INSTITUTE OF AGRICULTURAL AND FOOD ECONOMICS
NATIONAL RESEARCH INSTITUTE

Projection of income for 2015 for selected agricultural products

no 88.1
Warsaw 2013

MULTI-ANNUAL PROGRAMME
2011 - 2014

COMPETITIVENESS OF THE POLISH FOOD ECONOMY UNDER THE CONDITIONS OF GLOBALIZATION AND EUROPEAN INTEGRATION

Projection of income for 2015 for selected agricultural products

INSTITUTE OF AGRICULTURAL AND FOOD ECONOMICS
NATIONAL RESEARCH INSTITUTE

Projection of income for 2015 for selected agricultural products

Scientific editor
dr inż. Aldona Skarżyńska

Authors:
mgr Łukasz Abramczuk
mgr inż. Irena Augustyńska-Grzymek
mgr Magdalena Czułowska
dr inż. Marcin Idzik
mgr Konrad Jabłoński
dr inż. Aldona Skarżyńska
mgr inż. Marcin Żekało

MULTI-ANNUAL PROGRAMME 2011 - 2014

COMPETITIVENESS OF THE POLISH FOOD ECONOMY UNDER THE CONDITIONS OF GLOBALIZATION AND EUROPEAN INTEGRATION

Warsaw 2013

Dr inż. Marcin Idzik is an employee of the Warsaw University of Life Sciences
The other authors of the publication are employees of the Institute of Agricultural and Food Economics – National Research Institute

The work was carried out under the following theme:
Competitiveness of Polish agricultural holdings and agricultural products at present and in a mid-term perspective

in the task:

Economic surpluses of selected agricultural products, their current analysis and assessment of the scale and scope of changes expected in a mid-term perspective.

The aim was to show the possibility of using time-series properties combined with the ongoing impact of the factors of a quantitative and qualitative nature. The study also determined the impact on the incomes from selected products, projected in 2015, the pace of changes in the prices of agricultural inputs in relation to agricultural production and the direction and dynamics of income and profitability, expressed as a percentage ratio of the value of production to the cost of production.

Reviewer
dr inż. Janusz Majewski, Warsaw University of Life Sciences

Computer development
Łukasz Abramczuk

Proofreader
Joanna Gozdera

Technical editor
Joanna Gozdera

Translated by
Contact Language Services

Cover Project
AKME Projekty Sp. z o.o.

ISBN 978-83-7658-418-8

Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej
– Państwowy Instytut Badawczy
ul. Świętokrzyska 20, 00-002 Warszawa
tel.: (22) 50 54 444
faks: (22) 50 54 636
e-mail: dw@ierigz.waw.pl
http://www.ierigz.waw.pl

TABLE OF CONTENTS

***

due to the electronic method of data processing for certain calculations – due to rounding there may be differences

Introduction

The results presented in the work are the continuation of research in the research task "Economic surpluses of selected agricultural products, their current analysis and assessment of the scale and scope of changes expected in a mid-term perspective", which is implemented in the IAFE-NRI under the multi-annual programme "Competitiveness of Polish food economy in the context of globalization and European integration", established by the Ordinance of the Council of Ministers for 2011-2014.

Research questions focus on assessing and identifying the changes in the performance of selected agricultural products in 2015.

First of all, the study specifies the nature of changes in the prices of major agricultural products in dynamic terms, the underlying types of variations and strength of changes. The conclusions of these studies formed the basis for further analysis, including the basis for the selection of forecasting methods and determining the nature of the relationship between phenomena.

In agriculture and its environment, many of the phenomena are characterized not only by specific development trend, but also by periodic variability. The most common case is seasonal variations. Seasonality of production and supply is obvious. Periodicity of agricultural production, both plant and animal, entails similar effects in the supply (purchase) of agricultural products, level of their prices, farmers' income and the period of expenditures. Measurement and analysis of seasonal fluctuations and incorporating them in the forecasting process create the conditions for making effective business decisions.

In the following part, the paper discusses how to build the model for projections of income of agricultural products in the medium term and presents projections for 2015 for profitability of winter wheat, winter rye, spring barley, winter oilseed rape and milk production. Projection of results was done on average in the research sample of farms; this approach was considered as the average conditions of production, which is similar to that in the years that were the starting point for the projection. Projection models were developed independently for variants of cereals and oilseed rape crops and scale of milk production measured by the number of cows on the farm. The projection variants assume constancy *(ceteris paribus)* of other factors affecting the economic performance of studied activities.

The aim was to study the impact on the incomes from selected products, projected in 2015, the pace of changes in the prices of agricultural inputs in relation to agricultural production and to determine the direction and dynamics of income and profitability, expressed as a percentage ratio of the value of production to the cost of production.

The research covered only a certain percentage of individual farms in Poland. Nevertheless, it is estimated that in separate groups, it accurately reflects the trends in costs and gives a true picture of changes in profitability, and in this context, provides a basis for conclusions relating not only to the researched sample. However, the direction of the changes is crucial in the analysis of the results of projection not so much as the absolute values, which should be approached with caution. Agriculture is an area which is particularly difficult to predict because it is characterised by high volatility and high risk. Therefore, the results of projection may be an indication of what to expect in the near future, under certain conditions of the operation of farms.

Regardless of the authors' analysis of the results, the paper presents a tabular appendix (Tables 1-5), which contains detailed performance information, with the intention to enable the reader to carry out independent investigations and comparisons.

In case that the results presented graphically and in tables do not specify the source, it means that these are results of own research.

I. Morphology of the volatility of time series of prices of selected agricultural products

The projection presented below is focused on the use of time series properties combined with the ongoing impact of the factors of a quantitative and qualitative nature. The basic idea of projection is the assumption that the statistical properties of time series remain valid until the end of the prediction horizon. If the assumption is undisputable for the assumed horizon, the projection can be based on the predicators estimated for the historical period. To avoid errors of prediction, but also to properly interpret the results of projection in different periods, it is advisable to know the exact composition of time series used in the projection. This approach is especially important for time series of prices, the level of which is shaped by a combination of factors interacting regularly in long, medium and short term. It is important also to assess the strength and nature of the impact of factors affecting one time, causing random fluctuations in the price level changes. Often these events are symptomatic events (in particular, in time series of prices), prior to important, yet difficult to detect trend reversal. Trend reversal in these time series are relatively rare but cause crucial – usually negative for the accuracy of the prediction – results. This is all the more important because by definition, the models of time series used in the projection are mechanical, they usually do not have a substantive interpretation and are intended solely for forecasting. The object of the study is the description and forecast of the phenomena without penetrating the economic mechanisms underlying predicted phenomenon.

The purpose of studying the structure of time series was to identify slow and fast-changing components, including random components. The results of studying the structure of time series may be used in expert analyses for further quantitative processing. Expert analyses make important use of graphical presentation of the series, showing the course of individual components and distinguishing characteristic patterns. In quantitative analyses, the time series components can be further processed as separate diagnostic signals to aid in the interpretation of changes in prices and their projections. The identified patterns of change can be targeted to study concurrence, detect turning points, identify changes in the direction of the current trend, transition to the next phase of the cycle, etc. Depending on the results obtained, in particular in the case of slow-changing components, further prediction may use classical or adaptive models.

From the point of view of this paper, special role is played by slow-changing components analysis. These components reflected the impact of long-term factors. The analysis of fast-changing components reflects sudden qualitative events, both

incidental (manifesting themselves in the form of short-term deviations), as well as those that cause long-term effects. In the case of identifying such events, it is necessary to make further analysis in order to estimate the nature of the impact on the course of the time series in the future. An important part of the selection of information is to eliminate less important features of the series, allowing for a better assessment of the most important characteristics of the phenomena and corrects interpretation of projections.

Analysis of the variability of the time series is an important issue from the point of view of target users and decision makers. It involves isolation of the trend component, random component and seasonal component from input time series, and if there are cyclical fluctuations, also the cyclical component. These components can often be identified by visual assessment of the chart. It also allows the detection of outliers and turning points (reversal of the trend of development). The problem of interpretation arises, however, if the individual types of changes co-exist, mutually channelling, or increasing the leverage effect. Another of the important reasons of this analysis is the correct interpretation of the forecasts formulated on the basis of data in annual intervals, and related only to projection of development trend. These projections indicate the general direction of change; they are not (by definition) sensitive to the effects of medium-term factors causing, e.g. cyclical or seasonal fluctuations. Hence it is important to interpret the projection results in relation to a specific moment in the evolution of the phenomena, taking into account the impact of cyclical and seasonal fluctuations.

Decomposition of the time series has many benefits, allows you to explore the structure of the phenomenon, improve the accuracy of constructed forecasts. It facilitates and simplifies the research, and the main benefits of this analysis are:

- determining the actual direction of medium and long-term changes,
- evaluation of the actual scale of the effects of certain events, which are often "masked" in the raw series by the seasonal or casual effect,
- obtaining separate time series in the form of values arising from the development trend, cyclical fluctuations, seasonal fluctuations,
- separate forecasting of each separate volatility component,
- possibility of using data adjusted for the trend, seasonality and random changes in the analysis of business cycles,
- opportunity to assess the scale of the price risk depending on the horizon of decision-making.

1. Elements of time series variation

The analysis of time series can cover all the possible components and measurement of their values. The effect of the impact of various factors makes that clarification of the course of the time series requires analysis of each of its components. By modelling the behaviour of the time series of monthly or quarterly frequency, we can isolate the following components: trend or a constant level of phenomenon, cyclical fluctuations, seasonal fluctuations, irregular fluctuations, random fluctuations. All the components of variation can occur together in any configuration or penetrate one another, which in practice normally takes place. In analytical works, one of the first steps is to isolate individual components of the time series and measure their values.

Development trend refers to the existence of systematic, unidirectional changes (increase or decrease) in the level of the studied phenomenon, occurring over a long period[1]. The trend points to the long-term direction of the phenomenon development, provides information of a strategic, long-term nature. The trend is usually permanent, and reverses in the direction associated with the occurrence of new conditions, changing the current strength and direction of long-term influences on the phenomenon. The trend of development should be interpreted as a general direction of changes in the studied phenomenon in the long-term[2].

Cyclical nature is expressed in the recurrence of a certain pattern of fluctuations around the trend, or average level, while the fluctuation period is longer than one year. Cyclical nature is caused by changing economic conditions, related to business cycles in the economy[3]. Opinions on the causes of cyclical fluctuations in agriculture and its surroundings are divided. In general, they point to the economic factors, the causes of biological and external nature, such as drought, which initiate the occurrence of cycles. One should also bear in mind that these fluctuations may be related both to the general economic situation and they may occur as (special) commodity cycles.

In practice, cyclical fluctuations and the trend are difficult to distinguish if they concur and usually are estimated collectively as the trend-cycle component. Research on cyclical nature of economic developments indicates that time series can include several cycles of different periods. This is due to the overlapping of different types of cycles.

---

[1] G. Jóźwiak, J. Podgórski, *Statystyka od podstaw,* PWE, Warsaw, 1998.
[2] M. Cieślak (ed.), *Prognozowanie gospodarcze. Metody i zastosowania. Wydanie czwarte zmienione*, PWN, Warsaw 2008.
[3] As above.

Seasonal variations are variations in the value of the variable around its trend or permanent (average) level, recurring in a time interval that does not exceed one year. Variations of annual cycle are most often observed. The cause of annual cycle variations are generally natural factors, which is why they are called seasonal variations [4]. Seasonality implies similar effects in the supply of products, level of prices, incomes, period of incurring expenditures, etc. Often, the scale and the nature of seasonal variations are so large that they effectively impede the analysis of long-term changes.

Irregular and random variations are always occurring component of the variability of time series. Irregular changes include effects caused by random factors, impossible to predict, such as: natural disasters, sudden changes in government policy, strikes and outliers among which, due to the nature of the changes, the study distinguishes:

- additive outliers, i.e. constituting a significant deviation from the forecasted value of the phenomenon only in one period, not affecting series values in the following periods,
- level shift, i.e. resulting in a permanent change of the variable level,
- temporary change, resulting in a temporary change in variable level, with the linear or exponential return to the initial value,
- innovation outliers, which, contrary to the ones described above, result in changes in data-generation process, in particular the change in the form of the trend. An innovative outlier may be, for instance, the use of a new technology of production.

2. Methods for analysis of changes of time series in time

The theory of time series analysis uses many different statistical methods ranging from the simplest methods through various analytical models. The analysis used:

- deseasonalisation using Census II X-11 method,
- detrending by Hodrick-Prescott filter,
- derandomisation in order to eliminate the influence of random factors using the moving average with MCD (months of cyclical dominance) method,
- identification of turning points in line with the Bry-Boschan method,
- defining descriptive statistics characterizing the studied time series.

[4] G. Jóźwiak, J. Podgórski, *Statystyka od podstaw*, PWE, Warsaw, 1998.

2.1. Deseasonalisation using Census II X-11 method

One of methods, which allows determining the seasonal changes in the multistage procedure of seasonal decomposition, is Census X-11[5]. Analysis of Census II X-11 is a basis for the empirical recovery of the variations in the analyzed phenomenon. It is essential for assessing the properties of time series examined for their suitability for short-term forecasts. It is widely regarded as one of the best tools used in the analysis of economic phenomena in the world[6]. The method is based on the assumption that the dynamics of economic processes can be subdivided into three or four components of growth: seasonal variations (S), irregular changes expressing certain one-time impairment (I), cyclical fluctuations, expressed together with the trend or separately (TC, or C) and a long-term linear or non-linear trend (T). The components (S), (I) and (TC) are isolated by Census II X-11, and trend and cycle (TC) and (C) are most commonly isolated using Hodrick-Prescott filter (HP).

The analysis of cyclical changes used the concept of cycle based on the study of deviations from the trend. In the course of the empirical analysis, the study can make a positive or negative verification of hypotheses about the presence of individual components of dynamics in the process, their relative independence and required stability of distribution. Only after examining the empirical distribution of variations one can dispense with extracting non-essential or very irregular dynamic components (e.g. seasonal changes) and enclose them together with irregular changes. Use of time series decomposition techniques is therefore advisable not only for the evident seasonality, but even if one only wants to make sure that the process is not burdened with significant seasonality.

Deseasonalisation[7] is accomplished by iterative smoothing of a series based on moving averages, and comprising the following steps[8]:

---

[5] It was developed by the U.S. Bureau of the Census (CENSUS) in 1960s and has gained wide acceptance among practitioners. It is mainly used in the analysis of production changes where it is important to make adjustments for the number of working days and unusual events. Description of the method can be found in – acc. to S.C. Wheelwright, S. Makridakis, *Forecasting Methods for Management*, John Wiley, New York, 1989.

[6] S.C. Wheelwright, S. Makridakis, *Forecasting Methods for Management*, John Wiley, New York, 1989.

[7] Procedure for deseasonalisation Census X-11 was developed in 1980 and refined in 1988 by Dagum in Statistical Office of Canada as a development of the II/X11 method, already used in the U.S. Bureau of Census. Census Procedure II X-implements three basic functions – acc. to E.B. Dagum, *X11-ARIMA/88. Seasonal Adjustment Method - Foundations and User's Manual*, Ottawa, 1988, i.e. deseasonalisation of time series, decomposition of time series to irregular, seasonal, cyclical and trend components and extrapolation forecast for the next 12 months.

[8] E.B. Dagum, *X11-ARIMA/88. Seasonal Adjustment Method – Foundations and User's Manual*, Ottawa 1988; I. Kudrycka, R. Nilsson, *Cykle koniunktury w Polsce: analiza wstępna,*

1. calculation of 12-expression (for monthly data) moving average as a first approximation of the trend-cycle to obtain the coefficients (S and I);
2. with coefficients S and I calculated in the previous step, expressing the sum of seasonal and irregular components, one designates 5-term moving average as a preliminary estimate of the seasonal component for each month;
3. results of the preliminary assessment of seasonal components are adjusted using a 12-term centred moving average;
4. coefficients S and I calculated in step l are divided by the adjusted initial estimates of the seasonal component to determine the irregular component;
5. extreme values of irregular component are eliminated or adjusted on the basis of 5-term moving standard deviations of irregular component;
6. SI coefficients without extreme values use 5-term moving average in order to re-estimate seasonal components;
7. seasonal components determined in this way are re-adjusted using centred moving average;
8. preliminary estimate of seasonally adjusted series is done by dividing the original series by seasonal factors obtained in point 7;
9. in order to extract growth-cyclic components from the purified series, on uses so called Henderson filter in the form of 9-, 13-, or 23-expression moving average, with a length selected according to the ratio of irregular component to trend. By dividing the input series by estimated trend-cycle, a second approximation was obtained of the estimate of seasonal factors and irregular changes in SI;
10. SI coefficients calculated for each month separately determine 7-term weighted average with specification dependent on the value of overall SI, thus obtaining a second approximation of estimate of the same seasonality;
11. step 3 is done again, calculating a 12-month centred moving average of the seasonal factors and correcting them using this average;
12. input series is divided by seasonality factors designated in point 11, obtaining the final seasonally adjusted series.

Multiple estimation causes that the resulting estimates of seasonal fluctuations (factors) for univariate periods do not take equal values in each year using both additive and multiplicative model. Therefore, one deals with the possibility of recognizing a variable type of seasonality, which is most common in business practice.

---

from work of the Department of Economic and Statistical Research of CSO and PAS, v. 209, Warsaw 1993; OECD, *Leading Indicators and Business Cycles in Member Countries*, Sources and Methods 1960-1985 NO-39, 1987.

Listings include description of the major features of variability of time series analyzed using Census X-11 II. These are: average duration of run (ADR) of irregular component, cyclic component and cyclic component together with irregular component, total number of months needed to ensure that the changes observed in the series are cyclical, not irregular, i.e. MCD (months for cyclical dominance), share of irregular component I, seasonal component S and trend T and cycle C in observed variability. This shows the relative sizes of the components in price changes depending on the duration of the changes and their significance in explaining the variance in prices and the relationship between the components.

2.2. Detrending by Hodrick-Prescott filter

An important step in empirical analysis of series is to separate long-term trends and cyclical fluctuations. This is the starting point for the determination of cyclical components of changes in time series. Separation of trend and cyclical fluctuations was done using Hodrick-Prescott filter (HP), which smoothed values were trend level (Tt). Filtration is, in addition to the analytical method, the second way of assessing development trends related to some form of local averaging of data. These methods are intended to obtain an estimate of the trend, and the effect depends on the nature of the filter that will be used. In our case, the study used the maximum value of the smoothing parameter (9999), which allowed getting a smooth trend level with no cyclical variation[9].

One should remember that regardless of the reasoning and method of determining the development trend (T), the procedure for the separation of "pure trend" and "pure cycle" was often criticized as artificial and risky. Substantive objections are raised primarily by the assumption of mutual independence of the long-term growth and short-term fluctuations underlying this concept. Isolation of "growth" and "cyclical" component of the development process is, in the light of this criticism, a conventional procedure and insufficiently justified, precisely because of the interdependence of the trend and cyclical fluctuations as phenomena conditioned by similar or identical factors.

2.3. Derandomisation with the concept of Months of Cyclical Dominance

Removal of random component was done using moving average with smoothing window width equal to MCD or the number of months needed to extract cyclical changes (MCD – Month for Cyclical Dominance). MCD is used to

[9] H. Ongena, S*easonal Adjustment of European Community External Trade Statistics: Application of X11-ARIMA/88*, Workshop on Opinion Surveys for Business and Consumers and Time Series Analysis, Munich 1991.

study the relationship between systematic and random changes in evaluating the suitability of time-series in research of the economic situation. It is based on the estimation of the period of time units, which are also the basis for the shortest moving average for which the absolute average change of trend and cycle elements in a given period is equal to or greater than the average absolute change of irregular elements. The lowest value obtained for which this condition is met with the measure of MCD[10].

In practice, the obtained MCD measure is the number of months that on average have to "blend" together until the development of systematic elements, i.e. the trend and cyclical fluctuations, will exceed the development of irregular elements, which is expressed by the ratio I/TC lower than unity. This measure thus shows the period that one must wait in order to recognize with certainty that the change in trend of empirical values observed on the empirical values curve is the new phase of the cycle[11]. MCD value equal to e.g. 3 means that after three months of unidirectional upward or downward change in the test variable, it can be assumed that it marks the new phase of the cycle, rather than temporary irregular fluctuations.

2.4. Identification of turning points in line with the Bry-Boschan method

The basis for determining turning points and identifying major cyclical fluctuations in time series is the method based on the concept of trend determined in accordance with the Bry-Boschan procedure[12]. It involves the use of set of moving averages to determine the trend, and then determining the turning points. For this purpose, the moving averages of different lengths are calculated, ranging from the smoothest long-term curves, e.g. 75-month average, the Spencer curve and 12-month average, to the short-term 3-5-month average, and finally a series of raw data without trend[13]. Procedure for searching turning points is repeated in various smoothed curves in order to find those turning points that best fit the observed variability in the input series which includes no seasonal fluctuations[14]. Turning points are those that satisfy the following conditions[15]:

---

[10] R. Barczyk, Z. Kowalczyk, *Metody badania koniunktury gospodarczej*, PWN, Warsaw-Poznań 1993.

[11] Moving average with a period equal to the MCD is essential in the analysis of the cycle and in identification of turning points.

[12] R. Nilsson, *OECD Leading Indicators and the Phase Average Trend Method*, OECD Economic Studies No. 9, 1991.

[13] R. Nilsson, *OECD Leading Indicators and the Phase Average Trend Method*, OECD Economic Studies No. 9, 1991.

[14] R. Barczyk, Z. Kowalczyk, *Metody badania koniunktury gospodarczej*, PWN, Warsaw-Poznań 1993.

1. take extreme values on the empirical values curve with no seasonal variations, random values, but also the trend of development;
2. upper turning point – starting point of a phase of continuous decline, lasting a minimum of five months;
3. lower turning point – end point of a phase of decline, and at the same time the initial point of growth phase, lasting a minimum of five months;
4. turning points in the empirical values curve with no seasonal fluctuations, random fluctuations and the trend of development must be located in the immediate vicinity of points isolated on the MCD curve;
5. the first and last isolated upper (lower) point must achieve at least the high (low) value of any item in the series, lying at the beginning or end of the series, or as components between turning points;
6. turning points lying within five months from the beginning and the end of the period are eliminated;
7. turning points on both ends of the series with values higher (lower) than the values recorded closer to the end are eliminated;
8. cycles shorter than fifteen months are eliminated;
9. cyclical changes include only those for which one can determine at least four turning points, which means the occurrence of at least two complete cycles;
10. peaks and saddles must be alternated.

Some of these criteria (especially 6 and 9) shall be regarded as too restrictive with regard to the economy of less regular course and not fully formed mechanism of cyclical developments, such as the Polish economy at the present stage of development[16].

---

[15] OECD, *Leading Indicators and Business Cycles in Member Countries*, Sources and Methods 1960-1985 NO-39, 1987; Z. Matkowski, *Problemy identyfikacji cykli koniunkturalnych, Z prac nad syntetycznymi wskaźnikami dla gospodarki polskiej,* vol. 51, IRG SGH, Warsaw 1997; Matkowski Z., *Cykle w rozwoju gospodarki polskiej. Barometry koniunktury dla gospodarki polskiej*, IRG SGH, Warsaw 1999.

[16] R. Barczyk, Z. Kowalczyk, *Metody badania koniunktury gospodarczej*, PWN, Warsaw-Poznań 1993; Z. Matkowski, *Problemy identyfikacji cykli koniunkturalnych, Z prac nad syntetycznymi wskaźnikami dla gospodarki polskiej*, vol. 51, IRG SGH, Warsaw 1997; Z. Matkowski, *Cykle w rozwoju gospodarki polskiej. Barometry koniunktury dla gospodarki polskiej*, IRG SGH, Warsaw 1999.

2.5. Determination of descriptive statistics characterizing the studied time series

In addition to the estimation of the major components of a time series, various descriptive statistics have been calculated:

- percentage changes in monthly time series and its various components, depending on the duration of changes,
- percentage share of selected components of a time series of prices in total price variation depending on the duration of change,
- another indicator calculated on the basis of the results of seasonal adjustment by Census X-11 is the MCD. Calculated MCD values indicate what period is needed for the change resulting from the long-term component (TC) equalled the changes resulting from random component. It is also consistent with the fact that after such a period of unidirectional change in moving average (from the turning point), one can be sure about the correctness of the long-term trend.

3. Empirical analysis of price changes in 2001-2013

Formal and statistical features of tested time series allowed determining their structure and identifying the specific characteristics of the dynamics of prices in terms of their short-term forecasting. The graphs and tables show:

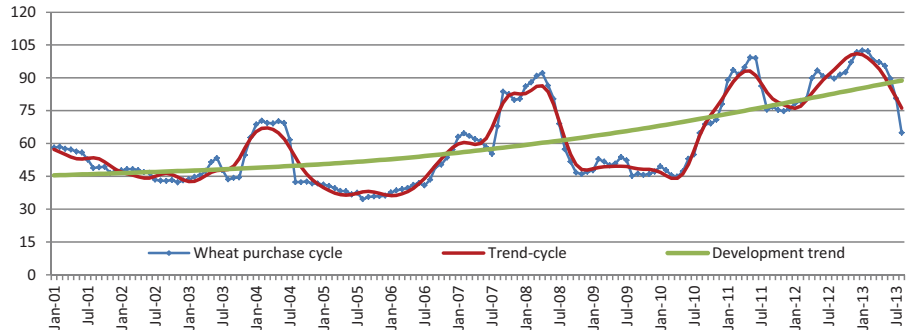
- changes in prices and their individual components over time,
- share of individual components in variability, depending on the duration of change,
- percentage changes in the individual components depending on the time horizon,
- share of the seasonal component and stability of the seasonal pattern,
- number of months necessary to disclose cyclical changes (MCD).

Analysis was performed for nominal prices in line with the assumptions of projection presented in the following chapters.

3.1. Analysis of changes in purchase prices of wheat

Investigation of the time series of purchase prices of wheat indicates the presence of all four major components of variation, i.e. development trend, cyclical fluctuations, seasonal fluctuations and random fluctuations (Figure I.3.1.1).

Figure I.3.1.1. Development of purchase prices of wheat in PLN/100 kg with long-term trend (trend-cycle) and the development trend

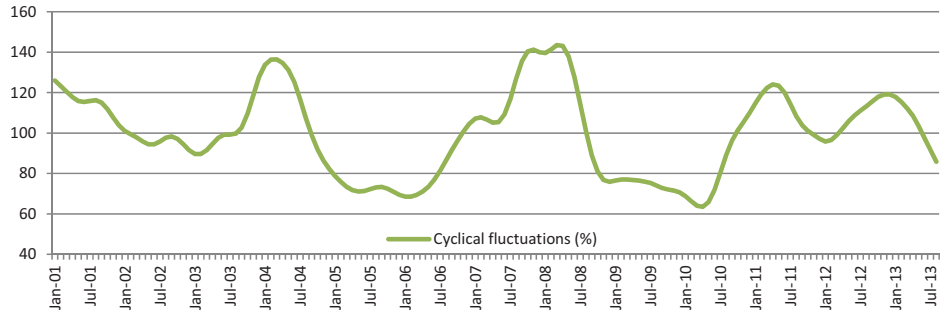


Source: Own study based on CSO data.

A characteristic feature of the course of purchase price of wheat is a significant modification of the standard course of cyclical fluctuations (Figure I.3.1.2). Since 2011, one can observe different morphology of cyclical fluctuations, as compared to previous years. The consequence of this condition is the reduced availability of using the current standard course as an indicator for constructing forecasts for subsequent periods. The outlined development trend is significantly influenced by the inflation factor.

The time series of purchase prices of wheat reveals the presence of periodic changes, both seasonal and cyclical fluctuations. Even from the graphical analyses, based on the scale of the amplitudes, one can observe that the importance of the cyclical component is greater than that of the seasonal component (Figure I.3.1.2 and I.3.1.3). The pattern of cyclical changes is periodic, but each sequence of changes presents different intensity of individual phases, different distribution of turning points and other characteristics of the so-called bottoms and peaks of individual cycles (Figure I.3.1.2). Average length of cyclical changes is approximately 3.7 years, and the cycles are unequal in length and change amplitude. This is confirmed by turning points of cyclical changes. Distribution of lower turning points of purchase prices of wheat is: January 2003, January 2006, May 2007, April 2010, January 2012. Distribution of upper turning points of purchase prices of wheat is: March 2004, January 2007, April 2008, April 2011, November 2012.

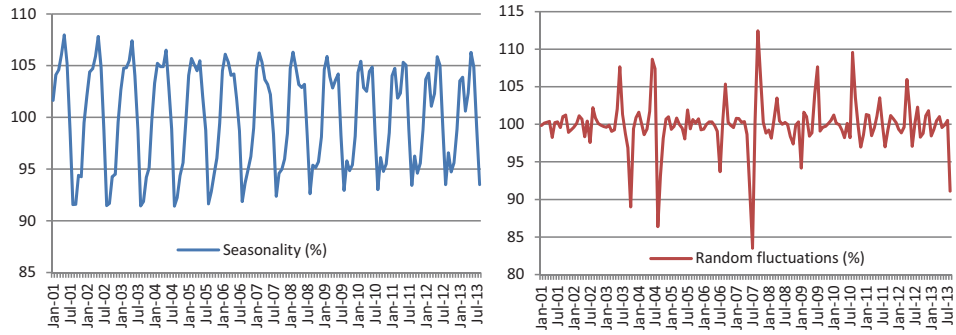
Figure I.3.1.2. Development of cyclical fluctuations in purchase price of wheat as % of deviations in long-term trend



Source: Own study based on CSO data.

Extent of cyclical fluctuations is varied, and the maximum amplitude of the fluctuations over the whole period was 79 percentage points. In the case of the cyclical component, the maximum amplitude of changes ranged from 64% to 143% of the long-term trend, which is a deviation of ± 24.5 PLN/100kg with regard to the average price resulting from the long-term trend.

Figure I.3.1.3. Development of seasonal and random fluctuations in purchase price of wheat as % of deviations in long-term trend



Source: Own study based on CSO data.

In the case of seasonal fluctuations, one observes a decrease in the amplitude of seasonal changes over the period under study. For example, at the beginning of the period in 2001, the value of multiplicative seasonal factors in May was 107.97%, in August 91.58% relative to the trend cycle. In 2013, in May deviation was 106.28% and 93.50% in August. The seasonality pattern itself is being modified; since 2010, there has been a seasonal rise in prices in February, and another peak in May, which was not observed in previous years.

The relative share of the trend and the cycle (TC) of the prices of wheat in the total variance on average over the year is 72.67% and the seasonality on average explains 17.82% of the variance of the time series. In turn, the share of random component in the variance of the time series of purchase prices of wheat is 9.51% (Table I.3.1.1).

Table I.3.1.1. Relative share of selected components of time series of wheat prices in their total changes depending on their duration

Relative % share of individual components of wheat prices in the total variance depending on duration of changes			
Month	I	TC	S
1	27.10	42.87	30.02
2	16.35	54.92	28.73
3	8.79	64.66	26.55
6	2.63	76.65	20.72
9	1.17	97.97	0.86
12	1.04	98.94	0.01
Average	9.51	72.67	17.82

Source: Own study based on CSO data.

MCD value for wheat purchase price is 3.75, which means that after nearly four months of unidirectional changes, the long-term component (TC) caught up with the changes resulting from the random component. The maximum amplitude of changes was 28 percentage points. In addition to average values, the share of individual fluctuations (components) depending on the time horizon of changes is relevant from the point of view of risk and forecasting. For example, when forecasting three months ahead, one must bear in mind that long-term changes (TC) in more than 64% determine the accuracy of the forecasts and seasonal fluctuations only in 26.55%, but when formulating the annual forecast, the long-term changes are of key importance – their significance is 98.94%. Overall, the pattern is such that as the horizon of changes under consideration increases, the importance of long-term component is increasing and importance of short-term fluctuations (seasonal and random) is decreasing.

The nature and scale of random changes (Figure I.3.1.3) is also important. In the case of wheat purchase prices, random fluctuations are on average 9.51% of the total variability of the time series, which is a relatively small part of total fluctuations.

From the point of view of assessing the variability as one of the elements for the assessment of risk, one can also analyze the nature of changes in percentage terms. Table I.3.1.2 shows that the average change in prices within one year is nearly 29.05%, and essentially it is the result of long-term changes, factors influencing the trend and cycle. In turn, within 6 months, the prices change on average by 18.88%. In the same period, long-term trend component (TC) is changed by 16.65%, and seasonal fluctuations by 8.66%. Results in Table I.3.1.2 show that the longer the forecast horizon, the more important are the changes in the form of trend-cycle.

Table I.3.1.2. Average percentage change in time series of prices of wheat and their selected components depending on the duration of change

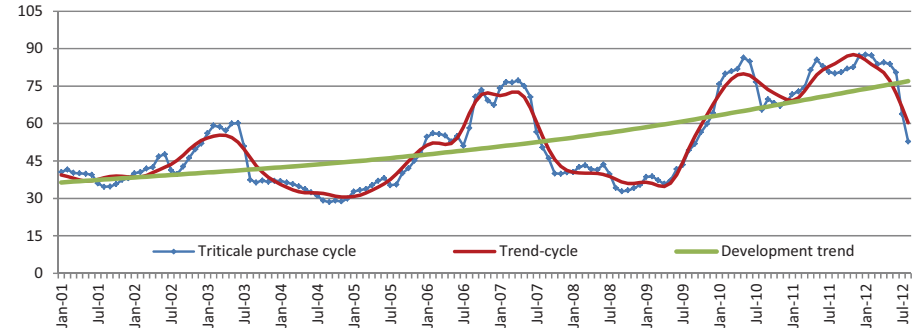
Average percent change in individual components of time series of wheat prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	4.61	4.05	2.50	3.15	2.64
2	8.24	7.41	3.38	6.20	4.49
3	11.35	10.36	3.35	9.08	5.82
6	18.88	17.43	3.09	16.65	8.66
9	25.16	24.10	3.29	23.25	5.85
12	29.05	29.09	2.96	28.89	0.35

Source: Own study based on CSO data.

3.2. Analysis of changes in purchase prices of triticale

The course of time series of purchase prices of triticale in terms of trends and changes over time is very similar with respect to morphology of changes in purchase prices of wheat. The main difference is the level of fluctuations. As in the case of wheat purchase prices, one observes occurrence of development trend, cyclical fluctuations, seasonal fluctuations and random fluctuations (Figure I.3.2.1).

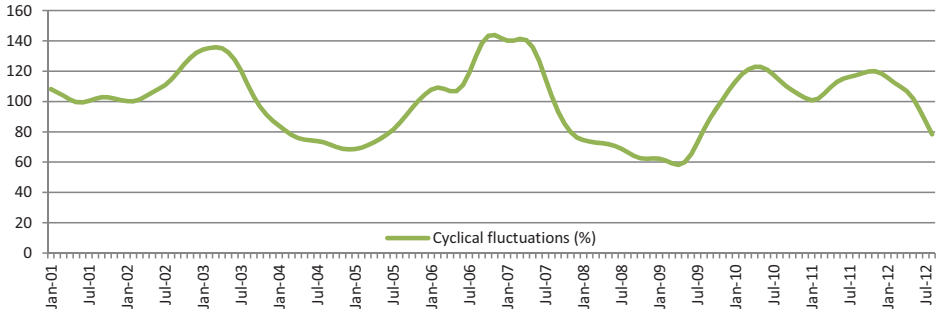
Figure I.3.2.1. Development of purchase prices of triticale in PLN/100 kg with long-term trend (trend-cycle) and the development trend



Source: Own study based on CSO data.

Medium-term variability of time series of triticale purchase prices is determined by the presence of periodic fluctuations. Cyclical fluctuations are of key importance; with respect to morphological properties, they are very similar to the fluctuations observed in the case of changes in the prices of wheat. Also in this case, the amplitude of cyclical changes is almost five times greater as compared to the amplitude of seasonal fluctuations in the prices of triticale (Figure I.3.2.2 and I.3.2.3).

Figure I.3.2.2. Development of cyclical fluctuations in purchase price of triticale as % of deviations in long-term trend



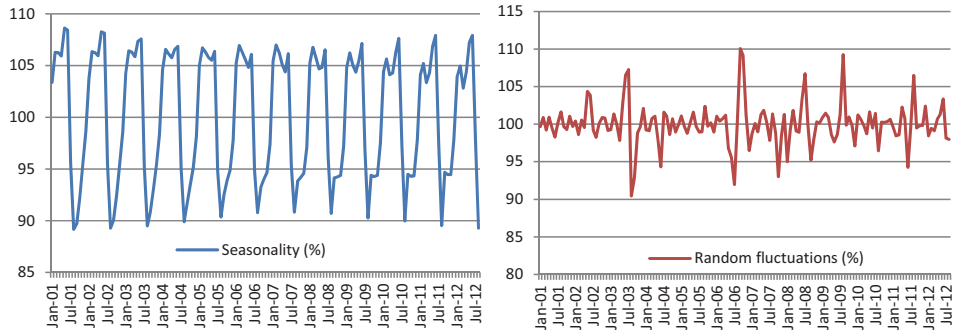
Source: Own study based on CSO data.

In the analyzed period, the pattern of cyclical changes has been changing; morphology of individual cycles varies in the intensity of the individual phases, distribution of turning points or characteristics of the so-called bottoms and peaks of individual cycles (Figure I.3.2.2). Average length of cyclical changes is the same as the prices of wheat and is about 3.7 years. Distribution of lower

turning points of triticale purchase prices is: January 2003, December 2005, May 2010, December 2011. Distribution of upper turning points in purchase prices of wheat is: February 2004, October 2007, April 2011, October 2012.

Extent of cyclical fluctuations is varied, and the maximum amplitude of the fluctuations over the whole period was 84.14 percentage points, i.e. 5.14 percentage points more than in case of wheat prices. In the case of the cyclical component, the maximum amplitude of changes ranged from 59.19% to 143.44% of the long-term trend. In the last cycle, the amplitude of the fluctuations was already 63 percentage points.

Figure I.3.2.3. Development of seasonal and random fluctuations in purchase price of triticale as % of deviations in long-term trend



Source: Own study based on CSO data.

In case of seasonal variations, one observes, unlike in the case of wheat purchase prices, an increase in the amplitude of seasonal changes since early 2010 (Figure I.3.2.3). For example, in 2009, the value of multiplicative seasonal factors was 106.77% in February, 106.52% in June and 90.71% in August, as compared to the trend cycle. In 2013, deviation in May was 104.94%, 107.24% in May and 89.3% in August. In 2009, the amplitude of seasonal fluctuations was 16.6 percentage points, whereas in 2013 already 18.63 percentage points. The pattern of seasonality itself is changing; since 2008, there has been a seasonal rise in prices in June, while in previous years, the highest value in seasonal deviation was in February.

The relative share of the trend and the cycle (TC) of the prices of triticale in the total variance on average over the year is 68.43% and the seasonality on average explains 23.76% of the variance of the time series, i.e. 5.94 percentage points more than in case of wheat purchase prices. In turn, the share of the random component in the variance of time series of triticale purchase prices is 7.81% (Table I.3.2.1). When forecasting the time series of triticale purchase

prices in a one year horizon one must bear in mind that long-term changes (TC) in more than 99.1% determine the correctness of the forecast, while seasonal variations only in 0.01%.

Table I.3.2.1. Relative share of selected components of time series of triticale prices in their overall changes depending on their duration

Relative % share of each component of triticale prices in total price variance depending on duration of changes			
Month	I	TC	S
1	23.72	38.24	38.03
2	12.87	49.55	37.58
3	6.61	57.91	35.48
6	1.79	67.82	30.39
9	0.99	97.94	1.07
12	0.89	99.10	0.01
Average	7.81	68.43	23.76

Source: Own study based on CSO data.

MCD value for triticale purchase price is 3.4, which means that after nearly 3 months of unidirectional changes, the long-term component (TC) caught up with the changes resulting from the random component.

Table I.3.2.2. Average percentage change in time series of triticale prices and their selected components, depending on the duration of change

Average percent change in individual components of time series of triticale prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	5.12	4.08	2.48	3.14	3.13
2	9.00	7.30	3.16	6.19	5.39
3	12.15	10.00	3.08	9.10	7.13
6	20.58	18.04	2.84	17.49	11.71
9	27.57	26.28	2.91	25.54	7.35
12	33.08	33.11	3.08	32.45	0.32

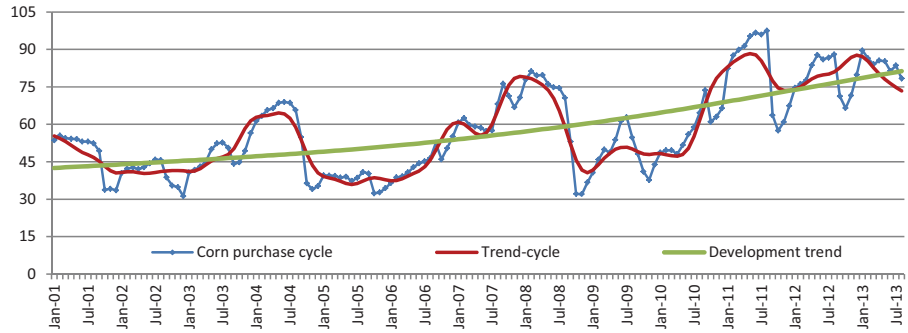
Source: Own study based on CSO data.

In the total triticale purchase price variability, random fluctuations are less important in comparison with wheat purchase prices, whereas the role of seasonal fluctuations increases. Despite that, the long-term changes outweigh the seasonal changes only after two months of observation (Table I.3.2.2). In such horizon, long-term price changes (TC) are on average 9.00% and seasonal price changes are 5.39%. Average price changes in the period of one year are 33.08% and result in a major extent from the factors influencing the trend and cyclical fluctuations.

3.3. Analysis of changes in purchase prices of maize

Changes in purchase prices of corn, as in previous cases, are significantly influenced by factors affecting the price level consistently over a long period of time. One can also see the seasonal effect and random fluctuations occurring at different scale. The increase in prices over a long period of time is a consequence of growth cycles, i.e. a situation in which lowering prices during the downward phase of the cycle is offset with extra pay by the increase in the growth period of the cycle (Figure I.3.3.1).

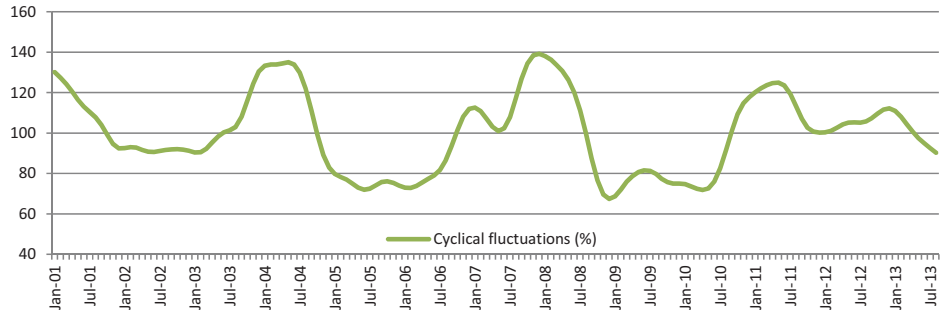
Figure I.3.3.1. Development of purchase prices of maize in PLN/100 kg with long-term trend (trend-cycle) and the development trend



Source: Own study based on CSO data.

A consistent feature of the observed cyclical fluctuations is their repeatability, due to the nature of cyclical fluctuations (Figure I.3.3.1 and I.3.3.2). However, it cannot be assumed that the observed cycles have a similar morphology. Such a scenario makes it difficult, if not impossible, to use extrapolative techniques in the projection of cyclical fluctuations.

Figure I.3.3.2. Development of cyclical fluctuations in purchase price of maize as % of deviations in long-term trend

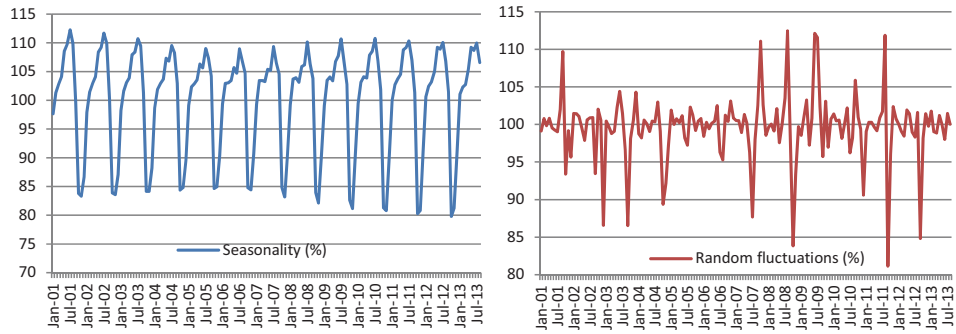


Source: Own study based on CSO data.

Average length of cyclical changes is approximately 3.5 years. Distribution of lower turning points of purchase prices of maize is: January 2003, June 2005, December 2008, December 2011. Distribution of upper turning points in purchase prices of maize is: April 2004, November 2008, May 2011, December 2012.

Extent of cyclical fluctuations is varied, and the maximum amplitude of the fluctuations over the whole period was 71.03 percentage points. In the case of the cyclical component, the maximum amplitude of changes ranged from 67.33% to 138,41% of the long-term trend.

Figure I.3.3.3. Development of seasonal and random fluctuations in purchase price of maize as % of deviations in long-term trend



Source: Own study based on CSO data.

In the case of seasonal fluctuations, one observes an increase in the amplitude of the seasonal changes since the beginning of 2007. For example, in 2006, the value of multiplicative seasonal factors was 108.97% in July, 84.41% in November, as compared to the trend cycle. In the last audited year, respectively, in July 2013 – 109.98% and in November 2012 – 81.23% (Figure I.3.3.3).

A special feature of the course of time series of maize purchase prices is an increase in the amplitude of random fluctuations over the period. In the first half of the period the variance of random fluctuations was 12.8 percentage points, in the second 25.7 percentage points, indicating the occurrence of heteroscedasticity (Figure I.3.3.3). It is a phenomenon that affects the accuracy of projections.

Table I.3.3.1. Relative share of selected components of time series of maize prices in their overall changes depending on their duration

Relative % share of each component of maize prices in total price variance depending on duration of changes			
Month	I	TC	S
1	33.61	19.89	46.50
2	16.61	26.40	56.99
3	9.01	32.66	58.33
6	4.68	54.21	41.11
9	2.50	94.11	3.39
12	2.34	97.63	0.03
Average	11.46	54.15	34.39

Source: Own study based on CSO data.

The average share of random fluctuations in the total maize purchase price variability is 11.46%, seasonality 34.39%, and the changes resulting from the tendency combined with the cycle, respectively 54.15% (Table I.3.3.1). The relatively high share of seasonality causes that only the forecasts formulated for a period of six months and longer are released from the dominant influence of seasonality. For example, when forecasting three months ahead, one must bear in mind that long-term changes (TC) in more than 32.66% determine the accuracy of the forecasts and seasonal fluctuations in 58.33%.

The average annual change in maize purchase price is 27.64%. Within six months, prices change on average by 23.28%, with the above-mentioned seasonality being of great importance (Table I.3.3.2). MCD value for a series of prices of maize is 3.48, which means that after three months of unidirectional changes, one can be convinced that they are permanent, equating to a random factor.

Table I.3.3.2. Average percentage change of time series of maize prices and their selected components depending on duration of change

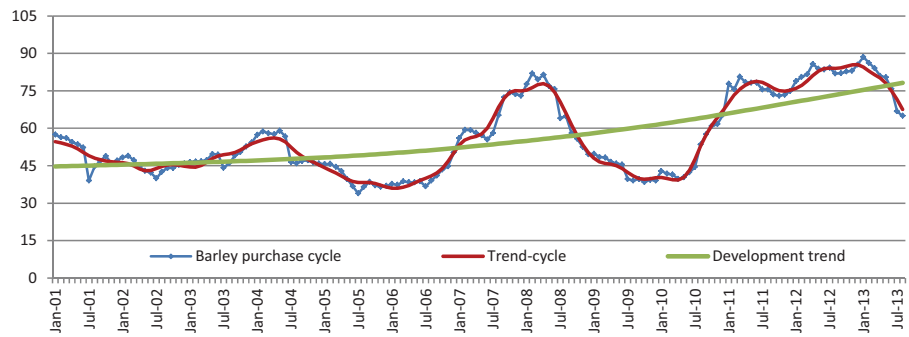
Average percent change in individual components of time series of maize prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	6.92	5.05	3.96	3.05	4.66
2	11.98	8.06	4.73	5.97	8.77
3	16.12	10.84	4.62	8.80	11.76
6	23.28	17.94	4.67	15.91	13.85
9	27.63	23.43	4.23	21.80	12.46
12	27.64	27.70	4.12	26.65	0.48

Source: Own study based on CSO data.

3.4. Analysis of changes in purchase prices of barley

Study of the time series of purchase prices of barley indicates the presence of all four major components of variation, i.e. development trend, cyclical fluctuations, seasonal fluctuations and random fluctuations (Figure I.3.4.1). A characteristic feature of the course of purchase price of barley, as in the case of wheat and triticale, is a modification of the standard course of cyclical fluctuations (Figure I.3.4.2). Since 2011, one can observe different morphology of cyclical fluctuations, as compared to previous years.

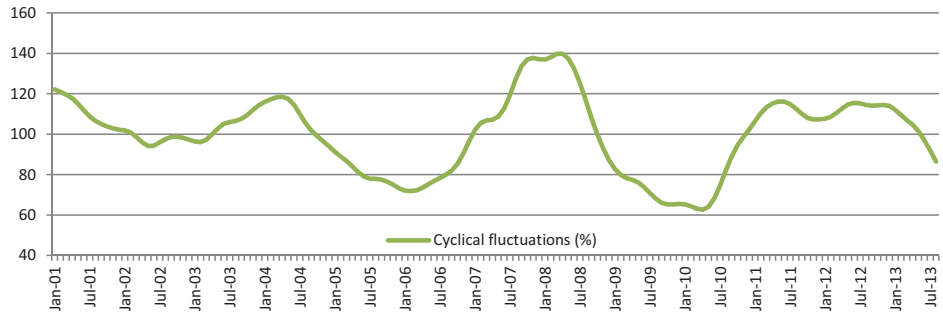
Figure I.3.4.1. Development of purchase prices of barley in PLN/100 kg with long-term trend (trend-cycle) and the development trend



Source: Own study based on CSO data.

The course of the time series of barley purchase prices reveals also the impact of seasonality, but on the basis of the scale of the amplitudes, one can observe that the importance of the cyclical component is several times larger than that of the seasonal component (Figure I.3.4.2 and I.3.4.3). As with the price of wheat and triticale, pattern changes over time. Each cycle has a different intensity of the different phases and different distribution of the turning points of cycles (Figure I.3.4.2). Average length of cyclical changes is approximately 3.7 years, and the cycles are unequal in length and amplitude changes. This is confirmed by turning points of cyclical changes. Distribution of lower turning points of purchase prices of barley is: May 2002, January 2006, April 2010. Distribution of upper turning points of purchase prices of barley is: April 2004, March 2008, May 2011. The scale of cyclical fluctuations is varied, and the maximum amplitude of the fluctuations over the whole period was 76.6 percentage points. In the case of the cyclical component, the maximum amplitude of changes ranged from 63.1% to 139.7% with regard to the average price resulting from the long-term trend.

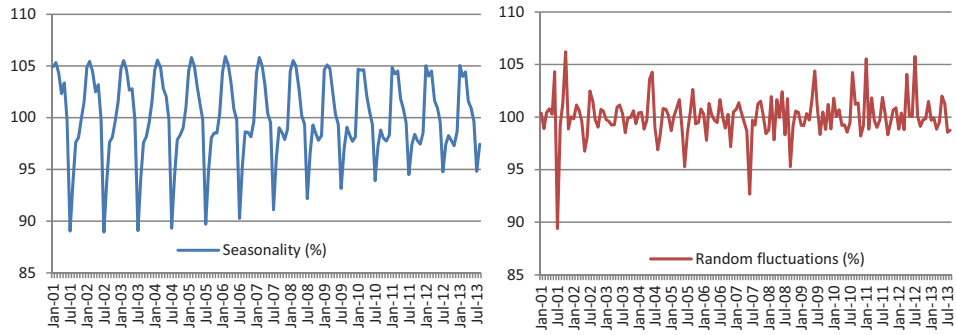
Figure I.3.4.2. Development of cyclical fluctuations in purchase price of barley as % of deviations in long-term trend



Source: Own study based on CSO data.

In case of seasonal variations, one observes, unlike in the case of triticale purchase prices, a decrease in the amplitude of seasonal changes (Figure I.3.4.3). For example, in 2001, the value of multiplicative seasonal factors was 105.33% in January, 89.04% in July, as compared to the trend cycle. In 2013, respectively in January, deviation was 105.05%, while in July only 94.83% of the average price level of the year. In 2001, the amplitude of seasonal fluctuations was 16.29 percentage points, whereas in 2013 already 10.22 percentage points.

Figure I.3.4.3. Development of seasonal and random fluctuations in purchase price of barley as % of deviations in long-term trend



Source: Own study based on CSO data.

The relative share of the trend and the cycle (TC) of the prices of barley in the total variance of prices on average is 71.50%, seasonality on average explains 20.81% of the variance of the time series, and random fluctuations comprise 7.69% (Table I.3.4.1). When forecasting the time series of barley purchase prices in a one year horizon one must bear in mind that long-term changes (TC) in more than 99.28% determine the correctness of the forecast, while seasonal fluctuations only in 0.01%. However, the forecast formulated with quarterly horizon will be in 30.71% dependant on the impact of seasonal factors.

Table I.3.4.1. Relative share of selected components of time series of barley prices in their overall changes depending on their duration

Relative % share of each component of barley prices in total price variance depending on duration of changes			
Month	I	TC	S
1	25.39	35.85	38.75
2	11.19	52.48	36.33
3	6.52	62.77	30.71
6	1.69	80.35	17.96
9	0.64	98.25	1.11
12	0.71	99.28	0.01
Average	7.69	71.50	20.81

Source: Own study based on CSO data.

Average price changes in the period of one year amount to 25.7%. These changes are primarily the result of long-term factors. Price changes arising due to seasonality are of less concern. The prices change due to seasonality to the greatest extent after 6 months, and the change is on average 6.43% (Table I.3.4.2). MCD value for purchase prices of barley is 2.8, which means that after three months of unidirectional changes, one can infer that they are permanent.

Table I.3.4.2. Average percentage change of time series of barley prices in their overall changes depending on their duration

Average percent change in individual components of time series of barley prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	4.01	3.24	2.02	2.40	2.49
2	6.73	5.50	2.19	4.75	3.95
3	9.08	7.66	2.26	7.03	4.91
6	15.41	13.82	1.94	13.40	6.34
9	20.66	19.71	1.91	19.49	4.90
12	25.70	25.69	2.14	25.30	0.24

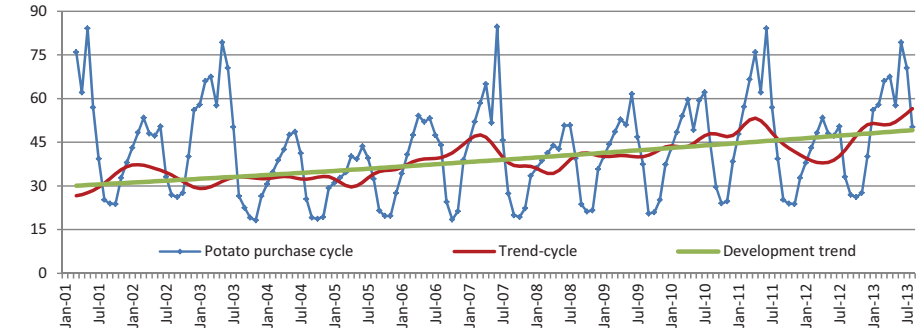
Source: Own study based on CSO data.

3.5. Analysis of changes in prices of potatoes

Long-term fluctuations in purchase prices of potatoes allow identification of long-term trend and cyclical fluctuations around it within a period of about five years (Table I.3.5.1). However, seasonal variability plays a dominant role. Significant scale of random fluctuations also draws attention.

Pattern of cyclical changes reveals significant changes in the morphology of the course of time series, but in contrast to the previously analyzed purchase prices of agricultural products. the length of change cycle is significantly greater (Figure I.3.5.2), while at the same time the amplitude of each cycle is relatively similar. Distribution of lower turning points of purchase prices of potatoes is: January 2003, June 2005, December 2008. Distribution of upper turning points in purchase prices of potatoes is: May 2004, December 2007, April 2011.

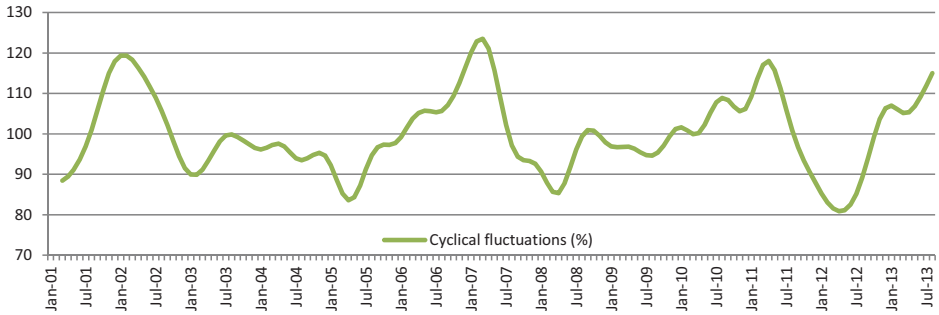
Figure I.3.5.1. Development of purchase prices of potatoes in PLN/100 kg with long-term trend (trend-cycle) and the development trend



Source: Own study based on CSO data.

Amplitude of fluctuations in individual cycles is similar, and the maximum value over the whole period was 71.1 percentage points. In the case of the cyclical component, the maximum amplitude of changes ranged from 67.3% to 138.4% of the long-term trend.

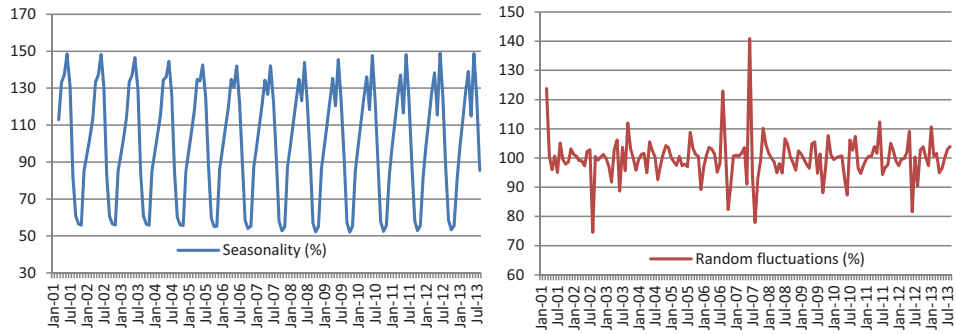
Figure I.3.5.2. Development of cyclical fluctuations in purchase price of barley as % of deviations in long-term trend



Source: Own study based on CSO data.

In case of seasonal fluctuations there is a constant amplitude of seasonal fluctuations in the period of time (Figure I.3.5.3), while at the same the seasonal pattern is modified. Since 2005, in spring and in summer, there are two peaks of seasonal price increases. The first is in May, when quoted prices are 138.9% of the average level in the year, and the second peak is in June with price deviation of 148.9%. Seasonal declines in prices fall in October throughout the period. Then, prices are 53.28% of the average annual level.

Figure I.3.5.3. Development of seasonal and random fluctuations in purchase price of potatoes as % of deviations in long-term trend



Source: Own study based on CSO data.

Seasonal fluctuations are a major factor in the short-term changes in the prices of potatoes. The average share of seasonal fluctuations in the total potatoes purchase price variability is 71.80%, the changes resulting from the tendency combined with the cycle, respectively 19.83% and random fluctuations 8.37 (Table I.3.5.1). The relatively high share of seasonality causes that only the forecasts formulated for a period of 12 months and longer are under the dominant influence of long-term factors. Each forecast formulated for a shorter period is under the dominant influence of seasonality. For example, when forecasting six months ahead, one must bear in mind that long-term changes (TC) in 2.40% determine the accuracy of the forecasts and seasonal fluctuations in 96.48%.

Table I.3.5.1. Relative share of selected components of time series of potatoes prices in their overall changes depending on their duration

Relative % share of each component of potatoes prices in total price variance depending on duration of changes			
Month	I	TC	S
1	11.44	1.19	87.38
2	5.26	1.64	93.10
3	3.00	1.72	95.28
6	1.12	2.40	96.48
9	7.75	33.96	58.29
12	21.65	78.05	0.29
Average	8.37	19.83	71.80

Source: Own study based on CSO data.

The largest change in the price level takes place in the period of six months, their level is then changed by an average of 64.87% compared to the price level six months before (Table I.3.5.2). This is a direct result of seasonal factor, and secondly the effect of the impact of factors affecting the price level consistently over a long period of time.

Table I.3.5.2. Average percentage change of time series of potatoes prices and their selected components depending on duration of change

Average percent change in individual components of time series of potatoes prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	18.38	7.11	6.45	2.08	17.82
2	31.86	9.06	7.24	4.04	30.46
3	44.42	11.01	7.75	5.86	43.66
6	64.87	13.14	6.80	9.95	63.08
9	53.60	15.33	6.57	12.74	50.31
12	17.97	17.95	7.57	14.37	0.88

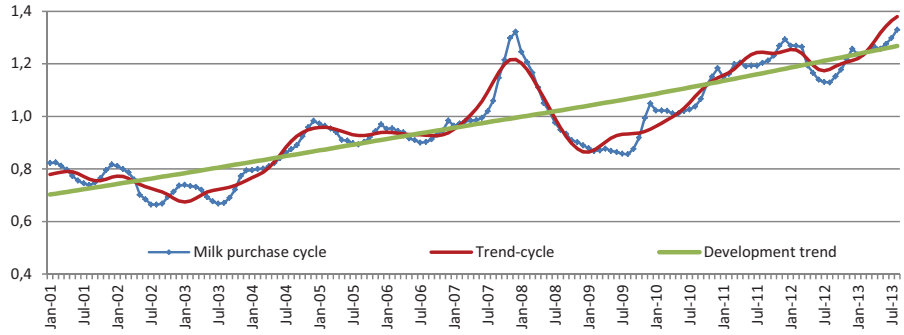
Source: Own study based on CSO data.

Average price changes in the period of one year amount to 17.79%. MCD value for purchase prices of potatoes is 3.30, which means that after three months of unidirectional changes, one can infer that they are permanent.

3.6. Analysis of changes in purchase prices of milk

Changes in nominal purchase prices of milk reveal, as in other cases of prices of agricultural products, the presence of all four major components of variability. A special feature of the course of time series of milk prices is the presence of the growth cycle, which means that the growth phase of the cycle offset with extra pay the lower prices in periods of downward phase of the business cycle. As a result, the analysis of cyclical fluctuations reveals that the increase in milk prices could be made as a consequence of the commodity cycle (Figure I.3.6.1).

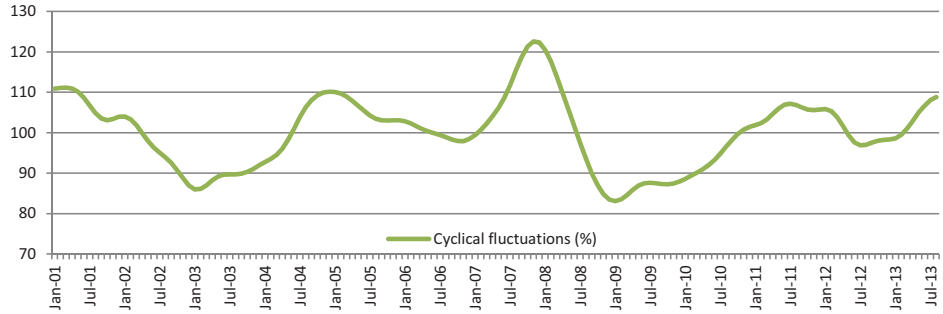
Figure I.3.6.1. Evolution of nominal and real milk prices in PLN/l with long-term trend (trend with cycle) as well as the development trend



Source: Own study based on CSO data.

The periodic variability of milk purchase prices includes seasonality changes and cyclical fluctuations. As in previous cases of the prices of agricultural products, cyclical changes are more noticeable than seasonal changes (Figure I.3.6.2 and I.3.6.3).

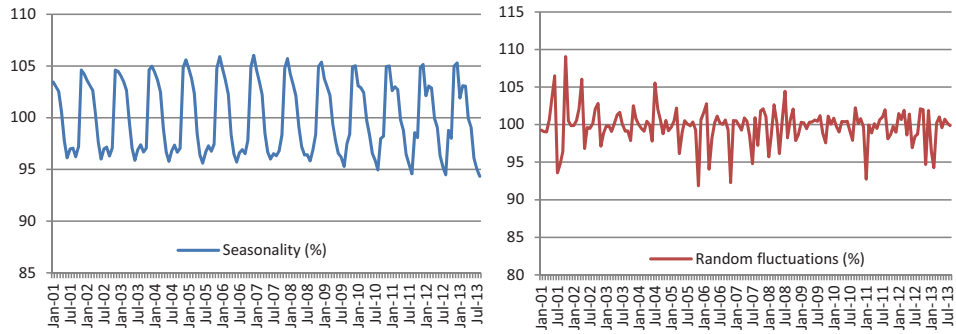
Figure I.3.6.2. Development of cyclical fluctuations in purchase price of milk as % of deviations in long-term trend



Source: Own study based on CSO data.

Average length of cyclic changes is approximately 3.2 years, with a tendency in recent years to shorten the length of the cycle and the maximum amplitude of fluctuations over the entire study period amounting to 39.1 percentage points. Distribution of lower turning points of purchase prices is: January 2003, January 2006, May 2007, April 2010, January 2012. Distribution of upper turning points of purchase prices of milk is: February 2001, December 2004, November 2007, July 2011.

Figure I.3.6.3. Development of seasonal and random fluctuations in purchase price of milk as % of deviations in long-term trend



Source: Own study based on CSO data.

Seasonality explains on average 27.36% of price variability. The amplitude of seasonal changes in 2012 was on average 10.81 percentage points, ranging from 94.48% (compared to an average of the phenomenon in the year) in August to 105.29% in December. Seasonal pattern over the period underwent modifications. The change in particular consists in the increase in amplitude of fluctuations from 8.49 percentage points in 2001 to 10.81 percentage points in 2012 and change in the pattern of fluctuations. Now one observes a sharp bottom of the seasonal cycle and bimodal peaks of seasonal pattern (Figure I.3.6.3).

Table I.3.6.1. Relative share of selected components of time series of milk prices in their overall changes depending on their duration

Relative % share of each component of milk prices in total price variance depending on duration of changes			
Month	I	TC	S
1	54.97	15.23	29.80
2	33.00	25.78	41.22
3	19.64	33.91	46.45
6	6.40	49.32	44.28
9	4.21	93.45	2.34
12	5.06	94.90	0.04
Average	20.55	52.10	27.36

Source: Own study based on CSO data.

The following tables (Table I.3.6.1 and I.3.6.2) summarize the results of calculations of percentage changes of time series and their components, and the relationships of time series components according to the duration of changes.

The relative share of the trend and cycle variable (TC) of milk purchase prices in the total variance on average is 52.10%, while that of seasonal fluctuations – 27.36%. The importance of seasonal fluctuations is higher than that of long-term fluctuations if one considers the changes in three months horizon. For a longer horizon seasonality is less important than TC (Table I.3.6.1).

Table I.3.6.2. Average percentage change of time series of milk prices and their selected components depending on duration of change

Average percent change in individual components of time series of milk purchase prices, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	1.90	2.52	2.34	1.23	1.72
2	3.61	3.96	2.77	2.45	3.09
3	5.01	5.12	2.75	3.61	4.22
6	8.40	7.64	2.40	6.65	6.30
9	10.10	9.91	2.49	9.15	4.19
12	11.30	11.37	2.60	11.25	0.23

Source: Own study based on CSO data.

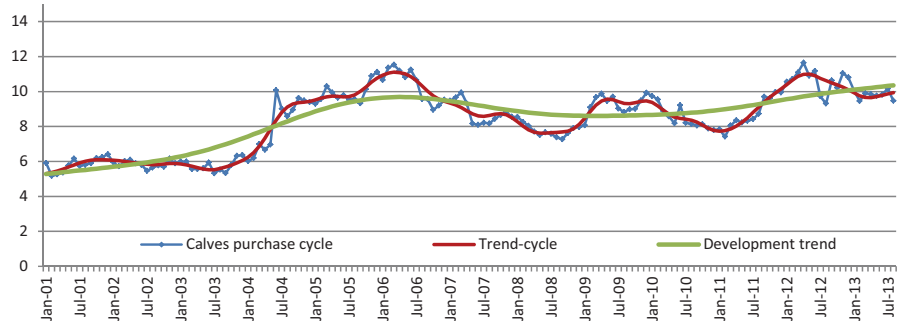
The average annual change in milk prices is 11.30%. Within six months, prices change on average by 8.4%, with the above-mentioned seasonality being of great importance.

The share of random component in milk price variance is 20.55%. MCD value for a series of prices of milk is 4.25, which means that after 4 months of unidirectional changes, one can be convinced that they are permanent, equating to a random factor.

3.7. Analysis of changes in purchase prices of calves

The course of long-term changes in purchase prices of calves reveals the collapse of the upward trend observed until the end of 2005 (Figure I.3.7.1). After this period, there was a reversal to horizontal direction, and in real terms there was a decrease.

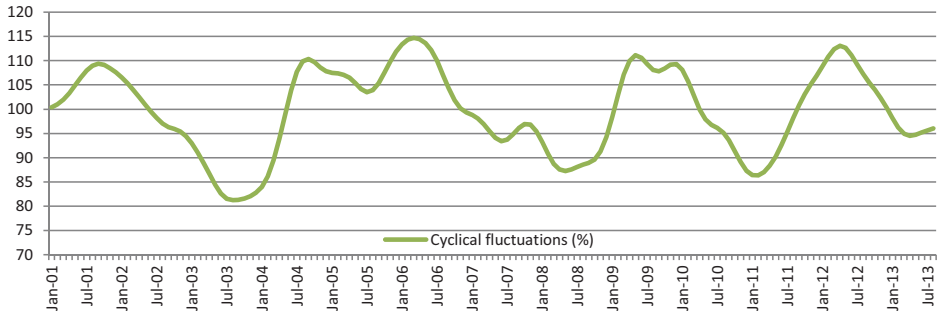
Figure I.3.7.1. Evolution of nominal and real prices of calves in PLN/kg with long-term trend (trend with cycle) as well as the development trend



Source: Own study based on CSO data.

The time series of purchase prices of calves includes seasonality changes and cyclical fluctuations. Seasonality explains on average 16.6% of variability of purchase prices time series. Cyclical pattern reveals significant changes in the morphology of the course of time series, both in the distribution of turning points and the intensity of the various phases of the course of cyclical fluctuations (Figure I.3.7.2).

Figure I.3.7.2. Development of cyclical fluctuations in purchase price of calves as % of deviations in long-term trend



Source: Own study based on CSO data.

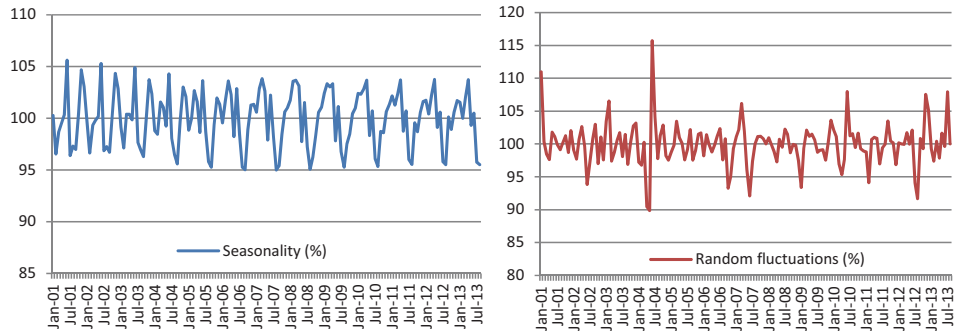
The average length of cyclical changes is less than three years; in the long-term, cycles with a period of fluctuations close to 10 years are observed in the cattle market. It can be assumed that the increase observed in the January 2001-January 2006 is part of the growth phase of a ten-year cycle, after which there was an adjustment from January 2009 and entry into the next phase of the cycle. However, the analysis period is too short to identify cycles of this length. In addition, as mentioned, variation includes cycles from 2.5 to 3 years. The maxi-

mum amplitude of these cyclical fluctuations over the whole period was 51.36 percentage points. Distribution of lower turning points of purchase prices of calves is: August 2003, July 2005, May 2008, February 2011, April 2013. Distribution of upper turning points in purchase prices of calves is: September 2001, August 2004, March 2006, May 2009, April 2012.

The time series of purchase prices of calves includes seasonality changes and cyclical fluctuations. Seasonality explains on average 16.6% of variability of this time series.

One should note the total change in the nature of seasonality over the period in question. The distribution of turning points and amplitude have changed. The breakthrough was in 2006, after which a new chronology of seasonal changes was established. In 2012, the highest prices were recorded in April (103.75% of the average for the year), the lowest in August (95.52% of the average for the year). For comparison, in 2001, the seasonal pattern was bimodal, the lowest price of the year was recorded in February and July and they were 96.4% of the average price in the year, and the highest prices were recorded in June – 105.62%. The main change in the seasonal pattern also occurred in the period before and after the accession (Figure I.3.7.3).

Figure I.3.7.3. Development of seasonal and random fluctuations in purchase price of calves as % of deviations in long-term trend



Source: Own study based on CSO data.

Random fluctuations are important in explaining the course of the time series in purchase prices of calves; their share in total variation is 24.38% (Table I.3.7.1). The scenario according to which from the beginning of 2008 one observes increase in the amplitude of the random fluctuations is also noteworthy. In the last twelve months, the maximum amplitude of changes in these fluctuations was more than 16 percentage points.

Table I.3.7.1. Relative share of selected components of time series of purchase prices of calves in their overall changes depending on their duration

Relative % share of each component of calves prices in total price variance depending on duration of changes			
Month	I	TC	S
1	53.83	14.48	31.69
2	41.20	30.30	28.51
3	28.76	46.50	24.74
6	11.00	76.59	12.41
9	5.11	92.72	2.17
12	6.40	93.53	0.07
Average	24.38	59.02	16.60

Source: Own study based on CSO data.

Seasonal fluctuations are relatively of little importance to the total variability of purchase prices of calves; this is evidenced by the fact that long-term changes outweigh the seasonal changes after two months of observation (Table I.3.7.1). In such horizon, long-term price changes (TC) are on average 6.06% and seasonal price changes are 3.03%. Average price changes in the period of one year amount to 16.34%, which indicates that the level of price risk is not high. Of course, one must bear in mind that adjustments of supply structure are slower than in other meat markets due to the long production cycle.

Table I.3.7.2. Average percentage change of time series of purchase prices of calves and their selected components depending on duration of change

Average percent change in individual components of time series of purchase prices of calves, depending on the duration of change (%)					
Month	Nominal prices	TCI	I	TC	S
1	4.34	3.51	3.04	1.58	2.33
2	6.06	5.00	3.67	3.15	3.06
3	7.45	6.45	3.67	4.66	3.40
6	10.60	9.65	3.34	8.82	3.55
9	13.52	12.95	3.17	12.69	3.38
12	16.34	16.34	4.15	15.87	0.45

Source: Own study based on CSO data.

4. Summary

The analysis aimed to determine the nature of the changes in prices of major agricultural products in dynamic terms, the underlying types of variability, and their strengths. The conclusions of the studies will form the basis for further analysis, including the basis for the selection of forecasting methods and determining the nature of the relationship between phenomena.

In agriculture and its environment, many of the phenomena are characterized not only by specific development trend, but also by periodic variability. The most common case is seasonal variations. Seasonality of production and supply is obvious. Periodicity of agricultural production, both plant and animal, entails similar effects in the supply (purchase) of agricultural products, level of their prices, farmers' income and the period of expenditures. Measurement and analysis of seasonal fluctuations and incorporating them in the forecasting process create the conditions for making effective business decisions.

The results show that the prices of agricultural products analyzed in 2001-2014 in Poland were characterized by high variability. The studies also reveal that the purchase prices of products, and particularly their short-term changes, are influenced by seasonality. At the end of the period, seasonal fluctuation pattern changed.

Quantification for cyclical fluctuations is much harder than for seasonal fluctuations. From this it follows that they are characterized by irregularity in terms of their duration and amplitudes. In most macroeconomic analyses, cyclical changes are often overlooked and combined with the trend due to the smaller (usually) scale compared to seasonal fluctuations or development trend. However, in the case of analyzed raw materials, the importance of the cyclical component is greater than that of the seasonal component. In addition, economic theory supported by empirical research on cyclical nature of economic developments indicates that an economy can be characterized by the simultaneous presence of multiple cycles of different periods. This leads to overlapping of different types of cycles and their interactions. Another problem is associated with structural changes, which directly affect the morphology of the isolated cyclical fluctuations.

Purchase prices of analyzed raw materials are characterized by presence of cyclical fluctuations. Their presence is the result of both macro-economic factors and the effect of the occurrence of the so-called commodity cycles in individual markets and their mutual interdependence. An additional element creating cyclical fluctuations are sudden changes in production caused by cli-

matic factors causing deviations from the market equilibrium and subsequent slow reaching of equilibrium.

The studies indicate that the cycles are in the range of 3-5 years. However, one cannot exclude the presence of cycles with a longer period, especially in the case of cattle prices, as can be seen in the case of prices in USA and old EU countries. However, the small number of observations cannot confirm this hypothesis.

As shown by the results of analyses, the amplitudes of cyclical changes reach more than 70 percentage points around the trend of development. This means that the most important element which should be included in the predictive method is the ability to predict the turning points of cyclical fluctuations and the pace of their changes.

As regards market predictability, its indicator can be the MCD measure (period of cyclical dominance). In most time series of real prices of agricultural products, MCD value indicating changes of a permanent nature is four months. This measure thus shows the period that one must wait in order to recognize with certainty that the change in direction of prices observed on the empirical values curve is the new direction of changes. The longer the period defined by the MCD measure, the greater the probability of making the mistake of not guessing the direction of trends in the forecasted variables. This means that the confidence about the direction of long-term changes is only achieved after more than three or five months. Thus, even a significant increase in prices for two or three months does not mean the change in long-term trend. The higher the MCD, the greater the risk of irrelevant forecasts.

Unidirectional changes in trend and cycle in the course of prices do not exceed one year in any of the analysed variables. This means that in the case of price forecasting the risk of error in the construction of forecasts increases significantly after exceeding one-year forecast horizon.

In addition to the average duration of unidirectional changes in prices, from the point of view of risk and forecasting, a relevant factor is the share of individual fluctuations (components), depending on the time horizon of changes. For example, when forecasting wheat prices three months ahead, one must bear in mind that long-term changes (TC) in more than 66% determine the accuracy of the forecasts and seasonal fluctuations only in one-fifth. Overall, the pattern in the analysed variables is such that as the horizon of changes under consideration increases, the importance of long-term component is increasing and importance of short-term fluctuations (seasonal and random) is decreasing.

II. Materials and research methods and presentation of results

To prepare projection of farm income from production activities for 2015, the study used empirical data from 2006-2011. These were the most recent data characterizing activities selected for testing, available during the construction of the projection models. The subject of research were four activities of plant production and one activity of animal production, namely:

- winter wheat,
- winter rye,
- spring barley,
- winter rapeseed,
- dairy cows.

Data describing economic and production results of individual agricultural production activities were gathered by conducting research in AGROKOSZTY system, which collects detailed data on the level of production and incurred expenditure and direct costs[17]. It was a part of research work carried out by the Institute of Agricultural and Food Economics – National Research Institute in Warsaw. Farms for the study were selected in a targeted manner from a representative sample, which was in the Polish FADN observation system. The selection of farms was made independently in each year.

Analysing the results of activities which were the "starting point" to prepare the projection (estimate for 2011 – data from the last few years were adjusted by indicators of changes designated on the basis of trend function and then averaged), and the expected results of projection for 2015, the study evaluated the level of value of production, costs and economic effects, but the basic measure of assessment of achieved results was the income without subsidies and income from activities. The method of calculating each income category is as presented:

(1) **gross margin without subsidies =**
= value of production – direct costs

(2) **income from activity without subsidies =**
= value of production – (direct + indirect costs)

(3) **income from activity =**
= [value of production – (direct + indirect costs)] + subsidies

[17] A. Skarżyńska, *Założenia metodyczne*, [in:] *Wyniki ekonomiczne wybranych produktów rolniczych w latach 2005-2006*. Zagadnienia Ekonomiki Rolnej. Supplement No. 3, IAFE-NRI, Warsaw 2007.

The computation, which leads to the calculation of income from operations includes direct and indirect costs. Direct costs are the cost components which, without doubt, can be attributed to a given activity. However, the indirect costs are costs which at the time of their emergence cannot be divided into specific products (production activities), these are the costs common to the whole farm. Indirect cost structure is shown in the diagram II.1.

Diagram II.1 Structure of indirect costs of a farm

1. Indirect real costs

general economic costs
- electricity
- fuel
- propellant
- repairs, maintenance, inspections
- services
- insurance (e.g. buildings, property, communication)
- other (e.g. fee for water, sewer, telephone)

taxes
- agricultural
- other (e.g. forest, special branches, real estate)

cost of external factors
- cost of hired labour
- lease payments
- interest

2. Estimated indirect costs - depreciation

- buildings and structures
- machines and technical devices
- means of transport
- other (e.g. irrigation, orchards and perennial plantations)

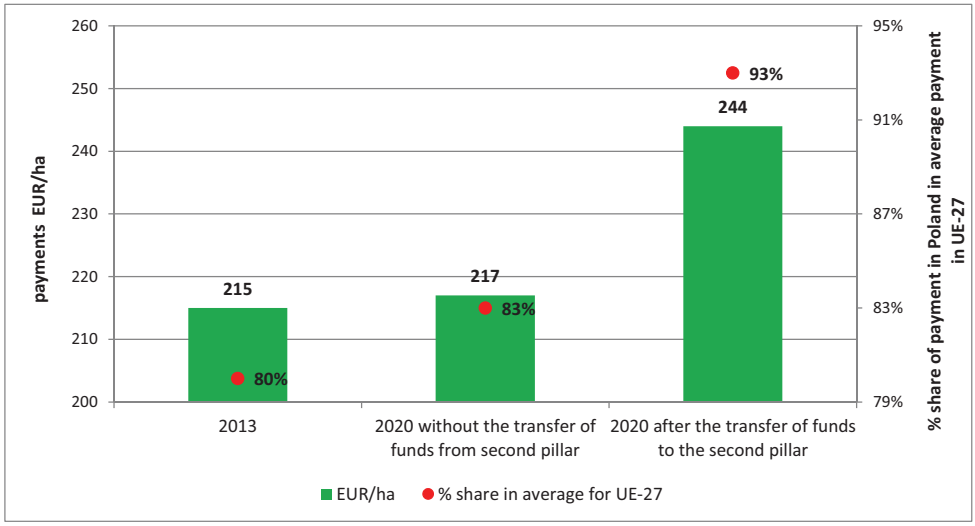
Source: L. Goraj, S. Mańko*, Systemy monitorowania sytuacji ekonomicznej i produkcyjnej gospodarstw rolnych,* [in:] Rachunkowość rolnicza. Wyd. II, Difin, Warsaw 2004.

Indirect costs are incurred under operating activities of a farm, they include all costs incurred in connection with the operation or only its existence. These costs are allocated to the activities according to certain distribution key. In this research, guided by the ability to access and use certain variables in databases (AGROKOSZTY and Polish FADN databases), the study applied one key to divide indirect costs, i.e. the share of the value of production each of them in the value of total production of a farm. The data used to calculate the indirect costs of the analyzed activities was derived from Polish FADN accounting database, which identifies farms conducting activities examined in the

AGROKOSZTY system. Indirect cost allocation algorithm was applied individually for each farm and activity.

In accordance with the principles of the Common Agricultural Policy, direct payments are the instrument for supporting and stabilizing farmers' incomes. In the budget for 2014-2020, as proposed by the European Commission, the direct payments are based on the reformed CAP, however, the European Commission proposes a number of changes in the granting system. According to experts, the requirements in relation to farmers are much more complicated than it is now. Rates of direct payments in 2013 and projected for 2020 (estimated by the Ministry of Agriculture and Rural Development and the Ministry of Foreign Affairs on the basis of available data) are presented in figure II.1.

Figure II.1. Rates of direct payments in 2013 and in 2020 before and after possible offset of 25% of funds from the second pillar to direct payments and a percentage share of these rates in the average EU rate in 2013 and in the new rate of 2020



Source: W. Guba, *Budżet ogólny UE i WPR na lata 2014-2020 po szczycie Rady Europejskiej w dniu 7-8 lutego.* Material presented at the seminar "Final stage of negotiations on the EU's multi-annual budget and the reform of the CAP for 2014-2010", Warsaw, 4 April 2013.

The prepared projection of income from production activities assumed the rate of payment for 2015 at 244 EUR/ha. One factor that has a major impact on the level of subsidies is the EUR exchange rate, the calculation assumes that rate will be: 1 EUR = 4.00 PLN. Taking the above assumptions, it was estimated that payments for 1 hectare is expected to reach PLN 976.

The aim of the research was to make a projection of income and thus determine of the direction of its change in the medium term. The first stage of works

was to adequately process data, which then became the starting point for the preparation of the projection. For activity: winter wheat, winter rye, winter rapeseed and dairy cows, individual variables, i.e. the components of the value of production and costs were estimated for 2011 on the basis of data from 2006-2011, while for spring barley – from 2007-2011. Amounts in subsequent years have been adjusted with indicators of changes determined on the basis of trend function. Average of several years for particular activities is calculated based on the corrected data. It was the starting point to build a projection for 2015, i.e. it has been extrapolated into the future based on trends observed for the time series of analyzed variables. The time series were set for the period 1995-2011.

This means that for all cost elements and components of the production value of each activity, selected models described well the variability of the studied phenomenon. The selection of models for use in the projection was based on the size of the coefficient of determination and expert knowledge on the formation of the phenomenon over time. The projection model assumes constancy of the structure and amount of expenditure incurred on various activities in the production process. This means that expenditures represent the average level in base years.

Presentation of the results. Results of the projection show the effect on the level of projected rate of change in prices and other factors affecting the value of production (income) of the individual activities and changes in the prices of agricultural inputs (e.g. seeds, fertilizers, pesticides, animal feed). As a result, they allow us to determine the dynamics of expected changes in the level of production and the income of the analyzed production activities.

In case of activities of plant production, the results of the projection determine the possible direction of changes, which is what one can expect in the average, similar to those in recent years, conditions of farm functioning, i.e. 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 which 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 minus* and *in plus*), compared to the level adopted in the calculation for the average conditions of functioning of farms.

Pessimistic scenario of the projection shows what changes in the level of income one can expect if climatic conditions are particularly bad and cause a strong decrease in the yield of cereal and oilseed. In the best-case scenario it shows the strong influence on the level of income of good – better than average – production results of activities in question.

In the case of dairy cows livestock production activity, projection results show the expected direction and magnitude of change in 2015 – in relation to the base year for the projection model (2011) – as regards production results, price results and profitability of milk production on average in the study sample and in farm groups. Projection was prepared for two groups that differ in scale of milk production. Scale selection criterion was the number of cows. The results were presented for quartiles, i.e. groups of farms:

- producing milk on a small scale (C) – 25% of the sample with a lower number of cows,
- producing milk on a big scale (D) – 25% of the sample with an upper number of cows,

The results are presented graphically and in tables. Projection results for 2015 (in current prices) are given in tabular appendix (Tables 1-5). Chapter 5 presents only the dynamics of selected accounting components, which describe the profitability of production in the period of the study.

It should be noted that obtained results reflect the average performance of groups of studied farms, and therefore should not be directly translated into the average results for the country. However, they allow for presentation of certain phenomena and relationships and trends (for example, formation of production profitability) and in this context, they provide a basis for conclusions relating not only to the tested sample.

III. Projection method for income from agricultural products

This chapter presents a manner (procedure) for building a model of income projection in the medium term for selected agricultural production activities. The object of the study were four crop production activities, i.e. winter wheat, winter rye, spring barley and winter oilseed rape and one livestock production activity – dairy cows.

The basis for the construction of the projection model was the data collected in the AGROKOSZTY system and the Polish FADN. In order to present the results of production activities they were processed in accordance with the methodology used in the AGROKOSZTY system. More specifically, the data that were extrapolated into the future were the components of the structure of:

- **production value**
  - for plant production activity – crop, selling price of products,
  - for dairy cows activity – milk yield of cows, selling price of milk, price of calves weaned and price of culled dairy cows;
- **direct costs**
  - for plant production activity – cost of seed, mineral fertilizers, pesticides, growth regulators, other direct costs,
  - for dairy cow activity – cost of herd replacement, cost of buying feed, cost of own commodity and non-commodity feed, and other direct costs (e.g. medical expenses, insurance of cows);
- **indirect costs** – for plant production and dairy cow activities; presentation on diagram II.1.

The projection model assumes constancy of the structure and amount of expenditure incurred on various activities in the production process. This means that expenditures represent the average level in years of studies of the activities.

Empirical material for the four activities (winter wheat, winter rye, rape oilseed and dairy cows) came from 2006-2011, and for spring barley from 2007-2011. These are therefore data time series for five and six years. Projection of results for 2015, that is for the next four years, on the basis of such short series would be burdened with a very big error. According to the researchers, extrapolation should reach no more than ¼ of the number of data

used to estimate the model[18]. To solve this problem, the construction of the model for projection of income from production activities used a different solution. Data describing production activities in the years of the study (i.e. components of the structure of the value of production and costs) were used as the starting point for further calculations and to produce a projection. Then they were assigned to the appropriate series which best characterized the variability of the studied phenomena (e.g. price, yield), and which were also long enough to be extrapolated for the next four years.

Using the data of official statistics (CSO), a time series was constructed covering 17 years, i.e. the period from 1995 to 2011. A limitation to the length of these series and determining development trends for individual phenomena was the denomination of PLN, which was carried out on 1 January 1995 (based on the act on denomination of PLN of 7 July 1994 – Dz. U. No. 84, item 386). In order to maintain uniformity of the data the study abandoned construction of longer time series.

For each component of the value of production (for each activity independently) and direct and indirect costs, the study chose an appropriate time series (in exceptional cases more than one). Diagram III.1 shows an example of the assignment of selected variables, i.e. input variables from AGROKOSZTY database with variables derived from official statistics that were used to construct time series.

After selecting the time series there was an attempt to prepare their modelling and projection. For this purpose, the study used classic models of development trends[19]. These models describe development of events in time and can be used to draw up medium-term forecasts. Forecasting based on them is done by extrapolating the trends observed in the past. It is necessary, however, to assume that the test variable will be affected by the same factors as before and in the same way as before. This means that the structural relationships included in the model and observed in the past on the basis of empirical data will not change during the forecast horizon[20]. This assumption, in practice, and in partic-

[18] S. Stańko, *Wyznaczenie prognozy i ocena jej realności*, [in:] *Zarządzanie ryzykiem cenowym a możliwości stabilizowania dochodów producentów rolnych – aspekty poznawcze i aplikacyjne,* IAFE-NRI, PW Report No 148, Warsaw 2009.

[19] The choice of this method was influenced primarily by practical considerations, such as the availability of data, forecast horizon and depth and technical capabilities of its use. This method is relatively simple in terms of calculations, and the results are easily interpretable.

[20] S. Bartosiewicz, *Ekonometria. Technologia ekonometrycznego przetwarzania informacji,* PWE, Warsaw 1989.; M. Cieślak, *Organizacja procesu prognostycznego* [in:] *Prognozowanie gospodarcze. Metody i zastosowania* (scientific ed. M. Cieślak), PWN, Warsaw 1999.

ular in describing the events as unpredictable as taking place in agriculture, is difficult to meet.

Diagram III.1. Example of variable assignment in the projection model

Variables from the AGROKOSZTY database		*Variables of public statistics*
Winter oilseed rape crop	⟷	Winter oilseed rape crop in individual farms
Price of winter rye	⟷	Average annual price of rye
Cost of spring barley seed	⟷	Price of spring barley seed
Cost of mineral fertilizers	⟷	Indicator of changes in the prices of mineral fertilizers
Milk yield of dairy cows	⟷	Milk yield from 1 cow in litres on individual farms
Cost of veterinary services	⟷	Indicator of changes in prices of veterinary services

Using the models of development trends requires separation of a trend, which is the main component of a time series. This is done by clearing the time series from all periodic and random fluctuations, i.e. by smoothing the time series. In this study, the development trend was distinguished using the analytical method[21]. This method consists of finding a mathematical function, called the trend function (development trend), that best describes the phenomenon changes over time. This function can be seen as a special case of the regression function, where explanatory variable is time *(t),* and the dependent variable is the level of the studied phenomenon *(y)*. The analytical method assumes, therefore, that the level of the analyzed phenomena is a function of time.

$$\hat{y}_t = f(t)$$

where:

t – time variable (period number), *t = 1, 2, ..., n,*

$\hat{y}_t$ – estimated level of phenomenon at time *t.*

[21] E. Wasilewska, *Statystyka opisowa od podstaw*, Warsaw University of Life Sciences – SGGW, Warsaw 2011.

However, the procedure for the prediction based on the regression (trend) model requires the adoption of two principles, i.e. that the regression function does not change and that random factors do not distort the studied phenomenon in the prediction horizon[22].

The choice of the analytical form of this trend function was made heuristically. It involves finding some forms the function, and then selecting one of them according to the criteria applied. Five functions were taken into account: linear, second-degree polynomial (quadratic), exponential, power and logarithmic functions. 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 (second-degree polynomial),
$Y_t = \beta_0 e^{\beta_1 t} \cdot \varepsilon_t$ – 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 integer values from *1* to *n*,
β_0 – independent part,
β_1, β_2 – directional coefficients of the function,
ε_t – random component.

The parameters of all models were estimated using the method of least squares. This method consists in finding such parameter estimates, for which the sum of the squared deviations of the values calculated from the model, from the values observed, will be the lowest.

After calculating the parameters of the models, they were used to calculate the theoretical values of each tested variable along with its predicted values for 2012-2015, i.e. the time series were extrapolated into the future. Then, for each analysed series, one model according to established criteria was selected.

First, the study discarded models for which the parameters were statistically insignificant. The test of significance of parameters was performed using Student's t-test. This test verifies the accuracy of the null hypothesis of no significance in the parameter (parameter is set to 0) in comparison to the alternative hypothesis, which says that the parameter is statistically significant (different from 0). The significance level of the test was set at 0.05. Verification of the null hypothesis was

[22] B. Pułaska-Turyna, *Statystyka dla ekonomistów*, 3rd edition, Difin 2011.

done by comparing the adopted level of significance with the p-value. This value indicates the probability that the test parameter is set to 0, i.e. is negligible. If p-value is lower than the assumed level of significance, there are basis for rejecting the null hypothesis in favour of the alternative hypothesis, which means that the parameter was significantly different from 0. The assumption was that the parameter standing at the t variable was statistically significant, because it means that the time has an important impact on the level of a given phenomenon.

After rejecting models with non-significant parameters, the study focused on matching other models to empirical data. The quality of the matching is evidenced, *inter alia,* by the coefficient of determination R^2, which determines the extent to which the estimated model explains the variability of the studied phenomenon in time. Therefore, the main criterion for selecting a model for subsequent work was the level of this coefficient. The standard example of such selection were models for time series containing data on milk yield per cow (milk yield of cows) in individual farms in Poland. The results of the estimation of models for this series are shown in Table III.1.

Table III.1. Estimation results of selected trend models for milk yield per cow in individual farms

Type of model	R^2	Parameter	Evaluation of parameter	P-value
Linear trend model	0.989	β_0	3072.191	2.10102E-24
		β_1	85.417	2.96709E-16
Quadratic trend model	0.996	β_0	2984.868	2.39798E-22
		β_1	112.993	7.39018E-11
		β_2	-1.532	0.000661685
Exponential trend model	0.979	β_0	3115.129	5.63329E-37
		β_1	0.023	6.30426E-14
Power trend model	0.942	β_0	2893.217	6.39016E-32
		β_1	0.141	1.09251E-10
Logarithmic trend model	0.919	β_0	2811.626	1. 95313E-15
		β_1	522.260	1.42313E-09

Source: Own study based on CSO data.

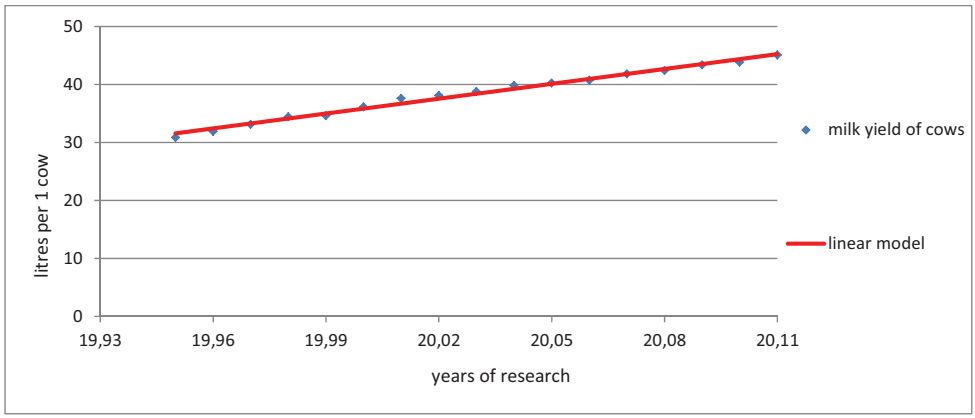
As shown in Table III.1, the parameters of all models are statistically significant (p-value < 0.05), and the coefficient of determination is high which may indicate good matching of models to empirical data. The highest R^2 was obtained for the quadratic trend model and that is why it was taken into account in further work. To test whether this model best characterizes the varia-

bility of the studied phenomenon, one can also analyse graphs of individual models. Figure III.1 shows the development of milk yield per cow in 1995-2011 and how these data were matched with the theoretical values calculated on the basis of individual models.

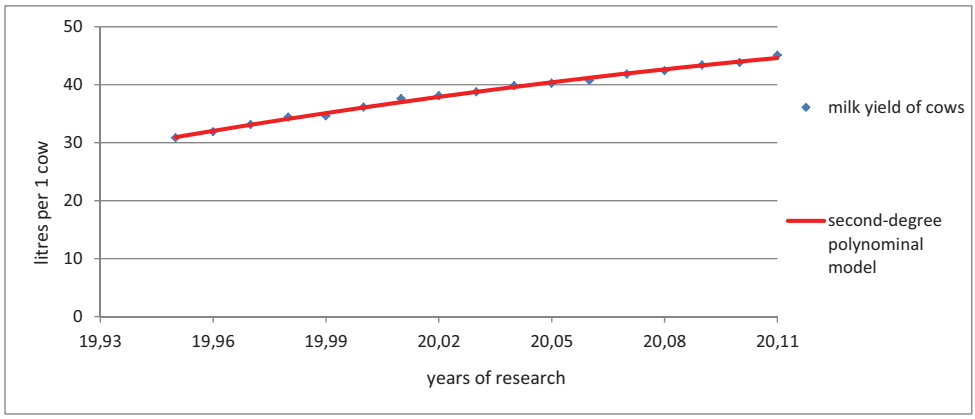
Analysis of plots for each model confirms very good matching to the empirical data. This is particularly evident for linear trend, quadratic trend and exponential trend. In this case, the model with the highest R^2, i.e. the quadratic trend model, seems to be the best one to describe the variability of the phenomenon under study.

Figure III.1. Milk yield per cow in litres and trend functions

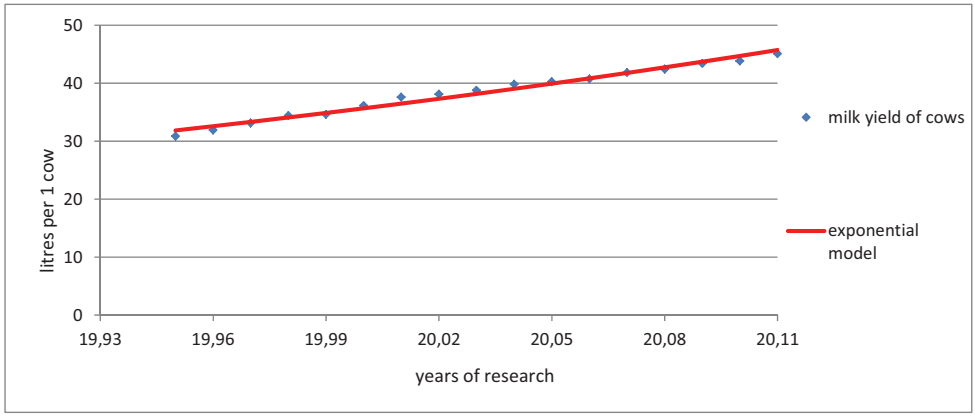
A. Linear trend



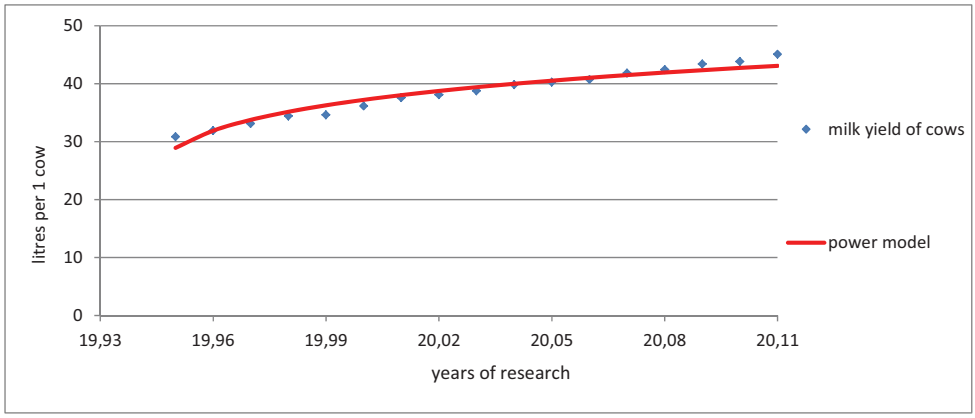
B. Quadratic trend



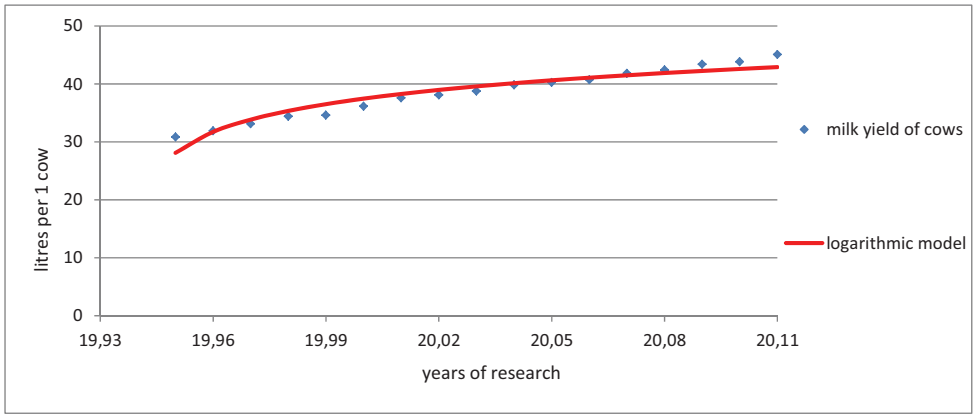
C. Exponential trend



D. Power trend



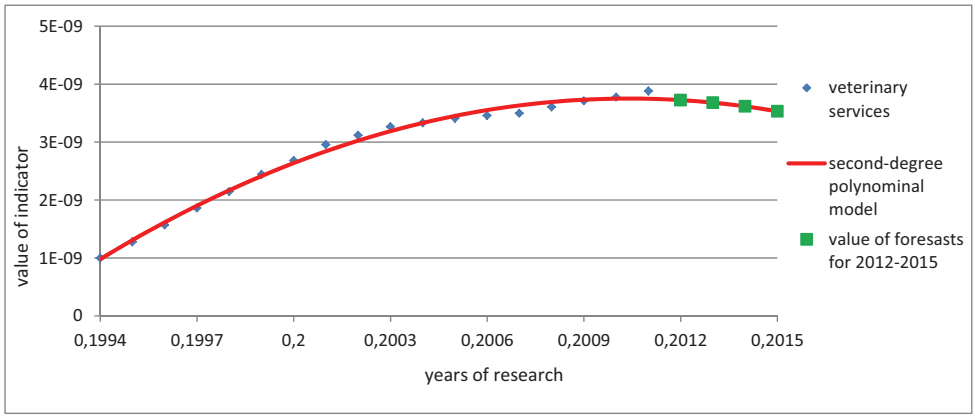
E. Logarithmic trend



However, choosing a model with the highest coefficient of determination is not always justified. This coefficient may give a misleading view of the matching of a model to empirical data. One could deal with the apparent regression or not all assumptions of the method of estimating the parameters, in this case, the least squares method, are met. For the purpose of analyses the study did not carry out a complete verification of models, neither did it present stationarity of the series. Therefore, taking only the amount of R^2 into account may be wrong. With some knowledge about the formation of the phenomenon over time it can be noted that the model for which this factor was the highest is not always the best to describe the variability of the tested series. This is particularly evident in the case of the series, for which all models were of poor quality (R^2 was low and took similar values for each of the models). In addition, specificity of data means that often the highest value of the coefficient of determination was observed for the quadratic trend model. Unfortunately, the values predicted with this model can be highly inflated or deflated even if the model itself matches the data well. Therefore, to avoid confusion relating to the mechanical approach to model selection, often the model was selected on the basis of the knowledge about the studied phenomenon, taking into account only the amount of the coefficient of determination (i.e. it was important it was as high as possible without sacrificing the quality of the forecast). A good example are the models describing development of the cumulative indicator of changes in prices of veterinary services over time.

Figure III.2. Cumulative indicator of changes in prices of veterinary services and selected trend functions (year 1994 = 1)

A. Quadratic trend



B. Power trend

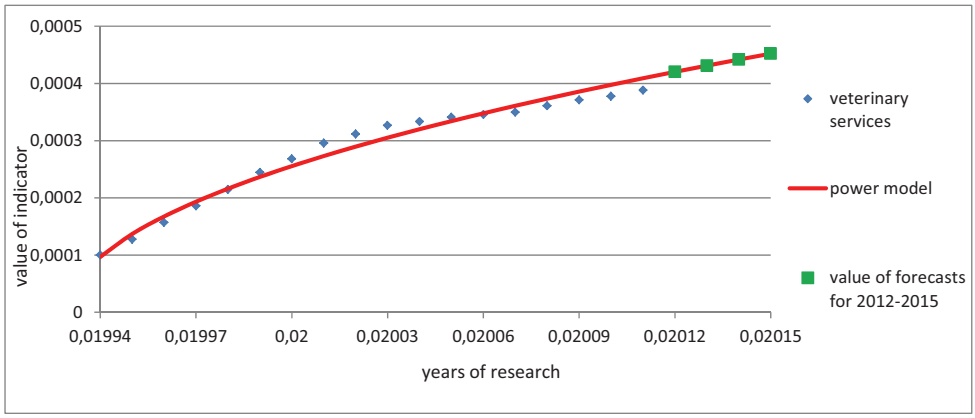


Figure III.2 shows the quadratic and power trend models, for which the coefficient of determination was 0.994 and 0.985, respectively. In addition, it shows the projected amounts on the basis of these models. Quadratic trend model has a higher R^2, but the forecasted values are not very reliable. Based on the analysis of real data from 1995-2011, it is hard to expect that the prices of veterinary services decline during the projection horizon. Ultimately, the power trend model was selected for the analysis; it had the second highest value of the coefficient of determination.

In a similar manner as in the above examples, the model was selected for each of the analyzed time series. Using the selected models, theoretical values were calculated for individual variables, along with forecasts for 2012-2015. On this basis indicators were calculated of change from year to year where the previous year = 1.

Table III.2. Empirical and theoretical values of milk yield of cows in individual farms and indicators of changes for 2006-2015

Specification	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Milk yield of cows in liters (CSO data)	4074	4183	4241	4342	4382	4508				
Milk yield theoretical values calculated from the linear model	4120	4195	4266	4335	4401	4463	4522	4579	4632	4682
Indicator of changes from year to year (previous year = 1) calculated on the basis of theoretical values	1.0192	1.0181	1.0170	1.0161	1.0151	1.0142	1.0133	1.0125	1.0116	1.0108

Source: Own study based on CSO data.

Table III.2. shows the milk yield of cows in individual farms according to CSO, the theoretical values calculated from the previously selected model (quadratic trend) and indicators of changes calculated based on theoretical data. Such calculations were also done for earlier years, but the table shows only the data that were used for further work.

After calculating indicators of change for all series, the study returned to the data from AGROKOSZTY that describe each production activity. As mentioned at the beginning of the chapter, these data were used as a starting point to make projections. Because the aim of the work was to project results for 2012-2015, the simplest solution would be to adopt data from 2011 as input data. However, it was an unusual year with particularly high fluctuations in sales price of grain. Therefore, in order to exclude the impact of unusual situations on the results of the projection, the average of research years, 2006-2011 or 2007-2011, was assumed as input data for each activity. At the same time to take into account the systematic changes that occurred during this period, such as the improvement of production technology or a change in the value of money, the data were corrected prior to averaging. In the analysis of time series variability, the study assumed that all systematic changes are described by the trend. Therefore, to correct input data, indicators of changes were used, calculated based on the selected trend functions.

Analyzing further the example of milk yield of cows (according to CSO data), we calculated the product of the indicators of change in 2007-2011 (2007/2006, ..., 2011/2010). This way one obtained indicator of change from 2006 to 2011, where 2006 = 1. This indicator was used to adjust milk yield in 2006 (according to AGROKOSZTY data). This way one obtained a value that it could take in 2011, taking into account the systematic changes that have taken place over the years 2006-2011. In the same way one adjusted milk yield of cows according to AGROKOSZTY system for the remaining years, i.e. 2007, 2008, 2009 and 2010. Then, based on the adjusted data, average milk yield of cows in 2006-2011 was calculated. The calculated average was used as the starting point for projection. A similar method was used in preparing input data for each variable.

After calculating the value for the starting point of the projection and the indicators of changes from year to year for 2012-2015, the last phase of constructing the projection started. Indicators that were calculated on the basis of selected models prepared for CSO data were used to convert input data from AGROKOSZTY to years of the projection. An example of such results is shown in Table III.3.

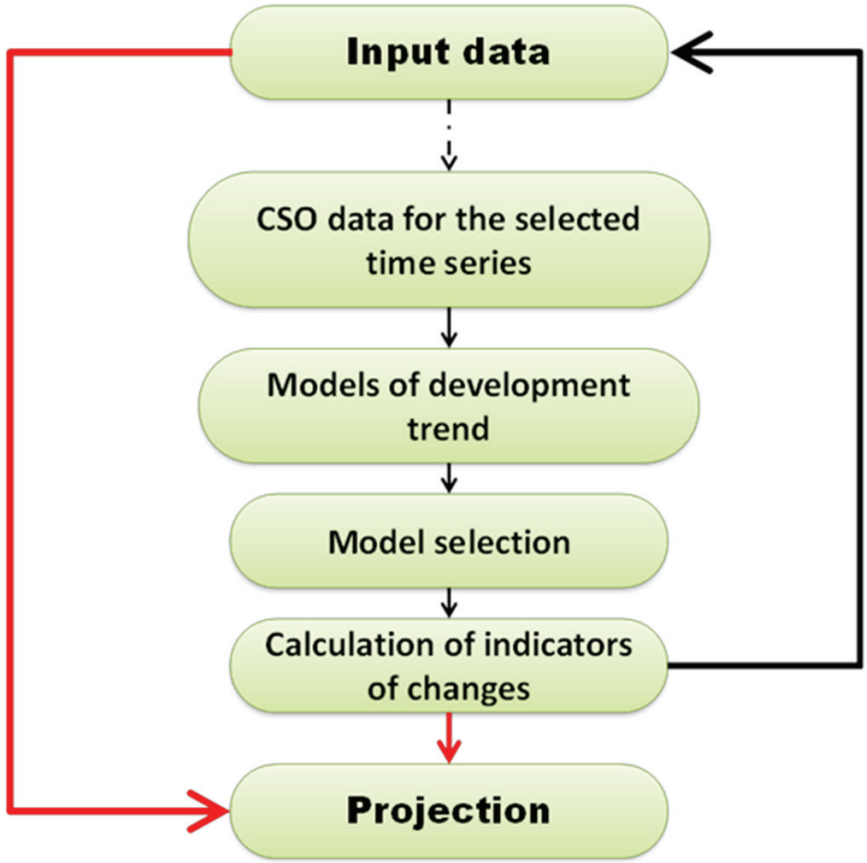
Table III.3. Input data and projection of milk yield of cows

Specification	average for 2006-2011	2012	2013	2014	2015
Indicator of changes from year to year (previous year = 1) calculated on the basis of theoretical values		1.0133	1.0125	1.0116	1.0108
Projection of the milk yield in liters (AGROKOSZTY data)	5815	5893	5966	6036	6101

Source: Own study based on CSO and AGROKOSZTY data.

The above example is to illustrate techniques for the proceeding. In this way, all components of the structure of production and cost values were projected, and then the income from activities without subsidies for the studied crop production and milk production activities was calculated. To better illustrate individual stages of constructing the projection model, they are presented in a synthetic manner in Diagram III.2.

Diagram III.2. Steps in the construction of the projection model



The first stage of constructing the model was to prepare input data that describe production activities. Then, for each variable, we assigned the corresponding series of data from the official statistics. For each of these series we built 5 models of development trends. On the basis of the adopted criteria – for each of the series – we selected one model for further analyses. Based on selected models we calculated theoretical values with the projection for the next four years. These values were used to calculate the indicators of changes from year to year. The indicators for 2006-2011 were used to adjust input data from AGROKOSZTY. Then, based on the adjusted data, we calculated the average for each year of studied activity. This average was the starting point for the projection for 2015.

Average values of the variables (previously adjusted) were reassessed with the previously calculated indicators of changes for the years 2012-2015. This way, one obtained the expected results for 2015 for all variables, i.e. the components of the structure of production and cost values of studied activities. Then the expected level of income from activities without subsidies was calculated. It should be noted that in terms of the construction method of projection there is no difference between crop production and milk production. Stages of the model construction shown in Diagram III.2 are the same for all activities. However, there are some differences in the preparation of input data and selection of the appropriate series from CSO data.

Livestock production, including dairy cows, is characterised by a more complex structure of costs. This is due, among other things, to the fact that breeding dairy cattle is associated with crop production (own feed from non-commodity products). Bearing in mind the adopted assumption of constant structure and amount of expenditures, the study used prices of each feed according to CSO (including cereals) to explain variability of own commodity feed costs. Another approach was required to calculate the cost of own feed from non-commodity products. Its cost was determined on the basis of actual direct costs borne by the farmer to produce feed. This is due to the fact that, according to the methodology used in AGROKOSZTY, own feed from non-commodity products are valued according to direct costs. To determine the variability over time in the cost of non-commodity feed, based on data from the period 2006-2011, the study defined the share of their main ingredients in the direct costs. The series corresponding to these ingredients were extrapolated and then change indicators projected on their basis were used – according to the share in direct costs – to produce a projection of non-commodity feed costs for 2012-2015.

Results of projection for dairy cows were done in groups of farms with different headage of livestock. Number of cows was a measure of the scale of milk production. The study took into account the whole sample of farms where research in AGROKOSZTY system was conducted. In addition, this sample, in individual years of study (2006-2011), was divided into quartiles based on the annual average number of cows. Then, a projection was made of income for milk produced on farms with low (lower quartile) and high (upper quartile) number of cows. The projection procedure was identical to the average results for the whole study sample. The projection used the same time series and pre-selected trend functions, and the differences in the results were solely due to input data, which were different for each group of farms.

Projection for plant production was done in average and unfavourable (worst case) and favourable (optimistic) conditions of production. The differentiating factor for the results of projection was the level of yield, which was taken as the criterion of eligibility of production conditions. This means that in both variants, the costs of production and the selling price of products remained the same as under average conditions. The optimistic and pessimistic options were obtained by adjusting the crop projection for 2015. For this purpose, the study used the data of official statistics on crops in studied activities in 1995-2011. To account for systematic changes that have taken place over the years, thus ensuring comparability of data, they were adjusted with change indicators calculated on the basis of selected trend functions. The approach was analogous to that described for adjustment of input data for projection. Then, for data prepared in this manner, the study calculated percentile 0.95 and percentile 0.05, and the percentage deviations of these percentiles from the median. With indicators obtained in this way, the projection of yield for 2015 was recalculated, obtaining possible values of yield in a given year in good and bad production conditions. For both variants, as in the case of medium yield conditions, the whole resulting calculation was prepared up to the income from activities without subsidies.

Using the available data, an ex-post assessment of the model was also made. For this purpose, an average relative prediction error was used. Empirical data were compared with the projected values year to year. On the basis of results obtained, it is concluded that prediction of yield or selling prices of individual agricultural products for the year ahead is virtually impossible. Changing weather conditions may cause that the results will be dramatically different than expected. In addition, the piling up of the following errors results in large differences in the categories of income. It was one of the reasons for preparing projec-

tion of crop production in two variants: optimistic for favourable conditions of production and pessimistic for adverse conditions.

A second comparison was also made, where the projected values were compared with the average of several years, adjusted in the same manner as the input data used for the projection. Therefore, at least in part, the impact of unexpected and abnormal situations was eliminated. Average relative prediction errors obtained in this way are much smaller. Unfortunately, not all errors were low, and after the accumulation they caused that the expected level of income differed from the real one to a much greater extent.

The evaluation of the model was not a determinant of its usefulness for analyses. Such assessment is required primarily for short-term forecasts, which are often used to make operational decisions. In addition, with respect to the calculations carried out, the term projection was used, which, in contrast to predictions, relates to predicting the future in a more general way. Projection is a simplified, sometimes schematic transfer of the past image to the future, and in this context, it better reflects the course of action in conducted studies[23].

The results of the projection may be an indication as to the direction of changes and the evolution of the income situation of the analyzed activities for crop production and milk production in 2015. An attempt to determine precisely the yield or the selling price of agricultural products for the upcoming years is rather doomed to failure. However, by taking some assumptions one can determine the directions of the investigated phenomena. Practical considerations also favour the use of the presented projection method, e.g. the availability of data, a relatively simple calculation and easy interpretation of results.

[23] S. Stańko, *Prognozowanie w rolnictwie*, 2nd edition, Warsaw University of Life Sciences - SGGW, Warsaw 1999.

IV. Means of production – consumption and trend in price changes in the period, selected problems

The second half of the twentieth century was a period of agricultural intensification, measured by large growth of crops, animal performance 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[24]. The quantity of mineral fertilizers and plant protection products used in the farm is mainly determined by the farmer. In terms of value, these are the components of direct costs, the level of which is often taken as a measure of the intensity of production. It should be noted that according to the literature, the intensity in agriculture is evidenced by the amount of expenditure per unit area. However, over the years, the approach to this problem has varied, mainly in the context of choosing appropriate parameters to evaluate the intensity[25].

The research results show that agricultural activity significantly interferes with the natural circulation of minerals, mainly by production intensification[26]. Production targets, i.e. obtaining sufficiently high and good quality yields, are being carried out mainly through the use of chemical means of production and progress in the technique of cultivation. Despite positive production and economic effects of production 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, their deficit may lead to a reduction in the productivity of soils[27]. It should be noted that dispersion in the environment of nitrogen and phosphorus compounds is proportional to the use of mineral fertilizers and headage of livestock.

---

[24] I. Dincer, *Renewable energy and sustainable development: a crucial review,* Renewable and Sustainable Energy Reviews No. 4, 2000; H. Runowski, *Rozwój zrównoważony rolnictwa i gospodarstw rolniczych,* [in:] *Wieś i rolnictwo perspektywy rozwoju*, IAFE-NRI, Warsaw 2002.

[25] R. Manteuffel, *Ekonomika i organizacja gospodarstwa rolniczego,* PWRiL, Warsaw, 1984; J. Hernández-Rivera, S. Mann, *Classification of agricultural systems based on pesticide use intensity and safety*, Paper presented at the 12th Congress of the European Association of Agricultural Economists, August 26-29, Gent, Belgium 2008.

[26] K. Górka, B. Podskrobko, W. Radecki, *Ochrona środowiska – problemy społeczne, ekonomiczne i prawne*, PWE, Warsaw 1998.

[27] *Environmental indicators for agriculture*, Vol 4 Chapt. 3. OECD Publ. Serv., Paris, 2008.

Polish agriculture, utilizing 61% of the total area of the country, takes special responsibility for the protection of the environment, which is reflected in the relevant laws, e.g. in the Constitution of 2 April 1997, the environmental law contained in the Act of 27 April 2001, the Act on fertilizers and fertilization of 26 July 2000, and others. The national activities in this regard are consistent with Council Directive 91/676/EEC, this is one of the first European Union legislation aimed at controlling pollution and improving water quality.

Fertilization stimulates production results of crop production activities, however, it should be borne in mind that the relationship between the volume of crops and a dose of fertilizer ingredient is actually very complex and depends on many factors (e.g. forecrop, soil pH, amount and distribution of rainfall, number and dosages of fertilizers and date of their application, ratio of nutrients N: P: K). A certain level of yield can also be obtained without fertilization, it is the effect of the natural fertility of soil. Furthermore, the same yield effect can be obtained with suitable amount or even several times higher fertilizer doses. Fertilization instead of the positive effect can also produce decrease in crop.

Research shows that from a certain level of fertilization, the effect of nitrogen and phosphorus on yield growth is decreasing. The highest efficiency of nitrogen fertilizers is obtained after the first application of nitrogen, the efficiency decreases at higher levels of fertilization. It is estimated that only 30-50% of the applied dose of nitrogen and about 45% of the dose of phosphorus is taken up by plants. Thus, significant amounts of nitrogen and phosphorus compounds are lost in the fields[28].

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. Two kinds of consequences take place: an increase in the volume of inputs is increasingly more harmful to the environment, and the declining income per unit of input deteriorates economic relations, especially when the price of the input unit – because of their limited supply – starts growing[29]. Sometimes greater use of chemicals is not economically justified, because there are other environmental factors that limit yielding, such as water shortages[30].

---

[28] D. Tilman, K.G. Cassman, P.A. Matson, R. Naylor, S. Polasky, *Agricultural sustainability and intensive production practices*, Nature, Vol. 418, 2002.

[29] J.St. Zegar, *Z badań nad rolnictwem społecznie zrównoważonym*, Report of the Multiannual Programme No. 175, IAFE-NRI, Warsaw 2009.

[30] J. Popp, K. Hantos, *The impact of crop protection on agricultural production*, Studies in Agricultural Economics No. 113, 2011.

When considering the issue of intensity and profitability of agricultural production one should also recall the question of the hormesis phenomenon 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[31]. Complementarity or competition occurring between plant growth agents leads in practice to a huge diversity of crops. Hormesis phenomenon 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 research on mineral fertilization of crops have shown that increasing doses of mineral fertilizers produce the effect that is consistent with that of the hormesis phenomenon effect[32].

Factors influencing the increase in prices of mineral fertilizers and plant protection products. The increase in prices of mineral fertilizers in Poland is a derivative of the price situation in the world. In recent years, the domestic market of mineral fertilizers was influenced by the increase in VAT rates. This resulted in an increase in production costs (e.g. through an increase in prices of raw materials for their production), which resulted in an increase of the prices. The price level of mineral fertilizers in Poland depends also on the cost of transport (ocean freight) and global fuel prices. Another important factor is the exchange rate fluctuations.

The increase in prices of mineral fertilizers is also the result of increased consumption in the world (along with increasing agricultural production in India, China and Brazil), which also is associated with a greater exploitation of the deposits. In the case of phosphate fertilizers this concerns the growing consumption of phosphate deposits used for their production. The result of an increased use was the upward trend in prices of phosphate rock, which started in 2006 in global markets, and over the next two years increased 10-fold.

Phosphate prices depend on suppliers of this raw material. Sources are limited, and most of the deposits (80%) is located in Morocco and Western Sahara and in Algeria. However, China is in the forefront of phosphate rock production, with nearly 40% of world production. The supply of phosphate rock is shaped by the behaviour of the "main players" in a global market of this raw

[31] E.J. Calabrese, L.A. Baldwin, *The Dose determines the Stimulation (and Poison): Development of a Chemical Hormesis Database*, Int. J. of Toxic, No. 16, 1997; S. Szarek, *Deficiencies in the law of diminishing returns*, Part I EJPAU, Series Economics, Vol. 8, iss. 3, 2005.

[32] S. Szarek, *Efekt hormetyczny a efektywność produkcji roślinnej,* Journal of Agribusiness and Rural Development, 2(12), 2009.

material, which affects the world prices of phosphate rock. They are mainly decided by Morocco and China, which introduced high export duties on exports to ensure the country's self-supply in phosphate rock[33]. It should be noted that also rising price of sulphuric acid, which is used for the distribution of phosphate raw materials, impacts the increase in prices of phosphate fertilizers

The prices of nitrogen fertilizers are impacted to the greatest extent by the price of natural gas, which is the basic raw material for their production[34]. The fact that nitrogen fertilizers from Russia and Kazakhstan are introduced on the domestic market is also important.

The price situation of potassic fertilizers is subject to more abrupt changes, it is associated with a strong concentration of supply, especially of potash salt. The raw material is supplied to the market by about 11 entities in the world. The increase of export duty for these fertilizers by 50% in 2011 by the government of Belarus (Russian-Belarusian company BPC is responsible for 30% of the global supply of potassic fertilizers) had a direct impact on the price of potassic fertilizers in Poland[35]. Higher tariffs contributed to the increase in the price of potassic fertilizers of international distributors operating also in the Polish market.

The price trends of mineral fertilisers in 2012 in Poland were reversed as compared to those on global markets. Prices of mineral fertilizers in the country rose by 10%, and average prices in the world fell by 3%[36]. In the first two months of 2013, the demand for fertilizers was low, which resulted in a stabilization of prices. Only increased demand in March 2013 caused a rise in prices of mineral fertilizers by an average of 0.3% as compared to February. However, in relation to March of the previous year, the prices rose by 0.4%[37].

The price situation on the market of plant protection products is more stable. According to the distributors of plant protection products, the sales volume continues to rise. It is to some extent associated with a higher incidence of dis-

---

[33] J. Korzeniowska, Z. Robaczyk, *Czy światu grozi brak fosforu do produkcji nawozów*? Nasza Rola, 2/ 2011, http://rolnictwo.re.pl/var/ifiles/56/30/document_e87643932408ffcf9d0e0e4bc0dd4167.pdf [access: June 2013].

[34] *Wiceprezes ZA Tarnów: Ceny nawozów zależą od cen gazu*. http://www.portalspozywczy.pl/zboza/wiadomosci/wiceprezes-za-tarnow-ceny-nawozow-zaleza-od-cen-gazu,56002.html [access: January 2012].

[35] *Białoruś podwyższa cła eksportowe na potas*. http://www.portalspozywczy.pl/technologie/wiadomosci/bialorus-podwyzsza-cla-eksportowe-na-potas,50456.html [access: January 2012].

[36] *Rynek środków produkcji dla rolnictwa. Stan i perspektywy,* No. 40, IAFE-NRI, AMA, MARD, Warsaw 2013.

[37] *Rynek rolny. Analizy, tendencje, oceny,* No. 3, IAFE-NRI, Warsaw 2013.

eases and pests. The need for these products is also characterized by high volatility during the season depending on the weather. In 2012, as compared to 2011, the prices of plant protection products increased by 3.3%, while in the first three months of 2013 they were subject to very little variation[38].

Consumption of mineral fertilizers in Poland and in selected EU countries. Data from International Fertilizer Industry Association show that consumption of mineral fertilizers in Europe is decreasing. Analysis of the level of consumption in 1994-2010 in 24 countries of the European Union showed that the use of nitrogen fertilizers decreased in 12 countries, and the use of potassic and phosphate fertilizers decreased in most of the sample under research.

This means that the increase in the use of nitrogen fertilizers in 1994-2010 occurred in 12 countries, namely Finland (16.1-fold), Lithuania (3.3-fold), Romania (by 63.4%), Estonia (by 43.1%), Poland (by 32.7%), Slovakia (by 25.2%), Latvia (by 17.5%), Hungary (by 11.8%), the Czech Republic (by 8.4%), Belgium (by 7.7%), Spain (by 4.1%) and France (by 1.0%) – Figure IV.1.

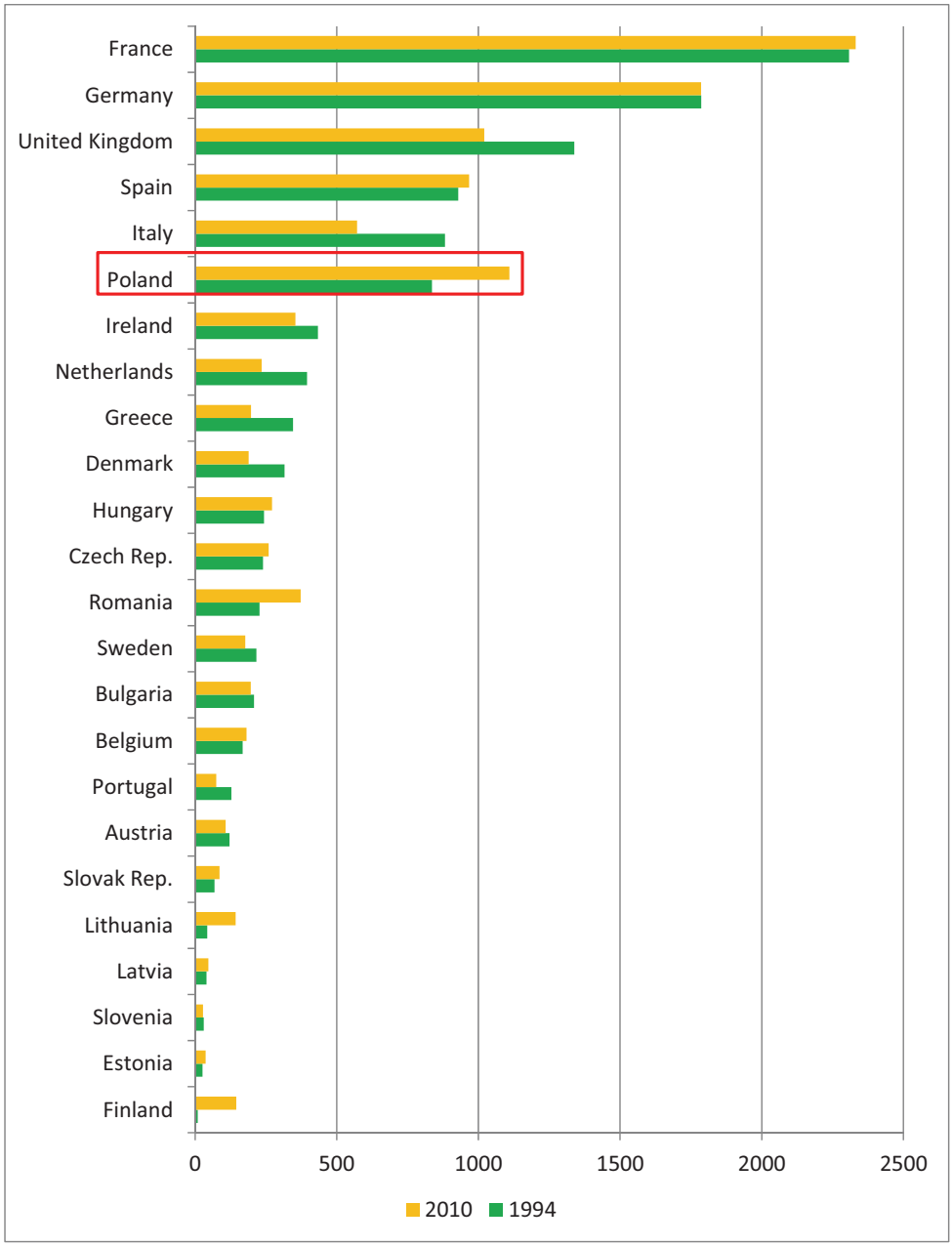
More phosphate fertilizers were used in six countries, namely Latvia (5.2-fold), Lithuania (2.5-fold), Bulgaria (2.3-fold), Hungary (by 73.8%), Poland (by 37.0%) and Estonia (20.0%) – Figure IV.2.

However, more potassic fertilizers were used only in three countries, namely Bulgaria (7.5-fold), Lithuania (by 106.8%) and Poland (by 37.7%) – Figure IV.3.

The consequence of changes in the consumption of N, P and K was the level of total NPK consumption. The data presented by the International Fertilizer Industry Association show that – in 2010, compared to 1994 – of the 24 countries surveyed, in 9 the consumption of NPK increased. The group of countries which saw an increase in consumption of NPK fertilizers included: Lithuania (increase by 183.2%), Poland (by 34.6%), Romania (by 28.0%), Estonia (by 24.0%), Finland (by 20.4%), Slovakia (by 12.0%), Bulgaria (by 11.0%), Hungary (by 8.2%) and the Czech Republic (by 0.6%). In contrast, lower consumption of NPK was recorded, *inter alia*, in: Portugal (by 47.4%), the Netherlands (by 44.8%), Denmark (by 44.5%), Ireland (by 33.4%), the UK (by 32.1%), France (by 27.2%) and Germany and Belgium (by 13.8%) – Figure IV.4.

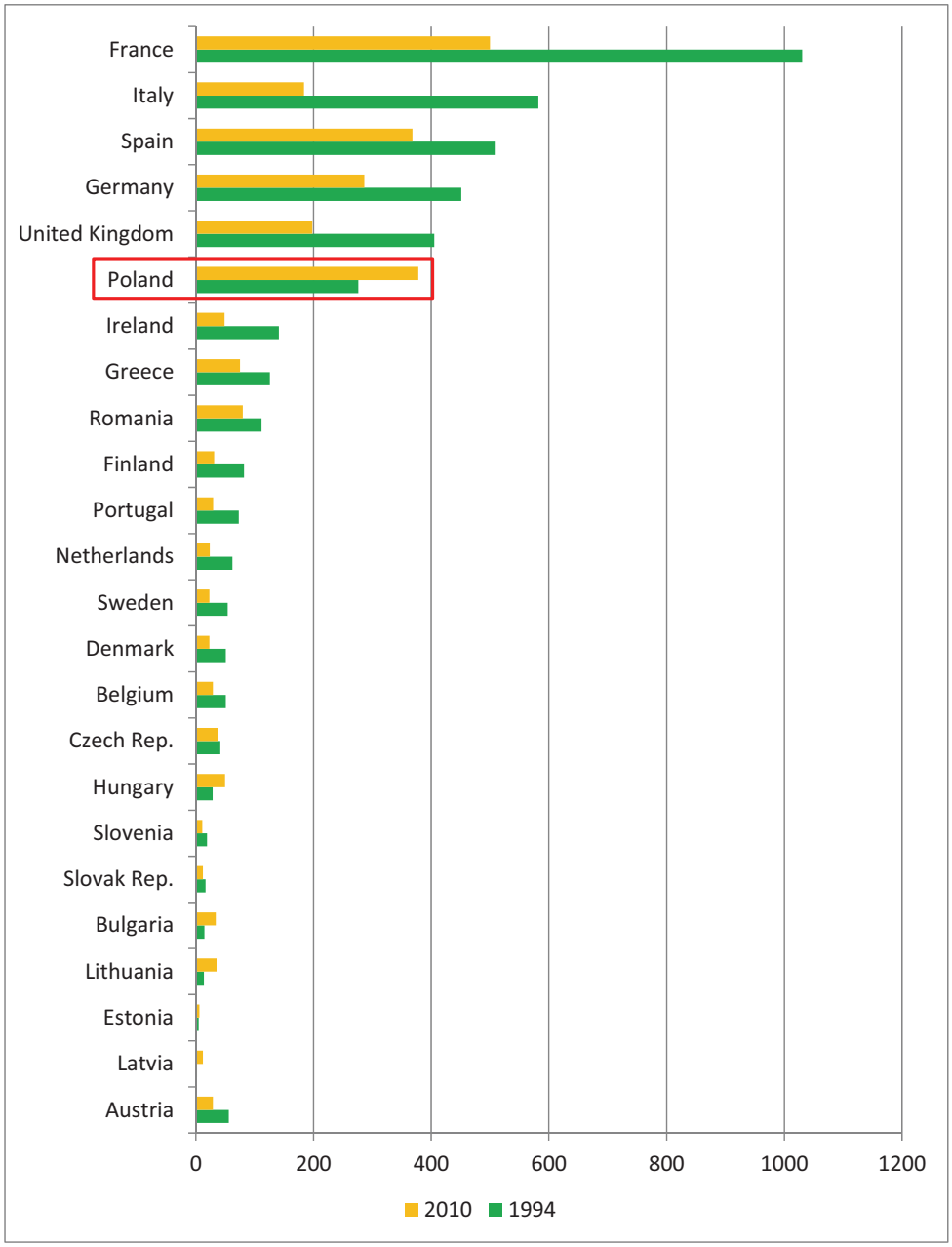
[38] *Rynek rolny. Analizy, tendencje, oceny*, No. 5, IAFE-NRI, Warsaw 2013.

Figure IV.1. Consumption of nitrogen fertilizers in selected EU countries in 1994 and 2010 (thousand tonnes)



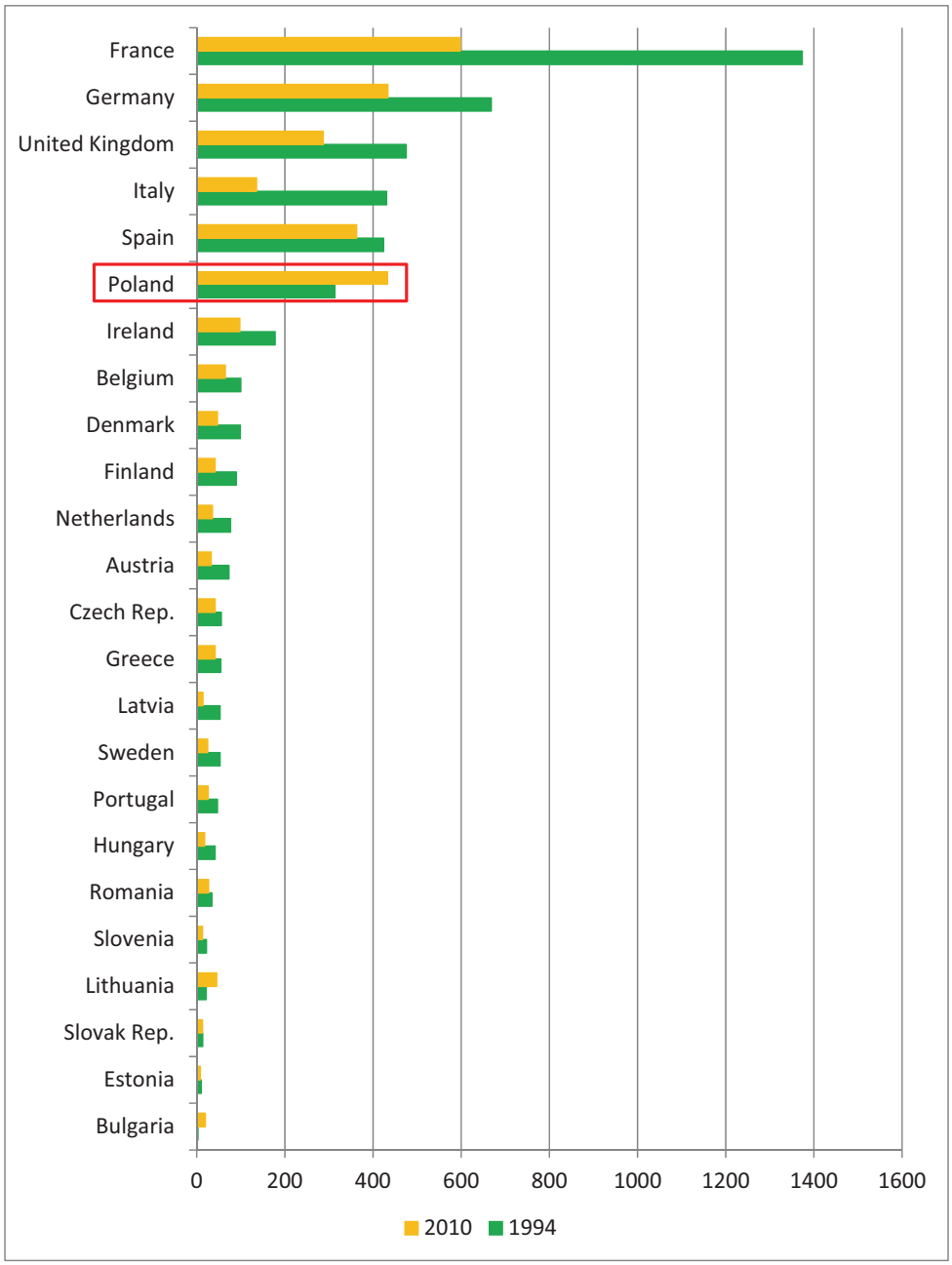
Source: Own calculations based on International Fertilizer Industry Association.

Figure IV.2. Consumption of phosphate fertilizers in selected EU countries in 1994 and 2010 (thousand tonnes)



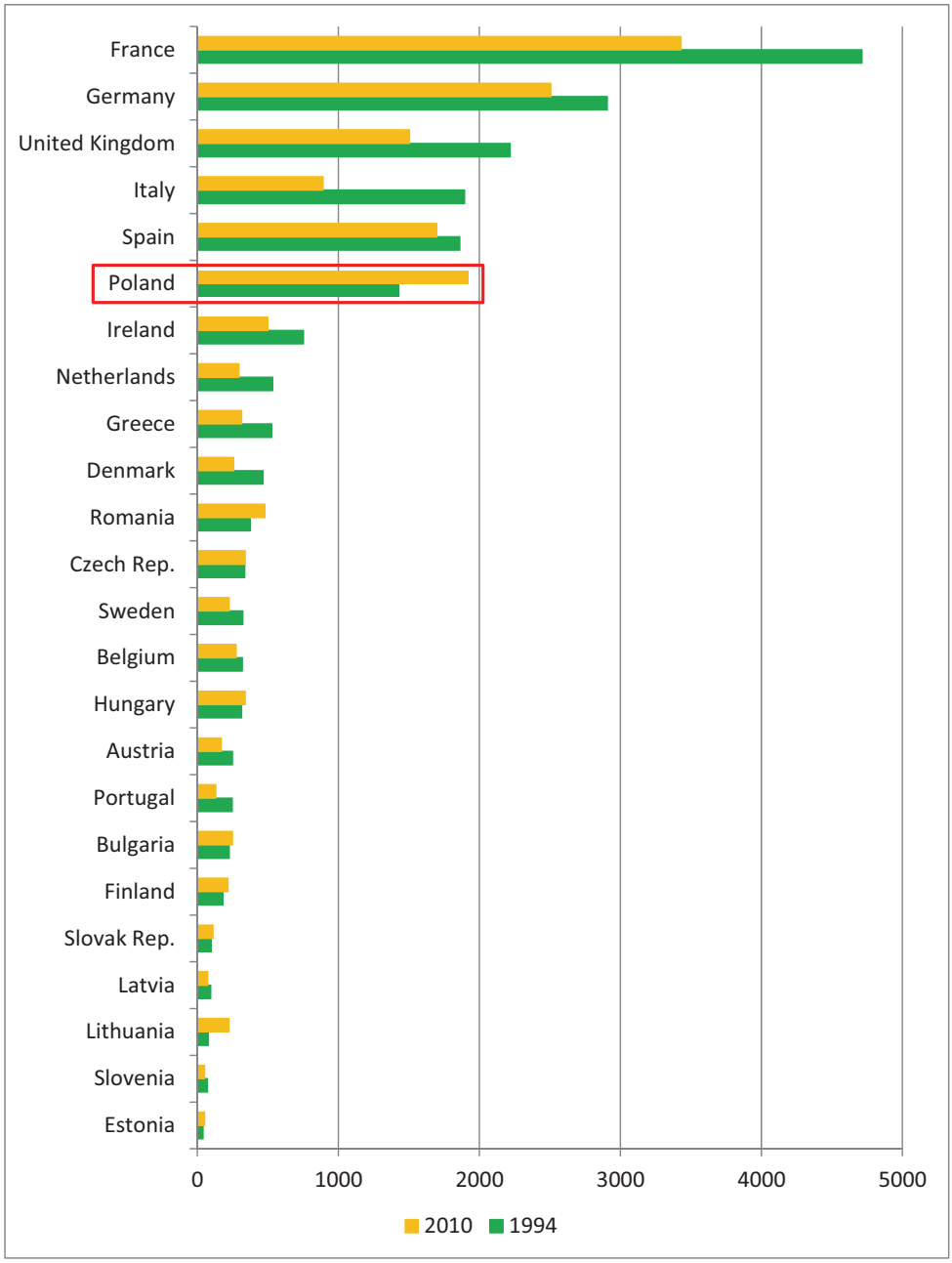
Source: Own calculations based on International Fertilizer Industry Association.

Figure IV.3. Consumption of potassic fertilizers in selected EU countries in 1994 and 2010 (thousand tonnes)



Source: Own calculations based on International Fertilizer Industry Association.

Figure IV.4. Consumption of NPK mineral fertilizers in selected EU countries in 1994 and 2010 (thousand tonnes)



Source: Own calculations based on International Fertilizer Industry Association.

Table IV.1. Consumption of NPK in selected EU countries (kg per 1 ha of AL) and change of use in years (in %)

Country	Farming years		2010/2011 / 1995/1996
	1995/1996	2010/2011	
Netherlands	272.4	159.0	58.4
Belgium and Luxemburg	206.7	179.0	86.6
Ireland	170.4	114.0	66.9
France	163.5	99.0	60.6
Germany	162.7	150.0	92.2
Denmark	160.7	96.0	59.7
Finland	150.9	115.0	76.2
Slovenia	140.4	83.0	59.1
United Kingdom	126.1	87.0	69.0
Italy	118.8	64.0	53.9
Poland	**84.5**	**119.0**	**140.8**
Czech Rep.	81.3	84.0	103.3
Austria	69.1	53.0	76.7
Spain	62.9	59.0	93.8
Hungary	59.6	60.0	100.7
Slovak Rep.	44.0	62.0	140.9
Lithuania	33.7	81.0	240.4
UE-27	**101.5**	**86.0**	**84.7**
UE-15	**122.1**	**92.0**	**75.3**
UE-12	**52.0**	**73.0**	**140.4**

Source: A. Zalewski, *Rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa. Stan i perspektywy,* No. 34, IAFE-NRI, AMA, MARD, Warsaw 2008;
A. Zalewski, *Światowy rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa*, No. 40, IAFE-NRI, AMA, MARD, Warsaw 2013.

Comparative analysis of NPK consumption in the country and per 1 ha of agricultural land presents some interesting insights. The data presented in Table IV.1. shows that in countries such as the Netherlands, Belgium, Luxembourg and Germany, the consumption of NPK per 1 ha of agricultural land – in the marketing year 2010/2011, as compared to 1995/1996 – decreased respectively by 41.6%, 13.4% and 7.8% (this situation was mainly a consequence of the decline in consumption of fertilizers in the country). Even so, the level of fertilization still remained higher than in Poland (119 kg NPK/1 ha of AL) in: the Netherlands by 33.6%, Belgium and Luxembourg by 50.4% and Germany by 26.1%. Taking it as a measure of the intensity of production, the presented calculations

show the scale of variation between countries. It should be noted that in 1995/1996, the difference in the level of fertilization was even greater.

However, the awareness of the negative consequences of high-fertilizing is growing. This is a problem perceived by many researchers, attention is paid to ensuring a certain level of yield but at the same time minimizing the negative impact on the environment while maintaining its biodiversity[39]. The State policy is of great importance in this respect[40].

Studies have shown that increasing the use of agricultural chemicals is not without effect on the environment understood not only in terms of the local agro-ecosystem, but as a hierarchy of ecological systems at the level of region, country and even the planet. It is not only about environmental degradation, but also about the decline in the value in use of the product for the buyer[41].

Trend of changes in the use of NPK mineral fertilizers and lime fertilizers. Studies show that the increase in fertilizer prices were followed by an adverse phenomenon linked to the structure of their consumption in farms. In the analysed period, the use of mineral fertilizers (NPK) gradually increased, while at the same time the consumption of lime fertilizers dropped. In the 1994-1998 period over 120 kg lime fertilizers and about 90 kg of NPK was used per 1 ha of agricultural land. In 2000-2003, the level of their consumption was equalised. However, since 2004/2005, use of lime fertilizers decreased dramatically, and use of NPK fertilizers increased. Since 2006, farmers consume less than 40 kg of lime fertilizers per 1 ha and over three times more NPK fertilizers – Figure IV.5.

Consumption of NPK fertilizers is high, Poland is among the countries which exceed 100 kg per 1 ha of agricultural land (Table IV.1). On average in the EU-27 consumption of NPK in 2010/2011 was 86 kg per 1 ha of agricultural land, in the EU-15 – 92 kg, with regard to 1995/1996 it decreased by 15.3% and

---

[39] C.T. Wit, H. Huisman, R. Rabbinge, *Agriculture and its environment: Are there other ways?,* Agricultural Systems, 23, 1987; D. Zilberman, S.R. Templeton, M. Khanna, *Agriculture and the environment: an economic perspective with implications for nutrition*, Food Policy, 24, 1999; A.J.A.M. Temme, P.H. Verburg, *Mapping and modelling of changes in agricultural intensity in Europe,* Agriculture, Ecosystems and Environment, 140, 2011.

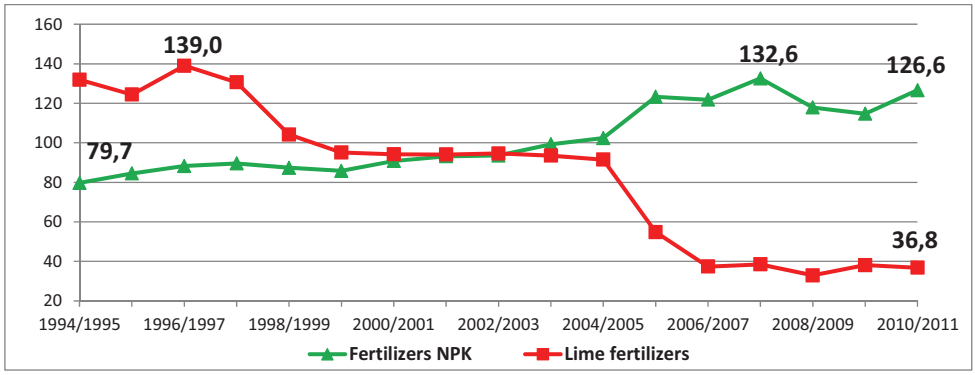
[40] H. Lehtonen, J. Lankoski, K. Koikkalainen, *Economic and environmental performance of alternative policy measures to reduce nutrient surpluses in Finnish agriculture*, Agricultural and Food Science, 16, 2007.

[41] J.St. Zegar, *Z badań nad rolnictwem społecznie zrównoważonym*, Report of the Multiannual Programme No. 175, IAFE-NRI, Warsaw 2009.

24.7% respectively. However, in the EU-12 it increased by 40.4% and was 73 and 52 kg per 1 ha of agricultural land respectively[42].

In Poland, the last few years have witnessed two tendencies, the increase in consumption of NPK fertilizers and decrease in consumption of lime fertilizers – Figure IV.5.

Figure IV.5. Consumption of NPK mineral and lime fertilizers per 1 ha of agricultural land in Poland in 1994-2011 (in kg)



Source: Own calculation based on CSO data.

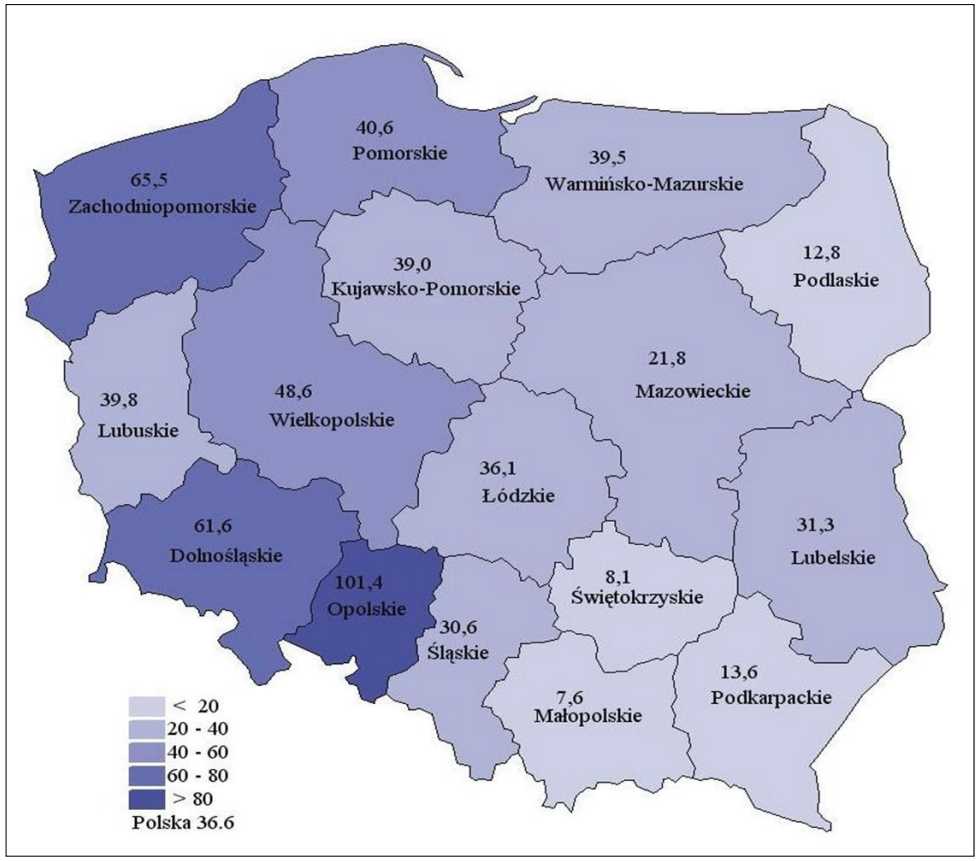
In the period of 20 years consumption of lime fertilizers per 1 ha of AL declined almost 4-fold. This situation is unfavourable – it causes acidification of soils, which has negative impact on yields. Optimum soil pH is necessary for good quality and high yield. High doses of nitrogen fertilizers cause soil acidity, the more the higher is the dose of nitrogen. The increase in soil acidity is also connected with the natural calcium losses resulting from its uptake together with the crops. Acidic soil pH causes a decrease of the absorption of nutrients by plants and soil degradation, which results in decreasing the yield. Appropriate calcium fertilisation should be used in order to prevent these negative changes. Unfortunately, Poland in recent years saw a significant decrease in the use of lime fertilizers, which resulted in acidification of more than half of the soils which now require deacidification (ca. 53%, according to the Institute of Soil Science and Plant Cultivation – NRI).

Fertilization with lime, however, shows large regional variations. On average, in 2007-2009, the range was from 7.6 kg per 1 ha of agricultural land in

[42] A. Zalewski, A. Zalewski, *Rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa,* No. 37, IAFE-NRI, AMA, MARD, Warsaw 2010; A. Zalewski, Światowy rynek nawozów mineralnych, [in:] *Rynek środków produkcji dla rolnictwa,* No. 40, IAFE-NRI, AMA, MARD, Warsaw 2013; *Rocznik Statystyczny RP 2011 r.*, CSO, Warsaw 2012.

Małopolskie Voivodeship to 101.4 kg in Opolskie Voivodeship. The national average consumption of lime fertilizers stood at 36.6 kg/ha – Figure IV.6.

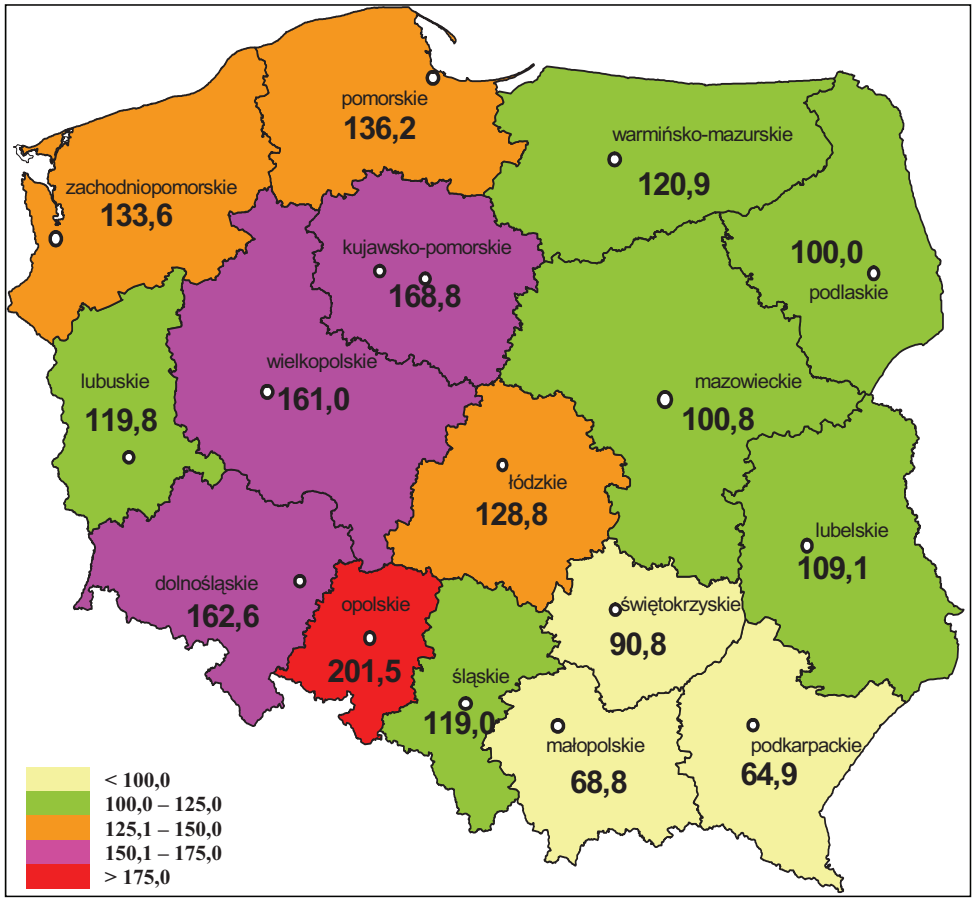
Figure IV.6. Average consumption of lime fertilizers in terms of pure component in Polish voivodeships in years 2007-2009 (kg/ha)



Source: J. Kuś, M. Matyka, *Zróżnicowanie warunków przyrodniczych i organizacyjnych produkcji rolniczej w Polsce.* Paper presented at the Conference on "Sustainable agriculture: harmony or competition of purposes", which was held on 15-17 November 2013, in ISSPC-NRI in Puławy.

There are also significant differences among Polish voivodeships in the level of NPK fertilization, on average in 2009-2011 the lowest was about 65 kg per 1 ha of agricultural land, and the highest nearly 202 kg – Figure IV.7.

Figure IV.7. Average consumption of NPK mineral fertilizers in Polish voivodeships in 2009-2011 in kg per 1 ha of agricultural land



Source: J Kuś, M. Matyka, *Zróżnicowanie warunków przyrodniczych i organizacyjnych produkcji rolniczej w Polsce.* Paper presented at the Conference on "Sustainable agriculture: harmony or competition of purposes", which was held on 15-17 November 2013, in ISSPC-NRI in Puławy.

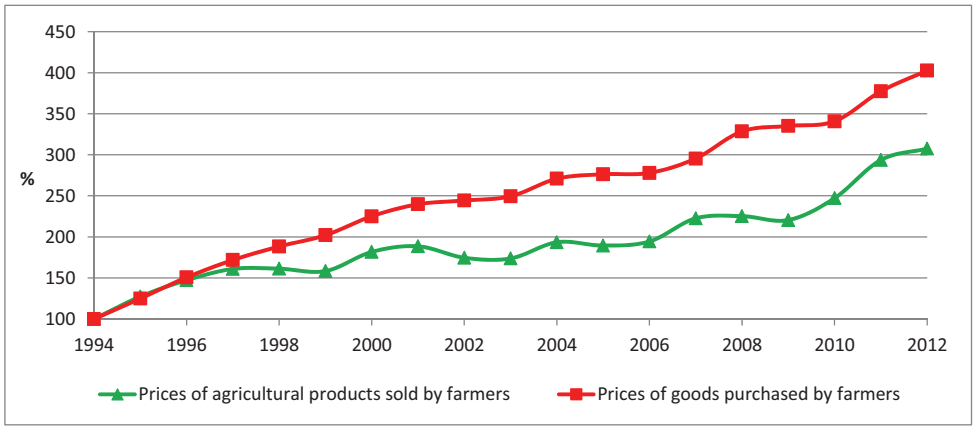
Consumption of NPK mineral fertilizers is largely determined by differences in the structure of farms. In Kujawsko-Pomorskie, Opolskie, Wielkopolskie and Dolnośląskie, fertilizer consumption reached a high level, comparable to that observed in the European Union. In eastern and central Poland, the use of mineral fertilizers was much lower and was within the range of 100 to 140 kg NPK per 1 ha of agricultural land. In Podkarpackie and Małopolskie voivodeships, with a fragmented agrarian structure and dominant extensive agriculture, the use of mineral fertilizers was the smallest. Low-input crop production is also characteristic for voivodeships: Świętokrzyskie, Śląskie and Lubuskie. The level of use of mineral fertilizers

was in those voivodeships in recent years ca 1.7 times lower than in voivodeship with the highest intensity of production[43].

Trend of yearly changes in the prices of the means of production. The high intensity of production does not go hand in hand with profitability. This is important, especially in the context of the phenomenon observed in the recent years, namely a decisively higher growth rate of prices of means of production than the growth of agricultural products sales prices[44].

Prices of goods and services purchased by individual farms for agriculture and prices of agricultural products sold by farmers showed a different rate of change in years – Figure IV.8.

Figure IV.8. Changes in prices of goods and services purchased for agriculture and prices of agricultural products sold in Poland in 1994-2012 (1994 = 100)



Source: Own calculation based on CSO data.

However, the graphic presentation shows that prices of goods and services purchased showed a much stronger rate of growth. In 1994-2012, the rate of change in their prices was 302.7%, while that of the prices of products sold – 207.5%.

Presented yearly price change trends point to a decrease in the unit profitability of agricultural production. In order to get income from a farm, farmers have to increase their economic efficiency. There are two basic ways to achieve this: increase in production value at unaltered costs and cost reduction at a fixed

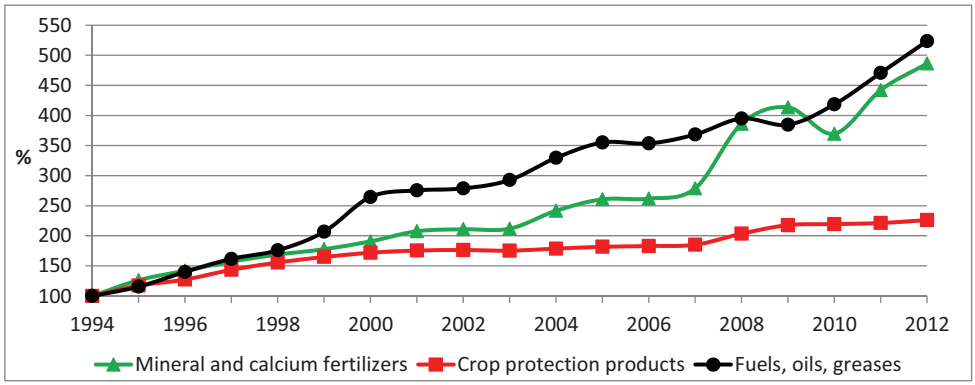
[43] J. Igras, J. Kopiński, M. Matyka, P. Ochal, *Zużycie nawozów mineralnych w Polsce w układzie regionalnym,* [in:] *Stan obecny i perspektywy nawożenia roślin w Polsce w aspekcie regulacji prawnych.* Studia i Raporty ISSPC-NRI, No. 25, Puławy 2010.

[44] W. Ziętara, *Organizacja i ekonomika produkcji mleka w Polsce, dotychczasowe tendencje i kierunki zmian*, Roczniki Nauk Rolniczych, series G, v. 99 iss. 1, 2012.

production value. In both cases the proper management and optimization of costs of production is crucial.

As for resources used for current agricultural production, particularly strong upward trend was characteristic to the prices of mineral fertilizer prices and the prices of fuel and other petroleum products. In 1994-2012, the increase in price of mineral fertilizers (including lime) was over 350%. A similar increase was observed in fuel prices. In turn, the prices of plant protection products more than doubled (increase by 120%) – Figure IV.9.

Figure IV.9. Change in prices of selected agricultural inputs in Poland in 1994-2012
(1994 = 100)



Source: Own calculation based on CSO data.

The results of the projection made for 2015 show that in the next few years, the prices of means of production are expected to further increase. It can be assumed that the consequence of this situation will be a significant increase in production costs. Table IV.2 shows the expected indicators of changes in selected cost components in 2015 with respect to the level of the base year (2011), which was adopted as a starting point for calculations. The fastest growth rate is expected for the cost of seed, which for cereals may be 3.9-5.0% per year, and for winter rape oilseed 5.2-6.2%. As a result, in 2015, compared to the input data, the cost of cereal seed can increase by 18-20%, while for rapeseed oil by about 25%.

Table IV.2. Indicators of changes for selected cost components, according to the projection made for 2015, compared to the level of the base year 2011*

Specification	2012 / level for 2011*	2013 / 2012	2014 / 2013	2015 / 2014	2015 / level for 2011*
Seed:					
winter wheat	104.4	104.2	104.0	103.9	117.5
winter rye	105.0	104.7	104.5	104.3	119.8
spring barley	104.5	104.3	104.1	103.9	117.9
winter oilseed rape	106.2	105.8	105.5	105.2	124.8
Fertilizers	104.8	104.5	104.3	104.2	119.0
Crop protection products	101.1	101.0	101.0	100.9	104.1
Protein concentrates for dairy cows	103.3	103.2	103.1	103.0	113.4
Mixtures of complete or complementary feedingstuffs for dairy cows	103.4	103.3	103.2	103.1	113.7
Electric energy	104.6	104.4	104.2	104.0	118.2
Fuels	104.4	104.2	104.0	103.9	117.4
Repairs**	103.4	103.3	103.2	103.1	113.4
Agricultural services	104.0	103.8	103.7	103.5	115.8
Medicines and veterinary services	102.7	102.6	102.5	102.4	110.5
Insurance on the farm	102.5	102.4	102.3	102.2	109.7
Interest on loans	97.6	97.7	97.9	98.0	91.4

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

** According to the changes in the prices of construction materials and renovation and construction service.

Strong growth is expected also for the cost of mineral fertilizers (19.0%), electricity (18.2%) and motor fuels (17.4%). Projection shows that by 2015 the cost of plant protection products may increase by 4.1%. This means that the rate of their growth – as compared to other means of production – is comparatively slow. However, in the case of interest on loans, one should expect a decline in the cost, with the annual rate of change of 2.0-2.4%. As a result, the cost of interest on loans in 2015 in relation to the base year may fall by 8.6%.

V. Projection for 2015 of production costs and economic performance of selected agricultural products

Predicting changes in the economic situation of agricultural products is difficult, but can be very helpful in making various decisions. Forecasts serve as an information and warning. In the opinion of many people, forecasts and projections are an essential element of an effective and efficient farm management. Specific knowledge and proper assessment of the development of various economic phenomena and processes allow taking advantage of emerging opportunities, but also reducing the risk of taking action. To make it more detailed, it can be assumed that appropriate early information, e.g. about the level of future agricultural production or demand will help farmers with proper planning of production. On the country level, it gives a basis for taking appropriate decisions on agricultural policy or regulating agricultural markets. In recent years, when all areas of economic life are subject to very rapid change, the importance of such research is increasingly recognized.

Despite the seriousness of the problem, forecasting often makes rational people to smile ironically. Forecasting is a prediction of the future, and the future almost by definition is something unpredictable. In any case, our minds perceive it this way. However, one must agree with the fact that in recent decades – through appropriate research methods – the quality of forecasts has increased, although it also happens that they are completely not true.

The quality of forecasts essentially depends on two factors – on the accuracy of the model, i.e. to what degree it is mathematically formalized and how faithfully it reflects reality. However, agriculture is a special sector, and many factors are out of control of a farmer. First of all, these are the factors that determine the yields of plant production, i.e. weather conditions and weather pattern.

Studies have reported[45], that both agriculture and forestry have seen clear effects of climate change. As a result, there are changes in plant phenology and the range of pests. The tick is now established in Scandinavia much farther north than the traditional range. In Poland, as well as in Central and Northern Europe, the length of the growing season has increased, and this affects the calendar shift of crops and agricultural practices. In many areas, the conditions for growing grapes are improving. More often, there are also very strong heat waves, and global losses caused by natural disasters related to climate have a strong upward trend. Projections for the future predict a further, more extensive, global warming, and this

[45] W. Kundzewicz, *Zmiany klimatu, ich przyczyny i skutki – obserwacje i projekcje*. Landform Analysis, vol. 15, 2011.

trend seems inevitable for at least several decades, but the deviation from the trend (even quite strong) in short periods can happen and they are quite normal.

Chapter V presents, with regard to data from previous years, the results of the projection for 2015 of profitability of **winter wheat, winter rye, spring barley, winter oilseed rape and milk production** on average in the sample of farms or under average conditions of production and in terms of variants. In the case of plant production activities, variations include the level of yield – lower and higher than the average, similar to those in recent years, production conditions. Projection models were built, where it was assumed that production conditions would be unfavourable for agricultural production and extremely beneficial. The consequence of these conditions will be change in yield. However, in the case of livestock production activity – dairy cows, variants are the scale of production in terms of number of cows. Results of the projection show what changes in the profitability of milk production can be expected for farmer with small and large herds of cows. Detailed results of the calculations are given in tabular appendix (Tables 1-5).

It should be noted, that projections based on the time series do not take into account the possible occurrence of changes in other environmental factors that can significantly alter the expected values.

Cereals. Many years of research indicate that cereals account for about 50% of the global value of crop production. They are an essential component of human food and animal feed. They are also increasingly being used as a raw material for energy purposes. The information the Central Statistical Office (CSO) shows that also in Polish agriculture cereals occupy a special position. On average, in 2007-2010, their share in the value of crop production accounted for approximately 40%, and in sowing – more than 70%. However, the share of each cereal in sown area of cereals in total changes, in recent years, for example, a gradual increase in winter wheat and decrease in spring wheat is noticeable[46].

According to the CSO, in 2011-2012 the area under cereals (total) in Poland was respectively 7803 and 7704 thousand ha, which accounted for about 75 and 74% of agricultural land for sowing. In 2011, the average yield from 1 ha of these plants was 34.3 dt, and a year later it was 7.9% higher. Total cereal harvest also increased – by 6.6% (from nearly 26.8 million tonnes in 2011 to more than 28.5 million tonnes in 2012). It should be noted, however, that the harvest of basic cereals (wheat, rye, triticale, barley and oats) with cereal mixes increased by very little – about 0.6% (from 24.3 to 24.4 million tonnes)[47].

---

[46] E. Arseniuk, T. Oleksiak, *Dlaczego zboża…*, Agro Serwis, 5th edition, May 2011.
[47] *Użytkowanie gruntów. Powszechny Spis Rolny 2010*, CSO, Warsaw 2011.
Wyniki produkcji roślinnej w 2012 r., CSO, Warsaw 2013.

According to "*Preliminary estimate of major agricultural and horticultural crops in 2013*" published by the CSO at the end of July 2013, the national basic cereal harvest with cereal mixture was estimated at 23.7-25,1 million tonnes, at a level of about 3% lower to about 3% higher than in 2012. Harvest of winter cereals was initially estimated at 16.6-17.7 million tonnes, and spring cereals at 7.0-7.4 million tonnes[48].

The production of cereals in the world – according to estimates of the Food and Agriculture Organization of the United Nations – FAO – will increase in 2013/2014 to the level of 2479 million tonnes, i.e. 7.2% higher than in the previous season. Harvest of wheat, corn and barley will be relatively high. Perhaps, this will allow cereal stocks to be rebuilt on a global scale, which could lead to a decline in sales prices of grain, but it will still be relatively expensive, due to the demand for grain from developing countries. The predicted global increase in cereal harvest will be above all the consequence of better production results in the EU, the countries bordering the Black Sea, and in the case of maize – mainly in the U.S. The world's wheat harvest may be higher by 6.8% than in 2012/2013, it is estimated at 704 million tonnes, while in the EU – at 128.9 million tonnes. World feed grain harvest is estimated at 1275 million tonnes, i.e. 9.7% higher compared to the previous season, including maize harvest will probably be 972 million tonnes, an in the EU – 69.7 million tonnes. World cereal stocks will likely rise by more than 11%, to 567.5 million tonnes, while wheat stocks will amount to 169 million tonnes, and maize to 175 million tonnes. This may be the highest level of grain reserves for 12 years. However, global grain consumption will also increase, probably by about 3% – up to 2 billion 402 million tonnes. This can be partly due to greater consumption of maize for feed and industrial purposes in the United States[49].

Supply and demand in cereals market is of great importance for the entire food industry. Cereal prices often critically affect the profitability of agricultural production, including livestock production (e.g. pigs). Experts from the IAFE-NRI estimate that in 2013/2014, the global grain markets can expect improved supply, but the demand will limit the possibility of falling prices[50]. However, the

---

[48] *Wstępny szacunek głównych ziemiopłodów rolnych i ogrodniczych w 2013 r.,* CSO, Warsaw 2013.

[49] *FAO: produkcja zbóż na świecie wzrośnie o 6,5 proc.*, http://www.farmer.pl/drukuj/44561.html; *FAO prognozuje wzrost produkcji zbóż na świecie*, http://www.piagro.pl/wiadomosci-rolnicze/swiat/fao-prognozuje-wzrost-produkcji-zboz-na-swiecie.html; *Tanieją zboża w Polsce i na rynkach światowych; będą dobre zbiory*, http://www.portalspozywczy.pl/zboza/wiadomosci/tanieja-zboza-w-polsce-i-na-rynkach-swiatowych-beda-dobre-zbiory,88046.html [access: September 2013].

[50] W. Łopaciuk, *Światowy rynek zbóż*, [in:] *Rynek zbóż. Stan i perspektywy,* No. 44, IAFE-NRI, AMA, MARD, Warsaw 2013.

differences in the prices of cereals between the Polish market and the markets of Western Europe will reduce, although domestic cereals will remain competitive. Probably after the harvest in 2013, there will be a seasonal reduction in grain prices in Poland, but in the longer term, the level will be a few to several percent lower than in 2012/2013. The expected decline in prices will result from improving situation on the world markets, although worsening of market relations in the country will reduce the scale of the decline[51].

Fluctuations in the level of production and the use of agricultural products, including cereals, affect the selling price. Opening up the market after Polish accession to the EU has weakened these relationships. After accession, the domestic prices of agricultural products are affected by the same policy instruments as in all Member States. As a result, the Common Agricultural Policy is an important price factor. The price level is also affected by trade policy instruments such as: tariffs, tariff quotas, SSG (additional duty), export subsidies. Depending on the assumed degree of market protection for a given agricultural product, there are varied duties, quotas and subsidies, and this is a result of the adoption of the Common External Tariff on agri-food products. In Poland, higher duties than before accession apply, e.g. to cereals (including rice), malt, milk and dairy products and some meats and meat products, most fish and selected tropical fruits. Another factor affecting the price of agricultural products is the volume of foreign trade. The increasing level of specialization of the net exporter allows for lowering unit prices of export products. An important price element in this case is the cost of transportation, allowing the flow of goods between countries with surpluses (exporting) and deficits (importing). Poland is already a net exporter of many agricultural products and further strengthening its position as a net exporter it will minimize transport unit costs due to increased degree of specialization. Transport costs may be therefore lower in Poland than in countries with deficits. In addition, prices of agricultural products in Poland are related to prices in the markets of our trading partners through the PLN exchange rate. This rate has a direct impact on the price competitiveness of imports and exports, and indirectly on the prices of goods for the domestic market[52].

Community instruments and border protection determine the minimum level of prices on agricultural markets. In addition to these factors, the price level is

---

[51] W. Łopaciuk, *Ceny zbóż na rynku krajowym*, [in:] *Rynek zbóż. Stan i perspektywy,* No. 44, IAFE-NRI, AMA, MARD, Warsaw 2013.

[52] *Analiza czynników kształtujących ceny produktów rolnych w Polsce po akcesji do UE.* Foundation of Assistance Programmes for Agriculture; http://www.fapa.org.pl/gfx/saepr/Scenariusz%20cenowy%20po%20akcesji_pdf [access: August 2013].

also affected by the size of stocks and supply of agricultural products. This is confirmed by a high increase in grain prices in 2010 because of smaller harvests and low stocks. The unfavourable ratio of stocks to consumption of cereals, continuing for several years, causes prices fluctuations in world markets. Taking into account the above information, cereal market experts have tried to determine how cereal prices will shape until 2020.

According to OECD-FAO forecasts, in 2020 there will be an increase in supply on the global market for wheat and feed cereals. At the same time, the rate of growth in demand will be reduced, it will be a result of high prices of these products. As a result of these changes, stocks will be slightly rebuilt. World cereal prices will decline, but their level will remain high. This is indicated by the continuing adverse relationship of stocks and consumption, as compared to that observed in previous decades (i.e. before 2010).

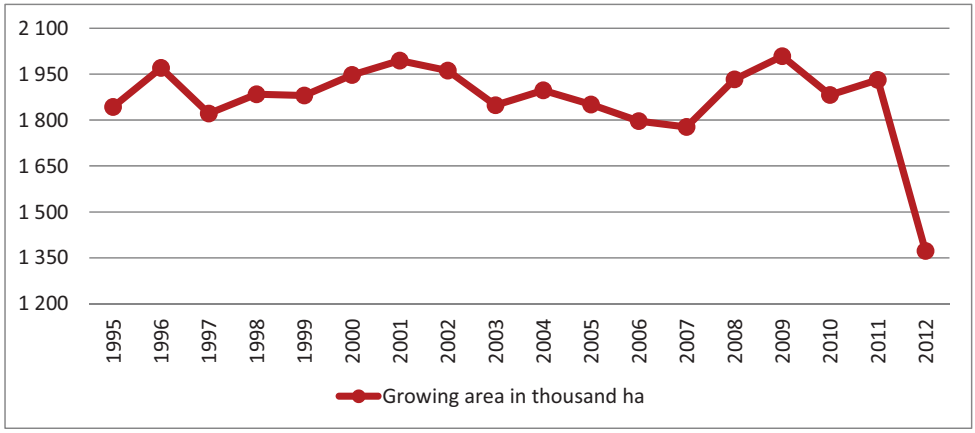
An important factor in sustaining the level of cereal prices is the development of the biofuels market, which are considered as an alternative source of energy production. The profitability of biofuel production depends on oil prices and prices of other traditional energy sources and on the rules on the production and use of biofuels applied by the governments of many countries. The rising prices of conventional fuels, and thus – the further expansion of the biofuels market, are likely to increase the demand for wheat, feed cereals and oilseeds, which will contribute to reducing their stocks. Experts predict that by 2020 about 13% of the global production of feed cereals and about 15% of oilseed production will be used to produce biofuels. It is also estimated that the increase in oil prices by 25% may result in an increase in feed cereal prices by 5%. 5% fall in harvest of cereals may cause an increase in the price of wheat by 25% and feed cereals by 24%. An increase in feed cereal harvest by 5% may result in a decline in sales prices of wheat by 18% and of other feed cereals by 17%. These data indicate that if cereal stocks is not rebuilt there will be a high risk that in the coming years there will be strong fluctuations in their prices[53].

[53] G. Dybowski, D. Rycombel, *Światowy rynek wieprzowiny i drobiu na tle bilansu zbóż i pasz,* IAFE-NRI, Report of the Multiannual Programme No. 17, Warsaw 2011.

1. Winter wheat

Wheat is the most important cereal in Poland in economic terms. This is due to its high yielding potential, high technological value of grain and large production capacity in the Polish climate and soil. According to the CSO, in 2012 winter wheat comprised 17.8% in the total cereal area[54]. Over the years, the area was subject to some volatility. Practically from 2001 to 2007 the area under wheat showed decreasing trend. Only in 2008 and 2009, there was a significant increase, but in 2010 there was a further collapse – Figure V.1.1.

Figure V.1.1. Winter wheat growing area in 1995-2012,total in the country



Source: Own study based on CSO data.

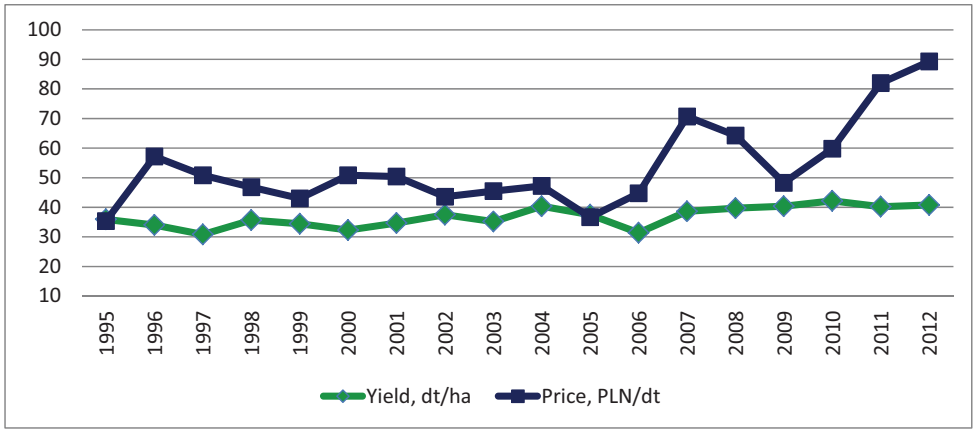
A drastic reduction in the area (to 1.4 million hectares) of winter wheat was recorded in 2012. This was the result of bad weather. Very low temperatures combined with lack of snow cover have caused a significant loss of winter crops. As a result, also winter wheat crops were often ploughed and sown with spring cereals[55].

An important factor affecting the size of cultivation area is the sales price, which largely shapes the income of the farmer. In Poland, in 1997-2004, i.e. in the last years before the Polish accession to the European Union (EU), sales prices of wheat grain remained at relatively the same level (40-50 PLN/dt). A very large increase in the price of wheat was recorded in 2007. It was among other things due to the relatively low harvest in that year, a decrease in stocks and various export restrictions imposed by several major producers, e.g. Argentina, Russia, China. Only in 2008, as a consequence of lower domestic demand

[54] *Wyniki produkcji roślinnej w 2012 r.,* CSO, Warsaw 2013.
[55] As above.

and a slight increase in the supply, there were the first signs of fall in the prices of that cereal[56]. Finally, in 2009, the wheat market saw a deep decline in prices, down to the level observed in 2004 – Figure V.1.2.

Figure V.1.2. Winter wheat crop in individual farms and the selling price of grain in 1995-2012



Source: Own study based on CSO data.

Since 2010, as a result of unfavourable demand-supply situation, the sales prices of wheat grain have been growing steadily. In 2011, the wheat price increase was significant in both the domestic and global market. It was, *inter alia*, the effect of increasing demand for grain, combined with lower export supply from major producers, and in particular the introduction of export restrictions in Russia and Ukraine. In 2012, wheat prices continued to rise, the reasons for this may be due to a decrease in production and to the resulting negative balance of cereals in the world. A decrease in production was due to unfavourable weather conditions occurring in key global producers of cereals, mainly in the countries bordering the Black Sea and in the U.S.[57].

As for the yielding of wheat in recent years, it can be concluded that it remained relatively stable. Grain yield of wheat fluctuated around 40 dt/ha (Figure V.1.2). However, with regard to the majority of EU countries, this figure was relatively low. For comparison, in 2005, the average yield in the EU-25 was 59.9 dt/ha, while in Poland, 37.5 dt/ha. The highest yields were achieved at that

[56] A. Ginter, S. Szarek, *Sytuacja dochodowa producentów zbóż na przykładzie uprawy pszenicy,* Journal of Agribusiness and Rural Development, 4(18) 2010.

[57] *Światowy Rynek Zbóż, Oleistych i Komponentów Paszowych. Opracowanie sygnalne,* Foreign Agricultural Markets Monitoring Unit, FAMMU/FAPA, Warsaw 2012.

time by: the Netherlands (86.6 dt/ha), Ireland (84.3 dt/ha) and Belgium (84.2 dt/ha), whereas in Germany wheat harvest in 2005 was 74.7 dt/ha[58].

The relatively low yielding of wheat in Poland is probably a consequence of over-simplified rotation, resulting from a very high share of cereals in production and diminishing share of legumes as intercrops. The low share of certified seeds in sowing is also of great importance, as well as relatively low quality of Polish soils and relatively low level of fertilizing and using conservation measures[59].

The forecast of wheat crops and yield in 2013 are also worth mentioning. According to Coceral[60], in 2013, in comparison with 2012, wheat harvest in the European Union will increase by 3.2 million tonnes, i.e. to the level of 127 million tonnes. Increasing wheat production is expected in the majority of key producers (e.g. France and Germany), with the exception of Great Britain, where production of soft wheat is expected to fall by about 1.3 million tonnes. However, the European Commission forecasts on the average yield of wheat in the European Union in 2013/2014 show its increase, from 54.1 dt/ha in 2012 to 55.4 dt/ha in 2013. It should be noted, however, that the level of yield is lower than the EU average for the last five years (56.3 dt/ha)[61].

Research done for the purpose of this paper was based on empirical data collected in 151 farms cultivating winter wheat on average in 2006-2011. These units were located throughout the country and were selected in an intentional manner from among Polish FADN farms. The condition for selection of a farm was growing wheat on a specific scale.

The results show that in recent years, the income of winter wheat cultivation was favourable. In the baseline year for the projection model, i.e. 2011 (data from 2006-2011 were adjusted by indicators of change designated on the basis of the trend function, and then averaged), on average in the sample of farms, the gross margin of 1 ha of winter wheat was PLN 3137, and income without payments was 1804 PLN/ha (Table 1). Additionally, the support that farmers receive in the form of subsidies (complementary area payment + single area payment), as in the case

[58] *Polskie rolnictwo na tle rolnictwa UE*, Foundation of Assistance Programmes for Agriculture; http://www.fapa.org.pl/gfx/saepr/Polskie% 20rolnictwo%20na% 20tle%20UE-raport%2009 _08.pdf [access: June 2013].

[59] E. Arseniuk, T. Oleksiak, *Dlaczego zboża...*,2011; http://www.ihar.edu.pl/dlaczego_zboza.php [access: June 2013].

[60] Coceral – European association representing trade of cereals, rice, feed, oilseeds, olive oil, oils and fats.

[61] *Rynek zbóż i oleistych,* Foreign Agricultural Markets Monitoring Unit, FAMMU/FAPA. Wiadomości No. 12 and 21, 22 March and 24 May 2013.

of all cereals, had a big impact on the income from activities. During this period, the income from growing wheat, after taking account of payments, stood at 2556 PLN/ha, subsidies accounted for 29.4% of its level. Production of winter wheat – against the background of other production activities covered by the study – was characterized by high economic efficiency. The measure of effectiveness was the rate of profitability, which was 168.9% – Table 1.

According to projections, by 2015, in the average production conditions, winter wheat cultivation will continue to be profitable. It is estimated that the income without subsidies from one hectare of wheat crop will be PLN 1931, that is 7.0% higher as compared to the baseline year 2011. This will be the result of both the increase in yield (by 4.7%) and higher selling prices of grain (by 7.6%). At the same time, one expects increase in subsidies, the research – in accordance with the opinion of the experts – assumes the amount of subsidies at 976 PLN/ha. As a result, income from activity (i.e. including subsidies) will be 13.7% higher than in 2011. However, economic efficiency of winter wheat production will fall by 5.6 percentage points.

Agricultural production consists in adapting the resources and forces of nature to produce material goods. For this reason, its dependence on natural conditions is unquestionable. This involves a degree of risk arising, *inter alia*, from the occurrence of random events that cannot be foreseen and which have a major impact on the growth and yield of crops. These events may be related to weather conditions which can positively or negatively impact agricultural production.

In order to determine – for 2015 – the changes in the economic performance of winter wheat depending on the conditions of production, the projection is made in two versions:

- pessimistic (A) – it was established that there are adverse production conditions, which will result in lower yields of wheat,
- optimistic (B) – it was established that there are very favourable conditions for the production, which will contribute to a higher than average yields.

Table V.1.1 shows the dynamics of the expected changes in production and selected items of costs and revenues, in 2015, under average conditions of production and in terms of variants, compared to the input data, which is the average of 2006-2011.

Table V.1.1. Dynamics of indicators of change in cultivation of 1 ha of winter wheat in 2015 under average conditions of production and in terms of variants, as compared to the average for the baseline year 2011*

Specification	The average production conditions	Variants of yield	
		pessimistic [A]	optimistic [B]
Yield of grain	104.7	93.4	113.8
Grain sales price	107.6		
Total value of production	112.5	100.4	122.3
Total direct costs	**114.8**	**114.8**	**114.8**
Gross margin without subsidies	111.6	94.6	125.5
Total costs	116.4	116.4	116.4
Income from activity without subsidies	**107.0**	**77.3**	**131.0**
Income from activity	**113.7**	**92.8**	**130.7**
Indicator of profitability	96.7	86.3	105.1
Income from activity without subsidies/1dt of grain	102.2	82.8	115.1
Total costs/PLN 1 of income from activity without subsidies	108.7	150.5	88.8
Subsidies for PLN 1 of income from activity without subsidies	121.3	167.9	99.1

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

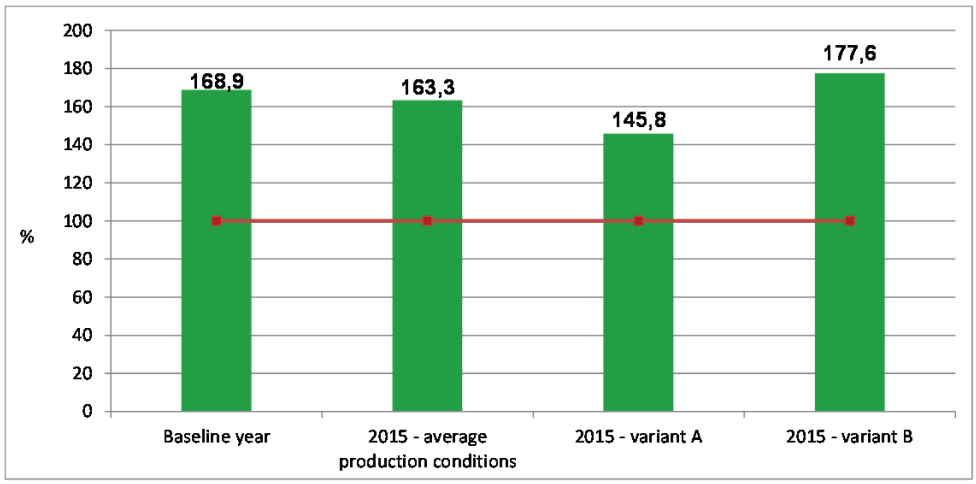
Results of the projection indicate that in 2015 both under the average and favourable production conditions (optimistic variant), there will be an increase in the yield of winter wheat, respectively by 4.7 and 13.8%. However, in the event of unfavourable production conditions (pessimistic variant), the decline in yield by 6.6% is expected. It is estimated that the price of grain will increase at a rate of 1.8% per year and in 2015 will increase by 7.6% compared to the baseline year (2011). This situation will affect the growth of the value of production, which in 2015 will reach the level: under the average conditions of production, higher by 12.5%, under the pessimistic conditions by 0.4%, and under optimistic by 22.3%.

It is expected that the annual growth of the direct costs of growing wheat will be in the range of 3.3-3.7% and, consequently, in 2015, as compared to the input data of 2011, the cost will be higher by 14.8%. The fastest annual growth rate is expected for the cost of mineral fertilizers (4.8-4.2%) and the cost of seed (4.4-3.9%) – Table IV.2.

However, total costs (i.e. direct and indirect together) of wheat cultivation will increase in the range of 3.7-4.0% per year. As a result, in 2015, as compared to 2011, they can increase by 16.4%.

According to the projection for 2015, under average conditions of production and under the worse-than-average conditions (variant A), one should expect weaker growth of the value of production than the total cost of cultivation of winter wheat. As a result, in 2015 – compared to 2011 – it is expected that the rate of profitability will decrease by respectively 5.6 and 23.1 percentage points. The level of cost-effectiveness in ratio terms for winter wheat in the baseline year (2011) and projected for 2015 are shown in Figure V.1.3.

Figure V.1.3. Cost-effectiveness of winter wheat in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

The study shows that in 2015, compared to 2011, the profitability of growing wheat will increase only if production conditions are extremely favourable (variant B), i.e. in case of high yielding. In this case, the growth rate of the value of production will be stronger than the total costs (by 5.9 percentage points) and as a result the cost-effectiveness ratio will reach 177.6% and will be higher than in the baseline year (2011) by 8.7 percentage points.

Below is the direction of change in the level of production (revenue) and income from winter wheat crop expected in 2015 – in relation to the baseline year 2011 – per 1 ha of crops[62]:

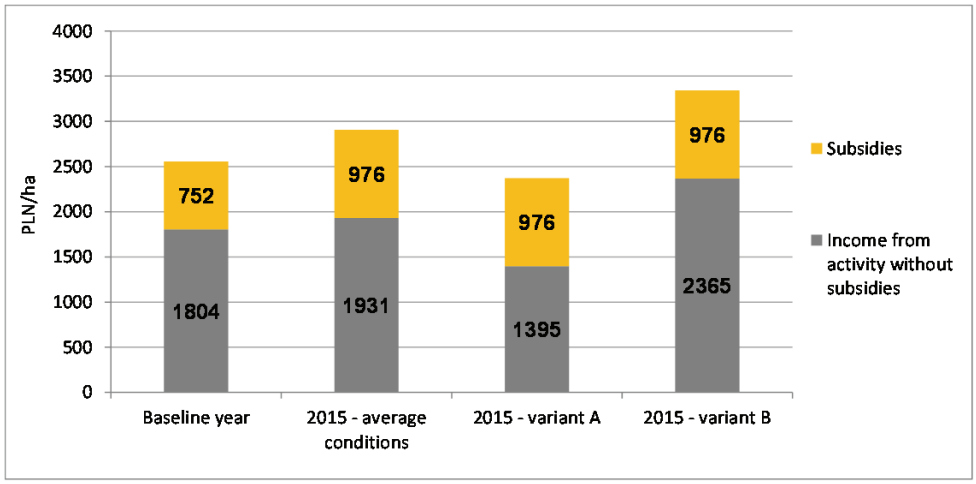
[62] The expected direction of change (increase or decrease) and the strength of this phenomenon is shown as a percentage. Changes are also expressed in quantity and value terms. The numbers should not be construed as absolute values, they are expected to show the scale of the changes against the percentage changes - in the present case, the results of winter wheat under average conditions of production and at a lower yield (unfavourable conditions of production) and higher yield (favourable conditions of production).

- **under average conditions of production:**
  - increase in yield – by 4.7% (by 2.7 dt/ha),
  - increase in value of production – by 12.5% (by PLN 555)
  - increase in gross margin without subsidies – by 11.6% (by PLN 364),
  - increase in income from activity without subsidies – by 7.0% (by PLN 127),
- **under unfavourable production conditions (variant A):**
  - decrease in yield – by 6.6% (by 3.9 dt/ha)
  - increase in value of production – by 0.4% (by PLN 20),
  - decrease in gross margin without subsidies – by 5.4% (by PLN 171),
  - decrease in income from activity without subsidies – by 22.7% (by PLN 409),
- **under favourable production conditions (variant B):**
  - increase in yield – by 13.8% (by 8.0 dt/ha),
  - increase in value of production – by 22.3% (by PLN 989),
  - increase in gross margin without subsidies – by 25.5% (by PLN 798),
  - increase in income from activities without subsidies – by 31.0% (by PLN 561).

The economic performance of winter wheat is affected not only by the value of production (as a derivative of yield and price), but also by the cost of cultivation. In the baseline year (2011), the total cost incurred for the cultivation of one hectare amounted to PLN 2621, while in 2015, it is estimated that it will reach the level of PLN 3049, i.e. increase by 16.4%.

Higher production costs, even if production results are better, will increase the cost of production of one dt of grain. Compared to 2011, under average conditions of production in 2015, the cost of production of 1 dt of grain could increase by 11.2% and under very favourable conditions (variant B) – by 2.2%. However, in the event of adverse conditions of production (variant A) and a decrease of yield, production costs for 1 dt of grain may be higher by as much as 24.6%.

Figure V.1.4. Income from winter wheat in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

By 2015, it is estimated that production and price results will be favourable enough that the level of production value will cover the total cost (i.e. direct and indirect together) for the cultivation of wheat and gaining income from activities without subsidies. This revenue, as compared to input data of 2011, will be higher under average and favourable conditions of production, respectively by 127 and 561 PLN/ha. However, under adverse conditions, decrease in income without subsidies will be sufficiently large (about 409 PLN/ha) that despite higher payments (by 29.8%), the income from activities will not reach the level of the baseline year and will be lower by PLN 185, i.e. by 7.2%. It should be noted that in 2015, under average and unfavourable (variant A) conditions of production, there will be an increase in the importance of subsidies for growing winter wheat. Their share in the income from activity compared to the baseline year (2011) will be higher by 4.2 and 11.8 percentage points respectively. However, in the favourable (B) variant of the projection, the share of subsidies (29.2%) will be similar to that in the baseline year – Figure V.1.4, Table 1.

Projection for 2015 of winter wheat crop results

The results show that in 2015 winter wheat crop will be profitable. Regardless of the conditions of production, the income from activity without subsidies will be realised. It is envisaged that under average conditions of production, that is similar as in recent years, winter wheat crop will be at the level of 61.2 dt/ha. The selling price of grain may reach 81.18 PLN/dt. As a result, revenues (value of production) of 1 ha of crops will reach 4980 PLN. It is estimated that after taking account the costs of cultivation (3049 PLN/ha), the income without subsidies of one hectare of cereal will be 1931 PLN.

However, given the variability of the climate and the possibility of adverse random events (e.g. heavy rains, drought), as well as those favourable to the achievement of relatively high yields, one can expect significant diversification in the economic performance of the activities.

The scale of variation is shown in the comparison of growing winter wheat by variants. Comparing production and economic results of wheat in variant B (favourable production conditions) and A (unfavourable conditions) per 1 ha of crops, the following were recorded:

- crop – higher by 21.8% (i.e. 11.9 dt),
- value of production – higher by 21.8%,
- gross margin without subsidies – higher by 32.7%,
- income from activities without subsidies – higher by 69.5%,
- indicator of profitability – higher by 31,8 percentage points.

Calculation of results shows the size of differences in the profitability of winter wheat that can be expected. The strength of these changes results from the assumptions of the projection model, which were based on the variability of wheat crop over time. It should be borne in mind that the impact of weather conditions, which are beyond the control of a farmer, does not have to be that intense.

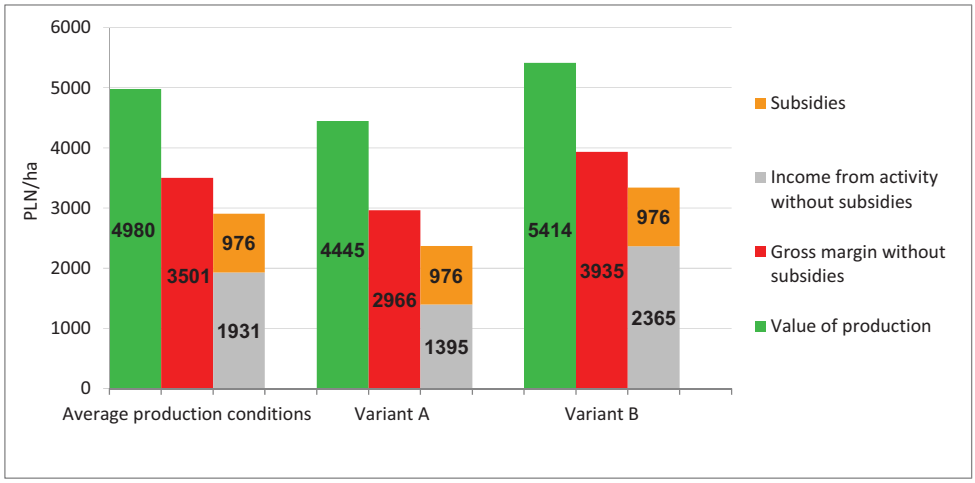
However, taking into account the results of the projection model – variant A and B – there are significant differences in the results of cultivation of one hectare, but also in the level of economic performance indicators. For example, the difference in favour of variant B in the amount of income from activity without subsidies for 1 dt of grain was nearly PLN 10, i.e. 39.1%. Advantage is also visible in the case of cost of PLN 1 of income (by 41.1%).

Comparing the results of the two variants, one should also pay attention to the importance of subsidies in the development of income from winter wheat. In the optimistic scenario (B), subsidies accounted for 29.2% of the income, while in

the pessimistic scenario (A) – 41.2%. Despite such support, the income from activity in variant A, as compared to B, was lower by PLN 970, i.e. by 29.0%.

Figure V.1.5 shows the economic performance of winter wheat and the impact of financial support in the form of subsidies in 2015, depending on the variability of conditions of production.

Figure V.1.5. Projection of the results of winter wheat cultivation in 2015 under average and unfavourable conditions (variant A) and favourable conditions (option B) of production



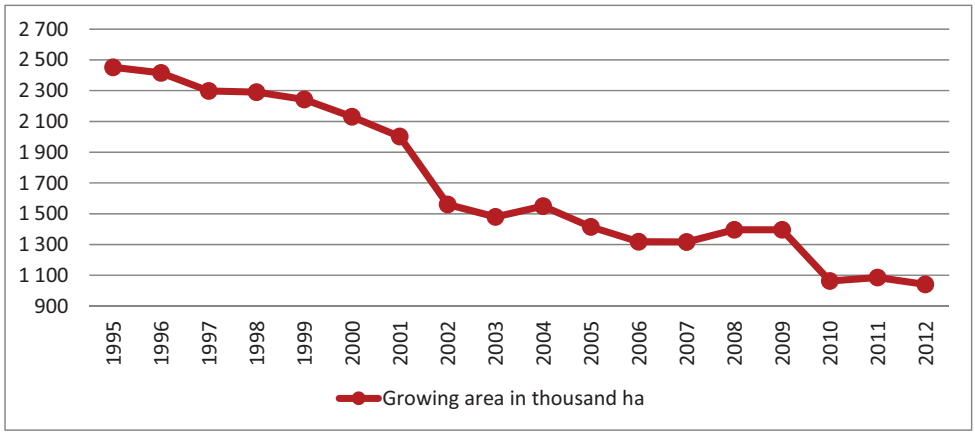
In conclusion – based on the results of projection – it should be stated that cultivation of winter wheat in 2015 will be profitable. However, significant fluctuations in income are possible due to the diversity of conditions of production. Taking into account the average conditions of production, it is estimated that income from activity without subsidies from 1 hectare will exceed the level achieved in the baseline year of 2011 – on average by 7.0%. However, in the case of exceptionally favourable production conditions (B), the increase in income will be stronger (by 31.0%), while under adverse conditions (A) income is likely to fall by 22.7%, which is below the level of 2011.

Variability of the results presented here is the consequence of possible differences in yielding wheat (the difference between variant A and B was 11.9 dt). The results show that in 2015 the growth rate of the value of production will be lower than that of the cost, which may result in lower production efficiency. An opposite direction of change can be expected only in the optimistic scenario (B). In this case, the economic efficiency of wheat production – compared to the baseline year – could be higher by 8.7 percentage points.

2. Winter rye

In Poland, the cultivation of rye is often conducted in an extensive way, mainly due to the smallest needs with respect to climate and soil among cereal crops. Among domestic producers of cereals, in recent years, rye is becoming less popular, which is reflected by the steady decline of its cultivation area – Figure V.2.1.

Figure V.2.1. Winter rye growing area in 1995-2012, total in the country



Source: Own study based on CSO data.

According to CSO data, in 2012, the area of rye was 1042 thousand ha, and its share in the total sown area of basic cereals with cereal mixture was 14.8%[63]. The decreasing area under rye is mainly the result of a much lesser significance of this cereal in the food industry. Value in use of rye grain is less than wheat, and only a small portion is earmarked for human consumption. More than half of the harvest is used as animal feed, but other uses, such as production of biomass for biogas plants, are indicated more often.

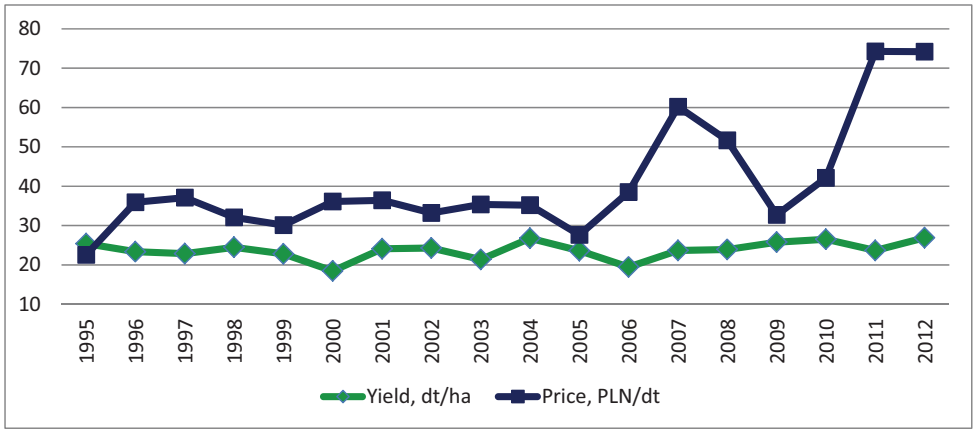
Extensive cultivation of rye to a large extent determines the yielding of this cereal. In 2012 – total in the country – the average yield of rye was 27.7 dt/ha, but the variation was large, the highest yield (about 37 dt) was obtained in Zachodniopomorskie and Opolskie Voivodeships, while the lowest (about 23 dt) in Mazowieckie and Świętokrzyskie[64]. It is worth noting that in COBORU experiments, the average yields of rye were within 60-80 dt/ha[65]. It follows from this that relatively high yields of rye are possible to achieve, but this requires

[63] *Wyniki produkcji roślinnej w 2012 r.,* CSO, Warsaw 2013.
[64] As above.
[65] R. Musolf, *Skuteczna uprawa żyta na wszelkiego rodzaju glebach.* Materials from conference "Rye from the perspective of 2012," RYE BELT Congress, Poznań 2012.

appropriate inputs and appropriate agronomical practices. Poor production results may be due to, for example, wrong forecrop (rye is often grown in monoculture or after other cereals), lack of balanced fertilization, improper soil pH, poor seed quality and inadequate sowing and harvesting dates.

From the point of view of a farmer who is primarily interested in the economic aspect of production, an important factor is the selling price of rye grain. However, large fluctuations in the prices of rye cause fluctuations in profitability of its cultivation[66]. With rather stable yields, price is a factor that largely shapes the income of the farmer. Purchase prices of rye grain, which were recorded in 1995-2006, were at the level of 30-40 PLN/dt – Figure V.2.2.

Figure V.2.2. Winter rye crop in individual farms and the selling price of rye grain in 1995-2012



Source: Own study based on CSO data.

A large increase in grain prices (up to 60 PLN/dt) was recorded in 2007. In the following years, as a consequence of a slight increase in supply and lower domestic demand, rye prices fell. However, the last two years (2011-2012) were very beneficial in terms of price. Rye producers could count on record grain purchase prices that were more than 74 PLN/dt[67].

It is estimated that further increase in purchase price of rye is possible, particularly in the face of limited supply of good quality grain on the domestic market. However, there is still an unfavourable price difference between rye grain and more expensive wheat in the market for feed cereals, and this is not an incentive for farmers to undertake cultivation of rye.

[66] As above.
[67] *Skup i ceny produktów rolnych w 2012 r.,* CSO, Warsaw 2013.

For the purposes of this study and to determine the changes in production and economic results of rye in 2015, a model of projection was built. The sample was empirical data collected on average in 122 individual farms cultivating rye from 2006-2011. However, for the purposes of projection the data were corrected by indicators of change designated on the basis of the trend function, and then averaged. The data characterising rye as a production activity were collected according to AGROKOSZTY assumptions, the research was conducted in households selected in a targeted manner from the Polish FADN sample. These were units located all over the country, and their production and economic results were better than the national average.

The results show that the income situation of winter rye crops in recent years has been quite favourable, i.e. the farmers did not lose by cultivating it. The results in 2011, i.e. the base year for the projection, indicate that on average in the sample of farms, the gross margin without subsidies of 1 ha of rye was PLN 1472, and revenue without subsidies PLN 763. It should be emphasized that support in the form of subsidies had a significant impact on the income from activities, because payments (complementary area payments + single area payments) were 49.6% of its level. As a result, income from the cultivation of rye (including subsidies) amounted to 1515 PLN/ha. However, the economic efficiency of rye production – compared to other cereals in the study – was the lowest. Cost-effectiveness ratio for rye was 155.3%, while for wheat it was 168.9% and 159.4% for spring barley – Tables 1-3.

Projection results indicate that in 2015, under average conditions of production, winter rye crop will continue to be a profitable activity. It is estimated that revenue without subsidies from 1 ha will be PLN 802 i.e. about 5.1% higher compared to the baseline year of the projection (2011). The increase in revenue is due to 12.9% higher value of production. This will mainly be determined by the selling price of grain – higher by 11.6%, because the increase in yield in 2015 is estimated only at 1.2%. In 2015, one also expects higher cost (29.8%), according to the experts, farmers may receive support in the amount of PLN 976 per 1 hectare. Taking into account the subsidies, income from activities (i.e. including subsidies) of 1 ha of rye may reach PLN 1778, in comparison to 2011 it would be higher by 17.3%. However, the economic efficiency of production will worsen. Cost-effectiveness ratio, i.e. the ratio of the value of production to total costs will fall by 5.7 percentage points. Decrease in profitability means that increase in the value of production will be too costly. Rye, however, still has a chance to be a profitable activity, and farmers

will have access to a surplus in the form of income from activity without subsidies – Table 2, Table V.2.1.

Projection model for 2015 assumes an unchanging structure and amount of expenditure incurred in the production of rye. However, during the growing and harvesting of plants there may be changing weather conditions which may result in very different levels of yields. Sometimes, the farmers get lower yields despite the high production inputs. For this reason – in order to determine the changes in the economic performance of growing wheat in 2015 – the projection involves two variants of yield, different for the average conditions of production:

- pessimistic (A) – i.e. lower yield due to unfavourable conditions of production,
- optimistic (B) – i.e. higher yield due to the exceptionally favourable conditions of production.

Projections results indicate that in 2015, unfavourable production conditions (variant A) will cause a decline in rye yield by 17.4%. However, if there are favourable conditions (variant B), one can expect the growth of 12.7%. It is estimated that in 2011-2015, the price of grain will increase at a rate of 2.9-2.7% per year (i.e., in the initial period at a rate of 2.9% and 2.7% towards the end of the period). As a result, in 2015, compared to the baseline year (2011), it will be higher by 11.6%. However, taking into account the change in yield and selling price of grain, in 2015 under adverse conditions (A) one can expect a decline in the value of production by 7.8%, and in favourable conditions (B), an increase of 25.6%.

Projection model assumes the same rate and direction of change in individual cost components, regardless of present conditions of production. Taking direct and indirect costs combined (total costs), it is estimated that the annual increase will be included in the range of 3.9-4.2%. As a result, in 2015 – compared to 2011 – the cost could be higher by 17.2%. However, the direct costs are likely to increase by 16.9%, particularly strong growth is expected for the cost of mineral fertilizers (19.0%) and rye seed (19.8%) – Tables IV.2 and V.2.1.

Table V.2.1 shows the dynamics of the expected changes in the level of the value of production from cultivation of rye and selected cost and income items under average conditions of production and in terms of variants, in 2015 as compared to the input data for the projection model.

Table V.2.1. Dynamics of indicators of change in cultivation of 1 ha of winter rye in 2015 under average conditions of production and in terms of variants, as compared to the average for the baseline year 2011*

Specification	The average production conditions	Variants of yield	
		pessimistic [A]	optimistic [B]
Yield of grain	101.2	82.6	112.7
Grain sales price	111.6		
Total value of production	112.9	92.2	125.6
Total direct costs	**116.9**	**116.9**	**116.9**
Gross margin without subsidies	111.1	80.9	129.6
Total costs	117.2	117.2	117.2
Income from activity without subsidies	**105.1**	**46.9**	**140.9**
Income from activity	**117.3**	**88.0**	**135.4**
Indicator of profitability	96.3	78.6	107.2
Income from activity without subsidies/1dt of grain	103.8	56.8	125.0
Total costs/PLN 1 of income from activity without subsidies	111.6	250.2	83.2
Subsidies for PLN 1 of income from activity without subsidies	123.6	277.0	92.2

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

Calculation results show what changes in 2015 revenues, earnings and profitability of production in ratio terms can be expected depending on the results of rye production.

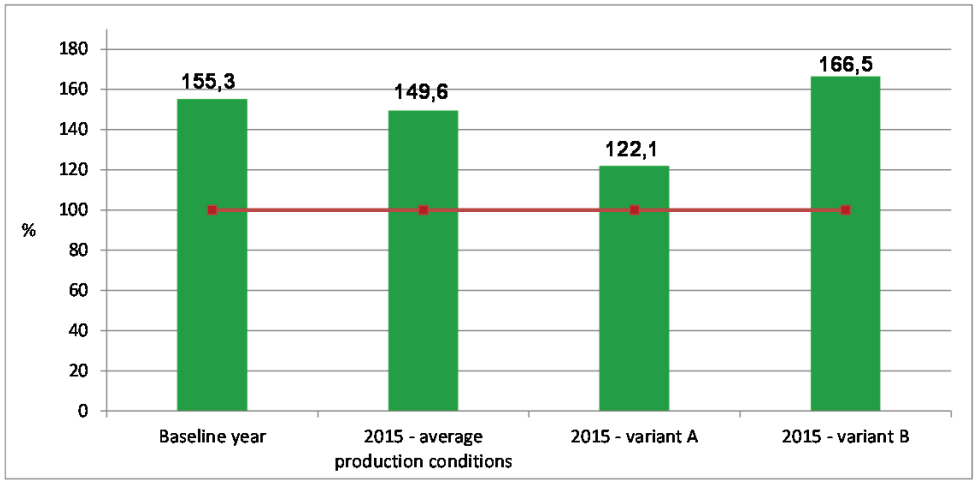
First of all, the A variant of projection, i.e. when rye yield is lower, income from 1 ha – in relation to the baseline year – will decline by 7.8%. This means that the increase in the price of grain (by 11.6%) will not offset the decline in yield (by 17.4%). Given the expected increase in the cost of cultivation (17.2%), it is expected that the income from activity without subsidies will fall by 53.1% and the profitability by 33.2 percentage points.

Under average conditions of production, one can expect a small increase in income without subsidies (by 5.1%), but also the deterioration of economic efficiency of production, the profitability index will be lower by 5.7 percentage points.

However, if there are favourable conditions for production (variant B) and yield of rye is relatively high, the rate of growth is likely to be faster than costs – by 8.4 percentage points. This will be extremely beneficial situation for farmers, as the income without subsidies of 1 ha of rye could rise by as much as 40.9%. Economic efficiency of production will also improve, the profitability index will reach 166.5%, which is higher than in the baseline year for the projection by 11.2 percentage points.

Figure V.2.3 shows the level of profitability of the crop of winter rye in the baseline year (2011) and projected for 2015 under average and unfavourable (variant A) and favourable (variant B) conditions of production.

Figure V.2.3. Cost-effectiveness of winter rye in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

In view of these results, it is estimated that in 2015 only under very favourable weather conditions and a high yield of rye, the farmers can expect to improve the economic efficiency of production.

The direction and magnitude of changes in the value of production and income from the cultivation of winter rye, which is expected in 2015 – in relation to the baseline year 2011 – are presented per 1 ha of crops[68]:

- **under average conditions of production:**
  - increase in yield – by 1.2% (by 0.4 dt/ha),
  - increase in value of production – by 12.9% (by PLN 276),
  - increase in gross margin without subsidies – by 11.1% (by PLN 163),
  - increase in income from activity without subsidies – by 5.1% (by PLN 39),

[68] The expected direction of change (increase or decrease) and the strength of this phenomenon is shown as a percentage. Changes are also expressed in quantity and value terms. The numbers should not be construed as absolute values, they are expected to show the scale of change against the change in percentage terms – in the present case, the results of winter rye under average conditions of production and at a lower yield (unfavourable conditions of production) and higher yield (favourable conditions of production).

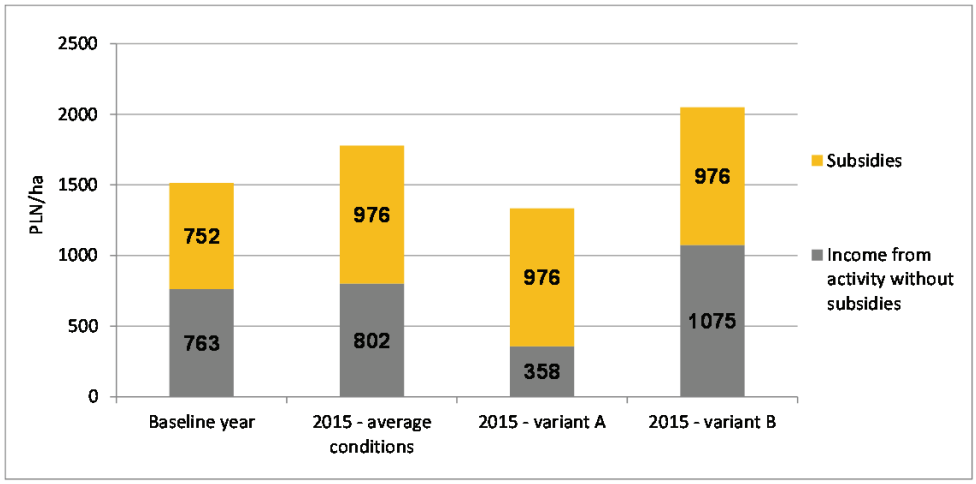
- **under unfavourable production conditions (variant A):**
  - decrease in yield – by 7.4% (by 5.7 dt/ha),
  - decrease in value of production – by 7.8% (by PLN 168),
  - decrease in gross margin without subsidies – by 19.1% (by PLN 281),
  - decrease in income from operations without subsidies – by 53.1% (by PLN 405),
- **under favourable production conditions (variant B):**
  - increase in yield – by 12.7% (by 4.1 dt/ha),
  - increase in value of production – by 25.6% (by PLN 549),
  - increase in gross margin without subsidies – by 29.6% (by PLN 436),
  - increase in income from activity without subsidies – by 40.9% (by PLN 312).

In 2015, the expected volatility of the conditions of production will have impact on the results of cultivation of one hectare of rye, but also on the level of measures that more accurately characterize the efficiency of management.

First of all – in comparison to the input data for the projection – there was an increase in production costs of 1 dt of grain. Higher costs (by 4.0%) are expected even in variant B, which assumes a relatively high level of yield. This is the evidence of the expected, strong increase in prices of means of production, which contributed to the significantly higher cost of cultivation of rye (by 17.2%). However, despite the higher cost, favourable production conditions caused that the cost of the unit of income without subsidies decreased by 17.1% (PLN 1.50 to PLN 1.81 in 2011). In variant A of the projection and under average conditions, the performance of measures is not as beneficial – Table 2.

The next point to which attention should be paid is the share of subsidies in the income from activity and the scale of support depending on the production results of rye. For rye farmers subsidies are very important in stabilizing income, because the income from production is usually lower than for other cereals. The graphical presentation (Figure V.2.4) shows that the share of subsidies in income from activity is generally around 50%, and if production results are weaker it can be up to three quarters of the income level.

Figure V.2.4. Income from winter rye in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A - lower yield (unfavourable conditions), B - higher yield (favourable conditions).

According to the projection, in 2015 the situation of rye producers will be particularly disadvantageous if conditions are not conducive to obtaining high yields (variant A). Even subsidies higher than in the baseline year (about 224 PLN/ha) will not offset the decline in income from production. As a result, income from activity (i.e. including subsidies) will not reach the level of the baseline year, it is estimated that it will be lower by 181 PLN/ha (i.e. 12.0%). In other analysed cases, this income may be higher, but the role of subsidies in shaping its level is significant – Figure V.2.4.

Projection for 2015 of winter rye crop results

The results show that in 2015, regardless of the conditions of production, winter rye will be a profitable activity. It is expected that under average conditions, the yield of rye will reach a level of 33.1 dt/ha, and the selling price of grain – 72.83 PLN/dt. As a result, the value of production, i.e. the income of farmers from 1 ha of rye will amount to PLN 2418. After the deduction of incurred costs (1616 PLN/ha) the farmer's income without subsidies will amount to 802 PLN/ha.

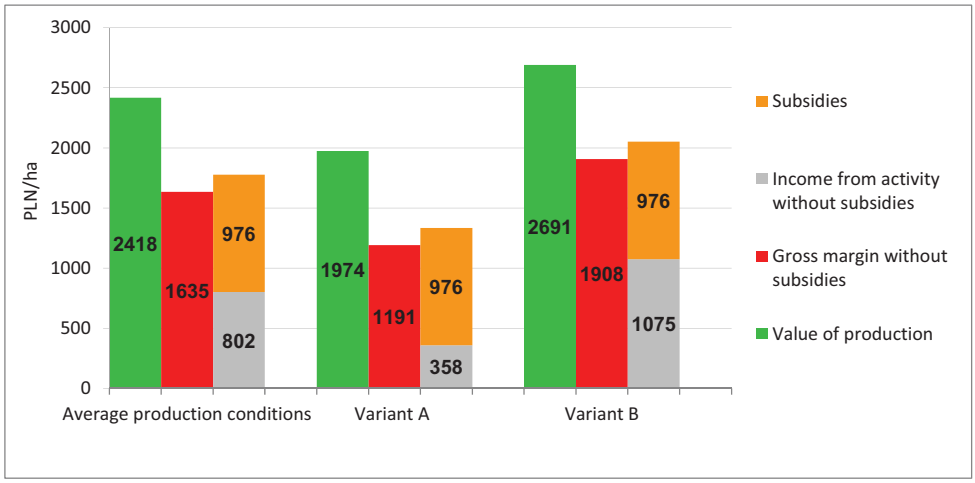
Production results of rye in 2015 may, however, vary considerably, due to the volatility observed in recent years (2006-2011). The diversity of crops in the database of input data, which were used to build the model of projection, was a prerequisite for the preparation of economic performance projection for rye in 2015 in terms of variants.

Below are the changes one can expect by comparing production and economic results of rye in variant B (favourable conditions of production) and in variant A (unfavourable conditions). Per 1 ha of crops:

- crop – was higher by 36.3% (i.e. 9.8 dt),
- value of production – higher by 36.3%,
- gross margin without subsidies – higher by 60.2%,
- income from activities without subsidies – 3-fold higher
- indicator of profitability – higher by 44,4 percentage points.

Figure V.2.5 presents economic results of winter rye and the impact of support in the form of subsidies, depending on the expected volatility of rye crop in 2015.

Figure V.2.5. Projection of results of winter rye in 2015 under average and unfavourable (variant A) and favourable (variant B) conditions of production



Diversity of economic performance of growing rye – at a yield differing by 9.8 dt – is significant. This is particularly evident at the level of income from activity without subsidies, which was 3-fold higher in favour of variant B. In this situation, the stabilizers of income in variant A were the subsidies which reduced the prevalence of variant B over variant A to 53.7%. Calculation results indicate the role of additional financial support for special circumstances where the person is often not in a position to counteract. The impact of this support on results illustrates well the amount of subsidies per 1 PLN of income from activity without subsidies; under favourable conditions of production it was PLN 0.91, while under unfavourable – up to PLN 2.73.

Research has shown the extent of the variety of economic performance due to crop a few decitonne lower. Therefore, one should make every effort to minimize the level of these losses. The fact is that sometimes they occur involuntarily, e.g. exceeding the optimum grain harvesting period by a few days increases the yield loss due to shedding of mature grain. However, the analysis of results and variability of yield assumes that it was decided only by factors beyond the control of the farmer. Of course, the range of changes may be different, both on the upside and the downside, with respect to the presented one. Each growing season is different, characterized by a different course of weather and other hazards.

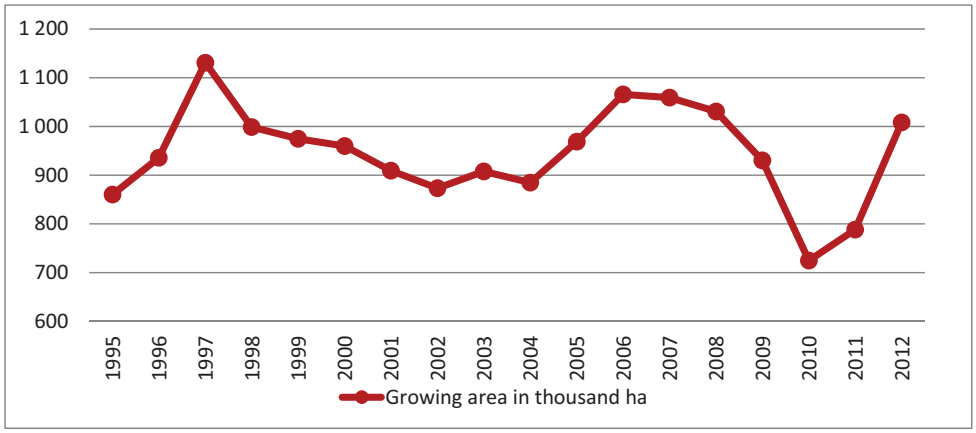
Results are presented to show the strength of changes under specific conditions of production that result from the variability in rye yield in the sample of farms over the past few years. The results should be the prerequisite for farm managers to ensure that all actions depending on the person and stimulating plant yield were carried out with the utmost care. They are after all an investment for future income.

In conclusion, it is estimated that the cultivation of winter rye in 2015 will be a profitable activity, but one must not expect a significant improvement in results. Under average conditions of production, the revenue without subsidies, achieved from 1 ha only slightly (by 5.1%) exceeds the level in the baseline year for projection (2011). However, in terms of yield variant level, the differences are larger. With favourable conditions of production (variant B), one should expect revenue higher by 40.9%, while under adverse conditions (variant A), the revenue may fall by 53.1% compared to the baseline period for the projection.

3. Spring barley

Barley takes on average more than 8% of the global area under cereals. Russia and Canada have been the largest producers of this cereal for many years[69]. However, the largest exporters of barley, in addition to the above, now include Argentina, Australia, the EU and Ukraine[70]. In Poland, over the last 18 years (1995-2012), the total area under barley accounted for 12-15% of the total cereal area, the area planted with spring barley accounted for about 80% of the total area under barley[71]. The data of official statistics show that in 1995-2012, the area of spring barley in Poland underwent great changes – Figure V.3.1.

Figure V.3.1. Spring barley growing area in 1995-2012, total in the country



Source: Own study based on CSO data.

After the dynamic growth of area under spring barley, lasting until 1997 (when it was 1131 thousand hectares), the trend reversed and for a few years, the area under cultivation of this cereal gradually decreased. In 2004 there was another turn and the area began to grow, this change was, however, short-lived. Therefore, from 2006, for the next four years, the area under spring barley decreased, and in 2010 it was the lowest during the period considered (1995-2012), it was 725 thousand hectares. After 2010, the area under spring barley has been growing again.

[69] Z. Jasińska, A. Kotecki, *Szczegółowa uprawa roślin. Tom I*, Agricultural University of Wrocław, Wrocław 2003.

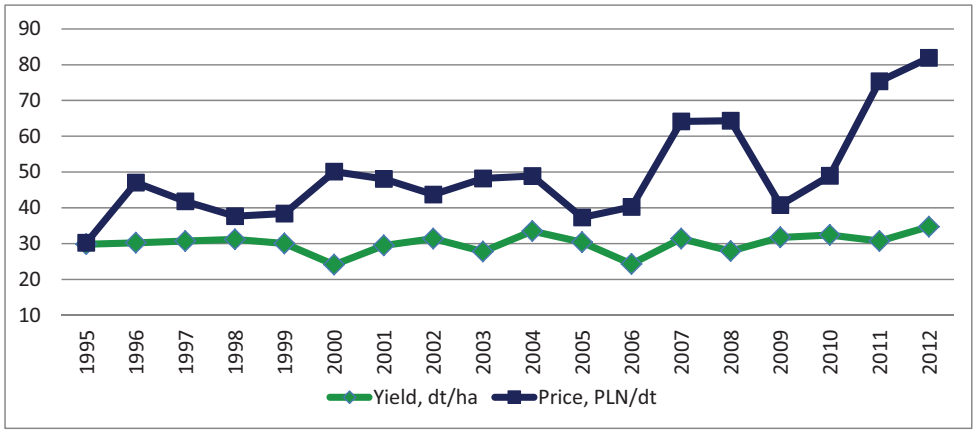
[70] *Światowy Rynek Zbóż, Oleistych i Komponentów Paszowych. Opracowanie sygnalne*, Foreign Agricultural Markets Monitoring Unit, FAMMU/FAPA, Warsaw 2012.

[71] *Rocznik Statystyczny Rolnictwa i Obszarów Wiejskich 2007*, CSO, Warsaw 2007; *Produkcja upraw rolnych i ogrodniczych w 2006 r.*, CSO, Warsaw 2007; *Produkcja upraw rolnych i ogrodniczych w 2010 r.*, CSO, Warsaw 2012; *Produkcja upraw rolnych i ogrodniczych w 2012 r.*, CSO, Warsaw 2013.

As a result, in 2012 it amounted to more than 1008 thousand ha and compared to 2010 increased by 283 thousand ha – Figure V.3.1.

The world's highest yields of barley (60-70 dt/ha) are obtained in Ireland, Belgium, France and Switzerland[72]. In Poland, the yielding of this cereal is much lower. Figure V.3.2 shows the level of spring barley yield and selling price of grain in the country in 1995-2012. The figure reveals that throughout the period under consideration, the yielding of spring barley in general was pretty even. The yield was around 30 dt/ha, but in 2000 and 2006 – when it was relatively the lowest – it was about 24 dt/ha, in 2012, when it was the highest – almost 35 dt/ha.

Figure V.3.2. Yield of spring barley in individual farms and selling price of barley grain in 1995-2012



Source: Own study based on CSO data.

The area of cultivation and yield levels make up the size of the harvest. In Poland, in general, about 80% of the barley harvest is spring grain. The vast majority of grain (about 70%) is used for animal feed, several percent is designated for brewing malt, and few percent for consumption in the form of groats and cereal flakes and for seed[73]. Depending on the quality and intended use of grain, the selling price may vary considerably. The study takes into account the average purchase price of barley grain in Poland, regardless of its use. Figure V.3.2 shows that during the period under consideration (1995-2012) the selling price of barley grain was characterized by greater volatility than yield. For 12 consecutive years (1995-2006) it was in the range of 30-51 PLN/dt, but in 2007-2008 it was more than

[72] Z. Jasińska, A. Kotecki, *Szczegółowa uprawa roślin. Tom I,* Agricultural University of Wrocław, Wrocław 2003.
[73] As above.

64 PLN/dt. In 2009, it declined to about 41 PLN/dt, but over the next three years gradually increased until in 2012 it reached, unprecedented in previous years, the level of 82 PLN/dt – Figure V.3.2.

The high sales price of barley grain in 2012 in the country was mainly due to relatively low grain stocks in the world, and the limited availability of grain. In 2012, global cereal harvest was about 3.7% lower than a year earlier (as opposed to Poland, where the cereal harvest was 6.6% higher). As a result, even with the global consumption of grain lower by 2.0%, it is expected that at the end of season 2012/2013 the stocks in the world will be reduced by 8.4% in relation to the previous season. Decline in grain stocks, and consequently increase in its sales prices was particularly evident in the major cereal exporters. Changes in world prices of barley grain in 2011-2012 are illustrated by the data for German and French grain. For example, in September 2012, the average export price of German barley was 32.2 USD/dt, while in September 2011 – 28.5 USD/dt (increase by 13.0%), and French grain – respectively 31.9 to 28.3 USD/dt in the previous year (increase by 12.7%)[74].

As already mentioned, in Poland, barley cultivation has been carried out on a fairly large area for many years, it is several percent of the area under cereals (in total). This was a prerequisite for including this cereal in research in AGROKOSZTY. The basis for the calculations presented in this section were the source data collected on average in 205 individual farms engaged in this activity in 2007-2011.

The results show that in 2011 (base year of the projection model) both yield and selling price of spring barley in the research sample of farms were high enough to make its cultivation profitable. Income obtained from one hectare from activity without subsidies amounted to 1033 PLN/ha, and with subsidies (complementary area payments + single area payments) increased by 76.4% – to the level of 1822 PLN/ha. Subsidies accounted for 43.3% of income from activity, so they were very important for improving the financial situation of producers. Economic efficiency of spring barley production was also quite high. This is evidenced by the indicator of profitability, i.e the percentage ratio of production to total costs (direct and indirect together). For spring barley this ratio was 159.4% and was 4.1 percentage points higher than that of rye, but by 9.5 percentage points lower in relation to winter wheat.

[74] *Rynek zbóż i oleistych*, Foreign Agricultural Markets Monitoring Unit, FAMMU/FAPA, Wiadomości No. 21, 24 May 2013; *Wyniki produkcji roślinnej w 2012 r.*, CSO, Warsaw 2013; W. Łopaciuk, *Światowy rynek zbóż*, [in:] *Rynek zbóż. Stan i perspektywy,* No. 44, IAFE-NRI, AMA, MARD, Warsaw 2013.

Projection of the results of spring barley cultivation made for average conditions of production indicates that in 2015 barley will remain a profitable activity. It is estimated that the income from one hectare from activity without subsidies will amount to PLN 995 (compared to PLN 1033 in 2011), it will be therefore – as compared to the base year – lower by 3.8%. If, however, in 2015, farmers receive support in the form of subsidies in the amount of 976 PLN/ha, the income from activity is projected to be 1971 PLN/ha, which means that in relation to 2011 it will increase by 8.2%. Thus, the expected higher level of income from the cultivation of spring barley in 2015 is exclusively due to subsidies. This results from the fact that economic efficiency of production will be probably lower, because there will be stronger growth of cost than of the value of production (by 7.7 percentage points). As a result, profitability index, compared to the base year of the projection (2011), will lower by 10.5 percentage points – Tables 3 and V.3.1.

Income from crop production is conditioned by the amount of crops, the selling price of grain and the level of expenses and costs. However, a factor that is largely beyond the activities of the farmer is the yield. Its level depends on the timing of tillage, use of the right kind and the right dose of fertilizer or pesticide, soil quality, but also to a large extent on weather conditions. The latter is not influenced by farmers, and their impact on crop yields may be favourable or unfavourable. The critical factor is the rainfall, although thermal conditions prevailing in the growing season are also of great importance[75].

The results of the study indicate a high variability of yield of spring barley in the research sample of farms. To illustrate the scale of the profitability of its cultivation depending on the level of yield – compared to average conditions of production – projection for 2015 is made in two versions, namely:

- pessimistic (A) – assumes that barley crop is lower,
- optimistic (B) – assumes that barley crop is higher.

It should be noted, however, that results assume invariability (*ceteris paribus*) of other factors affecting the profitability of spring barley.

[75] B. Gąsiorowska, G. Koc, D. Buraczyńska, K. Struk, *Wpływ warunków pogodowych na plonowanie zbóż uprawianych w Rolniczej Stacji Doświadczalnej w Zawadach*, Infrastruktura i ekologia terenów wiejskich. Infrastructure and ecology of rural areas, No. 6, Committee on Technical Rural Infrastructure in PAS, Kraków 2011.

Table V.3.1. Indicators of change in cultivation of 1 ha of spring barley in 2015 under average conditions of production and in terms of variants, as compared to the average conditions for the base year 2011*

Specification	The average production conditions	Variants of yield	
		pessimistic [A]	optimistic [B]
Yield of grain	100.7	80.5	107.3
Grain sales price	108.4		
Total value of production	109.2	87.4	116.4
Total direct costs	**116.0**	**116.0**	**116.0**
Gross margin without subsidies	106.3	75.3	116.5
Total costs	116.9	116.9	116.9
Income from activity without subsidies	**96.2**	**37.7**	**115.5**
Income from activity	**108.2**	**74.9**	**119.1**
Indicator of profitability	93.4	74.8	99.5
Income from activity without subsidies/1dt of grain	95.6	46.8	107.6
Total costs/PLN 1 of income from activity without subsidies	121.5	310.4	101.2
Subsidies for PLN 1 of income from activity without subsidies	128.6	328.7	107.2

* Estimation for 2011, data from the 2007-2011 adjusted by indicators of changes designated on the basis of the trend function, and then averaged.

On the basis of the projection it is estimated that in 2015, both under average and favourable conditions of production (variant B), spring barley yield will be higher, but in the first case by only 0.7%, in the second – by 7.3%. However, under unfavourable conditions of production (variant A), the level will drop by 19.5%. It is estimated that the selling price of grain will increase at a rate of 2.1-2.0% per year and in 2015 it will be about 8.4% higher than in the base year.

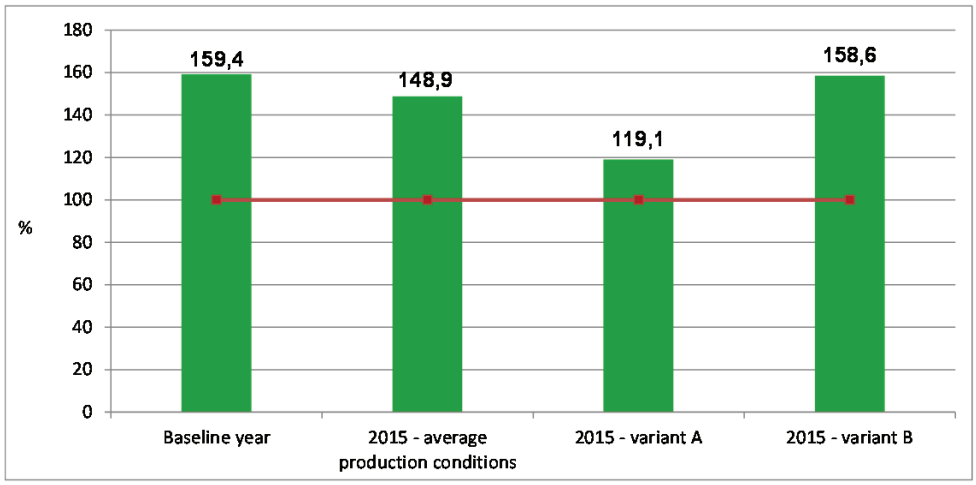
Expected changes in yield and selling price of grain will make that, as compared to 2011, for the target year of the projection (i.e. 2015), the value of production will rise under the average and favourable (variant B) conditions of production, respectively by 9.2 and 16.4%, while under adverse conditions (variant A) – it will be reduced by 12.6%.

It is expected that by 2015 (starting from 2011), the total cost of cultivation of spring barley, with an annual growth rate of 4.1-3.9%, will increase by 16.9% (2035 PLN/ha to 1741 PLN/ha in 2011). Direct costs are an important item in the cost structure, in the projection model adopted for the base year they accounted for almost half (47.4%) of total costs. It is estimated that by 2015 they will increase by 3.6-4.0% per year and will ultimately increase by 16.0% (they will

reach the level of 957 PLN/ha). Of these, the strongest increase will be in total cost of mineral fertilizers (by 19.0%) and seed (by 17.9%).

A fairly strong increase in costs expected in 2015 will contribute to a significant decline in profitability of spring barley. This is most evident in variant A because under unfavourable conditions of production one can expect also a decrease by 12.6% in the value of production. However, under average and favourable conditions of production (variant B) the value of production will be higher, but the dynamics of its growth will be weaker than that of the costs. As a result, in 2015 – compared to 2011 – in the first case, the profitability index will be 10.5 percentage points lower, in the second case 0.8 percentage points lower, and under unfavourable conditions of production it will be lower by as much as 40.3 percentage points. In view of these results, it is estimated that in 2015, even under favourable conditions of production, profitability of spring barley will not be matched to the level achieved in the base year for projection – Figure V.3.3.

Figure V.3.3. Cost-effectiveness of spring barley in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

It follows from the projection that the size of the crop has a very big impact on the amount of income. Calculations show that, while in 2015 spring barley will still be profitable, depending on the conditions of production, the level of economic surplus at farmer's disposal will be significantly different.

Below is the direction of change in the value of production (revenue) and income from spring barley expected in 2015 – in relation to the base year 2011 – per 1 ha of crops[76]:

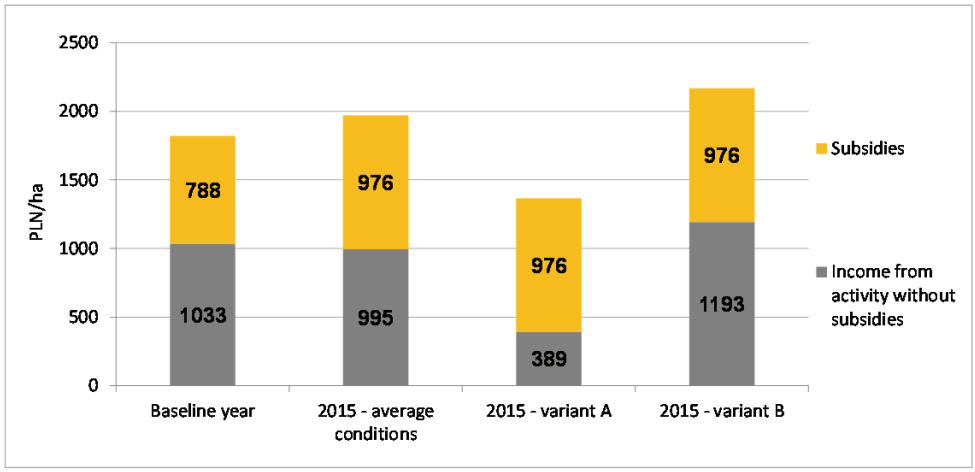
- **under average conditions of production:**
  - increase in yield – by 0.7% (by 0.3 dt/ha),
  - increase in value of production – by 9.2% (by PLN 255),
  - increase in gross margin without subsidies – by 6.3% (by PLN 123),
  - decrease in income from activity without subsidies – by 3.8% (by PLN 38),
- **under unfavourable production conditions (variant A):**
  - decrease in yield – by 19.5% (by 7.7 dt/ha),
  - decrease in value of production – by 12.6% (by PLN 351),
  - decrease in gross margin without subsidies – by 24.7% (by PLN 482),
  - decrease in income from activity without subsidies – by 62.3% (by PLN 644),
- **under favourable production conditions (variant B):**
  - increase in yield – by 7.3% (by 2.9 dt/ha),
  - increase in value of production – by 16.4% (by PLN 453),
  - increase in gross margin without subsidies – by 16.5% (by PLN 321),
  - increase in income from activity without subsidies – by 15.5% (by PLN 160).

The presented data shows that in 2015 an increase in income from activity without subsidies of spring barley may occur only under favourable conditions of production (variant B), it is estimated that the income can be higher by 15.5%. However, under average and unfavourable conditions (variant A), income is likely to decline, by 3.8 and 62.3% respectively. As a result of changes in production and price results, and invariability of production costs, the results of measures of economic performance are significantly different. It is estimated that in variant B, the cost of producing one dt of grain (48.03 PLN/dt) will be about 25.0% lower compared to variant A. One can also expect a 3.1-fold lower costs of producing PLN 1 of income from activity without subsidies. As a result, the level of income per 1 dt of grain can be 2.3-fold higher.

[76] The expected direction of change (increase or decrease) and the strength of this phenomenon is shown as a percentage. Changes are also expressed in quantity and value terms. The numbers should not be construed as absolute values, they are expected to show the scale of change against the change in percentage terms - in the present case, the results of spring barley under average conditions of production and at a lower yield (unfavourable conditions of production) and higher yield (favourable conditions of production).

When assessing the economic performance of production one must bear in mind that from the point of view of the farmer, it is very important what revenue can be obtained from one hectare of cultivation but support in the form of subsidies is also important. According to experts, in 2015 one can expect subsidies of 976 PLN/ha. In this situation, under average and favourable conditions of production, subsidies will account for almost half of the income from 1 ha of spring barley, and under adverse conditions for more than 2/3 of income – Figure V.3.4.

Figure V.3.4. Income from spring barley in baseline year (2011) and projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

It should be noted that only because of the subsidies, the income from activity (i.e. calculated including subsidies) that farmers can obtain under average conditions of production will exceed the level of the base year (by 8.2%). Under unfavourable conditions, even subsidies higher than in the base year (by 23.9%) will not offset the decline in income from production. As a result, income from activity (including subsidies) – as compared to the base year – will fall by 25.1%.

Projection for 2015 of barley crop results

The projection shows that in 2015 barley crop will be profitable. However, income from production (i.e. without subsidies) higher than in the base year (2011) will be achieved only if the yielding of barley is higher. The projection assumes yield increase by 7.3%, it is estimated that it will reach 42.4 dt/ha. However, under unfavourable conditions of production that cause a significant decrease in yield (by 19.5%) and under average conditions (i.e. close to that in 2006-2011), this income is likely to drop.

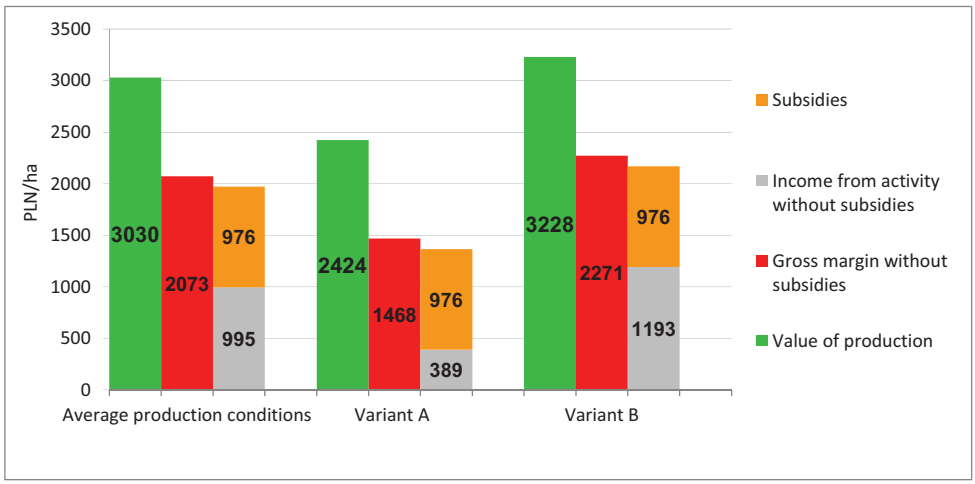
It is estimated that in 2015, under average conditions of production, barley crop will be 39.8 dt/ha, which means it will be higher only by 0.3 dt relative to the base year. The selling price of 1 dt of grain will increase by 8.4% to PLN 75.97 (compared to PLN 70.05 in 2011). As a result, revenue from one hectare is expected to reach PLN 3030, and revenue without subsidies – PLN 995.

However, in Poland, as well as around the world, there is a constantly changing weather situation. Especially in the last decade, there are alternating floods, droughts, periods favourable for plant growth, and days with heavy rain, hail and hurricanes. They can vary in intensity over time and regionally. Weather anomalies that occur often may determine plant crops and, consequently, the income from cultivation. Such events cannot be predicted even from day to day, and even more so for an extended period, it is therefore not possible to accurately determine the economic effects of the various production activities for several years in advance. However, as was done in the studies, one can try to extrapolate into the future the trend observed in recent years.

Below are the differences in the results of spring barley crops that may be expected by comparing results under favourable production conditions (variant B) and adverse conditions (variant A). As a result, per 1 ha of crops:

- yield – was higher by 33.3% (i.e. 10.6 dt),
- value of production – higher by 33.2%,
- gross margin without subsidies – higher by 54.7%,
- income from activities without subsidies – 3.1-fold higher,
- indicator of profitability – higher by 39,5 percentage points.

Figure V.3.5. Projection of the results of spring barley cultivation in 2015 under average and pessimistic (variant A) and optimistic (variant B) conditions of production



Calculations show the scale of variation of economic performance of spring barley depending on the yield. In the case of poor yields (variant A), revenues will cover costs, but income at the disposal of the farmer is low, only 389 PLN/ha. It will probably not even cover own labour. In this situation, subsidies will provide support and stabilization of differences in income levels – Figure v.3.5.

Increase in revenue is one of the objectives of the Common Agricultural Policy, it determines the achievement of competitive advantage as a precondition for the existence of farms in the future. With the support of subsidies, the advantage of variant B over A in terms of income (calculated including subsidies), decreased 1.6-fold.

The results of projection show in 2015 barley crop will be profitable. However, only under favourable conditions of production (variant B) income from activity without subsidies will exceed the level of the base year – by 15.5%. However, the economic efficiency of production – due to stronger growth of costs than the value of production – will deteriorate by about 1 percentage point. However, under unfavourable conditions of production (variant A) and average conditions, one can expect that income without subsidies will respectively 37.7 and 96.2% of its level in the base year of the projection. In this situation, the profitability of barley production will also fall, in variant A – by 40.3 percentage points, and under average conditions – by 10.5 percentage points.

4. Winter oilseed rape

Growing demand for food and renewable energy stimulates growing production of oilseeds, including oilseed rape. Oilseed rape production has shown a strong upward trend for the last 20 years. The world harvest has increased twofold in this period. This was due to an increase of the sown area by 50% and increase of yield by 36%[77].

The major producers of oilseed rape are China, Canada, India and the EU-27, with the largest acreage in China, and the highest yields and harvest in the EU-27. Unchallenged leaders in this regard are Germany and France, in 2007-2012 their total share in the EU-27 harvest was over 50%. The next position is occupied by the United Kingdom. Production of oilseed rape in Poland in 2007-2012 stood at 2 million tonnes per year or 11% of the harvest throughout the Union and ranked Poland in 4th place. It is worth noting that Poland is also one of the largest producers of rapeseed oils and rapeseed meal in the EU[78].

The growing importance of oilseed rape has been observed in Poland since 2003. It is connected with the accession in 2004 to the European Union and Polish policy on biofuels. In 2003-2010, the share of oilseed rape in the total sown area in the country increased from 3.9% to 9.1%. In the next two years, however, it decreased to 6.9%[79]. About 95% of the land under oilseed rape in Poland is winter oilseed rape, which gives higher and more stable yields.

Figure V.4.1. shows the changes in the area of winter oilseed rape in the past 18 years. The growth that occurred between 2003 and 2010 is very clear. During this period, the area under oilseed rape in Poland increased 2.7-fold, to 918 thousand hectares. However, in the next two years (2011-2012), there was a decline to 635 thousand hectares. The reason for this situation was mainly freezing of many plantations. Under climatic conditions in Poland, winter oilseed rape is burdened with a relatively high risk of freezing[80]. It is estimated that in 2012, as a result of poor wintering of crops, more than 30% of plantations were ploughed. Only a portion of this area has been sown with spring varieties, which resulted in a reduction in the total area under oilseed rape in Poland.

---

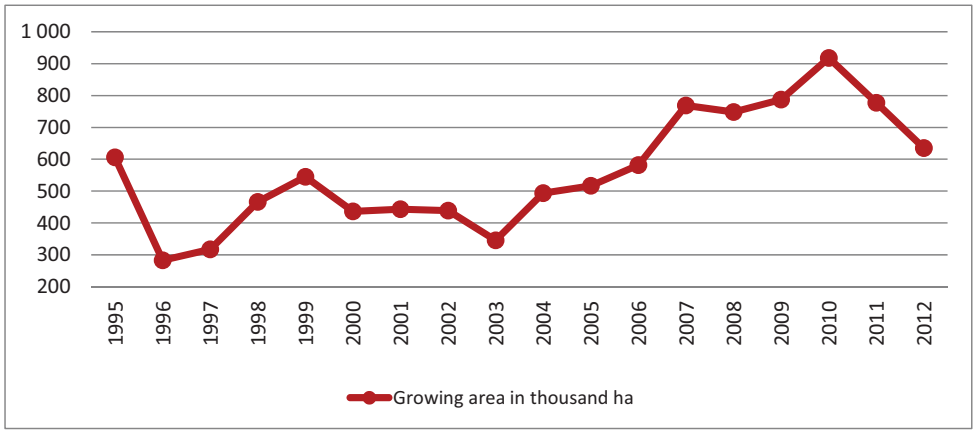
[77] E. Rosiak, *Dobre perspektywy dla rzepaku*, [in:] *Rzepak nowe wyzwania, wydanie 5*, Biznes-Press sp. z o.o., Warsaw 2012.

[78] *Rynek rzepaku, Stan i perspektywy*, No. 43, IAFE-NRI, AMA, MARD, Warsaw 2013.

[79] *Użytkowanie gruntów, powierzchnia zasiewów i pogłowie zwierząt gospodarskich w 2012 r.*, CSO, Warsaw 2012.

[80] W. Budzyński, *Efektywność wybranych czynników produkcji nasion rzepaku ozimego*, [in:] *Rzepak biopaliwa. Wydanie 2*, Biznes-Press sp. z o.o., Warsaw 2006.

Figure V.4.1. Winter oilseed rape growing area in 1995-2012, total in the country



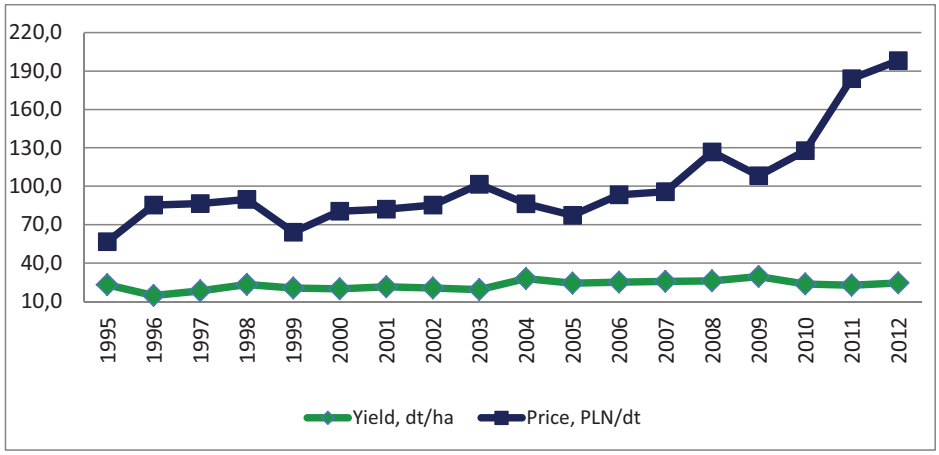
Source: Own study based on CSO data.

Despite the decline in the growing area in 2011-2012, oilseed rape is often cultivated in Poland. The reason is high demand and high price of seeds maintained for several years. However, the production potential of winter oilseed rape is limited by various natural factors, such as soil quality and weather conditions. With this in mind, it is considered that the surface of oilseed rape in Poland can reach at most 1 million ha[81].

Winter oilseed rape is a demanding plant, both in terms of soil and climate. Unfortunately, the climate in Poland is much less conducive to oilseed rape than in Western Europe. Lower annual temperatures, shorter growing season and less rainfall restrict the yield of the plant[82]. Figure V.4.2 presents the formation of winter oilseed rape yield in 1995-2012. The highest yield during this period was recorded in 2009 – 29.5 dt/ha, and the lowest in 1996 – 14.7 dt/ha. However, in 2012, it amounted to 24.5 dt/ha, in comparison, Denmark and Germany recorded yields above 35 dt/ha. In recent years, higher yielding of oilseed rape could also be observed in France, the UK or the Czech Republic. Such large differences between Poland and some Western European countries is difficult to explain only by worse agro-meteorological conditions. It is assumed that, as in the case of wheat, this is influenced by worse quality of soil, irregularities in crop agro-technique and a relatively low level of fertilizer and plant protection.

[81] J. Kuś, *Produkcja biomasy na cele energetyczne*, Biuletyn informacyjny No 7, PAS, Lublin 2002.
[82] Z. Jasińska, A. Kotecki (ed.), *Szczegółowa uprawa roślin, tom II*, Agricultural University of Wrocław, Wrocław 2006.

Figure V.4.2. Winter oilseed rape crop in individual farms and the sale price of seed in 1995-2012



Source: Own study based on CSO data.

In addition to yield, Figure V.4.2. also presents the selling price of oilseed rape in 1995-2012. Since 2010, there is a strong increase in its prices in Poland. In 2012, rape seeds cost on average 198.11 PLN/dt, which is about 55% higher than two years earlier. This situation is closely linked to the conditions prevailing in world markets. Oilseed crops in the past few years has been low. At the same time, the demand for vegetable oils and rapeseed and soybean meal does not decrease. Price of oilseed rape in the world market stood at 400-500 EUR/tonne, and reached a record of 525 EUR/t (MATIF) in July 2012.

The projection for 2015 was based on data collected in 2006-2011, on average in 135 individual farms with this activity. Farms participating in the study were selected in a targeted manner from among farms with agricultural accounting in the Polish FADN, and the study was conducted according to the methodology of the AGROKOSZTY system.

Research has shown that winter oilseed rape in recent years has been a very profitable crop. In the base year for the projection (2011), the average gross margin without subsidies under average conditions of production amounted to PLN 3991, and income from activity without subsidies amounted to PLN 2412 per 1 ha of crop. After taking into account the support mechanisms of the CAP, income from activity, i.e. including subsidies, amounted to 3177 PLN/ha. Subsidies accounted for 24.1% of the income, which was relatively high. Results of winter oilseed rape against other studied activities of crop production are very favourable. Its cultivation has provided the highest level of income without subsidies, but also was characterized by the highest economic efficiency. Cost-

effectiveness ratio was 174.2%, while in the case of winter wheat it was lower by 5.3 percentage points, for spring barley by 14.8 percentage points, and for rye by 18.9 percentage points.

According to projections, in 2015 the income situation of winter oilseed rape may be more favourable than in recent years. Under average conditions of production, one can expect a gross margin without subsidies higher by 13.1% and revenue without subsidies – by 9.8%. The improved results will be due to revenues higher by 13.8%, mainly due to the expected increase in the price of seed (by 13.1%), because the yield will stay close to the base year of projection (projected increase only by 0.6%). The role of subsidies in the generation of income is likely to be greater, as a result the income from activity (i.e. including subsidies) could increase by 14.1%. However, despite the favourable conditions for the changes, one should expect deterioration in the economic efficiency of the production of winter oilseed rape. Cost-effectiveness ratio could be lowered by 4.4 percentage points – Table 4 and V.4.1.

Agricultural production, however, is fraught with high risk, which primarily results from the high degree of uncertainty in terms of production results. They depend heavily on natural conditions. It should be noted that fluctuations in agricultural output are higher in comparison with other productive branches. This is a consequence of the nature of agricultural production, which takes place in natural conditions, and its object is a living organism. The weather conditions are of basic importance from among many factors affecting the yield of crops, including oilseed rape. Growth and development of plants depends on both the thermal and hydrological conditions in the growing season[83].

Therefore, in order to determine the extent of variability of production and economic results of winter oilseed rape, depending on the level of yield, the projection for 2015 is made in two versions:

- pessimistic (A) – or in adverse conditions of production, which, compared to the base year, will decrease yield,
- optimistic (B) – or exceptionally favourable conditions of production, which will stimulate the growth of yield.

Table V.4.1 shows the dynamics of the expected changes in income from oilseed rape and selected items of costs and revenues, in 2015, under average

[83] B. Gąsiorowska, G. Koc, D. Buraczyńska, K. Struk, Wpływ warunków pogodowych na plonowanie zbóż uprawianych w Rolniczej Stacji Doświadczalnej w Zawadach, Infrastruktura i ekologia terenów wiejskich, No. 6/2011, Polish Academy of Sciences, Division in Kraków, 2011.

conditions of production and in terms of variants, compared to the input data, which is the average of 2006-2011.

Table V.4.1. Dynamics of indicators of change in cultivation of 1 ha of winter oilseed rape in 2015 under average conditions of production and in terms of variants, as compared to the average for the base year 2011*

Specification	The average production conditions	Variants of yield	
		pessimistic [A]	optimistic [B]
Yield of seed	100.6	85.2	124.2
Seed sales price	113.1		
Total value of production	113.8	96.3	140.5
Total direct costs	**115.4**	**115.4**	**115.4**
Gross margin without subsidies	113.1	88.3	150.9
Total costs	116.7	116.7	116.7
Income from activity without subsidies	**109.8**	**68.8**	**172.4**
Income from activity	**114.1**	**83.0**	**161.6**
Indicator of profitability	97.5	82.5	120.3
Income from activity without subsidies/1dt of seed	109.1	80.8	138.8
Total costs/PLN 1 of income from activity without subsidies	106.3	169.7	67.7
Subsidies for PLN 1 of income from activity without subsidies	116.2	185.4	74.0

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

The projection based on time series estimates that in 2015 under the unfavourable conditions of production (variant A), the yield of winter oilseed rape – as compared to the base year – will fall by 14.8%. Under average conditions it should be maintained at a level close to the base year, while under favourable conditions (variant B) it will increase by 24.2%. Furthermore, the price of rape seed, with an annual growth rate around 3%, could be higher by 13.1% in 2015. As a result, in 2015, in comparison with 2011 (the base for the projection), income from the cultivation of oilseed rape under average and favourable conditions will increase respectively by 13.8 and 40.5%. Under adverse conditions it may be lower by 3.7%.

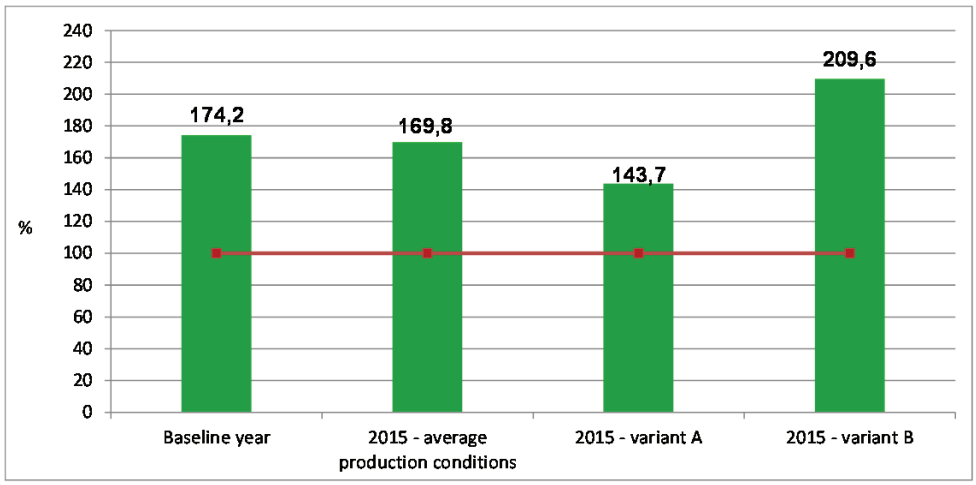
In 2015, it is expected that production costs will also increase. The dynamics of changes of selected cost components over the years is shown in Table IV.2. As a result of changes in the prices of means of production, total direct costs may be higher by 15.4% (including rape seed – by 24.8%), and total cost of cultivation of oilseed rape by 16.7% – Table V.4.1.

The expected increase in costs will contribute to a reduction in the profitability of production. This is particularly evident in variant A, i.e. when the yield of oilseed rape (as well as the value of production) falls below the base year level. Then, the income from activity without subsidies will fall by 31.2% and the ratio of production profitability (value of production to total costs) by 30.5 percentage points.

Under average conditions of production, the economic efficiency of oilseed rape production will be also lower, the profitability index will fall by 4.4 percentage points. But revenue without subsidies that farmers will have at their disposal will increase by 9.8% (236 PLN/ha). In this situation, decrease of profitability means that this income was generated in a very costly manner. Evidence of this is stronger growth rate of cost than value of production (by 2.9 percentage points).

Improved performance, taking into account both the level of income and profitability in ratio terms, can be expected only if the oilseed rape crop is higher than in the base year. The projection assumes its rise by 24.2% (38.4 dt/ha to 30.9 dt/ha in 2011). Assuming, of course, the immutability of other factors affecting the profitability of production. Under extremely favourable conditions, farmers can expect income from activity without subsidies higher by as much as 72.4% (i.e. about 1747 PLN/ha). Economic efficiency of production will also improve, the profitability index will reach 209.6%, which is higher than in the base year by 35.4 percentage points – Figure V.4.3.

Figure V.4.3. Cost-effectiveness of winter oilseed rape in baseline year (2011) and projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

Below is the direction of change in the level of production (revenue) and income from winter oilseed rape crop expected in 2015 – in relation to the base year 2011 – per 1 ha of crops[84]:

- **under average conditions of production:**
  - increase in yield – by 0.6% (by 0.2 dt/ha),
  - increase in value of production – by 13.8% (by PLN 780),
  - increase in gross margin without subsidies – by 13.1% (by PLN 522),
  - increase in income from activity without subsidies – by 9.8% (by PLN 236),
- **under unfavourable production conditions (variant A):**
  - decrease in yield – by 14.8% (by 4.6 dt/ha),
  - decrease in value of production – by 3.7% (by PLN 208),
  - decrease in gross margin without subsidies – by 11.7% (by PLN 467),
  - decrease in income from activity without subsidies – by 31.2% (by PLN 752),
- **under favourable production conditions (variant B):**
  - increase in yield – by 24.2% (by 7.5 dt/ha),
  - increase in value of production – by 40.5% (by PLN 2291),
  - increase in gross margin without subsidies – by 50.9% (by PLN 2033),
  - increase in income from activity without subsidies – by 72.4% (by PLN 1747).

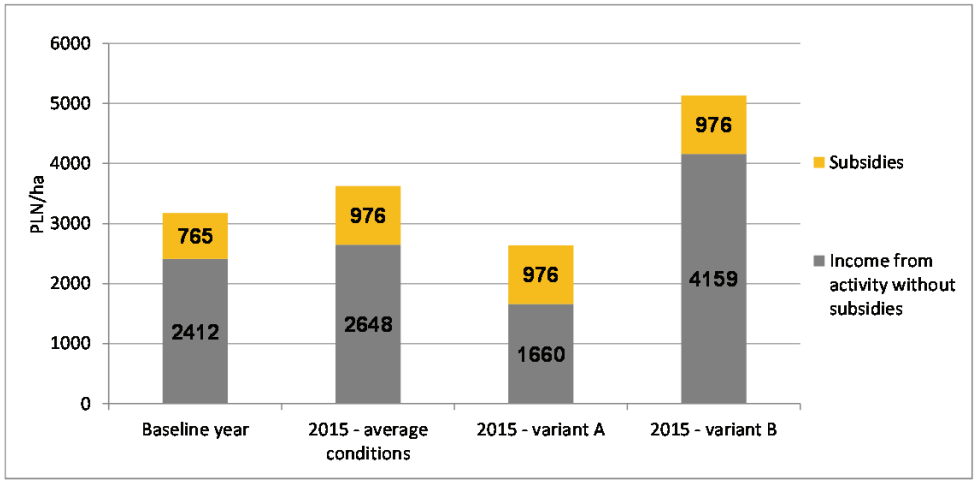
Projection results show a diversity of results that may occur due to the volatility of the yield of oilseed rape. Bearing in mind that some human activities may prevent a reduction in yield, for practitioners it is an indication to make every effort to minimize potential losses. Sometimes one does not pay attention to certain decisions and moves (e.g. optimal harvest date), which consequently adversely affect the level of income from production.

To some extent, these differences are offset by subsidies, but the spread of results will still be large. In the analysed case of winter oilseed rape, in variant A subsidies accounted for 58.8% of revenue without subsidies, that is derived from production, and in variant B – 23.5%. At the same level of subsidies, these results

[84] The expected direction of change (increase or decrease) and the strength of this phenomenon is shown as a percentage. Changes are also expressed in quantity and value terms. The numbers should not be construed as absolute values, they are expected to show the scale of change against the change in percentage terms in the present case, the results of winter oilseed rape under average conditions of production and at a lower yield (unfavourable conditions of production) and higher yield (favourable conditions of production).

indicate variation in income situation of oilseed rape producers. They also point to the importance of subsidies in the stabilization of income – Figure V.4.4.

Figure V.4.4. Income from winter oilseed rape in the baseline year (2011) and the projection for 2015 under average conditions of production and in terms of variants of yield level*



* Variant: A – lower yield (unfavourable conditions), B – higher yield (favourable conditions).

Projection for 2015 of winter oilseed rape crop results

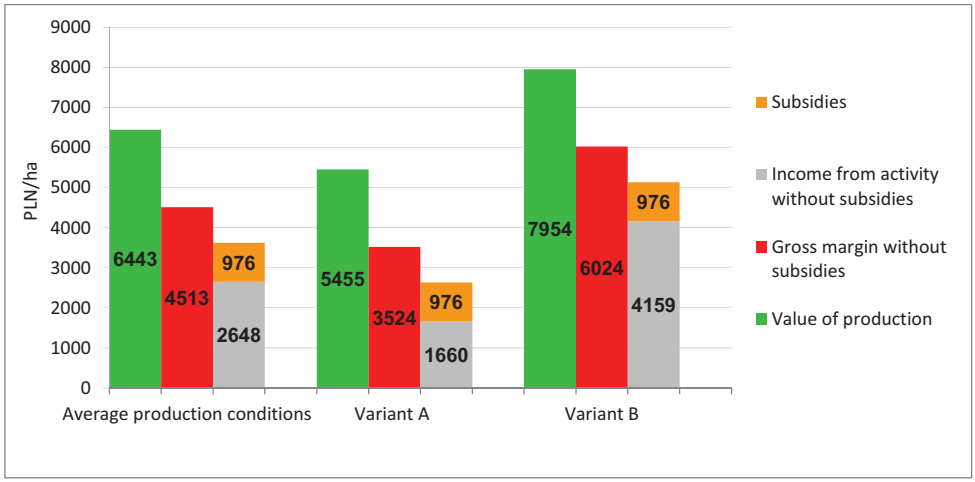
Projection results indicate that farmers growing oilseed rape in 2015 will obtain income under favourable, average and unfavourable conditions of production. Projected yield under average conditions will amount to 31.1 dt/ha, an increase of 0.2 dt in relation to 2011, the base for projection. It follows that the increase in value of production by 13.8% is mainly due to the increase in the price of rapeseed (by 13.1%). It is expected that direct costs of cultivation will increase by 15.4%, and total indirect costs by 18.1%. This will translate into an increase in the total cost of cultivation of 1 ha of oilseed rape by 16.7%, i.e. about PLN 544. As a result of these changes, the expected revenue without subsidies in 2015 will amount to 2648 PLN/ha, an increase by 9.8% compared to the base year.

In comparison to the presented results, those obtained under extreme conditions of production, namely at the yield higher and lower than under average conditions, are characterized by significant differences. Here are the differences when comparing the results for 2015 in variant B and variant A. Per 1 ha of oilseed rape:

- crop – was higher by 46.0%,
- value of production – higher by 45.8%,
- gross margin without subsidies – higher by 70.9%,
- income from activities without subsidies – 2.5-fold higher,
- indicator of profitability – higher by 65.9 percentage points.

Projection results for 2015 show that the impact of conditions of production on the economic performance of oilseed rape is significant. The projection assumed the same level of seed sale prices and cost of production for both variants, so the diversity of profitability is influenced only by the level of yield, and this varies depending on whether the economic conditions are favourable or not. A yield higher by 12.1 dt in the optimistic variant (B) – as compared to the pessimistic variant (A), results in increase of profitability by as much as 65.9 percentage points.

Figure V.4.5. Projection of the results of winter oilseed rape cultivation in 2015 under average and pessimistic (variant A) and optimistic (variant B) conditions of production



The differences are even more striking if one compares the level of income from activity without subsidies. At high yields (variant B), the revenue may be as much as 2.5 times higher than for low yields (variant A). The difference to some extent is offset by the subsidies, taking into account the income from activity, i.e. together with subsidies, the advantage of variant B over A is reduced to 1.9-fold – Figure V.4.5.

Worse production results stimulate the growth of cost-effectiveness of production. It is estimated that in 2015, under adverse conditions, the cost of producing 1 dt of grain may reach PLN 144.16, i.e. 45.8% (PLN 45.30) more than under conditions conducive to the cultivation of oilseed rape. It should be noted that in both projected variants, the cost will be significantly lower than the selling price of seeds, which is expected to reach 207.20 PLN/dt.

The overall conclusion is that production of oilseed rape in recent years allowed to obtain very good economic results. It is expected that by 2015, these

results should slightly improve, assuming average meteorological conditions, i.e. the same as in recent years. According to the projection, even with poorer conditions of production (e.g. floods, drought) and, consequently, a decrease of yield, winter oilseed rape still has a chance to be a profitable activity. This situation will be influenced by a further increase in the prices of oilseed rape expected by 2015, which are already high, and put this plant in a favourable price relationship relative to wheat. The study showed that under average, pessimistic and optimistic conditions of production, income from activity without subsidies is likely to be higher as compared to the studied cereals, i.e. winter wheat, winter rye and winter barley. Profitability of oilseed rape production in ratio terms will also be higher. The exception would be only wheat in a pessimistic scenario; the expected profitability is higher by about two percentage points.

The main factor contributing to the favourable economic performance of oilseed rape, which is expected in 2015, is the price of seed. This is due to the ever-growing market for biofuels. According to research by Borychowski[85], the increase in agricultural raw materials prices is correlated with an increase in the production of bioethanol, which is confirmed by the strong correlation of world production of bioethanol and prices of wheat (0.90), maize (0.81) and sugarcane in Brazil (0.92), and between production of biodiesel and the price of oilseed rape in the EU (0.80). The positive relationship between the production of bio-components and the world prices of agricultural raw materials shows the impact of the biofuels market on prices of these raw materials. Therefore, determining the upper limit of the share of biofuels[86] produced from raw materials in transport can contribute to the decline in prices of plant products (e.g. rapeseed) used as raw material for the production of bio-components.

The decision of the European Commission on the directive on renewable energies can also have impact on the price level, and thus the profitability of oilseed crops. In October 2012, the European Commission presented a proposal to move away from first generation biofuels, i.e. derived from agricultural raw materials, in favour of second-generation biofuels, i.e. produced from waste and agricultural residues that do not directly compete with food production.

[85] M. Borychowski, *Produkcja i zużycie biopaliw płynnych w Polsce i na świecie – szanse, zagrożenia, kontrowersje*, Roczniki Ekonomiczne KPSW No. 5, Bydgoszcz 2012.
[86] The share of renewable energy in transport, i.e. the percentage share of biofuels and other renewable fuels in the total volume of liquid fuels and liquid biofuels.

The provisions of Directive 2009/28/EC introduce the target of 10% share of renewable energy in transport by 2020. The plan to limit the use of first-generation biofuels to 5% met with objections from several Member States, including Poland[87]. According to organizations of rapeseed and biofuels producers, the European Commission's decision could result in a significant reduction in the area under oilseed rape in Poland. It should be added that in Poland in 2012, the share of bio-components in fuels used in transport amounted to 5.79%, i.e. already exceeded the target limit of 5%.

As regards the use of bio-components from food raw materials, which are currently the only widely used type of bio-components, there is a broad discussion in the European Commission. Moreover, the proposed solutions raise a number of objections from the European Union Member States. It can be assumed that the adopted share of bio-components made from food raw material will be a compromise, which, according to current evidence, may be in the range of 5-8%[88].

It is very difficult to predict how the expected regulations may affect the price of rapeseed in the next few years. In the absence of sufficiently strong evidence, projection of oilseed rape was left at the level that resulted from the assumptions of the projection.

---

[87] *UE: Spory wokół propozycji ograniczenia udziału biopaliw I generacji*, http://www.raportrolny.pl/index.php?option=com_k2&view=item&id=950:ue-spory-wok%C3%B3%C5%82-propozycji-ograniczenia-udzia%C5%82u-biopaliw-i-generacji&Itemid=464 [access: July 2013].

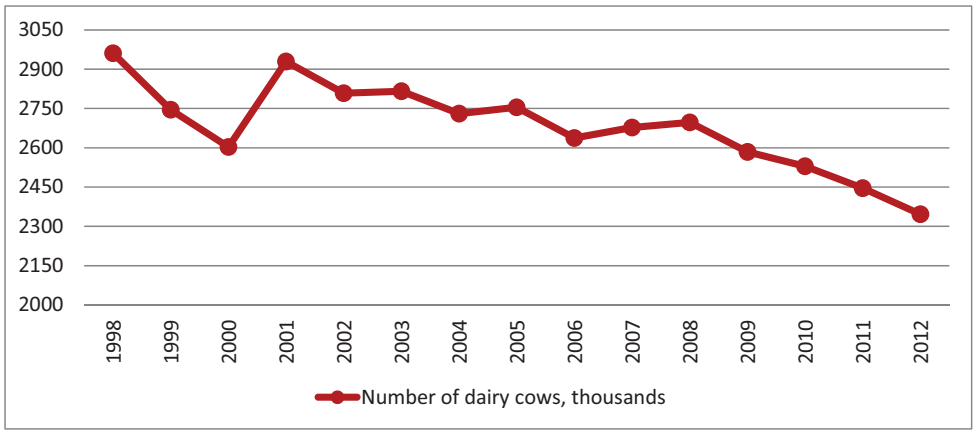
[88] *Projekt rozporządzenia Rady Ministrów w sprawie Narodowych Celów Wskaźnikowych na lata 2013-2018*, http://bip.mg.gov.pl/files/upload/18831/Rozporzadzenie%20NCW_RM.pdf [access: July 2013].

5. Milk

Animal production predominates agricultural commodity production in Poland; its share in 2004-2011 was 53,4-62,6%. Dairy cattle and milk production were 29.1-33.5% of commodity animal production[89]. This demonstrates the great importance of milk production for Polish agriculture as a sector of the national economy. It should be noted that Poland produces about 9% of the European production of milk, it is the fourth country after Germany, France and the UK in terms of production[90].

Public statistics show that population of dairy cows in Poland has been declining for several years. In 2001, the number of dairy cows was slightly more than 2900 thousand, while in 2012 it was 2346 thousand – Figure V.5.1.

Figure V.5.1. Number of dairy cows in 1998-2012, the total in the country



Source: Own study based on CSO data.

In recent years – in some farms – there has been a decline in the profitability of milk production, the result was reduced number of cows and reduced number of milk producers, particularly the smallest, i.e. with up to nine dairy cows. In 2010 – as compared to 2009 – the number of households with no more than nine dairy cows has decreased by as much as one third. In the same period the number of agricultural holdings keeping large herds of cattle, i.e. 30-99 heads, increased by approximately 3%. The number of the largest holdings, with more than 200 cows, also increased (56.0%), it was mainly due to increase in cow population in farms with 100-199 cows. A further concentra-

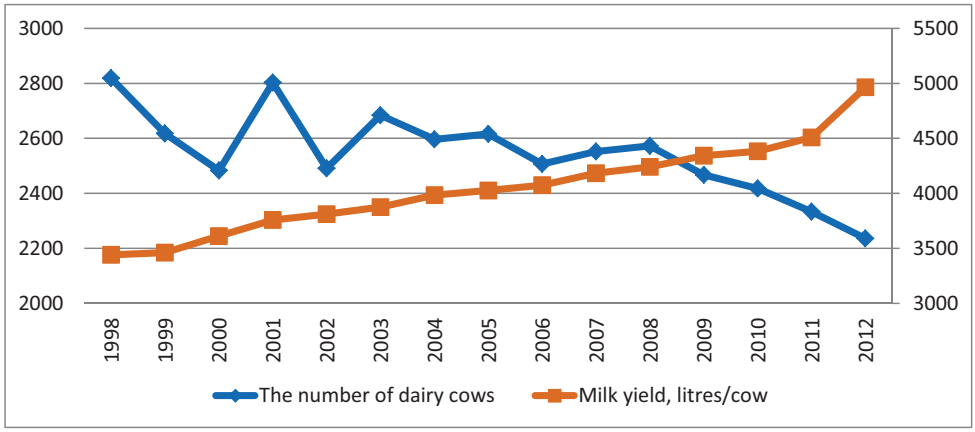
[89] *Rocznik Statystyczny RP 2004 r.*, CSO, Warsaw 2005; *Rocznik Statystyczny RP 2007 r.*, CSO, Warsaw 2008; *Rocznik Statystyczny RP 2011 r.*, CSO, Warsaw 2012.
[90] O. Olkowska, *Sytuacja na rynku mleka w Polsce w 2010 r.*, Polish Federation of Cattle Breeders and Dairy Farmers, 2011.

tion of breeding dairy cows is evidenced by the increase in their number on one farm, from 3.3 heads in 2002 to 5.9 heads in 2010[91]. However, fragmented production is still a major problem in the dairy industry in Poland. In 2010, an average supplier of milk to dairies had only 10 cows and delivered 53 thousand kg of milk to dairies[92].

Nonetheless, there have been positive changes, such as an increase in marketability of milk production. In 2009-2010, 80% of produced milk was allocated for sale, of which 73% was delivered to dairies. Before Polish accession to the EU, the dairy industry was buying only 60% of produced milk[93].

Along with the growing concentration of milk production and decreasing number of dairy cows, another trend is becoming visible, namely – a steady increase in milk yield of cows – Figure V.5.2.

Figure V.5.2. Number of dairy cows and milk production in 1998-2012 in individual farms



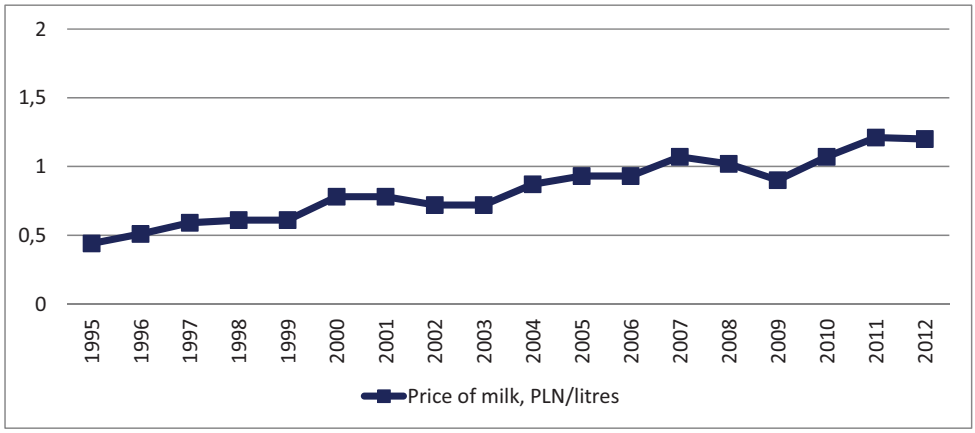
Source: Own study based on CSO data.

In 1998-2012, the population of dairy cows in individual farms in Poland decreased by 20.7% (from 2818.4 to 2235.8 thousand heads). At the same time, there was an increase in milk production by 44.2% (from 3443 to 4964 litres per cow)[94]. Despite the significant increase in performance, it is still more than 20% lower than the average milk yield of cows achieved in the EU-27 and approximately 30% lower than in the EU-15[95].

[91] *Rocznik Statystyczny RP 2011r.*, CSO, Warsaw 2012.
[92] J. Seremak-Bulge, *Rynek mleka na progu 2011 r.*, Przemysł Spożywczy, No. 3, 2011.
[93] As above.
[94] *Rolnictwo 2006*, CSO, Warsaw 2007; *Rocznik Statystyczny Rolnictwa 2012*, CSO, Warsaw 2012.
[95] O. Olkowska, *Raport: Rynek mleka – czerwiec 2011*, Polish Federation of Cattle Breeders and Dairy Farmers, 2011.

Figure V.5.3 shows the changes in the price of milk in 1995-2012. Throughout the period, there is a clear upward trend, with slight declines in prices in 2001-2003, i.e. before the Polish accession to the European Union, and in 2008-2009.

Figure V.5.3. Sale price of milk in 1995-2012



Source: Own study based on CSO data.

Large fluctuations in the price of milk in 2008-2009 were to a great extent the result of the global economic crisis. Domestic purchase prices of milk began to stabilise only in the first half of 2010. Since the second half of 2010, milk prices grew steadily, and in December of the same year the price for one litre was PLN 1.18, i.e. 12.9% more than in the same period of 2009[96]. Good situation on the dairy market meant that in 2012 milk prices remained relatively high. According to CSO data, the average purchase price of milk in 2012 was 1.20 PLN/l and was 1.2% lower than the price of milk in 2011 (PLN 1.21). The purchase prices of milk remained high also in early 2013. In February, the purchase price of milk was on average 1.23 PLN/l. This was 2.5% less than in the same period of 2012, but 6.0% more than in February 2011[97].

This section presents the economic results of milk production estimated for 2011 and projected results for 2015. Calculations for 2011 can be described as an estimate, because they reflect the results of 2006-2011, which were adjusted with rates change designated on the basis of the trend function, and then averaged. The aim of this approach was to create a starting point for building the model of projection for 2015. Therefore, comparison of results for 2011

[96] As above.
[97] *Biuletyn Informacyjny ARR*, No. 1/2013, AMA, Warsaw 2013.

should be considered as a comparison to the base year (i.e. the starting point) for the prepared projection.

Research shows that on average in 163 farms with dairy cows in 2006-2011 milk production was profitable. In 2011 – adopted as the base for the projection model – the average number of cows on farms was 21.5 heads, their milk yield was 5815 litres and the selling price of milk – 1.21 PLN/litre. In these conditions of production and price, the gross margin without subsidies realized per one cow was PLN 5317, and income – PLN 2958. However, after taking into account subsidies – PLN 496 (payment for animals, complementary area payments and single area payments attributable to the forage area for one cow) income amounted to PLN 3454. This means that for each PLN 1 of the income from activity without subsidies, farmers received support in the amount of PLN 0.17. The share of subsidies in the income was 14.4%. Milk production was also cost-effective. The measure was the rate of profitability (the ratio of the value of production to total cost), which was 160.9% – Table 5.

To illustrate the differences in the profitability of milk production and changes in milk yield of cows, farms in the survey sample were classified according to their numbers in the farm. Number of cows was the criterion for grouping farms by quartiles, but to show the scale of variation, the results are presented only for the two boundary quartiles, i.e.:

- first quartile, or 25% of farms with lower number of cows – milk production on a small scale (C),
- fourth quartile, or 25% of farms with upper number of cows – milk production on a big scale (D).

Comparative analysis of production and economic performance shows a clear advantage of large scale farms (D). Compared to the small scale (C), in the base year there was a higher milk yield and milk price – respectively 56.2 and 22.1%. To show the diversity, taking into account selected items in the results, per one dairy cow, there was (Table 5):

- value of production – higher by 71.6% (by PLN 3663),
- direct costs – higher by 19.4% (by PLN 435),
- total costs – higher by 33.6% (by PLN 1325),
- gross margin – higher by 112.2% (by PLN 3229),
- income from activity without subsidies – higher by 199.5% (by PLN 2338),
- indicator of profitability – higher by 36,9 percentage points.

Presented calculations show that farms with large herds of cows (average of 44.1 heads), as compared to individuals with low number of cows (average of 5.9 heads) – despite the higher cost of keeping animals – obtained much better economic results. Economic surplus at the disposal of the farmer was higher; also economic efficiency of production was higher.

Results describing the income situation of milk production in the base year (2011) were used to construct the projection (based on time series) of production and economic results in 2015. Predicting future events is legitimate. When taking certain management decisions, farmers should be prepared for various contingencies, both good and less favourable, and having specific knowledge will help remedy some of the events and, consequently, reduce losses.

Calculations included in Table V.5.1 show the dynamics of the expected changes in production and selected items of costs and revenues in 2015, as compared to the base year for the projection model (2011), on average in studied set of farms and in groups that differ in the number of cows. The projection anticipates that in 2015 there will be an increase in milk yield of cows by 4.9% and the selling price of milk will rise by 14.4%. The trend function covering several years shows that milk yield is increasing at an annual rate of 1.3-1.1% and milk price at a rate of 3.6-3.3%.

At this rate change, in 2015, on average in the studied set of farms – value of production calculated for one dairy cow – will be higher by 19.6% (annual growth in the range 4.3-4.9%). Analysing the dynamics and direction of changes in years in the various cost components, it is estimated that in 2015 – as compared to 2011 – the direct costs of keeping one cow can be increased by 13.1%. Particularly strong growth is expected for the cost of own feed from non-commodity products and purchased feed (from outside the farm), respectively by 15.1 and 14.9%. The decisive factor is the expected increase in prices, in the first case, mainly of fertilizers, and in the second – of various types of feed.

The actual indirect costs, including diesel fuel, electricity, repairs, agricultural services, play an important role in the structure of indirect costs. It is expected that the actual indirect costs associated with keeping one dairy cow in 2015, as compared to the base year for the projection model (i.e. 2011) will increase by 14.8%. Total costs, i.e. direct and indirect jointly, will be higher by 14.0% (Table V.5.1). It is estimated that on average their growth will not exceed 3.5% per annum. It should be noted that groups of farms that differ in the number of cows, the growth in total costs was different due to the different cost structures.

Table V.5.1. Indicators of changes in milk production results – per one dairy cow – in 2015, compared to the base year 2011* on average in the research sample, and depending on the scale of production

Specification	On average in the study sample	Depending on the scale of production**	
		Small [C]	Large [D]
Milk yield of cows	104.9		
Selling price of milk	114.4		
Total value of production	119.6	119.3	119.7
of which: milk	120.0	120.0	120.0
Total direct costs	**113.1**	**112.7**	**113.2**
of which: feed from outside the farm	**114.9**	**114.1**	**114.8**
own commodity feed	**110.4**	**111.3**	**109.9**
own non-commodity feed	**115.1**	**115.0**	**115.1**
Gross margin without subsidies	122.7	124.5	122.5
Total costs	114.0	113.7	114.1
Income from activity without subsidies	**128.9**	**138.4**	**128.2**
Income from activity	**126.1**	**126.9**	**126.1**
Indicator of profitability	104.9	105.0	104.9
Income from activity without subsidies/1 liter of milk	122.8	131.9	122.2
Total costs/PLN 1 of income from activity without subsidies	88.5	82.1	89.0
Subsidies for PLN 1 of income from activity without subsidies	85.0	76.1	86.7

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

** Criterion for the scale selection was the number of cows on the farm, small scale (C) - 25% of farms in the sample with a lower number of cows, large scale (D) - 25% of the sample with the upper number of cows.

In light of the expected changes in production, price and the cost of keeping cows, it is interesting to know the direction and dynamics of change, which in the coming years one can expect at the level of income.

Results of the projection indicate that by 2015, as compared to the base year (2011), on average in the sample of studied farms, the income from activity without subsidies from the production of milk (per 1 cow) will increase by 28.9%. However, in small scale dairy farms it will increase by 38.4%, and in large scale farms – by 28.2%.

The level of income is, of course, the highest in farms with large herds of cows and milk production on a large scale, but the rate of growth in the next few years will be the strongest in small-scale milk production units. Why is that? Ac-

cording to the projection, this is due to weaker growth in costs, both direct (by 14.1% compared to 14.8% at a large scale) and total (13.7% versus 14.1%). This is a consequence of the different cost structure and different growth rate of individual cost components – Table 5 and V.5.1.

According to the assumptions used in the projection, the annual rates of change of components of the value of production and costs in the farm groups were the same (due to the trend function), but the dynamics of their changes in 2015 was different. Determinants of these changes in case of the value of production are similar to conditions for increase in costs. Value of production – in accordance with established methodology – is the sum of the main product (milk), marketed by product (culled cows) and increase in livestock (calves weaned per cow). In separate groups of farms, small differences in the dynamics of growth of total production are a consequence of the different share in the structure of its individual components.

The results of calculations in the table V.5.1 show that in 2015, the growth rate of the value of production, calculated per one cow, will be stronger than the increase in maintenance costs – by 5.6 percentage points. As a result, compared to 2011, the profitability of milk production, as the percentage ratio of the value of production to total costs – on average in the sample – will improve by 7.9 percentage points. However, in farms with few cows (average of 5.9 heads) and milk production on a small scale, it will be higher by 6.4 percentage points, and in farms with bigger herds (average of 44.1 heads) and large-scale production of milk – by 8.2 percentage points.

In farms producing milk on a large scale (D), despite the high costs and intense dynamics of their growth, profitability of milk production is likely to increase the most. The determining factor is very beneficial, as compared to other farm groups, results of production and prices, i.e. the highest milk yield and milk sales price. The research revealed that the dependence of milk purchase price on the scale of supply and its quality is an important factor contributing to the concentration of milk production and, consequently, positively affecting economic performance. However, in this process, the factor positively influencing the effects is collaboration of milk processing plants and suppliers. Not without significance – for the whole process of milk production – is also the biological and technological progress that has been made in recent years, mainly due to the introduction of highly productive cows and production of good quality feed (silage, haylage). The idea is to obtain a relatively high level of milk production from roughage, providing relatively cheaper nutrients.

The results in Table 5 show that in 2011, the cost of own non-commodity feed per one cow at a large scale – as compared to the small scale – was greater by 48.1%. This indicates a much larger share of roughage in rations for animals. However, the cost of purchased feed and own non-commodity feed in total was 1.7% lower. In the light of these results, it is estimated that concentrate feeds stimulated the growth of milk yield of cows, but they were used as a supplement to good quality roughage.

Figure V.5.4. Profitability of milk production in the baseline year (2011) and the projection for 2015 on average in the study sample, and depending on the scale of production

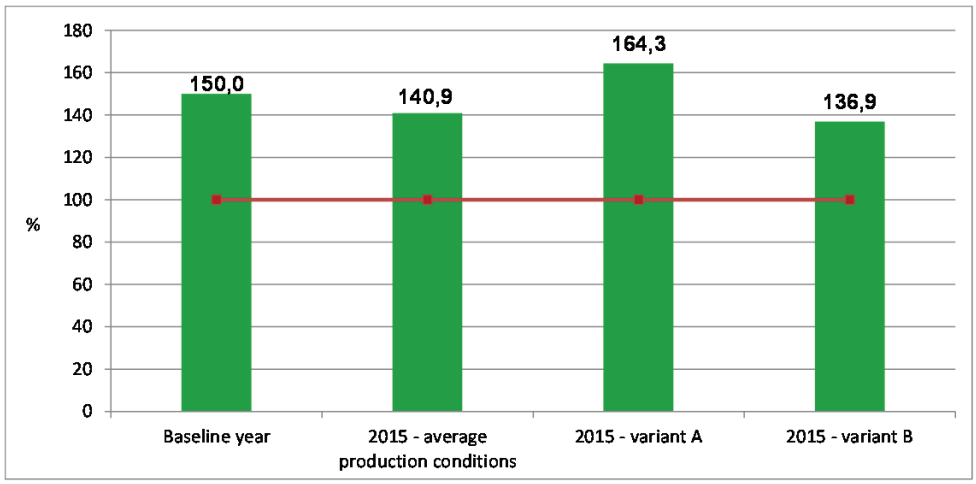


Figure V.5.4 shows that in the next few years, dairy cattle and milk production will remain a profitable activity. However, farmers who keep large herds of highly productive dairy cows will be by far in the most favourable situation. It is estimated that the economies of scale achieved by farms producing milk on a large scale will become larger, which is likely to be one of the factors contributing to a further concentration of milk production in Poland.

The expected increase in the value of production, costs and income from activity without subsidies, in 2015 – in relation to the base year (2011); per one dairy cow is shown below[98]:

[98] The expected growth and the strength of this phenomenon is shown as a percentage. Expected changes are also expressed in terms of value, but the numbers should not be taken as absolute values, they are to show the scale of change in view of the percentage change - in the present case the results of milk production in small-scale and large-scale farms. It should also be noted that at lower or higher reference base – and the same percentage rate of change – the change of value will also be lower or higher.

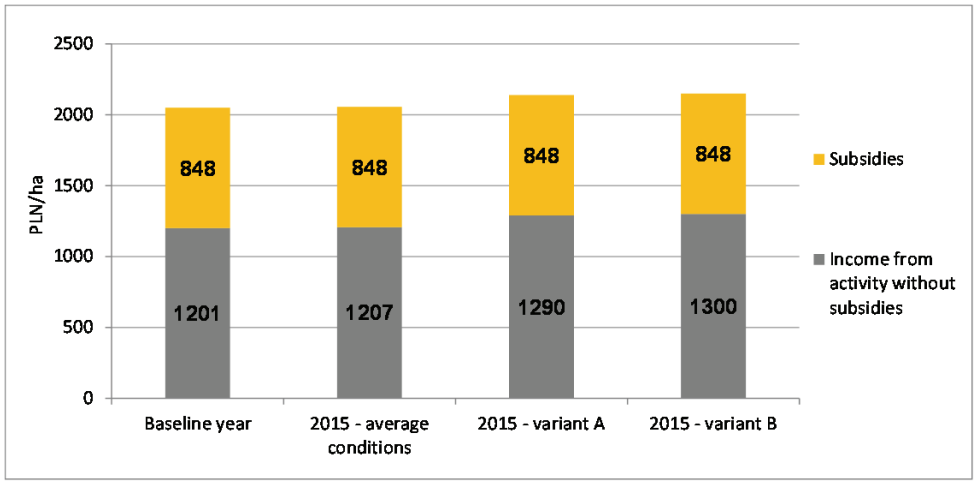
- **on average in studied set of farms** (number of cows – 21.5 heads):
  - total value of production – by 19.6% (by PLN 1535),
  - total costs – by 14.0% (by PLN 682),
  - income from activity without subsidies – by 28.9% (by PLN 854),
- **in farms with small-scale milk production** (number of cows – 5.9 heads):
  - total value of production – by 19.3% (by PLN 990),
  - total costs – by 13.7% (by PLN 539),
  - income from activity without subsidies – by 38.4% (by PLN 450),
- **in farms with large-scale milk production** (number of cows – 44.1 heads):
  - total value of production – by 19.7% (by PLN 1730),
  - total costs – by 14.1% (by PLN 741),
  - income from activity without subsidies – by 28.2% (by PLN 988).

The variability of milk production results in relation to the number of cows on the farm, as projected for 2015, has an impact on the economic performance. Its values in 2015 – as in 2011 – show a clear advantage of large-scale (Table 5). It is estimated that despite higher cost of keeping one cow, the cost of production of 1 litre of milk – in a large scale compared to the small – will be lower by 14.3%. In addition, one should expect a higher income from activity without subsidies per 1 litre of milk (by 78.9%) and a lower cost of revenue unit (by 51.6%).

Advantage of the large scale is clear, but the rate of change in these measures – in 2015 in relation to the initial year of the projection (2011) – is likely to be weaker than in the small-scale milk production. For example, growth in income from activity without subsidies for one litre of milk in farms with large herds of cows will be 22.2%, as compared to 31.9% at farms with low number of cows. The dynamics of the decline in the unit this revenue, in the production of milk on a large scale, will also be weaker – Table V.5.1. It is estimated that the driver of this situation is relatively high cost of keeping cows.

Figure V.5.5 shows the level of income from activity without subsidies per one dairy cow and subsidies for forage area used. Different amount of subsidies in farm groups is due to the size of forage area (average of the sample – 0.56 ha, on a small scale – 0.68 ha, on a large scale – 0.55 ha per one cow).

Figure V.5.5. Income from milk production in the baseline year (2011) and the projection for 2015 on average in the study sample, and depending on the scale of production



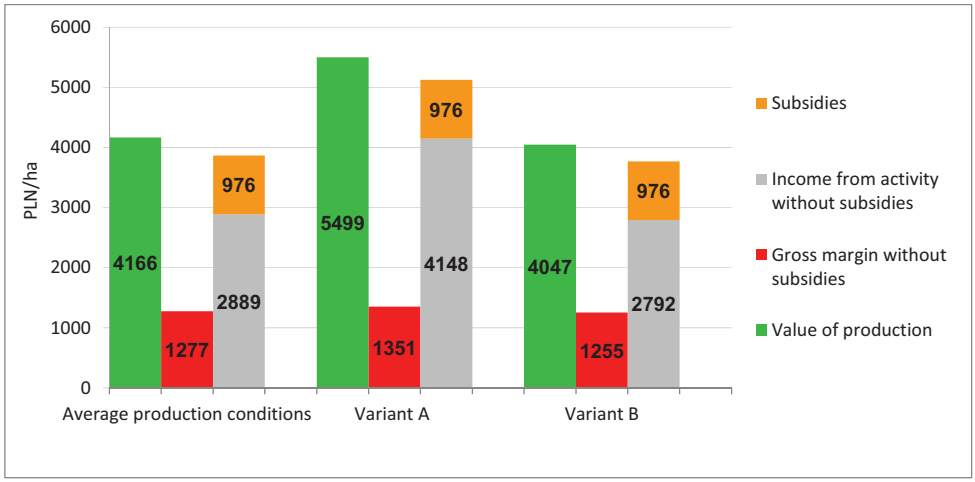
Calculations show that in 2015, the subsidies will be most significant to milk producers with small herds of cows. In this case, the share of subsidies in revenue without subsidies, i.e. realized from production per one cow is 40.8%, while in farms with large herds of cows – 11.8%.

In terms of value of the scale of subsidies, in 2015, for every PLN 1 of income without subsidies, the small-scale dairy farmers will receive support in the amount of PLN 0.41, and large-scale dairy farmer – PLN 0.12. Compared to 2011, it will be lower by 24.1 and 14.3%. This will be decided by the favourable results of milk production because the amount of subsidies is likely to be higher – Table 5.

Projection for 2015 of milk production results

The results of projection carried out on the basis of trend functions indicate that in 2015 milk production will be profitable. It is estimated that on average, in the studied sample of farms, milk price will be 1.39 PLN/litre, and milk yield will be 6101 litres per cow. As a result, the value of production per dairy cow will be PLN 9352, and income from activity without subsidies PLN 3812. However, in groups of farms that differ in the number of cows – which was the criterion of the scale – diversification of production and economic results is high – Figure V.5.6.

Figure V.5.6. Projection of milk production results in 2015 on average in the study sample, and depending on the scale of production



The difference in the number of cows between groups of farms was 7.5-fold (small scale on – 5.9 heads, large scale – 44.1 heads). Below are the changes one can expect by comparing the results of large-scale farms to small-scale farms per dairy cow:

- milk yield – higher by 56.3%,
- price of milk – higher by 22.9%,
- value of production – higher by 72.1%,
- gross margin without subsidies – 2.1-fold higher,
- income from activity without subsidies – 2.8-fold higher,
- indicator of profitability – higher by 38,7 percentage points.

It is estimated that the main factor differentiating the value of production and having a big impact on the level of income is the milk yield of cows. For this reason, in 2015, the large-scale dairy farms, despite the higher cost of keeping cows – as compared to the small scale farms of 34.0%, the cost of production of one litre of milk is likely to be lower by 14.3%.

The beneficial effect of scale is very clear. Farmers producing milk on a large scale obtained higher income per one cow and one litre of milk, and the cost of PLN 1 of income was lower. Economic efficiency of production was also higher (the measure was the profitability index), as well as technical efficiency (the indicator is milk production from roughage), which is evidenced by much higher cost of own feed from non-commodity products.

Research suggests that the role of milk yield of cows in the milk production is and will be very important. Its higher level stimulates the growth of revenue and profitability, despite the higher cost of keeping animals. Increasing the number of cows in the herd will have a positive effect on economic performance, the more so as it is closely related to the productivity of cows. The factor whose role is relatively the smallest is the price of milk, because it depends to the smallest degree on the farmer. However, in farms with large herds of cows, higher milk prices are associated with better quality of produced raw material and a stronger bargaining position of farmers, resulting from the possibility of providing larger quantities of milk for purchase.

The observed patterns and trends point to important relationships and can be a prerequisite for changes in farms; the objective is to provide high profitability of milk production in the future. This statement is all the more justified if one takes into account the fact that the average yield of cows in the farms in the country in 2011 amounted to 4508 litres (according to CSO), it was therefore only about 11% higher than in the surveyed farms producing milk on a small scale, while about 41% lower than the milk yield of cows on farms with large-scale production of milk.

Projection results – for the next few years – show an improvement in the profitability of milk production. However, the answer to the question, how milk production will develop in the future, is extremely difficult. It also results from the fact that from 1 April 2015 milk quotas will be abolished.

Polish presence in the EU has created opportunities for farms specializing in milk production. The introduction of milk quotas and limiting milk supply has led to a relative stabilization of prices, which contributed to improved profitability. EU funds targeted for milk industry made it possible to restructure the dairy sector. Thanks to the funds from the Common Agricultural Policy for dairy farms, there has been improvement in their competitiveness against agriculture of other Member States.

The strengths of dairy farms in Poland, conducive to the further development are: experience of farmers, milk quality and relatively low cost of its production, low price of raw milk compared to other EU countries, relatively good economic performance of large scale dairy farms, modern dairy industry and a wide range of dairy products in retail, and the natural conditions of the country favourable to the development of this type of production. However, despite many strengths of dairy farms in Poland there are also weaknesses, such as: fragmentation of milk production and the relatively low yield of cows, obsolete technologies for feeding cows in farms with small herds and unused production capacity.

It is the smallest holdings that are mostly afraid of abolishing milk quotas. Under the new conditions, these units may not be attractive to customers and in finding new milk purchasers they will be forced to accept less favourable terms and conditions, which may in turn force them to stop producing milk. In addition, reduction of protection may encourage some farmers to change production profile. As a consequence, the number of small producers will reduce, there will be also reduction in number of cows which could translate into an increase in milk prices.

Environment also carries other risks for agriculture, the producers strongly feel, e.g. the upward trend in the prices of means of production. Especially big problem for dairy farms is the lack of flexibility in the generated output. Despite favourable natural conditions it is not possible to immediately adjust production to demand, even assuming no milk quotas. However, large dairy farms have the opportunity for further development, farmers become more aware of the importance of economies of scale. They invest in new equipment and buildings, but, unfortunately, often forget about the high cost of debt, which in some cases can cause big problems.

Farmers who want to continue to engage in dairy farming see abolition of milk quotas – which have so far been the basis for the functioning of the milk market – as a great opportunity. Lack of formal restrictions on the supply will enable scaling-up of production. Assuming, however, that collection of milk from farms will be based on contracts, giving farmers confidence and guarantees of sale. Abolition of milk quotas does not determine the drop in prices. It is possible that increased production will be absorbed by the growing demand. The public shows increasing demand for protein-rich dairy products due to changes in eating habits. Increased interest in dairy products is caused by the increase in population[99].

According to counsel for Agriculture, Nature and Food Quality of the Netherlands Embassy, milk production after 2015, both in Poland and in Europe, will continue to grow. It will not be a fast rat, but 2-3 percent a year. The increase in production does not have to be associated with a decrease in milk prices, as global demand for raw material should also grow[100].

Despite many concerns, experts predict that until 2022 the situation on the world market will be good, mainly due to an increase in demand for dairy products in developing countries.

---

[99] K. A. Grajewska, *Kierunki Rozwoju Gospodarstw Mlecznych w Polsce do 2014 roku w świetle analizy SWOT, równań trendu i metody PEST*. Roczniki Ekonomiczne No. 4, 2011.

[100] *W Europie po zakończeniu kwotowania produkcja mleka wzrośnie.* http://www.portalspozywczy.pl/mleko/wiadomosci/w-europie-po-zakonczeniu-kwotowania-produkcja-mleka-wzrosnie,88520.html [access: July 2013].

VI. Summary

The part of the study entitled "Projection of income for 2015 for selected agricultural products" presents the results of projected profitability of growing winter wheat, winter rye, spring barley, winter rapeseed and milk production.

Projections focus on historical information and determine the possible processes without preconceived scenarios. By following this principle, based on the trend observed in the 17-year period (1995-2011), the study determined the likely trends of changes until 2015. The input data for projection were the multi-year averages of 2006-2011 (collected and processed according to the assumptions used in AGROKOSZTY system), which prior to averaging, have been adjusted by indicators of changes designated based on the trend function. This approach was applied to exclude systematic changes that have taken place during this period, e.g. improvement of production technology, change in the value of money.

Projection for 2015 of results of studied crop production activities was carried out for average conditions, and depending on the results of production (yield variants). In the case of dairy cows, calculations were made on average in the research sample of farms, and depending on the scale of milk production, the scale criterion was the number of dairy cows on the farm. Although the study covered only a certain percentage of individual farms in Poland, in separate groups, it accurately reflects the trends in costs and gives a true picture of changes in profitability, and in this context, provides a basis for conclusions relating not only to the researched sample.

An interesting approach is to capture the effects of production of cereals and oilseed rape in terms of variants. The strength of these changes results from the assumptions of the projection model, which were based on changes over time of the level of yield (*in minus* and *in plus* as compared to the average production results). It should be noted that the studies assume invariability (*ceteris paribus*) of other factors affecting the profitability of studied activities.

Running a farm is associated with making various decisions, which result in specific variants of actions. These decisions relate to the future, which is why they are based on predictions as to future operating conditions and the development of the given activity. However, when taking economic decisions, especially long-term ones, a factor that must be taken into consideration is the uncertainty of the forecast. Even scientific "prediction" of the future, i.e. the process of forecasting, does not give a fully accurate state of the given phenomenon in the future, and especially of the conditions of macro-environment of farms.

Inability to forecast error-free results is, *inter alia*, due to the fact that environmental conditions (e.g. temperature, precipitation) may considerably deviate from the average, which in turn has an impact on the obtained results (e.g. crops). In addition, business processes always involve people, and every process involving people is not fully predictable, and therefore one cannot develop a correct forecast of economic phenomena. However, one can predict the limits of variability of the results. Therefore, the direction of ongoing changes is of essential importance in the analyses, rather than absolute values which should be approached with caution.

On the basis of the projection it is estimated that in 2015, farmers will not lose by cultivating **winter wheat**. The diversity of economic performance is however possible, because of the variability of conditions of production. It is estimated that – due to a stronger growth rate of cost that of the value of production (by 3.9 percentage points) – under average conditions of production, i.e. similar as in recent years, the profitability of winter wheat (the ratio of the value of production to total cost) will decline by 5.6 percentage points. However, if the meteorological conditions are worse than average and the result would be a lower yield, the decrease of profitability in relation to the base year for the projection model (i.e. 2011) will be stronger – it is expected at the level of 23.1 percentage points. Comparing to the results expected under average conditions in 2015, the decline may reach 17.5 percentage points.

In the event of exceptionally favourable conditions of production, conducive to high yielding of wheat, one should expect improvement in profitability. It is expected that in comparison to 2011 by 8.7 percentage points, and with respect to the results obtained under average conditions in 2015, by 14.3 percentage points. It should be noted that only under these conditions, one can talk about increased unit profitability of winter wheat. This is evidenced by stronger (by 5.9 percentage points) growth rate of the value of production than of costs.

It should be noted that under adverse conditions of production, regardless of the decline in profitability in ratio terms, the income from activity without subsidies at farmers' disposal will also be lower, as compared to the base year – by 22.7%. In other two variants, the income may be higher, under average conditions by 7.0% and under favourable conditions – by 31.0%.

The projection of the results of **winter rye** in 2015 indicates that it will be a profitable business, although one should not expect a significant improvement in comparison to previous years. Under average conditions of production, income from operations without subsidies from one ha of rye will only slightly

exceed the level of the base year for the projection (it is estimated that by 5.1%). However, the economic efficiency of production will worsen, the profitability index will fall by 5.7 percentage points. This will be decided by fairly strong increase in costs (by 17.2%). According to projection for 2015, only with rye yield higher than in the base year (according to the assumptions by 12.7%), farmers can expect to improve the economic efficiency of its production. Under these conditions the growth rate of production will be stronger than the costs (by 8.4 percentage points). As a result, profitability index will reach 166.5%, which is higher than in the baseline projection by 11.2 percentage points, and compared to the average performance in 2015, by 16.9 percentage points.

The situation of producers will be particularly disadvantageous if rye production results will be worse than the average, then one can expect a drop in income from 1 ha by 7.8%. This means that the increase in the price of grain (by 11.6%) will not offset the decline in yield (by 17.4%). As a result, the profitability of growing rye will fall – as compared to the base year of the projection (2011) by 33.2 percentage points, and in comparison to average performance in 2015 by 27.5 percentage points. This situation reveals the role of subsidies in the stabilization of income – their share in income from activity (including subsidies) accounted for more than 73%, while in the other two variants of the projection it was around 50%.

It is expected that the cultivation of **spring barley** in 2015 will allow for obtaining income from activity without subsidies, but under average and unfavourable conditions of production, its level may be lower than in the base year (2011). In the first case, it will be due to stronger growth of cost than of the value of production (by 7.7 percentage points), and in the other, higher costs (by 16.9%) and the decrease in the value of production (by 12.6%).

It is estimated that in 2015, under average conditions of production, the income from activity without subsidies will fall by 3.8%, and the cost-effectiveness ratio of the value of production to total costs will fall by 10.5 percentage points.

However, if production results of barley are lower (projection assumes yield at 31.8 dt/ha), the profitability of production in relation to the base year will drop by 40.3 percentage points, and in relation to the average results in 2015 – by 29.8 percentage points. In this case, the income from production (i.e. without subsidies) at the disposal of the farmer will be only 37.7% of the level in the base year of the projection.

Higher income from activity without subsidies can be expected only at favourable production results. The variability in yield observed in recent years in-

dicates that in 2015 it may amount to 42.4 dt/ha. In this case, the income from production (i.e. without subsidies) may exceed the level of the base year for projection by 15.5%. However, the economic efficiency of production will worsen a little, the profitability index will fall by 0.8 percentage points. But it will be higher by 9.7 percentage points compared to the average results in 2015.

In 2015, **winter oilseed rape** should continue to be a profitable activity, mainly due to an expected increase in the price of seeds by 13.1%. The diversity of economic performance can be greatly influenced by rapeseed yield variability, the level of which was adopted as a criterion for isolating projection variants. In addition to the factors determining the income, one should also consider the cost of production – it is expected to increase by 16.7%.

The results show that under average agro-meteorological conditions for cultivation of oilseed rape (i.e. similar to the past few years), the income from activity without subsidies will exceed the level of the base year for the projection by 9.8%. However, stronger growth of cost than of production (by 2.9 percentage points) will contribute to the deterioration of economic efficiency, profitability index will fall by 4.4 percentage points.

The expected increase in costs will have a negative impact on the economic performance of oilseed rape, particularly when yield drops below the level recorded in recent years. In the projection it is the level of so-called base year (2011). Then the income without subsidies obtained from 1 ha will account for only 68.8% of the income in the base year. This will be due to higher costs (16.7%) and the drop in the value of production (by 3.7%), as 13.1% higher seed price will only partially offset the lower (by 14.8%) yield of rape. Under these conditions, the profitability of production – in relation to the base year for the projection model – will decline by 30.5 percentage points, and the results under average conditions in 2015 by 26.1 percentage points.

However, if the oilseed rape crop is higher than in the base year, research shows that by about 24.2%, the producers can expect a significant improvement in results. Income from activity without subsidies, as compared to the base year, will increase by as much as 72.4%. The cost-effectiveness ratio will reach 209.6%, it will therefore be higher than in the base year by 35.4 percentage points, under average conditions of 2015 by 39.8 percentage points. The unit profitability of oilseed rape will increase, this is indicated by stronger (by 23.8 percentage points) growth rate of the value of production than of cost.

It is estimated that in 2015, **milk production** will be profitable, although the best results – as in the base year of the projection (2011) – will be obtained by farmers with large herds of high yielding cows. It follows from the trend function of more than 10 years, that by 2015 milk yield will be increasing at an annual rate of 1.3-1.1% and milk price at a rate of 3.6-3.3% (i.e. in the initial period at a rate of 1.3 and 3.6% and in the final at a rate of 1.1 and 3.3% respectively). The value of the total production percentage points one cow – depending on the scale of production – will grow in the range of 19.3-19.7%. However, total costs (direct and indirect) of keeping one cow will be higher by 13.7-14.1%. It is estimated that on average their growth will not exceed 3.5% per annum. As a result, in 2015 the growth rate of the value of production (calculated for one cow) will be about 5.6 percentage points stronger than the costs of production. Thus, the profitability of milk production will improve, in farms with small-scale production by 6.4 percentage points, in large-scale farms – by 8.2 percentage points, and on average in the research sample – by 7.9 percentage points.

In 2015, prevalence of large-scale dairy farms will still be clear. Despite the higher cost of keeping cows – compared to the small scale of production by 34.0% – the cost of production of one litre of milk will be reduced by 14.3%. In addition, one should expect income from activity without subsidies per 1 cow to be 2.8-fold higher, percentage points one litre of milk – by 78.9%, and at the same time the lower cost of producing income unit (by 51.6%).

It should be noted that in 2015, the growth rate of income (without subsidies) in farms keeping large herds of cows will be weaker than in farms with small number of cows. Taking into account the income percentage points one cow – one expects increase by 28.2 and 38.4%, while percentage points one litre of milk – by 22.2 and 31.9% (compared to the base year). The factor determining this situation is the higher cost of keeping cows on farms with large herds. Despite this, advantage of these units will remain clear.

In conclusion, it should be noted that one of the key factors determining the amount of obtained yields of crop production activities, and one which is beyond the control of the farmer, is the weather and the weather pattern. This is important because crop production, forming the basis of agriculture, determines the situation of the whole food industry. The strategic importance of crop production for the entire sector makes that analyses related to forecasting yield variability, and their impact on profitability, are important and can be very useful to both producers and other customers.

Research has shown that in 2015, under average conditions of production – as compared to the input data of the projection model – the largest yield increase is expected for winter wheat (by 4.7%) and lowest for winter oilseed rape (by 0.6%) and spring barley (by 0.7%). If there are adverse conditions of production, the greatest decline will be in spring barley and rye, the yield is expected to decline by 19.5 and 17.4% respectively. However, the smallest decline will be in winter wheat, which may decrease by 6.6%. However, the extremely favourable conditions of production will be conducive to the greatest increase in winter oilseed rape crop which could rise by as much as 24.2%, and by far the least increase in spring barley yield – it is expected to be higher only by 7.3%.

The consequence of differences in production results – at equal variability and level of other factors (sales prices, level of expenditures and prices of means of production) is the different profitability.

According to projection for 2015, in relation to the input data – under average and unfavourable conditions of production – one should expect a decline in the profitability of production. In the first case, due to stronger growth of cost than of income, in the second, due to decrease in the value of production. However, with extremely high yields, one can expect to improve economic performance. Higher yields will determine more rapid increase of the value of production than of the cost of production. An exception can be spring barley, for which the increase in income offsets the increase in cost.

Despite these differences, the studied cereals and oilseed rape will continue to be profitable. However, taking into account the dynamics of profitability (*in plus* and *in minus*), the oilseed rape is the most profitable in any variant of the projection, and spring barley is the least profitable.

The projection for 2015 of milk production results indicates an increase in unit production profitability, as it projects stronger growth dynamics of the production value than of the costs incurred (by 5.6 percentage points). Farmers who keep large herds of highly productive dairy cows will be by far in the most favourable situation. Improving the profitability of milk production in these farms will be stronger than in small scale farms. It is estimated that the economies of scale will increase, which is likely to be one of the factors contributing to a further concentration of milk production in Poland.

TABULAR
ANNEX

Table 1. Results of winter wheat growing in the baseline year 2011* and the projection for 2015 (in current prices)

Specification		Level for 2011*	Projection for 2015		
		The average production conditions		Variants of yield	
				pessimistic [A]	optimistic [B]
Number of surveyed farms		151			
Crop area	[ha]	20.37			
Yield of grain	[dt/ha]	58.5	61.2	54.6	66.5
Grain sales price	[PLN/dt]	75.47	81.18	81.18	81.18
		Per 1 ha of crops, in PLN			
Total value of production		4425	4980	4445	5414
Total direct costs		1288	1479	1479	1479
of which: seed		185	217	217	217
mineral fertilizers in total		751	894	894	894
crop protection products		304	316	316	316
Gross margin without subsidies		3137	3501	2966	3935
Indirect costs in total		1332	1571	1571	1571
Income from activity without subsidies		1804	1931	1395	2365
Subsidies**		752	976	976	976
Income from activity		2556	2907	2371	3341
TOTAL COSTS		*2621*	*3049*	*3049*	*3049*
Measures of economic performance					
Indicator of profitability	[percent]	168.9	163.3	145.8	177.6
Total costs/1dt of grain	[PLN]	44.83	49.84	55.86	45.83
Income from activity without subsidies/1dt of grain	[PLN]	30.87	31.56	25.56	35.54
Total costs/PLN 1 of income from activity without subsidies	[PLN]	1.45	1.58	2.19	1.29
Subsidies for PLN 1 of income from activity without subsidies	[PLN]	0.42	0.51	0.7	0.41
Share of subsidies in the income from activity	[percent]	29.4	33.6	41.2	29.2

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

**In 2006-2011 subsidies include complementary area payments and single area payments, and for 2015 the estimate of subsidies is in accordance with the planned objectives of the CAP for 2014-2020.

Table 2. Results of winter rye growing in the baseline year 2011* and the projection for 2015 (in current prices)

Specification		Level for 2011*	Projection for 2015		
		The average production conditions		Variants of yield	
				pessimistic [A]	optimistic [B]
Number of surveyed farms		122			
Crop area	[ha]	10.72			
Yield of grain	[dt/ha]	32.7	33.1	27,0	36.8
Grain sales price	[PLN/dt]	65.28	72.83	72.83	72.83
		Per 1 ha of crops, in PLN			
Total value of production		2142	2418	1974	2691
Total direct costs		670	783	783	783
of which: seed		124	149	149	149
mineral fertilizers in total		441	525	525	525
crop protection products		84	87	87	87
Gross margin without subsidies		1472	1635	1191	1908
Indirect costs in total		709	833	833	833
Income from operations without subsidies		763	802	358	1075
Subsidies**		752	976	976	976
Income from operations		1515	1778	1334	2051
TOTAL COSTS		*1379*	*1616*	*1616*	*1616*
Measures of economic performance					
Indicator of profitability	[percent]	155.3	149.6	122.1	166.5
Total costs/1dt of grain	[PLN]	42.22	48.89	59.94	43.91
Income from operations without subsidies/1dt of grain	[PLN]	23.36	24.24	13.26	29.19
Total costs/PLN 1 of income from operations without subsidies	[PLN]	1.81	2.02	4.52	1.5
Subsidies for PLN 1 of income from operations without subsidies	[PLN]	0.99	1.22	2.73	0.91
Share of subsidies in the income from operations	[percent]	49.6	54.9	73.2	47.6

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

**In 2006-2011 subsidies include complementary area payments and single area payments, and for 2015 the estimate of subsidies is in accordance with the planned objectives of the CAP for 2014-2020.

Table 3. Results of spring barley growing in the baseline year 2011* and the projection for 2015 (in current prices)

Specification		Level for 2011*	Projection for 2015		
		The average production conditions		Variants of yield	
				pessimistic [A]	optimistic [B]
Number of surveyed farms		205			
Crop area	[ha]	10.3			
Yield of grain	[dt/ha]	39.5	39.8	31.8	42.4
Grain sales price	[PLN/dt]	70.05	75.97	75.97	75.97
		Per 1 ha of crops, in PLN			
Total value of production		2775	3030	2424	3228
Total direct costs		825	957	957	957
of which: seed		158	186	186	186
mineral fertilizers in total		513	610	610	610
crop protection products		136	141	141	141
Gross margin without subsidies		1950	2073	1468	2271
Indirect costs in total		916	1078	1078	1078
Income from operations without subsidies		1033	995	389	1193
Subsidies**		788	976	976	976
Income from operations		1822	1971	1365	2169
TOTAL COSTS		*1741*	*2035*	*2035*	*2035*
Measures of economic performance					
Indicator of profitability	[percent]	159.4	148.9	119.1	158.6
Total costs/1dt of grain	[PLN]	44.11	51.19	64.01	48.03
Income from activity without subsidies/1dt of grain	[PLN]	26.18	25.01	12.24	28.16
Total costs/PLN 1 of income from activity without subsidies	[PLN]	1.68	2.05	5.23	1.71
Subsidies for PLN 1 of income from activity without subsidies	[PLN]	0.76	0.98	2.51	0.82
Share of subsidies in the income from activity	[percent]	43.3	49.5	71.5	45.0

* Estimation for 2011, data from the 2007-2011 adjusted by indicators of changes designated on the basis of the trend function, and then averaged.

**In 2007-2011 subsidies include complementary area payments and single area payments, and for 2015 the estimate of subsidies is in accordance with the planned objectives of the CAP for 2014-2020.

Table 4. Results of winter oilseed rape growing in the baseline year 2011* and the projection for 2015 (in current prices)

Specification		Level for 2011*	Projection for 2015		
		The average production conditions		Variants of yield	
				pessimistic [A]	optimistic [B]
Number of surveyed farms		135			
Crop area	[ha]	18.08			
Yield of seed	[dt/ha]	30.9	31.1	26.3	38.4
Seed sales price	[PLN/dt]	183.23	207.2	207.2	207.2
		Per 1 ha of crops, in PLN			
Total value of production		5663	6443	5455	7954
Total direct costs		1672	1930	1930	1930
of which: seed		164	205	205	205
mineral fertilizers in total		1030	1225	1225	1225
crop protection products		405	421	421	421
Gross margin without subsidies		3991	4513	3524	6024
Indirect costs in total		1579	1865	1865	1865
Income from operations without subsidies		2412	2648	1660	4159
Subsidies**		765	976	976	976
Income from operations		3177	3624	2636	5135
TOTAL COSTS		*3251*	*3795*	*3795*	*3795*
Measures of economic performance					
Indicator of profitability	[percent]	174.2	169.8	143.7	209.6
Total costs/1dt of seed	[PLN]	105.18	122.04	144.16	98.86
Income from operations without subsidies/1dt of seed	[PLN]	78.04	85.16	63.04	108.34
Total costs/PLN 1 of income from operations without subsidies	[PLN]	1.35	1.43	2.29	0.91
Subsidies for PLN 1 of income from operations without subsidies	[PLN]	0.32	0.37	0.59	0.23
Share of subsidies in the income from operations	[percent]	24.1	26.9	37.0	19.0

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

**In 2006-2011 subsidies include complementary area payments and single area payments, and for 2015 the estimate of subsidies is in accordance with the planned objectives of the CAP for 2014-2020.

Table 5. Results of milk production in the baseline year 2011* and the projection for 2015 (in current prices)

Specification	On average, households in the study sample		Depending on the scale of production [number of cows/farm]**			
			Small [C]		Large [D]	
	Level for 2011*	Level for 2015	Level for 2011*	Level for 2015	Level for 2011*	Projection for 2015
Number of surveyed farms	163		41		41	
Number of dairy cows [szt.]	21.5		5.9		44.1	
Milk yield of cows [liter]	5815	6101	4061	4260	6345	6657
Selling price of milk [PLN/liter]	1.21	1.39	1.04	1.18	1.27	1.45
	Per 1 milk cow, in PLN					
Total value of production	7817	9352	5118	6108	8781	10511
of which: milk	7049	8461	4204	5046	8041	9652
weaned calf	482	562	650	758	434	506
cull dairy cow	286	329	264	304	307	353
Total direct costs	2500	2826	2239	2523	2674	3027
of which: herd replacement	519	594	442	506	626	716
feed from outside the farm	569	654	276	315	686	788
own commodity feed	671	741	1000	1113	568	624
own non-commodity feed	365	420	262	302	388	447
Gross margin without subsidies	5317	6526	2879	3585	6108	7484
Indirect costs in total	2359	2714	1708	1963	2598	2986
Income from activity without subsidies	2958	3812	1172	1622	3510	4498
Subsidies**	496	543	628	661	480	533
Income from activity	3454	4355	1799	2283	3989	5031
TOTAL COSTS	*4858*	*5540*	*3947*	*4486*	*5272*	*6013*
Measures of economic performance						
Indicator of profitability [percent]	160.9	168.8	129.7	136.1	166.6	174.8
Total costs/1 liter of milk [PLN]	0.84	0.91	0.97	1.05	0.83	0.9
Income from activity without subsidies/1 liter of milk [PLN]	0.51	0.62	0.29	0.38	0.55	0.68
Total costs/PLN 1 of income from activity without subsidies [PLN]	1.64	1.45	3.37	2.77	1.5	1.34
Subsidies for PLN 1 of income from activity without [PLN]	0.17	0.14	0.54	0.41	0.14	0.12
Share of subsidies in the income from activity [percent]	14.4	12.5	34.9	29.0	12.0	10.6

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

** Criterion for the scale selection was the number of cows on the farm, small scale (C) - 25% of farms in the sample with a lower number of cows, large scale (D) - 25% of the sample with the upper number of cows.

**In 2006-2011 subsidies include complementary area payments and single area payments, and for 2015 the estimate of subsidies is in accordance with the planned objectives of the CAP for 2014-2020.

Bibliography

1. *Analiza czynników kształtujących ceny produktów rolnych w Polsce po akcesji do UE.* Fundacja Programów Pomocy dla Rolnictwa; http://www.fapa.org.pl/ gfx/saepr/ Scenariusz%20cenowy%20po%20akcesji.pdf [access: August 2013].
2. Arseniuk E., Oleksiak T., *Dlaczego zboża...*,2011; http://www.ihar.edu.pl/dlaczego_ zboza.php [access: June 2013].
3. Arseniuk E., Oleksiak T., *Dlaczego zboża…*, Agro Serwis, wyd. 5, May 2011.
4. Barczyk R., Kowalczyk Z., *Metody badania koniunktury gospodarczej*, PWN, Warszawa-Poznań 1993.
5. Bartosiewicz S., *Ekonometria. Technologia ekonometrycznego przetwarzania informacji*, PWE, Warszawa 1989.
6. *Białoruś podwyższa cła eksportowe na potas;* http://www.portalspozywczy.pl /technologie/wiadomosci/bialorus-podwyzsza-cla-eksportowe-na-potas,50456.html [access: January 2012].
7. *Biuletyn Informacyjny ARR*, No 1/2013, ARR, Warszawa 2013.
8. Budzyński W., *Efektywność wybranych czynników produkcji nasion rzepaku ozimego*, [in:] *Rzepak biopaliwa. Wydanie 2*, Wyd. Biznes-Press sp. z o. o., Warszawa 2006.
9. Calabrese E.J., Baldwin L.A., *The Dose determines the Stimulation (and Poison): Development of a Chemical Hormesis Database*, Int. J. of Toxic, No 16, 1997.
10. Chatfield C., *The Analysis of Time Series. An Introduction,* Chapman and Hall, London 1980.
11. Cieślak M., *Organizacja procesu prognostycznego*, [in:] *Prognozowanie gospodarcze. Metody i zastosowania (scientific ed. M. Cieślak)*, PWN, Warszawa 1999.
12. Cieślak M., *Prognozowanie gospodarcze. Metody i zastosowania (scientific ed. M. Cieślak)*, PWN wyd. IV zmienione, Warszawa 2005.
13. Dagum E. B., *X11-ARIMA/88. Seasonal Adjustment Method – Foundations and User's Manual*, Ottawa 1988.
14. Dincer I., *Renewable energy and sustainable development: a crucial review*, Renewable and Sustainable Energy Reviews, No 4, 2000.
15. Dybowski G., Rycombel D.*, Światowy rynek wieprzowiny i drobiu na tle bilansu zbóż i pasz,* IERiGŻ-PIB, Raport PW No 17, Warszawa 2011.
16. *Environmental indicators for agriculture*, Vol 4 Chapt. 3. OECD Publ. Serv., Paris, 2008.
17. *FAO prognozuje wzrost produkcji zbóż na świecie*, http://www.piagro.pl/ wiadomosci-rolnicze/swiat/fao-prognozuje-wzrost-produkcji-zboz-na-swiecie.html [access: September 2013].

18. *FAO: produkcja zbóż na świecie wzrośnie o 6,5 proc.*, http://www.farmer.pl/drukuj/44561.html [access: September 2013].

19. *FAO: produkcja zbóż na świecie wzrośnie o 6,5 proc.*; http://www.farmer.pl/drukuj/44561.html [access: September 2013].

20. Farnum N.R., Stanton W., *Quantitative Forecasting Methods,* PSW-Kent Publishing Company, New York 1989.

21. Gąsiorowska B., Koc G., Buraczyńska D., Struk K., *Wpływ warunków pogodowych na plonowanie zbóż uprawianych w Rolniczej Stacji Doświadczalnej w Zawadach*, Infrastruktura i ekologia terenów wiejskich. Infrastructure and ecology of rural areas, No 6, Komisja Technicznej Infrastruktury Wsi PAN, Kraków 2011.

22. Ginter A., Szarek S., *Sytuacja dochodowa producentów zbóż na przykładzie uprawy pszenicy,* Journal of Agribusiness and Rural Development, 4(18) 2010.

23. Goraj L., Mańko S*., Systemy monitorowania sytuacji ekonomicznej i produkcyjnej gospodarstw rolnych,* [in:] Rachunkowość rolnicza. Wyd. II, Difin, Warszawa 2004.

24. Górka K., Podskrobko B., Radecki W., *Ochrona środowiska – problemy społeczne, ekonomiczne i prawne*, PWE, Warszawa 1998.

25. Grajewska K.A., *Kierunki Rozwoju Gospodarstw Mlecznych w Polsce do 2014 roku w świetle analizy SWOT, równań trendu i metody PEST*. Roczniki Ekonomiczne No 4, 2011.

26. Guba W*., Budżet ogólny UE i WPR na lata 2014-2020 po szczycie Rady Europejskiej w dniu 7-8 lutego.* Materiał prezentowany na seminarium, pt. „Końcowy etap negocjacji nad budżetem wieloletnim UE i reformą WPR na lata 2014-2010. Warszawa, 04.04.2013 r.

27. Hernández-Rivera J., Mann S., *Classification of agricultural systems based on pesticide use intensity and safety*, Paper presented at the 12th Congress of the European Association of Agricultural Economists, August 26-29, Gent, Belgium 2008.

28. Igras J., Kopiński J., Matyka M., Ochal P., *Zużycie nawozów mineralnych w Polsce w układzie regionalnym*, [in:] Stan obecny i perspektywy nawożenia roślin w Polsce w aspekcie regulacji prawnych, Studia i Raporty IUNG-PIB, No 25, Puławy 2010.

29. Jasińska Z., Kotecki A. (ed.), *Szczegółowa uprawa roślin. Tom II*, Wyd. Akademii Rolniczej we Wrocławiu, Wrocław 2006.

30. Jasińska Z., Kotecki A., *Szczegółowa uprawa roślin. Tom I*, Wydawnictwo Akademii Rolniczej we Wrocławiu, Wrocław 2003.

31. Jóźwiak G., Podgórski J., *Statystyka od podstaw,* PWE, Warszawa, 1998.

32. Korzeniowska J., Robaczyk Z., *Czy światu grozi brak fosforu do produkcji nawozów?,* Nasza Rola, No 2/ 2011; http://rolnictwo.re.pl/var/ifiles/56/30/ document_e87643932408ffcf9d0e0e4bc0dd4167.pdf [access: June 213].

33. Kudrycka I., Nilsson R., *Business Cycles in the Period of Transition,* Z prac Zakładu Badań Statystyczno-Ekonomicznych GUS i PAN, z. 216, Warszawa 1993a.

34. Kudrycka I., Nilsson R., *Cykle koniunktury w Polsce: analiza wstępna,* Z prac Zakładu Badań Statystyczno-Ekonomicznych GUS i PAN, z. 209, Warszawa 1993.

35. Kundzewicz W., *Zmiany klimatu, ich przyczyny i skutki – obserwacje i projekcje*. Landform Analysis, vol. 15, 2011.

36. Kuś J., Matyka M., *Zróżnicowanie warunków przyrodniczych i organizacyjnych produkcji rolniczej w Polsce.* Referat wygłoszony na konferencji, nt. „Rolnictwo zrównoważone: harmonia czy konkurencja celów*",* która odbyła się w dn. 15-17.05.2013 r. w IUNiG-PIB w Puławach.

37. Kuś J., *Produkcja biomasy na cele energetyczne*, Biuletyn Informacyjny No 7, PAN, Lublin 2002.

38. Lehtonen H., Lankoski J., Koikkalainen K., *Economic and environmental performance of alternative policy measures to reduce nutrient surpluses in Finnish agriculture*, Agricultural and Food Science, No 16, 2007.

39. Łopaciuk W., *Ceny zbóż na rynku krajowym*, [in:] *Rynek zbóż. Stan i perspektywy*, nr 44, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2013.

40. Łopaciuk W., *Światowy rynek zbóż*, [in:] *Rynek zbóż. Stan i perspektywy*, nr 44, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2013.

41. Makridakis S., Wheelwright S.C., *Forecasting Methods for Management, John Wiley,* New York 1989.

42. Manteuffel R., *Ekonomika i organizacja gospodarstwa rolniczego*, PWRiL, Warszawa, 1984.

43. Matkowski Z., *Cykle w rozwoju gospodarki polskiej. Barometry koniunktury dla gospodarki polskiej,* IRG SGH, Warszawa 1999.

44. Matkowski Z., *Metody diagnozowania i prognozowania koniunktur,* IKC HZ, Warszawa 1993.

45. Matkowski Z., *Problemy identyfikacji cykli koniunkturalnych,* Z prac nad syntetycznymi wskaźnikami dla gospodarki polskiej. Vol. 51, IRG SGH, Warszawa 1997.

46. Moore G.H., Shiskin J., *Indicators of Business Expanssions and Contractions,* Occasional Paper nr 103, NBER, New York 1967.

47. Musolf R., *Skuteczna uprawa żyta na wszelkiego rodzaju glebach.* Materiały pokonferencyjne „Żyto z perspektywy 2012", Kongres RYE BELT, Poznań 2012.

48. Nilsson R., *OECD Leading Indicators and the Phase Average Trend Method*, OECD Economic Studies nr 9, 1991.

49. OECD, *Leading Indicators and Business Cycles in Member Countries*, Sources and Methods 1960-1985 NO-39, 1987.

50. Olkowska O., *Raport: Rynek mleka – czerwiec 2011*, Polska Federacja Hodowców Bydła i Producentów Mleka, 2011.

51. Olkowska O., *Sytuacja na rynku mleka w Polsce w 2010 r.*, Polska Federacja Hodowców Bydła i Producentów Mleka, 2011.

52. Ongena H., *Seasonal Adjustment of European Community External Trade Statistics: Application of X11-ARIMA/88,* Workshop on Opinion Surveys for Business and Consumers and Tine Series Analysis, Munich 1991.

53. Paschawer J., *Prawo wielkich liczb i procesu masowego,* PWE, Warszawa 1967.

54. Pawłowski Z., *Ekonometria,* PWN, Warszawa 1975.

55. *Polskie rolnictwo na tle rolnictwa UE*, Fundacja Programów Pomocy dla Rolnictwa; http://www.fapa.org.pl/gfx/saepr/Polskie%20rolnictwo%20na%20tle%20UE raport %2009_08.pdf [access: June 2013].

56. Popp J., Hantos K., *The impact of crop protection on agricultural production*, Studies in Agricultural Economics, nr 113, 2011.

57. *Produkcja upraw rolnych i ogrodniczych w 2006 r.*, GUS, Warszawa 2007.

58. *Produkcja upraw rolnych i ogrodniczych w 2010 r.*, GUS, Warszawa 2012.

59. *Produkcja upraw rolnych i ogrodniczych w 2012 r.*, GUS, Warszawa 2013.

60. *Projekt rozporządzenia Rady Ministrów w sprawie Narodowych Celów Wskaźnikowych na lata 2013-2018*, http://bip.mg.gov.pl/files/upload/18831/ Rozporzadzenie%20NCW_RM.pdf [access: July 2013].

61. Pułaska-Turyna B., *Statystyka dla ekonomistów*, wyd. III, Difin, Warszawa 2011.

62. *PZPRZ: Zbiory zbóż niższe o 6-8 proc.*; http://www.farmer.pl/drukuj/44667.html [access: June 2013].

63. *Rocznik Statystyczny Rolnictwa 2012*, GUS, Warszawa 2012.

64. *Rocznik Statystyczny Rolnictwa i Obszarów Wiejskich 2007*, GUS, Warszawa 2007.

65. *Rocznik Statystyczny RP 2004 r.*, GUS, Warszawa 2005.

66. *Rocznik Statystyczny RP 2007 r.*, GUS, Warszawa 2008.

67. *Rocznik Statystyczny RP 2011 r.*, GUS, Warszawa 2012.

68. *Rolnictwo 2006*, GUS, Warszawa 2007.

69. Rosiak E., *Dobre perspektywy dla rzepaku*, [in:] *Rzepak nowe wyzwania, wydanie 5*, Wyd. Biznes-Press sp. z o. o., Warszawa 2012.

70. Runowski H., *Rozwój zrównoważony rolnictwa i gospodarstw rolniczych*, [in:] Wieś i rolnictwo perspektywy rozwoju, IERiGŻ-PIB, Warszawa 2002.

71. *Rynek rolny. Analizy, tendencje, oceny,* No 3, IERiGŻ-PIB, Warszawa 2013.

72. *Rynek rolny. Analizy, tendencje, oceny,* No 5, IERiGŻ-PIB, Warszawa 2013.

73. *Rynek rzepaku. Stan i perspektywy*, No 43, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2013.

74. *Rynek środków produkcji dla rolnictwa. Stan i perspektywy,* No 40, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2013.

75. *Rynek zbóż i oleistych,* Zespół Monitoringu Zagranicznych Rynków Rolnych, FAMMU/FAPA, Wiadomości nr 12 i 21, 22 marca i 24 maja 2013.

76. *Rynek zbóż i oleistych*, Zespół Monitoringu Zagranicznych Rynków Rolnych, FAMMU/FAPA, Wiadomości No 21, 24 maja 2013.

77. Seremak-Bulge J., *Rynek mleka na progu 2011 r.*, Przemysł Spożywczy, No 3, 2011.

78. Skarżyńska A., *Założenia metodyczne*, [in:] *Wyniki ekonomiczne wybranych produktów rolniczych w latach 2005-2006*. Zagadnienia Ekonomiki Rolnej. Supplement No 3, IERiGŻ-PIB, Warszawa 2007.

79. *Skup i ceny produktów rolnych w 2012 r.*, GUS, Warszawa 2013.

80. Stańko S., *Prognozowanie w rolnictwie*, wyd. 2, SGGW, Warszawa 1999.

81. Stańko S., *Wyznaczenie prognozy i ocena jej realności*, [in:] *Zarządzanie ryzykiem cenowym a możliwości stabilizowania dochodów producentów rolnych – aspekty poznawcze i aplikacyjne*, IERiGŻ-PIB, Raport PW No 148, Warszawa 2009.

82. Szarek S., *Deficiencies in the law of diminishing returns*, Part I EJPAU, Series Economics, Vol. 8, Iss. 3, 2005.

83. Szarek S., *Efekt hormetyczny a efektywność produkcji roślinnej*, Journal of Agribusiness and Rural Development, No 2(12), 2009.

84. *Światowy Rynek Zbóż, Oleistych i Komponentów Paszowych. Opracowanie sygnalne*, Zespół Monitoringu Zagranicznych Rynków Rolnych, FAMMU/FAPA, Warszawa 2012.

85. *Tanieją zboża w Polsce i na rynkach światowych; będą dobre zbiory*, http://www.portalspozywczy.pl/zboza/wiadomosci/tanieja-zboza-w-polsce-i-na-rynkach-swiatowych-beda-dobre-zbiory,88046.html [access: September 2013].

86. Temme A.J.A.M., Verburg P.H., *Mapping and modeling of changes in agricultural intensity in Europe*, Agriculture, Ecosystems and Environment, No 140, 2011.

87. Tilman D., Cassman K.G., Matson P.A., Naylor R., Polasky S., *Agricultural sustainability and intensive production practices*, Nature, Vol. 418, 2002.

88. *UE: Spory wokół propozycji ograniczenia udziału biopaliw I generacji*, http://www.raportrolny.pl/index.php?option=com_k2&view=item&id=950:ue-spory-wok%C3%B3%C5%82-propozycji-ograniczenia-udzia%C5%82u-biopaliw-i-generacji&Itemid=464 [access: July 2013].

89. *Użytkowanie gruntów, powierzchnia zasiewów i pogłowie zwierząt gospodarskich w 2012 r.*, GUS, Warszawa 2012.

90. *Użytkowanie gruntów. Powszechny Spis Rolny 2010*, GUS, Warszawa 2011.

91. *W Europie po zakończeniu kwotowania produkcja mleka wzrośnie.* http://www.portalspozywczy.pl/mleko/wiadomosci/w-europie-po-zakonczeniu-kwotowania-produkcja-mleka-wzrosnie,88520.html [access: July 2013].

92. Wasilewska E., *Statystyka opisowa od podstaw*, SGGW, Warszawa 2011.

93. Wheelwright S.C., Makridakis S., *Forecasting Methods for Management,* John Wiley, New York, 1989.

94. Wiceprezes ZA Tarnów, *Ceny nawozów zależą od cen gazu;* http://www.portalspozywczy.pl/zboza/wiadomosci/wiceprezes-za-tarnow-ceny-nawozow-zaleza-od-cen-gazu,56002.html [access: January 2012].

95. *Wiosenna ocena stanu upraw rolnych i ogrodniczych w 2013 r.*, GUS, Warszawa 2013 r.

96. Wit C.T., Huisman H., Rabbinge R., *Agriculture and its environment: Are there other ways?,* Agricultural Systems, No 23, 1987.

97. *Wstępny szacunek głównych ziemiopłodów rolnych i ogrodniczych w 2013 r.,* GUS, Warszawa 2013.

98. *Wyniki produkcji roślinnej w 2012 r.*, GUS, Warszawa 2013.

99. Zając K., *Zarys metod statystycznych,* PWE, Warszawa 1976.

100. Zalewski A., *Rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa. Stan i perspektywy,* nr 34, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2008.

101. Zalewski A., *Światowy rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa*, nr 40, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2013.

102. Zalewski A., Zalewski A., *Rynek nawozów mineralnych*, [in:] *Rynek środków produkcji dla rolnictwa*, nr 37, IERiGŻ-PIB, ARR, MRiRW, Warszawa 2010.

103. Zegar J. St., *Z badań nad rolnictwem społecznie zrównoważonym*, Raport PW No 175, IERiGŻ-PIB, Warszawa 2009.

104. Zieliński Z., *Metody analizy dynamiki i rytmiczności zjawisk gospodarczych,* PWN, Warszawa 1979.

105. Ziętara W., *Organizacja i ekonomika produkcji mleka w Polsce, dotychczasowe tendencje i kierunki zmian*, Roczniki Nauk Rolniczych, Seria G, t.99 z.1, 2012.

106. Zilberman D., Templeton S.R., Khanna M., A*griculture and the environment: an economic perspective with implications for nutrition*, Food Policy, No 24, 1999.

EGZEMPLARZ BEZPŁATNY

Nakład 200 egz., ark. wyd. 13,57
Druk i oprawa: EXPOL Włocławek