Efficiency of sustainability management in Bulgarian agriculture

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Abstract: The issue of assessment of efficiency of environmental and sustainability management in agriculture is among the most topical in the last few decades. In Bulgaria there are no comprehensive studies on efficiency of environmental and sustainability management in agriculture in general and in farms of different types. This article applies a holistic framework for assessing efficiency of environmental and sustainability management in Bulgarian agriculture. Initially the multiprinciple, multictiteria and mulriindicator framework for assessing environmental and sustainability management in agriculture is outlined. After that environmental sustainability of Bulgarian agriculture at national and farms levels is evaluated. Finally, factors for improving environmental and sustainability management in agricultural farms in the country are identified. Our assessment at national and farm level have found out that there are significant discrepancies in efficiency levels based on aggregate national data and assessment (perception) of farm managers. Therefore, in management practices all kind of data have to be used in order to be able to take efficient decision at different managerial levels. Having in mind the importance of holistic assessments of efficiency of environmental and sustainability management in agriculture, and the enormous benefits for the farm management and agrarian policies, such studies are to be expended and their precision and representation increased.

Key words: environmental management, efficiency, sustainability, Bulgarian agriculture

Introduction

The issue of assessment of efficiency of environmental and sustainability management in general and in agriculture in particular is among the most topical in the last decades (Andreoli and Tellarini, 2000; Bachev, 2005, 2006, 2010, 2014, 2016; Bachev and Ito, 2014; Bachev and Petters, 2005; Bachev et al., 2016; Bastianoni et al., 2001; EC, 2001; FAO, 2013; Fuentes, 2004; Häni et al., 2006; Jones et al., 2017; Khoiruman and Haryanto, 2017; OECD, 2001; Rigby et al., 2001; Sauvenier et al., 2005; Suteja et.al. 2017; Praswati and Aji, 2017; UN, 2015). Nevertheless, with a very few exceptions (Bachev, 2005, 2016, 2017) in Bulgaria there are no comprehensive studies on efficiency of environmental and sustainability management in agriculture in general and in farms of different types.

This article applies a holistic framework for assessing efficiency of environmental and sustainability management in Bulgarian agriculture. Initially the multiprinciple, multictiteria and mulriindicator framework for assessing environmental and sustainability management is outlined. After that evaluation is made of environmental sustainability of Bulgarian agriculture at national (sectoral) and farm levels. Finally, factors for improving environmental and sustainability management in agricultural farms in the country are identified. Study is based on aggregate statistical, monitoring, etc. data as well as large-scale surveys with managers of farms on environmental and sustainability management.

Methods

Efficiency of environmental and sustainability management is agriculture is measured by various ways:

– indentions and plans of related agents – e.g. eco-conscious farmers, plans for pro-environmental activity, etc.;

- environmental actions and behavior of agents – e.g. agro-techniques, environmental and sustainability codes of behavior, industrial initiatives, eco-certification, etc.;

- environmental modes of management – e.g. eco-cooperatives, eco-contracts, organic production, etc.;

- environmental pressure – e.g. application of chemicals, emissions of harmful gases and elements into environment, etc.;

- environmental state and risks – e.g. extent of soil erosion, nitrate and pesticide pollution of waters, etc.;

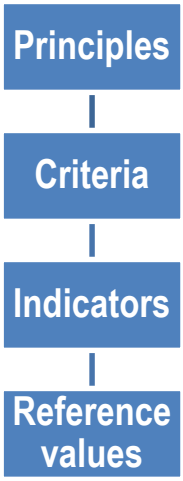
- environmental impacts – e.g. agricultural impact on climate mitigation and change, biodiversity, etc.

All approaches for assessing environmental management have their advantages and disadvantages (Bachev, 2014). One of the best way of evaluation of efficiency of environmental and sustainability management in agriculture is though actual level of sustainability of agricultural systems (Bachev, 2005, 2014, 2016). Accordingly, a high sustainability level means an efficient (good) system of management while low sustainability indicates inefficient (bad) system of management. Agriculture is environmentally sustainable if farming activity is associated with the conservation, recovery and improvement of the components of natural environment (lands, waters, biodiversity, atmosphere, climate, ecosystem etc.) and the nature as a whole, animal welfare, etc. Therefore, the measurement of efficiency of environmental and sustainability management is closely related with adequate measurement of sustainability level of agricultural systems of different type – farm, ecosystem, sub-sector, region, national agriculture, etc.

In this study we apply a hierarchical framework for assessing environmental sustainability of Bulgarian agriculture at national and farm levels. That framework includes 8 Principles, 11 Criteria, and 15 Indicators and Reference Values (Figure 1). The hierarchical levels, which facilitate the formulation of the system for assessing environmental sustainability includes:

Principles – the highest hierarchical level associated with the "environmental preservation" function of the agriculture. They are universal and represent the states of the sustainability, which are to be achieved in the environmental aspect of agrarian sustainability. For instance, a Principle "the soil fertility is maintained or improved".

Figure 1. Hierarchical levels of system for assessment of environmental sustainability of farm



Source: Sauvenier et al.

Criteria – they are more precise from the principles and easily linked with the sustainability indicators, representing a resulting state of the sector when the relevant principle is realized. For instance, a Criteria "soil erosion is minimized" for the Principle "the soil fertility is maintained or improved".

Indicators are quantitative and qualitative variables of different type (behavior, activity, input, effect, impact, etc.), which can be assessed in the specific conditions of Bulgarian agriculture, and allow to measure the compliance with a particular criterion. The set of indicators is to provide a representative picture for the environmental sustainability and efficiency of Bulgarian agriculture. For instance, an Indicator "the extent of application of good agro-technics and crop rotation" for the Criteria "soil erosion is minimized".

Reference value – these are the desirable levels (absolute, relative, qualitative, etc.) for each indicator for the specific conditions of Bulgarian agriculture. They assist the assessment of environmental sustainability level and give guidance for achieving (maintaining, improving) agrarian sustainability and efficiency. They are determined by the science, experimentation, statistical, legislative or other appropriate ways.

First of all, we have profoundly studied out the available academic publications, official documents, and experiences in Bulgaria and other countries as well as carried our numerous consultations with the leading national and international experts in the area of environmental management and sustainability in agriculture. On that base we have prepared a list (system) with potential principles, criteria, indicators and reference values for the contemporary socio-economic and natural environment of Bulgarian agriculture.

After that we organized a special expertise with ten leading scholars working on environmental management and sustainability of agriculture. The experts discussed, complemented and evaluated the importance of the suggested by us principles, criteria, indicators and reference values for assessing environmental sustainability of Bulgarian agriculture, and selected the most adequate ones for sectoral and farm levels for the contemporary conditions of the development in the country (Table 1 and Table 2).

Table 1. Principles, criteria, indicators and reference values for assessing environmental sustainability at sectoral (national) level in Bulgaria

Principles	Criteria	Indicators	Reference value
Air quality	Maintaining and improving air quality	Reduction of CO2 emissions	Scientific norms
Land quality	Minimizing soil losses	Soil water erosion index	Scientific norms
		Soil wind erosion index	Scientific norms
	Preservation and improvement of soil fertility	Amount of nitrogen fertilization	Scientific norms
		Amount of phosphorus fertilization	Scientific norms
	Maintaining a balanced land use structure	Share of arable land (without fallow) in total agricultural areas	Program targets
	Preservation of landscape features	Amount of area covering the requirements for "green" direct payments through maintaining landscape elements	Program targets
Water quality	Maintaining and improving water quality	Index of groundwater pollution	Scientific norms
Effective energy consumption	Minimizing the use of conventional energy	Fuel consumption per unit area	Scientific norms
Biodiversity	Maintaining or enhancing natural habitats	Change in the number of habitats	Program targets
		Share of agricultural land in NATURA 2000 and other protected areas	Program targets
Animal welfare	Compliance with the principles of animal welfare	Level of compliance with the principles of animal welfare	Program targets
Organic production	Increasing the organic production	Share of areas under conversion or certified for organic production	EU average level
Adaptability to the environment	Sufficient adaptability to climate change	Variation in the yield of main crops	EU average level
		Share of production losses in gross output in livestock sector	EU average level

Source: Author

Table 2. Principles, criteria, indicators and reference values for assessing environmental sustainability at farm level in Bulgaria

Principles	Criteria	Indicators	Reference values
Protection of agricultural lands	Chemical quality of soils	Soil organic content	Similar to the typical for the region
		Soil acidity	Similar to the average for the region
		Soil soltification	Similar to the average for the region
	Soil erosion	Extent of wind erosion	Similar to the typical for the region
		Extent of water erosion	Similar to the typical for the region
	Agro-technique	Crop rotation	Scientifically recommended for the region
		Number of livestock per ha	Within limits of acceptable number
		Rate of N fertilization	Within limits of acceptable amount
		Rate of K fertilization	Within limits of acceptable amount
		Rate of P fertilization	Within limits of acceptable amount
		Extent of application of Good Agricultural Practices	Approved rules
	Waste management	Manure storage type	Rules for manure storage
	Water irrigation	Irrigation rate	Scientifically recommended rate for the region
Protection of waters	Quality of surface waters	Nitrate content in surface waters	Similar to the average for the region
		Pesticide content in Surface waters	Similar to the average for the region
	Quality of ground waters	Nitrate content in ground waters	Similar to the average for the region
		Pesticide content in ground waters	Similar to the average for the region
Protection of air	Air quality	Extent of air pollution	Acceptance from rural community
Protection of biodiversity	Variety of cultural species	Number of cultural species	Similar to the average for the region
	Variety of wild species	Number of wild species	Similar to the average for the region
Animal welfare	Norms for animal welfare	Extent of compliance with animal welfare norm	Standards for animal breeding
Preservation of ecosystem services	Quality of ecosystem services	Extent of preservation of ecosystem services	Acceptance from communities

Source: Author

Assessment of environmental sustainability of agriculture in the country is based on available statistical, monitoring etc. data as well as large-scale surveys with the managers of "representative" market-oriented farms of different type. Surveys were carried out in the 2015-2016 with the assistance of the National Agricultural Advisory Service and the major associations of agricultural producers in the country, which identified the "typical" holdings of different type and location. They included 190 registered agricultural producers, which comprise around 0,2% of all registered agricultural producers in Bulgaria[1]. The structure and importance of surveyed farms approximately corresponds to the real structure of registered agricultural producers and market-oriented holdings in the country.

Since different indicators are in different measures a process of transferring each indicator into unitles indices is employed (Bachev, 2016). The primary level for calculating Integral indexes is the indicator sustainability score determined by the reference values. The reference values for each indicator have two thresholds (binary vector method). The lower threshold on which the indicator sustainability score is determined 0 (unsustainable) and an upper threshold, where the reference value complied to sustainability score up to 1 set up using the expert judgment, average numbers, trends, scientific norms, etc.

The Integral Index for a particular Criterion (IS_c), Principle (IS_p), Aspect of sustainability (IS_a) or Overall level (IS_o) is an *arithmetic average of relevant Indicators and Indices:*

$IS_c = \sum IS_i/n$ (n – number of Indicators)

$IS_p = \sum IS_c/n$ (n – number of Criteria)

$IS_a = \sum IS_p/n$ (n – number of Principles)

$ISo = \sum IS_a/3$

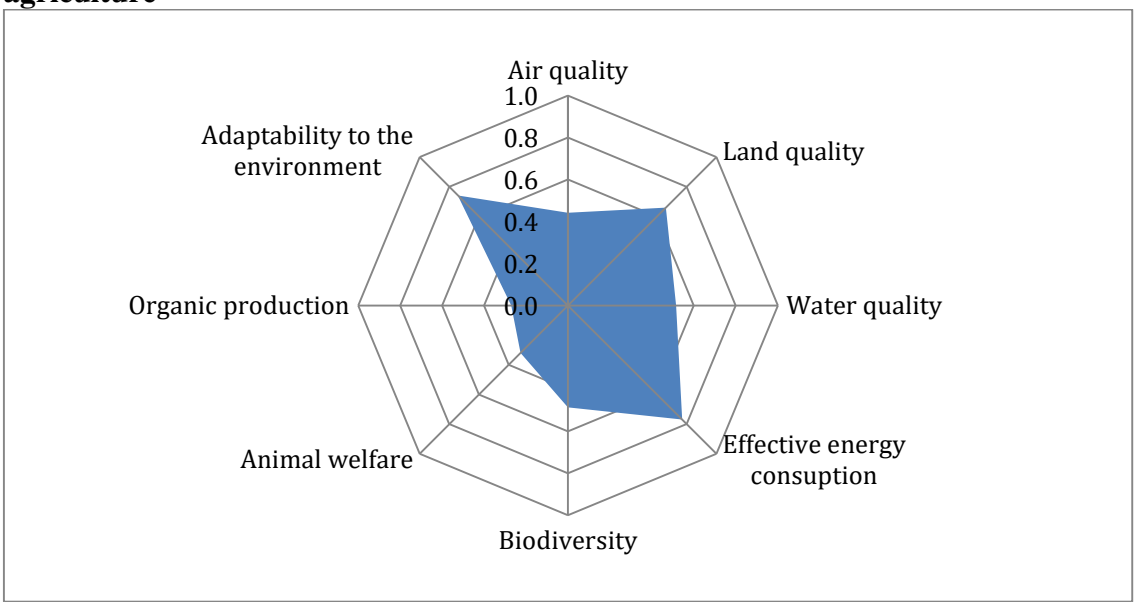
On the basis of the indicators value and the reference value for each indicator sustainability score is calculated. The score falls within one of five groups – high sustainability, good sustainability, satisfactory sustainability, unsatisfactory sustainability and unsustainable.

Results and Discussion

The aggregate level of *environmental sustainability* of the Bulgarian agriculture is assessed as *Good with a* score of 0.53. It is based on variety of indicators covering eight principles of environmental sustainability (Figure 1). The highest level of sustainability has been measured for the *Effective energy consumption* (0.77) and the *Adaptability to the environment* (0.74). Concerns stem from the level of the indexes for some of the principles that are critical for ensuring environmental sustainability. Such principles are the *Air quality*, *Biodiversity*, *Animal welfare,* and *Organic production*.

[1]1999 Regulation No 3 for Creation and Maintaining a Registry of Agricultural Producers in Bulgaria (MAF).

Figure 1. Indexes of environmental sustainability for the major principles in Bulgarian agriculture



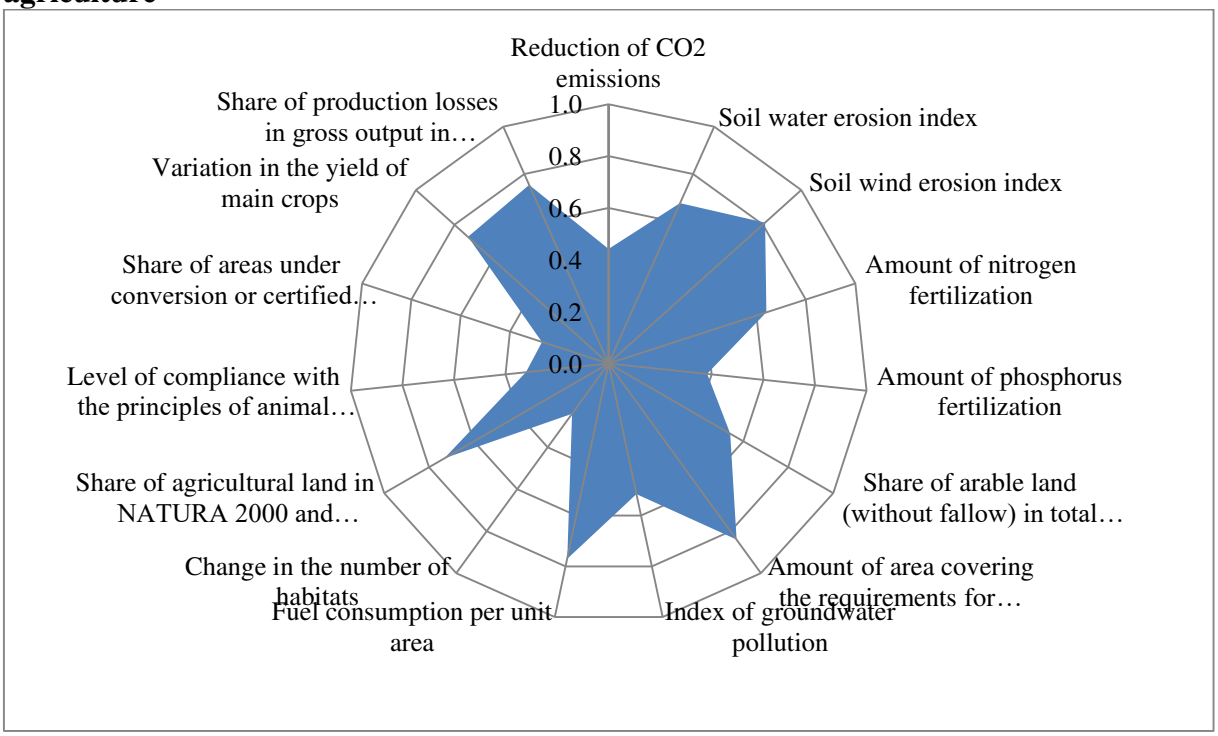
Source: own calculations, based on NSI, Agrostatistics department, EUROSTAT and reports from MOEW

The role of agriculture for maintaining and improving the air, water and soil quality, and preserving the biodiversity is important, since it has direct effects on the environment and its elements. As evident from the sustainability assessment we have conducted, these areas are also among the critical fields where the public and governmental efforts should be focused.

The individual scores of the different sustainability indicators are also very diverse (Figure 2). The highest sustainability score is calculated for the *Amount of area covering the requirements for "green" direct payments through maintaining landscape elements* (0.84) and the *Soil wind erosion index* (0.81). The high level of compliance of the Bulgarian farmers with the so called "green" requirements could be attributed to the different options they were able to choose from.

The lowest score is for the following indicators: *Change in the number of habitats* (0.24), *Share of areas under conversion or certified for organic production* (0.27), and *Level of compliance with the principles of animal welfare* (0.32).

Figure 2. Aggregate indicators of environmental sustainability of Bulgarian agriculture



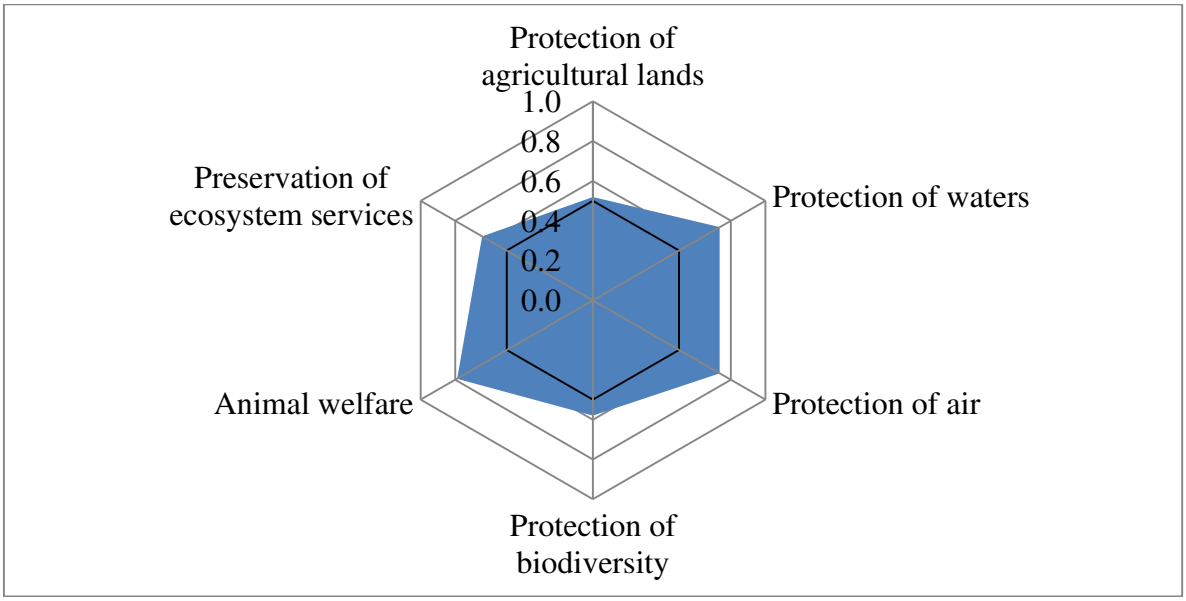
Source: own calculations, based on NSI, Agrostatistics department, EUROSTAT and reports from MOEW

All these indicators reveal that there is still much work needed in order to ensure that the agriculture does not harm the environment and the biodiversity. It is important to point out that in several areas the Bulgarian agriculture demonstrates strong sustainability, like the effective energy consumption. It should be made sure that in case of more intensive economic growth these high scoring factors will not deteriorate

Multi-indicators assessment of environmental sustainability at farm level is at a *good* level with an Index of Environmental Sustainability of 0,61.

Analysis of individual Indexes for major sustainability Principles, Criteria and Indicators let identify components contributing to diverse aspects of farms' environmental sustainability in the country. For instance, it is clear that despite that the overall environmental sustainability is relatively high, the Index of Preservation of Agricultural Lands (0,52) and the Index of Preservation of Biodiversity (0,56) are relatively low and critical for maintaining the achieved level (Figure 3).

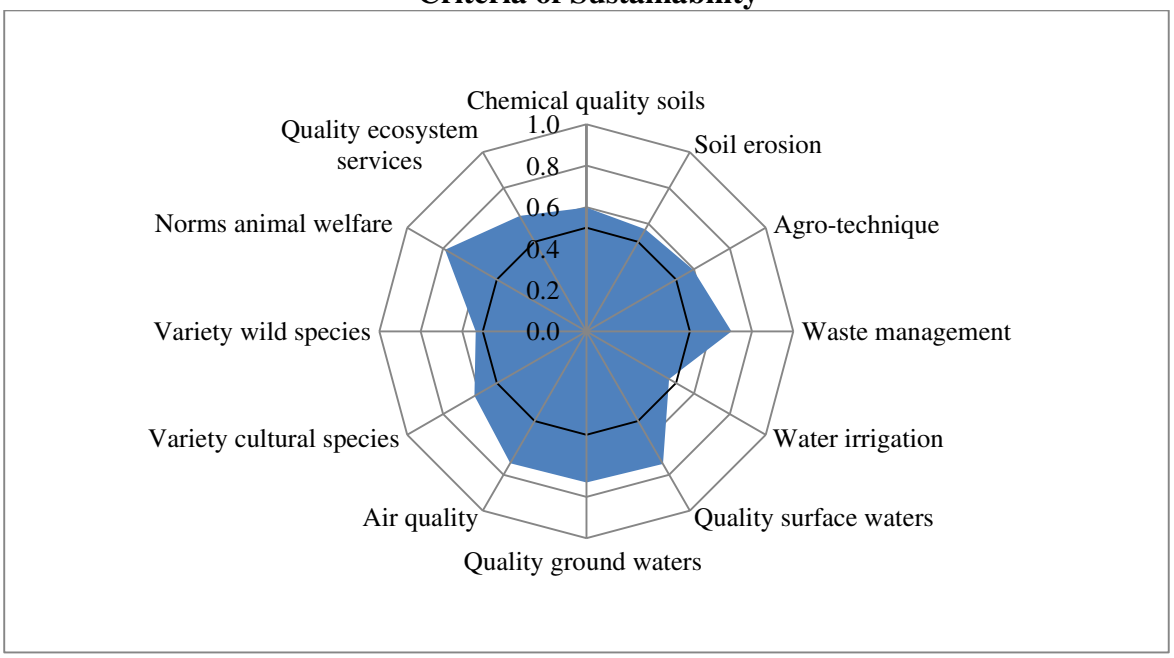
Figure 3. Index of Environmental Sustainability of Bulgarian Farms for Major Principles of Sustainability



Source: survey with managers of farms, July 2016

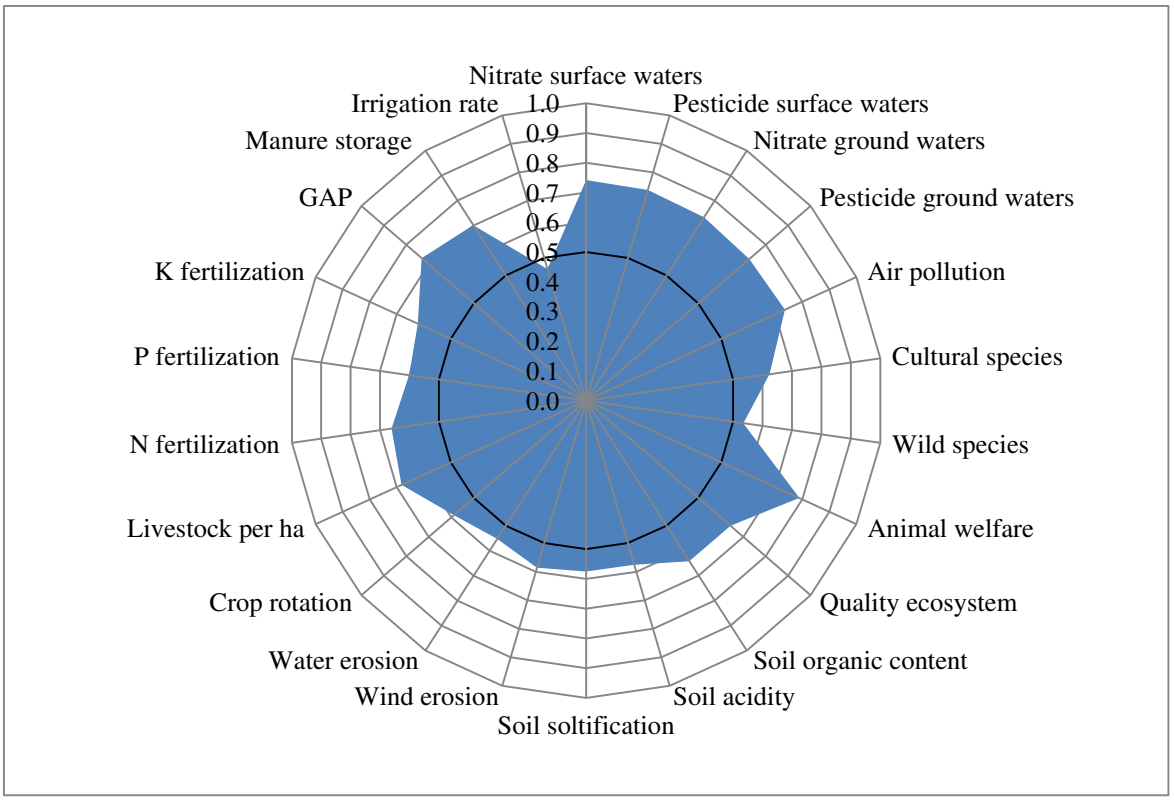
In depth analysis for individual Criteria and Indicators further specifies the elements, which enhance or reduce farms' environmental sustainability level. For instance, inferior levels of the Preservation of Agricultural Lands and the Preservation of Biodiversity are determined accordingly by insufficient Application of Recommended Irrigation Norms (0,46), high level of Soils Water Erosion (0,55), and lowered Number of Wild Species on Farm Territory (0,53) (Figures 4 and 5)

Figure 4. Level of Environmental Sustainability of Bulgarian Farms for Individual Criteria of Sustainability



Source: survey with managers of farms, July 2016

Figure 5. Indicators for Assessing Environmental Sustainability of Bulgarian Farms



Source: survey with managers of farms, July 2016

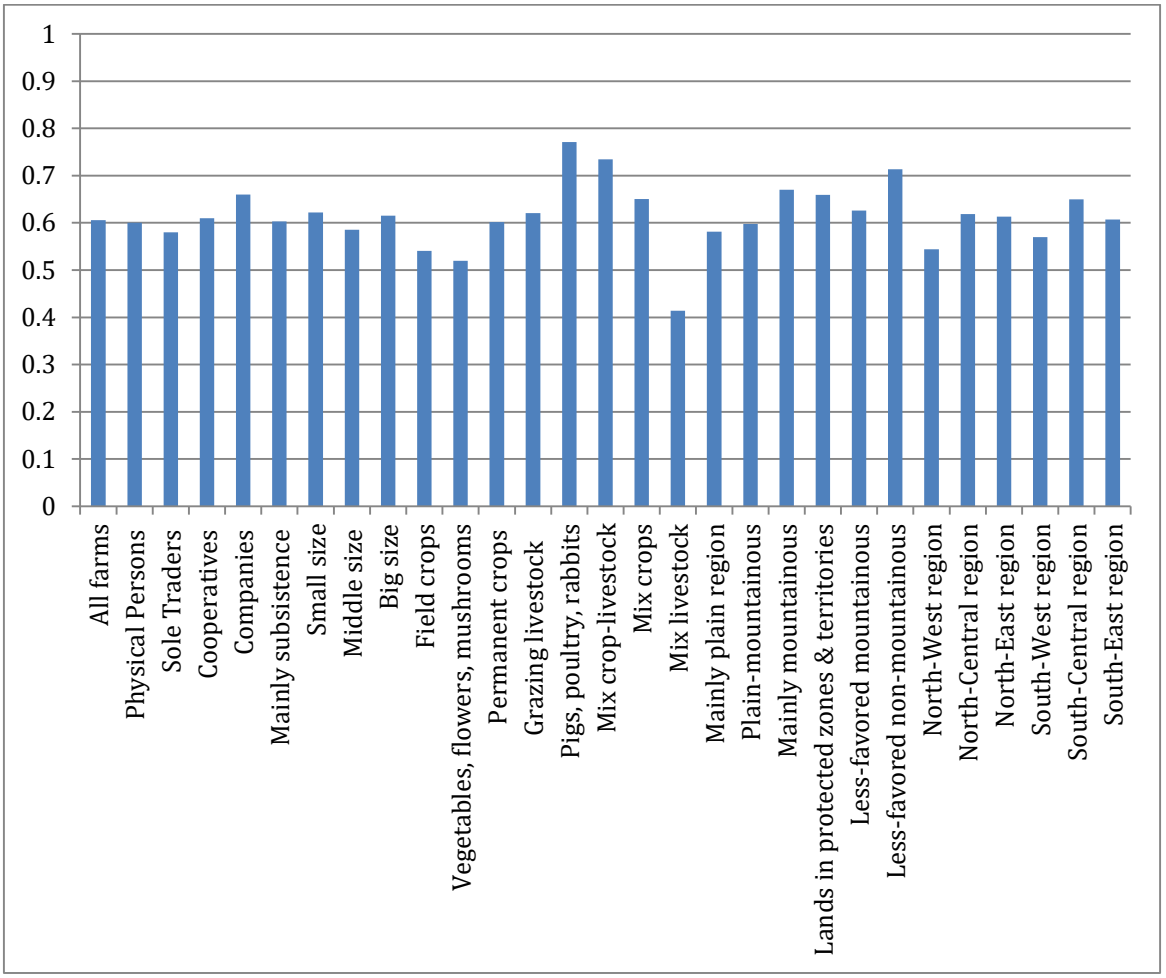
Low levels of sustainability indicators identify the specific areas for improvement of environmental sustainability of farms through adequate changes in management strategy and/or public policies. For instance, despite that the overall Environmental sustainability of Bulgarian farms is relatively high, the indicators for Irrigation rate, Wild species on Farm, Water erosion, Soil acidity and Soil soltification, and Wind erosion area relatively low (Figure 5). Therefore, effective measures are to be undertaken to improve the latter through education, training, information, amelioration of agro-techniques, structure of production and varieties, technological and organizational innovations, etc.

On the other hand, superior levels of certain indicators show the absolute and comparative advantages of Bulgarian farms related to sustainable development. At the current stage of development, the latter are associated with respecting Animal Welfare standards, Preservation of Quality of Surface and Ground Waters from contamination with nitrates and pesticides, Preservation of Air Quality, implementation of Good Agricultural Practices, and reduced Number of Livestock per unit of Farmland.

There is a great variation in sustainability levels of farms of different type and location (Figure 6). Only holdings specialized in Mix livestock are with a low environmental sustainability (0,41). Furthermore, some categories of farms are with an environmental sustainability on or close to the border with inferior level. In the latter group are holdings specialized in Vegetables, Flowers and Mushrooms and Field Crops, as well as farms located

in the North-West region of the country. For all these holdings effective measures have to be undertaken for improving environmental and overall sustainability.

Figure 6. Index of Environmental Sustainability of Bulgarian Farms of Different Type and Location



Source: survey with managers of farms, July 2016

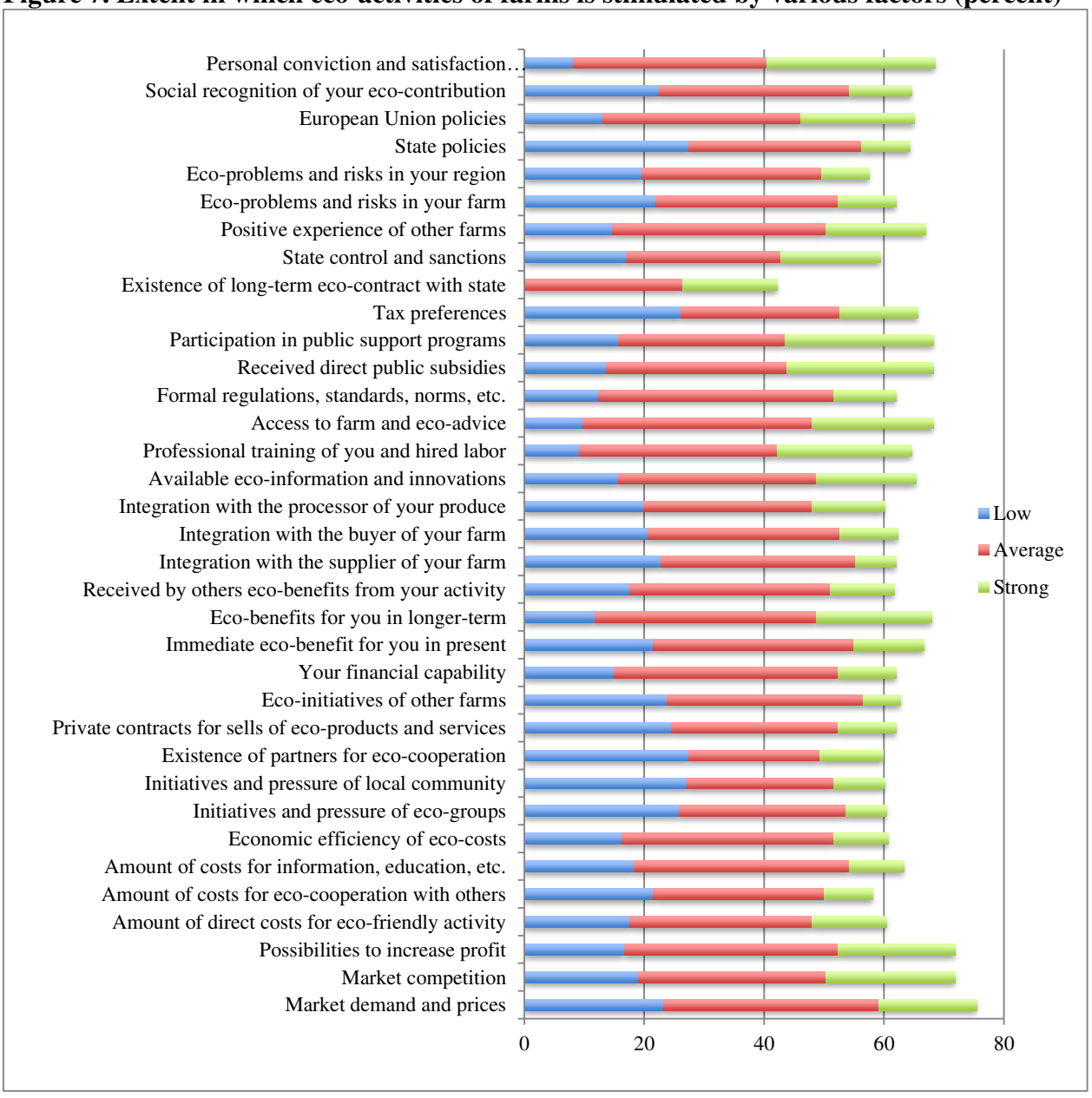
With the best environmental sustainability are Companies, and holdings specialized in Pigs, Poultries and Rabbit, Mix Crop-livestock production, and those located in Less-favored non-mountainous of the country.

Our approach has proven that assessment of efficiency of environmental management at aggregate and farm level gives different results but also allow have a better insight on diverse factors affective level of environmental efficiency and sustainability of Bulgarian agriculture.

Suggested holistic framework gives a possibility to improve assessment, analysis and management of environmental management at national and farms level though appropriate public policies and farming managerial strategies. That dual approach has to be further discussed, experimented, improved and adapted to the specific conditions of operation and development of agriculture and farms of different type, subsector of production, geographical region and ecosystem as well as the special needs of decision-makers at various levels.

The different ideological, economical, market, public, etc. factors in various extent stimulate or restrict the activities of agricultural producers for the protection of natural environment. Our large scale study has found out that to the greatest extent the eco-activity of a big part of Bulgarian farms is stimulated by: the "personal conviction and satisfaction of farmers from the eco-activity", farm "participation in the public support programs", "received direct public subsidies", "professional eco-training of the farmer and the hired labor", "market competition", "access to the farm and eco-advices", "possibilities to increase profit", "eco-benefits for your farm in the longer-term", and "European Union policies" (Figure 7).

Figure 7. Extent in which eco-activities of farms is stimulated by various factors (percent)



Source: survey with agricultural producers, 2015

For the different type of farms there is a considerable variation in ranging of the factors, which stimulate their eco-activity. For instance, the eco-actions of the most

Physical Persons to the greatest extend in stimulated by: the "personal conviction and satisfaction of the farmer from the eco-activity" (29%), "participation in the public support programs" (23,5%), "received direct public subsidies" (22,4%), "professional eco-training of the farmer and the hired labor" (21,6%), "access to the farm and eco-advices" (20,8%), "market competition" (20,5%), and "possibilities to increase profit" (20,5%). The eco-actions of the majority of the Sole Traders to the greatest extent are stimulated by: the "participation in the public support programs" (50%), "professional eco-training of you and the hired labor" (45,4%), "received direct public subsidies" (36,4%), "integration with the processor of your produce" (31,8%), "personal conviction and satisfaction of the farmer from the eco-activity" (27,3%), "European Union policies" (27,3%), "possibilities to increase profit" (22,7%), "economic efficiency of eco-costs" (22,7%), "immediate eco-benefit for the farm in the present" (22,7%), "eco-benefit for the farm in the long run" (22,7%), "integration with the supplier of your farm" (22,7%), "available eco-information and innovations" (22,7%), and "tax preferences" (22,7%). For the most Companies, Corporations, etc. the factors, which mostly stimulate the eco-actions are: the "received direct public subsidies" (47,1%), "market competition" (41,2%), "European Union policies" (41,2%), "state control and sanctions" (35,3%), "eco-benefit for the farm in the long run" (35,3%), "personal conviction and satisfaction from the eco-activity" (29,4%), "immediate eco-benefit for the farm in the present" (23,5%), "market demand and prices" (23,5%), "participation in the public support programs" (23,5%), "access to the farm and eco-advices" (23,5%), "financial capability of the farm" (23,5%), and "social recognition of the eco-contribution of your farm" (23,5%). For the Cooperative farms there has not been reported factors strongly stimulating and restricting eco-activities, which are common for the majority of this type of holdings

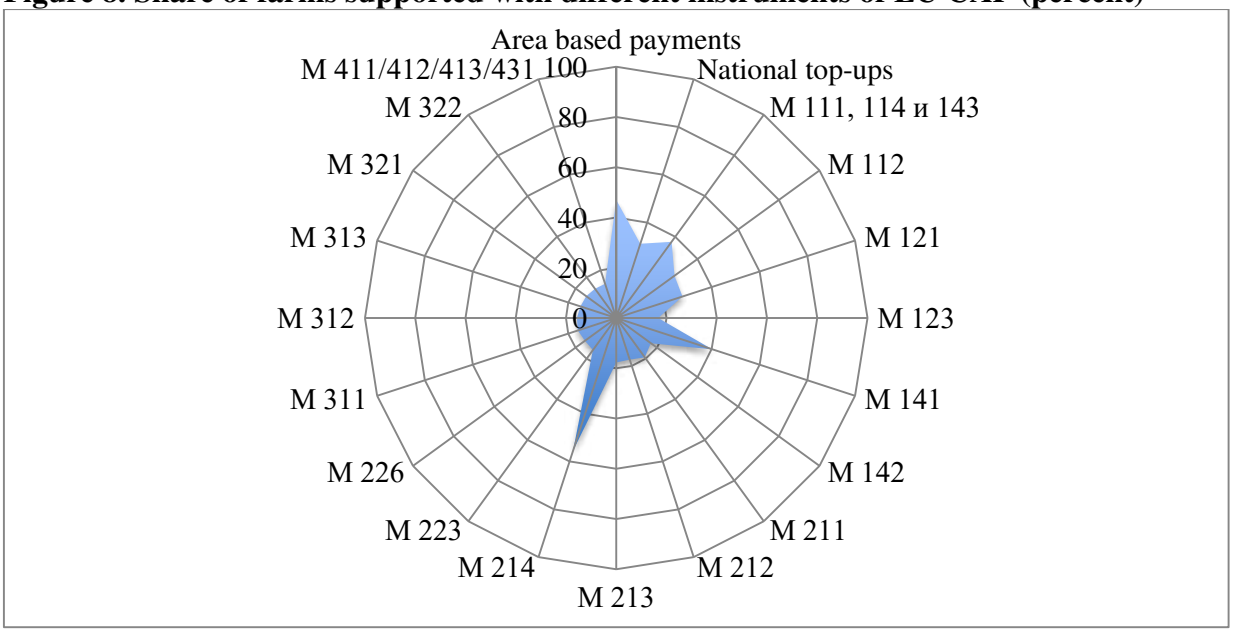
The identified above incentives (and restrictions) for the different type of agricultural farms are to be taken into account in the process of improvement of the public policies and programs for agro-ecology and eco-management.

The public support with diverse instruments of the European Union Common Agricultural Policy is an important factor for the improvement of eco-management of agricultural farms in the country. For instance, the direct Area base payments are linked with the requirement to "keep farmland in good agronomical and ecological state", the participation in the measures of the NPARD is associated with the compliance of the "good agricultural practices" (including appropriate protection of soils, waters, biodiversity, animal welfare, etc.), the involvement in the "environmental measures" of the NPARD aims at implementation of higher eco-standards in comparison to the good agricultural practices, etc. What is more, the public intervention (subsidizing, zoning, mandatory eco-norms and standards, market support, etc.) leads to development of diverse bilateral, trilateral, hybrid, etc. forms of governance of the agrarian sphere as well as of the eco-management in the sector. All they let improve the overall and the environmental protection capabilities of agricultural farms, and conserve, restore and/or improve natural resources through agricultural activity. In particular, the public subsidies make "economically possible" the agricultural activity in "less-favored" regions and in protected zones and territories (national parks, reserves, NATURA 2000, etc.) supporting conservation of the soil fertility, natural biodiversity, services of (agro)eco-systems, etc.

The most of the surveyed farms received in the past or are currently receiving support through Measure 214 "Agro-environmental payments" of the NPARD, the Directs Area-based payments from the EU, Measure 141 "Semi-subsistence farming" and Measures 111, 114 and 143 "Professional training and advise", the National tops-ups for products,

livestock, etc., Measure 112 “Setting up of young farmers”, and Measure 121 “Modernization of agricultural holdings” (Figure 8).

Figure 8. Share of farms supported with different instruments of EU CAP (percent)



Source: survey with agricultural producers, 2015

For other Measures of the NPARD the shares of participating farms in the forms of direct public support in relatively small. There is also a great differentiation in the support through various measures for the farms with different specialization, size and location.

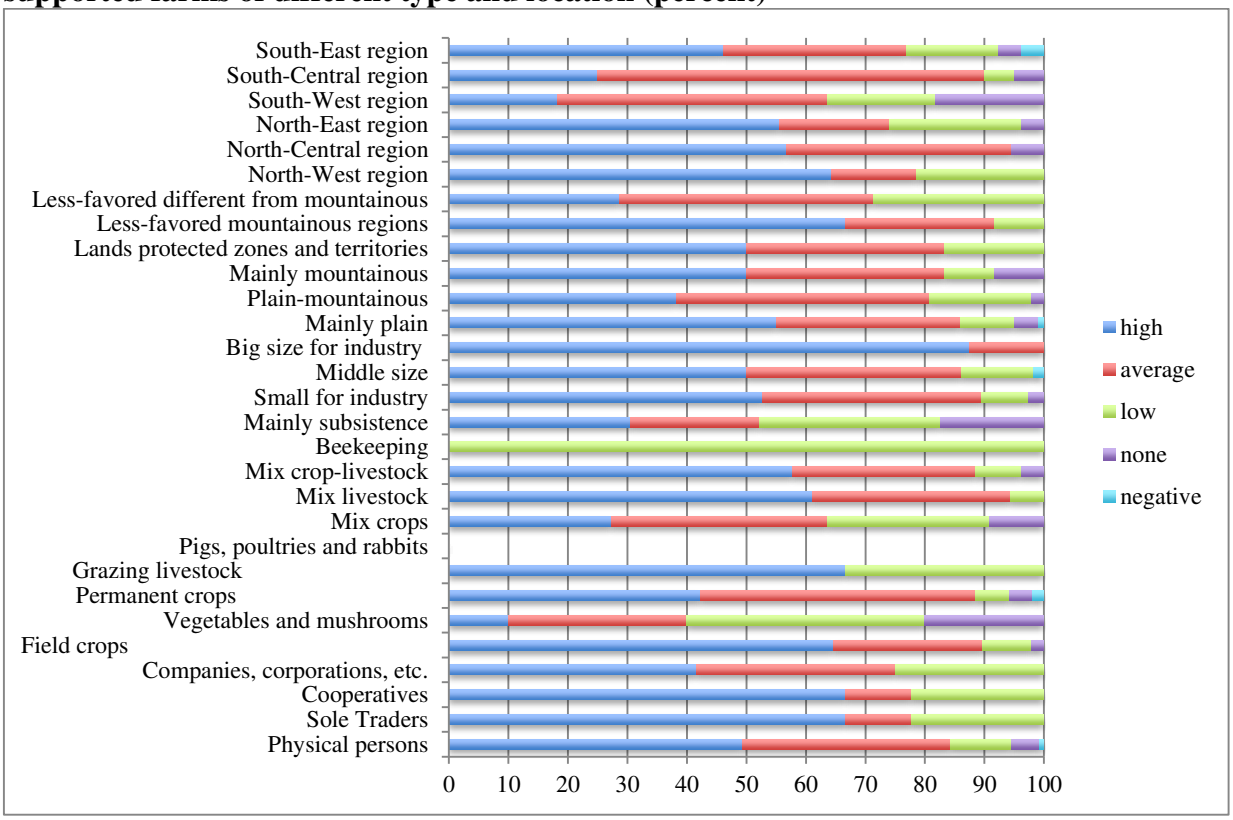
The individual mechanisms for support of the EU CAP impact unequally the agricultural farms, which received or are receiving public support. According to the majority of surveyed farms, the biggest (“average” or “strong”) impact on their farms have been caused by the Measures 111, 114 и 143 “Professional training and advices”, Measure 214 “Agro-environmental payments”, “Direct Area-based subsidies by the EU”, Measure 112 “Setting up of young farmers”, Measure 141 “Semi-subsistence farming”, Measure 121 “Modernization of agricultural holdings”, “National tops ups for products, livestock, etc.” and Measure 211 “Natural handicap payments to farmers in mountain areas”.

The impact of the remaining instruments of the CAP on the greatest part of the surveyed beneficiaries is “low” or “none”. What is more, a part of the farms evaluates the impact of the public support instruments on their holdings as “negative”. The later concerns more than 10% of the beneficiaries from the Measure 223 “First afforestation of non-agricultural land”, Measure 226 “Restoring forestry potential and introducing prevention actions”, and Measure 313 “Encouragement of tourism activities”.

The impacts of the eco-measures of the NPARD on surveyed farms of different type and location is dissimilar. For instance, for the two-third of the Sole Traders and the Cooperatives, supported in the past or currently with the Measure 214 “Agro-environmental payments”, the impact of that instrument on their farms is “strong” (Figure 9). Likewise, that measure effect is strong on the majority of farms specialized in the fields crops, grazing livestock, mix livestock production, mix crop-livestock production, the large scale farms, and the farms located in less-favored mountainous regions and the North parts of the country. For the remaining fractions of the farms the impact of the agro-environmental payments is with lower significance. Moreover, according to one fifth of the supported

farms in vegetables and mushrooms, and a good portion of predominately subsistence farms, as well as farms situated in the South-West region of the country these type of payments has got no impact at all.

Figure 9. Impact of measure 212 "Agro-environmental payments" of NPARD on supported farms of different type and location (percent)



Source: survey with agricultural producers, May 2014

Similarly, according to the bulk of the supported farms in the less-favored mountainous regions, those with lands in the protected zones and territories, the Sole Traders, the farms specialized in permanent crops, and the holdings located in the South-West region of the country, the impact of the Measure 211 "Natural handicap payments to farmers in mountain areas" on their farms in "strong".

Therefore, the accrual and likely effects of the different instruments of public support on the diverse type of agricultural holdings is to be taken into account in the process of the improvement and the design of support measures during the next programing period.

Conclusion

Having in mind the importance of holistic assessments of efficiency of environmental and sustainability management in agriculture, and the enormous benefits for the farm management and agrarian policies, such studies are to be expended and their precision and representation increased. The latter require more aggregate environmental data at national level as well as a close cooperation between all interested parties and participation of farmers, agrarian organizations, local and state authorities, interest groups, research institutes and experts, etc.

Our assessment at national and farm level have found out that there are significant discrepancies in efficiency levels based on aggregate national data and assessment (perception) of farm managers. Therefore, in management practices all kind of data have to be used to take efficient decision at different managerial levels (not as current practices based only on aggregate data). What is more, all aspects of sustainability are to be considered (including, governance, economic, social, environmental, etc.) and integration made in order to properly assess the efficiency of sustainability management in the sector.

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