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Trends in Polish agriculture in the 30-year period of 1990–2019

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Abstract. Presented paper analyzed changes in Polish agriculture assessed on the basis of 22 indicators characterizing agricultural resources, consumption of production goods and the result of agricultural production in the years 1990–2019. The aim of the research was to find the trends that have emerged in Polish agriculture in the last 30 years. The data published by the Central Statistical Office was used as source data. The results showed a significant dynamics of changes in both level and structure of agricultural production.

Since 1990s, the specialization of farms has deepened, which was a result of the systemic transformation and Poland's accession to the structures of the European Union. The specialization was deepened mostly through the changes in use of production factors to promote the leading agricultural activity of farm in terms of increasing the scale and marketability of production. The study showed some positive changes of Polish agriculture, i.e.: the development of large farms, an increase in the average area of farms and in land concentration, increased yields of plants, slaughter efficiency of livestock and milk efficiency of cows, reduction of employment in agriculture as a factor of increasing labor productivity. On the other hand, the unfavorable phenomena were found, such as: decreasing acreage of agricultural land in Poland, reduction of outlays on certain production goods (including low use of certified seeds and fertilizing lime), a downward trend in the number of livestock (but with a noticeable improvement in their productivity).

The main determinants of changes in the level and structure of agricultural production included a reduction in the area of agricultural land and the number of commercial farms, as well as an increase in their average area, but also an increase in plant and livestock production efficiency.

Keywords: agricultural resources, consumption of production goods, agricultural production, change tendencies

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INTRODUCTION

More than 30 years have passed since the beginning of the systemic transformation in Poland. System transformation is a set of processes initiated in Poland in the 1980s, aiming at establishing a free market, create a civil society, and democratize public life. In synthetic terms, transformation can be defined as the transition from a centrally planned economy to a market economy. According to Kobyłecki (2004), systemic transformation is not a one-off act, as it is constantly changing, although at a varying pace. System transformation and reconstruction of agriculture are interpreted as changes in agrarian structure, production potential, and production itself (Matyka, 2007).

The new legislation eliminated centralist instruments regulating the economy and introduced market solutions (Woś, 1998b). The transformation covered the whole country, including agriculture, it changed the conditions of functioning of farms and enterprises (Klepacki, 2002). The preparatory processes of agriculture proceeded slowly. Farmers were faced with two problems: freeing up prices in adapting to the market economy and integrating with the European market (Woś, 1998a). For individual agriculture, changes in its environment, determining its development conditions, became an essential element of the transformation (Woś, 1998a; Gołębiewska, 2010). Poland's accession to the European Union in 2004 accelerated the pace of economic transformation initiated by the change of the political and economic system in 1989 (Józwiak et al., 2019). Domestic agriculture was then covered by the mechanisms of the Common Agricultural Policy, and Poland gained greater access to the Community market (Siekierski, 2020). Shifts in agricultural production are shaped by the Common Agricultural Policy (CAP), arrangements are made within the framework of the World Trade Organization (WTO), taking into account the progressive globalization and fluctuation of markets (raw material, product, and capital) (Matyka, 2018; Nowak, Wójcik, 2013). Indeed,

changes in agricultural production are also caused by other factors, e.g., climate change, progress, innovations.

To date, assessments of the changes that have taken place in agriculture have covered periods of several or more than a dozen years (Domańska, Nowak, 2013; Dzun, 2004; Józwiak et al., 2019; Klepacki, 2002; Matyka, 2018; Woś, 1998 a b; Ziętara, 2003). However, the 30-year period provides a basis for a more comprehensive assessment of trends in Polish agriculture.

The paper aimed to identify the trends occurring in Polish agriculture between 1990 and 2019.

MATERIALS AND METHODS

The basic source material was the Central Statistical Office (GUS 1990-2019) data on agricultural resources, consumption of production goods in agriculture, and agricultural production results from 1990 to 2019. The research period was conventionally divided into three 10-year sub-periods:
– system transformation (1990–1999),
– transition stage (2000–2009),
– relative market stabilisation (2010–2019).

Furthermore, values of particular indicators characterising changes in the 30 years were presented graphically to determine agriculture trends. In total, 22 indicators were applied to assess changes that have taken place in agriculture, 6 of which characterise the resources of production factors in agriculture (Table 1) and the consumption of production goods (Table 2) and 10 concerning agricultural output (Table 3). Agricultural production factors include mainly land, living labour, and capital (technical equipment), and their resources are quantitatively and qualitatively specific. For cereals, as the largest, in terms of area, group of plants in sowings on arable land in the country, correlation calculations were performed considering more essential factors.

The indicators chosen to make the assessment of changes in agriculture in this study were based on calculation methodology that was unchanged over the whole research period(1990–2019) thus assuring the comparability of the results. The results are presented in tables for 10-year periods and trend charts for 30-year periods. However, due to variability in calculation methods, several other interesting indicators were not used in the study.

RESULTS

Agricultural factor resources

The utilized agricultural area in Poland has been decreasing during the 30-year period: in 2010–2019 was lower by 21% compared to the one occurring at the beginning of the system transformation (1990–1999) (Table 1). The rate of total utilized agricultural area loss in Poland was higher than the one assumed by Krasowicz and Kuś (2010) in their forecast for 2020. According to the prognosis, in 2020, the agricultural area could amount to 15 600 ha, i.e., by 6% more than was found on average in the last 10-year period 2010–2019 (14 720 ha); (Table 1). A clear downward trend in the total area of agricultural land occurred, while the total area of individual farms with an area above 1 ha changed only slightly, without a clear trend (Fig. 1). Decreases in the area of agricultural land have been more pronounced since 2002. The increase in areas allocated for non-agricultural purposes, mainly for buildings, is related to the intensive development of the economy and investments financed by European Union funds (Kowalik, 2017). On average, each year, over 180 thousand ha^{-1} of UAA were lost from agricultural use (Fig. 1), allocated for other purposes, such as building infrastructure (residential and industrial) and roads. In the analyzed period, the number of individual farms decreased (Table 1), and simultaneously, the average area of a farm increased. The above is confirmed by opposite solid trends: the decrease in the number of farms and the increase in their average area (Fig. 2). In the last 10 years, the number of farms was 31% lower than at the beginning of the system transformation, and at the same time, their average surface area increased by 42% (Table 1). An increase in the number of farms with

Table 1. Changes in agricultural resources in Poland.

Resource of agriculture	10-year periods		
	system transformation (1990–1999)	transient period (2000–2009)	relative market stabilization (2010–2019)
1. Agricultural area – UAA [thous. ha]	18578	16651	14720
2. Area of private farms exceeding 1 ha of UAA [thous. ha]	13649	13881	13396
3. Number of private farms exceeding 1 ha of agricultural land > 1 ha UAA [thous.]	2056	1838	1411
4. Average area of private farms exceeding 1 ha of UAA [ha]	6.7	7.6	9.5
5. Agriculture employment [persons per 100 ha UAA]	22.7	16.1	15.8
6. Gross value of fixed assets in agriculture and forestry [PLN ha^{-1} UAA]	5167	6864	9389

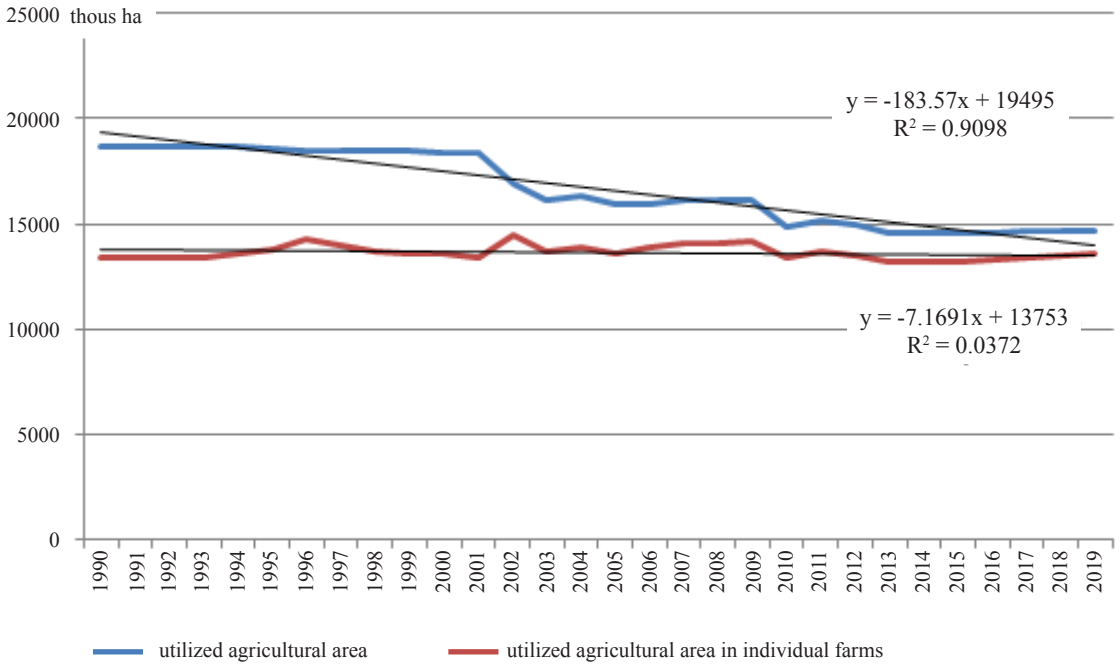

Figure 1. Changes in the total utilized agricultural area in Poland [thousand ha] and the utilized agricultural area in individual farms with an area of >1 ha of UAA [thousand ha].

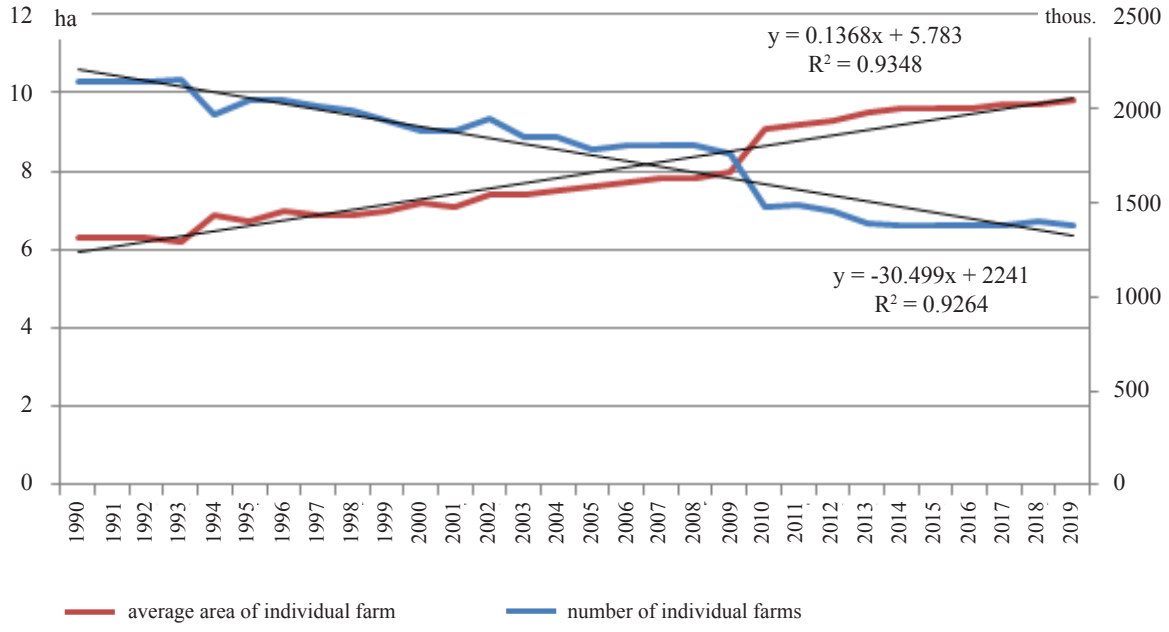

Figure 2. Changes in the number of individual farms of the area > 1 ha [thousand] and the average area of individual farms of the area of > 1 ha of UAA [ha].

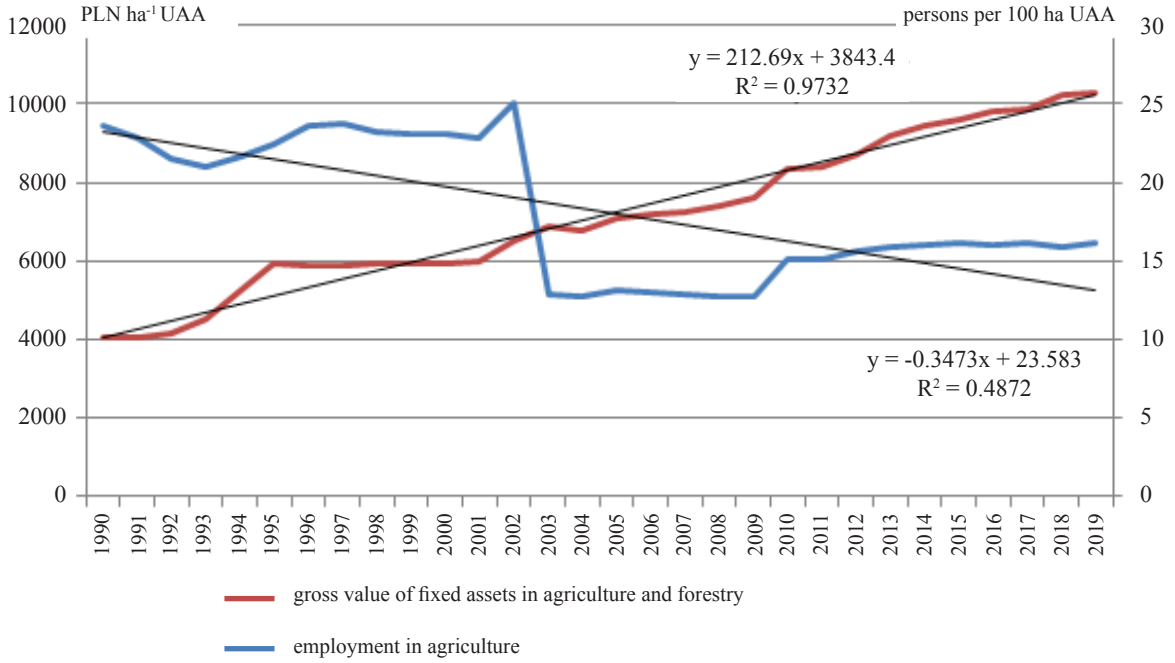

Figure 3. Changes in employment in agriculture and gross value of fixed assets in agriculture and forestry.

a larger area should be emphasised (Dzun, 2004). The most dynamically developing area group were large individual farms with 100 ha and more of arable land. The number of non-specialised and mixed farms decreased the most, while the number of those focused on livestock production dropped to a lesser extent (Józwiak et al., 2019). On average, the number of individual farms with an area of more than 1 ha of arable land declined annually by 30 thousand, and at the same time, there was an upward trend in the area of the same group of farms at a rate of 0.14 ha UAA year^{-1} (Fig. 2). Employment in agriculture in 2000–2019 was significantly reduced from about 23 to 16 persons/100 ha UAA, indicating that it decreased by about 30%. However, compared to other EU countries, labour resources in Polish agriculture are particularly large (Ziętara et al., 2021). An apparent reduction in employment occurred after 2002 (Fig. 3), while the gross value of fixed assets in agriculture and forestry showed a reasonably even upward trend. Moreover, progress in the technical equipment of farms occurred, as confirmed by the tendency to increase the number of machines and tools (Dzun, 2004). Over the years, both the number of tractors in agriculture and their power increased. In the first period of systemic transformation, the average power of agricultural tractors amounted to 31 kW; in the transition stage, it grew to 38 kW, while in the last 10 years (evaluation based on a 3-year study), it increased from 38 to 45 kW (GUS 2010, 2013, 2016).

Similar assessments of indicators characterising agricultural resources were presented by other authors (Domańska, Nowak, 2013; Dzun, 2004; Zegar, 2009; Ziętara et al., 2021). An improvement in the farms' area structure is noticeable, increasing their area and production scale (Ziętara et al., 2021). The predominant way of expanding the production scale in farms is to increase their size by purchasing or leasing land (Ziętara et al., 2021). A significant share in the transformation of the farms' area structure was using land from the former state-owned sector (mainly former state farms) to create new and expand existing individual farms (Zegar, 2009). The productive sector of state farms was almost wholly liquidated (Dzun, 2004). Zegar's (2019) forecast shows that in the transformation of family farms, mainly oriented to market production, by 2030, it is expected to reduce their number by 36% and increase their area by about 50%.

Consumption of production goods

The use of inputs in agriculture was determined by the consumption of mineral fertilisers (N, P, K, Ca), the sales of certified cereal seed, and the consumption of plant protection products (Table 2, Fig. 4 and 5).

At present, it isn't easy to imagine farming without mineral fertilisers, an essential yield-creating factor. The level of mineral fertilisation at the beginning of the system transformation in 1990 and 1991 declined rapidly, while since 1992 it has been systematically increasing concerning nitrogen consumption (a robust upward trend of 1.3 kg N ha^{-1} per year) and decreasing for lime fertilisation

Table 2. Consumption of production goods in agriculture.

Consumption of production goods	10-year periods		
	system transformation (1990–1999)	transient period (2000–2009)	relative market stabilization (2010–2019)
1. Consumption of mineral fertilizers (kg ha^{-1} AL):			
N	46.5	52.3	73.8
P_2O_5	18.6	21.7	23.8
K_2O	23.7	26.5	33.0
CaO	128.9	72.7	47.4
2. Sales of qualified seed material (cereals) (thousand t)	201.2	163.8	173.9
3. Consumption of plant protection products (active substances) (thousand t)	7.7	13.5	23.0

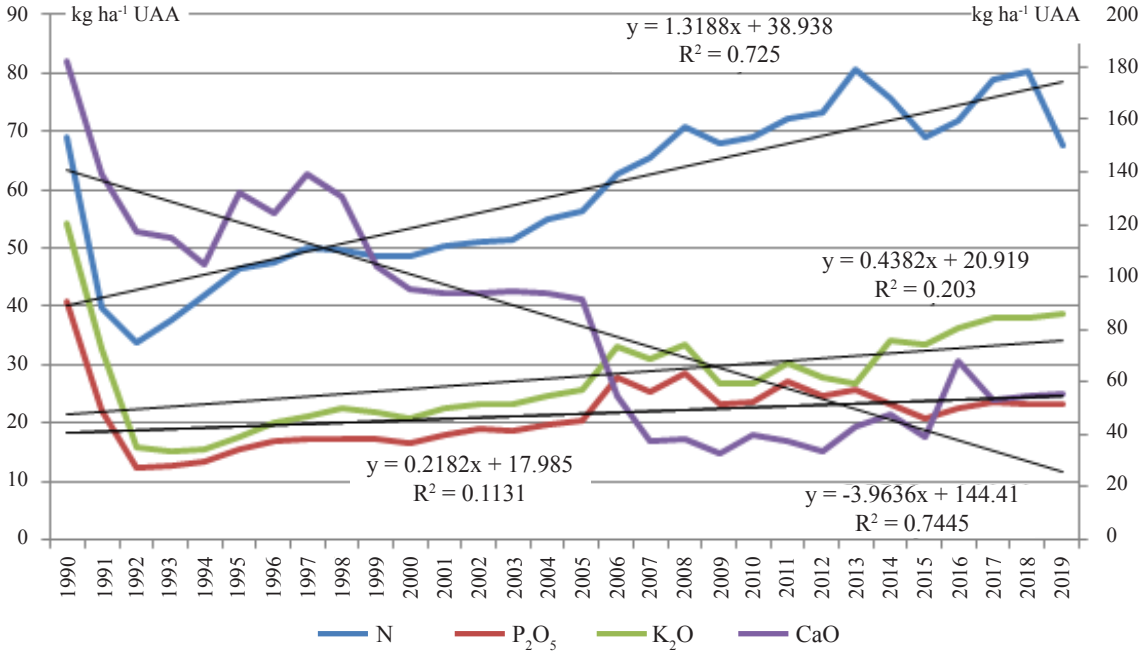

Figure 4. Changes in the use of mineral fertilisers N, P_2O_5, K_2O, CaO.

(a downward trend of 4 kg CaO ha^{-1} per year); (Fig. 4). However, phosphorus and potassium consumption showed a slightly increasing trend. In the last 10 years, the level of nitrogen fertilisation was on average by c. 60% higher than that recorded at the beginning of the system transformation period (Table 2). In the same period, the increase of phosphorus and potassium consumption was 28 and 39% higher, and the consumption of lime fertilisation decreased by 63%. The focus on intensive nitrogen fertilisation is justified by its more substantial yield-forming effect than other components. However, from the point of view of sustainable development of agriculture, proper relations between the main NPK components should be maintained, which translates into good plant yields and better use of fertiliser components without posing environmental risks. The unfavourable interactions between the main macronutrients (in favour of nitrogen) should be assessed as a negative phenomenon, resulting in potentially lower plant productivity and more significant environmental risks from unused nitrogen (Wrzaszcz, Kopiński, 2019). In turn, the low level of consumption of lime fertilisers affects the deterioration of soil reaction, reducing the efficiency of using other macronutrients (NPK) by crops, thus lowering their productivity. Disproportions in the consumption

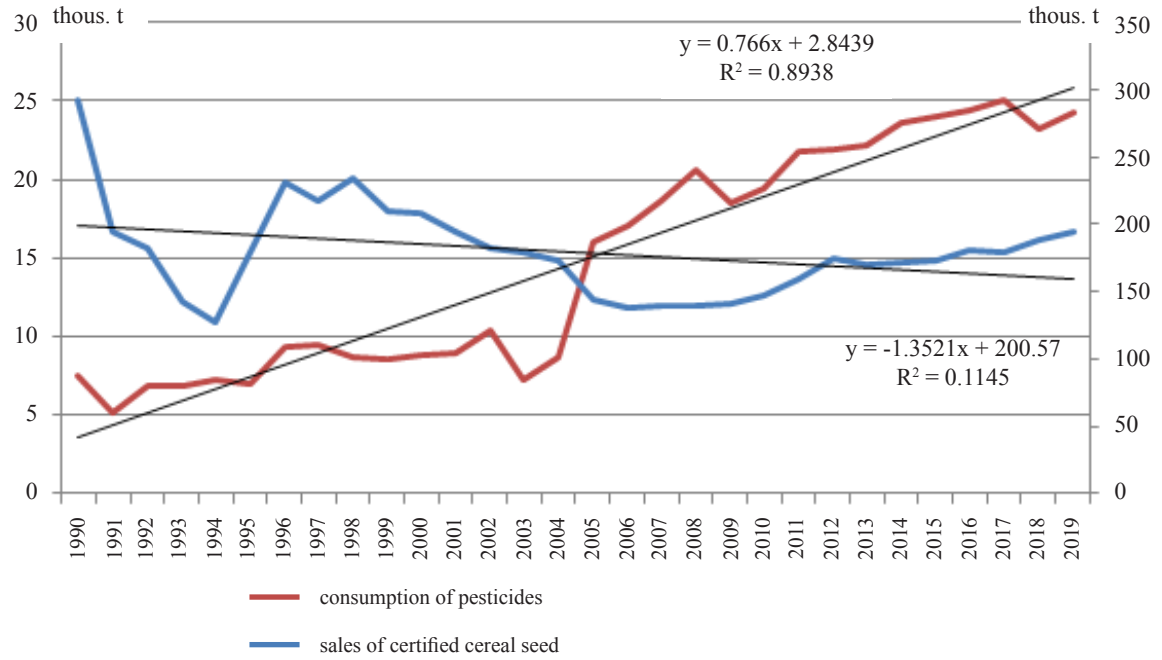

Figure 5. Changes in the sales of certified cereal seed [thous. t] and the consumption of pesticides [thou. t of active substance].

of macronutrients negatively influence the phosphorus and potassium balances, meaning that soil resources supplement P and K deficiencies. The low interest in the use of lime fertilisers, in the high share of acid and very acid soils, is worrying because of the significant influence of soil reaction on the effectiveness of the action and use of other nutrients. The strong downward trend in the use of calcium fertilisers was mainly due to the need to cancel budget subsidies for soil liming after Poland acceded to the European Union (Matyka et al., 2013). It should be concluded that over-fertilisation leads to economic losses and threats to the natural environment, while too low levels lead to a decrease in soil fertility and productivity.

The consumption of certified cereal seed, evaluated by its sale, showed a decreasing trend (Fig. 5). In the last 10 years (2010–2019), the level of cereal seed sales was 13% lower than at the beginning of the system transformation period (Table 2). Since 2013, an improvement in this regard was observed (Fig. 5). It is worth emphasizing that high-quality seed material is crucial to achieving good yields with suitable quality parameters.

The consumption of pesticides followed a different pattern (Table 2, Fig. 5). At the transition stage of the transformation (2000–2009), the consumption of pesticides increased significantly, and in recent years (2010–2019), it reached almost a 3-fold increase compared to the state at the beginning of the systemic transformation period. A stronger upward trend occurred after 2004 when Poland joined the European Union structures (Fig. 5). The average annual increase in the consumption of pesticides happened at the rate of 0.77 thousand t of an active substance.

Outputs of agricultural production

In 2000–2019, the share of cereals slightly exceeded the threshold value of 66% (Table 3), considered a sustainability criterion and an acceptable value for crop management reasons (Kuś, 1995; Majewski, 2010; Ziętara et al., 2021). The lowest contribution of cereals to total sown area was found in 1990 (60%) while the highest in 2002 (77%); (Fig. 6, 7). The forecast for 2020 predicted that it would reach 73% (Krasowicz, Kuś, 2010).

Among the main crop groups, the share of potato and oilseed rape and turnip rape in sown area changed the most (Fig. 6). The importance of potato is clearly decreasing; in 1990 it occupied 13% and in 2019 only 3% of the sown area. Rapeseed and turnip rape in the corresponding years occupied 3.5 and 8.1% of the planted area, respectively. The systematic increase in the percentage of oilseed rape in sowings can be associated with developing the liquid biofuel market (Matyka, 2018). Fodder crops between 1990 and 1993 accounted for 12–14% of the sown area, while between 2011 and 2019, their share decreased to 8–10%. Variations in the area under other plant groups were relatively small. It should be stressed that the sowing structure of the main crops in Poland shows significant regional dif-

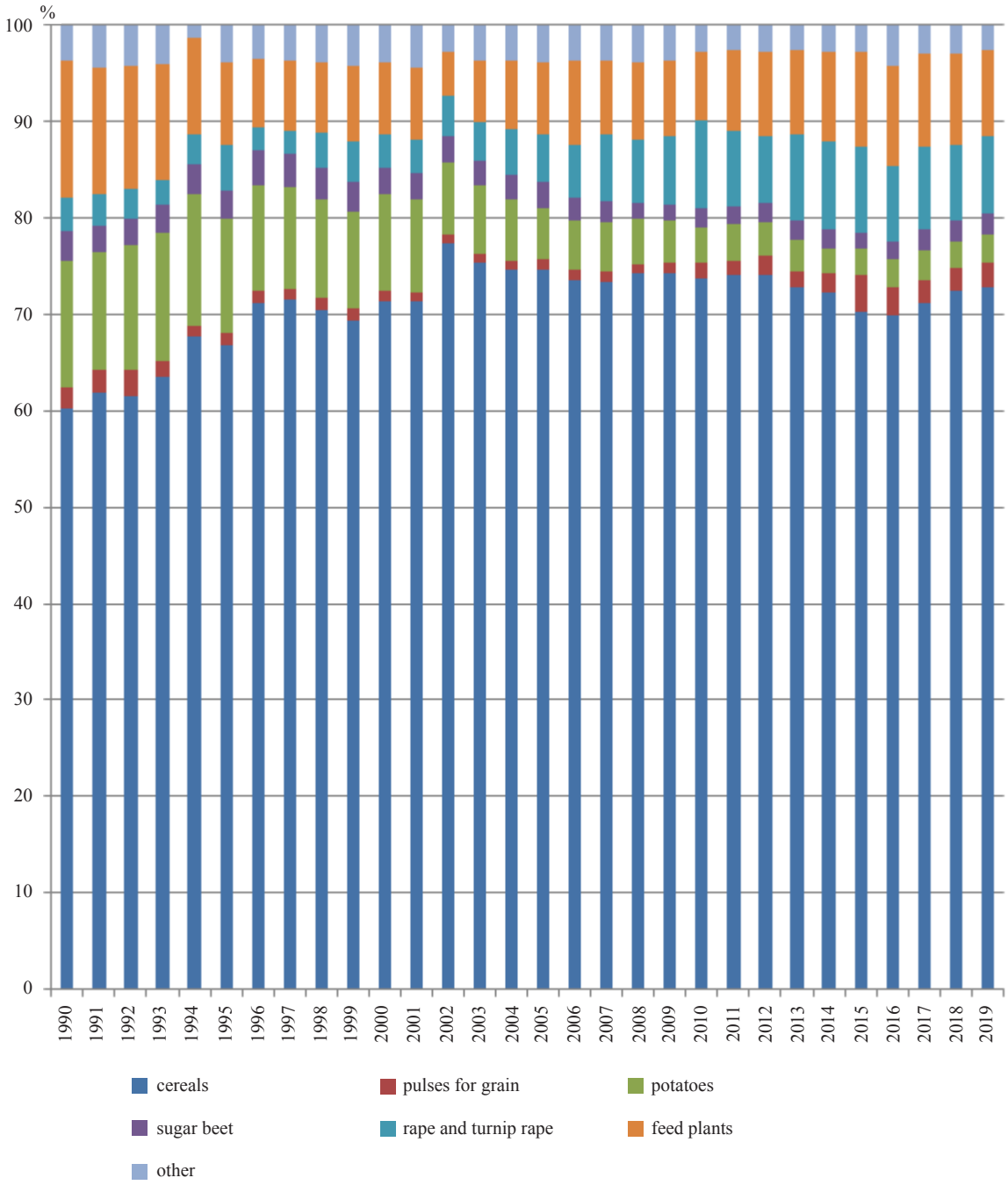

Figure 6. Sowing structure in Poland by groups of crops in 1990–2019 [%].

ferentiation (Matyka et al., 2013; Matyka, 2018). However, this issue was not the subject of the study.

Despite unbalanced mineral fertilisation (unfavourable ratios between applied NPK macronutrients), an apparent increase in yield levels was achieved for cereals and sugar beet (Table 3). The upward trend of sugar beet root yield was more substantial than that of cereal grain. The beet yield increase occurred at the rate of 1.18 t ha^{-1} year^{-1}, while the cereal yield was 0.04 t ha^{-1} year^{-1} (Fig. 8). It is worth adding that the reduction in cereal yields in 1992 and 1994 (Fig. 8) was primarily due to unfavourable weather conditions (drought) (Doroszewski et al., 2014; Klepacki, 2002; Ufnowska, Kukuła, 2002; Woś, 1998 a) and a low level of mineral fertilisation (Fig. 4). In the last 10 years, 2010–2019, the average cereal grain yield increased by more than 30% compared to that achieved in the initial period of sys-

Table 3. Indicators of agricultural production.

Agricultural production	10-year periods		
	system transformation (1990–1999)	transient period (2000–2009)	relative market stabilization (2010–2019)
1. Share of cereal in sown area [% AL]	66.0	70.0	68.3
2. Cereal yield [t ha^{-1}]	2.86	3.10	3.78
3. Sugar beet yield [t ha^{-1}]	35.1	44.1	59.4
4. Livestock density [LU per 100 ha UAA]	53.8	45.3	46.1
5. Livestock density of cattle [heads per 100 ha UAA]	41.9	34.1	40.6
6. Livestock density of pigs [heads per 100 ha UAA]	105.4	104.7	81.3
7. Production of diary milk [l ha^{-1} UAA]	672	703	868
8. Average quantity of diary milk per cow [l year^{-1}]	3220	4089	5229
9. Production of animals for slaughter [kg ha^{-1} UAA]	223	283	412
10. Production of meat [kg ha^{-1} UAA]	168	214	309

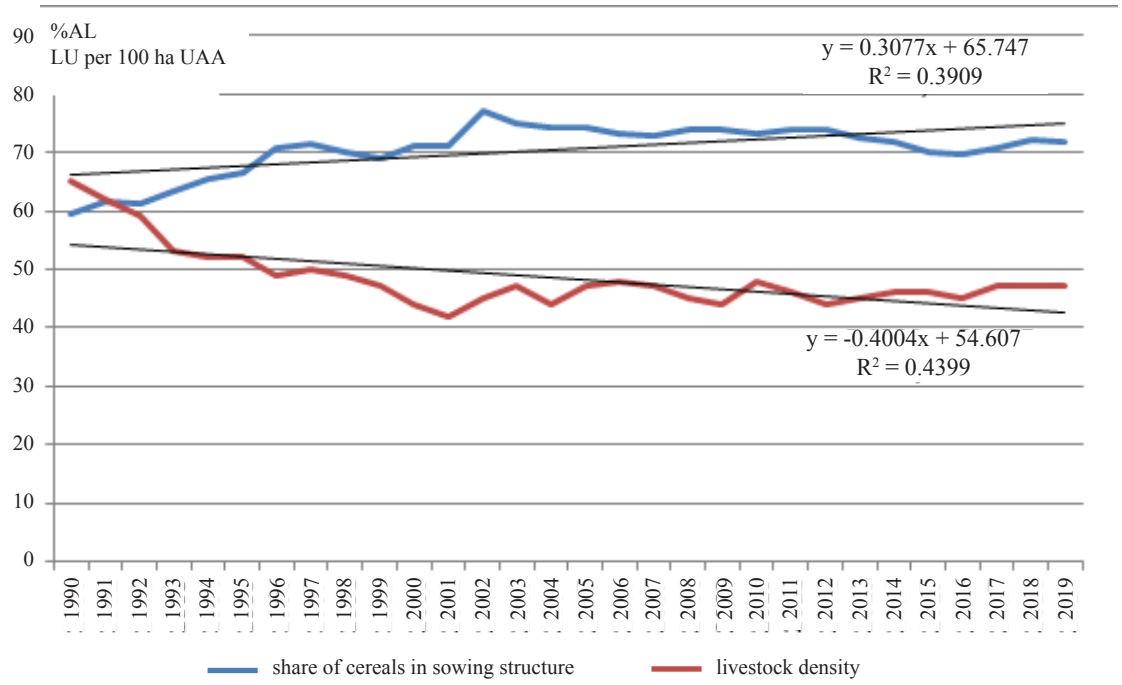

Figure 7. Changes in the share of cereals in sowing structure [% AL] and total livestock density [LU per 100 ha UAA].

temic transformation (Table 3). As for sugar beet, in the analogous comparison, the increase in the yield level was approximately 70%.

The level of grain yield in the examined 30-year period (1990–2019) was significantly (r = 0.73–0.80) affected by such factors as the size of agricultural area in a farm (x1), the level of NPK mineral fertilisation (x3) and the intensity of chemical plant protection (x4), which is confirmed by high correlation coefficients describing interdependencies between these factors (Table 4). At the same time, the percentage of cereals in the total crop area (x2) had no significant effect on their productivity. Based on statistical analysis, under a strong correlation between factors x1, x3, and x4, the dependence of cereal grain yield (Y) on the level of NPK mineral fertilisation (x3) can be described by the following regression equation:

$$Y = 1.6777 + 0.0145x3;\ R^2 = 0.53$$

Thus, the variability in cereal grain yields was explained by 53%.

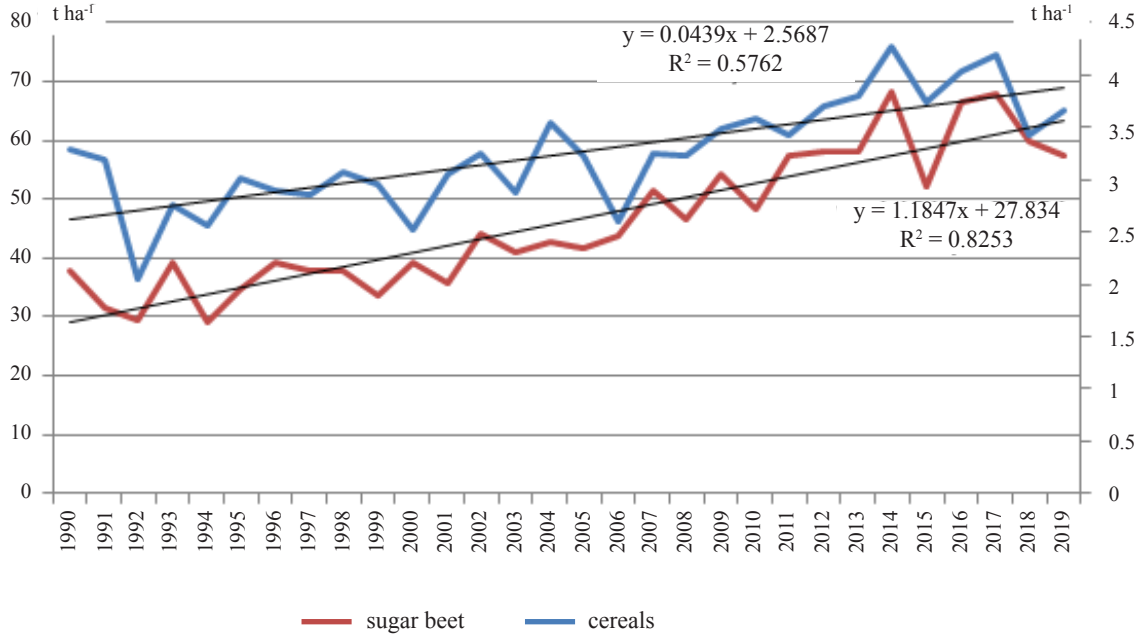

Figure 8. Yield changes of cereal grains and sugar beet roots [t ha^{-1}].

Table 4. Correlation between cereal grain yields and selected factors (n = 30).

Variable	Y	x_1	x_2	x_3	x_4
Y	1.00	0.80*	0.35	0.73*	0.78*
x_1	0.80*	1.00	0.51*	0.69*	0.97*
x_2	0.35	0.51*	1.00	0.24	0.45*
x_3	0.73*	0.69*	0.24	1.00	0.75*
x_4	0.78*	0.97*	0.45*	0.75*	1.00

* correlation significant at $\alpha = 0.05$
Y – cereal grain yield [t ha^{-1}]
x_1 – area of private farms exceeding 1 ha of UAA [ha^{-1}]
x_2 – share of cereals in sown area [%]
x_3 – mineral fertilizers NPK [kg ha^{-1}]
x_4 – consumption of plant protection products [active substances], [kg ha^{-1}].

The production of slaughter livestock and livestock converted to meat was characterised by a very similar and strong ($R^2 = 0.86$) upward trend (Fig. 9). Since 1994, both indicators have shown a developing trend. The livestock meat production during the whole research period represented on average 75% (in annual terms) of the slaughtered livestock production volume (reflected in Fig. 9). The livestock production in the last 10 years (2010–2019) was 84% higher than the period at the beginning of the system transformation (Table 3).

As an essential measure of agricultural production intensity, the total animal livestock rate showed a slight downward trend at an annual rate of 0.4 LU per 100 ha UAA (Fig. 7). The most significant decrease in animal livestock density occurred in 1990–2004, while later its fluctuations were small, without a clear tendency. In terms of livestock production, the total animal livestock density increased between 1990 and 2005, and in the following period, it remained balanced but lower. Between 2000 and 2019, a decrease in animal livestock density of about 15% with its status from 1990 to 1999 was observed (Table 3). In the prediction for 2020, it was assumed (Krasowicz, Kuś, 2010) that the total animal livestock density in Poland is going to be at a higher level (47.1 LU per 100 ha UAA) than in 2000–2019 (45.7 LU per 100 ha UAA) (Table 3).

In recent years, the upward trend in beef and veal livestock production has been considered a positive phenomenon, while the importance of pork livestock production has declined (Matyka, 2018). The lowest total cattle stocking rate level occurred in 2000–2009 (Table 3), while a slight improvement of such indicator has been observed since 2012 (Fig. 10). For pigs, the livestock rate decreased more in 2010–2019 by 23% compared to its level in 1990–2009 (Table 3). The falling trend for the 30 years amounted to 1.2 LU per 100 ha UAA per year (Fig. 10). Such indicators of animal production as production of cow milk and annual milk yield per cow were characterised by quite considerable dynamics. The milk production increased annually by 9.3 l ha^{-1} of UAA, and the milk yield per cow increased by 100 l year^{-1} (Fig. 11). In the last 10 years, 2010–2019, milk production was 29% higher than the one achieved at the beginning of the system transformation period (Table 3). In the comparable time comparison, the annual milk yield per cow was higher by 62%.

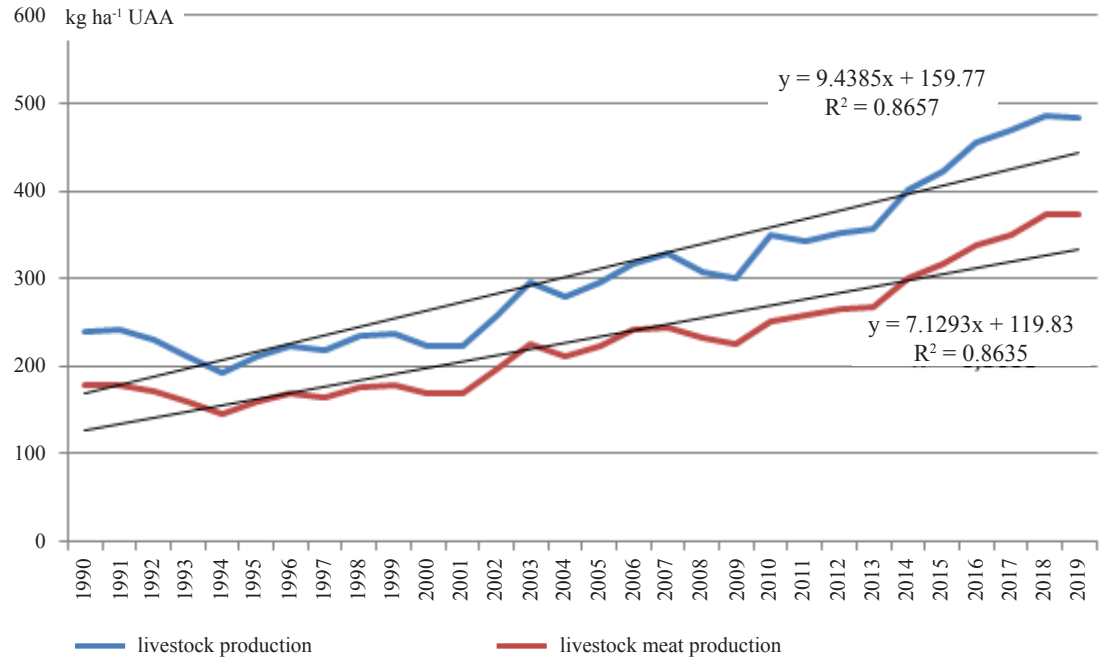

Figure 9. Livestock production changes [kg ha^{-1} UAA] and livestock meat production [kg ha^{-1} UAA].

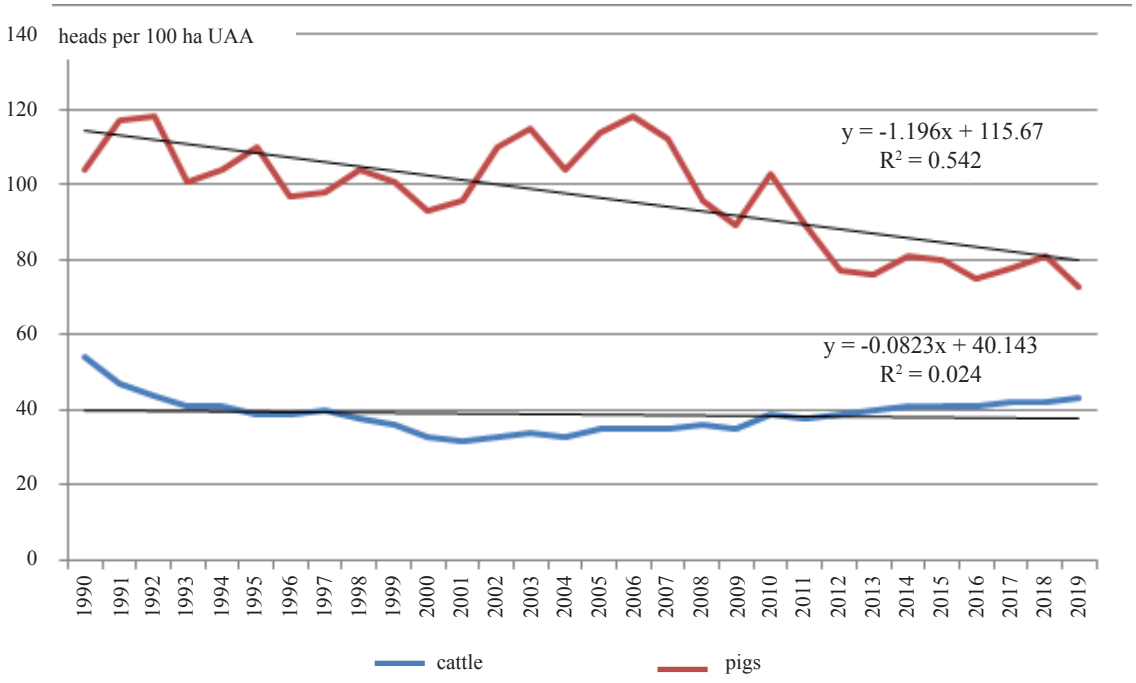

Figure 10. Cattle and pig stocking density changes [heads per 100 ha UAA].

It deserves to be emphasized that agricultural production (including farm fertiliser management) shows high regional differentiation (Matyka et al., 2013; Matyka, 2018; Krasowicz, Kuś, 2010; Wrzaszcz, Kopiński, 2019). The issue of regional agricultural differentiation requires a separate study, which would deepen the knowledge on this problem.

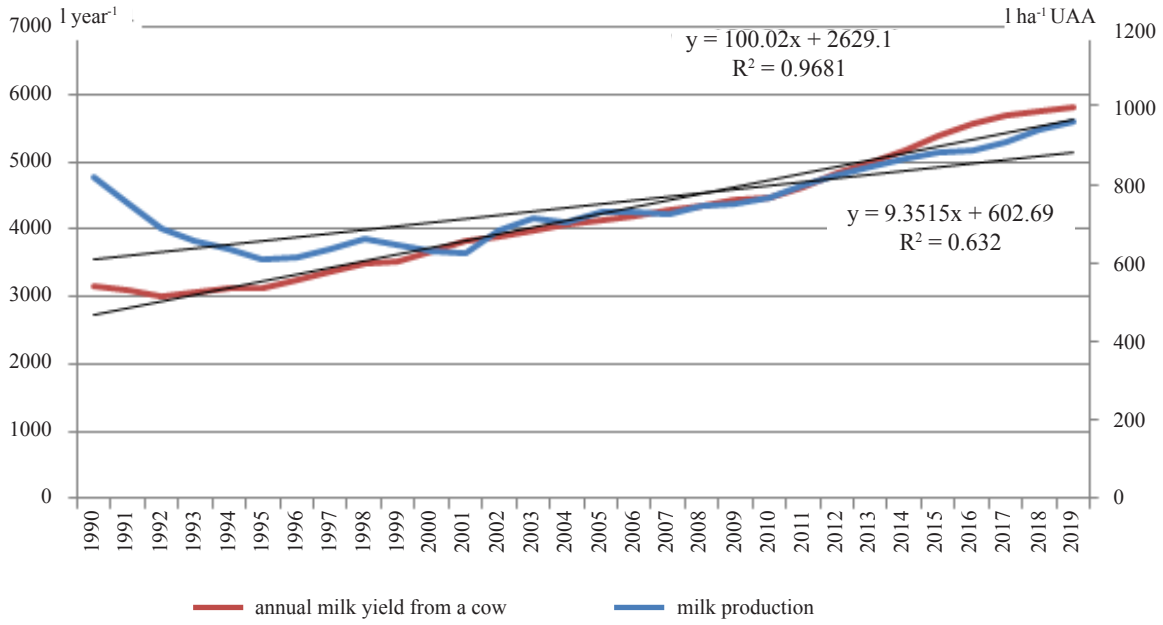

Figure 11. Changes in diary milk production [l ha^{-1} UAA] and annual milk yield from a cow [l year^{-1}].

SUMMARY

Significant dynamics of changes characterised the level and structure of agricultural production in the analysed years. The Common Agricultural Policy, whose instruments accelerated and strengthened transformation and restructuring processes in Polish agriculture, significantly impacted the changes taking place. There have been processes of specialisation and concentration of production.

As a result of the system transformation and Poland's accession to the structures of the European Union, farms deepened specialization by using production factors to develop leading agricultural activities in terms of increasing the scale and commodity production (Matyka, 2007; Matyka et al., 2013). Based on own assessment and analyses of other authors (Domańska K., Nowak A., 2013; Dzun, 2004; Klepacki, 2002; Matyka et al., 2013; Ufnowska, Kukuła, 2002; Zegar, 2009; Zegar, 2019; Ziętara et al., 2021), positive directions of Polish agriculture development can be distinguished, viz:

– development of farms larger in area,
– increase in the average area of farms and land concentration,
– increase in plant yields, animal slaughter and cow milk yields,
– reduction of employment in agriculture as a factor of growth of labour productivity.

On the other hand, unfavourable phenomena include:

– a decreasing area of agricultural land in Poland,
– decreasing outlays on some production goods, including low consumption of certified seeds and fertilizer lime,
– a downward trend in the stock of livestock but with a noticeable improvement in their productivity.

The main determinants of changes in the level and structure of agricultural production include: a decrease in the area of utilised agricultural land and the number of commercial farms, an increase in farm average size, and an improvement in plant and animal productivity.

REFERENCES

Domańska K., Nowak A., 2013. Polish agriculture changes in the period 2002-2010 in the context of sustainable development economy. Roczniki Naukowe Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich, 100 (3): 29-39. (in Polish + summary in English)

Doroszewski A., Jóźwicki T., Wróblewska E., Kozyra J., 2014. Susza rolnicza w Polsce w latach 1961 – 2010. IUNG-PIB Puławy, 144 pp.

Dzun W., 2004. Agriculture farms in the process of systemic transformation (1990-2002). Wieś i Rolnictwo, 1(122): 43 -64. (in Polish + summary in English),

Gołębiewska B., 2010. Organizational and economic effects of differentiation of relations between agricultural farms and their environment. Rozprawy Naukowe i Monografie, 363, SGGW Warszawa, 187 pp.

GUS 1998–2020. Rocznik Statystyczny Rolnictwa. Główny Urząd Statystyczny, Warszawa / Statistical Yearbook of Agriculture. Statistics Poland, Warsaw.

Józwiak W., Mirkowska Z., Sobierajewska J., Zieliński M., Ziętara W., 2019. Adjustment processes in selected types of farms depending on their income situation. Zagadnienia Ekonomiki Rolnej, 4: 29-54, doi: 10.30858/zer/115183. (in Polish + summary in English)

Klepacki B., 2002. Gospodarka i rolnictwo polskie w okresie transformacji systemowej. Wieś Jutra, 8(49): 7-8.

Kobyłecki J., 2004. Cele i zakres transformacji ustrojowej rolnictwa polskiego. pp. 9-18. In: Pozafinansowe czynniki rozwoju obszarów wiejskich, Akademia Podlaska Siedlce.

Kowalik M., 2017. Agricultural land use changes in Poland after 2010 – reasons, trends and risks. Polish Journal of Agronomy, 31: 45- 51, doi: 10.26114/pja.iung.345.2017.31.07. (in Polish + summary in English)

Krasowicz S., Kuś J., 2010. General directions of the agricultural production in Poland until the year 2020 – a prognosis. Zagadnienia Ekonomiki Rolnej, 3: 5-18. (in Polish + summary in English)

Kuś J., 1995. Rola zmianowania roślin we współczesnym rolnictwie. IUNG Puławy, 35 pp.

Majewski E., 2010. Selected production, economic and environmental aspects of crop rotations. Roczniki Nauk Rolniczych, ser. G, 97(3): 159-168. (in Polish + summary in English)

Matyka M., 2007. Przemiany wybranych gospodarstw o różnych kierunkach produkcji w okresie transformacji systemowej. Praca doktorska (PhD thesis), IUNG- PIB Puławy, 112 pp.

Matyka M., 2018. Zmiany poziomu i struktury produkcji w polskim rolnictwie. Studia i Raporty IUNG- PIB, 55(9): 77-97, doi: 10.26114/sir.iung.2018.55.04.

Matyka M., Krasowicz S., Kopiński J., Kuś J., 2013. Regionalne zróżnicowanie zmian produkcji rolniczej w Polsce. Studia i Raporty IUNG- PIB, 32(6): 143-165, doi: 10.26114/sir.iung.2013.32.07.

Nowak A., Wójcik E., 2013. The changes in the level and the structure of the rural production in Poland against a background of EU. Problemy Rolnictwa Światowego, 28(2): 59-67. (in Polish + summary in English)

Siekierski C., 2020. Conditions for the development of polish agriculture in the context of political changes, EU integration and evolution of the Common Agricultural Policy. Zagadnienia Ekonomiki Rolnej, 1: 122-137. (in Polish + summary in English)

Ufnowska J., Kukuła S., 2002. Zmiany w produkcji rolnej RZD IUNG w procesie przystosowawczym do gospodarki rynkowej. Wieś Jutra, 8: 27-30.

Woś A. (ed.)**, 1998a.** Rolnictwo polskie w okresie transformacji systemowej (1989 – 1997). IERiGŻ Warszawa, 357 pp.

Woś A., 1998b. Ustrojowe podstawy transformacji sektora żywnościowego. pp. 3-15. In: Rolnictwo polskie w okresie transformacji systemowej (1989 – 1997). IERiGŻ Warszawa.

Wrzaszcz W., Kopiński J., 2019. Fertilizer management in Poland in the context of agricultural sustainable development. Studia i Monografie, 178, IERiGŻ- PIB Warszawa, 145 pp. (in Polish + summary in English)

Zegar J.S., 2009. The concentration of land in the Polish private agriculture. Roczniki Nauk Rolniczych, ser. G, 96(4): 258 - 266. (in Polish + summary in English)

Zegar J.S., 2019. The perspectives of family farms in Poland. Zagadnienia Ekonomiki Rolnej, 3: 31-53, doi: 10.30858/zer/111997. (in Polish + summary in English)

Ziętara W., 2003. Przemiany w rolnictwie polskim w latach 1990 – 2001. Roczniki Nauk Rolniczych, ser. G, 1(90): 32-49.

Ziętara W., Zieliński M., Mirkowska Z., Józwiak W., 2021. Systemy i skala produkcji a obciążenia środowiskowo - klimatyczne. Forum Inicjatyw Rozwojowych, IERiGŻ-PIB Warszawa, 76 pp.

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