Impact of growing costs on the profitability of crop production in Poland in the mid-term perspective

Wpływ kosztów uprawy na opłacalność produkcji roślinnej w Polsce w perspektywie średnioterminowej

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Abstract

Main aim of this paper was to demonstrate the impact of cultivation intensity on economic of selected activities of crop production in Poland. The projection of income of these activities in mid-term perspective, i.e. in 2016, has also been developed. Studies have shown that for cultivation technology of low intensity, as compared to high, the economic results of examined activities were more favourable. The profitability of production, expressed as a ratio of the value of production to economic costs, was higher by 10.0 to 52.7%. According to the projection results, in the highly intensive cultivation, high costs and dynamics of growth, stronger than growth of income, had a negative impact on the level of income. It is expected, even with an exceptionally high yield, income level will be lower than in the cultivation of low intensity. The results show that the use of technological progress can reduce a negative impact of chemicals on the environment while maintaining the high economic efficiency of production.

Keywords: crop intensity, direct costs, income projection, profitability, yield

Streszczenie

W pracy pokazano wpływ intensywności uprawy na wyniki ekonomiczne wybranych działalności produkcji roślinnej w Polsce. Sporządzono także projekcję dochodów w perspektywie średnioterminowej, tj. do 2016 roku. Badania wykazały, że przy technologii uprawy o niskiej intensywności, w porównaniu do wysokiej, wyniki ekonomiczne badanych działalności były korzystniejsze. Opłacalność produkcji ujęta jako relacja wartości produkcji do kosztów ekonomicznych była wyższa od 10,0 do

52,7%. Według wyników projekcji przy uprawie wysoko intensywnej, wysokie koszty i silniejsza niż przychodów dynamika ich wzrostu miały negatywny wpływ na poziom dochodu. Przewiduje się, że nawet przy wyjątkowo wysokich plonach poziom dochodu będzie niższy niż przy uprawie o niskiej intensywności. Wyniki badań pokazują, że wykorzystując osiągnięcia postępu technologicznego można ograniczyć niekorzystny wpływ środków chemicznych na środowisko naturalne zachowując równocześnie wysoką ekonomiczną efektywność produkcji.

Słowa kluczowe: intensywność produkcji, koszty bezpośrednie, opłacalność, plon, projekcja dochodu

Szczegółowe streszczenie

Mając na uwadze niekorzystne oddziaływanie na środowisko rolnictwa intensywnego, podstawowym celem jaki przyjęto w badaniach było określenie zależności, między poziomem intensywności produkcji roślinnej a jej efektywnością. Skalę zróżnicowania intensywności produkcji pokazano na przykładzie sześciu działalności produkcji roślinnej o relatywnie dużym znaczeniu gospodarczym w Polsce (tj. pszenicy ozimej, żyta ozimego, pszenżyta ozimego, jęczmienia jarego, rzepaku ozimego i buraków cukrowych). Miarą intensywności były nakłady środków produkcji, których wielkość wyrażał poziom kosztów bezpośrednich. Zbadano wpływ intensywności produkcji na wyniki produkcyjne i ekonomiczne tych działalności. Dodatkowym aspektem była projekcja dochodów, a więc określenie kierunku zmiany w perspektywie średnioterminowej. Pokazano wpływ na wysokość dochodu, prognozowanego tempa zmian cen środków do produkcji rolnej oraz plonu czterech działalności, tj. pszenicy ozimej, żyta ozimego, jęczmienia jarego i rzepaku ozimego.

Wyniki badań dowodzą, że przy niższych nakładach środków produkcji, można uzyskać korzystniejsze efekty ekonomiczne w porównaniu do technologii wysoko intensywnych. Jako miarę oceny efektów ekonomicznych przyjęto nadwyżkę bezpośrednią, dochód z działalności oraz dochód z działalności z tytułu zarządzania. W przypadku nadwyżki bezpośredniej, wyższą uzyskali rolnicy w gospodarstwach o niskiej intensywności uprawy (A) – przewaga w porównaniu do gospodarstw o wysokiej intensywności uprawy (B) wynosiła od 9,4 do 45,4% (wyjątkiem była tylko pszenica ozima i żyto ozime). Natomiast kierunek zmiany dochodu z działalności oraz dochodu z zarządzania w przypadku wszystkich działalności był na korzyść gospodarstw z grupy A. Sytuacja gospodarstw z grupy B była gorsza, świadczy o tym fakt, że uprawa pszenżyta ozimego nie pozwoliła na uzyskanie dochodu, był on wartością ujemną. Oznacza to, że wartość produkcji zapewniła tylko częściowe pokrycie kosztów – ogółem w 99,6%, a ekonomicznych w 95,7%.

Wyniki projekcji wykonanej dla zbóż i rzepaku wskazują na znacznie silniejszy – w perspektywie 2016 roku – wzrost kosztów niż wartości produkcji, średnio w wyodrębnionych grupach gospodarstw zawierał się on w przedziale od 1,4 do 10,9 pkt. proc. Przyjmując za miarę oceny poziom dochodu, wyraźna jest przewaga technologii uprawy o niskiej intensywności, tj. niższych kosztach bezpośrednich (A). W gospodarstwach, w których technologia uprawy była intensywna (B), relatywnie

wysokie koszty i silniejsza niż przychodów dynamika ich wzrostu negatywnie wpływały na poziom dochodu. Korzystnej relacji przychodów do kosztów produkcji można spodziewać się tylko przy wyjątkowo wysokich plonach. Wtedy w gospodarstwach z grupy B dynamika wzrostu dochodu może być silniejsza niż w jednostkach z grupy A. Wyniki projekcji pokazują kierunek i dynamikę zmian przychodów, kosztów oraz dochodu z uprawy pszenicy, żyta, jęczmienia i rzepaku w perspektywie 2016 roku. Pokazują także granice zmienności uzyskanych efektów, spełniają więc rolę informacyjną i ostrzegawczą.

Introduction

In Poland, agriculture is one of the key sectors of the national economy determining the food production, the level of food supply to population and food security of the country. Agriculture manages the area constituting 61% of the total area of the country and is the main administrator of the environment. It has significant production potential, but also creates risks to the environment (Jankowiak, 2009).

The second half of the twentieth century was a period of agricultural intensification, measured by large growth of crops, animal and work productivity. In recent years, however, the negative consequences of such development are more clearly visible both in Poland as in other countries. Moreover, the awareness of the negative consequences of excessive fertilization and application of large amounts of chemical plant protection products is also more and more widespread (Dincer, 2000; Runowski, 2002).

The research results show that agricultural activity significantly interferes with the natural circulation of minerals, mainly by intensification of production (Górka et al., 1998). Despite positive production and economic effects of this intensification there are also negative consequences in terms of changes in soil fertility and the composition of groundwater. However, the most serious threat of agriculture are nitrogen and phosphorus compounds unused in agricultural production that can penetrate into groundwater and open water (nitrates, phosphates) and, in the case of nitrogen escape to the atmosphere (ammonia, nitrogen oxides). As a result, the deficit thereof may lead to a reduction in the productivity of soils (OECD, 2006).

Further increases in nitrogen and phosphorus application are unlikely to be as effective at increasing yields because of diminishing returns. All else being equal, the highest efficiency of nitrogen fertilizer is achieved with the first increments of added nitrogen; efficiency declines at higher levels of addition. Today, only 30–50% of applied nitrogen fertilizer and ~45% of phosphorus fertilizer is taken up by crops. A significant amount of the applied nitrogen and a smaller portion of the applied phosphorus is lost from agricultural fields (Tilman et al., 2002).

In case of lower consumption of plant growth agents it often happens that the yields decrease. The decrease, however, can also occur after exceeding the optimal threshold of fertilization (in such case the quality of agricultural products also deteriorates). Two kinds of consequences take place: an increase in the volume of investment is increasingly more harmful to the environment, and the declining income per unit of investment deteriorates economic relations, especially when the price of the unit of investment - because of their limited supply – starts growing (Zegar, 2009).

Sometimes greater use of chemicals is not economically justified, because there are other environmental factors that limit yielding, such as water shortages (Popp and Hantos, 2011).

When considering the issue of intensity and profitability of agricultural production one should also recall the question of the hormesis phenomen effect, by which is meant the stimulating effect of low doses of a substances (i.e. nutrients) on living organisms, which in high doses inhibit growth and development of these organisms (Calabrese and Baldwin, 1997; Szarek, 2005). Complementarity or competition occurring between plant growth agents leads in practice to a huge diversity of crops. Hormesis phenomen effect presupposes that the substances inherently harmful in large doses, in sufficiently low doses have a beneficial effect on the organism, they stimulate plant growth and development which results in increased yields. Multiannual researches on mineral fertilization of crops have shown that increasing doses of mineral fertilizers produce the effect that is consistent with that of the hormesis phenomen effect (Szarek, 2009).

In Poland, the use of mineral fertilizers is quite high, for several years it exceeded 100 kg NPK per ha of agricultural land, as in some European Union countries. In 2010/2011 fertilization amounted to 127 kg NPK, it was higher only in Germany – 150 kg, the Netherlands – 159 kg and in Belgium and Luxemburg – 179 kg. In recent years, the number of countries with such a high level of fertilization decreased from 13 in 2002/2003 to 5 in 2010/2011. In 2010/2011 the average consumption of NPK per ha of agricultural land in the EU-27 countries was 86 kg, and in the EU-15 countries, – 92 kg, compared to 2002/2003 it decreased respectively by 10.4% and 9.8% (GUS, 2012; Zalewski and Zalewski, 2010; Zalewski, 2013a). In addition to fertilizing an important element of crop production, which affects stability of crops, is plant protection against harmful organisms. In Poland, the use of plant protection products is also increasing. In 2011, as compared to 2010, the consumption of active substance per 1 ha of arable land and orchards increased by 0.2 kg and amounted to 2.0 kg (Zalewski, 2013b).

Lower consumption of plant growth agents obliges the farmer to use other environment-friendly methods to maintain agricultural production at profitable level. Then the importance of consolidated practises grow, the mechanical inputs increase and even manual methods controlling of harmful organisms increase, etc. Implementing the biological and technological achievements may reduce a negative impact on the environment while maintaining the high economic efficiency.

Given the negative impact of intensive farming on environment, the basic aim which was adopted in the study was to determine the relationship between the level of intensity of crop production and its efficiency. The scale of production intensity variation was shown on the example of six crop production activities of relatively high economic importance in Poland, i.e. for winter wheat, winter rye, winter triticale, spring barley, winter rape seed and sugar beet. The researched covered the impact of the production intensity on the production and economic results of these activities. An additional aspect was the projection of income and thus determination of the direction of change in the medium term. The study also showed the impact on the amount of income, forecasted rate of changes of price of agricultural means of production and yield of four activities, namely winter wheat, winter rye, spring barley and winter rape seed. In Poland the most important group of crops are cereals. This is a result of

changes which took place in Polish agriculture in recent decades, including those associated with the decline of potato importance as a feed for pigs. In the national area of sowing has also been noted a growth of the area of rapeseed which is related to the production of biofuels.

The paper is structured as follows. Section 1 describes the data sources and research methodology, section 2 presents the findings of the research, discussing the production and economic results of the surveyed activities and projection of income for selected activities for 2016. Section 3 contains discussion with the findings of other authors. The article ends with conclusions from conducted research.

Data and methodology

Empirical data for six crop production activities, which in 2006-2011 were covered by research, i.e. winter wheat, winter rye, winter triticale, spring barley, winter rape seed and sugar beet, were collected in individual farms located throughout Poland. The number of farms in the sample ranged from 118 to 275, depending on the activity and the year of studies. Farms for the study were selected in a targeted manner from a representative sample, which was in the Polish FADN system. The selection of farms was made independently in each year. The study of agricultural production activities was carried out according to the methodology established for AGROKOSZTY system, in which detailed data on the level of production and the direct costs are collected and processed (Skarżyńska, 2007). It was a part of research work carried out by the Institute of Agricultural and Food Economics – National Research Institute in Warsaw.

According to literature, the intensity of agriculture shows the amount of expenditure per area unit. Over the years, the approach to this problem has varied, mainly in the context of choice of appropriate parameters to evaluate the intensity (Manteuffel, 1984; Hernández-Rivera and Mann, 2008). The study adopts as the measure of production intensity the actual volume of production, which was expressed in value by the level of direct costs. The direct costs of crop production include: the cost of seeds, fertilizers, plant protection products and growth regulators and specific costs, that is of direct relevance to a specific activity and improving the quality and value of the final product (e.g. the costs of irrigation water, soil analysis). Generic structure of these costs is in line with the European Union guideline formulated in the context of the calculation of standard gross margin (Augustyńska-Grzymek et al., 2000; Eurostat, 2003).

For the analysis of the production intensity, farms from the study sample were put in order according to the amount of direct costs per 1 ha of crops of studied activities. The data were arranged by quartiles, but to show the scale of variation, the results for the activities were presented for the two boundary quartiles, i.e. groups of farms with low (A) and high (B) level of direct costs per 1 ha of crop.

The results for individual activities, as a several-year annual moving average covering the 2006-2011 period are presented in tabular form. This treatment reduces the impact of random variation possible in the analysis of average annual (e.g. the effects of sudden changes in market or weather conditions) and allows more reliably to determine the trend of changes.

Horizontal analysis was used by comparing parameters characterising studied activities in farms with low (A) and high (B) intensity of their crops. To illustrate the scale of variation, data was shown in form of relationships: A/B in percentage terms (assumed that data for the activities in farms from B group = 100). The study included income, it means the value of potential commodity production with 1 ha of crops, inputs and costs and economic effects. The level of gross margin, income from activity and income from management activity were taken as the basic measure of achieved effects. The method of calculating these categories is presented below:

gross margin = value of production – direct costs

income from activity = value of production – total costs (direct + indirect)

income from management activity = value of production – economic costs

Economic costs are determined as total costs of production (Samuelson and Nordhaus, 1995). They include the direct and indirect costs and costs of own production factors (i.e. labour, land and capital). Direct costs are the cost components which, without doubt, can be attributed to a given activity. However, the indirect costs are common to the whole farm. They include e.g. the costs of: electricity, diesel fuel, depreciation of fixed assets, current repairs of machinery and buildings, taxes. To settle the direct costs of a farm the division key was used, which was the share of the value of the various activities in the value of production in total.

Costs of own production factors are considered as alternative costs. For the analysis of own labour inputs valued at a rate of standard rates, established on the basis of the level of remuneration, average for the year, of employees in the national economy (according to the Central Statistical Office – CSO), assuming that one full-time paid employee works in agriculture 2200 hours a year. As a measure of the cost of land was adopted the lease payment. The rent is expressed in dt of wheat, which is converted into PLN according to the average price of purchasing wheat in the country (according to CSO). The cost of capital includes the cost of operating capital and fixed assets. The expenditures on current assets of production (i.e. seeds, fertilizers, plant protection products, fuel) were considered as the cost of operating capital used in production. However, the cost of fixed assets are the costs of capital invested in one's own production fixed assets (buildings, machinery). Capital cost was estimated according to the interest rate for accounts deposited in the major commercial banks in Poland (CSO). It was assumed that working capital was frozen for six months, and the fixed assets for 1 year (Skarżyńska, 2010).

The adopted methods of research made it possible to assess the economic efficiency of the production of studied activities. The focus is on the analysis of the level of production and direct costs, in total, i.e. direct and indirect costs falling under the economic costs. Three levels may be distinguished in the economic calculation, taking into consideration the purpose to which the information generated is meant to serve. The indicator of production profitability expresses the relation of the value of production and costs and according to the group of costs showed in the dominator, was designated as I, II and III. The profitability indicator I – means the surplus of the value of production over direct costs, indicator II – the surplus of the value of production over total costs (indirect + direct), and indicator III

– means the surplus of the value of production over economic costs. The indicator informs, what percentage of the value of the production, expressed in current prices, covers the incurred costs of its production.

The next research issue is a projection for 2016 of the income from cultivation of winter wheat, winter rye, spring barley and winter rape seed. The basis for the preparation of the actual data is characterised by activities in A and B group of farms in 2006-2011. This approach reduced the random fluctuation of individual variables. The construction of the projection was based on the method of time series (Mirer, 2002; Jabłoński, 2012).

Using the data from official statistics – for the variables describing the income and costs of production of studied activities – there were built time series which covered 17 years, the period from 1995 to 2011. Time series allowed for extrapolation of the studied phenomena into the future. Classical models of development trends were used for modelling and preparation of results projection. Development trends have been separated by the analytical method, i.e. by finding the trend function f(t) (t is time), which in the best way describes the changes of the phenomenon over time (Wasilewska, 2011). The selection of the analytical form of this function was made heuristically. It involves finding some forms of trend function, and then selection of one of them according to the criteria applied (Stańko, 1999). Two criteria were distinguished for the function selection: height of determination coefficient R^2 and the knowledge of the evolution of the studied phenomenon over time. It is also assumed that the function parameters were statistically significant. Five functions were taken into account: linear, second-degree polynomial (quadratic), exponential, power and logarithmic. For each of the considered series a model of development trends was drawn up in the following form:

$Y_t = \beta_0 + \beta_1 t + \varepsilon_t$ – linear trend model,

$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$ – quadratic trend model

$Y_t = \beta_0 e^{\beta_1 t} \cdot \varepsilon_t$ – exponential trend model,

$Y_t = \beta_0 t^{\beta_1} \cdot \varepsilon_t$ – power trend model,

$Y_t = \beta_0 + \beta_1 \ln(t) + \varepsilon_t$ – logarithmic trend model.

where:

Y_t – value of the dependent variable at the point t,

t – explanatory variable (time) takes total values from 1 to ∞,

β_0 – independent part,

β_1, β_2 – function parameters

ε_t – random component.

For each of the analysed time series one of the trend functions was selected, which was used to extrapolate the phenomenon for 2016, i.e. variables characterising studied activities. Projection was done for the average production performance results, and in worse (worst-case scenario) and better (best-case scenario) than the average level. Yield adjustments were made on the basis of percentage deviations of 0.05 and 0.95 percentiles of the median in the years 1995-2011.

Results

Production and economic results of the surveyed activities

The studies show the diversity of the results of economic activities of cultivation depending on the intensity of cultivation. The measure of intensity were direct costs incurred for 1 ha. The positive correlation between the amount of these costs and the land for cultivation is noteworthy. In farms with low intensity (A) the area of studied activities ranged from 5.9 to 16.8 ha, whereas with high (B) it ranged from 8.5 to 38.0 ha. It is estimated that with the larger scale of cultivation, greater input of plat growth agents were used deliberately, farmers were expecting better production and economic results. The more so, that better quality soils dominated in these farms (B). Their use value expressed in points ranges from 0.81 to 1.48 points, while for low-intensity (A) farms it ranged from 0.59 to 1.22 points. Among the factors that differentiate the level of yield, the farmer may control the level of direct costs. However, crop production is subjected to substantial risks and uncertainties due to changing climatic factors, which are beyond the control of the farmer.

Diversity of cost, production and profitable categories of studied activities, was expressed in the form of relationship comparing their level per 1 ha in farms with low (A) and high (B) intensity of cultivation technology. These values are given in percentages. Studies have shown that the direct costs in group A were from 29.6 to 58.0% of the level incurred in B. This means, that in units of low cultivation intensity (A) – in comparison to high (B) – they were lower from 42.0 to 70.4% depending on the activity.

The structure of the direct costs is dominated by two components: the cost of mineral fertilizers and the cost of plant protection products, their total share was from 61.9 to 85.8%. The cost of mineral fertilizers in farms from group A was from 24.4 to 60.8% of the level, which was incurred by farmers from the B group, while the cost of plant protection products from 13.6 to 53.8%. The diversity to some extend could have been caused by the difference in the purchase price of those products, but it is estimated that the number of protective treatments conducted had a decisive influence in the case of plant protection products, which was related to the amount of active substance consumed. Whereas, the difference in cost of mineral fertilizers resulted from the differences in the size of the dose of NPK used, in farms from group A – it was significantly lower than in group B (from 28.9 to 74.6%) – table 1.

Fertilization level is an important aspect of any production, its quantitative dimension is closely related to the effectiveness of fertilization. Efforts to improve the efficiency of effectiveness of use of fertilizers is important and desirable, and it is associated with a reduction of funding and improvement of the quality of products. A major difficulty in this area is, however, an occasional soil analysis of the content of fertilizer components in the soil made by farmers, and, consequently, often irrational fertilization.

Table 1. Plant production activity results for the surveyed farms in the lowest (A) and highest (B) quartile of cropping intensity in Poland on average in the surveyed years

Tabela 1. Wyniki produkcji roślinnej w gospodarstwach z najniższego (A) i najwyższego (B) kwartyla intensywności ich uprawy w Polsce, średnio w latach badań

Activity	Farm group	Data per 1 hectare expressed as a ratio A*B^{-1}, in %												
		Yield, dt*ha^{-1}	Selling price, PLN*dt^{-1}	Average fertilising efficiency, kg	NPK dose	Value of production (VP)	Direct costs (DC)	Total costs (TC)	Economic costs (EC)	Gross margin	Income from activity	Income from management activity	Profitability index I VP/DC	Profitability index II VP/TC	Profitability index III VP/EC
Winter wheat	A	42.0	56.81	35.05	37.8	68.9	43.0	57.9	62.7	86.2	105.1	95.8	160.4	119.0	110.0
	B	58.7	59.90	18.24											
Winter rye	A	22.3	48.67	41.79	25.7	57.6	29.6	45.1	50.8	81.1	156.4	149.3	194.6	127.8	113.4
	B	36.5	49.71	17.08											
Winter triticale	A	32.8	39.7	50.08	25.4	76.8	31.0	46.6	50.3	145.4	x	x	248.1	164.8	152.7
	B	44.4	38.32	18.10											
Spring barley	A	36.7	55.13	57.58	29.0	82.1	41.9	57.1	64.2	110.9	194.9	180.9	195.8	143.8	127.9
	B	42.3	58.69	18.00											
Winter rape	A	23.9	132.09	9.62	60.8	78.6	46.2	57.7	62.8	109.4	239.1	190.4	170.3	136.2	125.1
	B	29.8	135.93	7.27											
Sugar beet	A	574	11.04	192.88	71.1	97.8	58.0	74.9	74.1	132.7	254.5	242.9	168.6	130.6	132.0
	B	571	11.41	134.59											

Farm group: A – 25% of farms in the survey sample with a lower level of direct costs, low cropping intensity; B – 25% of farms in the survey sample with an upper level of direct costs, high cropping intensity.

Average fertilising efficiency – crop expressed in kg per 1 kg NPK.

x – means that in group B farms the income from activity and from management activity was a negative figure, the loss per 1 ha amounted respectively -7 and -77 PLN.

In order to evaluate the efficiency of the used mineral fertilizers (NPK) the average gross efficiency was calculated, which is the yield expressed in kg per 1 kg of NPK. The ratio of the average efficiency of gross fertilization, was higher in group A farms (from 1.3 times in the case of rape seed to 3.2 times for barley), that is, in those in which the applied cost of NPK per 1 ha was lower. It is estimated that the fertilizer used in group B farms (high cultivation intensity) was not fully rational, and thus its impact on the yield increase was limited. However, fertilization used in group A farms put much smaller pressure on the environment, and the additional attribute was better production results of harvest – table 1.

The analysis considered the total amount of costs and economic costs. The calculation results point to a direction of change in their level which is analogous to the direction of change of direct costs. In the farms with the low intensity of cultivation (A), compared to high (B), the total costs were less from 25.1 to 54.9%, and the economic costs from 25.9 to 49.7%. Focusing on the economic costs, it should be noted that this was caused by the direct costs, but also indirect costs and costs of production factors. In group A farms, indirect costs and costs of production factors were lower than in group B, in spite of this, the impact of direct costs on the level of economic costs was substantial. It is evidence by their share in the structure of the economic costs, that in farms from the group A ranged from 28.6 to 42.8%, and from the group B from 49.7,0 to 54.8%. The study results provide valuable information: the level of direct costs, which mainly depend on the farmer was a factor determining the amount of the economic costs.

In a view of the large differences in the intensity of cultivation, it is interesting to know the impact of its low and high level on the results of production activities. Studies showed, that in farms with low intensity of cultivation (A) – as compared to high (B) – yielding of crops was lower from 13.1 to 39.0%. The only exception were sugar beets, in their case, the level of yield in both groups of farms was similar. This could result from the fact that farmers care more about the timeliness and quality of agro-technical treatments, because the quality of soil in farms from group A was lower (soil valuation coefficient was 1.20 points, while in B – 1.31 points).

When it comes to the sale price, there was no big differences between the two groups of farms, it is a proof that a price slightly depends on the farmer. The executed production value is a derivative of yield and price, its amount of 1 ha on group A farms was 57.6-97.8% of the level achieved in group B. The main factor in this situation was lower yielding of the examined crops (except sugar beets).

The gross margin, income from activity and income from management activity were taken as the measure of economic effects (table 1). When it comes to gross margin, farmers from farms with low intensity of cultivation (A) received higher advantage compared to farms with high intensity of cultivation (B) and it ranged from 9.4 to 45.4% (except winter wheat and winter rye).The direction of change in income from activities and the income from the management was the same as the gross margin, but the difference was in favour of the farms from group A. Situation of group B was significantly worse, which was evidenced by the fact that the cultivation of triticale did not allow to obtain income, it was negative. This means that the value of production provided only partial coverage of costs – in total 99.6%, and economic costs 95.7%.

Gross margin is the first income category in economic account. It allows for simplified assessment of the economic effectiveness of making individual agricultural products depending on yield variations and products prices as well as changes in the level of input and their prices. Income from activity is a margin resulting after deducting from the value of production, direct and indirect costs. This income category is suitable for evaluating the results in the long-term perspective, assuming that the farm's production capacity is maintained at the constant level. Whereas, the income from management activities is for the farmer a payment for innovative activities and use of knowledge and management skills. This category was adopted as the criteria of production activity, because the farmer has the right to expect not only the income covering production costs (direct and indirect), but also the cost of using own factors of production, such as labour, land and capital.

To assess the economic efficiency of production activities in separate groups of farms a ratio of value of production was used, which is understood as the relationship of the value of production to costs (direct, in total and economic) expressed as a percentage. The calculation results show that the economic efficiency of production measured by the profitability indicator I, II and III was higher in group A farms, i.e. the lower intensity of cultivation. The advantage of this technology is very clear. When analysing profitability of production measured by a profitability indicator III (relation of production value to economic costs), it should be noted that in group of farms A compared to group B, the level of profitability was higher from 10.0 to 52.7% – table 1.

Projection of income for selected production activities for 2016

Farming is associated with making various decisions. These decisions relate to the future, that is why they are based on predictions as to future operating conditions of a farm. The specificity of agriculture, which consists in working with living organisms causes that forecasting in this field is difficult. Decisions taken by farmers are always associated with some risk as to their results. This is due to the differences of the time when decisions are made, and the time when their consequences appear.

At present, the importance of forecasts and projections increases due to a rapid technological progress and the effects that it produces, internal changes in farms and changes in their environment. Farms have to constantly adapt to the changing conditions. For the process of adaptation to be quick and aimed in the right direction, it becomes necessary to use relevant management tools. These are the instruments which allow to take the right decision or to choose from among many other alternatives.

Projections show, which trends may shape the predicted phenomenon in the coming years. Their mission is to inspire people using the results to take action aimed at consolidation of the direction of development recognised as beneficial or to prevent the direction of development, which is considered undesirable. Projections play an important information and warning role. Projection of changes in economic performance of agricultural products is difficult. It may nevertheless be useful in taking management decisions in farms, but also at the level of decision-making centres shaping agricultural policy.

Results of the projection made for cereal, such as winter wheat, winter rye, barley and winter rape seed indicate a much stronger – in 2016 perspective – increase of costs than the value of production. On average, in the established groups of farms it ranged from 1.4 to 10.9 p.p. – table 2.

Taking it into consideration, the impact of the forecasted increase in the cost on economic results of activities in farms with low (A) and high (B) cultivation intensity was examined (in outlays on the means of production were the measure of intensity, which expressed the level of direct costs). The projection assumes the same rate of change as regards individual components of cost in both groups of farms, but due to the different share in the structure of costs, the dynamics of cost changes in total – with respect to the base year – in groups varies. The calculations in table 2 show that the dynamics of cost changes was stronger in farms from group B, with one exception, which was winter rye.

Table 2. Projection for 2016 – dynamics indicators of performance of cereal and rape seed changes results in farms with the lowest (A) and the highest (B) quartile of cultivation intensity in Poland, compared to the base year*

Tabela 2. Projekcja na 2016 rok – wskaźniki dynamiki zmian wyników zbóż i rzepaku w gospodarstwach z najniższego (A) i najwyższego (B) kwartyla intensywności ich uprawy w Polsce, w stosunku do roku bazowego*

Specification		Winter wheat		Winter rye		Spring barley		Winter rape	
		A	B	A	B	A	B	A	B
Yield, dt*ha^{-1}		105.8		101.6		100.9		103.7	
Selling price, PLN*dt^{-1}		109.4		114.5		110.6		116.4	
Production value, PLN*ha^{-1}		115.7	115.9	116.5	116.3	111.4	111.4	120.6	120.6
Total cost (direct + indirect), PLN*ha^{-1}		121,1	122.0	122.6	122.6	121.5	122.3	122.0	123.0
Income from activity,	PLN*ha^{-1}	110.0	106.3	110.1	101.2	101.5	86.9	119.3	116.2
	PLN*1 dt^{-1}	104.0	100.4	108.4	99.6	110.5	86.1	115.1	112.1
Cost production of 1 unit income from 1 ha of crops, PLN		110.1	114.8	111.4	121.1	119.8	140.7	102.3	105.8

* The estimation for 2011, data from the 2006-2011 period adjusted by indicators of changes designated on the basis of the trend function, and then averaged.

Farm group A, B: see table 1.

The results presented in table 1 show that the high intensity of production does not always denote a high profitability (because the first is shaped on the farm and the other during the market exchange).The economic results of the studied cereals and rape seed were better in farms with lower direct costs, that is, with less intensive cultivation technology (A). According to projection by 2016 stronger dynamics of income increase from their crops should be expected in these very farms. The difference in favour of group A farms – compared to group B – can range from 3.1 to 14.6 p.p. A similar trend is visible in the income calculated for 1 dt of the product. The

projection also shows that in 2016 the results of the spring barley in intensive cultivation (B) can be particularly unfavourable. It is expected that the income from 1 ha will drop below the level of the base year (by 13.1%), while in farms with low intensity of cultivation (A) the income may increase (1.5%).

The measure of assessing the efficiency of production is the cost of production of the income unit from the activity. In the perspective for 2016, the two groups of farms are projected to increase, but in farms from group A, compared to B, the dynamics of growth will be weaker from 3.5 to 20.9 p.p. These results suggest a more rational way of running production in farms from group A, which are applying technology of low intensity – table 2.

Table 3. Projection for 2016 in pessimistic production conditions – indicators of dynamics of changes in cereals and rape seed production in farms with the lowest (A) and the highest (B) quartile of cultivation intensity in Poland, compared to the base year*

Tabela 3. Projekcja na 2016 rok w pesymistycznych warunkach produkcyjnych – wskaźniki dynamiki zmian wyników zbóż i rzepaku w gospodarstwach z najniższego (A) i najwyższego (B) kwartyla intensywności ich uprawy w Polsce, w stosunku do roku bazowego*

Specification	Winter wheat		Winter rye		Spring barley		Winter rape	
	A	B	A	B	A	B	A	B
Yield, dt*ha^{-1}	94.4		82.8		80.7		87.8	
Selling price, PLN*dt^{-1}	109.4		114.5		110.6		116.4	
Production value, PLN*ha^{-1}	103,3	103.5	95.2	95.0	89.1	89.1	102.1	102.1
Total cost (direct +indirect), PLN*ha^{-1}	124,1	122.0	122.6	122.6	121.5	122.3	122.0	123.0
Income from activity, PLN*ha^{-1}	94.5	74.0	66.3	27.8	57.4	14.7	83.9	63.4
Income from activity, PLN*1 dt^{-1}	89.5	78.3	80.0	33.6	71.1	18.2	95.6	72.2
Cost production of 1 unit income from 1 ha of crops, PLN	143.3	164.9	185.0	440.7	211.7	831.6	145.4	194.1

* The estimation for 2011, data from the 2006 to 2011 period adjusted by indicators of changes designated on the basis of the trend function, and then averaged.

Farm group A, B: see table 1.

The results determine the possible direction of changes, which is what should be expected in averaged, similar like in recent years, conditions of farm functioning (market and climatic conditions). Agriculture is a special area, this is due to the biological and technical nature of production. In agriculture, there are random events, such as droughts, floods, but also very favourable conditions for agricultural production, which cannot be predicted, but whose impact on the amount of crops is significant. In order to determine the direction of changes in the economic results of the examined cereals and rape seed – depending on the level of yield – the projection was made in two versions, i.e. pessimistic and optimistic one. The projection variants

assume only variations of yield (in plus and in minus), compared to the level adopted in the calculation for the average conditions of functioning of farms.

Table 3 shows the results of the projection of the examined activities in pessimistic production conditions. It was studied what changes in the level of income can be expected if climatic conditions are particularly bad and cause a strong decrease in yield. Studies indicate that an activity, which responds to the deterioration of conditions to the smallest extent is winter wheat, but for spring barley their impact will be the strongest.

The decrease in yield will affect the financial situation of activities, but the strength of the interaction of the farms from group A will be weaker, it means with the low intensity of cultivation. The advantage of farms from group A over B is clear. Taking into account the dynamics of the decline of income – in relation to the base year – the difference in favour of farms A can range from 20.5 to 42.7 p.p. This means that in adverse conditions of production the deterioration of the income situation of cereals and rape seed will be stronger in farms using intensive cultivation technology (B). Consequently, the efficiency of production will deteriorate, as evidenced by much stronger dynamics of growth of the production cost of income unit – table 3.

Table 4. Projection for 2016 in optimistic production conditions – indicators of dynamics of changes in cereals and rape seed production in farms with the lowest (A) and the highest (B) quartile of cultivation intensity in Poland, compared to the base year*

Tabela 4. Projekcja na 2016 rok w optymistycznych warunkach produkcyjnych – wskaźniki dynamiki zmian wyników zbóż i rzepaku w gospodarstwach z najniższego (A) i najwyższego (B) kwartyla intensywności ich uprawy w Polsce, w stosunku do roku bazowego*

Specification	Winter wheat		Winter rye		Spring barley		Winter rape	
	A	B	A	B	A	B	A	B
Yield, dt*ha^{-1}	115.1		113.1		107.5		128.0	
Selling price, PLN*dt^{-1}	109.4		114.5		110.6		116.4	
Production value, PLN*ha^{-1}	125,8	126.1	129.7	129.5	118.7	118.7	148.9	148.9
Total cost (direct + indirect), PLN*ha^{-1}	121,1	122.0	122.6	122.6	121.5	122.3	122.0	123.0
Income from activity, PLN*ha^{-1}	130.7	132.5	137.1	146.3	115.9	110.6	173.5	197.0
PLN*1 dt^{-1}	113.6	115.1	121.2	129.4	107.8	102.9	135.6	153.9
Cost production of 1 unit income from 1 ha of crops, PLN	92.7	92.1	89.5	83.8	104.8	110.5	70.3	62.4

* The estimation for 2011, data from the 2006 to 2011 period adjusted by indicators of changes designated on the basis of the trend function, and then averaged.

Farm group A, B: see table 1.

In the optimistic projection variant it was assumed that the results of production of studied activities will be better than average. It is estimated that the winter rape responds to these condition in the strongest way, thus contributing to a significant improvement of the financial situation. However, the relatively weakest dynamics of income growth is expected for spring barley – table 4.

Projection results presented in table 4 show that under conditions of extremely high harvest, the dynamics of income growth from 1 ha of winter crops cultivation – wheat, rye and rape seed, will be stronger in farms with high intensity of cultivation (B). Compared to farms with low cultivation intensity (A), the difference can range from 1.8 to 23.5 p.p. As a consequence the cost of production of the income unit from activity will be reduced, dynamics of cost decline will be stronger in farms from group B, compared to group A – from 0.6 to 7.9 p.p. However, in case of spring barley, the results of projection show that the dynamic of income growth from 1 ha of cultivation was stronger in farms from group A – by 5.3 p.p.

In the optimistic variant of projection it is forecasted that the dynamics of income growth from winter wheat, rye and rape seed cultivation, will be stronger in farms with high intensity of cultivation (B). However, having considered lower – compared to farms from group A – level of income from their cultivation (table 1), it is estimated that the income situation of those activities in highly intensive cultivation (B) will be still worse than in case of low intensity (A).

The presented projection results show the direction and dynamics of changes of income (the production value), costs and income from wheat, rye, barley and rape seed cultivation in the perspective of 2016 under certain production and price conditions. Thus they show the expected variability limits of the results. Knowing them is necessary for the proper picture of changes that may take place in the profitability of individual activities, while for an appropriate response of farm managers to these changes and other interested individuals and institutions.

Discussion

Agriculture in twenty-first century requires a multifaceted approach. Technology aims to contribute to the creation of such tools that farming does not cause environmental damage, while maintaining a certain level of production and reducing costs.

Agricultural producers often pay attention to the price, as a determinant of profitability, but studies show that more attention should be paid to the cost of production. This is important since to the large extent it depends on the farmer. Therefore, farmers wishing to derive income from agricultural production in the long term should focus on implementing low cost strategies. This statement derives from the guidelines of the ‘positioning school’ of management whose most prominent representative is Michael E. Porter (b. 1947), an American economist, and an expert on the strategy of organisation and competition. Proponents of this school address in particular the development of competition strategy, which mainly entails the gaining of competitive advantage in order to obtain the intended competitive position. The source of competitive advantage is to be the enterprise’s resources and skills in using them.

Input means of production stimulates the growth of production, but it is subjected to the law of diminishing incomes. Fertilization instead of the positive effect can also produce

decrease in crop. The relationship between the prices of means of production and the prices of agricultural products obtained by the producers in the market determine the profitability of agricultural production. This is an important issue, especially in the context of the recently observed definitely higher growth rate of prices of means of production as compared to the sales prices of agricultural products. Occurring trends are characteristic of all countries with a market economy. They have a timeless character regularity. Cause a decrease in unit profitability of agricultural production (Ziętara, 2009)

It is an important issue due to the efficiency of production and environmental protection. In recent years, the threats of intensive agriculture can be seen more and more clearly. Therefore, reducing the risk to the possible minimum is one of the tasks of modern agriculture. Different activities in this direction are taken. Improved cultivation technology, taking into account not only the production and economic effect, but also the safety of the natural environment. There is then the re-evaluation of the concept of development for quality solution. In the recent years, more and more attention is paid to the economy of nitrogen and phosphorus in the context of the risk associated with their dispersal in the environment. Dissipation is proportional to the use of mineral fertilizers and livestock population. The national activities in this area are consistent with the Council Directive 91/676/EEC (henceforth referred to as the "Nitrates Directive", EC, 1991), it is one of the first EU legal acts aimed to control pollutants and improve water quality.

Research shows that further increases in nitrogen and phosphorus application are unlikely to be as effective at increasing yields because of diminishing returns. All else being equal, the highest efficiency of nitrogen fertilizer is achieved with the first increment of added nitrogen; efficiency declines at higher levels of addition. At present, only 30-50% of applied nitrogen fertilizer and ca. 45% of phosphorus fertilizer is taken up by crops. A significant amount of the applied nitrogen and a smaller portion of the applied phosphorus is lost from agricultural fields (Tilman et al., 2002).

The high intensity does not ensure the relatively highest crop yields, nor the highest level of incomes. In Poland the highest yield of winter wheat, an average of 10 years, was achieved in the sustainable farm production system (6.5 $t*ha^{-1}$). In the intensive farming system the yield of winter wheat was lower by 6%, and in the case of organic – 34%, in comparison to the sustainable farm production system (Jończyk et al., 2007). Other authors also indicate that high yields can be obtained by using environmentally friendly farming practices, which also leads to lowering their negative impact on the environment (Tuomisto et al., 2009).

In the European conditions the model of intensive agriculture becomes obsolete, and perceiving agriculture in other than only production terms determines a new path for it to follow. The concern of human health, environmental protection and cleanliness, as well as preservation of the landscape at the same time determine the different direction of development of farms (Zilberman et. al., 1999; EC, 2011).

By 2050, the global population is projected to be by 50% larger than at present. Further increases in agricultural output are essential for global political and social stability and equity. To maintain the food production at the appropriate level, is the major challenge. But doing so in such a way that do not disturb the environmental

balance and public health is a greater challenge still. This direction of agricultural development, however, should predominate, the net benefits to society will be much higher in comparison to the highly intensive agriculture.

The sustainable and ecological system is proposed as an environment-friendly farming system. In Poland, because of the wide variety of natural and organisational conditions those three systems can coexist, i.e. sustainable system, organic and conventional farming preferring farms using intensive production technology. However, sustainable agriculture should prevail, agriculture which in addition to the function of producing food, can also shape the landscape and provide benefits for the environment.

Conclusions

Research conducted in Poland indicate that with lower input means of production one can obtain more favourable economic effects compared to more intensive technologies. Efficiency of production of cereals, rape seed and sugar beets was higher in farms applying technology of low intensity. Lesser outlays for the means of production contribute to a better use of land resources and its natural fertility. Therefore, it can be assumed that in those farms means of production were applied more rationally - having regard to both the quantity, but also the time of their introduction.

In the evaluation of each agricultural production activity the important part is to control input means of production and incurred costs. As one of the functions it is usually at the end of the management process, but also should be the starting point for the next stage of management. This is important in forecasting the development of future events, i.e. changes of economic agricultural products. What is true in agriculture flawless forecast does not exists, it results i.e. from the fact that the environmental conditions in agriculture (e.g. temperature, precipitation) considerably deviate from the average, which in turn has an impact on the obtained results (e.g. crops). However, one can predict the changeability limits of the results.

Generally the study, which aimed at projection of income from cereals and rape seed in the perspective of 2016 showed a significant advantage of cultivation technology with low intensity (a measure of the level of direct cost). The highly intensive cultivation, high costs and stronger than income, dynamics of the growth of their increase, had a negative impact on the level of income. Favourable relationship of the income and costs can be expected only at extremely high yields. The situation will cause, that the dynamics of income growth may be stronger than with the cultivation of low intensity, but the level of income will be still lower.

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