

CONSUMPTION OF MAJOR INPUTS IN POLISH AGRICULTURE IN 2010–2019 PERIOD

Wacław Jarecki 

¹Department of Crop Production, University of Rzeszów
ul. Zelwerowicza St. 4, 35-601 Rzeszów, Poland

ABSTRACT

Background. In agriculture, the most important inputs include fertilizers, pesticides, and seeds. First of all, they ensure high and generally good-quality yield. They constitute an important element of the cost structure in agricultural production and have an impact on the natural environment, which forces the optimization of their use. The aim of this study was to capture changes in the consumption of selected means of production in Polish agriculture in a long-term perspective.

Material and methods. The statistical analysis carried out included the amount of mineral and calcium fertilizers, plant protection products as well as certified seed of cereals and seed-potatoes. Data for 2010–2019 were obtained from the Central Statistical Office in Warsaw Based on the collected ten-year data, the trend equation was determined and the value of the determination coefficient R^2 was given.

Results. In the analyzed period, there was an upward tendency in the domestic consumption of NPK mineral fertilizers per 1 ha of total UAA (Utilised agricultural area). A growing trend in the consumption of potassium fertilizers, a stable use of nitrogen fertilizers and a downward tendency in the consumption of phosphorus fertilizers were shown. There was an upward tendency in the consumption of calcium fertilizers. In the analyzed years, the use of plant protection products in domestic agriculture increased. The sale of herbicides, however, showed only an upward tendency. In the analyzed decade in Poland, there was a growing trend in demand of triticale seed. In the case of other cereals and potatoes, this was a positive tendency.

Conclusion. Over 2019–2020 in Poland, the consumption of selected means of production varied and depended on the assessed assortment. The increase in the sales of cereal seed and the increase in the consumption of calcium fertilizers should be considered particularly favorable.

Key words: calcium fertilizers, mineral fertilizers, plant production products, Poland, seed material, seed-potatoes

INTRODUCTION

Industrial means of agricultural production, including mineral fertilizers and pesticides, play a significant role in agribusiness (Zalewski and Piwowar 2018). The largest increase in expenditure on fertilizers and plant protection products in 2010–2018 was recorded in Lithuania, Bulgaria and Estonia. A considerable increase was also recorded in Latvia, Poland, Romania,

the Czech Republic, Hungary, Spain, Great Britain and Slovakia. On the other hand, a decrease in expenditure on the above-mentioned means of production occurred in Belgium, Croatia, Slovenia, Denmark, Finland and Portugal (Zalewski 2020). Piwowar (2018b) also reports that the consumption of mineral fertilizers and herbicides in Poland is increasing. He also points out that, in Poland, it is regionally differentiated. Kopiński (2018b) states that

✉ wacław.jarecki@wp.pl

from 2004 to 2017 the highest intensity of plant production, measured by the level of nitrogen consumption in mineral fertilizers, was noted in the Kuyavian-Pomeranian and Opole voivodships, and the lowest in the Lesser Poland and Subcarpathian voivodeships. Czyżyk (2011), conducting a survey, showed that the use of mineral fertilizers, especially nitrogen fertilizers, was higher in farms with intensive plant production. The rates of the fertilizers used often exceeded the values recommended for sustainable agriculture. Zalewski and Piwowar (2018) point out that the use of fertilizers depends on the farming system (conventional, integrated, organic agriculture, etc.). Kopiński (2018a) concludes that the agricultural pressure to environment in the country has decreased. Thus of nitrogen use efficiency – NUE in Poland has improved. Ossowska (2017) concludes that, mainly due to the environmental consequences of using nitrogen fertilizers, it was necessary to introduce restrictive limitations in the EU. Despite this, the consumed rates of mineral fertilizers in many countries are still high. The next EU funding period, 2021–2027, provides for the implementation of the European Green Deal program, which assumes support for ecological agriculture (Nurzyńska 2020). In this context, Piwowar (2018a) draws attention to plant protection products, which has both positive and negative effects in modern agriculture. Adamski *et al.* (2018) examined the state of contamination with residues of plant protection products in freshwater ecosystems in intensively used agricultural areas. Out of 431 tested substances, only 23 active substances were detected, of which the most numerous group were herbicides.

The aim of this study was to capture changes in the consumption of selected means of production in Polish agriculture in a long-term perspective.

MATERIAL AND METHODS

The consumption of selected means of production in Polish farms is presented for the years 2010–2019 (for harvest). The statistical analysis involved the sales of mineral and calcium fertilizers, plant protection products and certified seed of cereals and potatoes. The source information was the data of the Central Statistical Office in Warsaw

(<https://stat.gov.pl>). The author's calculations were made with Excel. Based on the compiled ten-year data, the trend equation was determined and the value of the determination coefficient R^2 was given.

RESULTS AND DISCUSSION

Over 2010-2019 in Poland, there was an upward tendency in the consumption of NPK mineral fertilizers (Table 1). This was mainly due to the positive trend of consumption of potassium fertilizers. The obtained difference in this case between 2010 and 2019 was 12.1 kg per ha of UAA (Utilised agricultural area). The domestic use of nitrogen fertilizers was stable and amounted to an average of 73.8 kg per ha of UAA. However, there was a negative tendency in the consumption of phosphorus fertilizers. On average, in the analyzed period it was 23.8 kg per ha of UAA. The NPK ratio during the period considered averaged 1:0.32:0.45. In the case of calcium fertilizers, an increase in their consumption was observed, but it was only a tendency. It should be noted that the situation regarding calcium fertilizers may improve further as a result of introducing the so-called “National program of environmental regeneration of soils through liming”.

Matyka (2013) showed that the consumption of NPK mineral fertilizers in most EU countries in 2002-2010 showed a clear downward tendency. Increase in consumption was recorded only in some "new" EU member states. The consumption of mineral fertilizers in Poland increased particularly strongly and dynamically. Jarecki and Bobrecka-Jamro (2013) confirmed that the consumption of NPK mineral fertilizers in Poland increased in 2002-2011. There was a significant positive trend for nitrogen and phosphorus, and a positive tendency for potassium. The use of calcium fertilizers decreased then. Tarnowska (2016) stated that in Poland there is an increase in the consumption of nitrogen fertilizers, and a decrease in calcium fertilizers. Kopiński (2018b) believes that high nitrogen consumption in relation to other macronutrients is particularly unfavorable in Poland's fertilization management.

Table 1. Consumption of mineral fertilizers in Poland (kg per ha of agricultural area)

Year	NPK	N	P ₂ O ₅	K ₂ O	CaO
2010	119.2	68.9	23.7	26.6	39.8
2011	129.1	72.1	27.0	30.1	37.6
2012	125.8	73.1	24.8	27.9	33.9
2013	133.0	80.7	25.6	26.7	43.4
2014	132.9	75.5	23.4	34.1	47.9
2015	123.2	69.0	20.9	33.3	39.0
2016	130.3	71.7	22.4	36.2	68.4
2017	140.2	78.7	23.5	38.0	53.0
2018	141.6	80.4	23.1	38.1	55.1
2019	129.7	67.7	23.4	38.7	55.9
Mean	130.5	73.8	23.8	33.0	47.4
Trend equation	$y = 1.4315x + 122.63$	$y = 0.2533x + 72.387$	$y = -0.2945x + 25.4$	$y = 1.4733x + 24.867$	$y = 2.6x + 33.1$
R ²	0.39	0.03	0.28	0.85	0.54

The consumption of mineral fertilizers in Poland on agricultural area, indicated by the Central Statistical Office, as in good condition (Table 2) was similar to the total consumption per 1 ha of UAA. A positive trend was calculated for potassium fertilizers, and a positive tendency for calcium fertilizers. Nitrogen consumption showed no significant fluctuations, and phosphorus consumption showed a slight downward tendency.

Zalewski (2009) believes that fertilization is the basic yield-forming factor, as well as one of the main indicators of production intensity and efficiency in agriculture. Mineral fertilizers used in the production process have a significant impact on the growth and development of plants, enriching the soil with necessary minerals. The effect of fertilization on the size of the yields achieved is one of the largest. Kopiński (2018b) indicated an increase in the volume of nitrogen turnover in agricultural production. However, the increase in nitrogen output rate in agricultural crops was much higher than the increase in

its input, generated mainly by increasing nitrogen consumption in mineral fertilizers, which proves the improvement in the efficiency of this nutrient management in Poland. The analysis of changes in the gross nitrogen balance over many years allows us to track the directions and trends of structural, organizational and production transformations taking place in Polish agriculture. This allows us to provide valuable information that enables making rational decisions. In addition to environmental consequences, they can also have specific economic effects.

In the analyzed years, the total sales of plant protection products in tons of commodity weight increased (Table 3). It was diverse in terms of assortment. Increase in sales was recorded for insecticides, fungicides, seed dressings and to a lesser extent growth regulators. In turn, the sale of herbicides showed only an upward tendency.

Table 2. Consumption of mineral fertilizers in Poland (kg per ha of agricultural area, in good agricultural condition)

Year	NPK	N	P ₂ O ₅	K ₂ O	CaO
2010	122.6	70.9	24.3	27.4	40.9
2011	132.2	73.8	27.6	30.8	38.4
2012	129.6	75.3	25.5	28.8	35.0
2013	134.9	81.8	26.0	27.1	44.0
2014	134.2	76.2	23.6	34.4	48.3
2015	124.5	69.7	21.1	33.7	39.4
2016	131.6	72.4	22.6	36.6	69.1
2017	141.5	79.4	23.7	38.4	53.5
2018	142.8	81.1	23.3	38.5	55.6
2019	131.0	68.3	23.6	39.0	56.4
Mean	132.5	74.9	24.1	33.5	48.1
Trend equation	$y = 1.1497x + 126.17$	$y = 0.0818x + 74.44$	$y = -0.3521x + 26.067$	$y = 1.4188x + 25.667$	$y = 2.5382x + 34.1$
R ²	0.30	0.003	0.34	0.84	0.53

Table 3. Sales of plant protection products in Poland (tons of commodity weight)

Year	Total	Including:			
		Insecticides	Fungicides and seed dressings	Herbicides	Growth regulators
2010	51613	2945	12867	30228	3014
2011	58736	3320	13557	35948	3227
2012	61805	4247	14474	38748	2842
2013	61197	4381	15698	36676	3045
2014	64772	4541	17786	36333	4211
2015	67298	4687	18268	38799	4293
2016	68106	4569	18253	39544	4251
2017	71446	5440	17429	43030	4261
2018	65335	5451	19744	35864	3406
2019	68907	8267	17858	36185	4737
Mean	63921.5	4784.8	16593.4	37135.5	3728.7
Trend equation	$y = 1656.3x + 54812$	$y = 421.15x + 2468.5$	$y = 673.64x + 12888$	$y = 518.21x + 34285$	$y = 167x + 2810.2$
R ²	0.75	0.77	0.79	0.23	0.54

The comparisons conducted by Jarecki and Bobrecka-Jamro (2013) in 2002–2011 show that in Poland the overall consumption of plant protection chemicals in agriculture increased significantly. Tarnowska (2016) states that information on pesticide consumption in Poland is more difficult to analyze due to its multi-aspect nature. However, she points to an increase in their consumption on farms. Grygiel *et al.* (2012) confirm that herbicides are now commonly used in plant production. Residues present in crops can adversely affect the environment and the

health of consumers. Despite the fact that in Poland there are cases of detecting herbicide residues in agricultural crops, in the vast majority of cases they do not exceed the permissible values.

It has been shown that sales of plant protection products in tons of the active substance increased ($R^2 = 0.70$). In 2010, it was 19,449 tons, and in 2017–25,075 tons. In 2018 and 2019, sales of plant protection products stabilized at 23,178 tons and 24,281 tons of active ingredient, respectively (Fig. 1).

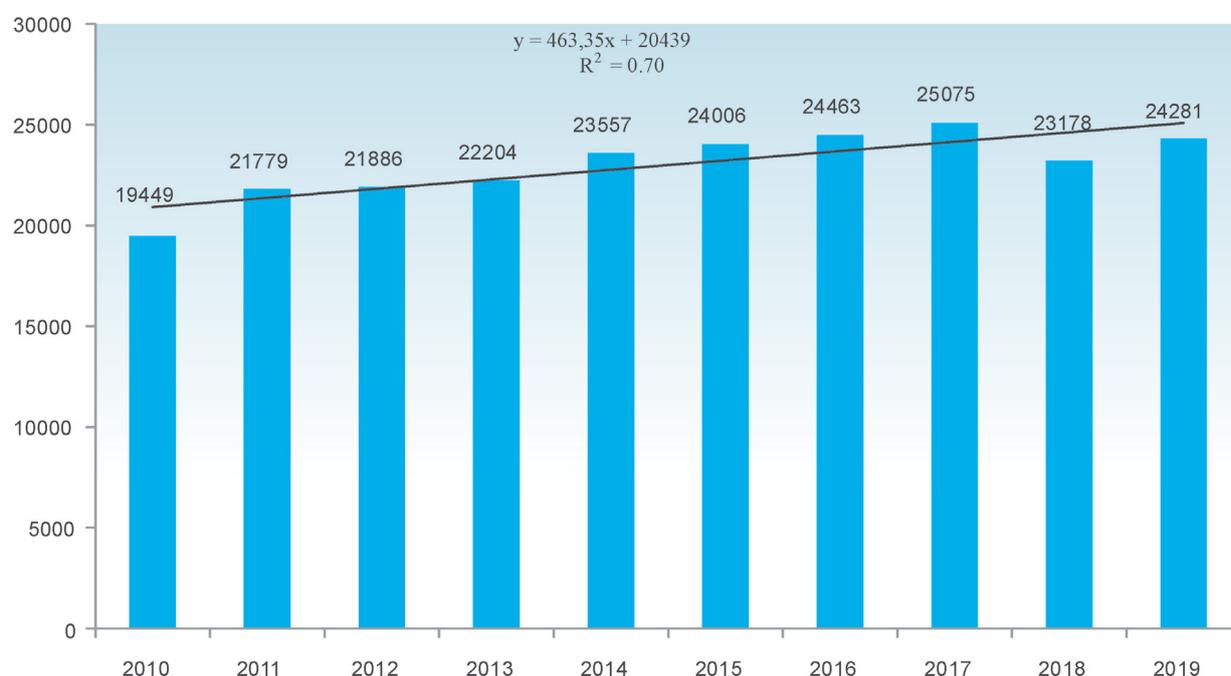


Fig. 1. Sales of plant protection products in Poland (in tons of active substance)

Urban (2014) claims that chemical plant protection products play an important role in modern agriculture. In 2005–2012, their sales in Poland increased by 36.5% in terms of the active substance. The consumption of biologically active substances per 1 ha of arable land and orchards increased from 1.3 kg in 2005 to 2.0 kg in 2012. Thus, in Poland there is a slow but steady and systematic increase in the use of plant protection chemicals, especially imported ones. Malinowska *et al.* (2015) report that in 2000–2012 in Poland, the sales of plant protection products increased

systematically. In 2000, the total sales of plant protection products in commodity weight amounted to 22 thousand tons, and in 2012 it was almost 3 times higher and amounted to 61.8 thousand tons. Herbicides dominated in the sales structure, followed by fungicides, insecticides, and the smallest percentage was for rodenticides and growth regulators. In 2012, the consumption of plant protection products in kg of the active substance per 1 ha of crops was over 2 kg·ha⁻¹, while in 2005 it was 1.3 kg·ha⁻¹. Matyjaszczyk (2014) showed that, both in terms of

quantity and value, sales of plant protection products in Poland per 1 ha of UAA is clearly lower than the EU average and much lower than in neighbouring countries (Czech Republic, Germany) which are characterized by similar structure of plant production and pressure of pests. Herbicides have the largest share in the Polish market, accounting for more than 50% of sales in terms of both quantity and value. In Poland, fungicides are also of great importance, and they account for approximately 40% of the market. Insecticides and other plant protection products have a smaller market share.

In the analyzed years, a growing trend in the sales of triticale seed was demonstrated (Table 4). In the 2018/2019 season, it was 43,109 tons. For other cereals, in turn, it was a positive tendency in order: wheat and rye, as well as oats and barley. Sales of seed-potatoes were stable with a slight upward tendency. However, it should be noted that in 2019 it was 79,798 tons, which is significantly above the average for the analyzed decade. Therefore, the situation regarding the use of seed material in Poland improved considerably.

Table 4. Sales of seed/seed-potatoes in Poland (tons)

Year	Wheat	Rye	Barley	Oat	Triticale	Potatoes
2009/2010	67811	11587	29153	10124	27972	62403
2010/2011	75329	12459	31125	10290	30401	55882
2011/2012	84021	12354	36655	10554	30824	57601
2012/2013	78210	12850	33003	10032	35951	55897
2013/2014	82824	12770	31685	9602	34063	56414
2014/2015	84734	12416	29752	10071	35727	52528
2015/2016	86032	12533	31095	10145	34871	55476
2016/2017	82401	12353	34027	11367	39756	53481
2017/2018	86591	13578	36293	10978	41576	66895
2018/2019	91522	13232	35739	11207	43109	79798
Mean	81947.5	12613.2	32852.7	10437.0	35425.0	59637.5
Trend equation	$y = 1875.8x + 71631$	$y = 129.26x + 11902$	$y = 452.44x + 30364$	$y = 117.79x + 9789.1$	$y = 1560.9x + 26840$	$y = 1260x + 52708$
R ²	0.73	0.52	0.25	0.39	0.91	0.21

The study by Jarecki and Bobrecka-Jamro (2013) showed that in 2002–2011 the consumption of certified seed material for basic cereals and seed-potatoes decreased significantly. They recorded an increase in sales of certificated seed only for triticale. Jarecki and Bobrecka-Jamro (2011) report that, from

2000 to 2009, the sale of certified seed of wheat, barley, rye, oats and seed-potatoes decreased in Poland. The strength of this decline varied significantly. Only in the case of triticale, an increase in sales of certified seed was recorded. Therefore, it was found necessary to disseminate wider information

campaigns about the benefits of the exchange of seed material. Tarnowska (2016) also showed an unfavorable trend in the sales of certified seed, mainly seed-potatoes. Urban (2013) concludes that the exchange of seeds of cultivated crops is the most dynamic and effective element of agricultural progress. In 1988–2011, the production of seeds was reduced, but after 2005 it began to increase. The extent of the seed exchange is insufficient. For cereals, on average, exchange occurs every 9 years, and it is recommended that it should take place every 4 years. In the case of potatoes, they are exchanged every 21 years, and for market crops it is recommended to be exchanged every 4 years.

CONCLUSIONS

1. During the 2010–2019 period, there was an upward tendency in the consumption of NPK fertilizers per 1 ha of total UAA. A growing trend in the consumption of potassium fertilizers, a stable use of nitrogen fertilizers and a downward tendency in the use of phosphorus fertilizers were shown. In the case of calcium fertilizers, there was an upward tendency in consumption.
2. The use of mineral and calcium fertilizers on agricultural area in good condition was similar to the general consumption in Poland. A positive trend was obtained for potassium fertilizers and a positive tendency for calcium fertilizers. The consumption of nitrogen fertilizers did not show any significant fluctuations, while the consumption of phosphorus fertilizers showed a downward tendency.
3. In the analyzed period, domestic sales of plant protection products, in total in tons of commodity weight and active substance increased. Increase in sales was recorded for insecticides, fungicides, seed dressings and to a lesser extent growth regulators. The sales of herbicides, in turn, showed only an upward tendency.
4. In the analyzed decade, a growing trend was recorded in the sales of triticale seed. In the case of other cereals, it was a positive tendency: wheat and rye (stronger) as well as oats and barley (weaker). The sale of seed-potatoes showed a slight upward tendency.

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ZUŻYCIE WYBRANYCH ŚRODKÓW PRODUKCJI W POLSKIM ROLNICTWIE NA PRZESTRZENI LAT 2010-2019

Streszczenie

W pracy przedstawiono zmiany zużycia podstawowych środków produkcji w polskich gospodarstwach rolnych. Głównym źródłem danych za lata 2010–2019 były informacje zawarte w bazach Głównego Urzędu Statystycznego w Warszawie. Na przestrzeni badanych lat wystąpiła wzrostowa tendencja krajowego zużycia nawozów mineralnych NPK na 1 ha UR ogółem; przy czym było to uzależnione od składu nawozowego. Uzyskano rosnący trend zużycia nawozów potasowych, stabilne wykorzystanie nawozów azotowych oraz malejącą tendencję zużycia nawozów fosforowych. W przypadku stosowania nawozów wapniowych wystąpiła tendencja wzrostowa. Wykorzystanie nawozów mineralnych i wapniowych, na użytkach rolnych w dobrej kulturze, było zbliżone do ogólnego zużycia krajowego. Dodatni trend uzyskano dla nawozów potasowych, a dodatnią tendencję dla nawozów wapniowych. Zużycie nawozów azotowych było stabilne, zaś fosforowych wykazało tendencję spadkową. W analizowanych latach wykorzystanie środków ochrony roślin w krajowym rolnictwie wzrosło, natomiast sprzedaż herbicydów wykazała jedynie tendencję wzrostową. W ocenianym dziesięcioleciu odnotowano rosnący trend sprzedaży materiału siewnego pszenżyta. W przypadku pozostałych zbóż i sadzeniaka ziemniaka była to tendencja dodatnia.

Słowa kluczowe: materiał siewny, nawozy mineralne, nawozy wapniowe, Polska, sadzeniaki ziemniaka, środki ochrony roślin