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Logistics of potato cultivation in terms of reverse logistics

Logistyka uprawy ziemniaka w zakresie logistyki zwrotnej

Abstract: In the era of growing competition against Poland's agriculture from other farms in the European Union, looking for competitive advantages and optimal use of available resources is necessary. The changing market and legal environment force Polish farmers to look for new solutions that will increase production efficiency and the competitiveness of farms. The law imposes methods of achieving the development of agricultural entities, but also carries numerous limitations and restrictions in their operation. One of the basic trends observed in international and domestic law is the development of all entities in Poland based on the assumptions contained in the concept of sustainable development. Therefore, it seems reasonable to implement logistic and ecological strategies on farms in Poland growing potatoes. The article presents the basic issues related to implementing ecological concepts for Polish farms engaged in potato production and the factors determining their development.

Key words: potato cultivation, logistics, ecology, sustainable development, Polish farms

Synopsis. W dobie rosnącej konkurencji z polskim rolnictwem ze strony gospodarstw rolnych Unii Europejskiej konieczne jest poszukiwanie przewag konkurencyjnych i optymalnego wykorzystania dostępnych zasobów. Zmieniający się rynek i otoczenie prawne zmuszają polskich rolników do poszukiwania nowych rozwiązań, które zwiększą efektywność produkcji i konkurencyjność gospodarstw. Prawo narzuca metody osiągnięcia rozwoju podmiotów rolnych, ale także niesie ze sobą liczne ograniczenia i ograniczenia w ich funkcjonowaniu. Jednym z podstawowych trendów obserwowanych w prawie międzynarodowym i krajowym jest rozwój wszystkich polskich podmiotów na podstawie założeń zawartych w koncepcji zrównoważonego rozwoju. Dlatego zasadne wydaje się wdrożenie strategii logistycznych i ekologicznych w polskich gospodarstwach uprawiających ziem-

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niaki. W artykule przedstawiono podstawowe zagadnienia związane z wdrażaniem koncepcji ekologicznych w polskich gospodarstwach zajmujących się produkcją ziemniaków oraz czynniki determinujące ich rozwój.

Słowa kluczowe: uprawa ziemniaków, logistyka, ekologia, zrównoważony rozwój, polskie gospodarstwa rolne

JEL codes: Q10, Q12, Q19, Q56, R11

Introduction

In Poland, about 60% of the country's total area is used by farms, which, while conducting their basic activities, impacts not only the condition of the natural environment, but also the structure of local markets and the development of specific social behavior in a given region or even country. Every farmer is aware that apart from producing agri-food products, they are responsible for maintaining the cleanliness of the environment and its natural and landscape values for future generations [Grabczyńska 2018]. This situation applies to potato producers in Poland too.

It is often stated that Poland was, for many decades, the “potato basin”. The cultivation of potatoes in the country by the Vistula River has often been compared to the cultivation of oranges, hence, for example, the term referring to the Wielkopolska region, which was called “the Kingdom of underground oranges” [Krugielka 2021].

The good times related to potato cultivation are now behind us, as there has been a breakthrough and a general decline in the cultivation acreage of this plant from 321,000 hectares of potato cultivation in 2017 to 226,000 hectares in 2020. Such a situation results, for example, from a change in human food preferences and a change in the approach to feeding pigs. This causes concerns among many farmers about the profitability of potato production and raises the question of whether the trends in reducing the area of potatoes in Poland will continue to be maintained. Agricultural producers are looking for factors contributing to reducing the size of potato production in Poland, and above all, they are considering the nature of activities aimed at increasing the profitability of potato production.

In view of the above, it seems reasonable to answer the question of what impact can the use of known logistic solutions have on the potato production process. It is known that logistics concepts are currently undergoing a transformation in such a way that they can

Table 1. Potato cultivation acreage in Poland in 2017–2020

Tabela 1. Powierzchnia uprawy ziemniaków w Polsce w latach 2017–2020

Year	Potato cultivation area in Poland (PIORiN estimates) [ha]	Potato cultivation area in Poland [ha]
2017	–	321,000
2018	289,524	291,000
2019	284,123	303,000
2020	275,451	226,000
2021		236,000

Source: own study based on data from GUS and PIORiN.

comprehensively support the supply chains of farms in Poland, including those involved in the cultivation of potatoes.

Still, despite the changes taking place in the agri-food markets, the known and used logistic tools do not constitute the basis for planning the strategy for the functioning of farms in Poland; this also applies to those entities that grow potatoes (Figs 1 and 2). This is due, inter alia, to the fact that Polish farmers mostly carry out production based on well-known, conventional methods, which are based on known and proven supply and distribution systems. The indicated systems operate based on groups of independent wholesalers, retailers and intermediaries. This means that both potato production in Poland and the planning of individual stages of its production are based on entities that usually function as independent links that determine themselves, which are not related to each other by relations that may impose a form of cooperation. They are, at best, loosely integrated into the food logistics chain. Due to this state of affairs, farms that grow potatoes have a limited ability to control the physical flow of raw materials and final products, which in turn may make it difficult to maintain the leading share of Poland in potato production [Andrzejczyk and Rajczakowska 2020].

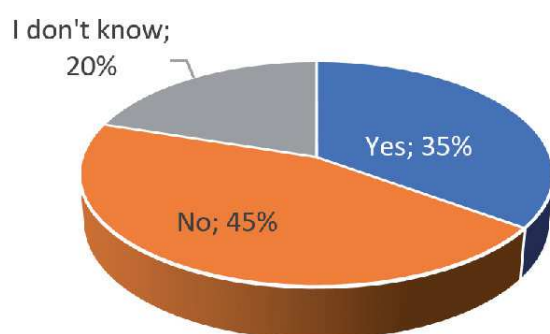


Figure 1. Share of farms using logistic tools
Rysunek 1. Udział gospodarstw korzystających z narzędzi logistycznych
Source: [Andrzejczyk and Rajczakowska 2020].

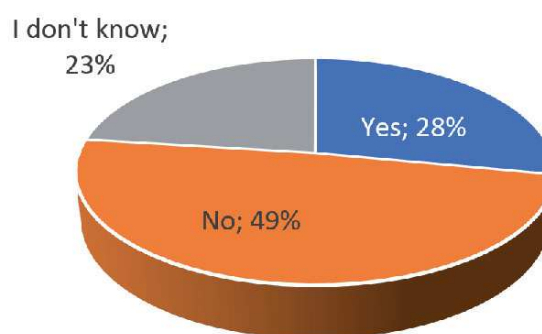


Figure 2. Share of farms using ecologicistic tools
Rysunek 2. udział gospodarstw stosujących narzędzia ekologiczne
Source: [Andrzejczyk and Rajczakowska 2020].

Therefore, the aim of the presented article is to identify the phenomenon related to the implementation of logistic concepts in the development of farms in Poland that deal with potato cultivation based on the available logistic and ecologicistic tools and to determine the current level of knowledge in potato farms for the application of these tools. The article was prepared based on the analysis of formal and legal documents and normative acts in force in the described area, as well as surveys carried out on farms located in Lower Silesia and in the Opolskie and Wielkopolskie voivodships. The research was carried out in a group of 51 farms selected by agricultural advisors cooperating with them. Their selection was purposeful (farms producing potatoes for the market).

These studies were compared with the studies carried out in 2022 for the purposes of the article prepared by Andrzejczyk and Rajczakowska [2020], entitled: Ecologistics as an integral element of the sustainable development of farms in Poland.

This study is a starting point for the next article, which will compare the described ecologicistic systems related to the functioning of farms in Poland involved in the cultivation of potatoes in the aspect of the competitiveness of Poland's agricultural industry.

Logistics and ecology as an element of potato cultivation for farms in Poland

Observing the entire nineteenth century, the following decades of the twentieth century and the first two decades of the twenty-first century, developed countries lived an increasing cult of modernity. Unfortunately, the threats and environmental disasters in the environment, which as a result of human activity, i.e., world wars, the Chernobyl nuclear reactor failure, the destruction of the biosphere after the Persian Gulf War, and recently a new conflict in Ukraine, will make society aware that the socio-economic development known to us is man-made and not safe. Therefore, based on the management of world civilization crises and the need to constantly modernize processes, it became necessary to create a development that would be sustainable, assuming respect for social, environmental and economic factors. In the literature on the subject, it is interchangeably referred to as sustainable development, in other words, eco-development, and most often sustainable development [Zarzecka 2014].

Sustainable development is in line with the assumptions of the Action Program of the Ministry of Agriculture and Rural Development for 2015–2019, which clearly outlines the actions that should be taken to equalize the standard of living of farming families and other rural residents compared to urban residents in Poland. Based on the above-mentioned assumptions, the Government of Poland is to ensure a stable situation in basic agricultural markets by creating economic processes in food chains in such a way as to enable the sustainable development of rural areas and effective land management. The above assumptions are reflected in the Strategy for Responsible Development of Polish Villages until 2020, with a perspective until 2030, as well as in other strategic documents prepared by the Ministry of Agriculture [Jurgiel 2018].

It is worth mentioning here that from 2020, the “Program for the Polish Potato”, developed by the Ministry of Agriculture and Rural Development in 2018, is a response to the needs of the entire sector of potato producers, processors and distributors. The program is a comprehensive analysis of the most important problems affecting the industry and defines actions to solve them. In line with the assumptions of the above document, an opportunity is seen for potato producers in Poland to increase the scale of cultivation and profitability of production through an increase in demand for potatoes in the domestic and international markets. The program indicates both the sources of competition for potatoes produced in Poland and the barriers to exporting this product abroad. The necessity to conduct thorough phytosanitary inspections was also indicated, which is due to the quite frequent detection of the quarantine organism *Clavibactermichiganensis* spp. *Sepedonicus* (Cms) causing potato ring rot. Based on the above-mentioned risk, in professional potato production, the obligation to plant only such propagation material that is free from bacteriosis was introduced. It is assumed that the proposals contained in the Program for the Polish Potato should help to organize the potato market in the country and increase the export of this product outside our country [Nowacki 2018].

Currently, in the age of the ongoing conflict in Ukraine, we are witnessing a collapse in the liquidity of all kinds of logistics chains, including those related to the logistics of agri-food products. An extremely important issue is the effective use of logistics in agricultural production, including that related to the cultivation of potatoes.

In connection with the above, it should be noted that the idea of integrated potato production is not to obtain a very high yield of tubers, but to produce a good potato that is safe for the health of consumers. This goal should be achieved with the lowest possible use of plant protection products (pesticides). Since integrated potato plant production is a technology that fits between conventional systems, which, unfortunately, are characterized by high inputs and costs, but thanks to this, we get relatively high yields, and purely ecological systems, in which the main goal is usually almost complete elimination of costs. Therefore, the use of synthetic protective preparations and fertilizers is abandoned, which translates into low expenditure, and this, in turn, brings lower yields [Nowacki 2020].

Considering the above, it should be clearly emphasized that the requirements of the potato market forces agricultural producers to correlate the size of the desired yields with their own needs and specific behaviors and trends of the market, which is currently not very stable. Today, it is not enough just to try to maximize the yield. Potato producers must strive to achieve the quality required by the end user. Currently, the quality of the potato is controlled at every stage of its production by inspectors, who are responsible for both the producer and the recipient. That is why it becomes so important to skillfully use logistic tools in the process of potato cultivation. This results from the need to adapt the entire potato cultivation program, which takes into account all its aspects from the moment of selecting the target customer, then the future cultivar, planting density and agrotechnical treatments, which also include measures to eliminate adverse situations, e.g. drought and potato disease, all the way to the activities related to reverse logistics, in which the maximum minimization of losses in the potato production process as well as production-related processes in this area should be achieved. All this should result in a high-quality crop that will fully meet the expectations of customers/consumers in the future.

From a logistic point of view, the production/cultivation of potatoes can be largely reduced to four stages of cultivation (Fig. 3). Each of these stages is extremely important and includes many components, which – depending on the potato variety selected by the farmer and the chosen place of cultivation – outline specific agrotechnical procedures. From the point of view of logistics, it is important that the planning process takes into account all the components that will optimize the cultivation process in terms of minimizing the formation of unwanted products/waste, which are very difficult to predict in the process of growing potatoes. This is due to, for example, the appearance of unplanned agrotechnical procedures and environmental disasters (e.g., floods, droughts, fires, plant diseases, and pests).

A big problem reported by farmers growing potatoes and other crops is the lack of enough places where farmers can utilize waste generated in the process of potato cultivation. Among others, we are talking here about all kinds of fertilizer and plant protection product packaging. Therefore, it is important to take into account reverse logistics at each stage of potato production/cultivation. Thanks to its application, we can obtain a way to minimize losses and maximize profits on a global basis. Coming back to the problem of unwanted fertilizer packaging, some farmers use them to sell specially processed soil or soil mixed with manure. This required farmers to purchase a heat sealer or bag sewing machine and learn how to properly cut the fertilizer bags. This solution, however, brought

several benefits in the form of getting rid of the disposal problem of unwanted fertilizer bags, savings in the purchase of packaging for the offered product, the appearance of a new product in the farmer's range and most importantly, improvement of the image as an ecological unit.

Mentioning the stages of potato production/cultivation, it should be noted that this process lasts all year round, even in winter. When the potato is not cultivated, it is stored, and in the early spring, we prepare its cultivation by preparing seed potatoes. As can be seen in Figure 3, the process of potato cultivation starts at the beginning of spring (it can also be assumed that the beginning of potato cultivation takes place in the fall. This is due to the preparation of the field during this period using appropriate agrotechnical measures. Potato cultivation follows a cycle of four stages, starting with stage I). Below is a simplified process for growing a potato [Lutomirska 2008].

1. The first stage requires a series of agrotechnical treatments to prepare the potato growing area, often starting with collecting the forecrop, covering its effects, leveling the surface, collecting stones, and proper fertilization. During these treatments, we also prepare and plant seed potatoes for cultivation. After these treatments, we move on to the planting process, which, depending on the type of potato and its intended use, requires selecting the appropriate technology. After the potato has been planted, the level of weed infestation should be monitored.
2. Stage II requires appropriate agrotechnical measures in the form of mechanical removal of weed infestation and possible treatments against diseases and pests. Nowadays, irrigation of arable lands is becoming extremely important due to the occurrence of droughts.

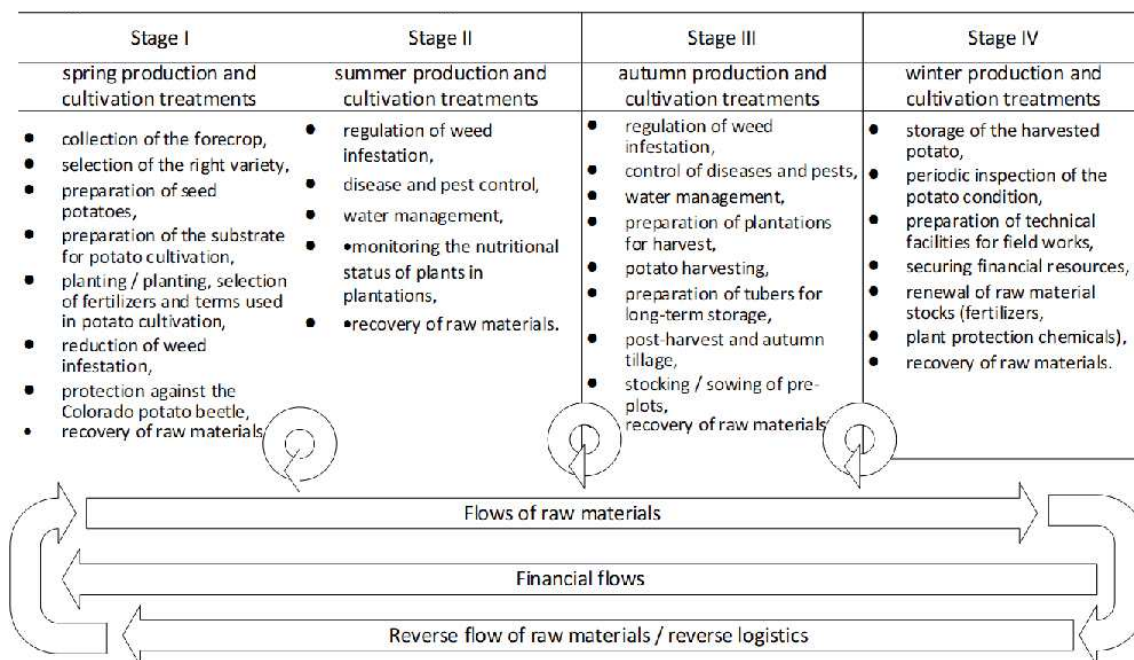


Figure 3. Stages of potato production/cultivation in terms of logistics
Rysunek 3. Etapy produkcji/uprawy ziemniaka w aspekcie logistycznym

Source: own study.

3. Stage III contains the same components as the second stage, supplemented with preparations for digging up potatoes and harvesting them from the field. When harvesting potatoes, work should be carried out in such a way that as few potato tubers as possible are damaged. After the harvest, the raw materials should be sorted according to quality and purpose. At this point, it is worth mentioning the basic purpose of potatoes. The simplest division of potato production divides it by intended use, i.e., for own and commercial purposes. The second division, very common in the industry, classifies potato production according to its use. In this category, potatoes are divided into: potatoes for direct consumption, potatoes for processing, potatoes for starch production, and potatoes for the production of seed potatoes. Each type of potato has specific parameters that should be borne in mind when selecting the crop type, cultivating it and assessing the harvested crop. These parameters are summarized in Table 2.

Table 2. The expected parameters of the potato according to its intended use
Tabela 2. Oczekiwane parametry ziemniaka w zależności od jego przeznaczenia

Destiny of the potato	Description of the requirements
Potatoes intended for direct consumption	The consistency, mealiness, moisture and structure of the flesh are determined according to four types of use: type A – salad, type B – general use, type C – mealy, and type D – very mealy.
Potatoes for processing	Potatoes intended for processing should be of even shape, standard size and quality from one end of the tuber to the other. For french fries and crisps, a high dry matter content in the tubers is necessary to achieve the desired frying color. Standard color charts are used by processors to achieve frying color stability. In the past, potato contracts started with a requirement of 18% dry weight in tubers as a minimum for processing into crisps and french fries. Nowadays, potatoes with a dry matter content of 20–25% are sought. Some sugars – especially reducing sugars – must be low; otherwise, the fries or crisps will start to darken during frying. Agreements usually specify an acceptable amount of reducing sugars. For french fries, these values are usually in the range of 0.25–0.5%, while for crisps, the optimal content is 0.05–0.15%, and the maximum allowable is 0.3% of the fresh weight.
Production of starch	Tubers containing more than 13 % starch are recommended. The higher the starch content, the less waste from its production. Potato tubers contain starch granules of very different sizes (0.4–4.0 compared to 0.2–1.6 in cereals) and a high phosphate content. The quality of the starch affects the final product quality, especially its viscosity. The varieties that meet the requirements of starch potatoes are culinary varieties C and D – floury with a long growing season.
Production of seed potatoes	Potatoes grown for seed potatoes should produce tubers of a uniform, small size – usually 30–60 mm. It is important that the plants develop as many tubers as possible.

Source: prepared on the basis of [Lutomirska 2008, Wymagania na rynku...].

4. Stage IV is based on the preparation of a new production cycle based on the effects obtained in the course of harvesting crops and resources, as well as on the basis of forecasted profits. At this stage, the obtained effects should be carefully assessed

against the planned ones and compared with the behavior of the potato market. It is necessary to assess the potato market's current and planned economic situation. At this stage, we are also planning new investments in this area and agrotechnical activities for the new season.

Bearing in mind the above, it should be noted that modern logistics concepts that comprehensively support supply chains consist of farms and other entities that support them. These systems are built of independent groups of wholesalers, retailers and intermediaries [Wajszczuk 2001, Kuboń 2008].

This means that these entities, in most cases, function as independent links that are only loosely related to the logistic food chain. This applies to the entire agricultural system in Poland as well as to Polish farmers growing potatoes. Due to this situation, these farms have a limited ability to control the physical flow of raw materials and final products, which has been illustrated by the figure presented below, Figure 4 [Andrzejczyk and Rajczakowska 2020].

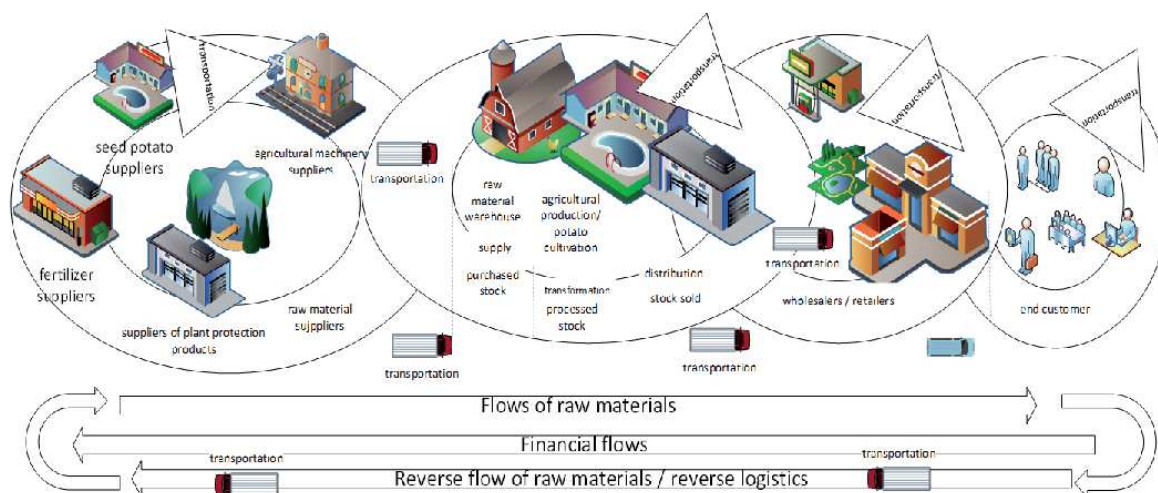


Figure 4. Logistic chain model for potato production/cultivation

Rysunek 4. Model łańcucha logistycznego produkcji/uprawy ziemniaków

Source: own study based on: [Andrzejczyk and Rajczakowska 2020].

Logistics, ecologistics and the functioning of farms cultivating potatoes in Poland – present situation

In order to achieve the intended goal of the article, in selected groups of farms, research was carried out on a sample of 51 entities located in the region of southern Poland. Their selection was purposeful (farms producing potatoes for the market), chosen by agricultural advisors cooperating with them.

The research aimed to determine the current potential of using logistic concepts and related them with a particular emphasis on the ecologicistic concepts in these farms.

Based on the logistic concepts presented, the objective of the study related to the position of ecologistics in the integrated logistic chains of agricultural products produced on Polish farms. It was carried out using the methods of analysis and criticism of the

literature and logical inference based on the obtained results of research carried out on a sample of Polish farms growing potatoes, which were divided according to the criterion of the size of the cultivated land (Fig. 5). The largest group of researched farms were entities using from 5 to 10 hectares, then farms with an area of 10 to 20 hectares. Both these groups together accounted for almost 56.9 % of the examined objects.

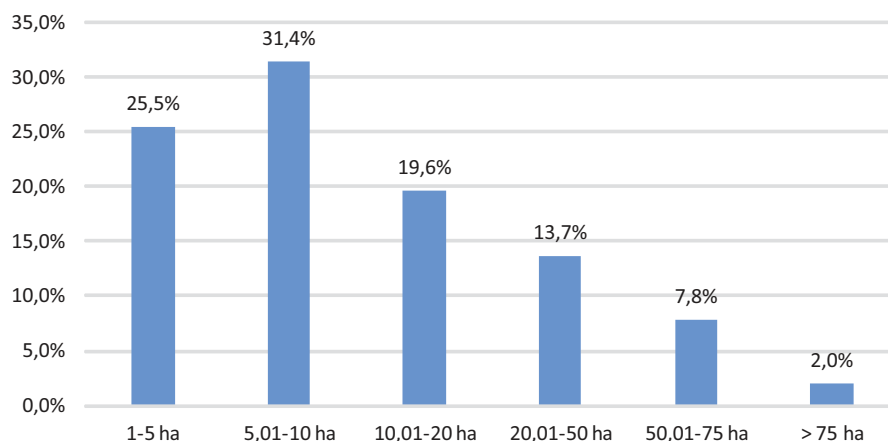


Figure 5. The size of the researched potato farms

Rysunek 5. Wielkość badanych gospodarstw uprawiających ziemniaki

Source: own study.

It should be noted that among the farmers who responded, as many as 61% believe that they use logistic tools in managing their farms (Figs 6 and 7). Comparing this with the research from 2020, it can be noticed that the use of the indicated logistic tools increased by 26 p.p. (Fig. 1). A similar increase was recorded in the use of ecologicistic tools by farms in Poland, as the tools available in the ecologicistic concept are already used by 47 % of the surveyed farms, which constitutes an increase of 19%.

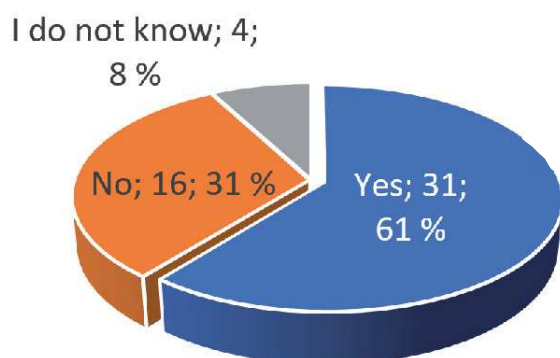


Figure 6. Share of potato farms using logistic tools

Rysunek 6. Udział gospodarstw ziemniaczanych korzystających z narzędzi logistycznych

Source: own study.

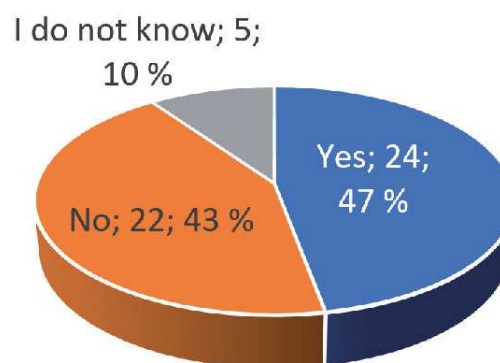


Figure 7. Share of potato farms using ecologicistic tools

Rysunek 7. Udział gospodarstw ziemniaczanych stosujących narzędzia ekologiczne

Source: own study.

Based on the conducted research, it can be observed that there is still a tendency for large farms to more often use logistic and ecologicistic solutions than smaller ones (compare Tables 3, 4 and the data contained in the scientific study: [Andrzejczyk and Rajczakowska 2020]). This situation is most often due to the fact that small farms are family-oriented (often, they produce only for their own needs), which is much more difficult to adapt to market requirements than in the case of large business entities. Therefore, such farms are much more difficult to develop. In the case of large farms, their continuous development can be observed. In order to survive in the market, these entities must constantly adapt to their conditions and limitations in such a way that leads to integrated supply chains.

Table 3. Share of potato farms using logistic tools – studies of the year 2020

Tabela 3. Udział gospodarstw ziemniaczanych korzystających z narzędzi logistycznych – badania za 2020 rok

Does your farm use logistic tools?	The size of the farm [%]						total
	1–5 ha	5.01–10 ha	10.01–20 ha	20.01–50 ha	50.01–75 ha	more than 75.01 ha	
Yes	46.15	62.50	60.00	71.43	75.00	100.00	60.78
No	38.46	31.25	30.00	28.57	25.00	0.00	31.37
I don't know	15.38	6.25	10.00	0.00	0.00	0.00	7.84
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: own study.

Table 4. Share of potato farms using ecologicistic tools – studies of the year 2022

Tabela 4. Udział gospodarstw ziemniaczanych stosujących narzędzia ekologiczne – badania za 2022 rok

Does your farm use ecologicistic tools?	The size of the farm [%]						total
	1–5 ha	5.01–10 ha	10.01–20 ha	20.01–50 ha	50.01–75 ha	more than 75.01 ha	
Yes	30.77	56.25	40.00	57.14	50.00	100.00	47.06
No	53.85	31.25	50.00	42.86	50.00	0.00	43.14
I don't know	15.38	12.50	10.00	0.00	0.00	0.00	9.80
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: own study.

From Table 5, it can be concluded that potato farms in Poland are mostly developing, but it is not an easy and problem-free process, and above all, it is not a process applicable to all entities. Unfortunately, almost 37% of them report problems in this area, and 6% are unable to define themselves [Andrzejczyk and Rajczakowska 2020]. It should be noted that, compared to the research from 2020, there is a slight change in favor of the assessment of development and an increase in awareness of their economic situation because much fewer respondents declare ignorance in this regard, i.e., 6%, and in 2020, this ratio was 12% (Figs 8 and 9.).

Table 5. Share of potato cultivating farms which recorded development in the last 10 years

Tabela 5. Tabela 5. Udział gospodarstw zajmujących się uprawą ziemniaków, które odnotowały rozwój w ostatnich 10 latach

Has your farm been developing in the last 10 years?	The size of the farm [%]						
	1–5 ha	5.01–10 ha	10.01–20 ha	20.01–50 ha	50.01–75 ha	more than 75.01 ha	total
Yes	46.15	62.50	60.00	57.14	50.00	100.00	56.86
No	38.46	31.25	40.00	42.86	50.00	0.00	37.25
I don't know	15.38	6.25	0.00	0.00	0.00	0.00	5.88
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: own study.

I do not know; 3;

6 %

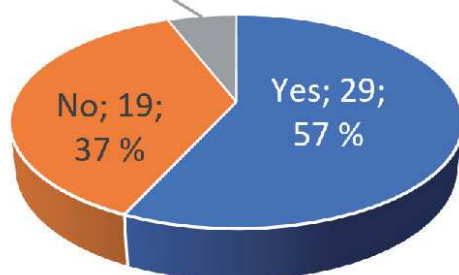


Figure 8. Share of farms that recorded development in the last 10 years – research in 2022

Rysunek 8. Udział gospodarstw, które odnotowały rozwój w ciągu ostatnich 10 lat – badania z 2022 roku

Source: own study.

I do not know;

12; 12 %

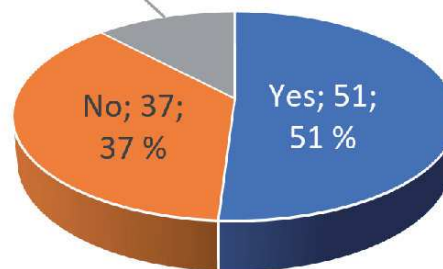


Figure 9. Share of farms that recorded development in the last 10 years – research in 2020

Rysunek 9. Udział gospodarstw, które odnotowały rozwój w ciągu ostatnich 10 lat – badania z 2020 roku

Source: [Andrzejczyk and Rajczakowska 2020].

Summary

The paper summarizes the results of pilot studies assessing the degree of applying logistics strategies in selected Polish farms based on the concept of sustainable development and with an emphasis on the ecologicistic concept compared with similar studies in this area carried out in potato farms in Poland. Based on the conducted literature analyses and surveys, it can be concluded that Polish farmers are more and more willing to use the tools included in logistic and ecologicistic concepts. It should be noted here that ecologicistic tools are even much less used in Poland's agriculture. This is due to the lack of appropriate infrastructure in this area and properly constructed legal norms.

It can also be concluded that the process of potato cultivation with the practical use of logistic and ecologicistic issues contributes to the increase in potato productivity on these farms and the minimization of losses related to wastage. Thanks to the use of the aforementioned tools, potato farms in Poland have a wider possibility of creating their

development on concepts that take into account sustainable development. With currently dynamically changing markets, including those related to potatoes, Polish farms are still a leading producer and may still be one.

For future potato production in the 21st century, the recipients of this product will continue to set new requirements in terms of its quality, quantity and purpose, the number of individual processes carried out on the potato farms, as well as at individual stages related to the supply and distribution of this product. Changes will also take place in the social, economic and, above all, ecologicistic dimensions. Today, a conscious farmer who grows potatoes is a Polish farmer who knows that conducting agricultural activity will be subject to constant changes. Today, a winning farmer is the one who has constant access to information and modern technologies that allow the processing of the acquired knowledge in such a way as to integrate their agricultural production in both local and global logistics chains, thus constituting an important link in the integrated logistics network [Andrzejczyk and Rajczakowska 2020].

The use of logistic tools in potato farms in Poland has already become a fact. On the other hand, the use of ecologicistic tools will be forced in the near future by the ever-growing pressure of society in this regard. Today's consumer groups expect increased safety in the flow of food products along the entire supply chain. Currently, the recipient of agricultural products is more and more educated, and thus is aware of their needs and ways of satisfying them. A farmer also has knowledge about the risks in the production, distribution and storage process. In connection with the above, today's recipient of the product requires agricultural entities growing potatoes and their partners to maintain full transparency in the course of the aforementioned processes related to the purchase of a finished product in the form of a potato. This forces the implementation of the principles of logistics, ecologicistics and sustainable development. This situation will apply to both small potato farms, which should already assume the independent implementation of the concepts in their development strategies, and large farms that have already implemented certain logistic concepts that will require review and adaptation to new realities.

Summarizing the considerations raised in this study, it is stated that potato farms in Poland are required to form larger producer groups that will be able to meet the challenges ahead. Only large producer groups will be treated as reliable and responsible entities that will be suppliers of products for both large enterprises and individual consumers, thus becoming business partners of the 21st century.

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