TAKÁCS-GYÖRGY Katalin* and TAKÁCS István*

Changes in cereal land use and production level in the European Union during the period 1999-2009, focusing on New Member States

The decrease in the area of arable land has further continued in the European Union (EU) since the Millennium. Sustainable development is partially based on the sustainable use of natural resources, which is based on the limitation of land use and on the introduction of different incentives. Previous direct subsidies resulted in increased production. The reform of the Common Agricultural Policy (CAP) has aimed to stop the increase in production, possibly even to decrease production. The objective of this research is to show whether such an effect on land use and on the change of production structure in the EU can be observed. Analyses have shown that agricultural and arable areas have further decreased within land use since the Millennium, continuing the previously characteristic trend in the EU. The proportion and the yield of cereals in the production structure have increased. We conclude that in this respect the effects of the CAP on agriculture are the opposite to its original aims.

Keywords: priority in agricultural policy, the role of cereal production, simplification of production structure

* Károly Róbert Főiskola, H-3200 Gyöngyös, Mátrai u. 36., Hungary. Corresponding author: tgyk@karolyrobert.hu

Introduction

The aims and means of agricultural policy have gone through numerous changes throughout the last fifty years of the history of the European Union (EU) and its predecessors. Specialties deriving from the characteristics of agricultural production and its structure have come continuously in the foreground when shaping the aims and means of the policy. The sustainable use of natural resources is of augmented importance, which is basically based on the limitation of land use and the introduction of various incentives. The (Axis 2) measures serve this objective of enhancing the utilisation and protection of arable land. Land use is affected by all the above.

The priorities of agricultural subsidies have been moved from direct producer income support to income support that is non-exclusively connected to production, thus also helping environmental protection and population retention related to the multifunctionality of agriculture. Earlier the direct subsidies had a demonstrable impact on the expansion of production; the farmers applied the practical elements of the above mentioned technical development. According to the intentions, the restructuring of the subsidy system – decoupling – should also have resulted in the containment of the expansion of production, or even in the reduction of production and in reducing the likelihood of overproduction.

From 2014 it is estimated that the reform of the Common Agricultural Policy (CAP) will give priority to the subsidisation of rural communities and society instead of direct production subsidies. The changes in subsidy policy and the introduction of the Single Payment Scheme (SPS) will have a significant impact on the distribution of income and, accordingly, on the structural reform of agriculture only if the movement of subsidy entitlements and land markets are free. The SPS will have the biggest impact on those areas where the land prices and land rents are the lowest, the land ownership is clearly separated from land use and the efficiency of production can be increased (Vásáry, 2008; Swinnen *et al*., 2009). The subsidies help to reduce the fear of risks and encourage farmers to increase production and/or change the production technology when individual decisions are to be made. Bíró (2010) notes that the introduction of the SPS in the short term enables the enforcement of agricultural policy considerations, improvement of livestock production, and contributes to the stabilisation of the land market by integrating it into the value of the farm and increasing the price of land. He adds, however, that it will not help the development of small- and medium-size farms and the improvement of their creditworthiness. He presumes that the system will remain the same in the Old Member States (OMS). All of these can affect the land use. As regards Hungary, the introduction of the SPS in the short term will be more favourable for the land users because it decreases the income outflow to land owners. Other authors focus on the importance of small, mainly family enterprises as they could be the key-elements of transition economies so their subvention is necessary in the future (Britz *et al*., 2006; Duh *et al*., 2009).

In a Hungarian impact model study Dorgai and Udovecz (2008) examined the possible social, economic and environmental impacts of the drastic reduction of direct subsidies. They stated a that 50% decline in subsidies would result in a 50% and 42% drop in wheat and maize production, respectively, and also a 50% reduction in the horticultural sector, which would ultimately lead to significant market losses for Hungarian producers. Arable crop production would primarily decline in the unfavourable areas. About 700-900 thousand hectares would be withdrawn from farming, but the alternative use of these areas is uncertain (regions in the Northern Great Plain, Southern Great Plain and Northern Hungary).

The agricultural and rural development subsidies are considerable in many countries of the world. The distortions caused by agricultural subsidies (e.g. the maintenance of production in uncompetitive farms, the undesirable changes of production structures) can be properly justified with economic or other benefits and whether these objectives could be reached more efficiently. Kovács (2009) noted that in Hungary only 65% of the transferred agricultural payments

appear in the profit, the remainder is spent on inputs. Following Hungary's accession to the EU, the subsidies in Hungarian agriculture significantly contributed to the objectives of agricultural policy concerning expansion, competitiveness and efficiency (Szabó, 2008).

Van Meijl *et al*. (2006) used model calculations to show that no drastic decline can be expected in agricultural land use and product output within the EU in the next 30 years following the liberalisation of the trade and subsidy system. The reason for the impact, which is just the opposite to what was previously presumed, is, on the one hand, the economic growth and increasing demand for food in developing countries, and on the other hand, that they underline that the declining competitiveness due to the declining subsidies will move production towards extensification and not towards withdrawal of land from agricultural production. They concluded that the lower quality land will be withdrawn and it may lead to an increase in yield. It was also underlined by another research team who showed that the areas with high marginal costs and unfavourable qualities are partly withdrawn from food production due to the introduction of the SPS instead of the former, direct payments. This process contributes to the improvement of environment (Brady *et al*., 2009). By analysing the Polish land use changes Sadowski (2009) verified that the poorer arable land was withdrawn from production after implementing EU subsidy system. Central and East European agriculture is characterised by a high incidence of small-scale farmers who are not producing for the market. Their agricultural activity has an effect on land use, but its strength depends on their real share in land use in different countries (Mathijs and Noev, 2004).

Zimmermann *et al*. (2009) summarised the main methods and determinants relevant for modelling farm structural changes and land use changes. The land use changes were modelled for Hungarian conditions by Vízvári *et al*. (2009) and this showed that the changes in land use are affected less by the changes of subsidy system and more by climatic changes. Further examinations should be made in the future concerning the impact of increasing demand for biomass production on land use. This agro-strategic question is a basic structural issue in most of the EU Member States – including Hungary – and it is also a reply to the typical cereal question (Popp and Molnár, 2009).

Kuldna *et al*. (2009) modelled land use in the long term. By examining the EU-15 and EU-10 Member States they concluded that the proportion of land used for bioenergy production can reach 10-30% of the total area in the New Member States (NMS) by 2080, while in the OMS, only 10-12% of the arable will be used for production of these crops in the different analysed scenarios. All this will be accompanied by the intensification of production, in spite of the fact that they calculated with the cut in direct production subsidies.

Others examined the question together with the subsidy system and the climatic changes and concluded that the climatic changes in the Carpathian basin will have a more significant impact on land use due to the diminishing water resources and will encourage cereal production instead of high water demand crops (Singh *et al*., 2007; Fekete-Farkas *et al*., 2008). The share of cereals within the production structure increased in the period before the EU accession. Burgerné Gimes (2003) examined the land use before the EU accession and revealed that the dominance of cereals could already be observed. She also stated that the reduction of fruit and wine-growing areas had already started in many countries. Since the level of sectors with higher specific production value decreased, the competitiveness of agriculture in the NMS further declined in international comparison (Takács, 2008).

So the changes in land use and production structure are also affected by the reforms of subsidy system. The review of the agricultural subsidy system of the EU from the beginning is beyond the scope of this study. Here we focus on exploring whether the intended objectives of the system were met concerning the quantities of basic crop product within the EU. We aim to show how the land use, production structure and yield – which expresses the level of production – changed in the OMS and NMS of the EU. We premise the following hypotheses:

1. The formerly typical decline of agricultural and arable areas in land use continued, the reduction of agricultural areas was higher in the NMS;
2. The proportion of cereals decreased in the production structure;
3. A slow but balanced growth of yield could be seen between 1999 and 2008, showing differences in yield levels for the benefit of the NMS.

Methodology

This research used the data regarding areas and land use, as well as the yields indicating the production level of the EUROSTAT database for the period between 1999 and 2009. The analysis was based on the following EUROSTAT datasheets "DS-072420-Crops products (excluding fruits and vegetables) (annual data)" of subsheets Wheat, Grain maize, Sunflower seed, Rape, Sugar beet, Fodder from arable land, and "DS-072422-Land use – 1000 ha (annual data)" of Land area – Total, Utilised agricultural area (UAA) of subsheets Arable land, Cereals excluding rice, Root crops, Industrial crops, Fodder from arable land, Forest area. Data were selected Group of countries of the EU (27 countries), EU (25 countries), EU (15 countries), European Community (12 countries, including ex-GDR), European Community (10 countries), as well as the individual Member States. From the statistical data the proportions of the area of the different species were calculated.

The data were evaluated by Member States and two groups: (1) EU-15 and (2) EU-10. This latter group does not include Cyprus and Malta from the Member States that accessed the EU in 2004, but includes Romania and Bulgaria that accessed in 2007. Data used: total area, total agricultural area, arable land, area of cereals, yield averages, etc. Calculated statistical indices: average, dispersion, slope, linear trend, correlation and classification.

During the analysis of the average annual relative changes in land use, Member States were classified into five categories (see caption of Table 1). These categories were based on the judgement of the authors, after empirical analysis of the distribution of data. We used linear regression to emphasise

the direction and strength of the changes, but there was no economic meaning of the alignment.

The average annual change of yield of wheat from 1999 to 2009 (100 kg/ha) and the average annual change of rate of cereals in arable land from 1999 to 2009 (%) as well as the average annual change of yield of maize from 1999 to 2009 (100 kg/ha) and the average annual change of rate of cereals in arable land from 1999 to 2009 (%) were graphically plotted in rectangular Cartesian coordinates, and the groups of quadrants of it are determined the classification of Member States.

Results

The area covered by the EU-27 is 432.5 million hectares, out of which the area utilised for agricultural activities is 181.1 million hectares, i.e. 41.9% of the total area in 2007. The crop production sector made up to 110.0 million hectares, 25.4% of the total area and 60.7% of the agricultural area. The agricultural land use showed a decreasing trend to different degrees between 1999 and 2009. The decline was 7.6‰ in the OMS between 2004 and 2008 (the available data did not allow a ten-year comparison).

There were a 12,1‰ drop in the NMS (Group 1) during the ten years. The pace of decline was higher than in the OMS (Group 2). Out of the OMS, the radical decline of the former period significantly slowed down in the Netherlands (1,8‰) and France (1,4‰), while the reduction was still considerable in Italy (15,5‰) and Germany (10,0‰). The agricultural areas were reduced in the NMS during the period studied. There was a 26,2‰ decline in Latvia, 17,2‰ in the Czech Republic, 14,3‰ in Poland, 10,2‰ in Bulgaria, and 6,5‰ in Hungary.

In the majority of the NMS the decrease of agricultural area was more than 10 per thousand during the examined period. In the case of Hungary, Romania and Slovenia the decrease was moderate, while in two of the OMS, Spain and the United Kingdom (UK), the rate of decrease was significant. However the growth in cereals was characterised by varying amounts within the arable lands in the NMS. The trend analysis proved our first hypothesis.

There was a general reduction in the crop production area. The arable land decreased by 4,3‰ in the EU-15, while the drop was more significant (5,4‰) in the NMS. Out of the OMS, the reduction was projecting in Spain and Italy. Out of the NMS, the average relative reduction of arable land was higher than 10‰ in Poland, Bulgaria, the Czech Republic and the Baltic States. The increasing proportion of arable land within the agricultural area was very high in Spain, Latvia, Slovakia and Slovenia. Because the area decrease expressible with per thousand centile, the purpose of clarity we marked the direction of changes, and disregard the notification of the specific numbers in Table 1.

In the OMS, the average relative growth of ratio of cereals was higher than 10‰ within the arable land in the case of

Table 1: Changes of land use of the EU (1999-2009).

Countries	Area and changes from 1999		Proportion and changes	
	UAA 1000 ha	Arable 1000 ha	Arable/UAA %	Cereals/Arable %
Austria	3384.3 -	1384.7 0	40.9 +	58.5 0
Belgium	1393.8 -	853.8 0	61.3 0	33.0 ++
Denmark	2997.5 -	2821.5 -	94.1 -	53.1 +
Finland	2201.4 +	2176.6 +	98.9 0	51.8 0
France	29793.2 0	18318.1 +	61.5 +	48.2 0
Germany	17151.6 0	11821.5 0	68.9 +	56.1 0
Greece	3918.9 0	2805.8 --	71.6 --	45.0 +
Ireland	4418.4 -	1076.4 0	24.4 +	26.9 +
Italy	15793.7 --	8553.1 --	54.2 -	46.2 ++
Luxembourg	127.4 0	61.6 -	48.4 -	44.6 ++
Netherlands	1982.9 -	1007.1 +	50.8 +	18.9 +
Portugal	3916.5 -	1739.2 --	44.4 --	32.7 --
Spain	25942.2 --	13463.4 --	51.9 ++	48.9 ++
Sweden	3055.4 +	2680.6 0	87.7 -	43.0 --
United Kingdom	16760.8 --	4495.0 ++	32.7 -	72.2 --
Bulgaria	5678.6 --	3493.6 --	61.5 -	55.4 --
Czech Republic	4282.5 --	3107.2 --	72.6 0	51.2 ++
Estonia	1001.1 --	860.5 --	86.0 0	37.3 ++
Hungary	6186.0 -	4167.6 0	67.4 +	58.0 +
Latvia	2470.0 --	1840.5 --	74.5 ++	22.6 ++
Lithuania	3495.7 --	2936.4 --	84.0 -	34.5 ++
Poland	18222.3 --	14134.2 --	77.6 -	61.6 ++
Romania	14781.3 -	9329.5 -	63.1 0	57.5 -
Slovakia	2443.6 --	1492.9 -	61.1 ++	51.9 +
Slovenia	514.5 -	171.2 +	34.3 ++	53.2 0

Key to signs: ++ Pace of average annual relative change is higher than 10‰; + Pace of average annual relative change is between 2‰ and 10‰; 0 Pace of average annual relative change is between 2‰ and -2‰; - Pace of average annual relative change is between -2‰ and -10‰; -- Pace of average annual relative change is higher than -10‰.
Source: Eurostat online database, own calculations.

Belgium, Italy and Spain, while in case of NMS, the Czech Republic, the Baltic States and Poland had similar trends. The increasing ratio of cereals can be connected the efforts of farmers to fully exploit the area-based production subsidies of the EU system. There was a decline in Germany, the UK, Portugal and Sweden, but these latter two countries are not considered to be primary cereal producers. At the same time, however, there were significant differences in the ratio of cereals across the years (Table 2).

Another clear trend is the relative reduction of industrial crops within the arable land. Taking into consideration the limits of the paper, we mention only these trends without showing the analysed data. The slow increase in cereals took place to the detriment of industrial crops. It could be observed in all the NMS within the period studied, so the second hypothesis was rejected.

The rate of average annual decline of fodder crop areas was significant in those Member States where the decline of ruminant livestock population was similar. Out of the OMS, Denmark, France, the UK and Spain, as well as most of the NMS belong to this group. Out of the NMS only Poland and Slovenia could actually increase the fodder crop areas according to the changes of their livestock production. The growth of afforestation meets the former intents and predictions according to which the forest sector increased during these the years even in the not particularly mountainous Member States.

The reduction of arable land in itself does not refer to the yield volume of basic field crops produced in the EU. We also analysed the relationships between the increasing ratio of cereals (winter wheat) and the changes in yield. The volume of winter wheat produced in the EU increased in total during the examined period. There was a reduction in the UK during this period both regarding the area of production and the average yield. The decline was significant in Lithuania and Portugal as regards the territorial ratio, while the area increased considerably in Spain, Poland, Estonia and Latvia. The average yield increased significantly in Estonia and Lithuania, so these two NMS grew their wheat output above their self-supply level. The average yield also increased in Latvia from the Baltic States and in Poland, thus they have become key wheat producers at regional level (Figure 1). A similar increase was observed in maize yield (Figure 2).

The crop share from the arable land considerably varied in production structure in Spain and in the UK from the group of OMS, while from the NMS it showed a similar trend in Bulgaria, Estonia, Latvia and Lithuania. In Hungary a relative compensatory balance characterised the high rate of cereals from arable land (58.0-66.6%) – similar to Poland (61.1-71.8%) – in the evaluated period. The increase of cereals showed a trend in Belgium, Italy, Luxembourg and Spain from the OMS. The same was observed in the Czech Republic, Estonia and Poland from the other group (Table 2).

Amongst the OMS – compared to the former higher average yield level – the production level further improved in the Netherlands and Belgium. The average yield growth did not reach the average of the EU-15 in Germany, while there was no significant improvement in average yield in France during the examined period.

The research confirmed the presumption that the sowing area of winter wheat within the cereals has not decreased in comparison to the situation prior to the enlargement of the EU, but the volume of cereals produced within the EU grew in total due to the increasing of average yield (Figure 1).

Table 2: Ratio of cereals within the arable land, % (1999-2009).

Countries	Arable land (average of 1999-2009)	Rate of area of cereals in arable land					
		Min	Max	Means	SD	Slope of change	Correlation
	1000 ha	%	%	%	%	-	-
Austria	1,377	56.4	61.5	59.2	1.6095	0.094	0.215
Belgium	844	33.0	43.0	37.8	3.2014	0.810	0.928
Denmark	2,512	53.1	61.7	59.8	3.0772	0.289	0.295
Finland	2,223	51.0	55.4	53.3	1.4593	0.065	0.160
France	18,596	42.7	52.8	49.2	3.1379	0.067	0.076
Germany	11,861	55.3	59.7	57.9	1.5039	-0.104	-0.245
Greece	2,572	45.0	49.7	47.1	1.7894	0.370	0.570
Ireland	1,140	23.8	28.5	25.7	1.5673	0.077	0.164
Italy	7,993	46.2	51.9	48.7	2.0351	0.559	0.899
Luxembourg	62	42.1	50.4	46.7	2.5834	0.549	0.798
Netherlands	1,048	18.9	23.5	21.4	1.5722	0.072	0.162
Portugal	1,411	24.4	32.7	28.0	2.8297	-0.660	-0.833
Spain	12,424	48.6	75.7	52.6	9.3558	1.311	0.556
Sweden	2,645	36.4	46.5	41.1	3.3758	-0.682	-0.726
United Kingdom	5,125	54.5	72.2	62.6	8.0359	-0.853	-0.342
Bulgaria	3,276	48.8	64.0	55.3	5.5196	-0.802	-0.486
Czech Republic	2,788	51.2	60.2	56.6	3.4787	0.897	0.875
Estonia	642	37.3	51.9	46.1	5.4387	1.405	0.890
Hungary	4,511	58.0	66.6	63.0	3.0125	0.510	0.578
Latvia	1,045	22.6	46.5	41.9	8.2154	1.212	0.529
Lithuania	1,968	33.4	58.0	51.1	9.3089	1.634	0.616
Poland	12,860	61.6	71.8	66.2	3.7900	1.175	0.977
Romania	9,130	56.7	68.9	61.2	4.4966	-0.376	-0.290
Slovakia	1,386	51.9	60.4	57.8	2.8461	0.212	0.277
Slovenia	175	53.1	60.1	56.5	2.4356	-0.037	-0.053

Source: Eurostat online database, own calculations

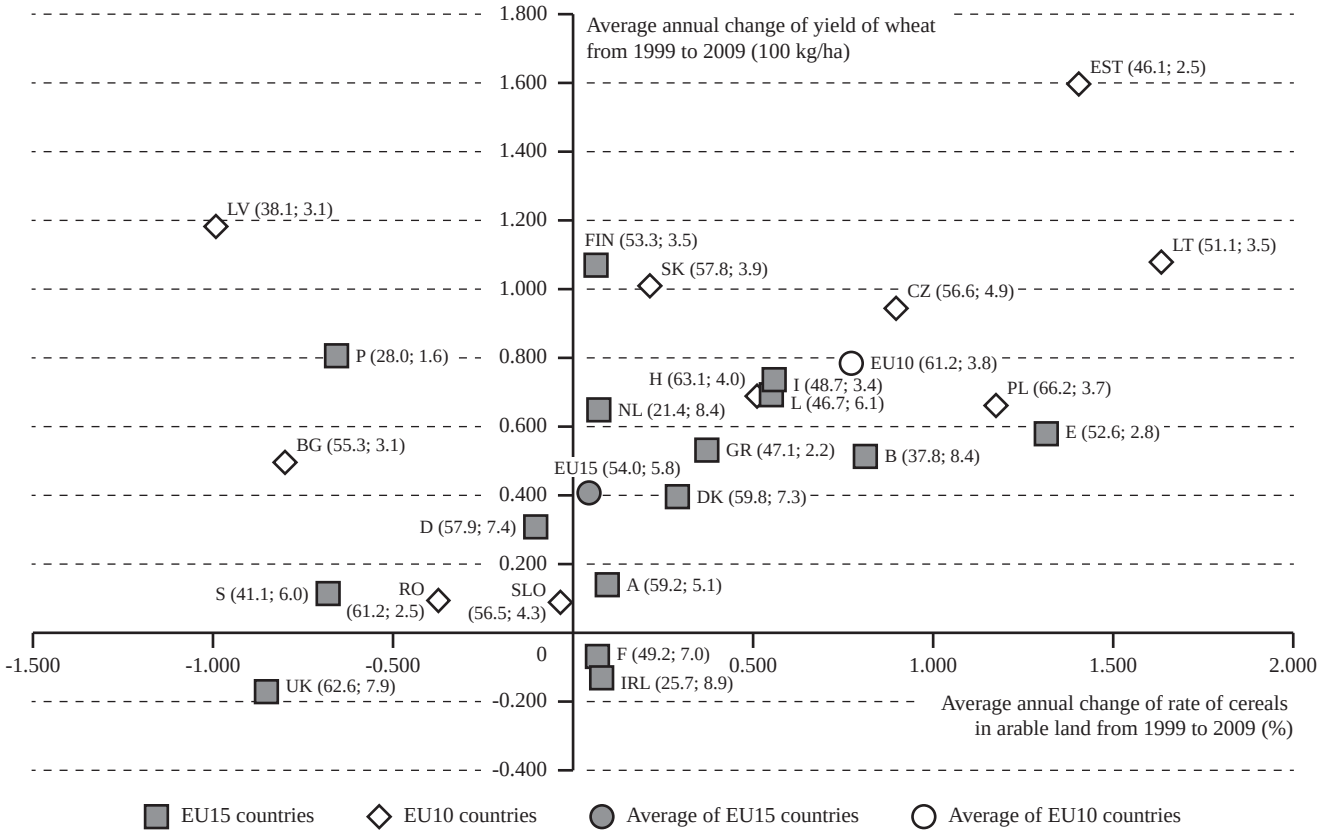

Figure 1: Winter wheat rate within the arable land and changes of average yield in the EU (1999-2008).

Information at marks: Country code (Average rate of cereals in arable land (%); Average yield of wheat (t/ha))

Source: Eurostat online database.

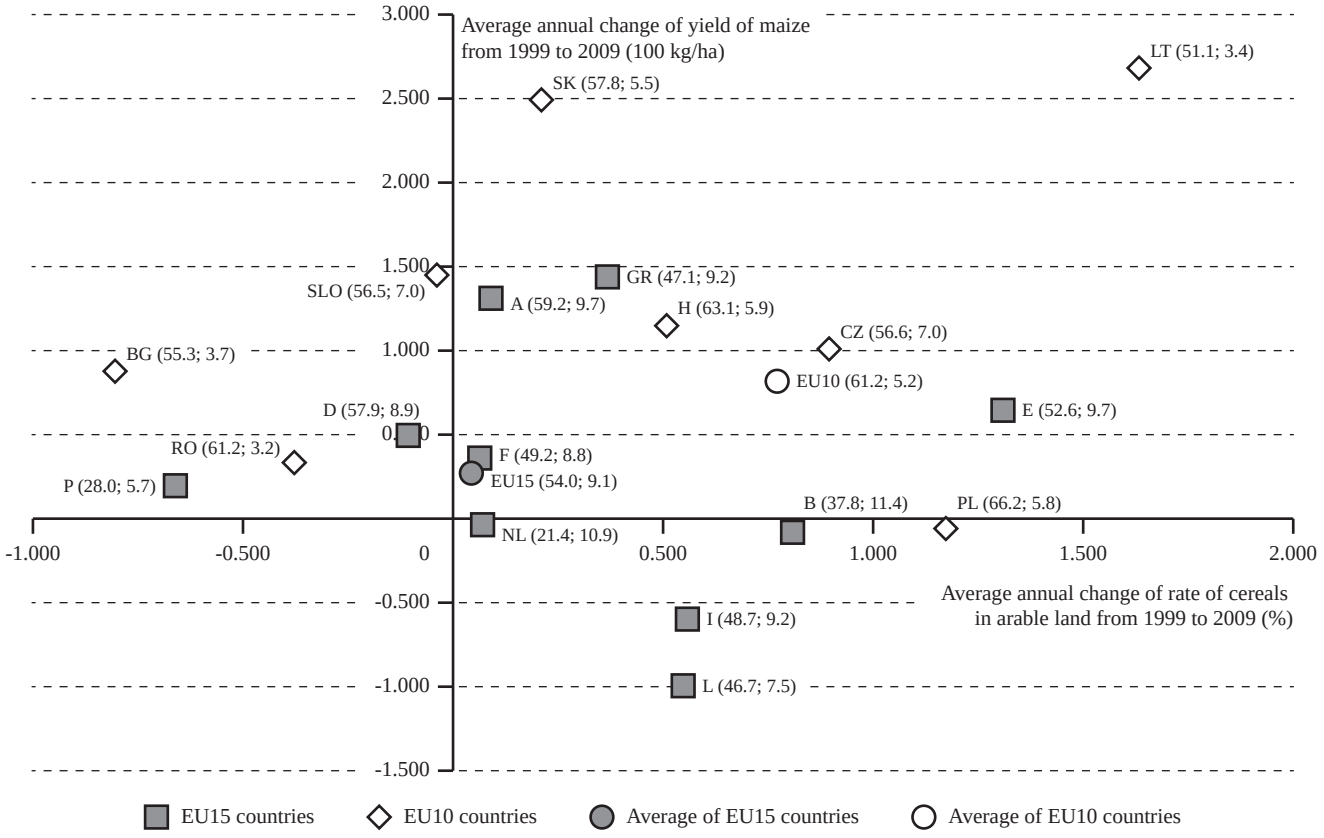

Figure 2: Maize rate within the arable land and changes of average yield in the EU (1999-2008).

Information at marks: Country code (Average rate of cereals in arable land (%); Average yield of maize (t/ha))

Source: Eurostat online database.

Examining the maize land changes in the NMS we observed an increase in the Czech Republic and in Hungary. A similar yield increase occurred in Slovenia while but maize land area was unchanged, while the yield increased by 2.5 times in Slovakia. In Poland nearly at the same yield level some increase of land use could be seen (Figure 2). The expansion of maize production area could also be observed in some of the OMS (at constant yield level in Spain and at diminishing yield in Belgium and Italy). In summary, the yield increase was not typical in the OMS – but it must be underlined that their starting yield level was higher than in the NMS – so in their case the maize production has not increased considerably.

Comparing the winter wheat and maize production in the EU we concluded that the wheat production increased mainly in all Member States, but the average yield increased by a higher rate in NMS in the evaluated period. Consequently the northeastern countries of the EU have become self-sufficient and have appeared on the wheat market. The share of maize of arable land has not increased remarkably in land use, but in the NMS the maize yield increased resulting in their significant role in the maize market.

Our third hypothesis relating to yield came true. It should be noted that in the majority of NMS, in the case of cereals, the higher yield increase originated from the typically lower yield level of 1999. The exploration of causes was not an object for our examination.

Discussion

The research showed that the formerly typical reduction of agricultural and arable land in the EU continued after the Millennium. The increase in the rate of cereals in the production structure was accompanied by the growth of production level (growth of average yield), so the former expectation of decline was not correct. The former presumption was verified that the sowing area of winter wheat within the cereals has not decreased in comparison with the situation prior to the enlargement of the EU. At the same time – due to the increase in average yield –the volume of cereals produced within the EU grew in total. In the NMS cereal land use increased with negative effects on the environment. In some EU Member States the crop share from the arable land considerably varied in production structure. This fluctuation can be explained by the higher weather exposition of these countries.

The increase of cereals' share in production structure anticipates the difficulty of optimal crop rotation at the farm level, or rather that the producers will not be able to produce constant yield quantity in some cases, or with the cost of economic sacrifice (yield loss vs. additional inputs). The question is whether it can be a common aim. The examination of the consequences of a simplified production structure requires further research.

The yield increase highlights that some of the NMS (Czech Republic, Poland, Hungary) have become significant participants in the maize market partly due to the implementation of EU subsidy system and partly to the strengthened demand for alternative energy sources. This is primarily due to – besides the relatively significant drop of fodder producing areas within the production structure – that part of the CAP subsidy system which, in spite of intentions, did not help to reduce overproduction. When subsidies are connected to production, the producers give priority to those crops for the production of which they know the technology, they have the required resources, the costs are not too high, the storage and sale of product is of relatively low risk, and appropriate income is ensured together with the subsidy.

Since the analysis of the effects of biomass production among the causes of land use change was not our goal, we only mention that the expansion of industrial plants within the production structure is already perceptible.

Despite the decrease of less favourable arable land there was no decrease in yields, due to the increase in land and input use efficiency there was a development in yields and in gross crop volume. This coincides with the results of the earlier authors (van Meijl *et al*., 2006; Angusa *et al*., 2009; Kludna *et al*., 2009; Popp and Molnár, 2010).

Considering the above trends of land use, the slowdown of reduction of agricultural areas, including arable land is positive. The increasing ratio of cereals within arable land – especially in the case of those Member States where the proportion of cereals has always been high (above 60%) – has a negative side: no diversified production structure can be developed at the farm and national economy level, and the production structure does not enable the advantages of vertical and horizontal relations to be utilised. On the one hand it causes the loss of biodiversity; on the other hand it increases the production costs due to the deterioration of input efficiency, thus damaging the competitiveness and income situation of producers. In conclusion, in this respect the CAP has resulted in effects on agriculture which are the opposite of its original aims (Popp and Molnár, 2010).

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