Original scientific paper
Journal of Central European Agriculture, 2019, 20(3), p.995-1008
DOI: /10.5513/JCEA01/20.3.2284

Economic issues of Hungarian table egg production in different housing systems, farm sizes and production levels

A magyar étkezési tojástermelés gazdasági kérdései különböző tartástechnológiában, üzemméretben és termelési színvonalon

László SZŐLLŐSI (✉), István SZŰCS, László HUZSVAI, Szilvia MOLNÁR

University of Debrecen Faculty of Economics and Business Institute of Applied Economics, Böszörményi str. 138. H-4032 Debrecen, Hungary

✉ Corresponding author: szollosi.laszlo@econ.unideb.hu

ABSTRACT

The aim of this study is to reveal the effects of housing systems, farm sizes and production levels on the economic indicators of Hungarian table egg production. This research is based on the farm-level cost and income data and the related weights of egg production farms between 2003-2015 from the Hungarian Farm Accountancy Data Network (FADN) database. These data were processed using descriptive statistics and correlation and regression analyses were performed to evaluate the correlations between each indicator. The results show that the unit cost of egg was 7.16 Eurocent/egg in enriched cage system and 39% higher (9.97 Eurocent/egg) in barns between 2012-2015 in Hungary. So in line with the international tendencies table egg can be more effectively produced in Hungary using enriched cage system as opposed to barns. However, these costs are significantly higher than the average of the most significant egg producing countries of the EU. It was also found that the unit cost of egg is lower in larger farm size; however, other factors also affect its value. The increase of production level (specific yield) is also in a positive correlation with the examined economic indicators (cost and profit). So the improvement of the current technological level would definitely enhance the physical and economic efficiency of Hungarian egg production by supporting modernising investments. The only technology that can be recommended for large-scale production is the cage system which is more cost-effective. On the contrary, alternative technologies are more favourable for smaller, family farms.

Keywords: barn, economic analysis, enriched cage, FADN, table egg production

ÖSSZEFOGLALÓ

Jelen tanulmány célja a tartástechnológia, az üzemméret és a termelési színvonal hatásának kimutatása a magyarországi étkezési tojástermelés gazdasági mutatóira vonatkozóan. A kutatáshoz a magyar FADN adatbázis tojástermelő gazdaságokra jellemző üzemsoros költség- és jövedelem adatait, illetve az azokhoz tartozó üzemi súlyokat használtuk fel a 2003-2015 közötti időszakra vonatkozóan. Az adatokat leíró statisztikai módszerekkel dolgoztuk fel, továbbá az egyes mutatók közötti összefüggések vizsgálatához korreláció- és regresszió-analízist végeztünk. Az eredmények alapján megállapítható, hogy a tojás önköltsége Magyarországon 2012-2015 között bővített ketreces technológiában 7,16 eurocent/tojás, míg a mélyalmos termelésben 39%-kal magasabb (9,97 eurocent/tojás) volt. Tehát a nemzetközi tendenciákkal összhangban Magyarországon a bővített ketreces tartástechnológiában hatékonyabb az étkezési tojás előállítása, mint mélyalmos tartásmódban, ugyanakkor ezek a költségek jelentősen meghaladják az EU meghatározó tojástermelő országainak átlagát. Az is megállapítható, hogy nagyobb üzemméretben alacsonyabb a tojás önköltsége, viszont annak alakításában más tényező is szerepet játszik. A termelési színvonalat kifejező fajlagos hozam növekedése szintén pozitív összefüggésben van a gazdasági mutatókkal. Éppen ezért a jelenlegi technológiai színvonal javítása korszerűsítő beruházások támogatásával mindenképpen javítaná a magyar tojástermelés naturális és ökonómiai hatékonyságát. A nagyüzemi termelés számára az egyetlen javasolható technológia, a legkedvezőbb költséghatékonysági mutatókkal jellemezhető ketreces tartási mód. Ezzel szemben a kisebb, családi méretű üzemekben az alternatív technológiák megvalósítása kedvezőbb.

Kulcsszavak: étkezési tojástermelés, FADN, feljavított ketrec, gazdasági elemzés, mélyalom

INTRODUCTION

Since the ancient times, egg has been one of the most fundamental and most valuable foods of mankind. The biological value of chicken eggs is the same as that of breast milk as it contains 40 types of proteins, including some which have bactericidal, strong antigenic and blood pressure lowering effect. Egg is relatively low in calories compared to other foods and it contains 18 different amino-acids, of which 9 are essential. In addition, eggs are low in fat and especially rich in vitamins (A, D, E, B_1, B_2, B_3, B_5, B_6, B_9, B_{12}) and minerals (Fe, Zn, Cu, Mg, I, Se, Ca, P, K). Egg contains an optimal proportion of saturated and unsaturated fatty acids, but it does not contain carbohydrates and trans fats. The most inexpensive way to cover the daily animal protein need of the human body is to consume eggs. Also, eggs can be produced with the least environmental load. At the same time, egg is not only an essential food, but it also has a significant role in health protection and disease prevention due to its functional characteristics. Egg enhances brain functions and embryonic development, it strengthens the immune system and reduces the risk of cardiovascular and tumour diseases (breast, skin, colon and cervical cancer), age-related ocular diseases (macular degeneration, cataract), thrombosis and vasoconstriction, as well as the degenerative loss of skeletal muscle mass quality and strength associated with aging (sarcopenia) (Szőllősi et al., 2017).

The egg production of the world increased by around 26% from 56 to 70 million tons between 2004 and 2014. China is the biggest shelled egg producer (representing 36% of the world's production) where the volume of production increased from 20.5 to 24.9 million tons (+28%) in the examined period. As regards the volume of egg production, China is followed by the USA (8.6%) and India (5.7%). The latter greatly increased its output from 2.5 to 4 million tons (+58%) in the last decade. In 2014, the EU28's share of the world's egg production was 10% in 2014 (Food and Agriculture Organization, FAO, 2017).

On a world scale, the amount of exported eggs nearly doubled, increasing from 1 to 1.97 million tons between 2003-2013, with Europe taking a significant share. In 2013, 23.8% of all exported eggs originated from the Netherlands, 14.2% from Turkey and 10.8% from Poland. In the same year, Germany was the biggest egg importer, importing 371 thousand tons of eggs (19.3%). Iraq is also a significant market outlet, as the quantity of imported eggs increased from 21 to 294 thousand tons in the examined period. In addition, the Netherlands, Italy, Mexico and Russia also greatly increased their volume of import (FAO, 2017).

The egg production of the EU28 increased from 7 to 7.7 million tons (10%) between 2006-2016. It is predicted that 0.6% increase is to be expected each year in the next decade and the output may exceed even 8.2 million tons by 2026. 74-79% of production originates from the EU15 countries, however, there was a significant increase in production (14%) in the EU-N13 in the past years. Egg consumption was in constant change in the EU between 2006-2016. Following the decline in the past years, egg consumption reached its decade-old level again in 2016 (12.7 kg per person per year). Further 4% increase is predicted for 2026 (European Commission, EC, 2016).

As opposed to international trends, the pullet population decreased by 18% and the amount of produced eggs by 14% between 2004 and 2016 in Hungary. In 2004, 4.7 million pullets were put in production and 1.3 billion eggs were produced, while the current figures are 3.9 million pullets and 1-1.1 billion eggs (Hungarian Poultry Production Board, HPPB, 2017). The Hungarian production is greatly affected by the EU supply. In case of overproduction, the surplus in EU countries was constantly present on the Hungarian markets at so-called dumped prices in the recent years, thereby making the players of the sector face significant challenges.

The sales prices of egg continue to be determined by demand and supply, but there is a significant difference both seasonally and between the prices in each member state. In general, the price of eggs is the highest in Sweden, Denmark and Austria, while it is the lowest in Spain and the Czech Republic (McDougal, 2017).

The most significant change in table egg production in the recent years was evoked by the welfare Directive 1999/74/EC. Starting from 1st January 2012, producers had to stop using traditional cage systems. In 2015, 56% of the laying flock of the EU28 countries were kept in enriched cages, while 44% were raised in alternative systems. Of non-cage systems, barn has a highlighted significance, as around 26% of the laying hen population of the EU28 countries are kept in barns. The share of free range is 14%, while that of organic system is 4%. In several countries, the proportion of alternative systems is especially high in comparison with the EU average. More than 80% of the laying flock is raised in non-cage systems in Germany, Luxemburg, the Netherlands, Austria and Sweden (Figure 1) (European Egg Processors Association, EEPA, 2017). Based on the current tendency, further increase of the proportion of alternative systems is expected in the future in accordance with consumer demand (McDougal, 2017).

It is important to note that housing systems have no effect on the internal and external colour or the nutritional values of the egg. At the same time, eggs produced in cages are the cleanest and safest, while hygienic and animal welfare risk is higher in alternative systems (Csobaji-Nagy et al., 2016).

Egg production in Hungary is concentrated, as nearly 40% of the Hungarian laying hen population are kept on 16 farms. On the contrary, nearly 40% of all farms have less than 350 places for hens, but only 1% of the total hen population is kept on these farms. In 2016, 519 farms with a capacity to raise more than 350 hens were active in Hungary, which represented nearly 6.2 million places for hens (Figure 2). 62% of these farms use enriched cages and nearly 80% of places for hens belong to these farms. 38% of farms use some alternative system, of which the proportion of barns (32%) is significant (Figure 3) (National Food Chain Safety Office, NFCSO, 2016).

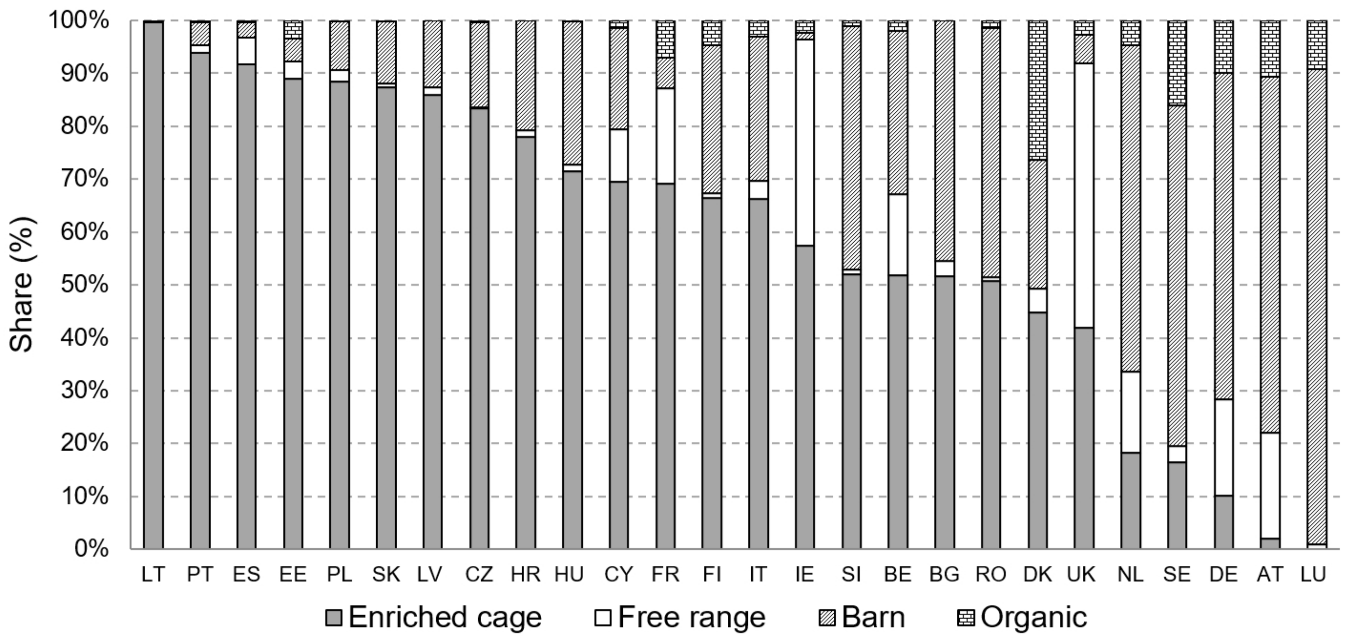

Figure 1. Distribution of housing systems in laying hens in the EU28 (2015) (Note: there is no data for Greece and Malta for that year. Source: EEPA (2017).)

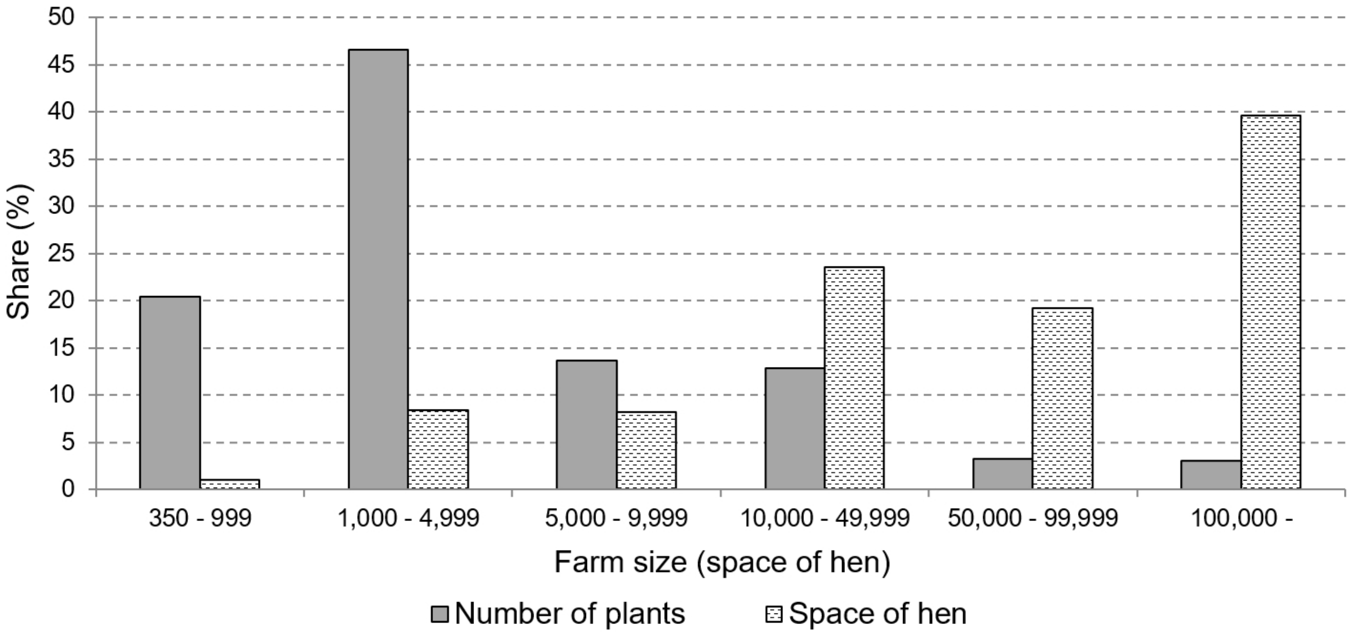

Figure 2. Hungarian table egg producing farms with more than 350 spaces for hens and their capacity distributed among farm sizes (2016) (Source: NFCSO (2016))

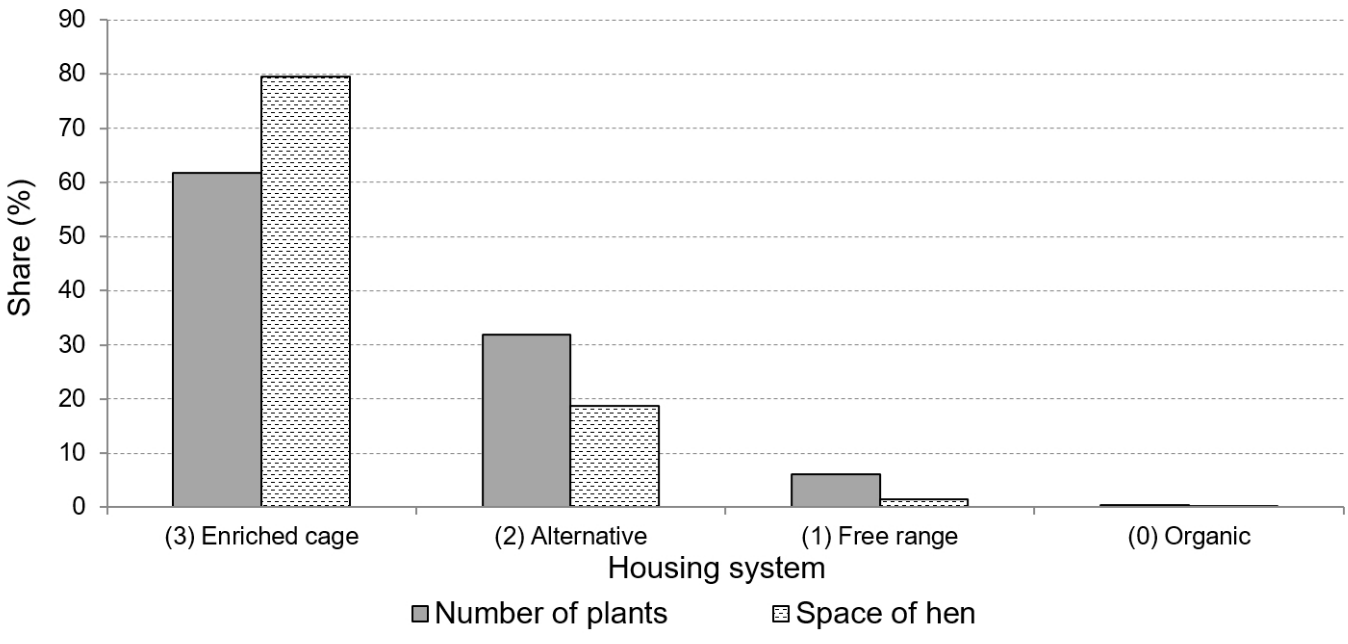

Figure 3. Hungarian table egg producing farms with more than 350 spaces for hens and their capacity distributed among housing systems (2016) (Source: NFCSO (2016))

The production cost of egg is different in the case of each housing system. According to Sossidou et al. (2015), the ban of conventional cage housing (Directive 1999/74/EC) increased the production cost of egg by nearly 28%. This finding is also confirmed by the research results of Matthews and Sumner (2015), i.e., the cost of feed per egg and the cost of pullet in enriched cage systems are somewhat lower than those of conventional housing systems, but the significantly higher labour costs result in 13% higher production costs altogether. In addition, the production cost of eggs produced in aviaries is nearly 36% higher than in conventional cages. According to the calculations of Van Horne and Bondt (2017), the production cost of one egg produced in conventional cages was 5.29 Eurocents in 2015 and it was 6% higher (5.59 Eurocents) in the case of enriched cages and 23% higher (6.52 Eurocents) in the case of barns/aviaries. A partial reason for this difference lies in the less effective use of place.

According to Szabó (2017a), the results of different housing systems are difficult to compare because there is a significant difference in efficiency between farmers using the same housing system. Furthermore, it was concluded that laying hens produce eggs at the same level both in conventional and enriched cages and even more favourable results can be obtained under specific circumstances. Differences between cage and non-cage systems constantly diminish as the proportion of alternative housing systems increases. Feed conversion ratio and mortality show improvement in countries where the proportion of alternative housing systems is high.

The objective of this study is to demonstrate the effect of housing systems, farm size and production level on the main economic indicators of Hungarian table egg production. Three hypotheses were proposed in relation to this purpose:

H_1: the production of table egg is more cost-efficient in (enriched) cage systems than in barns;

H_2: economies of scale prevail also in egg production, i.e., egg production cost is lower in larger farm size;

H_3: more favourable economic indicators (cost and profit) can be realised on higher production levels (specific yield).

MATERIALS AND METHODS

Farm-level data of egg production farms from the database of Hungarian Farm Accountancy Data Network (FADN) managed by the Hungarian Research Institute of Agricultural Economics (RIAE) were examined in this research in relation to the period between 2003-2015. In addition to the obligatory EU data provision, the Hungarian FADN is also the database of sectoral cost and income analyses. Sectoral cost and income data are based on the accounting of agricultural enterprises which is performed in conformity with rules set out in the Accounting Act and other financial prescriptions (Béládi et al., 2017).

The FADN is representative of the commercial agricultural holdings in the Union. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the Union. In order to extrapolate the data in the sample to all holdings in the Union covered by the survey, a special weighting system is used. It is based on the principle of free expansion: each holding in the sample has a weight corresponding to the number of agricultural holdings it represents (EC, 2007). RIAE determines these farm weights (based on Standard Gross Margin before 2010 and Standard Output after 2010) each year using the data of the Hungarian Central Statistical Office, which shows how many other farms from the respective group of the basic population are represented by the given farm in the sample providing sectoral data. Therefore, the data processed and published by this study show the weighted average of the represented farms, i.e., the typical values of the whole population represented by them. For this reason, the obtained data have no statistical uncertainty; therefore, no statistical tests were used to evaluate the differences between them.

239 samples are available for farms using cages, while there are 160 samples for farms which use barn systems for the 13 examined years. The whole data series were used only for the analysis of the time series and their tendency. In order to confirm the hypotheses, the database was narrowed down and only the data between 2012-2015 were used, thereby preventing the effects of technology change (enriched cages after 2012) and the notable price level changes before 2012. In the period between 2012-2015, the database of the analysis consisted of 94 samples in cage and 111 samples in barn systems.

In order to guarantee the lack of distortion of the Hungarian cost and income relations, as well as the differences between and their proportions, the financial data of the database were processed in HUF and the obtained results were converted to EUR using a base year exchange rate of the Central Bank of Hungary in 2015 (309.9 HUF/EUR).

The following clusters were developed during the grouping of farm-level data:

- based on housing systems: (1) cage, (2) barn;
- based on farm size (average number of hens): (1) below 350, (2) 350-999, (3) 1,000-9,999, (4) 10,000-50,000, (5) above 50,000;
- based on production level (yearly egg production per hen): (1) below 240, (2) 240-290, (3) above 290.

The specific yields of egg production, unit cost, sales price, net profit per egg, production value per hen, production cost per hen, net profit per hen and cost structure were analysed. Regarding these indicators, the mean, standard deviation and median of the whole population within the given group were determined considering farm-level weights. The comparative values of mean and median properly characterise the symmetry of the given indicator. In addition, correlation and regression analyses were performed to examine the correlations between each indicator.

RESULTS AND DISCUSSION

Based on the tendency of sales prices (Figure 4), it can be concluded that the sales price of eggs produced in cages increased by nearly 77% between 2003-2015, while this increase was close to 95% in barn systems. The yearly increase of caged eggs price was 0.27 Eurocents ($y=0.27x+3.98$; $R^2 = 0.84$), while that of barn eggs was 0.54 Eurocents ($y=0.54x+3.65$; $R^2=0.88$). The sales prices of eggs produced in various housing systems started to differ from each other significantly following 2009, as the price of barn eggs has been 30-50% higher in comparison with cages. There may be several reasons for this phenomenon, including consumer preferences, sales channels, farm size, batch size, etc.

Taking other income sources (e.g. selling spent laying hens, subsidies) into consideration, production value per hen shows a relatively steady increase in the case of cage systems during the 13 examined years ($y=0.92x+11.03$; $R^2=0.92$), with a value of 22.44 Euro per hen in 2015. On the contrary, there is a more notable fluctuation in the barn system ($y=0.97x+13.20$; $R^2=0.48$), as there was a more significant decline following the constant growth between 2003 and 2011, mainly because of the decrease

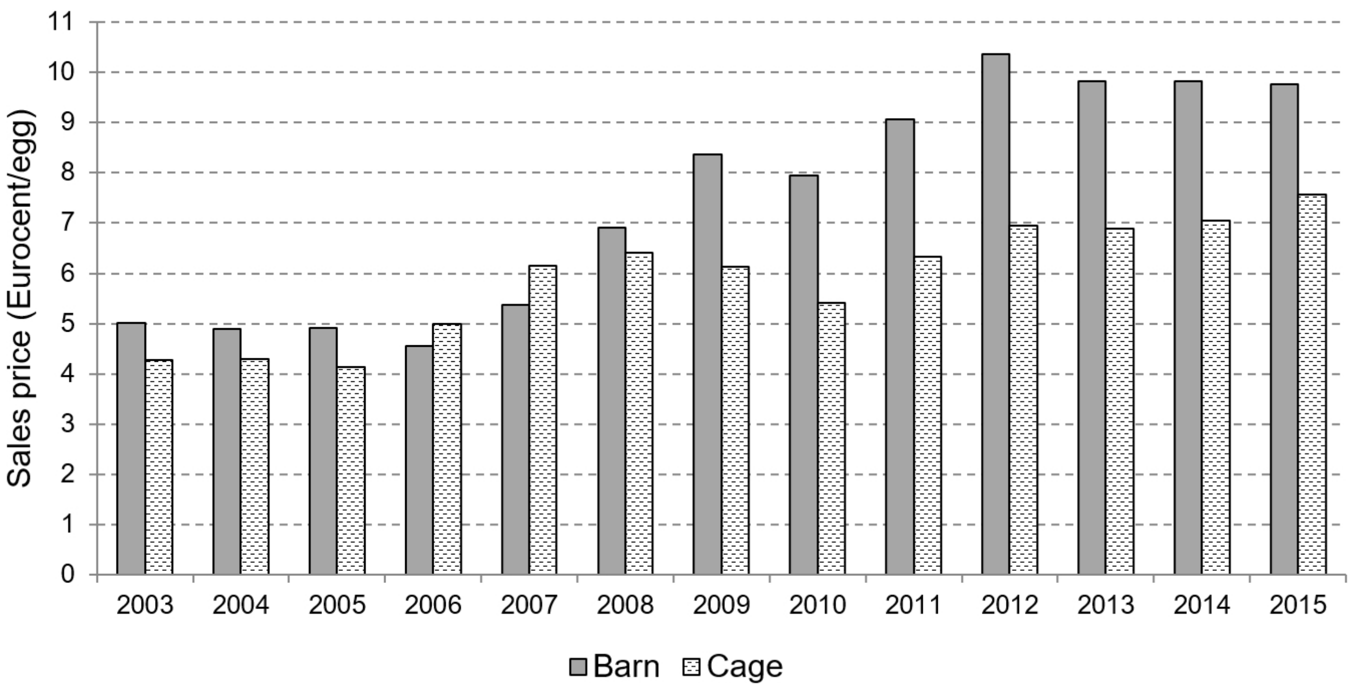

Figure 4. Sales price of table eggs in various housing systems (2003-2015) (Source: own calculation based on Hungarian FADN).

of specific yield. In 2015, farmers using alternative systems realised a production value of 21.35 Euros per hen.

Apart from the fluctuation between each year, the unit cost of egg significantly increased in both technologies (Figure 5). The level of increase exceeded that of sales price, as the production of egg was 77% more expensive in 2015 than in 2003 in cage systems, while there was a 111% increase in barns. In cage systems, the yearly average increase of unit cost was 0.31 Eurocents ($y=0.31x+3.63$; $R^2=0.77$), while it was 0.42 Eurocents ($y=0.42x+4.13$; $R^2=0.63$) in barns. Consequently, the production cost per hen also shows an increasing tendency, with the yearly average increase being 0.94 Euros in cages ($y=0.94x+9.50$; $R^2=0.83$) and 0.64 Euros in alternative systems ($y=0.64x+12.95$; $R^2=0.60$). In 2015, the production cost per hen was 19.12 and 20.17 Euros in farms using cage and barn systems, respectively.

Averaged over the 13 examined years in cage systems, the most significant cost items were feed costs (52.7%), hen depreciation (13.1%), other variable direct costs (12.5%) and labour costs (9.6%). The proportions of these costs in barn systems were 47.8%, 11.1%, 13.3%, and 10.4%, respectively. Based on the calculation of Van Horne and Bondt (2017), in 2015, feed costs ranged between 52 and 62% and labour costs varied between 3-7% on farms using cages in the most significant egg producing countries of the EU. In the case of barn systems, the same proportions were 53-56% and 2-9%, respectively. Of the examined countries, the proportionally lowest level of labour costs was realised in Poland.

Based on the obtained data between 2012-2015, it can be concluded that the size of farms using cages was 78.7 thousand hens (Std. dev. 72%), while that of barn systems is notably lower, as the average size is 409 hens. The difference in unit cost of egg is 2.81 Eurocents (39%) between the two housing systems, which is mainly due to the different farm sizes (Table 1). The unit cost of eggs is 4.6% higher in the case of farms with less than 350 hens and 9.8% higher in the case of 350-999 hens. On the contrary, farms with 1,000-9,999 hens show 5.1% more favourable values in barn systems. If the cumulated average values of farms belonging to these three farm size (1-9,999 hens) are compared, it can be concluded

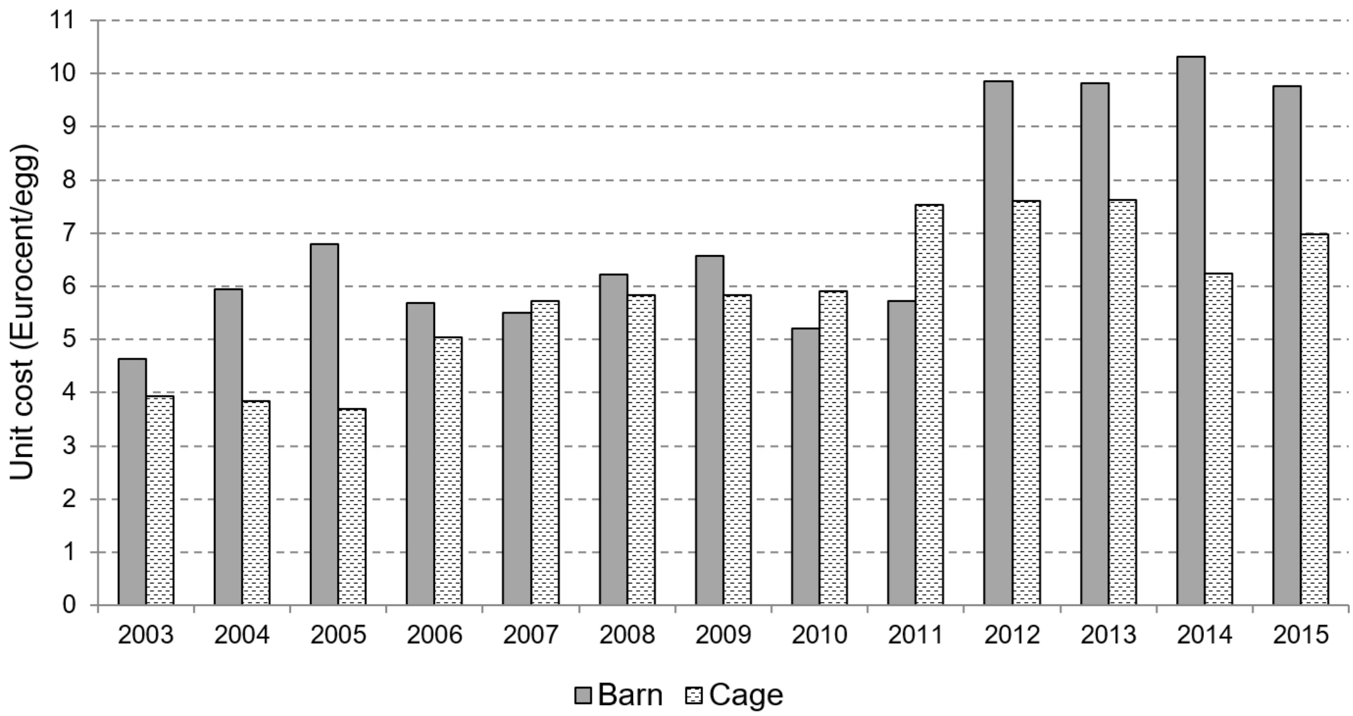

Figure 5. Unit cost of table eggs in various housing systems (2003-2015) (Source: own calculation based on Hungarian FADN)

Table 1. Unit costs in different farm sizes and housing systems (2012-2015)

Unit cost (Eurocent/egg)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	10.02	8.46	7.78	6.11	6.89	7.16
	Std. dev.	3.01	2.29	2.87	1.61	1.66	2.19
	Median	9.56	10.29	7.88	5.48	6.78	6.78
Barn	Mean	10.48	9.29	7.38	-	-	9.97
	Std. dev.	5.24	2.11	1.29	-	-	4.69
	Median	9.73	8.92	7.61	-	-	8.92
Total	Mean	10.29	9.06	7.69	6.11	6.89	7.61
	Std. dev.	4.47	2.19	2.61	1.61	1.66	2.93
	Median	9.68	8.92	7.61	5.48	6.78	7.59

Source: own calculation based on Hungarian FADN.

that farmers using barn systems produce eggs at 10.3% higher unit cost in comparison with cage systems (9.04 Eurocents per egg). However, it also has to be noted that the average size of cage farms with less than 10 thousand hens (2,201 hens) is five times as big as those using alternative systems.

When examining the unit cost in different farm sizes, up to 10-20% difference can be observed between each farm size category. As regards its magnitude, this difference is in accordance with the findings of Castello (2011), who obtained a 7-15% difference in unit costs between each farm size, depending on the given technology. At the same time, the correlation between farm sizes and unit costs is weak (r=0.26; P<0.05), which led to the conclusion that unit costs are affected by mostly other factors (technological and production level, expertise, etc.).

When comparing the Hungarian data with the 2015 EU average data of Van Horne and Bondt (2017), it can be stated that Hungarian farmers produce at significantly higher unit costs in both technologies. The unit cost of egg is 29.5% higher in cage systems and 52.7% higher in barns. Even in the case of larger farms, this disadvantage still ranges between 10-25%.

When examining production level in different farm sizes, the yearly volume of egg production per hen shows an increase with the rise of farm size (Table 2). The smallest farms obtain 25% lower specific yield than the largest ones. Medium correlation (r=0.43; P<0.05) can be observed between farm size and egg production per hen. There is also a difference between each housing system, as Hungarian producers realised 27% lower yield in barn systems than in cages. At the same time, in international comparison (Van Horne and Bondt, 2017), the average of Hungarian cage systems is 10-12% below the average values of the most significant egg producing countries of the EU.

As regards sales prices, similar correlations can be observed. Farmers using alternative technology and those with smaller farms realise higher prices (Table 3). When comparing the average sales prices of farms with less than 10 thousand hens, it can be seen that farmers using barn systems realise 7.4% higher prices on the market, which shows that consumers partially

Table 2. Specific yields in different farm sizes and housing systems (2012-2015)

Yield (eggs/hen/year)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	258	262	267	285	289	283
	Std. dev.	43	39	58	16	14	27
	Median	256	284	290	290	281	281
Barn	Mean	195	239	273	-	-	207
	Std. dev.	62	60	17	-	-	64
	Median	199	223	277	-	-	208
Total	Mean	217	245	268	285	289	267
	Std. dev.	63	56	52	16	14	49
	Median	219	264	285	290	281	281

Source: own calculation based on Hungarian FADN.

Table 3. Sales price in different farm sizes and housing systems (2012-2015)

Sales price (Eurocent/egg)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	9.72	9.74	8.50	7.26	6.48	7.08
	Std. dev.	0.99	0.77	1.10	0.89	0.50	1.27
	Median	9.99	9.55	8.53	7.11	6.45	6.47
Barn	Mean	10.06	9.61	9.35	-	-	9.92
	Std. dev.	1.12	0.34	1.02	-	-	1.06
	Median	9.82	9.62	9.18	-	-	9.68
Total	Mean	9.92	9.64	8.68	7.26	6.48	7.53
	Std. dev.	1.08	0.50	1.14	0.89	0.50	1.61
	Median	9.85	9.62	9.00	7.11	6.45	6.74

Source: own calculation based on Hungarian FADN.

acknowledge the extra costs of this housing system by means of the market prices. There is a close correlation ($r=0.73$; $P<0.05$) between farm size and sales price. The reason for this relationship is that while smaller farms sell eggs directly to consumers, bigger farms are forced to sell their products mainly through retail chains at the prices set by these chains due to the large batch sizes (Szabó, 2017b). Accordingly, it is important to note the conclusions of Molnár and Szőllősi (2015), i.e., the preferences of Hungarian consumers purchasing foods in retail stores mainly cover the egg size, colour, uniformity, undamaged condition and country of origin and not the housing system; therefore, the potential sales prices and consumer decisions are mostly affected by these factors.

The production value per hen is nearly the same concerning the countrywide average of the two technologies (Table 4). At the same time, farmers on larger farms using cages realise lower production value despite the higher production level, primarily due to the notable differences in sales prices. As opposed to cage systems, larger farm size is more favourable in the case of barn technology.

There is only 2% difference in the production cost per hen, considering the countrywide average of the two technologies (Table 5), but if only the cumulated averages of farms with less than 10 thousand hens are compared to each other, it can be seen that the production costs per hen are 17% higher in cages than in barns. This means that the opposite differences manifested in unit cost are rooted in specific yields. In addition, decreasing production costs can be realised in increasing farm size categories, which, based on average values, leads to the conclusion of economies of scale in both technologies. At the same time, there is a very weak correlation ($r=0.04$; $P<0.05$) between the two data series.

The net profit shows variance depending on the examined technology and farm size (Table 6). 0.53 Euro difference per hen can be observed between the countrywide averages of the two examined technologies in favour of the cage system. This difference is even bigger if only the average of farms housing less than 10 thousand hens in cages (1.78 Euro per hen) is considered. However, this situation is not entirely clear, since farmers using cages realised significantly higher profit in the case of farms with 350-999 hens, as opposed to farms with 1,000-9,999 hens, where barn systems provided higher profit. In the case of farmers using alternative systems, higher net profit was realised on bigger farms. On the contrary, the lowest profit was realised on the smallest and biggest farms in the case of cage systems, while profits more favourable than the countrywide average were realised on farms with 350-50,000 hens.

Table 4. Production value in different farm sizes and housing systems (2012-2015)

Production value (Euro/hen)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	26.21	27.55	23.94	21.29	20.68	21.67
	Std. dev.	5.94	6.25	6.14	2.16	1.96	3.72
	Median	26.48	29.90	26.34	20.89	20.56	20.70
Barn	Mean	20.66	23.80	26.45	-	-	21.55
	Std. dev.	7.62	6.47	2.74	-	-	7.42
	Median	20.53	21.59	26.63	-	-	21.59
Total	Mean	22.56	24.77	24.49	21.29	20.68	21.65
	Std. dev.	7.56	6.62	5.67	2.16	1.96	4.73
	Median	22.68	28.39	26.38	20.89	20.56	20.89

Source: own calculation based on Hungarian FADN.

Table 5. Production cost in different farm sizes and housing systems (2012-2015)

Production cost (Euro/hen)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	25.82	22.14	20.78	17.39	19.90	20.26
	Std. dev.	7.37	4.98	5.53	4.16	4.31	5.26
	Median	26.35	21.38	20.06	15.90	18.98	18.98
Barn	Mean	20.45	22.20	20.14	-	-	20.67
	Std. dev.	6.60	5.65	3.22	-	-	6.30
	Median	20.28	20.32	19.84	-	-	20.32
Total	Mean	22.29	22.18	20.64	17.39	19.90	20.34
	Std. dev.	7.33	5.48	5.12	4.16	4.31	5.49
	Median	21.29	20.32	20.06	15.90	18.98	19.75

Source: own calculation based on Hungarian FADN.

Table 6. Net profit in different farm sizes and housing systems (2012-2015)

Net profit (Euro/hen)		Farm size (hens)					
		<350	350-999	1,000-9,999	10,000-50,000	50,000<	Total
Cage	Mean	0.39	5.42	3.17	3.90	0.78	1.41
	Std. dev.	8.35	6.72	8.05	4.75	5.66	6.24
	Median	-0.26	6.74	4.00	4.68	-0.12	2.08
Barn	Mean	0.21	1.60	6.30	-	-	0.88
	Std. dev.	10.07	4.57	3.00	-	-	9.25
	Median	0.42	2.9	7.35	-	-	2.16
Total	Mean	0.27	2.59	3.85	3.90	0.78	1.30
	Std. dev.	9.52	5.47	7.38	4.75	5.66	6.97
	Median	0.39	4.07	4.49	4.68	-0.12	2.16

Source: own calculation based on Hungarian FADN.

When categorising farms into three clusters based on their production levels (yearly egg production per hen), a positive correlation with economic indicators can be observed (Table 7). Averaged over farms with yields above 290 eggs per hen, a yield of 303 eggs per hen approaches the yearly 310-320 eggs per hen value, as published by Van Horne and Bondt (2017). As regards unit cost, 33% and 26% decreases can be observed between the

Table 7. Cost and profit of egg production at various production levels (2012-2015)

Description		Yield (eggs/hen/year)		
		<240	240-290	290<
Yield (eggs/hen/year)	Mean	179	278	303
	Std. dev.	48	10	12
	Median	192	280	299
Unit cost (Eurocent/egg)	Mean	11.66	7.82	5.75
	Std. dev.	4.97	1.69	1.62
	Median	11.4	7.59	5.64
Sales price (Eurocent/egg)	Mean	9.58	7.04	7.6
	Std. dev.	1.03	1.47	1.39
	Median	9.68	6.45	7.11
Net profit (Eurocent/egg)	Mean	-1.58	-0.12	2.27
	Std. dev.	5.19	2.03	1.54
	Median	-0.54	-0.24	2.01
Production value (Euro/hen)	Mean	18.04	21.43	24.29
	Std. dev.	5.32	3.94	3.97
	Median	18.91	20.56	23.04
Production cost (Euro/hen)	Mean	20.88	21.76	17.43
	Std. dev.	6.73	4.53	5.09
	Median	20.28	21.24	15.9
Net profit (Euro/hen)	Mean	-2.83	-0.33	6.86
	Std. dev.	8.16	5.67	4.53
	Median	-2.9	-0.68	6.02

Source: own calculation based on Hungarian FADN.

averages of each production level. According to the linear model describing the correlation between yield and unit cost ($y=-0.06x+24.10$; $R^2=0.57$; $P<0.05$), if specific yield increases by one egg, the unit cost decreases by 0.06 Eurocents. Averaged over the best farms, the production of one egg costs 5.75 Eurocents, which is 4% above the EU average (5.53 Eurocents per egg) calculated by Van Horne and Bondt (2017) for 2015.

The highest sales price belongs to the cluster with the lowest production level, into which mainly the smallest farms were categorised (Mean=490 hens, Max=6,580 hens). The reason for this finding lies in the sales opportunities of smaller, but more extensively operating production farms to direct consumers. The production value per hen shows medium correlation with egg production per hen ($y=0.05x+7.76$; $R^2=0.29$; $P<0.05$). Furthermore, it was 6.25 Euros higher per hen at higher production levels, compared to the average of farms with the lowest yield. The production cost per hen was more favourable also in the case of farms performing at higher production levels, while there is a very weak correlation ($r=0.07$; $P<0.05$) between the production cost per hen and yield. Net profit per egg increases in parallel with production levels ($y=0.04x-11.56$; $R^2=0.35$; $P<0.05$) and while there was a loss on behalf of farms belonging to the first two clusters, the average profit per egg was 2.27 Eurocents in the case of higher specific yield in the examined period. Similar correlation was observed in the case of net profit per hen ($y=0.06x-14.74$; $R^2=0.18$; $P<0.05$).

CONCLUSIONS

H_1 hypothesis ("The production of table egg is more cost-efficient in (enriched) cage systems than in barns") was confirmed by the difference in unit cost which is basically explained by more favourable specific yield; therefore, the hypothesis is accepted. H_2 hypothesis ("Economies of scale prevails also in egg production, i.e., egg production cost is lower in larger farm size.") is only partially accepted. Even though it can be confirmed based on the average of clusters, but the correlation between the two variables is very weak; therefore, other factors also play a role in determining unit cost. H_3 hypothesis ("More favourable economic indicators (cost and profit) can be realised on higher production levels (specific yield).") was confirmed by the described correlations; therefore, the hypothesis is accepted.

Altogether, it can be concluded that the improvement of the current technological level (which is below the average of the most development EU countries) would definitely enhance the physical and economic efficiency of Hungarian egg production by supporting modernising investments. In addition to improving feed conversion ratio, the primary objective would be to reduce specific labour use and specific energy use. Alternative technologies are recommended for smaller, family farms, since the available manpower is not economically viable to be substituted by technical development at this scale. In addition, the price advantage provided by the alternative system can be exploited by directly selling products to the consumers along short supply chains. The only technology that can be recommended for large-scale production is the cage system which is more cost-effective.

ACKNOWLEDGEMENTS

Supported by the ÚNKP-17-4-III-DE-368 New National Excellence Program of the Ministry of Human Capacities

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

REFERENCES

Béládi, K., Kertész, R., Szili, V. (2017) A főbb mezőgazdasági ágazatok költség- és jövedelemhelyzete, 2013-2015. Budapest: Agrárgazdasági Kutató Intézet. 6-9. DOI: https://dx.doi.org/10.7896/ai1704

Castello, J.A. (2011) Options for egg production at EU: economic approach. 3th European round table on poultry economics, Working group 1 of the World Poultry Science Association. Barcelona, Spain, 27-28 October 2011.

Csobaji-Nagy, D., Molnár, Gy., Sütő, Z. (2016) A tojás maga a csoda. Budapest: Baromfi Termék Tanács, 14-15. Available at: http://www.mbtt.hu/mediatar/multimedia/a_tojas_maga_a_csoda_tojas_kisokos [Accessed 1 July 2016].

European Commission (EC) (2007) Farm Accountancy Data Network (FADN) – Definitions of Variables used in FADN standard results. Brussels: European Commission DG-AGRI, 3-4. Available at: https://www.aki.gov.hu/file/f9075c64a1b26d257d3700f2f71976ab [Accessed 9 October 2017].

European Commission (EC) (2016) EU Agricultural Outlook – Prospect for the EU agricultural markets and income 2016-2026. Brussels: European Commission. Available at: http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/index_en.htm [Accessed 23 October 2017].

European Egg Processors Association (EEPA) (2017) Laying hens by way of keeping. Brugge: European Egg Processors Association. Available at: http://www.eepa.info/Statistics.aspx [Accessed 14 November 2017].

Food and Agriculture Organization of the United Nations (FAO) (2017) Food and Agriculture Organization of The United Nations' database. Rome: Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/faostat/en/#data/QL [Accessed 23 October 2017].

Horne, P.L.M., van, Bondt, N. (2017) Competitiveness of the EU egg sector, base year 2015. Report 2017-062. International comparison of production costs. Wageningen: Wageningen Economic Research, 11-20.

Hungarian Poultry Production Board (HPPB) (2017) Hungarian Poultry Production Board database. Budapest: Hungarian Poultry Production Board.

Matthews, W.A., Sumner, D.A. (2015) Effects of housing system on the costs of commercial egg production. Poultry Science, 94 (3), 552-557.

McDougal, T. (2017) 75% of EU egg production is concentrated in 7 countries. [Online] Poultry world. Available at: http://www.poultryworld.net/Eggs/Articles/2017/9/75-of-EU-egg-production-is-concentrated-in-7-countries-184560E/ [Accessed 14 November 2017].

Molnár, Sz., Szőllősi, L. (2015) Fogyasztási és vásárlási szokások Magyarországon. Baromfiágazat, 15 (3), 60-68.

National Food Chain Safety Office (NFCSO) (2016) Nyilvántartott tojótyúk-tartó telepek. Budapest: National Food Chain Safety Office. Available at: http://portal.nebih.gov.hu/-/nyilvantartott-tojotyuk-tarto-telepek [Accessed 28 April 2016].

Sossidou, E., Cziszter, L.T., Szűcs, E., Gavojdian, D. (2015) Socioeconomic framework of farm animal welfare. Állattenyésztés és takarmányozás, 64 (2), 81-93.

Szabó, V. (2017a) A feljavított ketreces és az alternatív tojótyúktartás naturális hatékonysági mutatói. Journal of Central European Green Innovation, 5 (1), 103-120.

Szabó, V. (2017b) The economic comparison of cage and deep-litter systems in Hungary. Annals of the Polish Association of Agricultural and Agribusiness Economists, 19 (4) 201-206. DOI: https://dx.doi.org/10.5604/01.3001.0010.5187

Szőllősi, L., Molnár, Sz., Molnár, Gy., Horn, P., Sütő, Z. (2017) A tojás mint alapvető és funkcionális élelmiszer táplálkozás-élettani jelentősége. Táplálkozásmarketing, 4 (1-2), 7-22.