sustainable for: dynamics of the number of raised livestock in las 5 years (0,81) and protection of natural biodiversity (1) (Figure 3). The sustainability of crop-livestock holdings has satisfying levels of economic indicators for profit/ production costs (0,37), land productivity (0,49), share of sold production in the total (0,43), sales growth in last 3 years (0,34) and investments growth in last 5 years (0,39); social indicators: degree of compliance to normative labour conditions (0,37), presence of a family member ready to take the farm (0,4), share of employed with special agricultural education/qualification (0,33), degree of participation of women in the farm management (0,3), number of participation in professional organizations and initiatives (0,3); and ecological indicators for compliance to norms of nitrate fertilization (0,4), compliance to norms of potassium fertilization (0,33), compliance to norms of phosphorus fertilization (0,33), share of arable land in the total agricultural land (0,49) and number of cultural species (0,42). These productions have unsatisfying levels of sustainability for the ecological indicator presence of protected species on the farm territory (0,1) and for several social indicators: payment of hired labour/ average income in the region (0,24), manager's age (0,2), participation in education programs in last 3 years (0,1), public positions of farmer, manager or owner (0,1) and participation in local initiatives (0,1). These productions are socially unsustainable regarding the share of hired workers, members of trade unions and ecologically unsustainable for the implementation of principles of organic production.

The production of the mixed livestock is highly sustainable in relation to: share of own capital in the total (1), livestock productivity (1), share of sold output in the total (0,94), sales' growth in last 3 years (1) and investments growth in last 5 years (1) (Figure 3). This sub-sector is socially strongly sustainable for: net farm income/average income in the region (1), degree of satisfaction from farming activity (1), number of family members working in the farm (0,86), participation in education programs in last 3 years (1), number of participations in professional organizations and initiatives (1), and share of unoccupied seasonal working positions in the total number of employed (1). In ecological aspect the production

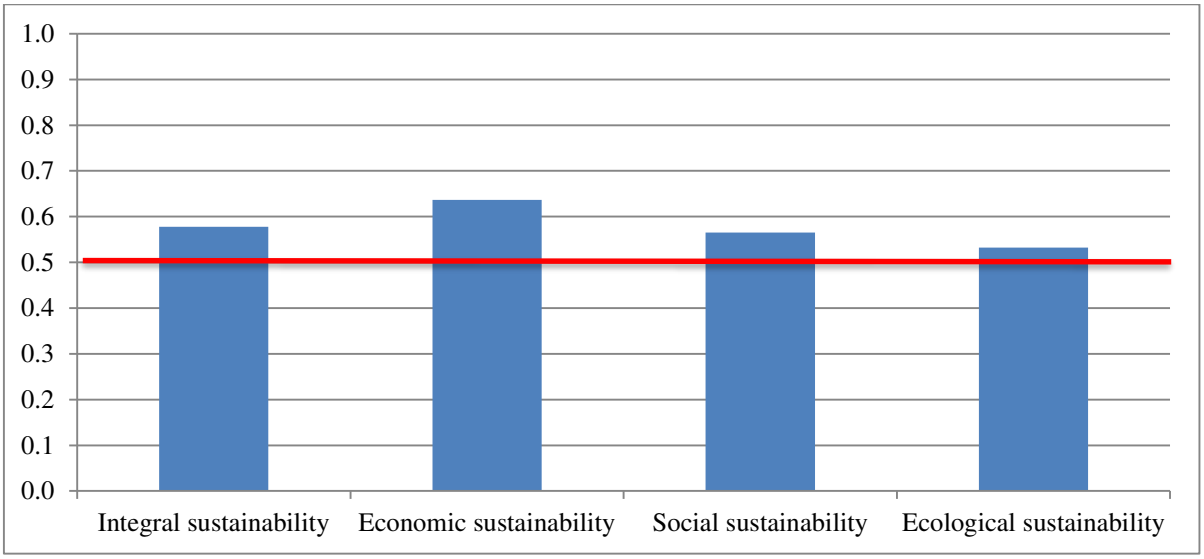
sustainability is high for lot of indicators: dynamics of UAA in last 5 years (0,95), dynamics of the number of raised livestock in last 5 years (1), soils erosion (1), share of arable land in the total agricultural land (1), keeping of practices for landscape maintenance (1), degree of pollution of underground waters with nitrate (1), presence of protected species on the farm territory (1), natural biodiversity protection (1) and meeting the norms for animal welfare (1).

The mixed livestock productions have satisfying social sustainability regarding the share of employed with special agricultural education/ qualification (0,39); and unsatisfying ecological sustainability for level of fuel consumption (0,25) and number of cultural species (0,1). This type of productions are unsustainable for several social-economic and ecological indicators: land productivity, presence of a family member ready to take the farm, degree of participation of women in the farm management, share of hired workers, members of trade unions, public position of the farmer, manager or owner, participation in local initiatives, compliance to norms of the nitrate fertilization, compliance to norms of the potassium fertilization, compliance to norms of the phosphorus fertilization and implementation of principles for organic production.

Comparison of assessment of agrarian sustainability with the previous studies in the area

The multi-indicator assessment of agricultural sustainability in the surveyed 4 geographical regions of the country shows that the integral indicator of overall sustainability is 0,58, which expresses a good sustainability level of agriculture (Figure 1). The biggest value has the indicator of economic sustainability (0,64), the social sustainability shows lower value (0,57) and the ecological sustainability is close to the unsatisfying value level (0,53). Therefore, the improvement of the last two indicators is critical for maintaining the good agricultural sustainability of the country.

Figure 4. Integral, economic, social and ecological sustainability in analysed 4 administrative regions of Bulgaria



Source: survey with managers of farms, 2017 and author's calculations

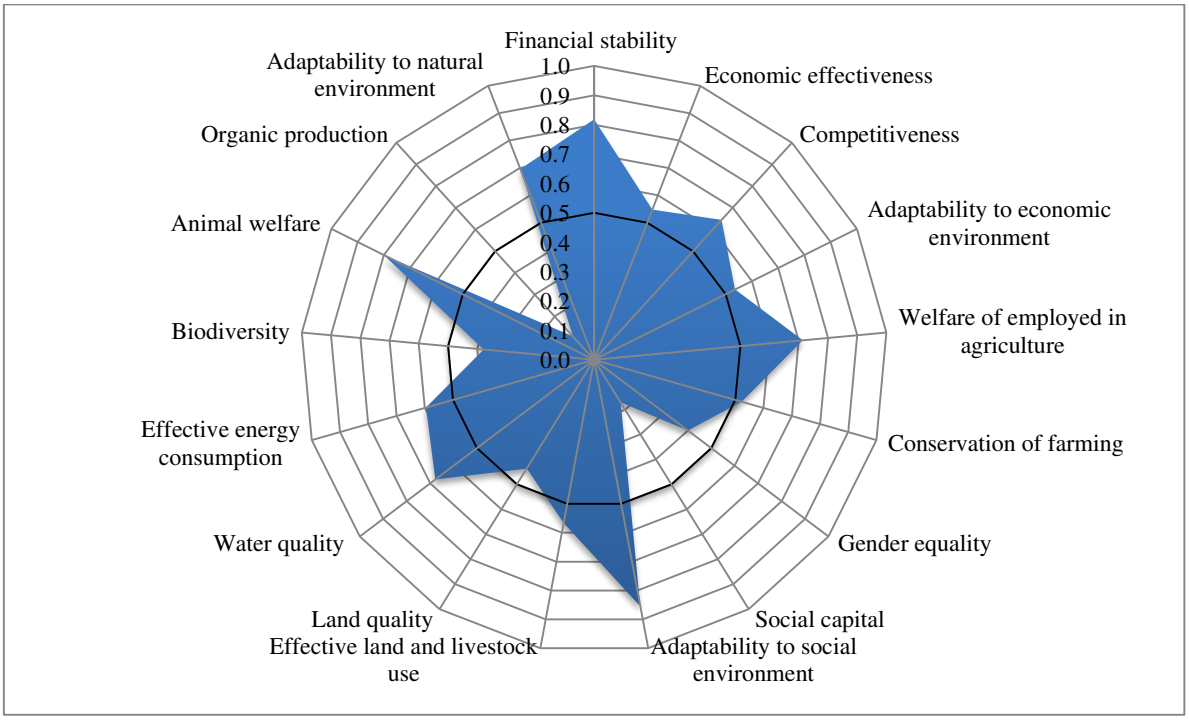
According to the precious study based on aggregate sectoral (statistical, etc.) data using the same methodological approach (Bachev et al., 2017) the integral sustainability index of the Bulgarian agriculture is 0.58 which correspond to a Good sustainability. The same study

has found out that the Economic sustainability of the Bulgarian agriculture is Good (index of sustainability 0.7), while the Social and the Environmental sustainability are also as Good but with a lower index (for both of them is 0.53) close to satisfactory level. Therefore, integral assessment results based on the "micro" subsectors (farm) data are similar with the results based on aggregated sectoral (statistical, etc.) data. It means that both approaches are reliable and could be simultaneously used for assessing agrarian sustainability at various levels – sector, subsector, region, and farm.

The analysis of private indexes on basic principles, criteria and indicators of the sustainability gives also opportunity to identify components contributing for the levels of different aspects of agricultural sustainability in the country.

The current assessment ascertained that the ecological sustainability is relatively low due to the fact that the indicators for the principles "land quality" (0,44), "biodiversity" (0,38) and "organic production" (0,11) are low (Figure 5). Thus, the improvement of these low levels of above-mentioned principles is a factor for maintenance and rising of ecological and integral sustainability in the sector. Also it becomes clear that despite the relatively high integral economic sustainability, the indicator of adaptability to economic environment is relatively low (0,54) and critical for maintaining the reached level. Analogically, for the social sustainability improvement would contribute mostly the increase of low levels of indicators for the principles "farming conservation" (0,52), "gender equality" (0,40) and "social capital" (0,17).

Figure 5. Sustainability index according the main sustainability principles in analysed in 4 administrative regions of Bulgaria

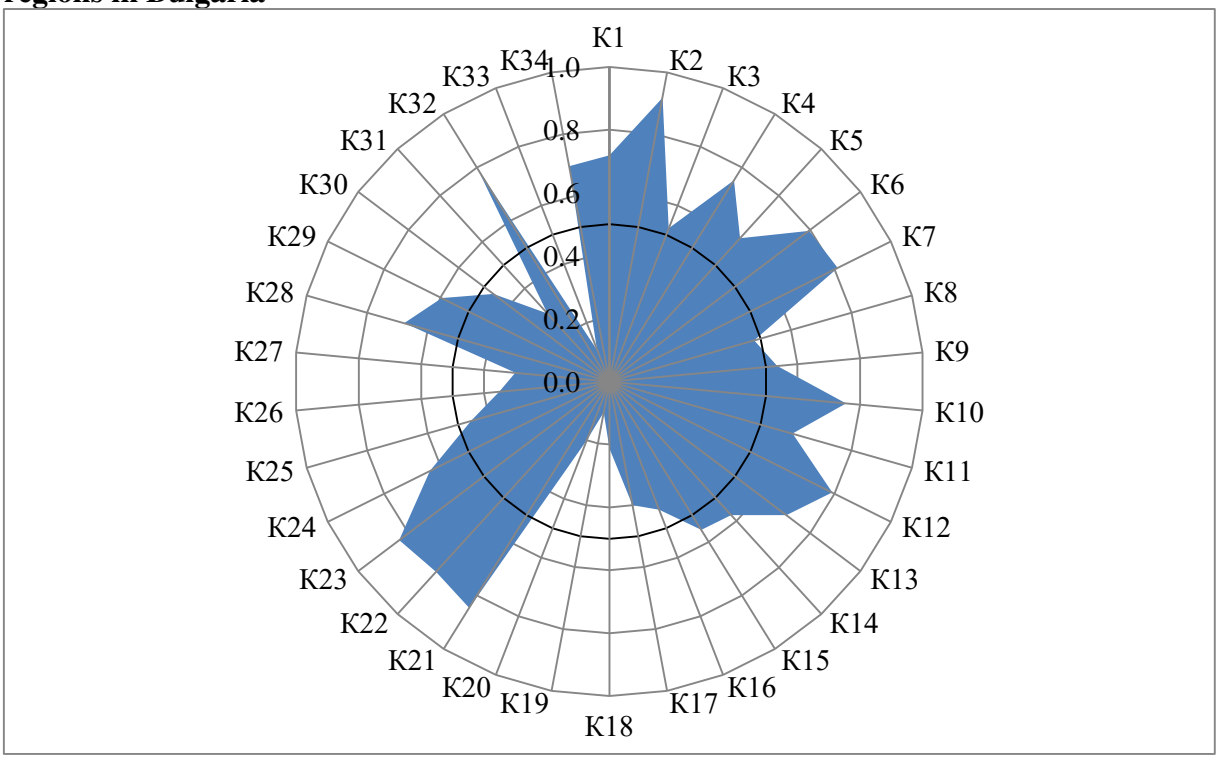


Source: survey with managers of farms, 2017 and author's calculations

The profound analysis according different criteria and indicators gives opportunity for detailed analysis of elements contributing for/or decrease the agricultural sustainability level. For example, the low levels of ecological sustainability are determined from the low criteria "conservation and improving of soil fertility" (0,46); "balanced land use structure maintenance" (0,35; "landscape elements conservation" (0,30); "natural biodiversity maintenance and improvement" (0,46); "cultural biodiversity maintenance and improvement"

(0,29) and "organic production increase" (0,11) (Figure 6). The unsatisfying levels according these criteria for ecological sustainability are (pre)determined of low levels of indicators for eco-sustainability, as: insufficient conformity of norms for fertilization with potassium (0,38) and phosphorus (0,38), high share of arable land in the total agricultural land (0,33), low degree of compliance with practices for landscape conservation (0,3), insufficient protected species on farms' territory (0,18), limited number of cultural species in farms (0,29) and low degree of application of organic production principles (0,11) (Figure 7).

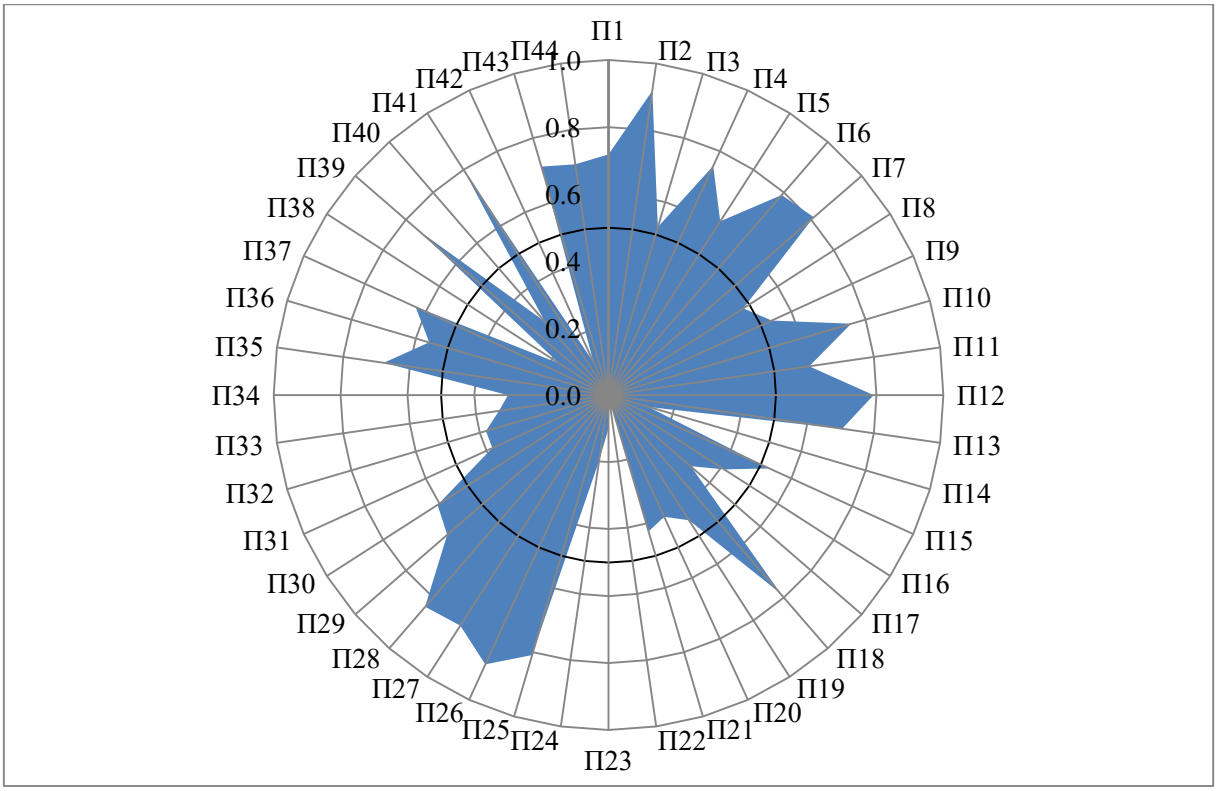
Figure 6. Sustainability index according the main criteria* in analysed 4 administrative regions in Bulgaria



* K1-Decrease of dependence on subsidies; K2-Minimization of dependence on exterior capital; K3-Positive or high profitability; K4-Maximal or increasing labour productivity; K5-Maximal or increasing land productivity; K6-Maximal or increasing livestock productivity; K7-Conservation or increase of sold output share ; K8-Conservation or increase of sales; K9-High investment activity; K10-Incomes parity with other sectors; K11-Equitable distribution of income in agriculture; K12-Sufficient satisfaction of farmer activity; K13-Satisfying labour conditions; K14-Keeping the number of family farms; K15-Knowledge and skills increase; K16-Conservation and improvement of agricultural education; K17-Equality of relations man-woman; K18-Participation in professional organizations and initiatives; K19-Participation in public management; K20-Contribution for the development of region and communities; K21-Sufficient potential for reaction to activity cession and to demographic crisis; K22-Keeping or increase of UAA size; K23-Keeping or increase of livestock number; K24-Minimization of soil losses; K25-Keeping and improvement of soil fertility; K26-Keeping of balanced land-use structure; K27-Protection of landscape elements; K28-Keeping and improvement of water quality; K29-Minimization of conventional energy use; K30-Keeping and improvement of natural biodiversity; K31-Keeping and improvement of cultural biodiversity; K32-Implementation of principles of animal welfare; K33-Organic production increase; K34-Sufficient adaptability to climatic changes.

Source: survey with managers of farms, 2017 and author's calculations

Fig. 7. Indicators* for sustainability in analysed 4 administrative regions in Bulgaria



Source: survey with managers of farms, 2017 and author's calculations

Social sustainability in agriculture is usually decreased almost by: lack of family member, ready to continue the farm work (for individual and family farms) (0,13), elderly age of managers and farm owners (0,41), insufficient participation in training programs in the last years (0,33), low share of employed with special agricultural education and qualification (0,44), insufficient participation of women in the farm management (0,4), low participation of farms in professional organizations and initiatives (0,43), lack of membership of hired workers in trade unions (0), weak participation in the public governance from the side of farmers, managers and owners (0,1), and insufficient involvement of farms in local initiatives (0,2).

Critical for the keeping and improvement of the sector's economic sustainability are the increase of production profitability (0,52) and the keeping and increase of sales (0,48). The low levels of indicators for sustainability show also the specialized areas for agricultural sustainability improvement through adequate change of farms strategies and/or of public policies in relation to the sustainable development of the sector, of different sub-sectors, ecosystems and farms types. On the other hand, the high levels of some indicators express the absolute and relative advantages of Bulgarian agriculture regarding the sustainable development. On the actual stage they are expressed in: high share of own capital in the total capital of farms (0,92), high share of sold production in the total output (0,81), lower share of non-occupied permanent (0,81) and seasonal (0,88) work places in the total number of employed, increase of UAA (0,82) and livestock number (0,84) in the last years and respect of norms for animal welfare (for the livestock breeding farms) (0,8).

Conclusion

This first in kind assessment on agrarian sustainability at sub-sectoral level in Bulgaria let make some important conclusions about the state of their sustainability, and recommendations for improvement of managerial and assessment practices. Elaborated and experimented holistic framework gives a possibility to improve general and aspects sustainability assessment. That novel approach has to be further discussed, experimented, improved and adapted to the specific conditions and evolution of each sub-sector as well as needs of decision-makers at various.

There is a considerable differentiation in the level of integral and aspects sustainability in individual sub-sectors in Bulgaria. With the highest integral sustainability is the mixed livestock-breeding, mixed crop-growing, and perennial crops sub-sectors while pigs, poultry and rabbits; vegetables, flowers and mushrooms, and mixed livestock-crops subsectors have the lowest integral sustainability. There are also substantial variations in the levels of economic, social and ecological sustainability of different agricultural sub-sectors, and individual indicators with the highest and lowest values show (critical) factors enhancing and deterring particular or overall sustainability of evaluated agro-industries.

Results on the integral agrarian sustainability level of this study based on the micro sub-sector (farm) data are similar to the previous assessment based on the aggregate sectoral (statistical, etc.) data. Having in mind the importance of holistic assessments of this kind for improving agrarian sustainability, farm management and agrarian policies, they are to be expended and their precision and representation increased.

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