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Sustainable agriculture: The study on farmers' perception and practices regarding nutrient management and limiting losses

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Abstract

The paper presents the results of a scientific project focused on limiting nutrient losses from farms by introducing measures to apply fertilizers in a more sustainable way. It is a case study of selected aspects of farm management, focussing on the issue of sustainable agriculture and their tools. The main aim of the study was to analyse and evaluate farmers' knowledge of the fertilizing process and its aspects, as well as applying sustainable agricultural activities on farms. The study emphasised the importance of nutrient management, as very important for sustainable farming. Also, the links between farmers' opinions and their activities were analysed. The important issue concerned measures for sustainable farm management introduced on the farms, as well as measures to limit nutrient leaching into groundwater. Twenty-eight farmers from two regions in Poland were interviewed about their perceptions for the case study. In general, the farmers considered their farm activities to be more sustainable than in the past. They demonstrated an understanding of the general idea of sustainable agriculture. However, many farmers still demonstrated a poor grasp of nutrient flows and nutrient balances on farms. Their knowledge and perception was based on general, rather than specific knowledge gleaned from an academic/vocational course. The farmers demonstrated a realization that there were some new, or low-cost measures that could be introduced to make management more sustainable and pro-environmental, but there was still a need for wider adoption of sustainable agricultural practices.

Key words: *farmers, fertilizers, nutrients, sustainable agriculture*

INTRODUCTION

Agriculture impacts on the national economy, the environment, as well as contributing to climate change. Farming and animal husbandry is essential to food production, and in Poland the ongoing specialisation in agriculture influences the structure and economy of the entire society [KRASOWICZ 2008; PRUS 2008]. Over time, competition and the wish to increase one's income have been accompanied by the enlargement of farm units and higher livestock densities [STANISZEWSKA 2008; ZEGAR 2005]. But farms with intensive animal production have the highest nutrient losses. The Helsinki Convention [Conven-

tion… 1992], as well as the Directive 2000/60/EC and the Council Directive 91/676/EEC, all emphasize the need to reduce nutrient losses and improve nutrient management to ensure agricultural sustainability and meeting climate change [QUERNER, MULDER 2007].

Agriculture was once understood to cater to a narrow, local market but it has now taken on an international role. On the one hand, Polish farmers are subject to international competition arising from mechanization and other issues related to increasing efficiency. But they must also deal with the resource management and the environment, which requires an improved system of training in farm management. For example, nutrient leaching from agriculture causes eutrophication, and animals emitting greenhouse gases to the atmosphere contribute to global warming [RUDZIANSKAITE, MISNEVICIENE 2005].

The Food and Agriculture Organization defined sustainable agriculture as "production which fulfils food security, environmental protection, and economic and social needs in rural areas" [FAO 2016]. This task is complex, because it involves not only human activities such as a farm management and agricultural policies but also many independent factors, for example climate conditions, terrain, soil type, gas emissions from animals, etc. [CYMERMAN 1994; KIEŁBASA *et. al.* 2016].

The purpose of sustainable agriculture is to protect and save natural resources. Some of these may become depleted, e.g. soil nutrients, or seriously damaged or contaminated (groundwater or water courses). Some natural resources such as phosphorus are expected to run out later this century. Therefore, more sustainable agricultural practices are emerging to conserve and protect resources [CORDELL, WHITE 2011].

As a result of market and social needs, farm managers are expected to ensure good quality of food while protecting the environment, including water and air quality, soil properties, and ecosystems services [SOBCZYK 2014]. Thus, farmers face the challenge of balancing social and economic goals without sacrificing the environment or natural ecosystems. This is particularly difficult when the economic outcome is dependent on the use of natural goods. Achieving a balance in this area is particularly difficult [PRUS 2010].

Various research projects have investigated means and processes to implement the idea of sustainable agricultural development. One such initiative in Poland and Sweden was the pilot project "Self-evaluation and risk analysis by farmers concerning losses of nutrients and low cost remedial measures conducted in 2013–2016".

Farmers´ perceptions of the impact of their practices on the environment, and their readiness to adopt various methods to improve the degree of sustainability have been analysed in this paper. Specifically the aim was to analyse the development of more sustainable usage of nutrients on farms. Some results of the case study were drawn from the initial investigation made of the group of 28 subjects (case study). The paper makes use of the reports developed under the pilot project, including detailed research results, i.e.: "Self-evaluation of the risk of enhanced nutrient leaching by Polish farmers: nutrient balances, soil maps, farm walks and other tools" [RAMNERÖ 2015], "Analysis of advisors' collaboration with farmers. Report 1: Final report of questionnaire study" [DRANGERT, KIEŁBASA 2015] and "Self-evaluation and risk analysis by farmers concerning losses of nutrient and low cost remedial measures. Report 2: Post-project interview study" [DRANGERT, KIEŁBASA 2016].

MATERALS AND METHODS

The empirical studies were drawn from the pilot project which was conducted by Stockholm University, Swedish University of Agricultural Sciences, Vatema AB and Instute of Technology and Life Sciences (Pol. Instytut Technologiczno-Przyrodniczy) in Falenty, focussing on two Polish provinces: Mazovieckie and Pomorskie, in the 2013–2016 period.

The farmers were introduced to the farm-gate nutrient balance concept, a method for assessing how the risk for nitrogen leaching from individual fields is dependent on farming practices, and farm walks together with agricultural advisors (from the public advisory offices), and they were provided with soil surveys and subsidized lime and catch-crop seeds. Twenty-eight farmers were selected for interview before (2013) and after (2015) in order to identify changes in farm activities and farmers' perceptions of the impact of their land use activities.

The subjects were selected initially as representing farmers of all type of farms (ranging from 13 ha to 150 ha of arable land), and representing crop, husbandry and mixed farms. All the subjects cooperated with agricultural advisors, either public (via public agricultural advisory centres) or private (private consultancies). The farmers were drawn from different age groups and educational backgrounds. They were grouped into two classes depending on the criteria: owners (or renters) of 13–45 ha or 45–150 ha areas; 20–45 or 45–67 age groups, and those with no or basic agricultural education or those with some agricultural (above basic level) (Tab. 1).

According to the most recently published Agricultural Census, most farmers in Poland have a basic vocational education, while 40% of farm managers have a secondary or higher education. Although the overall level of farmers' educational exposure is improving, 56% of farmers still lack an agricultural education [ŁĄCZYŃSKI (ed.) 2014]. In our study group, 68% of farmers run large farms, which exceed 45 hectares of agricultural land (Tab. 1). Most of the farmers (60%) had not attended agricultural college or university. The rest had gained vocational or formal academic agricultural education, or had completed agricultural training of at least one year. The study group was dominated by farmers with lengthy experience in farm management, the average age of the farmer being 45 years.

Table 1. Characteristics of selected farmers taking into account age, education and farm size (in 2015)

Province	Farmer`s age	Education	Farm size, ha
Mazovia	24	basic	35
	64	basic	20
	28	basic plus	32
	29	basic	40
	46	basic	34
	39	basic plus	70
	43	basic	45
	47	basic plus	18
	66	basic	20
	47	basic plus	100
	63	basic	51
	52	basic	20
	31	basic plus	22
	52	basic	112
	24	basic plus	69
Pomerania	43	basic	30
	47	basic plus	13
	63	basic	38
	51	basic plus	80
	27	basic plus	16
	64	basic	40
	63	basic	55
	50	basic	153
	58	basic	15
	49	basic	42
	23	basic plus	41
	36	basic plus	52
	38	basic	20

Source: own study.

Most of the interviewees had extended their farms since Poland had joined EU and they had also introduced mechanised to a large extent. They had invested in new buildings and manure handling equipment to facilitate work. They may have alternated crops and the types of animals, but only a few had ventured into complementary activities such as machinery repair workshop services or producing bird feed for sale.

TOOLS FOR SUSTAINABLE NUTRIENT MANAGEMENT ON FARMS

At a farm level, the global resource challenges and environmental hazards are less pronounced. Here, nutrient management is an essential part of sustainable agriculture as it affects not only farm results but also soil and water conditions [PIETRZAK 2013]. Achieving a balanced and sustainable management of organic and mineral fertilizers on farms poses a significant challenge, and affects production results as well as the state of the environment [BEEGLE *et al.* 2000].

A number of tools have been developed to support farm managers to improve their nutrient management, as well as to prevent nutrient losses. These are often based on an analysis of nutrient flow on a farm. Nutrient flow analyses on farms indicate if there is a need to focus on achieving improved efficiency of some nutrients. The balance is typically calculated for N, P and K, and includes the most common input routes, stores of nutrients (in animals, manure or goods) on the farm, and amounts of output leaving farms (Fig. 1).

The practical value of an FGB depends on the accuracy of the data entered. Nutrient surpluses or deficits may be used as qualitative indicators of the environmental impact generated by a farm [HENDRIX *et al.* 2008; ULÉN *et al.* 2012]. On the basis of a nutrient flow analysis, the farm-gate balance may be developed, as one tool towards sustainable agriculture.

Another important tool for sustainable nutrient management is a fertilization plan without which it is difficult to achieve sustainable nutrient management [ULÉN *et al.* 2013]. The plan specifies the optimal dosages of mineral fertilizer and manure for each crop, taking into account its nutritional requirements and soil fertility, i.e. content of available macronutrients [GOULDING *et al.* 2008].

Complementary to a fertilization plan is the calculation model developed to assess how the risk of nitrogen leaching from individual fields is related to farming practices, including crop rotation, ploughing timescales, previous year yields and fertilization activities. A particular challenge regarding fertilization is the need for updated knowledge about the nutrient content of manure; data that is largely absent in Poland [OENEMA, PIETRZAK 2002]. As practical results indicate, and many research studies show, detailed knowledge about this aspect of farm management is re-

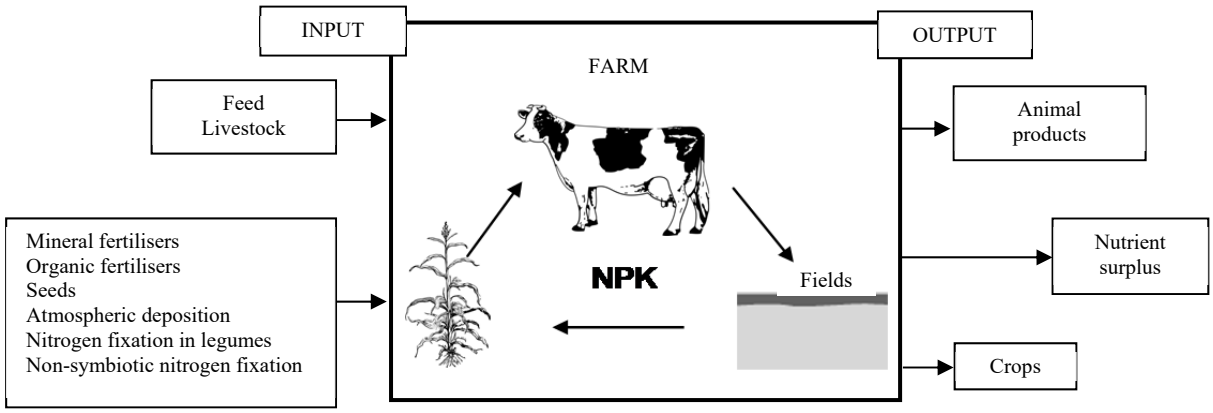

Fig. 1. Nutrient flow model on a farm; source: PIETRZAK [2013]

quired if the process of counter-acting nutrient flows from agricultural activities is to be addressed [DEUMLICH *et al.* 1999].

RESULTS

FARMERS' ATTITUDES TOWARDS SUSTAINABLE NUTRIENT MANAGEMENT ON A FARM

At the start of the study, farmers were asked about their fertilizer practices and their knowledge particularly concerning:
- constraints of the Nitrates Directive,
- differences in nutrient content between cow and pig manure (the two most commonly used organic fertilizers), and
- nitrogen and phosphorus behaviour in soil.

The aim of the examination was to evaluate farmers' knowledge and awareness of some essential issues on the fertilization process.

All farmers stated that they had responded to the requirements of the EU Nitrate Directive in terms of maximum admissible nitrogen dosages. Farmers acknowledged that nitrogen dosages per hectare must not exceed 170 kg per year. They confirmed that those dosages had not been exceeded at the selected farms. It is worth noting that the farmers complained about the shortage of fertilizers, rather than excess availability.

As regards to their knowledge and understanding of nutrient content in different types of manure, fifteen farmers (53%) were of the opinion that there were significant differences in nutrient composition between manure from cows and pigs. Thirteen (46%) farmers considered cow manure to be better than pig slurry because it was richer in phosphorus and potassium, and furthermore that nitrogen was more concentrated in cow manure than in pig manure. In contrast, two farmers advanced the view that pig slurry was better than cow manure because it contained more nutrients, and was absorbed more easily than cow manure. Two farmers (7%) suggested that it was difficult to judge if there was any difference or not, while four (14%) farmers considered pig and cow manure to have very similar in nitrogen content. Generally, most respondents advanced the view that pig manure acidified the soil to a greater extent than cow manure.

The farmers were also invited to comment on nitrogen (N), phosphorus (P) mobility in the soil, and the significance of mobility in the process of balanced fertilization. Almost all of the subjects (86%) claimed that nitrogen (N) was more mobile in soil and that phosphorus (P) was less mobile. In contrast, P was said to remain in the soil and accumulate, and according to those respondents P could therefore be applied at any time. However, three (10%) farmers considered that everything depended on the natural condition of the soil, as well as the prevailing environmental conditions. Most of the farmers (68%) responded that N should be applied in precise dosages, because if more was applied than needed, the nutrients would be lost to the atmosphere or would percolate into watercourses. These responses demonstrate the farmers were aware that they should not apply excess nitrogen than required. Nine (32%) farmers were of the view that the type of soil played a role, whereby N became more mobile in sandy soil and was at risk of leaching. These subjects stated that these losses could be reduced through the use of catch crops. A third of respondents advocated the growing of catch crops such as lupine, phacelia and mustard to ensure N was retained in the catch crop during the winter months.

Next, the farmers were invited to evaluate some tools that may be deployed for sustainable fertilization. These tools were measures and methods either applied or designed during the term of the project. Some were new, and others had either been known or had been applied previously by the selected farmers. The tools were tested by the subjects together with their respective agricultural advisers. Each were working together to conduct the tests and study the results on the farms. These tools may be described as sustainable nutrient management tools because they help to manage a farm in a more balanced and environmentally-friendly way. During the project, the following tools or methods were used:
- soil survey,
- identifying hotspots for potential nitrogen leaching,
- the farm-gate balance,
- fertilization plan.

Table 2 shows the results of the inquiries into each farmer's experiences regarding about the use of sustainable nutrient management tools.

Table 2. The numbers given indicate the farm sizes, farmers' ages and educational backgrounds, where farmers gave a positive response[1)] to the use of tools for sustainable nutrient management and improved water quality

Ranking number	Specification	Farm size, ha		Farmers age, yr		Education	
		13–45	46–150	20–45	46–67	basic	basic plus
1	soil survey	19	9	12	16	12	16
2	fertilization plan (balance)	6	10	11	5	2	14
3	identifying hotspots for leaching (i.e. farm-walk)	7	7	8	6	3	11
4	farm-gate nutrient balance (FGB)	1	5	3	3	1	5

[1)] Either the farmer had already used the tool or had changed agricultural management activities after the advisor's visit.
Source: own study.

The soil survey emerged as most important factor for farmers, as well as wide availability and low-cost measures used in sustainable agriculture (Tab. 2). All farmers (28) interviewed attested to the usefulness of the soil surveys, which they considered to be necessary and important in order to optimize fertilizer dosages. Economic benefits were anticipated, but only

a few interviewees cited financial benefits in terms of environmental protection measures and more sustainable production methods. Only four (14%) farmers stated that they had conducted such soil surveys for the first time in response to this project.

As for the fertilization plan (balance), all respondents indicated that they had a basic idea of what such a plan entailed, but not all of them stated that they knew about the details well enough to apply it in practice. These farmers stated that the instructions were either too complicated or unfathomable, and revealed that they had often outsourced the task of developing a plan to the agricultural advisors. Only 16 of the farmers (57%) reported that they had developed and applied a fertilization plan by themselves. The rest of the study group (43%) admitted that they had encountered difficulties in understanding the task or had encountered the concept for the first time as part of the project.

One way of conducting a comprehensive analysis of all farm activities is what is known as the farm-walk, where the farmer walks through his/her farm together with the agricultural advisor. The objective is to identify hotspots for potential leaching of nutrients and to propose and agree remedial measures. Half of the farmers (14) pointed out that the farm walk conducted jointly with the advisor had elicited new and interesting information, which could be used to limit nutrient leaching on the farm and as a guide to using nutrients in a more sustainable way. The farmers stated that they regarded the input of agricultural advisors as applicable and useful to the job of running the farm. It is noteworthy that nearly 40% of the farmers reported that the farm-walk did not generate any new information. They stated that they were already sufficiently familiar with issues on their property and had all the necessary knowledge to manage the farm effectively.

The farm-gate nutrient balance (FGB) was a new tool for all farmers interviewed at the beginning of the project (2013). They had never calculated a nutrient balance for their farm prior to the project. The second round of interviews (2015) revealed that more than 80% of the farmers were able to recall details of the FGB to a lesser or greater extent. Their answers demonstrated that their knowledge on how to use the FGB was still not well established and required wider dissemination within the agricultural sector. However, six farmers (21%) revealed that they changed their farm management practices as a result of the farm-gate balance recommendations: they applied non-tillage systems and reduced applications of mineral fertilizers of NPK or just N. Another nine (32%) farmers stated that the calculation showed that their farms had a good nutrient balance and, accordingly, that they had managed their farm in a more sustainable way with respect to nutrients.

The number of farmers who responded positively to these tools used for sustainable production and improved water quality are depicted in Table 1. In general, they are ranked in terms of: 1) soil surveys; 2) fertilization plans; 3) hot spot identifications, and; 4) farm-gate balances; reflecting the farmer`s attitudes and willingness to use the tools. As would be expected, younger, educated farmers with more than a basic agricultural education were generally more positive in their appraisal of the project results. They were able to identify the value of the tools better than more poorly educated or older generation farmers, who tended to be less enthusiastic about the project. It is also noteworthy that farmers who ran larger farms were more interested in the tools, most likely because the farms were the main sources of revenues and income. It follows that farmers in this position prefer not to operate blindly. They place an added value on scientific research and attach more importance to such studies.

However, not all tools were understood and recalled in detail by the farmers involved in the project. The farm-gate balance, as well as the identification of leaching sites, proved to be particularly difficult for some. The identification of hot spots frequently proved to be too time-consuming and too intricate and detailed, according to the responses received. As for the farm-gate nutrient balance, the farmers stated that details has been presented in an overly-academic way, and also that their advisors had not appeared to have been as well prepared to collaborate with them on this issue as the farmers had expected. In general, the farmers' responses indicated that some had a problem explaining how the nutrient flow affected the balance of fertilizer components. The farm-gate balances prepared during the project were frequently misinterpreted by the farmers. To determine the factors influencing the farm-gate nutrient balance and the identification of nutrient spots on their farms, the farmers often fell back on their own intuitive skills and what would be best described as their 'common sense'.

FAMERS´ PERSPECTIVES ON SUSTAINABLE PRACTICES IN AGRICULTURE

As noted above, the farmers offered similar views on several issues, but differed widely on other issues. Government policies and EU regulations influence mainstream farmers' knowledge of the practical. At the same time, farmers exchange experiences and ideas to improve the outcomes of their efforts, particularly in smaller communities where social relationships play an important role. Here, the process of individual's knowledge development becomes complex and challenging.

The farmers surveyed were asked to identify the impact their practices and tools used might have on other farmers in the local community (neighbourhood, village) – along the lines of: Did other farmers emulate their activities? Were they interested in pro-environment practices and the idea of sustainable agriculture? The results are shown in Figure 2.

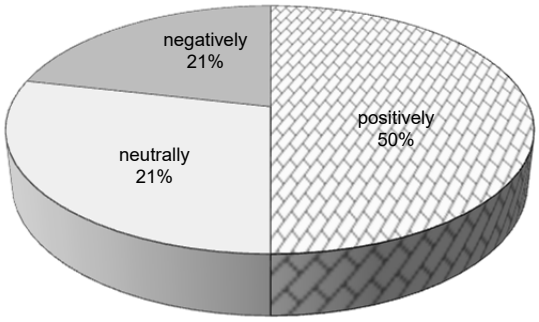

Fig. 2. The structure of respondents` answers to the question: "How pro-environmental practices are being perceived by other farmers in the neighbourhood?"; source: own study

Fourteen (50%) farmers responded that their neighbours perceived their activities positively, and replicated their management practices because they saw that something new worked well (Fig. 2). Some claimed that they had learned from each other, and had adopted the same procedures. Nine also added that farmers had mirrored other's methods of avoiding nutrient losses and preventing pollution of the environment, especially watercourses and ponds. This emulation practice also concerned the wider use of fertilization plans and nutrient balances, which were largely unknown but had since become more prevalent. A trend towards cost-effective precise fertilization could be discerned. This resulted not only in economic savings, but also in enhanced protection of the environment through minimizing nutrient losses, water eutrophication, and soil degradation.

Eight farmers (29%) said that most of their neighbours ran their farms in traditional ways and had adopted a non-committal attitude towards innovation in as much as they did not conduct soil surveys or test new fertilization techniques. This does not necessarily mean that these farms were managed in non-sustainable ways. On the contrary, these businesses are capable of being managed in harmony with nature. New tools or innovations were often implemented by younger famers and some farmers adopted more environmentally-friendly measures when they foresaw financial benefits (e.g. they had engaged in the EU's CAP programmes).

Six farmers out of 28 stated that they had formed the view that other farmers were not interested in environmental protection and sustainable practices. One respondent considered that some of his neighbours had adopted a "wasteful" approach – having extracted benefits from the fields until these resources had been exhausted.

DISCUSSION

Farmers levels of knowledge and awareness of environmental issues have an unquestionable impact on the natural world. However, farmers interviewed during this project were usually unable to volunteer accurate formulas or give authoritative explanations related to nutrient cycles on farms or nutrients behaviour in soils. In many cases (57%), the farmers interviewed took an intuitive approach to the problem of sustainable nutrient management. Older farmers (under 50-years old, 32%) predominantly drew on their long experience of farming and tacit knowledge gathered through informal channels. They had exchanged views and ideas with other farmers and agricultural advisors. In addition to the measurable benefits (income, revenue, yields), more experienced farmers perceived the environment and natural resources as important and inseparable elements of their everyday activities. On the other hand, younger farmers were mainly oriented towards short term profits, but were willing to introduce changes and implement innovations if they expected positive outcomes. They primarily gained from knowledge attained at agricultural schools or universities, and complemented this with information from the Internet or various training activities. They tended to have less experience of farming techniques but had received a more formal agricultural education than the older farmers examined in the survey group.

On the basis of this research, it should be borne in mind that farmers generally understood the importance of sustainable agriculture in terms of keeping down the use of chemical fertilisers. The main drivers for this approach tended to be high prices and a need to fulfil EU regulations in order to benefit economically. However, in our study, farmers' comments often betrayed generalised and somewhat vague notions of nutrient cycling and their responses demonstrated that their knowledge was not so developed and sophisticated when it came to furnishing the details. Their practices were very often based upon their own experiences, as not all of them had received the benefit of an academic, agricultural education. However, their own observations and experiences were usually 'in simpatico' with the concept of sustainable agriculture.

All the farmers were aware of the requirements resulting from EU regulations and directives. These regulations tightened measures and rules to ensure that agricultural production were compliant with the needs of nature. These rules contain many provisions concerning water, air and soil protection. All farmers in the EU are obliged to fulfil the cross-compliance requirements if they wish to receive full direct payments. Therefore, it should be stressed that it is not economic pressure that is the most important factor behind farmers changing perceptions and practices towards more environmental-orientated activities. There is also external pressure resulting from the law (at national and EU levels). However, legal pressure is closely linked to financial pressure, for example receiving full direct payment or subsidies from the "Agro-environmental programme" is dependent on satisfying the regulations. This study demonstrates that farmers have changed their perceptions as a result of external pressures in many cases: they have built manure pads or slurry tanks, invested in modern machinery, or have taken care of ditches. They have demonstrated an eagerness to seize the opportuni-

ty of obtaining financial support from EU programmes to make such environmentally-friendly investments. All these factors have led them to adopt more efficient farm management practices which are, in many cases, more sustainable (reducing leakage into the ground and surface water, less reliance on chemical fertilizers and greater precision in the application of such substances).

One of the benefits of this project is that the farmers have acknowledged that there are tools or measures that can be adopted to contribute to more sustainable farm management, especially in the case of the fertilization process and the improvement of nutrient management on farms. They have recognised that the implementation of these tools does not require a large financial outlay. The benefits of the FGB sheets, soil surveys and fertilization plans have been demonstrated, through the project. Farmers have identified the point that less mineral fertilizers are needed and may be applied with improved precision. Thereby, farmers may achieve similar production results but with a reduced environmental impact on soils and rivers. Applying the tools requires knowledge and awareness, as well as time to calculate dosages and conducting soil tests. Some farmers noted that their knowledge base was not sufficient to introduce new pro-environmental measures.

CONCLUSIONS

Farmers manage and control many aspects of their business, while the weather, market changes, and the law are outside their control. They face increasing EU and national-wide regulations of their activities that may be helpful or restricting. The challenge of environmental sustainability adds existing aspects to be taken into consideration in terms of planning and day-to-day activities. There are a number of external factors, e.g. availability of donor funds, agricultural policies, agricultural entities, and environmental requirements that affect the implementation of pro-environmental practices and significantly impact on a businessman's thinking processes. Such factors affect the implementation of sustainable development and determine to what degree sustainable agriculture objectives can be achieved.

Based on the studies conducted and analyses undertaken, the following conclusions are drawn.

1. Project intervention using tools to calculate farm nutrient balances and risks for nitrogen leaching on individual fields were well received, although more training is needed for a full and comprehensive assessment of the systems being applied. In addition, some of the required input data may not be readily available to farmers or among agricultural advisory agencies. This means that the full effect of such tools will be a long-term process involving both training and more studies on manure nutrient content, soil nutrient storage and the impact of farm practices on the movement of nutrients in different Polish soils in the prevailing climate conditions.
2. The advisors need to be focused not only on the short-term (operational) goals of their clients, but also on longer time perspectives including but not restricted to sustainable development goals. They should be encouraged to offer activities and events in different ways and to different timescales, so that farmers may choose what they need. The concept of sustainable agriculture needs to be particularly emphasised in such activities. Agricultural advisory institutions should be sensitive to all aspects of sustainable agriculture and offer guidance and support in all activities (training, individual visits, group communications, etc.).
3. It is extremely important to emphasize to farmers that their management activities not only impact on soils on the farm and around nearby ditches, but also affect groundwater and surface water on a larger scale. It needs to be stressed that sustainable agriculture requires a broader view and a system-wide thinking approach, not only on the farmers' side but also on the part of advisory institutions and other entities cooperating in the rural economy and agribusiness. There is a requirement for targets to be set on a coherent and common level among agencies and farmers to reduce losses, improve effectiveness and promote the recycling of nutrients alike. Farmers may be primarily guided by concrete benefits in terms of higher yields and increased subsidies while agencies also need to be sensitive to, not least, the applicable regulations.

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Zrównoważone rolnictwo: badanie percepcji i praktyk rolników w zakresie zarządzania składnikami pokarmowymi i zmniejszania ucieczki nutrientów

STRESZCZENIE

W pracy przedstawiono wybrane wyniki polsko-szwedzkiego projektu badawczego, realizowanego w latach 2013–2016, dotyczącego upowszechniania metod zmniejszania strat składników odżywczych w gospodarstwach rolnych oraz narzędzi służących zarządzaniu składnikami nawozowymi w sposób bardziej racjonalny i zrównoważony. W badaniu wzięło udział 28 rolników z dwóch województw Polski. Głównym celem niniejszego artykułu była analiza i ocena sposobów zarządzania gospodarstwem rolnym, ze szczególnym uwzględnieniem

aspektów rolnictwa zrównoważonego. Nacisk został położony przede wszystkim na zarządzanie składnikami pokarmowymi, jako jeden z najważniejszych czynników rolnictwa zrównoważonego. Analizie poddano opinie rolników na temat zależności między procesami nawożenia a zanieczyszczeniem wody, a następnie także zweryfikowano ich działania prowadzone w gospodarstwach rolnych. Istotną część analizy stanowiły wybrane narzędzia zrównoważonego zarządzania gospodarstwem rolnym, wdrożone w badanych gospodarstwach, jak również wybrane metody zmniejszania ucieczki składników pokarmowych do wód powierzchniowych. Przeprowadzone badania dają podstawy do stwierdzenia, że – mimo wzrostu świadomości rolników – nadal wielu z nich nie dysponuje specjalistyczną wiedzą w zakresie obiegu składników pokarmowych oraz bilansów składników w swoich gospodarstwach. Wiedza rolników i ich percepcja w dużej mierze bazuje na wiedzy ogólnej lub wynika z własnego doświadczenia. Dzięki wdrożonemu projektowi rolnicy uświadomili sobie istnienie nowych, bezkosztowych sposobów gospodarowania, które można wdrożyć w celu prowadzenia bardziej zrównoważonej produkcji rolnej. Nadal jednak istnieje duża potrzeba upowszechniania zrównoważonych praktyk w rolnictwie, w tym również przez agencje rolnicze i okołorolnicze, jak i instytucje doradcze, które powinny szczególnie podkreślać wagę tego zagadnienia we wszystkich swoich działaniach.

Słowa kluczowe: *nawożenie, rolnictwo zrównoważone, rolnicy, składniki pokarmowe*