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FACTORS DETERMINING PROFITABILITY OF PRODUCTION OF SELECTED AGRICULTURAL PRODUCTS BY 2020

Abstract

Growing volatility of farming conditions makes farmers resort ever more often to different tools helping them in the decision-making process. What also increases is the demand for results of forecasts and projections which are aimed at encouraging to take up actions to strengthen the development trend considered as favourable or to counteract the one recognised as undesirable. The results of projections for 2020, prepared under ordinary conditions, i.e. resulting from long-term trends, point to decreasing profitability of winter wheat farming by 2.4 percentage points, and spring barley by 8.6 percentage points given a stronger growth rate of costs over income. For rye and winter rape farming, it is expected that profitability will improve by 6.2 and 4.8 percentage points, respectively. Whereas, the profitability of sugar beet farming will most likely remain at a level similar to the reference years for the projection (2011-2013).

Research showed that fluctuations in the selling prices, which are caused by changes over the years, have a stronger impact on the level of income than crop fluctuations. Rye and rape are the most sensitive to crop and price fluctuations. Costs are another important element of profitability account. Among the examined field crops, rye farming was characterized by the greatest sensitivity, which means that a unit change in their level has the strongest impact on a change in income.

Introduction

From the earliest times man strove to know the future, but not in a scholarly manner. Only the development of science gave rise to methods based on seeking for interrelations between facts in the past that may determine the future. Such methods include forecasting, which may be defined as a form of cognitive activity aimed at identification of the most probable future events (Stańko 1999).

Accuracy of forecasts depends on the conditions of the forecasting process. Predicting changes in production results or economic situation in agriculture is especially problematic because of the biological and technological character of agricultural production. Unpredictable natural disasters, such as: droughts and hailstorms, sometimes happen and they cause major losses which can influence the level of product prices. The premises of the government's policy regarding agriculture can also be unstable over the years. Moreover, the human element is always involved in the economic processes and every process involving humans is not fully predictable. Thus, the forecast used by an economist is still biased by smaller or greater error.

It should be also noted that there is no well-founded and universally accepted body of coherent knowledge on the shaping of economic phenomena. Such body of knowledge is available, for instance, to astronomers and it makes their forecasts of solar and lunar eclipses accurate. Economists do not have it. Furthermore, no set of uniform, generally accepted principles of economic forecasting exists that would deserve the name of a stable theory of economic forecasting (Zeliaś 2005).

Economic research uses different models that help the economists to justify the methods of going from observations of the past to predicting the future.

A model should be understood as a representation of an existing or hypothetical fragment of the reality created for a defined purpose, devoid of details and insignificant properties to achieve the assumed objective (Kuc 2014).

According to professor J. Machaczka (1998), the communication function is the most important one of the many model functions. Since models are not used to explain simple phenomena, such phenomena do not need models. Models are, however, required by phenomena difficult to imagine and know, which the models allow to present in a simple and communicative form. The author rightly notes that "modelling is always the result of a compromise between a desire to make as accurate as possible representation of the phenomenon and an attempt to maximally simplify it". Thus, too complicated models and models that do not reflect many important properties fail to meet the communication function.

The more we know about formation of a given phenomenon in the past, the more exact forecasts can be expected and thus the lesser the deviations of actual data from the planned ones.

In the existing reality, forecasts and projections are an indispensable element of effective and efficient farm management. Decisions of a farmer cannot be limited to solving present-day problems only. Prospective thinking is needed to identify, e.g., directions and range of investments. Acquired knowledge and correct assessment of development of diverse economic phenomena and processes, make it possible to use emerging opportunities and reduce the risk of undertaken measures. To survive in the market, one needs information illustrating the future conditions to a lesser or greater degree. Development of an agricultural holding in a long-term perspective is a "game of tomorrow" (Penc 2003). It entails strategic thinking characterised by perceiving the surrounding in a way to find opportunities, recognise threats and solve problems considering not only current but also future benefits.

In the case of agricultural products, predicting changes in the economic results is difficult, but it can be useful for decision-making processes at farms. For example, sufficiently early information on the expected level of future agricultural production or demand can help to plan the scale of production. Whereas, on the country scale, it gives grounds to take relevant decisions regarding agricultural policy or regulation of individual agricultural markets.

The research aims at determining the impact, forecasted with a view to 2020, of selected agricultural products (i.e. winter wheat, winter rye, spring barley, winter rape and sugar beets), pace of changes in the prices of means of agricultural production, and changes in yields and product prices on the level of income. Analysis covered also the scale of deviations of income, less payments, generated by researched agricultural products from the level predicted for 2020, i.e. following from the trend, taking into account:

- variation of yields and prices in 1995-2013 determined on the basis of public statistics,
- unit changes in yields, prices and cultivation costs.

The research covered only a certain share of individual farms in Poland. Despite this, it is expected that – in the isolated groups – they accurately reflect the trends in the formation of costs and give a reliable picture of changes in production profitability. In the context, they give grounds to formulate conclusions pertaining not only to the researched sample.

The directions of changes rather than the absolute values, which should be approached with caution, are very important elements of the analyses. The results of economic forecasts should not be treated as inerrant. They should, above all, inspire the interested persons to undertake actions aimed at strengthening a direction considered as favourable or to counteract a direction of development recognised as undesirable.

Data sources and research method

Empirical material characterising five types of plant production activities, i.e. winter wheat, winter rye, spring barley, winter rape and sugar beets in 2011-2013, which was gathered and processed by the principles of the AGROKOSZTY system, was used to build up the projection model. The research also used the Polish FADN database and public statistics. The model assumed invariance of the structure and quantity of inputs incurred on production.

Components of production value (yield and price) and cultivation costs (direct costs and overheads)¹ of the researched activities, presented as an average for 2011-2013 (in the analysis defined as 2013), were the “starting point”

¹ Direct costs cover: costs of seed material, mineral fertilisers, plant protection products, phytohormones, other direct costs.

Overheads include: (1) farming overheads – electricity, heating fuel, motor fuels, current repairs and maintenance, services, building insurance, property and motor insurance, other costs, e.g., telephone charges; (2) taxes – agricultural, forest, special sections of agricultural production, property and others; (3) costs of external factors – paid employment, rents, interest on loans; (4) depreciation of productive fixed assets – e.g. buildings, machinery, means of transport.

for the projection of income of these activities for 2020. Time series were built up for all variables describing revenues and costs of production of the researched activities. They covered 19 years, i.e. the period from 1995 to 2013 (based on the data from the Central Statistical Office [*Polish: Główny Urząd Statystyczny, GUS*]). Time series allowed for extrapolation of the researched phenomenon into the future. Quantitative methods, grounded in classical development trend models, were used for their modelling and preparation of projection of results.

Development trends were separated by analytical method, i.e. by identification of the trend function $f(t)$ (t stands for time) which best describes the changes of the phenomenon over time (Wasilewska 2011). The analytical form of the function was chosen by heuristic method. It consists in finding several forms of the trend function and then selecting one of them according to the applied criterion (Stańko 1999). Two function selection criteria were given, namely height of the coefficient of determination R^2 and knowledge on the formation of the researched phenomenon over time. The analysis covered seven functions: linear, quadratic, exponential, power and logarithm, and hyperbolic trend and linear-hyperbolic trend functions. Development trend models in the following form were made for each series:

$$Y_t = \beta_0 + \beta_1 t + \varepsilon_t - \text{linear trend model,}$$

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t - \text{quadratic trend model (second degree polynomial),}$$

$$Y_t = \beta_0 e^{\beta_1 t} + \varepsilon_t - \text{exponential trend model,}$$

$$Y_t = \beta_0 (t + 2)^{\beta_1} + \varepsilon_t - \text{power trend model,}$$

$$Y_t = \beta_0 + \beta_1 \ln(t + 2) + \varepsilon_t - \text{logarithm trend model,}$$

$$Y_t = \beta_0 + \beta_1 \frac{1}{t+2} + \varepsilon_t - \text{hyperbolic trend model,}$$

$$Y_t = \beta_0 + \beta_1 t + \beta_2 \frac{1}{t+2} + \varepsilon_t - \text{linear-hyperbolic trend model}$$

where:

Y_t – value of dependent variable over time t ,

t – independent variable (time), assuming integer values from 1 to n ,

β_0 – intercept,

β_1, β_2 – function slope,

ε_t – random component.

On the basis of the adopted criteria, one trend function was chosen for further analyses. The selected function was used to extrapolate to 2020 the given phenomenon, i.e. values of variables characterising the researched activities

The procedure presents two stages of building up the projection model under average production and price conditions. But yields and prices fluctuate. Changes in yields result, primarily, from weather factors, and prices of agricultural products and means of production are, mainly, affected by market conditions. Each change thereof modifies the economic results of production activities. Thus, it was researched how unit changes will influence the level of income in researched activities. Analysis covered the scope of change (+/- deviation) in income, less payments, against the results of projection for 2020 in view of a change in each of the income-generating factors separately, i.e.:

- yields of cereals and rape by +/-1 dt, and for sugar beets by +/-10 dt,
- sales prices of 1 dt of products by PLN +/-1,
- total costs by PLN +/-100 per ha.

To determine the scale of changes in the yields and prices of the researched crops the coefficient of variation in 1995-2013 was also calculated based on the GUS data. The results of the calculations show that yields and prices are subject not only to random fluctuations but also to a long-term trend following from regular changes. The variation of yield and price of each of the products was calculated as the quotient of the root of the residual sum of squares from the models (selected to build the projection) to the arithmetic mean of the subsequent variables (Skarżyńska 2014):

$$V = \frac{\sqrt{\sum(Y - \hat{Y})^2}}{\bar{Y}}$$

where:

V – variation of the researched variable,

Y – empirical values of the variable,

\hat{Y} – theoretical values of the variable following from the model,

\bar{Y} – arithmetic mean of the value of the variables.

The projection model assumed that only yield or price fluctuates, and the other variables are subject to changes resulting from the trend. The impact of the yield and price on the level of income of individual activities was researched separately. This was possible because the correlation between the yield and price shows no significant interrelation between the two.

The variant presentation of the projection results for 2020 points to the impact on the level of income (in plus and in minus) of unit changes in yield, price and cultivation costs, and also changes in the production and price results springing from the variation over time (the projection model does not show interrelations, e.g., how a change in supply of products may influence the level of prices in the next year). Thus, it is a premise for the changes in the income situation of the analysed production activities.

The basic measure of the assessment of effects obtained under the research is the level of income from activity, less payments, i.e. the surplus of revenues – meaning the value of potentially commercial production from 1 ha of cultivation over total costs (i.e. total direct costs and overheads). The assessment

of economic efficiency of production used the profitability index, i.e. the ratio of revenues to total costs expressed in percentage.

Research results

Public statistics show that, for several years, the growth rate in the prices of means of production for agriculture has been faster than the growth rate in prices of sold agricultural products. In 1995-2013, the index of change in the prices of goods and services purchased by farmers amounted to 321.2%, and for the prices of sold products – 241.2% (1995 = 100), Figure 1. Comparing extreme years, shows that in 2013 the prices of means of production grew by 221.2%, and the prices of agricultural products by 141.2%.

The index of price scissors in respective years amounted to ca. 100%. In 1996-1999, 2001-2003, 2005, 2008-2009 and 2012-2013 it was below 100%, and in the remaining years it was above 100%. The years 2007, 2010 and 2011 were exceptionally favourable for agriculture; back then the index amounted, respectively, to 107.7%, 110.1% and 108.3%. The aggregated index of price scissors in 1995-2013 was definitely unfavourable for agriculture and it amounted to 75.2%. This means that the prices of means of agricultural production grew clearly faster than the prices of sales of agricultural products (by nearly 25%).

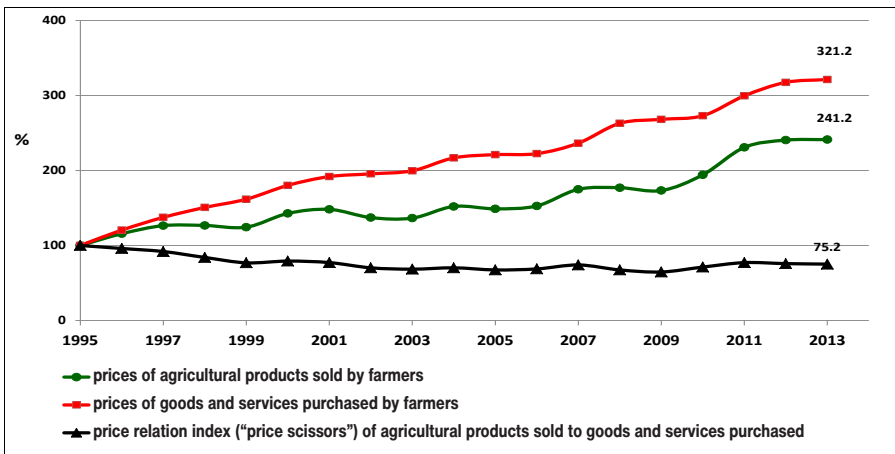


Fig. 1. Changes in the prices of goods and services purchased by individual farms and the prices of sold agricultural products in 1995-2013 (1995 = 100)

Source: Rocznik Statystyczny RP 1997, 2005, 2012; Rolnictwo w 2013 r. (2014).

Among the means used for current agricultural production, the prices of fuels and other petroleum products, and the prices of mineral fertilisers demonstrated a particularly strong upward trend. In the 1995-2013 period, the growth in the prices of fuels was 336% and for mineral fertilisers (including lime) – nearly 291%. The prices of plant protection products grew by over 97% – Figure 2.

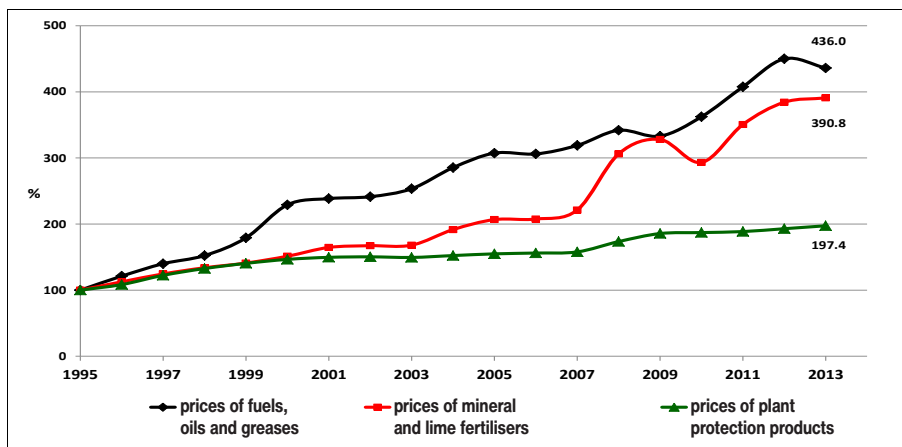


Fig. 2. Changes in the prices of mineral fertilisers, fuels and plant protection products in 1995-2013 (1995 = 100)

Source: Rocznik Statystyczny RP 1997, 2005, Rolnictwo w 2003 r. (2004), Rolnictwo w 2006 r. (2007), Rolnictwo w 2011 r. (2012), Rolnictwo w 2013 r. (2014).

The interrelations between the prices of means of production and prices of crops determine profitability of agricultural production. The presented trends of changes in prices over the years point to a drop in profitability. To generate income from an agricultural holding, farmers have to increase their economic efficiency. There are two basic methods to achieve the goal: growth in production value at the same level of costs, or reduction in costs at fixed production value. Proper management and optimisation of costs incurred on production is vital under both these variants.

Control of incurred inputs and costs is an important element in the assessment of each activity. It is usually located at the end of the management process, but it, simultaneously, should be the starting point for the next management stage. It is important if we expect development of future phenomena, e.g., change in economic results of agricultural products. Although there is no such thing as spot-on forecast in agriculture, which is due to the fact that natural conditions can deviate considerably from the average thereby affecting the results, the limits of variation of the effects can be projected.

Projection results point to a growth or drop in the production profitability of researched crops in 2020 against the input data, i.e. the average for 2011-2013 (defined as 2013).

In 2011-2013, the income situation of **winter wheat** was, on average, favourable. The research sample covered 161 agricultural holdings where the average winter wheat cultivation area was 23.84 ha. The production (56.3 dt per ha) and price (PLN 79.13 per dt) results – compared to other cereals – were relatively favourable and generated revenues at the level of PLN 4 482. Total costs (i.e. total direct costs and overheads) per 1 ha amounted to PLN 3 111. Income from

activity, less payments, per cultivation of 1 ha of winter wheat reached the level of PLN 1 372, and the production profitability in percentage terms, expressed as relation of the production value to total costs, was 144.1%.

What changes can be expected by 2020? The applied projection method – extrapolation of a trend observed in the past – allowed defining the expected change trend both on the side of revenues and production costs. It is predicted that, under production and price conditions following from long-term trends, annual increases in the production value (revenues) may range from 3.4% to 3.8% (with yield increase at the level of 1.2% and prices of grain ranging from 2.2% to 2.6%), and costs of production (total direct costs and overheads) will increase at the rate of 3.4–4.2%.

Stronger increments in costs than revenues will cause that in 2020 – against 2013 – the costs of wheat production will grow by 30.0% and revenues by 27.8%. As a result, the economic efficiency of wheat production will deteriorate – profitability index will drop by 2.4 pp (amounting to 141.7%). This means that production will become too expensive. Despite an improvement in the production results, unit costs of production of 1 dt of grain will increase. It is expected that in 2020, against 2013, it will be higher by 19.9%, and sales price of grain will grow by only 18.1%. Despite this, it is estimated that in 2020 income, less payments, from 1 ha will exceed the level of 2013 by 22.9% (it may amount to PLN 1 686) for farms cultivating almost 24 ha of winter wheat.

Winter rape, due to similar soil requirements, is considered as competition for wheat. According to experts, if the price of rape seeds is higher than the prices of wheat grains by over 2 times, it may be considered that rape cultivation is competitive to wheat. Such interrelation continues as of 2008. For the researched farms, the advantage of rape prices was, on average, 2.2 times in 2011-2013.

Research held in 2011-2013 in 149 agricultural holdings cultivating rape (average 16.29 ha), show that it was a profitable activity, which is evidenced by the economic surplus that may be used by a farmer and the profitability index. In the years of the research, the income, less payments, from cultivation of 1 ha of rape reached the level of PLN 1 125 and economic efficiency of its production totalled 133.4%. It should be mentioned that from 1 ha producers obtained 25.9 dt of seeds at average sales price of PLN 173.99 per dt. Production and price results generated revenues at the level of PLN 4 499 per ha. Rape cultivation was, however, a rather cost-intensive activity, total costs amounted, on average, to PLN 3 374 per ha.

The projection results for 2020, justify optimistic view on the economic situation of rape in the coming years. It should be expected that the production value, i.e. revenues from cultivation of 1 ha of rape annually, will grow from 3.9% to 4.8% (with yield increases ranging from 1.0% to 1.2%, and the prices of seeds – from 2.9% to 3.5%) and in 2020 – against the projection baseline years – they will be higher by 34.5%. The total costs with annual increases ranging from 3.4% to 4.2%, may grow by 29.8%. This means that by 2020, the expect-

ted growth rate of the value of production will be stronger than that of costs by 4.7 pp. Consequently, the profitability index will grow by 4.8 pp and it will amount to 138.2%.

Under the conditions defined by the projection model, it may be expected that in 2020 against 2013, the production cost of 1 dt of rape seeds will increase by 20.4% and the price of seeds by 24.7%. In such circumstances, the income from activity, less payments, per 1 dt may be higher by 37.8% (it will amount to PLN 59.97 against PLN 43.52 in 2013). But then the income, less payments, from cultivation of 1 ha of rape in 2020 – against 2013 – may increase by as much as 48.6%. Its level (PLN 1 672 per ha) will be similar to the income from winter wheat cultivation (PLN 1 686 per ha).

On average in 2011-2013, the farmers cultivating **winter rye** were not at a loss, but it is hard to describe the situation at hand as very favourable. The research was held at 118 farms where the rye cultivation area amounted, on average, to 9.39 ha. The production (32.2 dt per ha) and price (PLN 58.31 per dt) results ensured income at the level of PLN 1 890 per ha. The cost-intensity of winter rye cultivation, against other cereals, was substantially lower – PLN 1 515 per ha. Under the circumstances, the income from activity, less payments, per 1 ha of rye amounted to PLN 376, and the production profitability index – 124.8%.

It is expected that by 2020, revenues from winter rye cultivation will increment annually by 4.2-4.8% and, consequently, as compared to the projection baseline years (2011-2013), the level of revenues will be higher by 35.9%. This will be the effect of changes in the production and price results. Research shows that the annual growth rate of yield will fluctuate around 1.6%, and the price increase for grain may be higher by 2.6-3.2%.

The projection model assumes invariance of the structure and quantity of inputs incurred in the production process. This means that the projected increase in costs is the exclusive result of the expected (based on extrapolation into the future of trends observed in the past) changes in the price of the means of production. It is predicted that by 2020 the annual growth in production costs (total direct costs and overheads) will range from 3.4% to 4.2%. As a result, they may be higher by 29.5% than in 2013. This, in turn, means that the growth rate of cost will be by 6.4 pp weaker than that of production value. Given the above the profitability index will achieve the level of 131.0%, i.e. it will be higher than in the projection baseline years by 6.2 pp.

In the target year of the projection (2020), the cumulative increase in production costs of 1 dt of rye grain may amount to 16.0%, and the grain price will grow by 22.1%. Stronger growth in price than in costs will stimulate an improvement in results. Thus, economic efficiency of rye production will be higher just as well as the economic surplus at the disposal of farmers. Income from activity, less payments, per 1 ha will rise by as much as 61.8% (it will amount to PLN 608 per ha in the research sample). But, despite such a strong growth, its level will remain lower than the income from wheat and barley cultivation.

On average in 2011-2013, the economic results of **spring barley** cultivation were better than those of rye, but much weaker as compared to wheat. The research was held at 142 farms where the barley cultivation area amounted, on average, to 11.09 ha. Barley yield was at the level of 43.3 dt per ha and the prices of grain sale – PLN 70.79 per dt. The results generated revenues amounting to PLN 3 079 per ha. Deducting the incurred costs – PLN 2 035 per ha (total direct costs and overheads), the income, less payments, from cultivation per 1 ha of barley was PLN 1 043 and the profitability index reached the level of 151.3%.

In line with the projection, in 2020 – against 2013, i.e. projection baseline year – the revenues per 1 ha of barley will probably be higher by 22.9%. This will be possible if their annual growth rate ranges from 2.8% to 3.2% (annual growth rate of yield is estimated at 0.5%, and grain price – 2.3-2.7%). The growth in (total) production costs will be at 3.5-4.3%. This represents that in 2020 – against 2013 – these will be higher by as much as 30.3%. Although the growth rate of costs will be stronger than that of revenues, it is expected that in 2020 income from activity, less payments, will amount to 108.5% (i.e. PLN 1 132 per ha) of the level obtained in 2013. The economic efficiency of barley production will be, however, weaker and the profitability index will drop by 8.6 pp (from 151.3% to 142.7%). A decline in profitability implies that the rise in production value will take place at too high a cost.

It is estimated that in 2020, given minor improvement in production results, the unit cost of grain production will be higher by as much as 25.9%, and its price will grow by only 18.9%. In the context, improvement in economic results of spring barely cultivation may be ensured by productivity increase, since higher yields may cause a drop in unit production cost. To sum up, it should be stated that in the coming years, spring barely cultivation will not make losses to farmers, but it will also not generate too high an income.

In the last years (2011-2013), the income situation of **sugar beets** was favourable. In the sample of 140 farms and cultivation areas of 8.91 ha, farmers obtained income, less payments, per 1 ha at the level of PLN 2 564. Production profitability in quotient terms reached 141.4%. The results were favourable, despite rather high cost-intensity of beet cultivation (PLN 6 189 per ha). This was possible because revenues, i.e. value of potentially commercial production, per 1 ha of beet was at the level of PLN 8 754. It needs to be added that the sugar beet yield for the farms was 611 dt and the price of their sales – PLN 14.30 per dt.

What can be expected in the coming years? It is a difficult question in the context of the sugar market reform and “the great unknown” of the amount of sales price of sugar beets. In line with the agreement reached by the European Commission, the EU Agriculture Council and the European Parliament, the sugar and isoglucose quota system, and the application of minimum prices of sugar beets is to terminate on 30 September 2017. No rules of operation of the EU sugar market after abrogation of the production quotas have been specified

so far. It can be expected that increased sugar production will result in reduction of both the sugar price and the price of sugar beets. Many EU Member States, fearing for market stability, opt for upholding the quota system at least to 2020. Considerable price variation is the chief threat in case of abrogation of the quota system (Bolisęga 2012).

The projection model assumes that the price of sugar beets by 2020 will be subject to changes following from the trend observed in the past. Thus, the calculations assume only a slight increase, annual growth rate may fluctuate around 1.8%. But the annual increment of root yields may range from 2.0% to 2.3%. Consequently, in 2020 it is expected that the revenues from sugar beet cultivation will be higher by 31.1% (with annual growth rate at 3.7-4.2%). The expected annual growth in total costs is estimated at 3.6-4.2% and may thus exceed the level of 2013 by 30.4%.

Cumulative increase in production costs of 1 dt of sugar beet roots may amount to 12.3% and prices of their sales – 12.9%. Stronger growth in the price of roots than the unit cost of their production will stimulate income growth. Its level from 1 ha, against the projection baseline year, may be higher by as much as 32.8% (in the research sample of farms it will achieve the level of PLN 3 404 per ha). Then again, the economic efficiency of production will remain basically the same, it is expected that the profitability index will grow by only 0.8 pp.

However, there may be significant deviations from the results projected for 2020 and following from long-term trends. In the plant growing season mutable weather conditions often cause substantial fluctuations in the yield. Product prices and cultivation costs may also change and the dynamics of the changes does not have to reflect the trend observed in recent years. An always true forecast is not possible in agriculture but it is possible to project the variation limits and observe the direction of changes of the obtained effects.

Therefore, the built up models allow to define the strength of impact on the scale of change in income from agricultural products, individual factors determining the income, i.e. yield, costs and cultivation costs. But it needs to be kept in mind that the scope of presented changes is also affected by data that were the starting point for the conducted research. This entails that the presented changes in income from individual products refer only to the research sample of agricultural holdings.

However, they conjure up a picture of the situation and its effects pointing, at the same time, to substantial risk of literal interpretation of projection results, i.e. treating figures as absolutely accurate. This is not the right approach, reality in agriculture is that changes in yield, product prices or prices of the means of production cannot be predicted with absolute accuracy, both in the medium and long term.

The calculations, done on the basis of the GUS data, showed that within 19 years (1995-2013) variation in the yield of researched cereals, i.e. winter wheat, winter rye and spring barely, was similar to each other. It ranged from

6.1% to 8.3%, respectively for wheat and barley, and it was by ca. 2 times smaller than for rape (12.6%). This means that rape responds to the conditions of cultivation much stronger. Variation in yielding of sugar beets was 7.6% and thus it was similar to cereals and by 5.0 pp lower than for rape – Table 1.

Table 1

Impact of yield variation in 1995-2013 on the deviations from the projection results for 2020 – yield and income from activity, less payments, per agricultural products, on average, in the research sample of farms

Specification	Yield variation according to GUS (%)	Deviations from the projection results for 2020	
		Yield (dt)	Income from activity, less payments (%)
Winter wheat	6.1	+/-3.7	+/-20.8
Winter rye	7.9	+/-2.8	+/-33.0
Spring barley	8.3	+/-3.7	+/-27.7
Winter rape	12.6	+/-3.5	+/-45.5
Sugar beets	7.6	+/-53.6	+/-25.4

Source: own compilation based on own research.

Table 2

Impact of variation of sales price in 1995-2013 on the deviations from the projection results for 2020 – product prices and income from activity, less payments, on average, in the research sample of farms

Specification	Variation of sales prices according to GUS (%)	Deviations from the projection results for 2020	
		Prices of 1 dt (PLN)	Income from activity, less payments (%)
Winter wheat	19.8	+/-18.46	+/-66.8
Winter rye	23.9	+/-17.02	+/-100.5
Spring barley	19.0	+/-15.96	+/-63.1
Winter rape	20.9	+/-45.45	+/-75.8
Sugar beets	7.9	+/-1.28	+/-26.7

Source: own compilation based on own research.

Variation of sales prices of grain and rape seeds was higher than the variation of their yields and ranged from 19.0% to 23.9%. The variation of prices of sugar beet roots, in turn, was lower (from 2.4 to 3 times) – it amounted to 7.9%, and was similar to the variation of yield (7.6%) – Table 2.

Taking into account the variation of yield and prices observed in 1995-2013, deviations of income generated by the researched agricultural products from the results projected for 2020 was determined. Research of the correlation between yield and price demonstrated that the interrelation between them is statistically insignificant. Thus, it was possible to determine the impact on the level of income of each factor independently.

Tables 1 and 2 present deviations of the income from activity, less payments (in plus and in minus), from the level projected for 2020 considering the variation of yield and prices observed in the last years. The variation calculated on the basis of the GUS data was expressed in absolute numbers (dt or PLN) and next its impact on the level of income, less payments, from agricultural products in the research sample of farms was illustrated. As mentioned before, the model assumes that only yield or price is affected by fluctuations while other variables are subject to changes following from the trend.

Research results show that cereals and rape are definitely more sensitive to fluctuations in sales prices than yield fluctuations. Prices, above all, are affected by much greater variation over the years, which means that producers may make profit but in exceptionally unfavourable market conditions they may also incur great losses. In the research sample of farms this is evidenced by the fluctuations in income from rye cultivation. It should be, however, noted that the range of these fluctuations depends, also, on the input data used in the model, i.e. in this case the amount of income from activity, less payments, on average in 2011-2013.

In line with the projection, the income from rye cultivation in 2020 may constitute 54% of the level of income expected from barley cultivation and only 36% of income from wheat and rape cultivation. Despite similar variation in the prices of cereals and rape over the years, the quite low level of income from rye cultivation determined the substantially greater strength of impact of variation on the income fluctuations. Income, less payments, from rye cultivation projected for 2020 may be affected by fluctuations of $\pm 100.5\%$, and for cultivation of wheat: $\pm 66.8\%$, barley: $\pm 63.1\%$, and rape: $\pm 75.8\%$ – Table 2.

Income from sugar beet cultivation will be subject to substantially lower fluctuations ($\pm 26.7\%$). This springs from the fact that the variation in beet price is lower and, what is more, the income from cultivation thereof – both on average in 2011-2013 and expected in 2020 – was at a much higher level than that from cultivation of cereals and rape.

To better know the strength of impact on the level of income of the main factors determining its amount, the estimation covered also the impact of unit changes in yield, price and cultivation costs (total) on the deviations of income from the level expected in 2020.

The research shows that the change in yield by one unit (1 dt) will have the strongest impact (positive or negative) on the level of income from rape ($\pm 13.0\%$) and rye ($\pm 11.7\%$) cultivation, i.e. activities, whose yield at the background of other researched activities was much lower. This proved high sensitivity of rape and rye to yield fluctuations. Whereas, a change by one yield unit of spring barley

will cause a growth or drop in income, less payments, by 7.4% and winter wheat by 5.5%. In case of sugar beets, a growth or drop of yield by one unit (10 dt) will cause a change in income, less payments, by 4.7% – Figure 3.

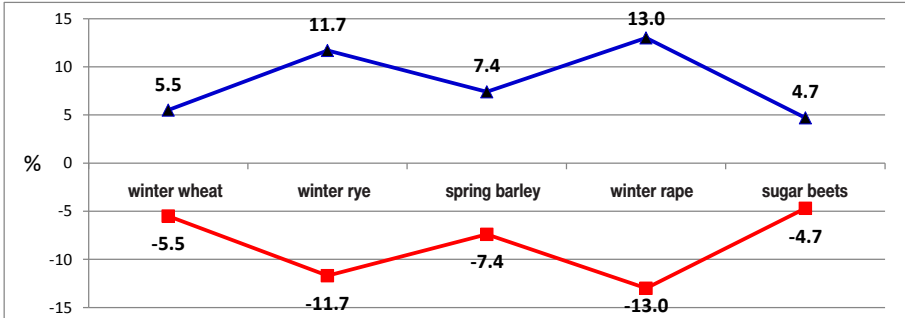


Fig. 3. Projection of changes for 2020 in income from activity, less payments, from agricultural products given a growth or drop in their yield by one unit (cereals and rape by 1 dt, sugar beets by 10 dt)

Source: own compilation based on own research.

Unit price change (by PLN 1) will have the strongest effect (in plus or in minus) on the income from sugar beet cultivation. It may grow or drop by as much as 20.8%. The impact of price fluctuations will be weaker for cereals and rape. It is estimated that the level of income, less payments, from winter wheat cultivation projected for 2020 may be affected by a change of $\pm 3.6\%$, and from the cultivation of: rye by $\pm 5.9\%$, spring barley by $\pm 4.0\%$, and winter rape by $\pm 1.7\%$. The presented calculations show that sugar beets are characterised by a rather high sensitivity to changes in their prices. This results from the fact that the sales price of beets, against the sales price of cereals or rape, is lower and thus income response, expressed in percentage, to each change thereof will be stronger – Figure 4.

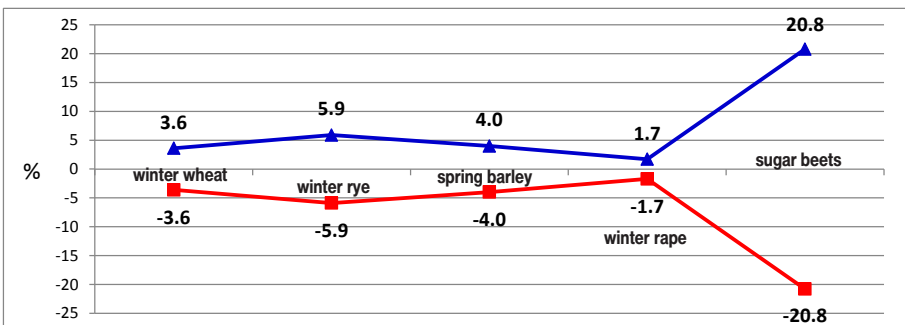


Fig. 4. Projection of changes for 2020 in income from activity, less payments, from agricultural products given a growth or drop in sales price of 1 dt by PLN 1

Source: own compilation based on own research.

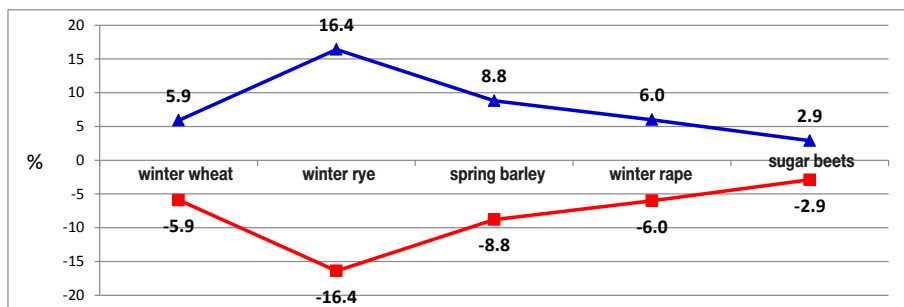


Fig. 5. Projection of changes for 2020 in income from activity, less payments, from agricultural products given a growth or drop in total cultivation costs of 1 ha by PLN 100

Source: own compilation based on own research.

Considering the impact of unit change in the cultivation costs (by PLN 100 per ha) on the level of income, it has to be stated that rye is definitely the most sensitive to such changes. A growth or drop in costs by PLN 100, against the level following from the trend, will cause a growth or drop in costs, less payments, for researched farms by as much as 16.4%. Barley ranked second – the income will change by $\pm 8.8\%$. The cultivation costs of 1 ha of these activities – against the others – are lower; hence each change in their level will cause a greater percentage change in income. A growth or drop in cultivation costs of 1 ha of winter rape by PLN 100 will result in income fluctuations by $\pm 6.0\%$, winter wheat by $\pm 5.9\%$, and sugar beets by $\pm 2.9\%$ – Figure 5.

Research results show that even unit changes in income-generating factors, i.e. yield, price or cultivation costs has a fairly clear impact on the level of income. In case of some products, e.g. rye and rape, their impact proved especially strong.

Conclusions

The projection results drawn up for 2020 under average conditions, i.e. following from long-term trends, point to an improvement in the production and price results of researched cereals, namely winter wheat, winter rye and spring barley. Annual growth rate of yield will probably range from 0.5% to 1.6% and grain price: 2.2-3.2%. Whereas the annual increment of production costs may range from 3.4% to 4.3%. In these conditions, wheat and barley production will be characterised by stronger growth rate of costs than revenues thus, against the input data for the projection, it is possible that there will be a drop in the production, respectively, by 2.4 pp and 8.6 pp. Rye production profitability will be probably higher by 6.2 pp given the stronger growth in revenues.

It is estimated that by 2020, winter rape yield will grow by ca. 1%, the price of grain by ca. 3% and the production costs will range from 3.4% to 4.2%. This will result in stronger growth rate of revenues than costs and a growth by 4.8 pp in rape production profitability.

It is expected that by 2020 the annual growth rate of sugar beet yields will fluctuate around 2% and sales prices of roots around 1.8%. On the other hand, the expected annual increase in the costs will total 3.6-4.2%. Under the conditions, the economic efficiency of the production of sugar beets will basically be the same, and the profitability index may increase by only 0.8 pp.

However, there might be various unforeseeable annual deviations from the general trends, for instance, because of mutability of weather conditions or especially strong fluctuations in product prices or means of production. Their impact on production and economic results of researched crops may be significant.

Rye and rape are the most sensitive to fluctuations in yield and sales price of products. This means that, under favourable production and price conditions, a significant increase in income may be expected, but, simultaneously, their cultivation is very risky.

The research results prove that fluctuations in sales prices of researched products, following from variation over the years, have a definitely stronger impact on the level of income than yield fluctuations. A strong drop in the price of rye grain caused unprofitability of its cultivation. But farmers will rather not incur losses from production of the other crops, despite the expected quite high drops in sales prices.

Rye is also characterised by high sensitivity to cultivation costs, unit change in their level has a very strong impact on income fluctuations. This entails that a rise in the prices of means of production will have an even stronger negative impact on the amount of income from rye cultivation than from other researched crops.

The results projection for 2020 and its variants demonstrate benefits but also possible threats. Nonetheless, knowledge thereof is very useful as it reduces uncertainty and can contribute to greater accuracy of decisions taken and thereby to elimination of losses that can otherwise occur.

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