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CONDITIONS OF POLISH SOVEREIGNTY WITH REGARD TO PLANT FEED PROTEIN SUPPLY

Key words: food security, protein self-sufficiency, globalisation, cost-effectiveness of substitution, European Green Deal

ABSTRACT. The study aimed to identify the main factors contributing to the limited physical self-sufficiency of the country in terms of plant protein supply for feed purposes, as well as to indicate the directions of possible actions leading to the improvement of this situation in Poland. Selected methods of descriptive statistics, substitution calculation and descriptive and comparative analysis were used to compile the numerical data. In the summary, it is concluded that the main market factor contributing to the reduction of the country's physical self-sufficiency in plant protein is the progressive globalisation processes that are seen in Poland both in the sphere of feed production and in pig rearing. It was also recognised that European Union policy measures such as the "Agricultural Green Deal" strategy could result in an increase in the volume of domestically produced protein crops in Poland, which would increase the country's security of supply of plant protein for feed purposes. It was also stated that in view of the ineffectiveness of market-based measures in developing protein crop production in the country, the government could intervene to introduce a plant protein indicator target to activate the market for this raw material.

INTRODUCTION

The challenging situation for the food commodities market caused by the Russian-Ukrainian war makes ensuring food security a particularly important task in today's world. Despite the currently relatively good situation of the country in terms of production levels of agriculture and foodstuffs, the impact of the events of recent months in Ukraine on the global food market and, above all, the difficulties in exporting cereals from that country, are resulting in declining global food stocks. The consequent rise in food prices contributes significantly to higher inflation levels and high market uncertainty. This has resulted in both Poland and the European Union facing challenges related to the problem

of food security, with self-sufficiency in terms of plant protein supplies for feed and food purposes at its core. There is no consensus in the literature on the definition of food security and the methods of measuring it are also ambiguous, which raises problems in assessing the issue [Coates 2013]. Among the various interpretations, the essence of food security is most clearly presented by a definition that points to three dimensions of the problem. The first relates to disposability, i.e. having sufficient amounts of food available for the entire population to sustain human life. The second dimension of food security is its availability regardless of economic fluctuations, the country's climatic conditions or its foreign policy. The third dimension is food adequacy in the sense of well-balanced dietary intake [Lacey, Busch 1984, Obiedzińska 2016]. However, it is widely recognised that the most important conditions for food security are the physical and economic availability of food. Physical availability refers to the guarantee that the national economy will cover at least the minimum physiological needs of the population for food.

The economic availability of food, on the other hand, indicates the level of financial resources that make it possible to purchase enough food to cover the needs of all social groups in the country [Marzęda-Młynarska 2014, Michalczyk 2019]. At the core of any country's food security problem, however, is the adequate availability of resources of plant protein for feed purposes which is an essential component of food production. Currently, soybean meal imported from the American continent, mainly from Argentina, is the main source of feed vegetable protein for food production in Poland. This raw material accounts for 70% of the country's protein balance. The remaining portion is provided by domestic production of plant protein, i.e. rapeseed meal and legumes. The situation is slightly more favourable with those EU countries where dependence on imports of American soybean meal is at the level of 40% of demand [Jerzak et al. 2020, AMIS 2021]. These data indicate that there is currently a state of economic availability of plant protein in both Poland and the EU countries, as countries have sufficient financial resources to purchase this raw material outside the EU. However, in the event of a financial or political crisis, or natural disaster on the American continent, soybean meal supplies would be at risk. As a consequence, the country's physical food security would also be threatened, as the national resources of plant protein for feed purposes are markedly insufficient. This problem is also recognised by participants in the plant protein market, as shown by research within the Ministry of Agriculture and Rural Development's Multi-Annual Programme implemented from 2016 to 2020.

MATERIAL AND METHODS

Therefore, this article aims to identify the main factors contributing to the country's limited physical self-sufficiency in plant protein supply for feed purposes, as well as to point out the directions of possible efforts to improve this situation in Poland.

The paper assesses the determinants of the development of domestic plant protein production and its availability on the market. The impact of globalisation processes on the domestic feed protein market and the issue of substitutability of domestic protein crops are also analysed. Possible policy measures to improve the existing situation in this area are also pointed out, such as the importance of sustainable development in agriculture and the Green Deal agricultural strategy. Possible government interventions to meet specific indicator targets in the production and use of domestic plant protein for feed purposes are included as well.

The results of 10 years of research under the Ministry of Agriculture and Rural Development's Multi-Annual Programme 2011-2015 and 2016-2020 were used to achieve the aim. Data from publications of Statistics Poland and other scientific literature were additionally taken into account. Selected methods of descriptive statistics were used to analyse the figures, as well as substitution calculation and descriptive and comparative analysis.

LIMITATIONS FOR NATIONAL SELF-SUFFICIENCY WITH REGARD TO THE SUPPLY OF PLANT PROTEIN FOR FEED

Native plants rich in protein belong to the family of broad-seed legumes (peas, field beans, soybeans, lupins). Traditionally have been used by local small and medium-sized businesses producing feed to be used by local farmers. However, in the last decade, there has been a high concentration of feed production in multinational corporations, which has also had a negative impact on the volume of production of domestic protein-rich native crops. Between 2002 and 2019, large enterprises (over 250 employees), mainly transnational corporations, increased their share of the feed market from 11.8% to 55.8% (Figure 1). The observed progressive globalisation of the feed market in Poland is additionally linked to the intensive concentration of livestock production, in particular pig production, which, alongside poultry production, uses the largest amount of plant proteins.

In pig production, there has been a reduction in the number of herds by 33,291 facilities over a period of one year (2021). As a consequence, farms with herds of less than 100 pigs accounted for 81.4% of this production structure, while their commercial production accounted for only 14% of the national herd [Farmer 2022]. This means that 18.5% of the farms are responsible for the production of about 86% of the Polish herd (Table 1).

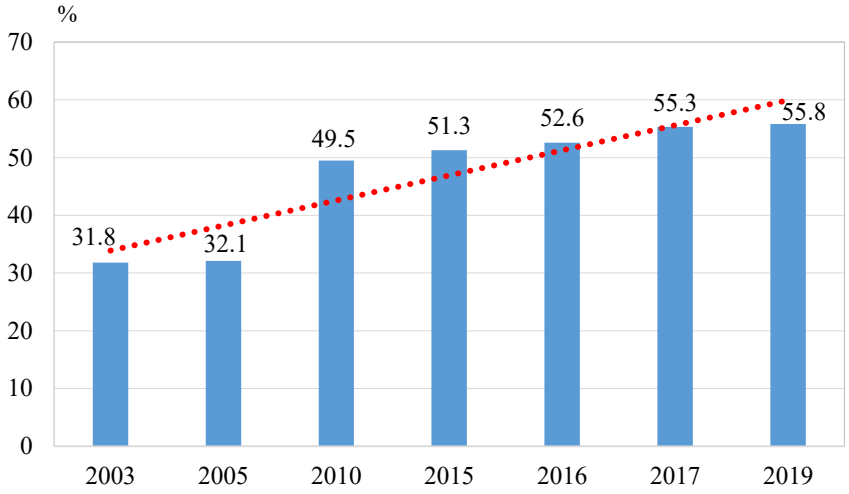

Figure 1. The share of large enterprises (more than 250 employees) producing livestock feed in total sales revenue from 2003 to 2019

Source: own study based on data from Statistics Poland [CSO 2015-2022]

Table 1. Size of pig herds in Poland

Size of the pig herd [number of pigs]	Herds as at January 2021		Herds as at January 2022		Decline in the number of herds
	number	%	number	%	%
1-5	24,384	23	11,577	16.5	-52.5
6-10	13,737	13.2	8,344	11.8	-39.2
11-15	11,101	10.7	7,829	11.1	-29.4
16-20	7,142	6.8	5,102	7.2	-28.5
21-30	10,602	10.2	7,708	10.9	-27.2
31-40	6 ,447	6.2	4,932	7.0	-23.4
41-50	4,454	4.3	3,423	4.8	-22.47
51-100	10,411	10.0	8,238	11.7	-20.87
101-1,000	13,285	12.8	11,072	15.7	-16.4
Over 1,000	2,076	0.002	1,952	2.7	-5.9
Total	103,448	-	70,157	-	-33,291

Source: own study based on CSO data and [Farmer 2022, Ceny Rolnicze 2022]

A significant proportion of these farms have ownership-related or contractual ties to feed corporations forming rigid marketing channels for both feed and live-pig marketing. These operators use new livestock production technologies based on feeding high-quality soybean protein to the exclusion of domestic protein crops. This has led to the marginalisation of the domestic vegetable protein feed market and thus to the country's dependence on imports of this raw material from the American continent, mainly from Argentina (70%). The level of globalisation of the domestic feed industry was assessed using the method developed by Piotr Chechelski [2008] based on the share of sales revenues of multinational feed producers in the domestic feed market. It was found that the current domestic market for vegetable protein, which is so important for the production of animal feed and further for animal protein, which is the basis of human nutrition, is highly globalised at 55.8% [Śmiglak-Krajewska et al. 2019]. This situation means that there is little demand in the domestic market for domestic protein crops from the feed industry, which in turn leads to disinterest on the part of agricultural producers in this production both for commodities and feed.

However, it could be considered that producers of, for example, pig livestock with a certain acreage of arable land as feed area could be interested in producing protein crops cheaper than soybean meal for their own needs. After all, every livestock farm dedicates a certain area of arable land to growing fodder crops such as triticale. Some of this area could be used to grow domestic protein crops, e.g. native soybean or other leguminous crops that provide a substitute production for imported soybean meal. However, research from the Multi-Annual Programme shows that this is not the case and livestock farms buy soybean meal or soybean meal-based protein concentrates as a source of protein within the so-called supplementary feed area. This is because in deciding to grow soybean or other leguminous crops, farmers allocate a specific area of land for this purpose and expect to obtain a certain amount of their own protein feed (approx. 2-2.5 t of soybean or other leguminous crops). At the same time, they lose the opportunity to grow feed grains there, the yield of which is higher and more stable (e.g. triticale 6-9 t). There is, of course, an economic calculation behind this decision. In an attempt to justify this, the cost-effectiveness of substituting a typical feed cereal such as triticale with native protein crops such as peas, field beans or domestic soybean was calculated, which is a method somewhat forgotten in agricultural economics. For this purpose, the rate of substitution of the indicated products was compared with the inverse of their price relationship[1] [Heady 1967].

[1] Earl O. Heady's substitution cost-effectiveness calculation: $\frac{\Delta S}{\Delta Z} > \frac{Cz}{Cs}$, where – ΔS increase in legume production, Cs – legume price, ΔZ – triticale production loss, Cz – price of triticale.

On the basis of a cost-effectiveness calculation of substitution of triticale with domestic soybean, it was found that, in particular years and at the prices prevailing at that time, it was only profitable to substitute the same area of triticale for native soybean in 2018 when the rate of substitution of these crops was slightly higher than the inverse relationship between the prices of these products. In the remaining years under review, such a substitution was economically unviable (Table 2).

For substitution of triticale with pea cultivation, the rate of substitution was less than the inverse relationship between the prices of these products throughout the entire period under review. This indicates that such a substitution is not cost-effective.

Table 2. Cost-effectiveness calculation for substituting triticale with domestic soybean

Year	Yield [t/ha]		Price [PLN/t]		Substitution rate soybean/triticale		Price relationship triticale/soybean
	soybean	triticale	soybean	triticale			
2021	3.54	9.44	2,400	1,149.5	0.3750	<	0.4789
2020	3.19	9.41	1,500	586.0	0.3390	<	0.3906
2019	2.68	8.99	1,400	680.0	0.2981	<	0.4857
2018	3.73	8.35	1,600	660.6	0.4467	>	0.4129
2017	3.44	9.86	1,500	583.4	0.3489	<	0.3889
2016	3.11	8.64	1,450	571.9	0.3600	<	0.3944
2015	1.93	9.66	1,400	562.3	0.1998	<	0.4016

Source: compiled on the basis of [CSO, COBORU, Sobczyński 2020]

Table 3. Cost-effectiveness calculation for substituting triticale with peas in 2016-2021

Year	Yield [t/ha]		Price [PLN/t]		Soybean/triticale substitution rate		Price relationship triticale/soybean
	peas	triticale	peas	triticale			
2021	2.16	9.44	1,087.0	1149.5	0.2288	<	1.0574
2020	2.00	9.41	957.0	586.0	0.2125	<	0.6123
2019	1.72	8.99	945.0	680.0	0.1913	<	0.7127
2018	1.59	8.35	866.0	660.0	0.1904	<	0.7621
2017	2.13	9.86	756.0	583.0	0.2160	<	0.7711
2016	1.90	8.64	830.0	571.0	0.2199	<	0.6879
2015	1.68	9.66	808.0	562.3	0.1739	<	0.6955

Source: own study based on CSO data

A similar situation occurred in the case of an attempt to substitute triticale production with field beans, where the substitution rates for these products in all the years under review showed a lower value than the inverse relationship between their prices, which also indicates the cost-ineffectiveness of substituting triticale production with field beans (Table 4). As can be seen from the above analysis, the current situation in the protein feed raw material market is not conducive to the decision to engage in the domestic production of protein-rich raw materials.

In general, it can be considered that the primary market factor directly influencing a country's level of self-sufficiency in plant fooder protein is globalisation processes. In Poland, they have led to the dominance of multinational corporations in the feed market in both feed production and pig rearing. It is clear that in their operations, these companies are motivated solely by economic calculation. For this reason, they use some specific feed production technologies based on imported soybean meal, as well as technologies for their use in livestock corporations that are also dominant in the pork market. This situation has led to the extreme marginalisation of the use of domestic plant protein sources, which has resulted in a drastic reduction in the production of native legumes these crops. Indeed, the lack of demand for domestic protein crops on the part of the feed industry has also resulted in a significant reduction in the supply of these pulses. In addition, the cost-effectiveness calculation for substituting feed grains with domestic protein crops has shown the unprofitability of such substitution. For this reason, farmers grow fodder cereals as part of their main feed area, but make up for the protein shortfall with protein from imported soybean meal as part of the so-called supplementary feed area. These conditions, therefore, result in farmers not being interested in growing domestic protein crops.

Table 4. Cost-effectiveness calculation for substituting triticale with field beans

Year	Yield [t/ha]		Price [PLN/t]		Soybean/triticale substitution rate		Price relationship triticale/soybean
	field beans	triticale	field beans	triticale			
2021	2.70	9.44	1,149.5	890.0	0.2860	<	1.0574
2020	2.80	9.41	1,220	586.0	0.2975	<	0.4803
2019	2.37	8.99	866	680.0	0.2636	<	0.7852
2018	2.94	8.35	788	660.0	0.3520	<	0.8375
2017	2.68	9.86	671	583.0	0.2718	<	0.8688
2016	2.58	8.64	639	571.0	0.2986	<	0.8935
2015	2.46	9.66	723	562.3	0.2546	<	0.7777

Source: own study based on CSO and COBORU

MEASURES TO IMPROVE THE COUNTRY'S PROTEIN SELF-SUFFICIENCY

Measures are currently being introduced at both European Union and national level to encourage the demand and supply side of the plant protein market alike to make better use of the domestic resources of this raw material. One of the oldest of these measures, with environmental protection at its core, but which can also have a positive impact on the development of domestic protein crops and thus on self-sufficiency in plant protein production, is the agricultural sustainability strategy. A definition formulated in a UN report in 1987 states that sustainability is meeting the needs of the present without depriving future generations of the opportunity to meet their needs. However, agricultural sustainability is an ambiguous and multifaceted concept. Thirty years after its principles were introduced at the World Commission on Environment and Development (1991), it has unfortunately not been possible to change development practices sufficiently for stopping environmental degradation. Therefore, when talking about sustainability in agriculture, it would be necessary at the outset to define what is being made sustainable and in relation to what. In the case of agriculture, sustainability should consist of a production system in which the ecological footprint is absorbed and neutralised by the environment. Working towards such a state would require either extensification of agricultural production or the use of very expensive technology to treat environmental pollution resulting from agricultural activities to a level that the environment can cope with. Neither of these approaches is currently accepted for economic reasons. In addition, the achievement of sustainability entails many problems, which has resulted in some researchers considering it to be in part a fiction, an illusion or a utopia [Szumski 2008]. Hence, sustainability in relation to agriculture, despite the introduction of indicators to determine the level of sustainability [Matuszak 2013], is still defined ambiguously and in very general terms. According to the Association of Sustainable Agriculture in Poland "ASAP", sustainable agriculture is the effective production of safe, high-quality food in a way that protects and improves the environment, social and economic conditions of the farmer and local communities. Such a definition is wishful thinking and has no practical consequences in terms of environmental improvement and the development of domestic protein sources. The 2023-2027 CAP reform, on the other hand, targets farm profitability and income, as well as more effective implementation of policies concerning the environment, climate and sustainable rural development. Among specific objectives, "supporting viable farm income and resilience across the Union to enhance food security" is listed as the first one. In order to achieve its objectives, the European Commission is taking various measures and, among others, has adopted a strategy referred to as the European Green Deal, as well as the Farm to Fork and Biodiversity strategies. The aim of the Farm to Fork strategy is to create a fair, healthy and

environmentally-friendly food system. The Farm to Fork strategy assumes that 25% of the agricultural land will be managed under organic farming by 2030. The use of mineral fertilisers will be reduced by 20%, the use of pesticides by 50%, and the sale of antibiotics used in animal husbandry by 50%. These strategies propose specific objectives which, however, are not yet binding and do not impose any obligations on countries, individual industries or farms. Turning these proposed strategies into actual law can only take place in the Common Agricultural Policy (CAP), the new version of which will be in force from 2023 [Jakubowska-Lorentz 2020]. However, the implementation of the proposed principles of this new strategy into agricultural practice will have a significant impact on both crop yields and farm profitability. In fact, available research indicates that the current legume crop area of 250,000 ha allows mineral nitrogen fertilisation in the pure component to be reduced for succeeding crops by approximately 16,875 tonnes. This represents a savings value of PLN 22,106,250 (at 2021 prices). An increase in the area of crops to 500,000 ha, i.e. an area guaranteeing the country's security in terms of plant protein supplies, makes it possible to reduce mineral nitrogen fertilisation in pure components by 33,750 tonnes, which amounts to PLN 44,212,500 (calculated at 2021 prices) [Jerzak 2021]. Thus, the introduction of the European Green Deal and the Farm to Fork strategies could act as a catalyst for the production of domestic protein crops due to the possibility of partially compensating for restrictions in mineral fertilisation with nitrogen from these very crops. This will obviously improve the country's protein balance.

The issue of food security and the country's protein self-sufficiency is a priority for every government. With the market for domestic protein crops so heavily marginalised, trying to achieve self-sufficiency in this raw material by relying solely on market laws seems rather illusory. However, this is such an important issue that one should consider whether economic reasons should play a major role. Should food security not be treated on a par with, for example, energy security, which must be ensured regardless of the costs involved? Based on this assumption, the government, in fulfilment of its primary duty, can take certain incidental intervention measures in the plant protein market in order to stimulate and activate the domestic plant protein market. One of the possible actions to achieve the desired goal is for the government to decide to introduce an "indicator target" for domestic plant protein in feed products. This is an already proven form of interventionism in the rapeseed market for the production of biofuels and therefore offers substantial potential for success. The plant protein indicator target is a concept understood as the amount of domestic plant protein output that will ensure the food security of the country's population. It will therefore be an indicator of the necessary minimum amount of domestic plant protein that feed producers would be required to use in the products they manufacture. This instrument of government intervention, in the case of vegetable protein, could result in a gradual reduction in the use of imported soybean meal in feed

production and an increase in the proportion of protein from domestic protein raw materials. It is therefore a form of forced market demand at the expense of a slight change in the formulation of feed products that could trigger an increase in production and an increased supply of domestic proteins on the market. Due to the extreme marginalisation of domestic legumes on the market, exclusively market-based measures have proved ineffective, hence the solution proposed in the results of the Ministry of Agriculture and Rural Development's Multi-Annual Programme study. So far, however, due to strong resistance from the market-dominant feed corporations, the government has not decided to bring this solution into practice.

CONCLUSIONS

1. The main market factor contributing to the limitation of the country's self-sufficiency in fodder plant protein is the progressive globalisation processes, which in Poland are observed both in the sphere of feed production and in pig rearing. The feed production technologies used in this area, which are based on imported soybean meal, have led to the extreme marginalisation of the use of domestic protein sources, resulting in a drastic reduction in the production of these crops.
2. A cost-effectiveness calculation for substituting fodder cereals with selected domestic protein crops has shown the unprofitability of such a substitution, so farmers grow fodder cereals as part of their main fodder area, while making up the protein shortfall with the so-called feed area with additional protein from imported soybean meal and are not interested in growing domestic protein crops in these circumstances.
3. Restrictions on the use of mineral fertilisers included in the Agricultural Green Deal strategy have the potential to increase the volume of production of domestic protein crops in Poland. This will contribute to balancing the demand for vegetable feed protein with domestic raw materials and, at the same time, improve the country's physical security in the supply of vegetable protein for feed purposes.
4. Achieving the country's physical security in the supply of plant protein for feed purposes, in view of the ineffectiveness of market-based measures in this area, may require government intervention to introduce a plant protein indicator target to activate the market for this raw material.

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UWARUNKOWANIA SUWERENNOŚCI POLSKI W ZAKRESIE ZAOPATRZENIA W PASZOWE BIAŁKO ROŚLINNE

Słowa kluczowe: bezpieczeństwo żywnościowe, suwerenność białkowa, globalizacja, opłacalność substytucji, Europejski Zielony Ład

ABSTRAKT

Celem badań była identyfikacja głównych czynników wpływających na ograniczony stan fizycznej samowystarczalności kraju w zakresie zaopatrzenia w białko roślinne na cele paszowe, a także wskazanie kierunków możliwych działań prowadzących do poprawy tego stanu w Polsce. W opracowaniu danych liczbowych posłużono się wybranymi metodami statystyki opisowej, wykorzystano także rachunek substytucji oraz analizę opisową i porównawczą. W podsumowaniu stwierdzono, że głównym czynnikiem rynkowym przyczyniającym się do ograniczenia fizycznej samowystarczalności kraju w zakresie białka roślinnego, są postępujące procesy globalizacyjne, które w Polsce występują zarówno w sferze produkcji pasz, jak i w chowie trzody chlewnej. Uznano również, że działania polityczne Unii Europejskiej, takie jak strategia „Rolniczy Zielony Ład" mogą spowodować wzrost wielkości produkcji rodzimych roślin białkowych w Polsce, co wpłynie na zwiększenie bezpieczeństwa kraju w zakresie dostaw białka roślinnego na cele paszowe. Stwierdzono także że wobec nieskuteczności działań rynkowych w rozwoju produkcji roślin białkowych w kraju, rząd może podjąć działania interwencyjne w kierunku wprowadzenia celu wskaźnikowego białka roślinnego, aktywizującego rynek tego surowca.

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