REDUCTION OF MARGINAL YIELD IN CEREAL CROPS PRODUCTION AND POSSIBILITIES TO INCREASE THEIR YIELD

Zmaić, Krunoslav; Petrač, Božidar; Sudarić, Tihana

REDUCTION OF MARGINAL YIELD IN CEREAL CROPS PRODUCTION AND POSSIBILITIES TO INCREASE THEIR YIELD

UDC 633.1:338.439(497.5)

K. Zmaić[1], B. Petrač,[2] T. Sudarić[1]

[1] *Faculty of Agriculture, University of J.J. Strossmayer in Osijek, Trg Sv. Trojstva 3, 31000 Osijek, Croatia*

[2] *Faculty of Economics, University of J.J. Strossmayer in Osijek, Gajev trg 7, 31000 Osijek, Croatia*

ABSTRACT

This paper analyses and evaluates production of cereal crops indicating the importance of agricultural and economic development, but it also elaborates on causes and consequences of decreasing production and use of cereals. In the Republic of Croatia cereal crops make up for more than two thirds of the total sowed area. Maize is the dominant cereal crop; it covers 56% of total sowed area. Wheat has a share of 33% of total sowed area and is produced mostly on family farms. Analysis of marginal cereal crop yield in the Republic of Croatia throughout a longer period of time confirms that changes in the yield are not uniform, but they fluctuate around the average yield and development trend. The direction and intensity of changes in shorter intervals do not have these identical characteristics. This, as well as the fact that cereal yields in the Republic of Croatia are not always satisfying when compared with the results achieved in the European Union, indicates insufficient exploitation of the genetic potential of cereal crops. This paper focuses especially on the analysis of achieved level and dynamics of yield increase and determination of those factors that limit the dynamic development of cereal crops production.

Key words: cereals production, marginal yields, economic development of farms

INTRODUCTION

Production of cereals has a great importance on individual and national level as it directly provides food for people as well as food necessary for animal production. Volume and structure of cereal crops affect the volume and structure of animal production. Namely, growth of cereal production is in direct correlation with economic growth, which places Croatia in an inferior position in relation to cereal yields in Europe and in the world. Although cereals take up more than two thirds of the total sowed area, with maize at 56% share and wheat at 33% share as dominating cultures, the downward trend has been noticed on an average yearly rate of 0.41%. Achieved average yield between 1995 and 2004 for wheat has been 3.5 t/ha (tons per hectare), for maize 4.7 t/ha, barley 3 t/ha, oats 2.5 t/ha and rye 2.2 t/ha. Apart from that, the cereal production is characterized by cyclic decrease of growth and fall, which indicates insufficient exploitation of production potential and decrease of competitive

ability. The characteristics of cereal production mentioned above and the fact that our yields, compared with the results achieved in Europe and in the world, have not been satisfactory prove insufficient exploitation of the genetic potential of crop cultures. For that reason the object of our paper has been the analysis of marginal yields, as per achieved growth and dynamics of yield, as well as the research of those factors that are limiting to their dynamic development.

MATERIALS AND METHODS

Intensity of the change in yield is observed through applying exponential ($y=ab^t$) and linear ($y=a+bt$) trend, as well as use of third level polynomial ($y=a+bt+ct^2+dt^3$). Through interpolation of the analysed parameters on the achieved yields by applying third level polynomial, we created the possibility for determination of extreme value in yield change as well as of the point of inflection where yield increase changes from the increase phase to the decrease phase. The fact that the use of polynomial when extreme value, i.e. maximum yield, is achieved, shows decrease in production is well-known, although methodologically hard to explain, because in theory there is no point in extrapolating it. The use of polynomial in this paper is justified, however, data interpolation within time series shows phases with different marginal yields values. Marginal values we got by derivation method are compared with values of average production and in that way we were able to calculate elasticity.

RESULTS AND DISCUSSION

Dynamics and long-term tendencies of primary crop cultures are reflected in huge oscillations of achieved yields in this year as compared to the year before. These kinds of oscillations have many disadvantages when it comes to productivity achievement. These have been reflected in inappropriate agro-technique, which is then reflected on the economic result, i.e. yields level in the observed crop production. Yields of observed crop cultures by acreage unit in the Republic of Croatia show significant instability when compared to countries in the European Union. Many factors influence the average cereal crop yields, for example yields achieved in family farms should be separated from those achieved in agricultural business companies, also volume i.e. acreage of the sowed area is an important factor.

The observed period from 1995 to 2004 shows that the yields of primary crop cultures have a more or less emphasized tendency of growth. In all primary crop cultures a small interval of absolute yield variation is present. Extreme yields values are the highest in maize, barley and oats production (1:1.6) while in wheat (1:1.5) and rye (1:1.4) production they are somewhat lower. Those values show the intensity of changes that is characteristic for the development of a specific crop culture, as well as the source of its growth and changes in general. The changes we observed in the yields of primary crop cultures can also determine the variation coefficient, the values of which are highly connected to the average growth (fall) rates; if the yield growth rate is higher, the fluctuation of the yield around the arithmetical mean is greater.

Table 1: Situation and dynamics of average yields in primary crop production in the period 1995–2004

Cereals	Yields (t/ha)		Variation coefficient		Growth (fall) level	
	Croatia	EU	Croatia	EU	Croatia	EU
Wheat	4.25	5.83	0.22	0.07	0.3	0.2
Maize	5.45	8.36	0.66	0.41	0.6	0.2
Barley	3.47	4.34	0.10	0.07	0.2	0.7
Oats	2.43	3.43	0.11	0.15	0.2	1.2
Rye	2.70	4.37	0.10	0.03	0.5	0.1

The yields growth achieved throughout the observed period is characterized by different dynamics, which can be seen if observed through a shorter period of time. Namely, the growth of average yields of all the observed crop cultures in the period of 1998 to 2001 has a positive trend, which is reflected in the decrease of relative fluctuation in yields around the mean value. The period between 2001 and 2004, however, in all observed crop cultures shows the highest relative fluctuation of yields.

Table 2: Distribution of average yields in primary crop production in the Republic of Croatia in the period 1995-2004

Cereals	Arithmetical mean	Coefficient Variation	Interval of Variation		Annual rate growth /fall
			minimum	maximum	
Wheat	3.85	0.22	2.96	4.37	0.3
Maize	5.19	0.66	3.76	6.14	0.6
Barley	3.05	0.10	2.49	3.37	0.2
Oats	2.41	0.11	1.70	2.73	0.2
Rye	2.56	0.10	1.90	3.00	0.5

In order to analyse the development of yields the third level polynomial is applied. Its interpolation values are adapted by the determined coefficients with the values of the exponential trend (Fig. 1). In that way all the critical points of the polynomial function, which are characteristic for the observed period, are defined. The key points are the years of maximum yields, which are equal to the years in which marginal yield value crosses the x-axis, i.e. in which the elasticity of the yield equals zero. Also, the point of inflexion is defined, i.e. the point where yields growth has the maximum value, after which it starts to fall.

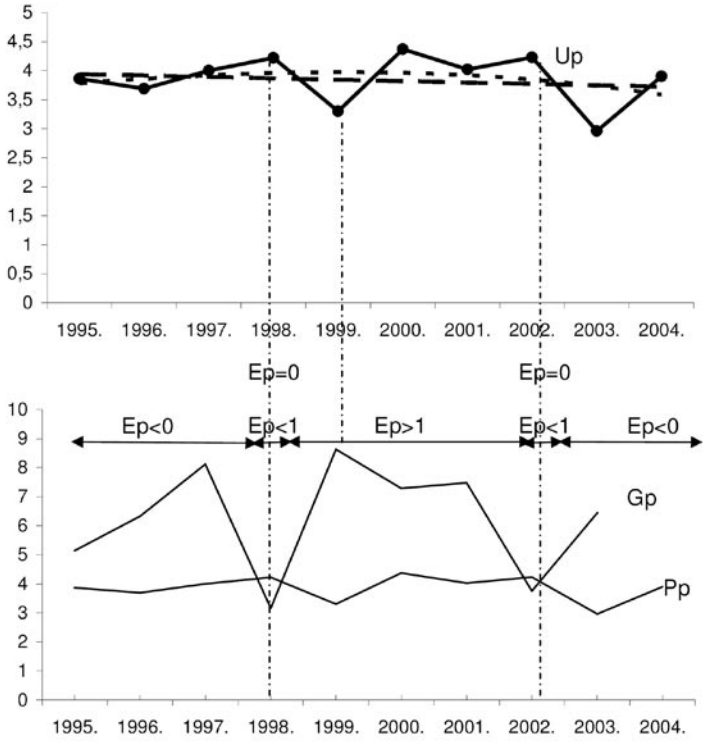

Figure 1 The whole, average and marginal wheat yield

It is interesting to point to the time periods where the point of inflexion of the productivity function is achieved, i.e. where the phase of increasing marginal values goes to decreasing marginal values phase. Those phases of slowing down of marginal value growth may last for a longer or shorter period of time for different crop cultures, but they do exist. In order to answer the question, whether this is a case of real slowing down of yields growth or are those just relative relations that are expressed by means of change rate that happen to be lower and lower, because the base is growing, they have been analysed by a linear trend taking the starting level of the occurrence and average annual growth. Results of such an analysis show that the highest annual yield during the whole observed period – in reference to the starting yield rate – was achieved for in the period 1998 to 2001 for all observed crop cultures (wheat, barley, oats, rye).

What may be observed is that value for the minimum and maximum yield for all primary crop cultures is in 1996 and 2003 respectively. Yields of all observed crop cultures are lower in family farms than in business companies. However, regardless of the ratios that may lead to conclusions that the potential unexploited part of the yields is on family farms, the exploitation of which could positively influence the average yield in the Republic of Croatia, the researched and analysed differences show that the slowing down of growth is limited and the growth of production may only be achieved if real causes for the slow growth in agricultural production are found.

Table 3: Years of critical yield points of primary crop production based on third level polynomial

Cereales	Years where polynomial extreme value is achieved (GV=0)		Years where is polynomial point of inflexion
	minimum	maximum	Gp=max.
Wheat	1998	2002	1999
Maize	1996	2003	2001
Barley	1996	2003	1995
Oats	1996	2001	1998
Rye	1995	2002	2001

Possibilities of solving reduced yield growth of primary crop cultures found in the Republic of Croatia when compared to European Union, requires scientific approach and detailed examination of possible causes. The basic causes of such occurrences should be looked for in the process of production preparation, in the technological production process, in economizing the productivity factors, in business and economical approach to agriculture and measures of agricultural protection. The achieved trends and dynamics of yield development are evaluated according to the use of genetic potential of crop cultures as well as agro-technical measures. However, it would be wrong to conclude that all problems in agricultural production could be solved by agro technical and zoo technical production conditions. Economic relations are the key factor in the above-mentioned circumstances, especially in a market economy. Namely, neglect of agriculture in economic development and primary division, influence the general efforts for extension of agricultural production, insufficient use of all categories of arable agricultural areas as well as decrease in yields during the years when some of the agricultural products are imported. If we take into consideration all these factors, we may conclude that a whole range of complex causes influence the yield development trend for a long period of time. A more detailed examination of all mentioned negative factors is essential along with systematic efforts on all levels, in order to remove these negative factors and increase comparative and competitive advantages in production of basic crop cultures.

CONCLUSION

Through analysis of yield dynamics in production of primary crop cultures throughout the entire observed period it was found that yields by sowed surface area unit in relation to the starting level are growing, although genetic potential still is not exploited enough and yields are still not equal to those achieved in the countries of the European Union.

The analysis showed that the dynamics of change in yields differs in intervals. During the last period there is considerable reduction of yields growth, i.e. reduction of its marginal values. Reduction in marginal yields causes a tendency of yields stagnation as well as more emphasized decrease in yields.

Possibilities of correcting such situation are in scientific approach to this occurrence and detailed determination of its causes. The research presupposes at first a detailed analysis of the applied technological process, its application in practice, combining production factors in order to find their optimal relationship in technical, energetic, biological and economic sense in order to remove the factors that have evident limiting/negative function. Secondly, a research of the economic conditions in production should be conducted, especially in relation to the price of specific factors and production results, as well as determination of measures needed to stimulate investment in production and get producers who are highly motivated for further yield growth and production improvement.

REFERENCE

[1] Goodman, D., and Watts, M. J. 1997. Globalizing Food, Agrarian Questions and Global Restructuring, Routledge, London

[2] Hayami, Y., and Ruttan, V. W. 1985. Agricultural Development: An International Perspective, The Johns Hopkins University Press, Baltimore, Maryland

[3] Justman, M., and Teubel, M. A. 1991. Structuralist Perspective on the Role of Technology in Economic Growth and Development, Pergamon Press, New York

[4] Eurostat Agriculture Statistical Yearbook 2000. FAO, Production Yearbook, Rome

[5] Lončarić, R., Tolušić, Z., Zmaić, K. (2004): Croatian Cereal Market under condition of World Market Globalization, International Congress FLOUR-BREAD 03, 4th Croatian Congress of Cereal Technologists, Opatija, Croatia, p.p. 314-321.

[6] Petrač, B., Zmaić, K., T. Sudarić (2004): Grain Production as a basis of Agricultural and Economic Development, International Congress FLOUR-BREAD 03, 4th Croatian Congress of Cereal Technologists, Opatija, Croatia, p.p. 24-31.

[7] Zmaić, K., Petrač, B., Sudarić, T. (2005): Crop Production in a Function of Agricultural and Economic Development, Prospects for the 3rd Millenium Agriculture, Cluj-Napoca, Romania, p.p. 196-202.

RETARDACIJA GRANIČNIH PRINOSA ŽITARICA I MOGUĆNOST NJIHOVOG POVEĆANJA

SAŽETAK

U radu se analizom i ocjenom stanja proizvodnje žitarica ukazuje na značaj poljoprivrednog i gospodarskog razvoja, te na uzroke i posljedice pada proizvodnje i iskorištavanja žitarica. Žitarice u Republici Hrvatskoj participiraju s više od dvije trećine svih zasijanih površina pri čemu dominira kukuruz sa udjelom od 56% i pšenicom od 33% čija se proizvodnja najviše odvija na obiteljskim poljoprivrednim gospodarstvima. Analizom retardacije graničnih prinosa žitarica u Republici Hrvatskoj, kroz duže vremenskom razdoblje, utvrđeno je kako promjene prinosa nisu ravnomjerne, već osciliraju oko prosječnih prinosa i razvojnog trenda, ali kako smjer i intenzitet promjena u pojedinim kraćim intervalima, nemaju identična obilježja. Ova okolnost, kao i saznanja kako prinosi žitarica koje ostvaruju proizvođači u Republici Hrvatskoj, komparirani sa rezultatima u Europskoj uniji nisu uvijek zadovoljavajući što upućuje na neiskorištavanje genetskog potencijala žitarica. Uslijed navedenog u radu su analizirane, posebice sa stajališta dostignute razine i dinamike razvoja prinosa i determiniraju oni činitelji koji limitirajuće djeluju na njihov dinamični razvoj.

Ključne riječi: proizvodnja žitarice, granični prinos, razvoj poljoprivrednih gospodarstava