Acta Universitatis Sapientiae, European and Regional Studies, **4** (2013) 51–72

The Performance of Agriculture in Denmark and Hungary with Special Focus on Sustainability and Lack of Capital

Judit BEKE LISÁNYI
Budapest Business School, College of International Management and Business, Department of International Relations

Anna FORGÁCS
Budapest Business School, College of International Management and Business, Department of Management and Human Resources

Abstract. The main purpose of the present study was to examine whether the lack of capital could be a significant constraint of agricultural performance in Hungary, whereas in Denmark, commitment to advancing the sustainability of agriculture results in a lower agricultural performance. Two European country groups were formed (an Eastern and a Western group), then their potential output paths were constructed by applying a Cobb-Douglas-type agricultural production functions. The output figures were compared to the potential output of the group. Compared to the average group performance, Denmark showed a 9%, while Hungary a 5% point difference. In Hungary, the lack of capital greatly reduces performance; however, because of the low employment rate, the replacement of capital by labour can be justified. In Denmark, agricultural performance is weakened because significant efforts are made to ensure sustainable agriculture.

Keywords: agriculture, Hungary, Denmark, performance of agriculture, sustainability, practical guidelines

Introduction

It is particularly important to assess the performance of agriculture not only in the underdeveloped regions (where the agricultural sector provides food and employment for an ever-increasing population), but in developed regions as well. The reason is that although the sector's contribution to the GDP is only about 1–3%, feeding the population has remained strategically important, food consumption is of a very high ratio (approx. 15–20%), large amounts of state and community (EU) support are provided to the sector, and in many developed

countries the external trade (exports) of agricultural products still represent a significant share.

While technological progress is transforming products and services, it is the agricultural sector that provides and will always provide food and fibre, therefore more emphasis is put on the new and diversified activities of a multifunctional and sustainable agriculture. We have decided to analyse Denmark and Hungary since both of them are traditionally agricultural countries with relatively high performance in their regions. In these countries, the climate, the geographical location, the topographical conditions and the traditions are suitable for agricultural production. In spite of the similarities, a lot of differences can be observed, e.g. the development of agriculture is determined by the different cultural conditions, by the inherited differences in economic development and by the historical roots. Hungary has natural endowments and high-quality agricultural lands, but in Denmark the conditions for agricultural production are more unfavourable, but cooperative collaboration, the various means of support and the use of advanced technologies resulted in significant progress. Technical development in Denmark has been significant from the seventeenth century while our country has still been struggling with technical incapacity and the lack of capital improvements. Despite the fact that both countries are known to have prominent agricultural sectors, our studies examining 12 EU countries show that performance is below the regional average. According to our hypothesis, the reason could be that in Denmark a significant proportion of the resources are devoted to sustainability, while Hungary still faces the problem of the lack of capital.

Material and methods

Our study begins with a systematic literature review of studies on agricultural performance and considers the different methods to assess the performance of Hungary and Denmark. First, a simple comparative analysis has been performed; secondly, Cobb-Douglas-type agricultural production functions and two-variable linear regression have been applied in the comparison of the actual and potential outputs of the two countries with the involvement of additional data from 12 European countries. In the third part of our study, we have endeavoured to show that the relatively lower performance of Danish agriculture could be partly the result of sustainable farming practices, which can require some short-term sacrifices in economic performance (with the long-term goal of providing public goods and enhancing the multifunctionality of agriculture). For this reason, we have examined pollution from agriculture (chemical use and GHG emissions) and the importance of organic products (area under organic farming and the share of organic pigs). Our research was based on figures released by Eurostat and FAO.

1. Scientific literature on the measurability of the performance of agriculture

Literature on agricultural performance was reviewed, and in the present paper only those important aspects are summarized that served as a starting point in our study. To measure the performance of agriculture, first labour and capital were considered as the determinants of output, then fertilizer use, irrigation and other agricultural services, and finally the impact of institutional economics were involved.

The first production function was made by Cobb and Douglas (1928). Productivity was studied by Barton and Cooper (1948), and Cooper, Barton, and Brodell (1947). The first comparative country study was made by Bhattacharjee in 1955. Bhattacharjee compared the 1955 performance of 22 countries where only land, labour and fertilizer use were the considered inputs. Paige and Bombach made similar studies in 1959.

Capital became one of the most important factors in the analysis of the performance in the studies of, e.g. Hayami and Ruttan (1970), Evans and Kislev (1975), Nguyen (1979), Yamada and Ruttan (1980), Mundlak and Hellinghausen (1982), Rao (1986, 1992). The authors considered the role of property, machinery, livestock and plantations. Human capital was first considered by Hayami and Ruttan (1970), where the role of education and expertise were emphasized. Nguyen (1979), Yamada and Ruttan (1980) and Ruttan (2002) studied the role of general education and the level of technical skills.

Research and development and technical expertise were also involved by Evensen and Kislev (1975), the infrastructure by Antle (1983). Non-agricultural inputs (energy, pesticides) and non-agricultural use of services (maintenance and construction, real estate, rental, administrative, veterinary, irrigation, insurance services) are considered by Maddison (1970), Maddison and van Ooststroom (1993), Maddison and Rao (1996). In the United States, the reported inputs were land, labour, capital, fertilizer use, pesticides, seeds, livestock, feed and energy in the studies of Kendrich and Grossman (1980), Jorgenson, Gollop and Fraumeni (1987), Ball, Bureau, Nehring and Suwaru (1997), and Ball, et al. (2001).

From the early and mid 1990s, technology and many other factors affecting the economy, which have been identified by social sciences, have become an integral part of the analysis. The role of technology in agriculture was intensively studied by Crego et al. (1998). According to Mundlak, the applied technology is determined by factors such as state variables like resources (capital is scarce and of poor quality), the incentives (price ratios), the physical environment (weather, soil quality), or the available technologies (crop yields) and the general development, i.e. the level of development compared to the U.S. (Mundlak, 2000).

In the model of Mundlak (1992) and Mundlak, Larson and Butzer (1997), the output depends on the inputs, technology, as well as on other determining factors. In a study published by the World Bank in 2008, Mundlak, Butzer and Larson argue that agricultural efficiency and productivity growth plays a direct role in economic growth and welfare, often in the developing world, where a significant proportion of the population lives in rural areas and depends on agriculture. The authors conclude that changes in technology result in an increased factor productivity, changed role of labour and capital and in restructuring in the economy.

2. Scientific literature on the productivity of agriculture in Denmark and Hungary

No study comparing the productivity of agriculture in Denmark and Hungary was found; however, many researches compared the performance of developed countries, European, European Union or Central Eastern European countries.

Agricultural productivity change in Denmark was studied by Hansen and Rasmussen. Hansen (1995) estimated that the total factor productivity index (which was measured by aggregate input and output rate: TFP = QY / QX) grew by 1.8% between 1973 and 1980, and by 3.2% between 1981 and 1993. He argued that productivity change is primarily a consequence of technological change and depends on the size of farms to only a lesser extent. Rasmussen (2000) conducted a similar research, but he applied econometric techniques, cost functions and flexibility tests. Since the 1990s, technology has changed in Denmark, institutional changes have occurred; new regulations have been put in place, which have led to a rise in productivity (NN 2008).

Udovecz (2009) found that efficiency in Hungary is about 20%, below the average of the EU-15 countries, since we need more inputs to reach 1 euro output. Production value per one hectare in Hungary is only half as much; food processing is 75% less than in more developed countries.

Rao et al. (2004) calculated that in the 1970s agricultural output growth rates in Hungary were more than double of the Danish agricultural output growth (4.09 vs. 1.72), then between 1980 and 1990 the annual average growth rate was a little higher than zero (0.09%) compared to 1.85% in Denmark. In the 90s, annual growth rates in Hungary were negative (-3.21%), against the increase of 0.76% in Denmark. TFP calculations were also made by the same authors. In the 1970s, the Hungarian values (1.67) were higher than the Danish values (1.38). Hungary performed slightly worse (1.34 compared to 1.46 in Denmark). In the 90s, productivity was higher in Denmark (1.29 compared to 0.68 in Hungary).

Agricultural productivity in the European countries was examined with the application of the Malmquist productivity index by Rungsuriyawiboon and Lissitsa (2006a, 2006b). In one of their studies, agricultural productivity in 44 countries, while in another study, agricultural productivity in 46 European, mainly Central Eastern European and emerging economies was considered in the period between 1992 and 2002. Inputs were land, tractors, fertilizer, labour and the number of live animals and the outputs were the total value of crops and live stock.

The direction and extent of productivity growth was examined together with the sources of growth. TFP growth was divided into two factors: (technical) efficiency changes and changes in technology. It was found that in the first decade of the 20th century eight European countries including Hungary were highly efficient. The authors conclude that both in Denmark and Hungary the real outputs are closest to the potential outputs.

In the EU, TFP growth is higher in Malta and Estonia than in Denmark. The average annual change in productivity in Denmark was 3.65% and in Hungary 1.62%. In Denmark, productivity has increased by 2.5 times faster than in Hungary, and this was achieved by using modern technology and by improved efficiency. The Hungarians have acquired modern techniques to a lesser extent and the efficiency of using the available techniques has not improved.

Blaas (2004) compared the performance of the EU-15 and some of the newly joint Member States, including Hungary, and he found that in Hungary the size of agricultural areas (hectares) and work units (AWU) per capita performance was extremely inefficient with low levels of intermediate consumption and capital stock. The net investments per hectare figures are high in Denmark, preceded only by the Dutch and the Greeks, while Hungary is the 6th out of 19 countries. According to the results of Blaas, in Hungary, agricultural production employs a limited amount of capital and low levels of intermediate consumption, a lot of people work in the sector with low efficiency; however, the output of the sector is relatively high.

3. Scientific literature on sustainable agriculture

There have been numerous attempts to define sustainable agriculture. The common feature is that the definitions include three main issues, namely the demand for satisfying humane food and fibre needs, enhancing environmental quality and satisfying the society's needs. Among many others, the three-pillar approach is considered by FAO (1991), USA Congress CRS Report, (1991), SARE (1997), DFID, (2002), ATTRA, (2005), Yunlong–Smit, (2003).

However, it is very difficult to define the *practical guidelines* which may serve as a standardized, acceptable guidance on farming issues for every farmer.

Sustainable farming ensures both the increase of profitability and the improvement of life and food quality. There is increasing intention for a change-over to bio or organic farming where farming practices are harmonized with the natural resources and the special characteristics of the ecosystems. Many practices have been consistent with sustainable agriculture, e.g. extensive agriculture, low input or organic agriculture. In an attempt to be sustainable, organic farming applies farming practices that minimize the amount of pesticide residue on the products, particular pest control practices and renewable resources are used as much as possible. Diversification, green manuring, crop rotation, cover cropping are key strategies for soil building. Low-input farming refers to using less off-farm inputs, while extensive agriculture combines practices like crop rotation and green manure crops, weed management with careful use of current technology. There is no single solution; farmers are required to pursue farming to ensure sustainability that is suitable for local circumstances and is profitable (the literature of sustainable practices is broad; only some examples are given here: Tilman et al. 2002, ATTRA 2005, USAID 2009, Institut de l'agriculture durable, 2011).

Results and discussion

The agricultural performance of Denmark and Hungary was compared by a multi-method analysis.

1. Land use efficiency (output per hectare)

First, the efficiency of the two countries was compared, where the output is at basic price in purchasing parity standard (PPS) and land use is calculated by utilized agricultural area (UAA) figures. The ratios are shown in Table 1. The index value is 34% higher in Denmark, i.e. output per land figures are higher than the output per land figures for Hungary.

Table 1. Land use efficiency (1000 euro/ha) in Denmark and Hungary between 1997-2008

Years	Denmark - 1000 euro/ha	Hungary - 1000 euro/ha
2008	2.47	2.02
2007	2.44	1.74
2006	2.17	1.69
2005	2.09	1.64
2004	2.37	1.82

Years	Denmark - 1000 euro/ha	Hungary - 1000 euro/ha
2003	2.27	1.63
2002	2.37	1.68
2001	2.53	1.79
2000	2.42	1.61
1999	1.95	1.56
1998	2.03	1.63
1997	2.22	1.64
Average	**2.28**	**1.70**

Source: own compilation based on Eurostat, a, b

2. Real and potential outputs estimated by two-factor (land and labour) agricultural production functions

In an earlier study conducted by fellow researchers (Forgács - Beke - Tarján, 2010), we made the simplistic assumption that agricultural output depends only on the size of the land used and the hours worked because reliable and consistent data were found only for these factors, and these are closely linked to the output of the sector.

Agricultural output figures were considered as dependent variables, agricultural area (hectares) and the hours worked in agriculture (AWU) as independent variables.

Assume that a Cobb-Douglas production function is given by the equitation $Y= s*L^{b} \times LD^{1-b} - z$, where Y is agricultural output, L is labour in agriculture, LD is land (Utilized Agricultural Areas in hectares), s and z are constants, b is labour, 1-b is land elasticity; the value of s, z and b were estimated by fitting the real terms logarithms of independent variables by two variables linear regression, where $\ln Y = \beta_0 + \beta_{LD} \ln LD + \beta_L \ln L + \varepsilon$. The potential paths were estimated for six Western European countries (Austria, Denmark, France, the Netherlands, Germany and Italy). Student's test was applied to test whether the null hypothesis is supported. The t-test value of all the three coefficients in the six Western European countries are well above the thresholds, so the linear model assumption is correct. Table 2 depicts the Hungarian and Danish Y' potential output levels estimated based on the linear model fitted to the six countries, the real output (Y), the annual labour in agriculture and the size of agricultural area in hectares.

Table 2. The deviation from the potential agricultural output in Denmark and Hungary (1997-2008)

Denmark					
Year	Land (ha)	Labour (AWU)	Y (PPS)	Y'	Y/Y'
1997	2781.9	86.1	6087.81	6436.05	0.95
1998	2801.1	82	5545.84	6234.65	0.89
1999	2821.5	77.9	5379.49	6029.73	0.89
2000	2468.1	75.5	5919.65	5792.59	1.02
2001	2493.6	75.8	6260.76	5816.57	1.08
2002	2478.8	72.2	5761.93	5624.74	1.02
2003	2445.7	70	5449.69	5498.46	0.99
2004	2470.2	66.9	5706.08	5341.27	1.07
2005	2480.8	62.9	5631.84	5127.72	1.10
2006	2475.8	60.5	5870.52	4994.01	1.18
2007	2451.3	58.2	6460.1	4877.26	1.32
2008	2452.7	56.9	6376.05	4803.74	1.33
Average					**1.07**
Hungary					
Year	Land (ha)	Labour (AWU)	Y (PPS)	Y'	Y/Y'
1997	4710.8	735.1	10194.7	29302.08	0.35
1998	4274.7	700.8	9900.75	27985.70	0.35
1999	4167.6	723.5	9448.11	28488.08	0.33
2000	4457.5	676	9768.59	27480.28	0.36
2001	4734.1	642.9	10855.02	26798.27	0.41
2002	4958.7	646.7	10305.78	27083.16	0.38
2003	4497.7	581.9	9213.32	24879.85	0.37
2004	4499.6	553.8	10007.77	24067.69	0.42
2005	4503	522.2	8956.74	23138.81	0.39
2006	4500	504.4	9202.28	21884.76	0.42
2007	4493.8	459.3	9715.3	21221.24	0.46
2008	4487.8	421.8	11618.48	20522.72	0.57
Average					**0.40**

Source: own compilation based on Eurostat c, d

As it can be seen in Table 2, in the test period, Danish agricultural outputs acted according to the estimated agricultural production functions of the 6 Western European countries (average 1.07), while the average in Hungary was 0.4, i.e. almost 40% of the Danish performance. These results can be explained as follows: in Hungary, a lot of people are employed in agriculture, but the wages are low. Table 2 shows that, as opposed to Denmark, in Hungary, employed labour (in annual work units) is eight times higher, the cultivated area is twice

the size, and less capital is available, however, almost the same result was achieved. Hungarians work just as much as less is the capital available for them. In summary, few well-equipped, well-paid Danish labour force and many poorly equipped, poorly paid Hungarian labour force show the same factor productivity.

3. Real and potential outputs estimated by three-factor (land, labour, capital) agricultural production functions

Table 3. The deviation from the potential agricultural output in Denmark and Hungary (land, labour and capital)

Denmark						
Year	Land	Labour	Capital	Y	Y'	Y/Y'
1997	2781.90	86.05	10598.90	6087.81	5760.87	1.06
1998	2802.10	82.03	10524.94	5545.84	5758.27	0.96
1999	2821.50	77.93	10450.98	5379.49	5754.17	0.93
2000	2778.70	75.54	10377.01	5919.65	5777.84	1.02
2001	2493.60	75.79	10303.05	6260.76	5890.16	1.06
2002	2478.80	72.18	10229.09	5761.93	5897.61	0.98
2003	2445.50	69.99	10155.12	5449.69	5921.44	0.92
2004	2470.20	66.90	10081.16	5706.08	5919.58	0.96
2005	2480.80	62.90	10007.20	5631.84	5912.61	0.95
2006	2475.80	60.47	9933.23	5870.52	5923.59	0.99
2007	2451.3	58.40	9859.27	6460.10	5935.61	1.09
2008	2452.7	56.90	9785.31	6376.05	6010.34	1.06
Average						**1.00**
Hungary						
Year	Land	Labour	Capital	Y	Y'	Y/Y'
1997	4710.80	735.10	6328.29	10194.70	9763.25	1.04
1998	4709.50	700.78	6277.53	9900.75	9775.71	1.01
1999	4708.00	723.49	6226.76	9448.11	9866.10	0.96
2000	4499.80	676.05	6176.00	9768.59	9916.11	0.99
2001	4516.10	642.94	6125.23	10855.02	9923.00	1.09
2002	4515.50	646.74	6074.46	10305.78	9990.33	1.03
2003	4515.50	581.91	6023.70	9213.32	9948.24	0.93
2004	4510.30	553.79	5972.93	10007.77	9963.35	1.00
2005	4513.10	522.25	5922.17	8956.74	9967.83	0.90
2006	4500.00	504.40	5871.40	9202.28	9953.42	0.92
2007	4493.80	459.29	5820.64	9715.30	9974.33	0.97
2008	4487.80	421.80	5769.87	11618.48	9991.85	1.16
Average						**1.00**

Source: own compilation based on Eurostat c and d; estimations are based on FAO Statistical Yearbook data

Capital was involved in the calculations in an extended version of the production function. Capital stock data were only available in the FAO Statistical Yearbook.

These results suggest that – as have been mentioned above – the relatively low performance of Hungary may be the result of the lack of capital. As it can be seen in Table 3, when the amount of capital available to the sector was taken into consideration, we found that the performances of both countries are similar to the path determined by the six Western European countries. Consequently, the efficiency of the two countries is nearly identical. The Danish and the Western European model is the so-called intensive agriculture, the Hungarian and the Eastern European model is called extensive agriculture. In the next phase, the two models were examined separately.

4. Intensive and extensive agricultural models

Since the direct comparison of Denmark and Hungary was considered irrelevant, their relative performance was examined. The performance can only be understood by the comparison of each individual country to group of countries at similar levels of development; therefore, the countries with intensive and extensive agricultural models were analysed separately.

Next, with the actual labour input and with the arable land figures, we estimated the potential agricultural output (Y') of each Western European country by applying a Western European production function. The potential output was compared to the real output (Y), then a production function was applied to Eastern European countries and, finally, the ratio of Y/Y' was calculated. The Y/Y' values are shown in Table 4.

Finally, the average difference from the potential output of the period was calculated, then group averages were calculated and the performance of each country was compared to them (Table 4).

Table 4. Agricultural performance of 12 countries (1999–2009)

Y/Y'	DK	D	F	I	NL	AU
1999	0.90	1.02	1.12	0.87	1.64	0.49
2000	1.03	1.12	1.18	0.88	1.78	0.51
2001	1.09	1.20	1.23	0.91	1.85	0.53
2002	1.04	1.16	1.25	0.88	1.84	0.53
2003	1.01	1.17	1.18	0.90	1.78	0.53
2004	1.09	1.32	1.23	0.93	1.85	0.56
2005	1.02	1.20	1.24	0.87	1.91	0.51
2006	1.09	1.28	1.17	0.87	2.11	0.55

Y/Y'	**DK**	**D**	**F**	**I**	**NL**	**AU**
2007	1.23	1.50	1.34	0.93	2.25	0.62
2008	1.23	1.60	1.38	0.99	2.26	0.64
2009	1.13	1.44	1.29	0.87	2.18	0.60
Average in the period	1.08	1.27	1.24	0.90	1.95	0.55
Group average	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*
Difference from potential output (%)	-8.75	10.94	7.15	-26.41	78.36	-61.28
Y/Y'	CZ	H	PL	RO	SI	SK
1999	0.98	0.87	0.76	0.87	0.94	0.79
2000	1.07	0.90	0.79	0.79	0.99	0.73
2001	1.17	0.98	0.85	1.10	0.97	0.88
2002	1.11	0.92	0.87	1.08	1.07	0.89
2003	0.99	0.90	0.87	1.15	0.96	0.83
2004	1.22	1.02	1.07	1.46	1.14	0.97
2005	1.10	0.94	1.02	1.06	1.09	0.86
2006	1.11	0.98	1.03	1.10	1.08	0.88
2007	1.36	1.03	1.26	1.05	1.13	0.94
2008	1.33	1.22	1.22	1.39	1.05	1.01
2009	1.09	0.86	1.08	1.05	0.95	0.92
Average in the period	1.14	0.97	0.98	1.10	1.03	0.88
Group average	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*
Difference from potential output (%)	12.2	-5.1	-3.42	8.23	1.6	-13.5

Source: own compilation based on Eurostat b, c, d

Table 4 consists of two parts. In the first six columns, the efficiency of the Western European countries (Denmark, Germany, France, Italy, the Netherlands and Austria) can be seen in relation to the performance of the group average of the six Western European countries. In the second six columns, the efficiency of the Eastern European countries (Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia) can be seen in relation to the performance of the group average of the six Eastern European countries.

Data for the Eastern and the Western European countries cannot be compared directly; however, the efficiency of a given Western European country can be compared to the average efficiency of the six Western European countries.

Similarly, the efficiency of an Eastern European country can be compared to the performance of the six Eastern European countries. For example, Italy's

performance in relation to the Western European countries is about 75%, while the performance of the Czech Republic exceeds the average by more than 12%.

Table 4 does not show the relationship between the Western European and Eastern European countries. The Y/Y' index (real output/potential output of the own group of countries) shows the relative performance of a given country in a given year compared to the expected performance of the whole period. Larger numbers indicate higher performances.

In Hungary, the efficiency of resource use (land and labour) is about 5% lower than the group average, whereas resource use is approximately 9% less efficient in Denmark than in the six Western European countries.

5. Sustainable vs. conventional agriculture

Once we have found that in Hungary the lack of capital hinders production, in the last phase of our study, we intended to find a relationship between the more sustainable practices or producing organic crops and livestock and the relatively lower performance of Danish agriculture. During the past decades, significant efforts were made in Denmark to adopt sustainable farming practices that can bring improved environmental performance. We have found that there is a relationship between agricultural performance and the application of sustainable farming practices.

Regarding sustainable farming, two indicator groups were applied.

– Pollution of the environment: two indicators were chosen to show whether agricultural practices ignore sustainability, namely intensive fertilizer use and considerable GHG emission of agriculture.

– Share of organic products: two indicators were chosen to show the commitment to organic farming, namely the share of organic crop area and the share of organic pigs.

For the period of 1999–2009, data indicate that among the 6 Western European countries examined Austria, Denmark and in some areas (e.g. crop production) Italy pursue environment-friendly agriculture, while the Netherlands, France and Germany pursue not at all environmentally friendly farming practices, however, for the two bigger countries only to a lesser extent. It must be noted, however, that there were no data on the share of organic pigs available for France and Germany.

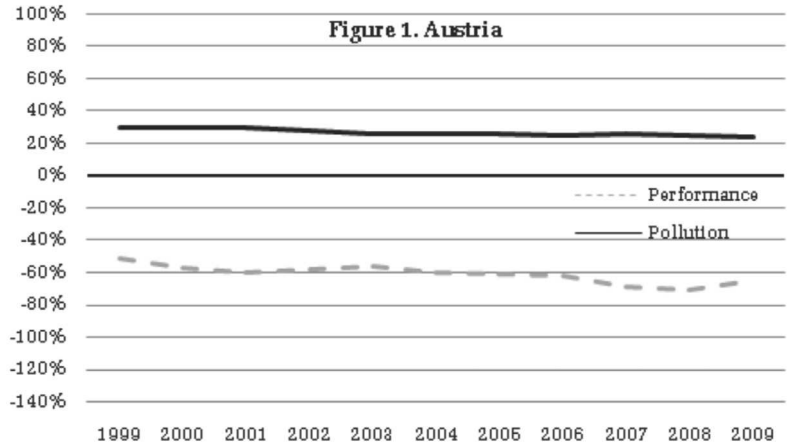
5.1 Pollution of the environment

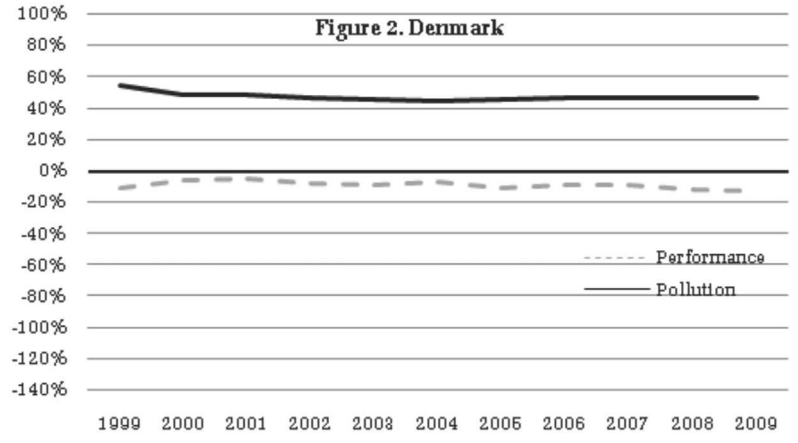
As regards ignoring sustainability, inorganic fertilizer use (nitrogen and phosphorus) in tons per 1000 hectare of arable land, and greenhouse gas emissions (N_2O, CH_4 and CO_2) from agricultural practices were applied. GHG emission is considered to have a significant (more than 10%) impact on air quality in the

EU-27, which is the result, among others, of fertilizer and manure use, livestock emissions and stored animal manure (Eurostat).

Inorganic fertilizer use and GHG emissions (hereinafter pollution) were summed up and expressed as per hectare figures for the period between 1999 and 2009. The average values of the six countries were calculated and each country data was compared to the group average. The deviation from the average for each year was considered for the period as it can be seen in figures 1–6. Pollution is converted into inverse in order to help the reader capture the extent of the pollution in the given country. If pollution is massive, the line is in the lower part of the graph. The figures will be assessed considering how the time series for performance and pollution changed over the period of 1999–2009.

Figures 1–6. Performance and sustainability of agriculture in the selected countries (1999–2009)





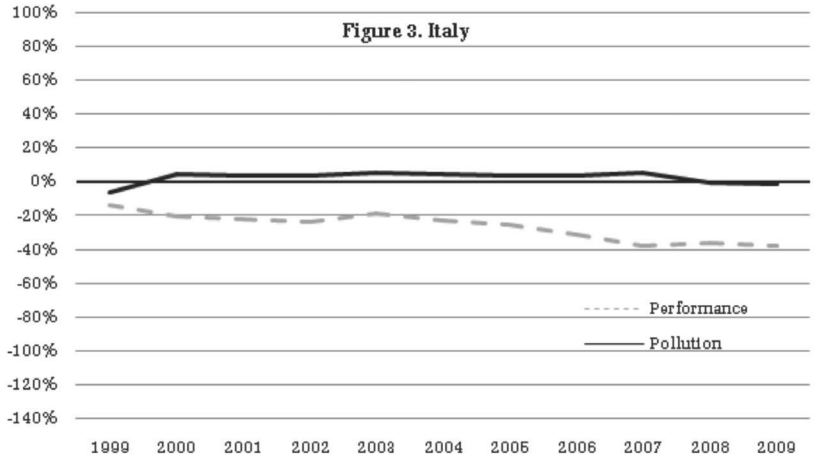


Figure 3. Italy

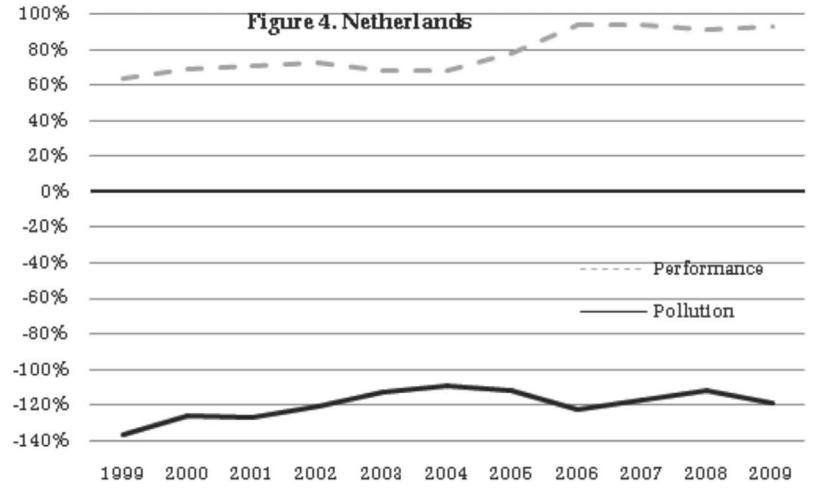


Figure 4. Netherlands

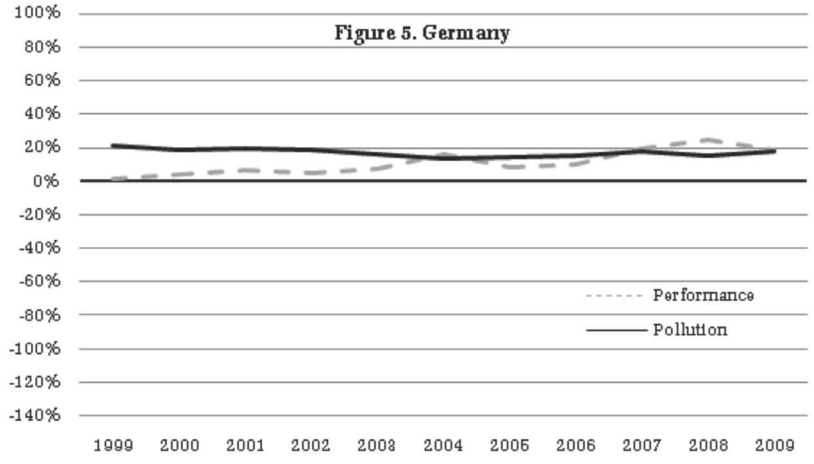
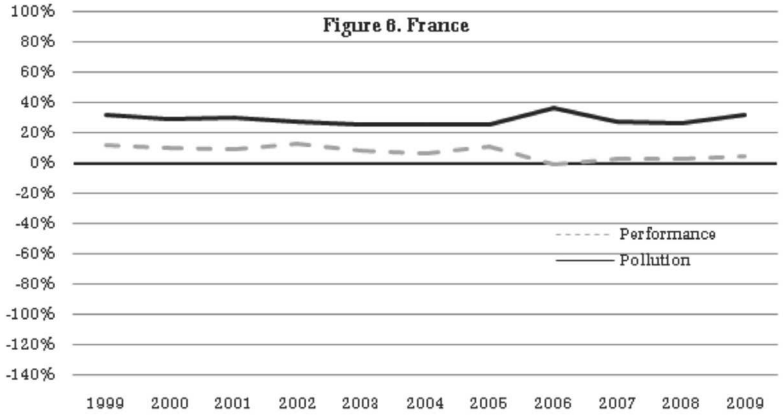


Figure 5. Germany



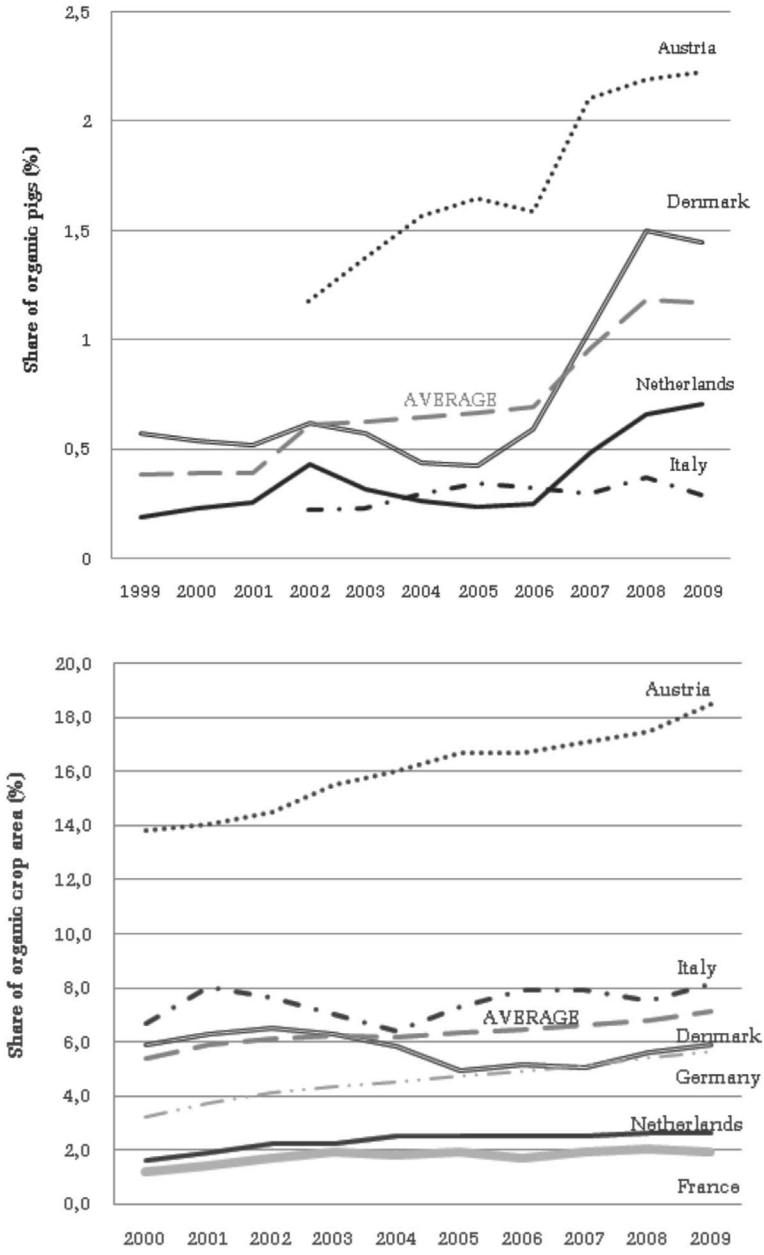
Source: Own compilation based on Eurostat

The figures depict that environmentally conscious countries (listed in order of its extent) are Denmark, France and Austria, where less inorganic fertilizer is used and the GHG emissions are the lowest. Germany, Italy and the Netherlands can be said to be rather polluting countries (listed in order of its extent). To be able to conclude that there is a strong correlation between performance and pollution, we should have found a reverse order regarding performance. However, we found that Austria was the farthest behind the average, followed by Italy; the third in line was Denmark. France was almost average, a somewhat better performance was reached by Germany, but far the best performance was achieved by the Netherlands. It can be concluded that although there is a relationship between the two, it cannot be stated that environmental consciousness is a cardinal factor, but it certainly boosts achievements.

5.2 Share of organic products

Regarding organic production, two indicators were considered: the share of total organic crop area out of the total utilized agricultural area (hereinafter UAA) and the number of organic pigs out of the total of pig population (Eurostat). The above-mentioned indicators were chosen because in Denmark the number of pigs was approximately 13 million in the past decades, which is 8% of the EU total figures, while the total population of Denmark was about slightly more than 1% of the EU's population. Pork production per capita was almost 330 kg in 2009, which is 5 times as much (56 kg/capita) compared to the EU average. The per capita pork production is the highest in Denmark, the second biggest producer is the Netherland with 137kg/capita pork production, which is 40% of the Danish figures.

Figures 7–8. Organic agricultural production in the selected Western European countries (1999–2009)



Source: Eurostat

How widespread is the population's commitment to sustainable practices depends on many factors, one of the indicators could be the share of total organic crop areas. Organic farming regulations date back to 1991 in the EU. The figures depict that the share of organic production is the highest in Austria (for pigs approx. 2% and for crops it is about 20%), whereas regarding organic crop area the next in line is Italy, where the share is only 8%, and regarding pigs the second highest share can be seen in Denmark (1–1.5%). Only restricted conclusions can be made as no data regarding organic pigs were available for France and Germany. The performance of Austria, Denmark and the Netherlands is in accordance with the above-mentioned. Due to data availability, conclusions be drawn only based on the size of the crop area, and this is not in opposition with our hypothesis. The only atypical country in this context is Italy since commitment to organic production can be observed for the share of crop production and low performance is in accordance with it. However, the share of organic pigs is the lowest among the countries, which does not harmonize with the above-mentioned low performance. The reason for this atypical feature of Italy is that the country has experienced organic movements as early as the beginning of the 1980s. Olive trees are grown by a large part of Tuscany's organic farmers and in Emilia-Romagna cereals, fruit and vegetable are grown, and these regions highly promoted organic farming (Organic Report).

To sum up, we found that by all means there is a correlation between agricultural performance and sustainable practices, but they are not decisive in performance. If a country is environmentally conscious, performance is hindered, and organic production results in lower yields. Despite that Denmark is committed to sustainability to the largest extent among the countries examined, its performance is not the lowest but slightly below the average. This can be explained by the fact that Denmark has a traditionally highly developed agricultural sector.

Conclusions

The main purpose of the study was to examine whether lack of capital could be a significant constraint of agricultural performance in Hungary, whereas in Denmark commitment to advancing the sustainability of agriculture results in a lower agricultural performance. Since Denmark is a Western European country and Hungary is Eastern European, their performance can only be assessed relative to their country group; therefore, two European country groups were formed (an Eastern and a Western group).

Within the groups, there can be seen significant differences among the countries. In the Western group, the Netherlands performed substantially better, almost twice (1.95) of its potential output, while Austria managed to reach

only slightly more than half (0.55). In the Eastern group, the Czech Republic and Romania exceeded the potential figures by almost 10%, whereas Slovakia showed a 10% lower performance. It deserves attention that within the members of the Western group the deviations from the average are significantly higher, while in the Eastern group, performance was almost equal to the potential output. Compared to countries at similar levels of development, Denmark exceeded its potential output by 8%, while the group average showed a significantly higher positive (16%) difference. Hungary lagged behind its potential output by 3%, while the group average showed a 2% positive difference. At their own level of development, the relative efficiency of Hungary was -5% and the efficiency of Denmark was around -9%. Denmark was the 4th, Hungary was the 5th one in their 6-member country group.

In the Eastern European countries, capital scarcity and old technology results in a lower level of performance. In the Western European countries, an increasing share of resources is devoted to environmentally friendly practices, which gives rise to lower performance.

First, we have found that in Hungary it might have been the lack of capital that caused a nearly 60% shortfall compared to the developed countries; secondly, there is a correlation between agricultural performance and sustainable practices, although being environmentally conscious is not decisive in the performance. If a country is environmentally conscious, performance is hindered, and organic production results in lower yields. Despite that Denmark is highly committed to sustainability, its performance is only slightly below the average. It can be explained by the fact that Denmark has a traditionally highly developed agricultural sector.

References

ANTLE, J. M. (1983): *Infrastructure and Aggregate Agricultural Productivity: International Evidence. Economic Development and Cultural Change* 31(3):609–620.

ATTRA (2005) What is sustainable agriculture? http://www.sare.org/publications/whatis/whatis.pdf

BALL, V. E. – BUREAU, J. – BUTAULT, J. – NEHRING, R. (2001): *Levels of Farm Sector Productivity: An International Comparison*, Journal of Productivity Analysis vol. 15, pp. 5–29.

BALL, V. E. – BUREAU, J. – NEHRING, R. – SOMWARU, A. (1997): *Agricultural Productivity Revisited*, American Journal of Agricultural Economics, vol. 79, pp. 1045–1063. http://www.agec.ntu.edu.tw/faculty/huang/paper/Agricultural%20productivity%20revisited.pdf last access 24 March 2012

BARTON, G. T. – COOPER, M. R. (1948): *Relation of Agricultural Production to Inputs,* Review of Economics and Statistics Vol. 30(1), pp. 117–126.

BEKE J. – FORGÁCS A. – TARJÁN T. (2011): *Európai Uniós országcsoportok mezőgazdasági teljesítményének összehasonlító vizsgálata*. In: Gazdálkodás. 2010. I., pp. 39–51.

BHATTACHARJEE, J. P. (1955): *Resource Use and Productivity in World Agriculture*, Journal of Farm Economics, vol. 37 (1), pp. 57–71.

BLAAS, G. (2004): *Productivity of Factors in the Enlarged EU*, Agricultural Economics – Czech, vol. 50 (11), pp. 509–513. http://www.cazv.cz/attachments/5-Blaas.pdf (last access: 24 March 2012)

COOPER, M. R. – BARTON, G. T. – BRODELL, A. P. (1947): *Progress of Farm Mechanization*. MB-630, U.S. Dept. of Agr., Bur. Agr. Econ.

CREGO, A. D. – LARSON, D. – BUTZER, R. – MUNDLAK, Y. (1998): *A New Database on Investment and Capital for Agriculture and Manufacturing*, World Bank Working Paper 2013. http://www.wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2000/02/24/000094946_9903191110563 6/Rendered/PDF/multi_page.pdf (last access: 26 March 2012)

CRS REPORT FOR CONGRESS [1991]: http://www.fas.org/sgp/crs/row/RL32294.pdf

DFID [2002]: *Sustainable Agriculture. Resource Management* Keysheet 10. DFID: London, UK. last access 2 April 2012

EUROSTAT a. *Utilized agricultural area* (UAA 1000 hectare): http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

EUROSTAT b. *Agricultural output*. Value at basic price, PPS, million euro. http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

EUROSTAT c. *Total agricultural labour force input* (in 1000 AWU) http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

EUROSTAT d. *Arable land 1000 hectare.* http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

EVENSON, R. E. - KISLEV Y. (1975): *Agricultural Research and Productivity*, New Haven, CT, Yale University Press

FAO [1991]: *The Food and Agriculture Organization of the United Nations* (FAO) – Sustainable agricultural resources development. http://www.nationsencyclopedia.com/United-Nations-Related-Agencies/The-Food-and-Agriculture-Organization-of-the-United-Nations-FAO-SUSTAINABLE-AGRICULTURAL-RESOURCES-DEVELOPMENT.html (last access: 12 March 2012)

FAO Statistical Yearbook 2007-2008: *Capital stock and its components*. http://www.fao.org/economic/ess/ess-publications/ess-yearbook/fao-statistical-yearbook-2007-2008/a-resources/en/ (last access: 24 March 2012)

HANSEN, J. (1995): *Udviklingeni produktivitet ogbytte forholdi dansk landburg* 1980/81-92/93. Copenhagen.

HAYAMI, Y. – RUTTAN V. (1970): *Agricultural Productivity Differences Among Countries* American Economic Review, 40, pp. 895–911

INSTITUT DE L'AGRICULTURE DURABLE (2011): *Agriculture 2050 starts here and now*. http://www.institut-agriculture-durable.fr/images/fichier/86_L-agriculture-de-2050-commence-maintenant-VF-ANGLAIS-19012011.pdf (last access: 5 January 2013)

JORGENSON, D. W. – GOLLOP, F. M. – FRAUMENI, B. M. (1987): *Productivity and US Economic Growth*. Cambridge, Harvard University Press.

KENDRICK, J. W. – GROSSMAN, E. S. (1980*)*: *Productivity in the United States: Cycles and Trends*, Johns Hopkins University Press, Baltimore, MD

MADDISON, A. – RAO, D. S. P. (1996): *A Generalized Approach to International Comparison of Agricultural Output and Productivity* Institute of Economic Research, University of Groningen, Research Memoranda GD-27 http://www.ggdc.net/maddison/ARTICLES/GD27.pdf (last access: 15 March 2012)

MADDISON, A. – van OOSTSTROOM, H. (1993): *The International Comparison of Value Added, Productivity and Purchasing Power Parities* in Agriculture, Institute of Economic Research, University of Groningen, Research Memorandum 536 (GD-1) http://ggdc.eldoc.ub.rug.nl/FILES/root/WorkPap/1993/199301/gd01.pdf (last access: 17 March 2012)

MADDISON, A. (1970): *Economic Progress and Policy in Developing Countries*, Norton, New York

MUNDLAK, Y. – BUTZER, R. – LARSON, D. (2008): *Heterogeneous Technology and Panel Data: The Case of the Agricultural Production Function*.

http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/02/24/000009265_3971110141412/Rendered/PDF/multi_page.pdf (last access: 19 December 2011)

MUNDLAK, Y. – HELLINGHAUSEN, R. (1982): *The Intercountry Agricultural Production Function: Another View* American, Journal of Agricultural Economics, Vol. 64 (4), pp. 664–672

MUNDLAK, Y. (1992): *Agricultural Productivity and Economic Policies: Concepts and Measurements,* OECD Development Center, Working Paper No. 75 http://lysander.sourceoecd.org/vl=1693858/cl=16/nw=1/rpsv/cgi-bin/wppdf?file=5lgsjhvj7g21.pdf (last access: 19 December 2011)

MUNDLAK, Y. (ed.) (2000): *Agriculture and Economic Growth: Theory and Measurement*, Harvard University Press, MA

MUNDLAK, Y.– LARSON, D. – BUTZER, R. (1997): *The Determinants of Agricultural Production A Cross-Country Analysis,* The World Bank Policy Research Working Paper, 1827

N. N.: *Data for Analysing Productivity Changes in Danish Agriculture* 1985-2006. http://www.foi.life.ku.dk/Publikationer/~/media/Foi/docs/Publikationer/Working%20Papers/2008/WP_15_2008.ashx (last access: 19 December 2011)

NGUYEN, D. (1979): *On Agricultural Productivity Differences among Countries*. American Journal of Agricultural Economics, vol. 61, No. 3, pp. 565–570

Organic Report (Country Report about Organic Agriculture in Italy) http://www.organic-europe.net/country-info-italy-report.html (last access: 19 April 2012)

PAIGE, D. – BOMBACH, G. (1959): *A Comparison of National Output and Productivity*, OEEC, Paris

RAO, P. – COELLI, J. T. – ALAUDDIN. M. (2004): *Agricultural productivity growth, employment and poverty in developing countries, 1970-2000* http://www.ilo.org/public/english/employment/strat/download/esp9.pdf (last access: 19 April 2012)

RAO, P. D. S. (1986): *Inter-Country Comparisons of Agricultural Production Aggregates*, FAO, Rome

RAO, P. D. S. (1992): *Inter-Country Comparisons of Agricultural Output and Productivity*, FAO, Rome

RASMUSSEN, S. (2000): *Technological change and economics of scale in Danish agriculture.* Copenhagen, Agricultural University. KVL.

RUNGSURIYAWIBOON, S. – LISSITSA, A. (2006a): *Agricultural Productivity Growth in the European Union and Transition Countries*, Leibniz Institute of Agricultural Development in Central and Eastern Europe, Discussion Paper No. 94 http://ageconsearch.umn.edu/bitstream/14903/1/dp060094.pdf (last access: 19 April 2012)

RUNGSURIYAWIBOON, S. – LISSITSA, A. (2006b): *Total Factor Productivity Growth in European Agriculture* www.nesdb.go.th/econSocial/macro/TNCE/.../1/supawat.pdf (last access: 19 April 2012)

RUTTAN, V. (2002): *Productivity Growth in World Agriculture: Sources and Constrains*

http://ageconsearch.umn.edu/bitstream/14176/1/p02-01.pdf (last access: 19 April 2012)

TILMAN, D. – KENNETH, G. – NAYLOR, R. – POLASKY, S. (2002): *Agricultural Sustainability and intensive production practices* http://www.nature.com/nature/journal/v418/n6898/abs/nature01014.html (last access: 17 March 2012)

UDOVECZ G. (2009): *Alkalmazkodási kényszer, az „élelem-energia-környezet" összefüggésrendszerben*, Magyar Tudomány 2009/4. http://www.matud.iif.hu/09apr/10.html (last access: 17 March 2012)

USAID (2009): http://www.usaid.gov/our_work/agriculture/sustainable_ag.htm (last access: 17 March 2012)

YAMADA, S. – RUTTAN, V. W. (1980): *International Comparison of Productivity in Agriculture*, In: New Developments in Productivity Measurement and Analysis, eds. J.W. Kendrick and B. N. Vaccara, Chicago, The University Press of Chicago

YUNLONG, C. – SMIT, B. (2003): *Sustainability in agriculture: a general review*. Agriculture, Ecosystems & Environment, Vol. 49, Issue 3, July 1994, pp. 299–307.