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ECONOMICS OF EGG PRODUCTION IN ALTERNATIVE HOUSING SYSTEMS – A HUNGARIAN CASE STUDY

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Abstract: *In the European Union, in addition to the enriched cage system, non-cage housing systems represent an increasing market share, although their proportions are different in each Member State. In Hungary, the ratio of hen stock producing eggs in cage systems is 83% currently, but it is estimated that the market share of alternative systems will increase in the future. Nevertheless, it is worth dealing with the economic aspects of egg production in non-cage systems. The main goal of this study is to present production parameters, cost and income situation and market opportunities of two Hungarian farms, which produce in alternative systems (aviary and barn). The data collection involves primary and secondary data. Primary data collection involves the collection and processing of data from two Hungarian farms, which also carry out production in different alternative systems (aviary and barn). Secondary data collection means the utilisation of literature. Primary data collection was based on data from 2016-2017 and focused on production and technological parameters (farm size, used hybrid, change in the animal stock, egg production, feed consumption and other expenditures), input and output prices and average cost items. Based on the collected data, the cost and income situation of egg production in the analysed farms were determined using a deterministic model calculation. The examined farms are of different size: the aviary farm has 10 thousand hens, while the barn farm has 3 thousand hens. The former one uses Lohmann Brown Lite, the latter one uses Tetra SL hybrid. The egg production period of the aviary farm is 73 weeks long, while that of the barn farm lasts for 65 weeks. During this period, the average egg production intensity was 74% and 85%, respectively and the egg yield was 360 and 382 eggs/hen, respectively. The daily feed consumption was 110 g/hen in the aviary farm and 145 g/hen in the barn farm. The unit direct cost of the main product (Class A egg) was 7.24 Eurocent/egg on the aviary farm and 7.85 Eurocent/egg on the barn farm. The unit production value of the main product was 7.80 Eurocent/egg on the aviary farm and 9.87 Eurocent/egg on the barn farm. Therefore, the gross margin of unit egg was 0.56 Eurocent/egg on the aviary and 2.02 Eurocent/egg on the barn farm. Results show that egg production is profitable in both farms which is related to the used housing systems and direct sales along short supply chains due to the smaller farm size.*

Keywords: *table egg production; economic analysis; alternative systems; production parameters; efficiency.*

JEL Classification: *M11; Q12.*

1. Introduction

The global production of eggs increased by approximately 34.4% to nearly 80.1 million tonnes between 2007 and 2017, which is expected to continue to grow in the future as a result of rising global food demand. China currently produces the largest quantities of eggs (31.3 million tonnes). The second largest country is the US (6.3 million tonnes), and the third is India (4.8 million tonnes). These three countries produce more than 50% of the world's egg production. According to the latest official data, the average annual consumption of eggs in 2013 was 9 kg per capita, which is expected to increase further in the future (FAO, 2019).

The European Union's egg production was 6.9 million tonnes in 2018, which may increase by about 9.5% between 2018 and 2028 (EC, 2018). Member States' production represented 9% of global production in 2017. France (13.4%), Germany (11.6%), Spain (11.6%), the United Kingdom (10.5%), Italy (10.4%), the Netherlands (10.1%), and Poland (8.3) accounted for a significant share of EU egg production in 2017 (FAO, 2019).

Egg consumption per capita in the EU has not changed significantly over the last decade, but is expected to grow by 7.8% by 2028. In terms of EU external trade, imports declined by 7.1%, while exports increased by 16.8% between 2008 and 2018, with significant future growth expected in both cases (imports: +13.8%; exports: +38.7%) (EC, 2018).

According to Directive 1999/74/EC, which entered into force on 1 January 2012, farms could no longer apply the traditional cage housing method, instead they had to switch to enriched cage housing or non-cage systems (Council Directive, 1999). As a result, the proportion of housing technologies used within the European Union has changed, which varies from country to country. In 2018, about half (50.4%) of the hens were kept in enriched cage, more than a quarter (27.8%) in aviary and barn, and the rest (21.7%) in free range and organic housing. Within the EU Member States, predominantly (over 80%) enriched cage housing technology is used in Poland, Spain, Portugal, Czech Republic, Slovakia, Latvia, Lithuania and Malta. In contrast, in Germany (93.5%), the Netherlands (83.9%), Sweden (90.8%), Austria (99.2%), Denmark (94.8%) and Luxembourg (100%), mainly non-cage housing is used (Figure 1).

In Western Europe, but also in the US, major supermarket chains have started to prefer eggs from cage-free technologies (barn, aviary, free range, organic), referring to consumer demand, sustainability and animal welfare considerations, and certain wholesale chains will cease trading by 2025 at the latest the sale of cage-based eggs (Van Horne, 2019). As a result, the proportion of cage-free housing technologies is expected to increase further in the future. This process has already begun, as alternative housing technologies are gaining ground in Poland in the recent years, even though it is one of the largest EU producers and mostly cage technology is used (Sokolowitz et al., 2018).

Contrary to international data, the proportion of enriched cage housing is 83% in Hungary. Currently, non-cage housing technologies account for a lower proportion (17%) of which barn and aviary (15.5%) are the most important, while free range (1%) and organic (0.5%) are negligible (NFCSO, 2019).

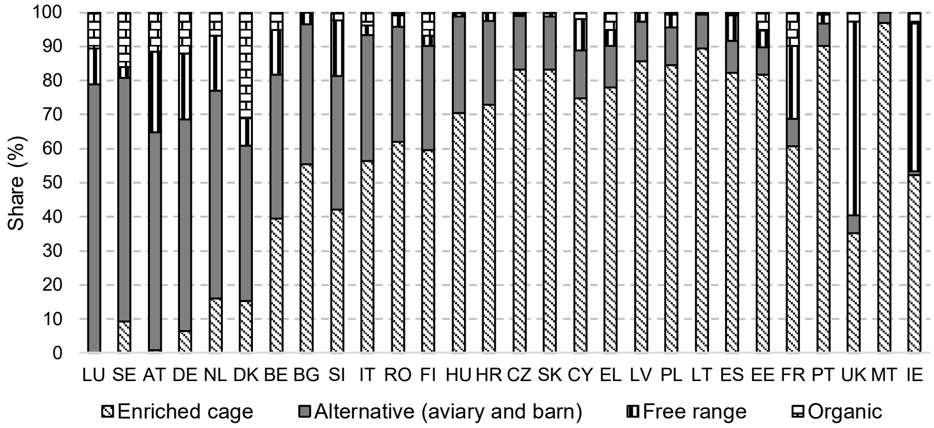

Figure 1: The rate of housing systems in laying hens in the EU-28 (2018)
Source: EC, 2019

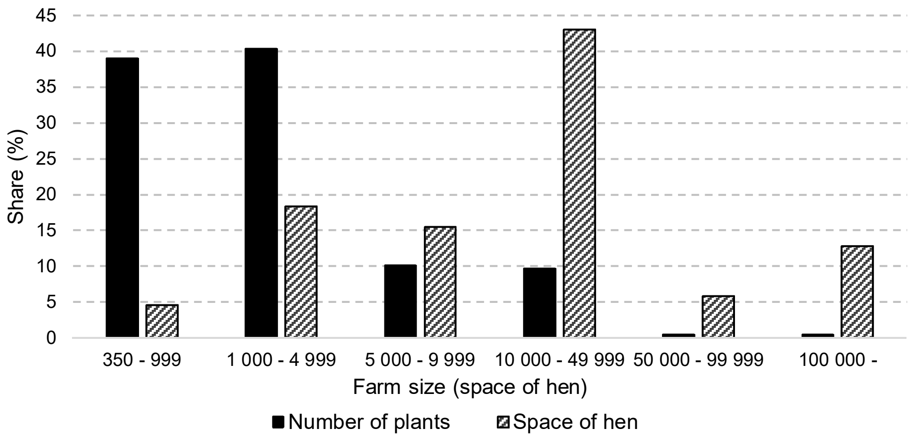

Figure 2: Capacity sharing by farm size of non-cage (aviary, barn, free range, organic) farms in Hungary
Source: NFCSO, 2019

We examined the size of farms using non-cage housing systems in Hungary. Nearly 90% of farms using non-cage systems are small farms (below 10,000 space of hens), with 38% of their hens in production. In contrast, about 43% of laying hens are kept in medium-sized farms (10,000-49,999 space of hens). Only 0.9% of the farms have

a capacity of over 50,000, while 19% of laying hens produce in these farms (Figure 2).
Demand for eggs in Hungary is determined by a significantly lower wage level than the EU average, and the kind of consumer awareness that exists in Western Europe is not yet typical in the country (Molnár – Szőllősi, 2015). However, the technology change will soon be forced by the market and supermarket chains are expected to switch, partially or completely, to eggs from cage-free technology throughout the Central and Eastern Europe region. This poses a major challenge for the Hungarian egg sector in the medium term and the sector must consciously and gradually prepare for this challenge.
In the context of the above, the main objective of the study is to present case studies of the production parameters, cost-income relationships, and sales channels of two Hungarian egg producing companies that use different alternative (aviary and barn) housing methods.

2. Material and methods

During the data collection, primary and secondary data are also applied. The latter one is used by different kinds of databases such as HPPB (Hungarian Poultry Product Board), NFCSO (National Food Chain Safety Office), RIAE (Research Institute of Agricultural Economics) and FAO (Food and Agricultural Organization). Primary data was collected from two Hungarian farms, which perform production using different alternative systems (aviary and barn). It has to be highlighted that the farm size was not equal, but both farms are small (below 10 000 hens) which is general in the Hungarian non-cage farm structure. Primary data collection (production and financial parameters) was based on the 2016-2017 period. As for the currency exchange rate, financial results were calculated with 310 HUF/EUR. Production and technological parameters were focused on farm size, applied hybrid, change in the animal stock, egg production, feed consumption and other expenditure. Input, output prices and average cost items were also taken into consideration. The cost and income situation of egg production in the analysed farms was determined using a deterministic model calculation based on the methodology of Szőllősi and Szűcs (2014).

3. Results

Not only were different alternative housing technologies used in the examined enterprises, but also the size of the farm and the stable area were different. The visited farms can be considered small in size. Stocking density is based on technology, as the aviary farm uses multi-level alternative technology and the barn farm applies single level housing system, i.e., the aviary system enables 35-40% higher stocking density. The applied hybrids were different: Lohmann Brown Lite and Bábolna Tetra SL, respectively. The production periods of the examined farms were also different (73 and 65 weeks, respectively), which is a management decision influenced by the market situation and financial issues. Naturally, the length of the production period also affects production and financial data, i.e., it is advisable to

interpret the discrepancies between the data of the two farms with this in mind. Ingredients of feed were purchased in both farms, but their compound feed were self-produced. The pullets were also bought in both farms (Table 1).
During the production period, the average egg production intensity was 74% on Farm 1 and 85% on Farm 2. The egg yield was 360 and 382 eggs/hen housed/production period, respectively (Table 2). Although Farm 1 kept the stock for 8 weeks longer, it produced 22 eggs less than Farm 2, i.e., there is a significant difference in production levels. In Figure 3, it is clearly shown that barn farm surpassed, while the aviary farm performed below the references of the breeding companies. The assumed causes of this difference could be higher mortality rate caused by technology and animal health or pullet rearing problems in Farm 1.

Table 1: Main data of the analysed farms

Denomination	Unit	Farm 1	Farm 2
Housing system	-	aviary	barn
Farm size	hen	10 000	3 000
Stable	m^2	1 161	480
Stocking density	hen/m^2	8.61	6.25
Hybrid	-	Lohmann Brown Lite	Bábolna Tetra SL
Length of production period	weeks	73	65
Ingredients of feed	-	bought	bought
Compound feed	-	own-produced	own-produced
Pullet	-	bought	bought

Source: own data collection and calculation, 2018

Table 2: Yield and average egg production intensity in the analysed farms

Denomination	Unit	Farm 1 (aviary, 73 weeks)	Farm 2 (barn, 65 weeks)	Reference of the breeding company	
				Lohmann Brown L.	Bábolna Tetra SL
Average egg production (65 weeks)	%	-	85.02	-	83.16
Average egg production (73 weeks)	%	74.42	-	82.15	-
Egg production (65 weeks)	eggs/hen housed	-	382	-	372
Egg production (73 weeks)	eggs/hen housed	360	-	410	-

Source: own data collection and calculation, 2018; Lohmann Tierzucht, 2014; Bábolna Tetra Ltd., 2018

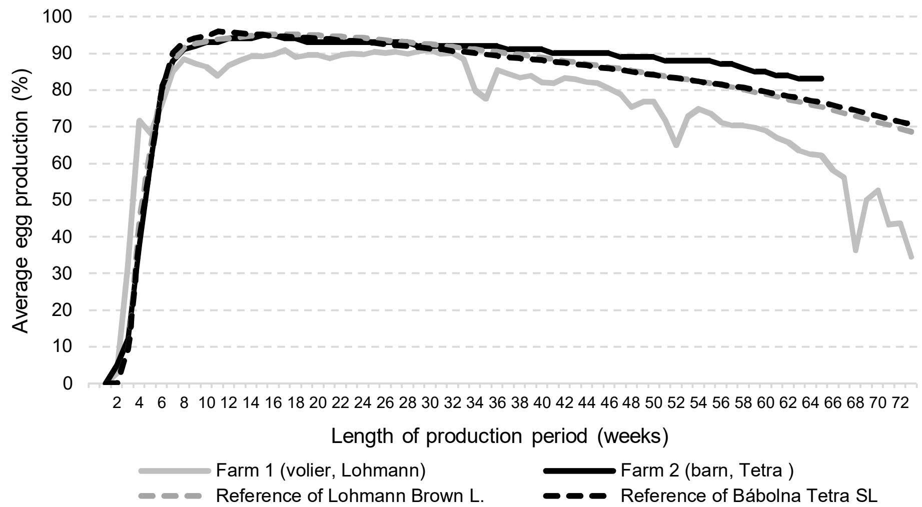

Figure 3: Average egg production in the analysed farms
Source: own data collection and calculation, 2018; Lohmann Tierzucht, 2014; Bábolna Tetra Ltd., 2018

Further physical efficiency indicators were also calculated. The rate of Class A egg is similar in both farms. However, the mortality rate in the henhouse is greatly differed. On the aviary farm, this value was 16% during the 73 weeks, while on the barn farm, it was only 2.5% in 65 weeks. This difference can be explained not only by the longer production period, but technology and animal health or pullet rearing problems on Farm 1. A study by Nernberg (2018) has also shown that the mortality rate on the aviary may be higher than in the case of other housing systems which are “mainly attributed to hypocalcaemia, vent picking/pick-outs, prolapses, bumble foot, and birds simply getting caught or injured in the cage structure”. The daily feed consumption was 110 g/hen on Farm 1, while on the other farm it was 145 g/hen. On Farm 1, the used hybrid has lower average body weight. As a result, the daily feed consumption could be lower by nearly 25%. Therefore, the feed use of Farm 2 per unit egg is 16% higher than that of the other farm, with 6% better egg production per hen (Table 3).
In addition to production indicators, the cost-income ratios of egg production are basically determined by input-output prices. After examining the expenditures, it was revealed that pullets were purchased for both farms. As a result, the aviary farm had a pullet purchase price of 4 Euros and nearly 5 Euros for the barn farm. The price of the pre-layer and layer I feed were about 19-20 Eurocent/kg in Farm 1 and 22 Eurocent/kg in Farm 2. The selling price of Class A eggs was influenced by several factors. Despite the fact that both farms sell their products directly to consumers, the geographical location of the farms and, consequently, their distribution channels are different. The selling price of Farm 1's main product was 7.5 Eurocent per egg, while Farm 2's price was 9.2 Eurocent per egg during the examined period, which means

that the latter farm could reach a 23% higher price (Table 4). Compared to the national average prices of HPPB (2017) for this period, Farm 1 achieved a 6% lower and Farm 2 a 16% higher sales price.

Table 3: Other physical efficiency indicators

Denomination	Unit	Farm 1 (aviary, 73 weeks)	Farm 2 (barn, 65 weeks)
The rate of Class A egg	%	97	98
Mortality rate in henhouse	%	16.0	2.5
Feed consumption	g/hen/day	110	145
Feed consumption	kg/hen/65 weeks	-	65.15
Feed consumption	kg/hen/73 weeks	52.89	-
Feed consumption	g/egg	147	171
Average body weight of spent layer	kg/hen	1.89	2.10

Source: own data collection and calculation, 2018

Calculated from the collected data, the direct farm-level cost of production at Farm 2 was one third compared to Farm 1, which can be explained by the smaller farm size and the shorter production cycle. For the sake of comparability, it is important to examine the evolution of specific direct production costs (per hen, per m^2 of stable, per one egg) over the whole production cycle and per year (Table 5).

Table 4: Input and output prices of the examined farms

Denomination	Unit	Farm 1 (aviary)	Farm 2 (barn)
Input prices:			
Pullet	Euro/pullet	4.35	4.77
Pre-layer feed	Eurocent/kg	19.04	21.03
Layer I feed	Eurocent/kg	19.99	22.12
Layer II feed	Eurocent/kg	20.32	20.86
Layer III feed	Eurocent/kg	18.65	-
Output prices:			
Class A egg	Eurocent/egg	7.45	9.19
Class B egg	Eurocent/egg	-	3.23
Spent layer	Euro/spent layer	0.93	2.26
Manure	Euro/ton	4.84	6.45

Source: own data collection, 2018

The production cost per hen of Farm 2 is 16% higher than that of the other farm, with a difference of 30% per year, which is mainly due to higher daily feed consumption. Compared to the average production cost of the determinant producer farms in the Hungarian Farm Accountancy Data Network (FADN) in 2017 (17.50 Euro/hen/year) (RIAE, 2019), the direct production cost per hen of the tested farms was 3% and 35% higher, respectively. Farm 1 has 19% higher in production costs per m^2, but this difference is only 6% over a year. The production cost per unit of the main product was around 7.2 Eurocent/egg at Farm 1 and about 7.8 Eurocent/egg at Farm 2. The difference is smaller (8%) compared to the value per hen, which is reduced by the difference in yield.

Table 5: Direct cost of egg production in the analysed farms

Denomination	Unit	Farm 1 (aviary, 73 weeks)	Farm 2 (barn, 65 weeks)
Direct cost	Euro/production period	252 675	88 103
Direct cost per hen housed	Euro/hen/production period	25.27	29.37
	Euro/hen/year	18.05	23.56
Direct cost per m^2	Euro/m^2/production period	217.64	183.55
	Euro/ m^2/year	155.45	147.24
Direct cost per main product	Eurocent/Class A egg/ production period	7.24	7.85
	Eurocent/Class A egg/year	6.61	7.86

Source: own data collection and calculation, 2018

Table 6: Production value of egg production in the analysed farms

Denomination	Unit	Farm 1 (aviary, 73 weeks)	Farm 2 (barn, 65 weeks)
Production value	Euro/production period	272 097	110 777
Production value per hen housed	Euro/hen/ production period	27.21	36.93
	Euro/hen/year	21.62	29.35
Production value per m^2	Euro/m^2/production period	234.36	230.79
	Euro/ m^2/year	186.23	183.43
Production value per main product	Eurocent/Class A egg/ production period	7.80	9.87
	Eurocent/Class A egg/year	7.92	9.80

Source: own data collection and calculation, 2018

For the purpose of calculating the production value, the turnover data of the main product (Class A egg) with the highest proportion and that of the by-products (Class B egg, manure, subsidies) were taken into account (Table 6). Farm 1, despite having three times the size of Farm 2 and keeping the stock in production for longer, had only 2.5 times higher production value than Farm 2, due to differences in yield per hen. This, together with the higher selling price, also explains that the production value per hen is 36% higher for Farm 2. Compared to the average production value of the determinant producer farms in the Hungarian FADN in 2017 (25.03 Euro/hen/year) (RIAE, 2019), the annual production value per hen for Farm 1 is 13% lower and that of Farm 2 is 17% higher. The production value per m^2, irrespective of the different stocking densities, does not show a significant difference between the two farms, which also points the lower production level of Farm 1. The production value per egg was 27% higher in Farm 2, mainly due to higher selling prices.

Despite the difference in farm size, there is no significant difference when comparing the gross margin interpreted at the farm level, and both farms are profitable (Table 7). In terms of value per hen, Farm 2 realized about four times the value of Farm 1, which is due to unfavourable production indicators at the latter farm owing to higher mortality resulting from the previously mentioned problems (technology, pullet breeding, animal health) and lower sales prices. Compared to the average sectoral income of the determinant producer farms of the Hungarian FADN in 2017 (7.53 Euro/hen/year) (RIAE, 2019), the annual gross margin per hen of Farm 1 is about half, while Farm 2 performed 23% worse. The gross margin per m^2 of stable was around 17 Euro/m^2 for Farm 1 and 47 Euro/m^2 for Farm 2 during their production cycle. The gross margin of the examined farms per unit of the main product during the whole production period is 0.6 and 2 Eurocents, respectively. Based on the data recalculated for one year, it can also be concluded that, for Farm 1, it would have been economically more advantageous to have the stock culled sooner than to maintain it at low production levels.

Table 7: Gross margin of egg production in the analysed farms

Denomination	Unit	Farm 1 (aviary, 73 weeks)	Farm 2 (barn, 65 weeks)
Gross margin	Euro/production period	19 422	22 674
Gross margin per hen housed	Euro/hen/production period	1.94	7.56
	Euro/hen/year	3.57	5.79
Gross margin per m^2	Euro/m^2/production period	16.73	47.24
	Euro/ m^2/year	30.78	36.19
Gross margin per main product	Eurocent/Class A egg/ production period	0.56	2.02
	Eurocent/Class A egg/year	1.31	1.93

Source: own data collection and calculation, 2018

In order to further assess the economic situation of the examined farms, certain economic efficiency indicators have been calculated. In terms of direct average cost, the two farms are characterised by nearly the same value (7.01 and 7.18 Eurocent/egg, respectively). In comparison, the average cost of the determinant producer farms of Hungarian FADN is 6.52 Eurocent/egg (RIAE, 2019) in 2017, which is typical of farms using enriched cage technology due to the Hungarian production structure. Thus, the direct average cost of the examined farms using alternative technologies is 8-10% higher than this. According to Van Horne's (2019) calculation for 2017, in Western European countries, the average cost of an egg in the aviary and barn housing method was 6.52 Eurocent/egg, which was 6% higher than that of the eggs in the enriched cage system.

In terms of human resource use efficiency, Farm 2 using barn technology is 35% less favorable. Farm 1 has a production value of 7.40 Euro per 1 Euro labor cost, whereas Farm 2 had a production value of 4.79 Euro. By comparison, based on the

average data of the determinant producer farms of the Hungarian FADN in 2017 (RIAE, 2019), the production value is 17.48 Euro per 1 Euro labor cost.
The cost-to-profit ratio of Farm 2 was 26% and that of Farm 1 was 8%. The respective average value of Hungary's determinant producer farms was 43% in 2017 (RIAE, 2019). However, compared to other livestock sectors, the profitability of Farm 1 can be considered favorable despite its lower production levels.

4. Conclusions and recommendations

Altogether, the two examined farms are profitable, which is related to the used housing technology and the higher selling prices that can be obtained through direct farm sales due to smaller farm sizes. It should be noted that Farm 2 was able to achieve higher values in terms of both selling price and average egg production because their hybrid presumably has more favorable parameters and technology adaptability, the farm had lower mortality and better geographical location, while their sales channel also developed more favourably. Based on all these factors, it is worth examining how cost-income relationships will develop in larger farms using alternative housing technologies, which, however, may result in a more reduced selling price when producing and then selling large volumes of commodities. If a farm is planning to switch to alternative housing technology, it is imperative to consider that both management and the technique used are different from those of cage housing. Furthermore, it is not only the available capital that is important but also the appropriate expertise, which essentially defines the fundamentals of the operation of the farm.

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