Open Access Library Journal
2023, Volume 10, e10975
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Environmental Indicators for Assessment Sustainability of the Agricultural Sector in Bulgaria for the Period 1990 (Political Changes)-2007 (Acceptance in EU)

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How to cite this paper: Pistalov, N. and Sotirov, A. (2023) Environmental Indicators for Assessment Sustainability of the Agricultural Sector in Bulgaria for the Period 1990 (Political Changes)-2007 (Acceptance in EU). *Open Access Library Journal*, **10**: e10975.
https://doi.org/10.4236/oalib.1110975

Received: November 7, 2023
Accepted: December 8, 2023
Published: December 11, 2023

Abstract

Environmental indicators in the considered DPSIR model can be grouped into indicators for assessing the state of natural resources, indicators for analyzing the efficiency of the use of natural resources and indicators for assessing critical points in the agricultural sphere. Data from official statistical sources and the National Programme of Action for Sustainable Land Management and Combating Desertification in Bulgaria (2007-2013) were used for the assessment. The first group of environmental indicators with which the state and quality of natural resources can be determined are soil resource indicators, water indicators, and ambient air indicators. As a result of the analysis of the economic, social and environmental side of sustainability at the sectoral level, we find a number of problem areas and a divergence with the principles of sustainability.

Subject Areas

Historic Review of Sustainable Development

Keywords

Sustainable Development, Sustainability, DPSIR-Framework, Agriculture

1. Introduction

Population growth and economic growth rates in recent decades have greatly increased the pressure on nature and seriously threatened its carrying capacity. Future generations, according to various assessments, are increasingly threatened by the reduction and depletion of natural resources, predatory destruction of the environment and limitation of development opportunities. Humanity has reached a point where an urgent rethinking of the previous approach to economic growth and the management of natural resources is required. Growth, as a purely quantitative expansion of the economy, needs a qualitative reassessment, taking into account a number of important social and environmental goals in the development process, on which the well-being of future generations depends.

2. Materials and Methods

The used methodology is the use of ecological indicators for assessment of the agricultural sustainability. The assessment of sustainability is a key element of the theory for sustainable development. It gives us resources and agriculture sustainable development. The assessment must show within what ecological limits the anthropogenic activity develops so that it qualifies as sustainable, as is the case with renewable natural resources that must not be used beyond their natural reproducibility. Statistics are the basis of indicator analysis. Without available information, no indicator would be measurable, nor could we quantify the processes leading to change. Therefore, it is an important criterion for indicator selection.

3. Indicators for Assessing Agricultural Sustainability

3.1. Soil Resource Assessment

The main soil issues are irreversible losses due to land fragmentation resulting from construction activities, soil erosion, and continued contamination from local and diffuse sources (including acidification), salinization and compaction. The causes of adverse changes in soil resources are land use practices, economic activities outside the agrarian sphere, as well as climate change. Due to its static, the soil absorbs easily most harmful substances released into the environment for various reasons [1]. Since the decay period of these substances is significantly longer when they are in the soil than in the air or in the water, the problem often remains hidden for a long time. Unlike air and water, the soil is mainly privately owned, which makes its conservation difficult and makes it dependent on the will of owners and users. The most important functions of soil are to filter groundwater, to retain nutrients and water necessary for plants, to be a living environment for various organisms (including degraders), and to absorb, accumulate and reflect solar energy. Problems arise when different soil functions come into conflict. Deterioration of soil characteristics usually occurs as a result of human activity and leads to the degradation of one or more of the soil functions. The sustainable use of soil requires a balance to be found between the interests of all countries in order that soil functions can coexist and constantly. Soil degradation occurs when phenomena induced by human activity degrade its present or future ability to sustain life. The most common processes of soil degradation are erosion, acidification, pollution and salinization. National and international efforts to protect soil, according to the European Commission (EC), should address the following: Strategies for soil protection should be turned from remedial to preventive; Conservation to focus on soil functions; Land use to be consistent with the qualities of the soil; In addition to repairing old damage, preventive measures should be implemented.

According to the first European Atlas on Soil Resources, prepared by experts commissioned by the EC, over 16% of land in the EU is affected by soil degradation and in Eastern European countries over a third. This destruction is mainly due to changes in agriculture itself, land use and climate. Soils are an extremely important element of agrarian sustainability and their simultaneous quantitative and qualitative assessment as a resource requires a complex approach. The following indicators are appropriate as quantitative measures: areas of agricultural use, utilized agricultural area and uncultivated land. A qualitative measure can be both the species diversity of soils (with their specific composition and properties) and the degradation processes associated with soils due to natural-climatic factors or anthropogenic activity. Among the latter, of particular importance are potential indicators that measure the status of erosion, reduction of humic content, salinization and acidification of soil, contamination with heavy metals and other chemical elements, as well as disturbed agricultural land used for non-agricultural purposes—for construction, infrastructure, oil and gas transmission network, mining activities, landfills, etc.

Their qualitative presentation considered simultaneously and quantitatively in terms of a particular region or in general for the country, would outline more fully the problems facing the sustainable use of soil resources in our country. For this purpose, the study is aimed at four main destructive processes—erosion, acidification, salinization and soil contamination, which are related to the human factor.

1) Soil erosion. Soil erosion is a major degradation process. According to the Executive Environment Agency (2006) [2], it affects today 18% of the country's territory or 2,010,223 ha. It can be the result of any human activity that exposes the soil to rain and wind, increases the rate of rainwater runoff, or expands the affected area. Agricultural activities such as plowing of sloping terrains, slope tillage, removal of the vegetative soil layer, removal of terraces, growing excessive numbers of livestock, improper crop management and trampling with heavy machinery amplify erosion processes. The size, shape and orientation of the blocks are in most cases not consistent with erosion prevention requirements. Overgrazing, deforestation and fires also accelerate erosion processes. Other factors, such as loss of organic matter, degree of infiltration, soil structure and surface, also have an influence along with external circumstances, such as relief, climate, vegetation and management practices. The strong decline in areas irrigated in a gravitational way after 1990 reduces the risk of irrigation soil erosion, which has a positive impact on the environmental dimension of sustainability, although it worsens the economic and social dimension because it reduces the productivity and income of farmers. Solving the problem of limiting erosion is a difficult process due to the complexity of factors that have an impact. A number of technical solutions (construction of field protection belts, alternation of crops, regulation of livestock numbers, use of drip irrigation, construction of mechanical barriers, etc.) can contribute to reducing erosion. One part is related to investments, while others require the observance of precautionary measures when choosing the structure of production and carrying out agricultural practices. Particularly useful in these cases would be expert assistance from the National Agricultural Advisory Service as a specialized structure for informing, advising and training farmers.

2) Salinization of soils. Salinization is a process adversely affecting vegetation and very often leading to alkalization of soils, which is a prerequisite for the development of erosion processes. Although limited to the country, salinization affects the environmental and economic dimensions of sustainability. Saline soils in Bulgaria occupy over 30 thousand ha (2006) [3] or 0.6% of arable land and over 2.5% of irrigated areas. Potentially saline soils are significantly more. Notwithstanding the small relative share, they present a problem because their distribution takes the form of patches among fertile soils subject to intensive agriculture, adversely affecting the economic performance of agricultural production. Salinization is a reversible process, but extracting salt from the soil is unprofitable even for the most developed countries. Therefore, the strategy here must be turned from a healing strategy to a preventive one. Reducing irrigation measures or changing the irrigation system, for example, can limit soil salinization. Secondary salinization processes could also be avoided if the felling of adjacent forests or the removal of that vegetation that evaporates water from the deeper layers through its root system and plays the role of biological drainage is not allowed. Effective advisory assistance from the National Agricultural Advisory Service, together with specialized scientific units would assist landowners in choosing solutions.

3) Acidification of soils. Acidification of soils is a natural process that has been expanding more and more recently. Excessive and unbalanced fertilization with nitrogen fertilizers and overdrying of soils can cause acidification. The reason for it may also be the deposition of sulfur and nitrogen compounds, which are released during the combustion of fossil fuels and industrial activities. The cross-border transfer of acidic substances from industrial regions in Central and Eastern Europe is an external cause of acid rain in our country. Acidification in combination with the cations of iron, aluminum, calcium, magnesium and some heavy metals reduces the buffering capacity of the soil. The consequences of acidification for forests and agricultural production can be prevented in part by lime cultivation, which adversely affects the soil microflora and is not always desirable. The difficult restoration of the neutralizing function of the soil makes acidification one of the worst environmental threats with irrecoverable consequences. According to the National Action Programme for Sustainable Land

Management, over 4,300,000 ha have a high suppleness to acidification. About 1,500,000 ha of arable land in lowland and hilly areas and 1,200,000 ha in the mountains have already been oxygenated. 4.5% [4] of the acidified soils in agricultural land have harmful acidity, *i.e.* degraded. The increase in the use of nitrogen fertilizers and the disturbed balance in fertilization with potassium and phosphorus fertilizers is a serious reason for the change in the acidic composition of the soil. In order to limit acidification processes, it would be appropriate to influence producers, by appropriate economic and information means, to eliminate unbalanced nitrogen fertilisation practices and to encourage a fuller use of manure. With regard to industrial and foreign sources, responsibility for compliance with international standards on permissible air pollution must be strengthened.

4) Soil contamination. Soil contamination is the result of past and ongoing business activities. Most often, potential contaminants are heavy metals and their compounds, organic chemicals, and pesticides, as well as radioactive, biologically active, combustible and other harmful substances. Their source is industrial emissions and municipal waste accumulated in illegal landfills, as well as some unecological farming practices. According to official data [5], the contaminated agricultural land with heavy metals and metalloids from industrial activity is 44,900 ha (less than 1% of the utilized agricultural areas), of which 8160 ha is contaminated five times above the PDK. The lands around the large industrial sites where the relevant metal-ore raw materials are processed are hardest hit. About 1000 hectares of land were contaminated with natural radioactive elements from uranium mining in the past. Soil contamination from former and operating industrial sites poses a potentially serious threat to human health. The possible environmental consequences of soil contamination are release of harmful substances on the ground, in surface water and groundwater; uptake of harmful substances by plants; direct contact of people with contaminated soil; inhalation of dust particles or volatile substances; causing a fire or emitting harmful gases from landfills; formation of harmful secondary waste substances; There are two sides to the issue of contaminated soils: the first, concerns the contaminated in the past, the purification of which is the subject of investment projects financed mainly at the expense of the state, and the second, concerns the prevention of the risk of future pollution by strengthening environmental responsibility for certain risky activities. From the analysis of soil resources, it is revealed that behind every destructive change in their quality, there is a certain human activity. The specifics of the manifestation of individual soil-damaging processes require concrete solutions such as a response from institutions, farmers and other sectors of the economy. The problem of sustainable use of soil resources has recently engaged the attention of European institutions as well. Due to non-compliance with soil quality standards, the European Commission has initiated infringement procedures against Greece, Portugal and Spain. In order to stop the practice of unsustainable use of soil resources, she redefined the concept of "regions with agricultural handicaps" and the criteria for granting aid from the 2007-2013 budget, with subsidies depending not only on climatic and soil criteria but also on productivity itself. The reform has led to a shift in subsidies from farmers cultivating poor soils but receiving high yields due to higher inputs and labour to green spaces used for other purposes that qualify for soil-friendly farming. Increasing the share of funds for agri-environmental measures under the Rural Development Program, such as planting and caring for tree soil protection belts or habitat conservation schemes under the NATURA ecological network, as well as compensation for land of high nature value, should reduce the negative environmental effects of agricultural subsidies.

3.2. Quality of Water Resources

In recent years, the quality of groundwater and surface running water satisfies the requirements for threshold concentrations in most of the areas where observation points have been established. Still high values of nitrate in groundwater are reported, mainly due to non-implementation of good agricultural practices. In certain areas with intensive agriculture, a consistently high level of nitrate is found, which is an unfavorable indicator of the purity of groundwater and irrigation water. According to data in the Agricultural Report 2005, of the 183 samples of irrigated water analyzed in 2004, 63% had a nitrate content above the limit concentrations (PCA), with pollution ranging from 2 to 17 times the PCA. In almost all river streams after settlements that do not have wastewater treatment plants, there is a high content of nitrogen forms and phosphates, especially in low water [6]. The content of substances of synthetic origin (pesticides, petroleum products, cyanides, etc.), with the exception of petroleum products, has been decreasing in recent years. The quality of irrigated water is of particular importance not only for conventional vegetable and fruit production but also for organic farming, which in these limiting conditions could hardly be extended. On the other hand, the enrichment of river waters with biogenic substances adversely affects aquatic ecosystems, including the final receivers—the Danube River and the Black Sea. In order to achieve the requirements of the EU Water Framework Directive, it is necessary to strengthen the control of waste industrial, livestock and domestic water discharged into rivers, as well as to use mineral fertilizers in a balanced and more reasonable manner.

3.3. Air Quality and Greenhouse Gas Emissions

The main greenhouse gas emissions from agricultural activity are carbon dioxide, ammonia and methane. A source of carbon dioxide can be both emissions due to the direct use of fuels for production processes, as well as the carbon footprint that indirectly carries the funds used, such as machinery, fertilizers, pesticides, etc. Erosion, soil treatment, burning of plant waste, fallow, and deforestation [7] are other reasons for increasing carbon emissions and reducing their sequestration. The sources of methane are mainly from animal husbandry caused by fermentation and microbiological processes in the digestive systems of animals—

enteric fermentation, manure and anaerobic processes of plant mass decomposition. Sources of nitrogen oxide are denitrification and nitrification processes, as well as animal husbandry. It has been found that the potential of agriculture to reduce greenhouse gases is greater than it emits into agricultural activity [8]. Therefore, addressing the problem of greenhouse gas emissions from agriculture must take place in the context of the potential of agriculture to reduce some of them (e.g. in the production of biogas) or be a source of overall reduction (as is the example of the production of biofuels, which when burned emit much less harmful ingredients than petroleum products).

As can be seen from **Figure 1**, the share of the industry in total greenhouse gas emissions, according to EEA [9] data, for the period 1990-2007 moves within 12.2% - 7.3%, with a pronounced downward trend due to the crisis in the industry and the increase in the share of other areas of the economy in greenhouse gas emissions.

The agricultural sector is one of the largest sources of nitrogen oxide with about 60% - 70% share of total nitrogen emissions, and the share of methane is about 15% - 25% of the national total. In **Figure 2**, the amount of greenhouse gases, including methane and nitrogen oxide, measured in millions of tonnes of carbon equivalent, is shown [10].

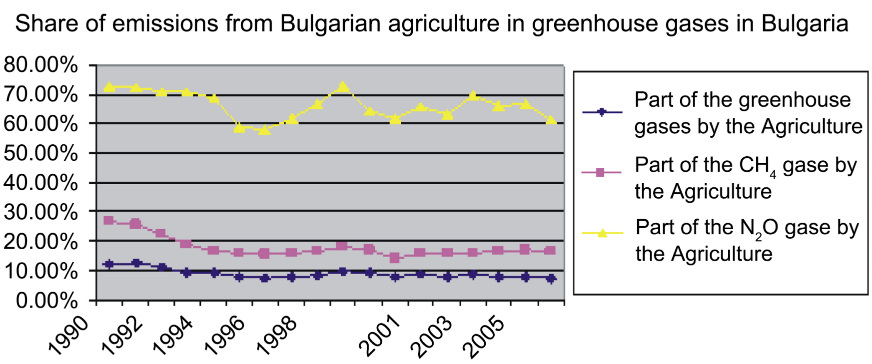

Figure 1. Share of emissions from Bulgarian agriculture in greenhouse gases in Bulgaria (Source: Eurostat).

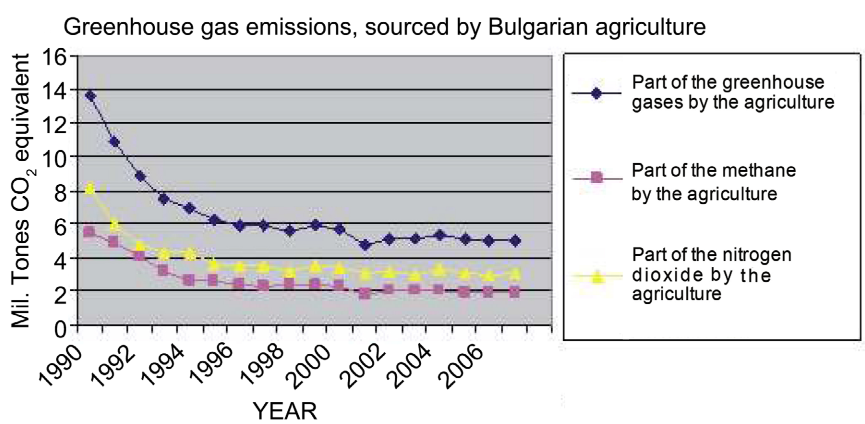

Figure 2. Greenhouse gas emissions, sourced by Bulgarian agriculture (Source: Eurostat).

There is also a downward trend in the amount of gases emitted, mainly due to a slowdown in the economic growth of the sector, the decrease in ruminants and the decrease in the amount of mineral fertilizers used. In this sense, as a preventive step, more effective measures to limit emissions are needed, such as more efficient fertilization, compliance with the requirements of the Nitrates Directive and prevention of pollution from improper storage or use of manure. From a survey conducted in the municipality of Kyustendil, it was found that between 30% and 40% of the surveyed farms are potentially dangerous in the sense of not meeting the requirements of manure storage.

According to the National Action Plan on Climate Change 2005-2008, applicable policy instruments to reduce emissions in the agricultural sector are: Manure management (with financial instruments and consultancy) to achieve in 2010 respectively 0.07 Mt. greenhouse gas reduction; Improvement of fertilization practices (with legal and financial means) and reduction of water consumption for irrigation (with financial resources under the SAPARD Program and State Fund Agriculture) to achieve 0.17 Mt. reduction of greenhouse gases.

3.4. Efficient Use of Natural Resources

Extensive agriculture is considered to be significantly more environmentally friendly than intensive. In the context of the CAP and its reforms, emphasis is placed on forms of agriculture that protect the environment in all its aspects. This does not mean that intensive agriculture is denied, but the negative effects it causes are taken into account. Currently, the intensification of production in Bulgaria is at a low level and this adversely affects the productivity and competitiveness of agricultural products. The increase in intensive factors in compliance with good agricultural practices would not conflict with environmental requirements and would improve economic performance in the agricultural sector.

1) Risk of environmental pressures in arable land use

The ratio between arable and uncultivated land in the agricultural areas used (UAA) gives an idea of the extent to which, through the processes of cultivation, production and harvesting, arable land is at risk of environmental pressure. It was found that other things being equal, in larger arable areas, the risk increases because the same crop is grown in larger areas, which is more vulnerable to pests and requires more pesticides, as well as because of an increase in the risk of soil compaction as a result of the use of large-scale equipment. Arable land includes the sum of the areas in rotation in the year of observation and annual grass mixtures of cereals and legumes, as well as fallows.

For the studied period 1998-2007, there is a trend of decrease of arable land of about 10% or 334,386 ha. Compared to 1989, however, when the arable land was about 4.1 million ha, this decline is more than 25%. The share of arable land in utilised agricultural area (UAA) for the period 1998-2007 remained relatively constant—around 60%, which is also due to the simultaneous decrease in UAA (**Figure 3**).

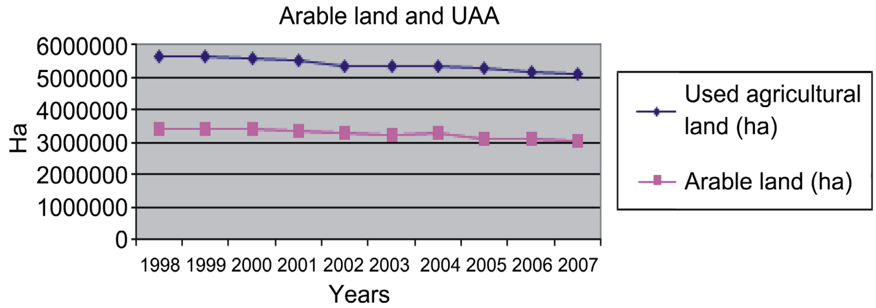

Figure 3. Arable land and UAA (Source: MAF).

The decrease in the total area of arable land can be assessed as a good trend from an ecological point of view only for limited categories of land, but not from an economic and social point of view. In most cases, abandoned land, when near arable land, becomes incubators for enemies and landfills. It is assumed that with programs to promote the production of energy crops, these lands will become a potential source of biomass, including for second-generation biofuels, *i.e.* those that do not compete with food balance.

2) Influence of crop structure on the ecological status of land used

The structure of agricultural crops is an indicator giving an idea of the extent to which the ratio between crops grown affects the ecological status of the land used. As is known, extensive agriculture is more environmentally friendly, while intensive farming increases the risks of negative environmental pressure. The structure has an influence through the specific technologies of growing crops and the relevant intensive factors such as the use of mineral fertilizers, pesticides, irrigation, and mechanization.

In the areas with agricultural use in our country, the leading share is occupied by cereals and to a lesser extent oilseed crops, which require the use of a large amount of artificial fertilizers and mechanization. The analysis for the period 1998-2007 shows some decrease in the cereals area and a slight increase in oilseeds, but overall there was a decrease in the total area of the two crops amounting to 377,086 ha over 1998. However, the predominant share of cereals gives a certain appearance of monocultural production in terms of the use of arable land in our country. Together with oilseeds, they account for about 82% of arable land and use over 70% of mineral fertilizers, mainly nitrogen and more than half of pesticides. It can be assumed that only unbalanced fertilization and the need to overcome the adverse effects of climate change in the future will determine the environmental impact of this production structure. We learn from the experience of developed countries, where monocultural production, smaller rotation of lands with winter forage crops and shorter rotation, together with deep intensive ploughing with large-scale technique are believed to be the main reasons for the loss of soil organic matter and hence economic fertility. So, monocultural production in our country, combined with unbalanced fertilization and lack of motivation on the part of large tenants to maintain rented agricultural land, can become a potential threat to the state of soil resources.

The structure of crops grown can also be successfully used as an economic indicator to determine the specialization of production and economic efficiency in individual crops. Combining the above indicator with others that complement it appropriately, such as dynamics and structure of agricultural imports and exports, may reveal lost production opportunities, either due to imports or untapped export potential for agricultural produce.

A long-standing characteristic trend for the sector is the inability to meet the needs of the population for some products such as mainly fruit and vegetables, which remain almost invariably low, despite investments made with the help of the Sapard program in recent years, due to both reduced areas grown and lower yields and still unsatisfactory investments (**Figure 4**).

3) Used and treated wastewater in the agricultural sector

The water used in the agricultural sector (the data are common for agriculture, hunting, forestry and fishing) has a trend of increased in the last few years and reaches an annual size of 258,022 thousand. m3. The sector's share in the total amount of water used also recorded a growth rate, but slightly within 2.7% - 5.2%. There is a trend of increase in wastewater from the agricultural sector (data are common for agriculture, hunting, forestry and fishing), by about 25% in 2007 compared to 2000.

4) Generated wastewater from the agricultural sector

According to NSI data for the period 2000-2005 (**Figure 5**) More than half of the used water is discharged without treatment, reaching up to two-thirds in 2007. This trend is environmentally unfavourable and would make it difficult to achieve the requirements of the Water Framework Directive and the EU Nitrates Directive in the future. It is associated with significant investments, some of which could be from the Rural Development Program and the rest private or under the public-private partnership.

3.5. Energy Efficiency of Agriculture

This is an indicator that can serve environmental and economic purposes. It gives an idea of the amount of energy that is used in the production processes in agriculture. According to NSI data, due to a decline in the gross domestic product (GDP) of the agricultural sector for the period under review, energy efficiency, expressed as a ratio of GDP to oil consumption, deteriorates slightly, unlike industry, which becomes more energy efficient by consuming twice less energy per unit of GDP. This indicator can be considered in a broader sense as an energy intensity factor and, in particular, as a relationship between the age of the equipment available and the consumption of fuel and lubricants, hence greenhouse gas emissions emitted into the atmosphere. Despite the process of upgrading the equipment, supported by the SAPARD program, depreciated and outdated equipment still prevails, which negatively affects energy efficiency and environmental sustainability.

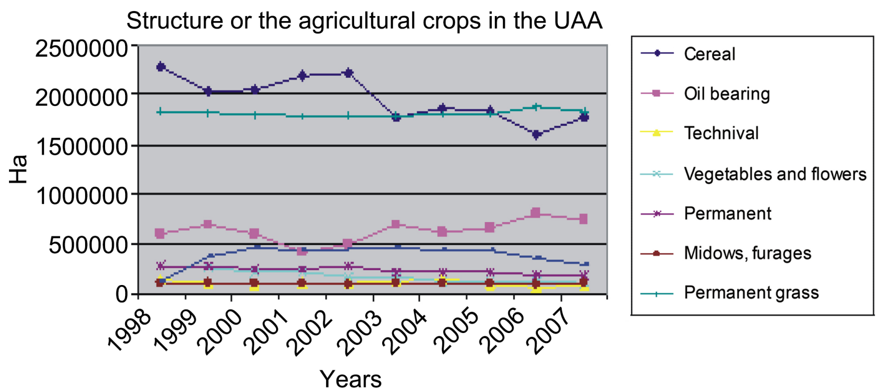

Figure 4. Structure of agricultural crops in the UAA (Source: MAF).

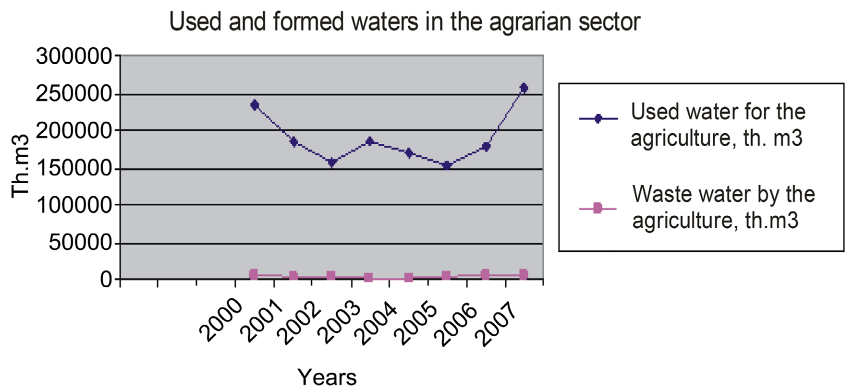

Figure 5. Used and formed waters in an agricultural sector (Source: NSI).

3.6. Composting and Production of Renewable Energy

Bulgaria's potential for growing "energy crops" for renewable energy production is estimated at large [11]. Biomass, in the face of plant waste, remaining each year after harvest is of the order of 4.6 - 5.2 million. This is a largely untapped resource mainly for second generation ecobriquettes and biofuels. A common practice is burning directly in the field, in opposition to modern European legislation prohibiting such procedures as environmentally incompatible with the protection of soil fertility and prevention of the spread of dangerous toxic substances—furans. With rising prices for conventional energy sources and the need to meet the EU's renewable energy targets, the agricultural sector could become competitive to attract private investment. An example is investment in waste biomass absorption projects under the Joint Implementation Facility and the Kyoto Protocol's Green Investment Facility.

The cultivation of energy crops to produce biofuels (e.g. rapeseed) is another example of a fuller use of arable land. The boom in the increase in these areas is not accepted uncritically. In Bulgaria, the areas sown to rapeseed for the period 2000-2007 increased sevenfold, reaching 54,707 ha. As a winter-spring crop, it makes good use of seasonal moisture and finds demand on the market in Bulgaria and in the EU, but due to its market competitiveness, the issue of its financial support is controversial.

The potential for biogas production in Bulgaria is difficult to absorb and limited mainly due to the fragmented nature of livestock breeding. Investing in farms that reach the optimal European size is a prerequisite to meet the requirements of the Nitrates and Groundwater Protection Directive, and to achieve greenhouse gas reduction targets in the agricultural sector. This is an indicator that, although partially traceable, for the time being, in a limited number of larger and larger livestock farms that need significant investments in projects to absorb the energy potential of animal waste.

3.7. Impact on Species Diversity and Landscape

These are two relatively recent indicators that are observed in the agricultural sector. They are mandatory after the establishment of the NATURA 2000 ecological network and the survey of lands of high nature value in Bulgaria and are present in agri-environmental measures under the Rural Development Program, as well as other European programs for biodiversity conservation (e.g. the LIFE + instrument).

From the survey among farmers in the region of Kyustendil, we found that they are not aware of where they can get information about whether their lands fall within territories of the ecological network or their lands have the status of lands of high nature value in order to apply for compensation under the measures of the Rural Development Program.

In the framework of the DPSIR analysis, indicators for assessing habitats, biodiversity and landscapes are present both when they are established in the "State" phase in the specific areas at the local level and in the "Impact" phase for the EU environment.

The landscape and its conservation and maintenance should be considered not only as an element of environmental sustainability but also as a prerequisite for an alternative income in the development of tourist and recreational activity. As with the conservation of species diversity, landscapes are also subject to financial support under the relevant measures of the Rural Development Programme.

In the first half of the period 1998-2007, with the exception of individual pilot projects for agri-environment schemes, targeted programmes with a corresponding budget and expected results are not available. With the implementation of the National Rural Development Plan (NRDP) with the help of the SAPARD Programme, a change later occurred in the direction of integrating environmental requirements into agrarian policy, with funds for agri-environmental measures reaching 2.8% of the total programme budget. According to the NRDP, in 2006 in Bulgaria, agri-environmental measures covered only 0.7% (32,000 ha) of arable land, while in the EU member states they were 20% of it.

3.8. Investments in the Agricultural Sector for Environmental Protection

This is an important indicator, but there is still a lack of complete data with which to measure it. Although investments in environmental projects for the period 2000-2007 have grown from 1.3% to 2.7% of gross domestic product for the period 2000-2007, their share in environmental projects in the agrarian sphere, according to the Ministry of Environment and Water, has increased marginally—only by 12% - 15%. There is almost no investment in ecological projects for fertilizer sites and for wastewater treatment from livestock farms.

Therefore, the role of the state should be more active in the direction of control and incentives, as well as in terms of advisory assistance through the National Agricultural Advisory Service. The latter must inform producers about EU environmental requirements and the financial support options provided by measures under the second pillar of the Common Agricultural Policy. Some priority areas can be supported by the Enterprise for Management of Environmental Protection Activities at the Ministry of Environment and Water (MOEW) and the National Trust EcoFund [12]. Agri-environmental projects as well as biodiversity conservation projects in the areas covered by the NATURA ecological network can also be supported in the future through the LIFE+ Fund, which is an EU instrument and is managed by the Ministry of Environment and Water.

3.9. Assessment of Critical Ecological Points

It concerns the use of mineral fertilisers, pesticides, irrigated areas, manure and areas occupied by organic farming.

1) Use of mineral fertilisers

The use of mineral fertilisers (**Figure 6** and **Figure 7**), for the period 1989-1998 as a total amount decreased dramatically—more than 5 times. This can be seen twofold, on the one hand, as a good environmental signal that it reduces environmental pressure, but on the other, a strong decline adversely affects productivity.

The reasons are the limited financial possibilities of farmers in the initial period to purchase mineral fertilizers and the faster increase in their prices compared to the prices of agricultural products, which makes them economically unprofitable to use. For the period under review 1998-2007, there was a rate of a slight increase in mainly nitrogenous fertilisers used. The interpretation of this indicator must necessarily be supplemented by its qualitative side—the use of mineral fertilizers per unit area and the ratio of active substances.

The general conclusion that can be drawn from the data given is that the practice of unbalanced fertilization is imposed in the country, with a predominance of nitrogen. With an optimal ratio between nitrogen, phosphorus and potassium respectively 1:0, 8:0.4, it is actually 1:0, 17:0.08, *i.e.* it is 5 times lower for phosphorus and potassium respectively. The advantage of fertilization with nitrogen fertilizers increases the risks of nitrate pollution of soils, water and production, and turns the agricultural sector into a source of unused nitrogen compounds, destabilizing the climate. Unbalanced fertilization has a destructive effect on soil fertility and is contrary to soil protection requirements.

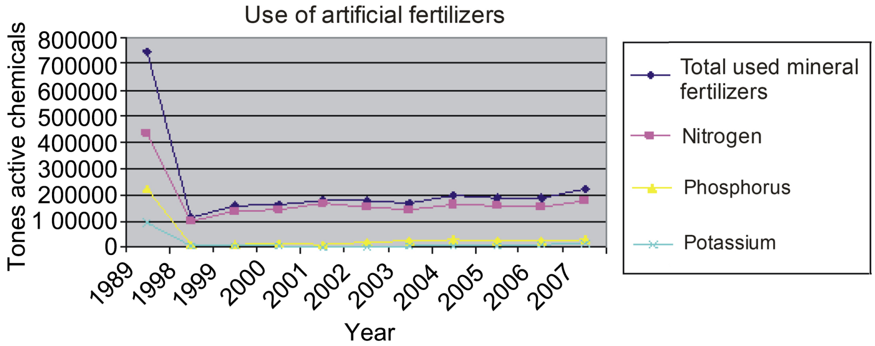

Figure 6. Use of artificial fertilisers (Source: MAF).

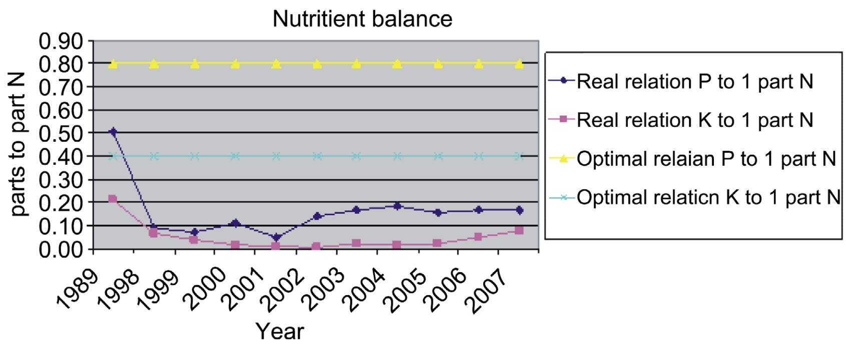

Figure 7. Nutrient balance (Source: MAF).

At the same time, there is an extremely negative trend of net leaching of nutrients from the soil. The average production for the period 2002-2004 in the agricultural lands was exported. According to the assessment of specialists from the system of MAF [13], 165,000 tons of nitrogen, 51,100 tons of phosphorus and 191,900 tons of potassium and were recovered with imported fertilizers only 85% of nitrogen, 46% of phosphorus and 1.5% of potassium. Insufficient and unilateral fertilization leads to depletion of soil fertility, and the resulting yields are increasingly at the expense of its quality, which is contrary to one of the fundamental principles of environmental sustainability to maintain a balance between extracted and restored nutrients in the soil system. For such violations, the European Commission may bring criminal cases. Experts from the Ministry of Agriculture and Forestry (2004) [14] have concluded that “Bulgaria continues to be the only country in Europe where systematic agrochemical control of agricultural land is not carried out, and this does not make it possible to track changes in the stock of soils with absorbable forms of nutrients, as well as for reliable diagnostics of fertilizer needs. Data from analyses show that in some fields the level of absorbable phosphorus is reduced to “traces”. This means that the economic and environmental risks in Bulgarian agriculture will increase.

With the help of a sociological survey conducted in the region of Kyustendil, it was found that more than 60% of the surveyed producers do not comply either due to economic reasons or ignorance of the requirements for the use of mineral fertilizers and chemical protection equipment. About 16% of them control the ecological status of their land, and only between 10% and 22% of the respondents know and comply with environmental requirements in land cultivation. This trend from a sustainability perspective is worrying and is likely to make it necessary to link support from EU funds to soil maintenance and soil fertility.

2) The use of pesticides as a critical point for environmental sustainability

The economic downturn in the sector has had a somewhat positive impact on the environment, as it is associated with a decrease in the applied pesticides and, on the other hand, is a prerequisite for the "self-cleaning" of soils and water from residues from the time of high-intensity agriculture. This reduces the risk of contamination of food products from our agricultural sector, but the very decline in production opens up a niche for imports of products, such as vegetables and fruits, which are mainly from neighbouring countries with intensive agriculture.

The problem with the use of pesticides in our country has another aspect related to the storage of banned, overdue and expired pesticides, which are a serious potential contaminant. According to data from the Ministry of Environment and Water, in 2004, 11,222 tons of deposited and unfit pesticides were registered in 561 warehouses, of which 477 did not meet the requirements, 1/3 of which were unguarded. Under the program for disposal of deposited pesticides, over 37% of the registered quantities are stored in concrete containers type "BB cube". It is believed that such storage, although safe, is economically acceptable in the short term. However, it postpones the solution of the problem over time, passing it on to the next generations, which is contrary to the principles of sustainable development.

3) Use of manure

Figure 8 and Figure 9 respectively for the quantities of manure used and percentage of fertilised areas, show a variation in the downward trend in the last year of the period considered. After some rate of increase from 2004 to 2006, the amount used fell in 2007 to 173.9 thousand three times less than in 1998, when it was 497 thousand Tonnes. The decrease is a result of the significant decline in the number of animals, which, with the exception of poultry, is most pronounced in pigs at 51%, cattle—at 10% and sheep—at 45%, as well as the low number of animals kept on farms, many of which are semi-subsistence.

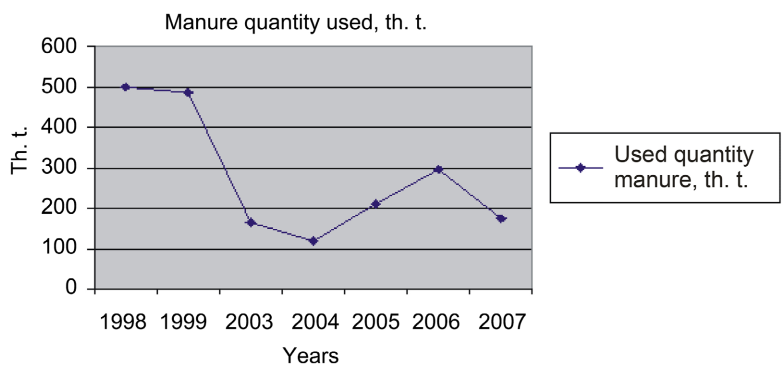

Figure 8. Manure quantities used (Source: MAF).

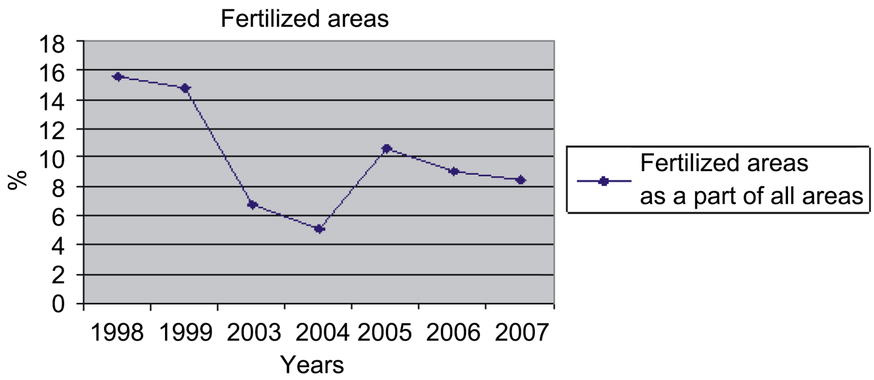

Figure 9. Fertilised areas (Source: MAF).

In terms of fertilised areas, there has also been a trend of variation and decline over the past two years. On average, about 10% of the agricultural areas used are fertilized for these years, and the data for 2003-2007 are below the average, with the exception of 2006, after which there is a decrease again.

Non-utilization of manure is assumed to be ecologically unacceptable, on the one hand, because a resource of rational value for soil fertility is not used and, on the other hand, it becomes a pollutant. Organic fertilizer is not only an alternative to fertilizers, which are expensive and used unbalanced, but it is also important for reducing losses of soil organic matter, on which the ability of the soil to absorb (sequestrate) part of the greenhouse carbon dioxide depends. Soil carbon sequestration is known to be the most cost-effective (costless) way to reduce carbon emissions, for which the agricultural sector has great potential.

According to data from the National Statistical Institute for the indicators "animal waste from feces, urine and manure" respectively "handed over for recovery" and "handed over for disposal", it is found that only about 10% is utilized and 3% disposed of on average for 2004-2007. This is a risk of water pollution and at the same time a missed opportunity to use part of the animal waste for biogas production. With regard to the storage and disposal of manure, the agricultural sector is contrary to the requirements of the Nitrates and Groundwater Protection Directive, which obliges each farm to build a sufficient site for the storage of organic manure. In Denmark, for example, the investment process took more than 5 years, while the capacity of the sites covered 97% of the manure stored for up to 6 months.

4) Areas with an established irrigation network

We will pay a little more attention to this indicator, as it is extremely important economically.

Hadjieva [15] summarizes the environmental benefits of properly organized irrigation as overcoming the risk of drought; saving and rational use of water; improving soil characteristics and conditions for the development of flora and fauna and microclimate; reducing soil erosion and desertification risk; helping to prevent the risk of nitrate contamination of groundwater from agricultural activities.

We will add that irrigation, in addition to environmental impact, also has an enormous impact on the economic and social environment, increasing employment and creating stability in yields, normally fluctuating as a result of natural climate change and global warming. An instability in output is also a factor for instability in prices, and their increase is accompanied by social pressure.

The share of areas with an irrigation network in the utilized agricultural area (**Figure 10**), from 20.3% in 1989 decreased to reach 3.5% - 4.5% for the period 2001-2007 or a decrease of 12 times (or from 1.2 mil. ha of potentially irrigated area in 1989 it reached 104,578 ha. in 2007).

According to Varlev (2008) [16], in order to ensure relatively stable productivity, irrigated areas must reach a minimum of 300 - 400 thousand. ha. Analysing the causes of the crisis in irrigated agriculture the following summary can be made:

- A manifestation of mismanagement on the part of the state during the period of active restoration of land ownership (1990-1993), when the destruction of the canal irrigation network occurred;
- Inconsistent with the capabilities of farmers in the first years of transition price of irrigation water, making the process economically inefficient;
- The lack of skilled manpower to maintain the canal network;
- Insufficient financial government support (in terms of both the current irrigated water subsidy and investment)
- Uncontrolled and useless waste of water for irrigation.

Irrigated agriculture is one of the main intensive factors for the efficiency and competitiveness of agriculture, which needs a strategy consistent with the growing unsustainability of the global climate system. It has a direct bearing on the viable development of such intensive sectors as vegetable production and perennials, which at this stage could hardly recover their export positions without the necessary investments in hydromeliorations. The destructive wastage of the meliorative system generates instability for the agricultural sector and overcoming the accumulated problems.

3.10. Good Agricultural Practices

Good Agricultural Practices (GAPs) can serve as a basis for comparing whether agricultural activity fits into agri-environmental criteria for environmental

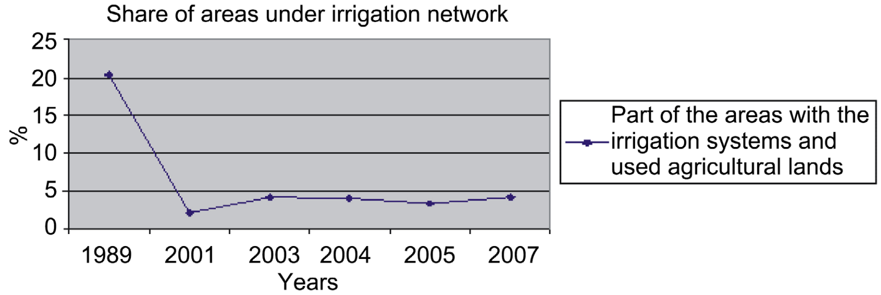

Figure 10. Share of areas under irrigation network (Source: NSI).

protection. For this reason, they are a mandatory element of environmental indicator analysis. Proposing for an environmental indicator "Good agricultural practices", we need to specify several mandatory conditions:

- This indicator is not typical, in the aspect of a classically measurable quantitative indicator;
- The input meaning is more extensive and covers a wider range of issues. That is why we qualify it as a quality dimension, showing how well Bulgarian agriculture fits and meets modern agro-ecological requirements and the implementation of the CAP;
- Given the above defined broad meaning which they show, GAPS cover different areas and cover with already existing agri-environmental indicators is possible;
- GAPs are also a good measure of institutional efficiency and compliance with standards and environmental protection in a sustainable context;
- The implementation of the GAP also shows the level of ecological culture and contemporary thinking.

Organic farming is also a type of good agricultural practice, which, when viewed with the indicator share of areas under organic farming in total agricultural areas, can serve as a comparison with other countries. The MAF [17] defines three areas of action of the GAPs, according to the existing environmental legislation in the agrarian context:

- Water pollution;
- Land use and soil fertility;
- Environmentally sensitive areas and historical sites.

Additional activities, in the context of the GAP, such as organic farming, are also outlined; conservation of preserved endangered local breeds; management of semi-natural habitats.

3.11. Areas under Organic Farming

As already mentioned, organic farming is a kind of good agricultural practice. Numerous publications in the world and Bulgarian context deal and prove its advantages. We will not dwell on this point, but will use as a specific quantitative indicator characterizing organic farming the share of areas occupied by organic farming in the total amount of agricultural areas used (UAA). According to Eurostat [18], in 2007 only 0.4% of the UAA was used for organic production. This is extremely small in the background of:

- The environmental, social and economic prerequisites that exist in Bulgaria, such as the purity of natural resources; extensive predominant production; a high rate of unemployment in rural areas and hence the availability of free labour; market support, in the face of a number of CAP measures and the good institutional support expressed in the face of the developed "The National Plan for the Development of Organic Agriculture in Bulgaria 2005-2013" [19], envisaging an increase of up to 8% of organically managed land in the UAA; inability to have another source of income in a number of

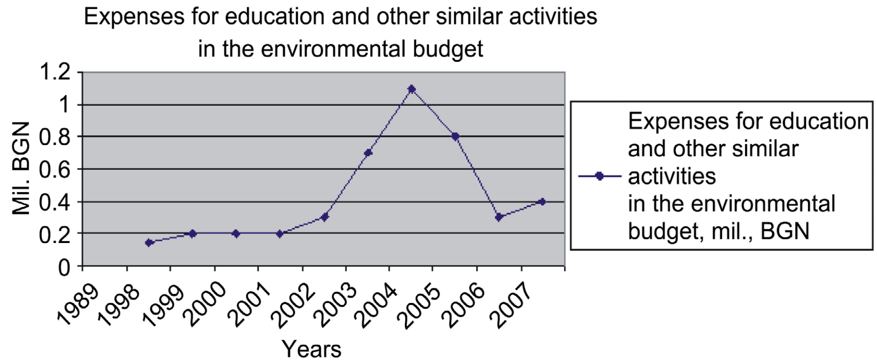

Figure 11. Expenditure on educational and educational activity in expenditure on environmental protection and restoration (Source: NSI).

rural areas; Expanding the market demand for organic products worldwide—the development of organic farming in European and global aspect [20]. On average for EU 15 the same level for 2007 is 4.7%, for Austria—11.7%, for Germany—5.1%, Italy—9%, former socialists countries in the EU (excluding Poland, Hungary and Romania)—between 4.5% and 9.8%.

3.12. Knowledge of the Principles of Sustainable Agriculture and Level of Environmental Qualification of Farmers

The analysis of this indicator is based on the interpretation of the data from the survey for the territory of the municipality of Kyustendil and speaks of an extremely low level of ecological culture and ignorance of the principles of sustainable agriculture. In the logic of things, although we are talking about two related but still different concepts, we cannot talk about a high level of environmental qualification, given a low ecological culture. An obligatory condition for improving the environmental qualification is the presence of an ecological culture first. The role of the National Agricultural Advisory Service as a specialized structure for information, advice and training at the farm level is not yet sufficient. The data for expenditure of funds for educational and educational activities in the expenditures for environmental protection and restoration (**Figure 11**) vary, and until 2001 their amount did not exceed the modest BGN 200,000 and doubled in 2007.

4. Conclusions

The main conclusions we can draw from the analysis of environmental indicators at the sectoral level are:

- Good general condition of natural resources associated with agricultural activity as a result of a number of reasons, such as a change of system and change in the type of agricultural production; reducing pressure from other sectors of the national economy as a result of a decline in industrial production; the stagnation in the industry after 1990 and the "self-cleaning" of soils and water; reducing the pressure of intensive agriculture, in view of the high degree of extensification of agriculture and the application of the agri-environmental principles of sustainable agriculture, in accordance with the CAP.

- Despite the above characteristics, some serious problems are still present. According to the DPSIR methodology, at the industry level, we can define them as referring more to its pressure and negative impact on the resources of the agricultural sector and, to a lesser extent, related to its condition. We will point out some of them.
- The potential threat of erosion processes, mainly as a result of natural—climatic factors and geological processes, but also increasing anthropogenic factors neglected by all economic entities.
- Presence of acidified soils in high sizes (as areas) and of salinisation in more limited sizes. Their strategies should be from remedial to preventive.
- Danger of nitrate pollution of soils and waters, especially in intensive areas where unbalanced nitrogen fertilization is applied.
- The danger of water pollution by nitrates when the slurry is discharged or leached as a result of the absence of fertiliser sites.
- The risk of pesticide contamination resulting from an increase in intensification of production or in areas where inappropriately obsolete pesticides are stored.
- The danger contamination with heavy metals and radionuclides—transport, energy, accidents, military actions, etc.
- Pollution risk by anthropogenic waste, microdetritus and microplastics.
- There is a danger of further land degradation and the opposite effect, expressed in the abandonment of business and the abandonment of arable land.
- Deterioration of the structure of agricultural crops, predominating more intensive and monocultural production.
- The compost is mainly produced in the home yard, not industrial composting plants [21].
- Inefficient use of manure, which from a valuable resource becomes a potential pollutant.
- The low energy efficiency of the industry, expressed in high consumption of used fossil fuels and products.
- Non-exploitation of the industry's potential for growing energy crops in areas not competing with the food balance as well as biofuels from waste biomass.
- Destroyed and morally worn meliorative network and need to create new irrigated areas with progressive irrigation technologies.
- Low level of knowledge of the principles of sustainable agriculture and good agricultural practices and their implementation.
- The application of organic farming to a small and insufficient extent.

Conflicts of Interest

The authors declare no conflicts of interest.

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