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ANALYSIS OF PRO-ENVIRONMENTAL MEASURES UNDER IMPLEMENTATION OF THE BALTIC DEAL PROJECT

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ANALIZA PROŚRODOWISKOWYCH DZIAŁAŃ W RAMACH REALIZACJI PROJEKTU BALTIC DEAL

STRESZCZENIE: Artykuł prezentuje informacje oraz analizę działań prośrodowiskowych wdrożeniowych gospodarstw rolnych z terenu województwa opolskiego, biorących udział w projekcie Baltic Deal. Na podstawie analizy działalności gospodarstw, można zauważyć, że pomimo podejmowanych działań prośrodowiskowych, sposób produkcji rolnej stanowi ciągle zagrożenie dla jakości środowiska przyrodniczego, w tym dla jakości wód. W ramach projektu Baltic Deal na przykładzie pokazowych gospodarstw rolnych dokonuje się ich oceny pod kątem zapobiegania „ucieczce" składników pokarmowych do wód. Projekt ma także służyć wskazaniu nieprawidłowości pojawiających się w toku produkcji i zagrażających środowisku wody oraz określeniu, jakie działania powinny być podjęte, by zapobiegać skażeniom środowiska wodnego.

SŁOWA KLUCZOWE: Dyrektywa Azotanowa, rolnictwo zrównoważone, bilans N, Projekt Baltic Deal

Introduction

Agricultural production plays one of the most important functions in all the national economies, but if it is not properly managed can cause a variety of negative effects on water environment, the quality of which may be deteriorated through, for example the appearance of pesticide residues and nutrients from fertilizers. Water protection is one of the principal issues of the Common Agricultural Policy with the key efforts directed to reduction of pollution from agricultural activities, mainly through the sustainable consumption of pesticides and fertilizers, in particular to avoid nitrate contamination.[1]

The problem of water pollution by fertilizer compounds is not marginal, as it confirms the prepared Nitrates Directive being implemented[2]. Based on its provisions, in Poland 21 nitrate vulnerable zones (NVZs) were designated that are areas where agricultural nitrate pollution is a problem. In these areas the nitrate concentrations in groundwaters must be reduced. In 2008 the number of NVZs was 19. Currently, these areas occupy approximately 1.5% of the territory of Poland. Action programs designated particularly to farmers, the main actors and subjects responsible for the water quality state were developed for these areas. Their main tasks, among others, are:

- implementation of good agricultural practice;
- proper storage and management of animal manures;
- use of mineral, natural and organic fertilizers in doses commercially reasonable, as well as safe for the environment.[3]

Practice shows that not all agricultural activity takes place according to the good agricultural practice. Farmers supplying nutrients from chemical, natural and organic fertilizers mainly seek to obtain high yield in crop production and doses of fertilizers are often higher then plant nutrient requirements. This raises implications for the contamination of soil and groundwater, as well as causes economic losses to farmers. To illustrate this,[4] as much as 80% of nitrogen used in Swedish agricultural sector is being lost in the surrounding environment. Part of it is released into the atmosphere. In turn, other part is escapes into streams and lakes. A significant amount of nitrogen which goes into the atmosphere returns to soil and groundwater as precipitation. Similar situation is in the case of phosphorus, which goes to water during soil erosion. In order to avoid the loss of nutrients, agricultural producers are obliged to implement manure management

[1] *Agriculture and water*, www.europa.ec.eu [19-12-2012].

[2] Council Directive 91/676/EEC of 12 December 1991 *concerning the protection of waters against pollution caused by nitrates from agricultural sources (O.J. No. L 375/1, 31 December 1991).*

[3] The Nitrates Directive, www.kzgw.gov.pl [18-12-2012].

[4] A. Granstedt, *Farming for the future – with a focus on the Baltic Sea Region*, COMREC Studies in Environment and Development No.6, BERAS Implementation Reports, No.2, 2012, www.beras.eu, [18-12-2012].

plan. On the one hand, such action is intended to help maintaining high and stable yields, as well as to limit unnecessary spending on fertilizers. In this way, the environment is protected and social costs are limited. Indeed, it is worth noting that high concentration of nitrates in drinking water can cause, for example methemoglobinemia a disease occurring in babies leading to death (known as blue baby syndrome)[5].

Agricultural activities do not remain indifferent to waters of the Baltic Sea Region, while Poland has a relatively large impact on its condition. Municipal and agricultural actions are recognized as point sources of pollution for the marine environment of the basin. Already in 1992[6] was pointed out that agriculture and poor agricultural practice pose a serious threat to the Baltic Sea catchment area with river basins discharging their waters to this sea. The Convention, among others, gives priority to groups of substances, which are generally recognized as harmful substances, including nutrient compounds from the overused fertilizers of natural, organic and mineral sources.[7]. In 1999, there were also indicated the so called „hot spots" [8] consisting of, i.e. nonpoint source water pollution affecting a water body from sources such as polluted runoff from agricultural and rural areas, covering almost the entire area of Poland and defined as:

- Hot spot No. 95 – Agriculture and livestock farming – so called Agriculture Run-off Programme for the Vistula River basin;
- Hot spot No. 112 – Agriculture and livestock farming – so called Agriculture Run-off Programme for the Oder River basin.[9]

According to HELCOM[10], which plays a significant role in the assessment of eutrophication in the Baltic Sea, despite application of various measures, eutrophication in the Baltic Sea is still a problem, and this state is mainly due to excessive nutrients from agricultural production, especially from specialized intensive farming. About 75% of nitrogenous and at least 95% of phosphorus substances reach Sea Baltic from rivers or via waterway discharging their waters to this area. Poland has significant contribution, because from this area as many as 28% nitrogen and 45% of phosphorus run-off to Baltic Sea catchment area. Therefore,

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[5] *Agricultural Nonpoint Source Fact Sheet, Protecting water quality from agricultural runoff*, EPA 841-F-05-001, March 2005, www.epa.gov [18-12-2012].

[6] The Convention on the Protection of the Marine Environment of the Baltic Sea Area, signed in Helsinki on 9 April 1992, entered into force on 17 January 2000, O.J. of 2000, No. 28, item 346.

[7] M. Radzimierski, *Edukacja ekologiczna mieszkańców obszarów wiejskich. Podsumowanie realizacji programu BAAP,* in*: Dobre praktyki w rolnictwie – sposoby ograniczania zanieczyszczeń wód*, Regional Advisory Centre for Agriculture and Rural Development in Przysiek, Przysiek 2000, p.87-89.

[8] The so called „hot spots" were defined under the Baltic Sea Declaration and the Joint Baltic Sea Research Programme adopted at the Baltic Sea Conference in Ronneby in 1999.

[9] *Assessment of designated in Poland Nitrate Vulnerable Zones*, Alterra, Nauki Przyrodnicze, Wageningen University and Research Centre, Wageningen, November 2007, www.kzgw.gov.pl [21-12-2012].

[10] Helsinki Commission – the Baltic Marine Environment Protection Commission.

the main objective is to achieve natural environmental nutrient concentrations that do not lead to eutrophication in Baltic Sea[11].

Actions for water protection, including Baltic Sea from agricultural pollutions are nothing new. Such efforts have been made under various projects for many years. RCD and RRD [12] have carried out works under the BAAP Project[13] (1995-1997) – „Program to reduce nutrient run-off from agriculture sources to the Baltic Sea", which is a long-term policy program and institutional reforms in order to restore the ecological balance of the Baltic Sea. During 1999-2000, the RCD was also implementing the „Protecting the quality of groundwater and surface water through the implementation and promotion of good agricultural practices as an element of sustainable development of agriculture in rural areas." Programme[14].

More recently implemented projects supporting actions for water quality improvement of Baltic Sea. As an example, the BERAS Implementation[15] – a transnational project part-financed by the European Union and Norway can be mentioned. It is one of the parts of the Baltic Sea Region Programme 2007-2013. Its purpose is to reduce water pollution of the Baltic Sea by lowering the loads of nitrogen and phosphorus run-off from rural and urban areas and to promote sustainable use of resources and nutrients in the entire food chain – from the farmer's field to the consumer.

Similar programme is the one described below – Baltic Deal Project implemented in the Baltic countries since 2010. Baltic Deal Project brings together farmers and advisory services of the Baltic Sea countries in order to improve the skills of farmers in the implementation of agri-environmental practices. Under the programme, farmers receive advisory support to reduce nutrient losses from farming of their crop production. At the same time, their farms are analysed and assessed according to the used agricultural practices.

Baltic Deal Project– safe environment managed by biogenic components

Baltic Deal is a new project of the European Union Strategy for the Baltic Sea Region and joint undertaking of many countries. The aim is to exchange practical knowledge between farmers and to provide them with advisory services on implementation of actions to reduce nutrient run-off from farms. The actions are directed on implementation of sustainable agri-environmental practices in the Baltic Sea region.

[11] Ibidem: *Assessment of designated in Poland NVZs.*

[12] Regional Advisory Centre for Agriculture and Rural Development in Przysiek.

[13] Baltic Agricultural run-off Action Programme.

[14] Ibidem, M. Radzimierski, *Edukacja ekologiczna mieszkańców obszarów ...,* op. cit.

[15] Baltic Ecological Recycling Agriculture and Society Implementation.

The project involves the development of a common international strategy for the Baltic Sea Region in order to support and strengthen agricultural advisory services, demonstration, documentation and promotion of best practices and agri-environment measures[16]. Under the project was established a network of relations between demonstration farms and national advisory services.

The project is funded by the Baltic Sea Region Programme 2007-2013 and by the NEFCO/NIB[17], Baltic Sea Action Plan Trust Fund. The total budget is around 4 million Euros. The project period is 2010 to 2013. For consecutive years next edition of the project implementation is scheduled to include larger number of demonstration farms implementing good agricultural practices, in particular with respect to protect water resources, including water resources of the Baltic Sea. In the Baltic Deal project participate seven Baltic countries: Poland, Estonia, Lithuania, Latvia, Denmark, Sweden, and Finland (five of them are advisory services and two are farmers' federations). In addition, the project has 30 associated partners in all the nine countries around the Baltic Sea (11 farmers' associations,

8 advisory services, 6 ministries and 5 other agricultural institutes and organisations). Under the project a network of 117 demonstration farms was created, including 48 from the territory of Poland with a total area of 6,953 hectares. Farms in the network are of different cultivated areas and have various lines of production[18]. General information characterizing the farms is shown in table 1.

In Poland, the project is coordinated by the Department of Agricultural Advisory Centre in Radom by means of the Agricultural Advisory Centres. During its implementation, as a result of on-farm research and observation, farmers and advisers have the opportunity to exchange knowledge and experiences on good agricultural practices. Baltic Deal also makes study trips for farmers and advisors both within the country and to other countries in the Baltic Sea region.[19]

Other results are, among others, the common strategy of selected actions that are tested, assessed and adjusted within the selected pilot areas, such as at the B7 islands (the seven largest islands in the Baltic Sea) and contribute to the reduction of eutrophication in the Baltic Sea and treatment of run-off waters. Some examples of the tested measures are improved fertilization methods, manure management and waste water treatment.[20]

In all implementation farms in Poland, assessment of measures to reduce nutrient losses from farms that pollute the Baltic Sea region was performed. The assessment of farms was carried out based on selected agri-environmental indicators. Some of them are mandatory due to the environmental law in force affec-

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[16] *Protection of the Baltic Sea* www.wodr.poznan.pl [11-12-2012].

[17] NECO – Nordic Environment Finance Corporation; NIB – Nordic Investment Bank.

[18] M. Krysztoforski, *Wprowadzanie najlepszych praktyk rolniczych do produkcji*, www.baltic.cdr.gov.pl [05-12-2012].

[19] Leaflet on Baltic Deal Project, www.baltic.cdr.gov.pl [05-12-2012].

[20] *Inteligentny układ rolny dla Morza Bałtyckiego – region Morza Bałtyckiego – Łotwa, Szwecja, Finlandia, Litwa, Polska i Dania /Project the Baltic Deal – the Baltic Sea Region – Latvia, Sweden, Finland, Lithuania, Poland and Denmark/*, www.ec.europa.eu [12-12-2012].

Table 1
Information on demonstration farms in the Baltic Deal project

Nubmer of farms	48
Total area of farms[ha]	6953,00
The average area of farm [ha]	144,80
The smallest farm [ha]	7,50
The biggest farm [ha]	1703,00
The average area of farm with no animal stock	184,70
The average livestock density [LU/ha AL]	0,52
The livestock density in animal farms [LU/ha AL]	1,09
Production direction [%]	
Field crops	23
Mixed production	23
Cattle	24
Pigs	21
Horticulture	9

Source: M. Krysztoforski, *Wprowadzanie najlepszych praktyk rolniczych do produkcji,* www.baltic.cdr.gov.pl [05-12-2012].

ting the agriculture or because of farm participation in agri-environmental programme (table 2).

The primary indicators, by which the analysis of farms was carried out, are:

- Vegetation cover outside the growing season (intercrops and undersown, buffer zones; setting aside agricultural land as grass areas; sowing winter crops; maintaining stubble)
- Soil cultivation (tillage methods that has positive effects on soil's nutrient retention);
- Fertilisation;
- Manure management;
- Chemical analysis of waters in farming;
- Agricultural Production.

Good Agricultural Practice for the Prevention of Water Pollution

The above-mentioned elements of farm analysis allow for assessment of existing practices on farms. According to the Nitrates Directive, the primary method of reducing water pollution is the priority of implementation of good agricultural practices by farmers. The Code of Good Agricultural Practice, which is a set of principles, guidances and recommendations that should be respected by each

Table 2
Chosen agrienvironmental measures used in Poland

Measure	Obligatory by low	Subsidized	Currently feasible
Plant cover in winter	X		X
Catch crops		X	X
Buffer zones	X	X	X
Grassland cultivation		X	X
Winter crops			X
Stubble			X
Spring tillage			X
Reduced soil tillage			X
No till farming			X
Liming			X
Incorporation of fertilizers			X
Split applications of nitrogen fertilizers			X
Combined drilling			X
Fertilization plan	X – in parts of the country		X
Nutrient balances		X	X
Avoiding the spreading of fertilizers at high risk	X		X
Reduced fertilization		X	X
Manure spreading techniques			X
Manure storages	X		X
Crop diversification			X
Extensive farming in sensitive areas			X
Integrated farming			X
Organic production		X	X

Source: On the basis of *Study on available agri-environmental measures*, Work Package 4, March 2011, www.balticdeal.eu [10-12-2012].

farmer, was prepared to facilitate this process. Although, compliance with the provisions of the Code is voluntary, then every farmer should be aware that its content follows directly the Nitrates Directive standards. On the other hand, good agricultural practice implementation should come directly from the inner conviction that the environmental protection in agriculture is indispensable.[21]

[21] Code of Good Agricultural Practice, Ministry of Agriculture and Rural Development, Ministry of the Environment, Warsaw 2004.

Land cover by plants outside the growing season

For agricultural land, especially for arable land (AL), the vegetation cover during the winter period is extremely important. Not only winter corn, but also catch crop, grass on AL and other perennials help to protect the soil from erosion. They also play important role in retention of nutrients (NPK) that means protection of their run-off to waters and atmosphere. In this regard, it is important to create buffer zones along water courses, areas covered with vegetation and unfertilised. Their presence significantly reduces the risk of nutrient run-off into watercourses. The presence of stubbles is vitally important, as well. If for some reason it is not possible to cover the AL with vegetation in the winter period, at least the soil should be protected from erosion and leaching of ingredients by stubbles.

Soil cultivation methods

In order to protect the soil, its structure, organic matter and to counteract the leaching of nutrients, for example no-till farming is recommended. It is recommended where the soils are heavy, of good structure and without weeds. In other cases, reduced ploughing should be used.

Fertilisation and Manure Management

Providing the soil with appropriate amount of fertilizer and using them at the right time positively impacts not only the environment, but also surpluses the budget of the farm. Therefore, starting point for applying the correct approach in fertilization is knowledge about nutrition needs of the soil. Soil analysis allows using correct amount of fertilizers and also indicates the need for liming, which facilitates absorption of fertilizer components by corps. The quantities of both, mineral and natural fertilizers used in farming affect the nutrient balance. Positive balance indicates that some components remain in the soiland may pose a threat to the environment. Also from the economic perspective, significant surpluses of nutrients are unprofitable. In the long term, negative balance favours decline in soil fertility. Therefore, ideal outcome would be balancing nutrients to null. From the point of water protection, application of fertilizers at the right time is extremely crucial. It is unacceptable, for example to use manures during the winter and on lands with no vegetation cover due to leaching of ingredients insight into the soil, into the groundwater. On fields located on steep slopes (over 10%) without ground cover, any liquid fertilizers should not be used, as well. Furthermore, manure must be stored in such manner, so it is prevented from leaching. If the reservoir for manure storage is located near watercourse, a barrier should be created to allow for elimination of leachates.

Water Treatment

In farming, a guiding principle in water protection is aiming to retain nutrients in the field during the period of plant growth, although some losses by leaching are inevitable. An interesting solution and method for flowing water purification is recycling of drainage waters. It means retention of waters flowing from arable land during spring thaws and heavy rains. Such waters should be collected in a seperated place. Consequently, they can be used for irrigation of AL during droughts. This approach helps to reduce the amount of run-off waters from arable areas to steams and the downstream watercourse and thus decreases the nutrient load to the watercourse that can be recycled back.

Various production systems

Differentiation in the approach to quality in the used production can have a huge impact on the quality of the environment. Implementation of environment-friendly agricultural systems, such as organic farming as defined in Regulation 834/2007[22], sustainable, integrated agricultural production or various forms of extensive farming can significantly improve the quality of the natural and agricultural area. It is expected that from 2014 the mandatory system of production and protection will be the integrated production and plant protection[23].

Baltic Deal Project – examples of farms from the Opolskie Voivodeship participating in the project

Farming of the Opolskie Voivodeship – selected environmental issues

Farming in the Opolskie Voivodeship is characterized by significant intensity of production. The region has excellent conditions for functioning and development of agricultural production, as evidenced by the ratio of valorisation of agricultural production area: 81,5 points. These conditions are reflected in performance of production farms. The table 3 below shows selected results of agricultural production in the Opolskie Voivodeship compared to the country.

[22] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No. 2092/91, (O.J. L189 of 20 July 2007, p.1).

[23] Having regard to Article 14 of the Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides and the Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. Article 55 of the aforementioned Regulation provides that plant protection products shall be used properly. *Study on available agri-environmental measures*, Work Package 4, March 2011, www.balticdeal.eu [10-12-2012].

Table 3
The important data for agriculture in Poland and Opolskie Voivodeship (2010)

Items	Opolskie voivodeship	Poland
Area of UAA [thousands of hectares] total, including:	518,00	15534,00
UAA in good agricultural culture [thousands of hectares], in this:	511,00	14548,00
Sown area [thousands of hectares]	456,00	10565,00
Permanent grassland [thousands of hectares]	45,00	3254,00
The share of UAA in the area of the region / country [%]	55,16	49,58
Sown area [thousands of hectares]:		
• Total cereals	323,00	7646,00
• Potatoes	9,00	387,00
• Industrial crops	102,00	1172,00
• Fodder crops	16,00	900,00
Yields of chosen crops [dt/ha]:		
• Wheat	54,80	43,90
• Rye	37,70	26,80
• Potatoes	252,00	211,00
• Sugar beet	499,00	483,00
Rape and turnip rape	24,30	23,60
milk yield of cows [liters/year]	6109,00	4487,00
NPK consumption in terms of pure component [kg/ha UAA]	181,60	114,70

Source: On the basis of: *Raport z wyników*, Powszechny Spis Rolny 2010, GUS, Warszawa 2011; Rocznik Statystyczny Rolnictwa 2011, GUS Warszawa, 2010; *Użytkowanie gruntów*, Powszechny Spis Rolny 2010, GUS, Warszawa 2011.

Potential risks affecting the natural environment largely are the effects of overdose of fertilizers used in the Voivodeship, which may lead to accumulation of the excess of nutrients and imbalance of fertilizer components, especially nitrogen. According to statistical data[24], consumption of mineral fertilizers (NPK) in a pure component, in the marketing year 2009/2010, amounted to 117,9 kg/ha of UAA (utilized agricultural area), nationwide. In Opolskie Voivodeship – 186,6 kg/ha of UAA. As regards to nitrogen, at average the national consumption was 68 kg/ha of UAA and in the Opole Voivodeship – 104,5 kg/ha of UAA and it was the highest consumption in the country. At the same time, a small amount of manure is used. It is a fertilizer, which besides bringing valuable nutrients has a structure-creative impact on the soil, as well[25].

[24] 2011 Statistical Yearbook – Environmental Protection, GUS, Warsaw 2011.
[25] *Land Use*, 2010 Agricultural Census, GUS, Warsaw 2011.

Gross nitrogen balance for the years 2007-2010 in the Opolskie Voivodeship was at average of 49,5 kg N/ha of UAA, which indicates a very sufficient use of this nutrient (65,9%).[26] The situation, where nearly 100% of the UAA is maintained in good agricultural condition is desirable, which is mainly the result of farmers' participation in various agri-environmental programmes, such as soil and water protection or sustainable agriculture. About 90% of farmers use crop rotation on the entire areas of the arable land and in winter period 85% of the land is covered with vegetation, which limits nurtient run-off into the groundwater.[27]

Characteristics and Assessment of Implementation Farms Participating in the Project in the Opolskie Voivodeship

In the Opolskie Voivodeship during 2011-2012 the Baltic Deal Project was implemented by two farms. Entity responsible for implementation and carrying out associated analysis was, in both farms, the Opole Agricultural Advisory Centre in Łosiowo. Farms participating in the project are demonstration farms. Their assessment and presentation is aimed at mutual exchange of knowledge between farmers and advisory services. The criteria for selection of farms are indicated in table 4.

One of the selected farms is specializing in swine fattening, the second one leads intensive crop production. The first analysed farm is situated in Strzelecki Poviat (farm 1) and the second (farm 2) in the south of the Opolskie Voivodeship – Prudnicki Poviat. Basic information about farms is presented in table 5.

An analysis of relation between farms and the environment was made by assessing their selected measures and indicators to describe their impact on the natural environment, including contributions to the improvement of water quality.

Agricultural Production

Both farms run production in the conventional system and are participants in the agri-environmental programme since 2004:

- farm 1 – measures: sustainable agriculture, soil and water protection and maintenance of extensive meadows;
- farm 2 – measures: soil and water protection and sustainable agriculture.

Due to the participation in agri-environmental programme, both farmers are obliged to implement restrictive practices of soil and water contamination of nutrients. For these measures they also receive benefits. In the context of sustainable farming, the farmers are obliged,. to comply with proper selection of crops, annual preparation and implementation of the fertilization plan based on the balance of nitrogen and actual soil chemical analysis, determination of nitrogen doses (maximum dose of nitrogen from manure, compost and mineral fertilizers

[26] *Land Use*, 2010 Agricultural Census, GUS, Warsaw 2011.

[27] *Agricultural Crops and Selected Items of Agricultural Production Methods,* 2010 Agricultural Census, GUS, Warsaw 2011.

Table 4

Criteria for selection of farms to participating in the Baltic Deal project

Basic criteria	The consent of the farmer to participate in the project
	Activities in accordance with the Code of Good Agricultural Practices
	Communication, motivation, knowledge of foreign languages
Specific criteria	Selection of farms according to the natural conditions of the region
	Direction of production: plant, animal, etc.
	Farm size
	Geographical location in relation to the country, region and APV
	Production system: conventional, organic, integrated, industrial, precision agriculture
	Innovative practices, investments, activities: buildings, structures, equipment, machinery, organizational, marketing
Additional criteria	Farmer interest in future investments on the farm
	Winners or candidates in the competition for the Farmer of the Year WWF Baltic Sea Region
	Participation in the competition for the Best Organic Farm
	Participation in the Contest Agroliga, Farmer of the year

Source: on the basis of: *Kryteria doboru gospodarstw,* www.baltic.cdr.gov.pl [05-12-2012].

Table 5

Basic information on the farms

Items	Farm 1	Farm 2
Area of AL [ha], in this:	225,33	68,46
Arable lands	223,54	68,46
Permanent grassland	1,79	----
The soils on the farm	Domination of the medium soil: IV a and IV b classes. There are also classes III, IIIb, V and VI	The soils are classified as class: I, II, III a and III b
Valuation indicator of soil	Medium soil – 0,86	Good soil – 1,23
The predominant direction of production	Raising pigs in a closed cycle. Livestock has an average of 340 sows. The final product are pigs. Crop production is allocated for the feed in the total.	Only crop production: cereals, root crops, oilseeds, legumes.
Farm equipment	Old buildings are modernized with a new equipment fully operational. New buildings, with full technical equipment, were built in 2009. They contain necessary sectors for livestock production. In all buildings there is mechanical ventilation, feed is given automatically, there is full computerization.	Grain silos for storing grain. The farm is equipped with new equipment for crop production.
Crop production results	Winter wheat 4,5 tons / ha Spring wheat 4,5 tons / ha Barley 4,0 tons / ha Winter rye 4,0 tons / ha Maize 6,0 tons / ha	Cereals 9-10 tons / ha Maize 10-12 tons / ha Rape 4 – 4,5 tons / ha Sugar beet 60-70 tons / ha
Livestock production results	The annual production: about 843 tons of pigs	---

Source: Based on data of the OAAC Łosiów.

per AL should not exceed 150 kg N and on permanent grassland 120 kg N/ha with no sewage sludge usage). In the context of soil and water protection, the measures undertaken by farmers are reducing water pollution from agricultural sources by maintaining vegetation on UAA as postharvest handling of underplant catch crop, winter catch crops and stubble catch crops.

The aim of maintaining extensive meadows is to reduce fertilization, to keep quantities and schedules of the performed swaths and intensities of grazing. Compliance with measure leads to sustain the existence of meadow and pasture landscapes. The use of wastewater and sewage sludge is prohibited. Liming and nitrogen fertilization is allowed (up to 60 kg/ha per year), except areas fertilized by river alluvia. On pasture land the minimum amount of stocking is 0,5 LU/ha of UAA and the maximum is 1,0 LU/ha of UAA. Maximum load on pasture land is up to 10 LU/ha (5 t/ha). In hay-pasture, the stocking density should not exceed 0,3 of the maximum load on pastures – up to 10 LU/ha of UAA (5 t/ha).

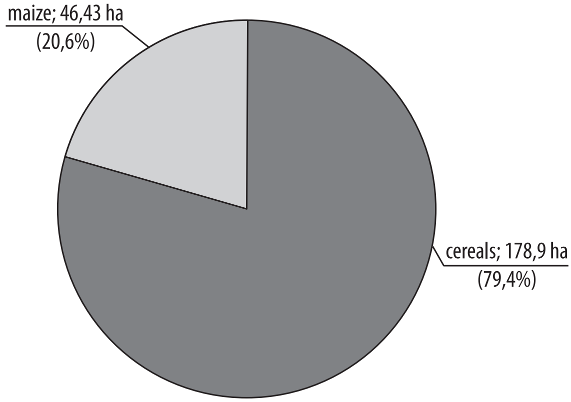
The structure of crops and vegetation cover outside the growing season, tillage (plowing methods influencing the retention of nutrients in the soil)

Based on the crop structure (figures 1 and 2) dominant share of cereal crops and other cultivations, degrading organic materials of the soil, can be observed in both farms' productions. Using degradation and soil organic matter reproduction coefficients[28], the soil organic matter balance (OM) was calculated. For the farm 1, positive balance was achieved in the value of +0,50 tons of OM/ha of AL. For the farm 2, the balance was lower: 0,1 tons of OM/ha of AL. Differences between farms were directly due to the fact that the farm producing cattle used manure. The presence of organic matter in the soil promotes maintaining of nutrients and reduces their leaching into the water. Therefore, the balance of OM is an important agri-environment measure. However, the structure of sowing indicates the need for change in the diversity of crops.

In both farms are sown catch crops to protect soil in winter period and thereby to prevent or reduce „leakage" of nutrients to the water. Groundcover in wintertime, also using catch crops, is an important indicator of agri-environment measures. In the financial year 2010-2011, the catch crop area in the farm No. 1 was 85,64 ha (38% of the AL) and in subsequent year – 74,96 ha (33,5% of the AL). In the farm No. 2, the catch crop area in 2010/2011 was 17,30 ha (25,3% of AL) and in the next year – 11,16 ha (16,3%). Other area of the AL was largely covered with winter crops protecting the soil in almost 100%. In both farms the approach of shallow tillage or no-till farming (Farm 1) for maize production using traditional equipment preventing run-off of nutrients, including nitrogen in the soil is carried out.

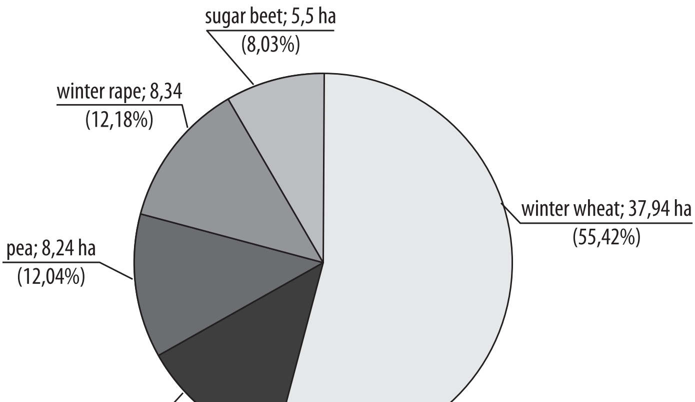
[28] W. Wrzaszcz, *Bilans nawozowy oraz bilans substancji organicznej w indywidualnych gospodarstwach rolnych*, „Z badań nad rolnictwem społecznie zrównoważonym" 2009 t. 7, nr 129, 2009, p. 27-33.

Figure 1
Structure of the crops on the farm 1 (2011)



Source: Based on data of the OAAC Łosiów.

Figure 2
Structure of the crops on the farm 2 (2011)



Source: Based on data of the OAAC Łosiów.

Fertilization, nitrogen balance, manure management

Above measures (proper crop structure, used catch crops) and rational fertilization based on soil analysis to avoid or reduce the water pollution of nitrogen and in effect the unnecessary losses for the farm. For both farms, fertilizer plan is being developed that defines the maximum amount of fertilizers, especially nitrogen. To determine whether the farm exhibit environmentally correct nitrogen

Table 6
Nitrogen balance for farms (2011)

Items	Farm 1	Farm 2
N supply [kg]	32 266,02	10232,61
N supply N/ha UAA	143,19	149,50
N outflow [kg]	23 307,57	10222,10
Difference [kg]	8 958,45	10,50
N balance [kg/ha UAA]	39,4	0,2
N use efficiency [%]	72,24	99,50

Source: Based on data of the OAAC Łosiów.

balance and that the element is not lost as a result of an irrational fertilization, the balance value was estimated[29], which results for both farms are presented in table 6.

The data presented in the table indicates quite rational nitrogen balance. According to the literature[30] the balance of N is not equal zero and its slight surplus, which can safely remain in the environment should be in the range of 30 to 70 kg N/ha of UAA. In cases, the balance of N/ha of UAA was environmentally proper and was not a threat to the water quality. However, in the case of the farm 2, more efficient use of nitrogen could be observed. In addition, both farms use mineral fertilization and in farm producing cattle manure and manure slurry are also used. All crop fertilization takes place in the period from 1 March to 30 November and in quantities compliant with the requirements of the agri-environment programme. Dosage of manure provides environmentally safe amount of contributed nitrogen, not exceeding 170 kg N/ha on UAA per year, while, as it was noted above, due to the fact that the two farms participate in „Sustainable Agriculture", the amount of nitrogen input is less.

Manure storage

In the cattle farming, manure is collected in manure storage. Liquid manure is held in suitable containers adapted to the size of the livestock on the farm.

Farming and water quality

Participation in the agro-environmental programme, especially in the soil and water protection measure, obliges farmers to put efforts to improve water quality. Threats to the water quality in the rural areas can originate from both

[29] Nitrogen balance was calculated using a spreadsheet developed by AAC in Radom.
[30] Code of Good Agricultural Practice, 2004, W.Wrzaszcz, *Bilans nawozowy…*, op. cit.

farming and municipal sewage. By far the greatest threat is improper fertilization, either through defective storage and gathering of manure but also as a result of high doses of fertilizers.

For the project, in the two farms were carried out selected water chemical analyses. Water abstraction points were located in such way, so they can reflect the potential impact of farming activities on the environment. Table 7 below provides information on water outlets and selected chemical analyses.

Sampling of water from different places on the farm allows for the following analysis:

- There is standard pH of the water samples, in accordance with the Regulations of the Minister of the Environment[31] – standards for surface waters 6-9, depending on the quality class and for groundwater: 6,5-9,5 depending on the quality class. Agricultural production is a major run-off of chloride, for example, through the use of potassium fertilizers (mainly in the form of KCl); salt is added to feedingstuffs with mineral supplements or salt licks[32]. On the example of the analysed farms, chloride loads are significantly lower in relation to the quality of surface water (e.g., for I class quality, the chloride load should be ≤ 200 mg Cl/dm^3). In the case of chloride loads in groundwater for waters of quality Class I, the loads should amount up to 60 mg Cl/dm^3. In the collection point next to the pig house (farm 1) and at the point of abstraction originating from well for farming No. 1 (farm 2), chloride loads have slightly higher values, which may be caused by leachates from pig house, containing compounds that arise during cleaning of the livestock facility.
- The phosphorus loads in waters increase primarily due to intensity of subsurface run-off, which are conditioned by the method of use and the amount of fertilization. Therefore, the knowledge of proper selection and dosage of organic and mineral fertilizers in accordance with the nutrient needs of plants is so important to the aquatic environment[33]. The phosphorus loads in the surface water should be in the range of 0,07-0,10 mg $P\text{-}PO_4/dm^3$. In the case of farm No. 1, only the water sampled in the measuring point near pig house (the old building) shows significant pollution of phosphorus compounds, which may be the result of loads of this compound, which is located in the animal faeces. In the case of farm No. 2, in three measuring points, slightly higher phosphorus loads can be observed, which can get into waters from households (wells for farming are located near the house and also the

[31] Regulation of the Ministry of the Environment of 9 October 2011 on the classification of the surface water body status and environmental quality standards for priority substances („The Polish Journals of Law" 2011 t. 257, nr 1545) and Regulation of the Ministry of the Environment of 23 July 2008 on the criteria and methods of assessment of the groundwater status („The Polish Journals of Law" 2008 t. 143, nr 896).

[32] A. Sapek, *Współczesne źródła chlorków w środowisku wód śródlądowych*, „Ochrona Środowiska i Zasobów Naturalnych" 2009 nr 40, p. 455-464.

[33] M. Rauba, *Zawartość związków azotu i fosforu w wodach gruntowych w zlewni użytkowanej rolniczo na przykładzie zlewni rzeki Śliny*, „Ochrona Środowiska i Zasobów Naturalnych" 2009 t. 40, p. 505-512.

Table 7
Water uptake points and the results of chemical analysis

Items	Farm 1					Farm 2			
Date of test the water	19-07-2012					19-07-2012			
Indicator	Uptake points					Uptake points			
	Pond 1 on the field farm	Pond 2 on the field farm	River flowing through the meadows	Well on property	Piezometer next to the piggery	Farm well 1, next the house	Farm well 2, next the house	Drainage ditch at the wheat field	Drainage ditch at the heating plant
pH	7,23	7,39	7,32	7,36	7,19	6,48	6,78	7,14	7,18
Chlorides [mg Cl/dm^3]	46	46,1	35,8	39,6	76,9	63,9	31,1	20,3	41,8
Phosphate phosphorus [mg P-PO$_4$/dm^3]	0,031	0,019	0,016	0,039	3,169	0,143	0,498	0,191	0,075
Nitrate nitrogen [N-NO$_3$]	0,16	0,04	7,46	11,85	32,41	22,27	17,06	0,96	1,94
Ammonium nitrogen [N-NH$_4$]	0,68	0,14	0,22	0,11	0,13	0,09	0,68	0,14	0,15

Source: Based on data of the OAAC Łosiów.

septic tank), as well as from fertilization (drainage ditch near the wheat field). Because wells border with neighbouring building plots, the impact of the neighbouring farms cannot be excluded. Referring the discussion to the quality of groundwater, water from the collection point at the pig house, well for farming purposes near the house 2 and the drainage ditch near the wheat field, the standard for waters of first and second grade quality is exceeded. This may indicate particular sensitivity of these areas to pollution of surface water and groundwater, as well.

- Agricultural production should be carried out in such way, so the farm water pollution by nitrogen compounds, in accordance with the standards of nitrate nitrogen in surface waters, should be ≤ 2 mg N/dm^3 for Class I water quality and ≤ 5 N/dm^3 for Class II water quality. In the case of groundwater, the range is greater: N/dm^3 (Class I) to over 22,60 (Class V). For the analysed farms, water quality in fixed water reservoirs (ponds) in farm 1 and water in drainage ditches (farm 2) is located in the standards prescribed by the regulations. Oversized nitrogen loads in the collection point from river flowing through meadows are most likely to be the result of run-off from other farms. The analysed farm, due to its participation in agri-environmental programme, does not use fertilizers on meadows. The increased loads of nitrogen near pig house may result from animal faeces that leak to the ground. Water in wells in both farms is used only for domestic purposes. The increased nitrogen loads may be due to the fact that they are ambient waters, where biological denitrification process is slowed. It is probable that the increased amounts of nitrates in farm wells may also result from processes of leaching and transfer to containers of fertilizers used in farming, including those from neighbouring farms.

- Ammonium nitrogen. The source of it is inorganic salts, being used as fertilizers. Certain amounts are formed as a result of the reduction of nitrite and nitrate loads in the water. In the characterized farms its loads in the tested samples of water were of the standard value.

Conclusions

Analysis and observation of pro-environmental activities during farming allows for specification of the following conclusions, which also serve as farm recovery plan.

1. Both farms received positive balance of soil organic matter that promotes good soil structure and reduces leaching of nutrients.
2. However, it is recommended to increase crops on land susceptible to wind and water erosion.
3. Present crop rotation should be analysed according to structure-plants increase, especially on the farm No. 1.
4. The introduction and increase of leguminous crops on both farms may contribute to drainage of deeper layers of the soil;
5. For swine farming, it is recommended to export manure, especially liquid manure in accordance with the agrotechnical schedules and ongoing monitoring of leakage of slurry tanks and to reduce odors due to this;
6. In this farm, it is recommended to use appropriate machinery and equipment facilitating protection of the environment: sewage tanker with trailing hoses, seeders for catch crops, slurry mixer;
7. Rationalization of fertilization (farm 1) and the use of mineral fertilizers in split doses;
8. The overall balance of N/ha of UAA in both farms is safe for the environment, however it is recommended to carry out annual analysis of nitrogen and phosphorus balance and current analysis of soil fertility in nitrogen and humus;
9. Research results on waters coming from different collection points in farming indicate, in some cases to exceed the legal limits. It can not be explicitly stated that the given farming is the polluter, while some pollutants can also come from neighbouring farms. Therefore, further analysis should be carried out in subsequent years, and for a wider group of farming.