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MARKET ANALYSIS

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Economic impacts of banning the enriched cage housing system in Hungarian table egg production

This study aims to examine the economic impacts of phasing out enriched cages in Hungarian table egg production. An online questionnaire survey was conducted among 42 enriched cage egg producers and in-depth interviews were carried out with barn and aviary egg producers, as well as a company specialised in designing and implementing housing systems for laying hens, using economic and physical efficiency data for the year 2021 from egg producers. Economic situation was examined via a simulation model, which was based on on deterministic principles. The results indicate that aviary and barn housing systems exhibit lower physical efficiency and weaker economic indicators when compared to the enriched cage housing system. Aviaries and barns showed reduced egg production per hen (-7% and -12%, respectively), increased feed conversion ratio (FCR) (+17% and +24%), reduced labour efficiency (-40% in both cases), and increased mortality rate (+2.49 and +3.31 percentage points). Key determinants of unit gross margin alterations were found to be egg production per hen, the share of class 'A' eggs, FCR, and pullet acquisition cost. Aviary housing systems proved as profitable as enriched cage systems in terms of gross margin per egg, whereas barn housing systems were unprofitable based on 2021 data. However, those barn eggs producers who sell directly to consumers can still be profitable. The investment payback periods of enriched cage (7 years) and aviary (10 years) housing system differ. In conclusion, aviaries and barns could not outperform the enriched cage housing system in economic terms.

Keywords: laying hen, aviary, barn, enriched cage, gross margin, investment cost

JEL classifications: Q12, Q13.

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Introduction

In 2021, the EU-27 produced almost 6.5 million tonnes table eggs, an increase of 15% compared to 2012. Despite a 14% growth in EU egg consumption (reaching 6.2 million tonnes), the self-sufficiency level remained notably stable over the past decade, ranging between 103-106%. France (14%), Germany (14%), Spain (12%), Italy (12%), the Netherlands (10 %), and Poland (9%) were the leading egg-producing countries in the European Union, accounting for approximately 71% of the community's egg production (including hatching eggs) in 2021 (EC, 2023a).

In the European Union, including Hungary, the cage housing system of laying hens underwent several changes between 1999 and 2012. The minimum cage area of 450 cm^2 had to be changed to 550 cm^2 in unenriched cages from 2003 (20/2002 (III.14.) FVM Regulation). However, only a minimum cage area of 750 cm^2 was allowed in enriched cages from 2012 (Council Directive 1999/74/EC). In addition to the perch, a perching area of 15 cm per bird, a minimum of one laying nest and scratching area with litter had to be provided. Only the slope of the floor (14%) and the number of drinkers per cage (min. 2 pieces per cage) did not change between 1999 and 2012 (Marlok and Kovácsné Gaál, 2008). The latest requirement is still in force.

In Hungary the latest change of cage housing system in 2012 resulted in an increase in the unit cost of eggs produced for each farming method. Compared to conventional cages, the unit cost of eggs produced in barn housing systems has increased by 20%, free-range housing system by 50% and organic housing system by 100% (Alicki, 2012). Since Hungarian consumers lack sufficient information about various production housing systems – a situation similar to that highlighted by the study by Molnár and Szőllősi (2015) – their purchasing decisions are not primarily based on this factor. Their preferences include undamaged eggs, shelf life, and food safety (Szőllősi *et al.*, 2022).

Based on 2021 data from the National Food Chain Safety Office (NFCSO, 2021), 83.9% of layer spaces in Hungary were occupied by hens in enriched cage system. Barn and aviary housing systems make up 15.2% while free-range and organic housing systems represent only 0.5% and 0.4% respectively (Csorbai *et al.*, 2022).

At the EU level, cage systems make up 44.9% of egg production, while aviary and barn housing systems account for 35.6%, free-range housing systems represent 12.8%, and organic housing systems make up 6.6% in 2021 (EC, 2023a). The proportion of cage systems decreased by around 5% in 2022. Among the major egg-producing countries (France, Germany, Spain, Italy, the Netherlands, and Poland), enriched cage systems are still predominantly used in Poland (71.8%) and Spain (68.6%) (EC, 2023b). Therefore, the removal of cage systems would put many egg-producing businesses in the EU at risk.

The 'End the Cage Age' civil initiative (2021) of the European Union strives to produce animal products in housing systems devoid of cages. Recently, Potori *et al.* (2023) investigated the socio-economic implications of abolishing use of conventional farrowing crates in the pig sector. The Hungarian pig production would fall by 23.6% in case of immediate termination scenario and by 8.4% in the case of a phase-out until 2035. This banning would affect both domestic demand and the EU's trade negatively.

Since the European Commission addressed table egg production in their announcement, conducting an impact assessment is crucial. Majewski *et al.* (2024) found that an immediate ban would cause a significant drop in the EU's egg production (from 6.9 million tonnes to 5.6 million tonnes). The additional investment cost of the alternative housing systems would range from 2 to 3.2 billion EUR based on the different scenarios.

As enriched cage is the most common housing system of the Hungarian table egg production (85%) and no studies in Hungary have examined the impact of banning of the enriched cage housing system, our study intends to examine the economic alterations which are likely to take place upon the phase-out of cage in Hungarian table egg production.

Literature review

In the literature, studies mainly focus on animal welfare, production features, parameters, cost-income analysis and investment costs of different housing systems. For instance, a report conceded that a significantly higher number of bacterial (mainly colibacillosis) or parasitic diseases (coccidiosis and red mite), and cannibalism occur in laying hens kept in barn housing systems or in free-range housing systems than in hens kept in cages. The occurrence of viral diseases was significantly higher in indoor barn housing system than in cages (Fossum *et al.,* 2009). Keel bone damage is also a frequent problem of commercially raised laying hens. In Greek farms this type of injury was observed mainly in the free-range system (50 %), followed by enriched cages (24 %) and floor system (7 %) (Dedousi *et al*., 2020). According to Campbell *et al*. (2021) there is a much higher occurrence of diseases, exposure to predators, and heat stress in free-range housing system, however, it has the advantages of foraging and better plumage.

Table 1: The changes in physical efficiency indicators of non-cage housing systems compared to the cage system.

Indicators	Enriched cage = 100%	Barn/ Aviary	Free-range	Organic
Laying period (laying days)	100	100	94	94
Egg production (hen housed)	100	98	91	91
Feed consumption (g/day/hen)	100	105	109	110
Egg production per hen housed (kg)	100	97	89	89
Number of hens per worker	100	57	36	19

Source: own compilation based on van Horne and Bondt (2023)

Table 1 presents that moving from enriched cage systems to non-cage housing systems (barn, aviary, free-range and organic) leads to a deterioration of physical efficiency indicators (van Horne and Bondt, 2023).

In the European Union, the production cost of enriched caged eggs is approximately 16-27% higher compared to some third countries (USA, Ukraine, India, Argentina). This is due to the facts that, on one hand, US, Ukrainian and Argentinian farmers experience 5-19% lower feed costs, and on the other hand, they have 18-24% lower pullet costs compared to European farmers. The only exception was India, where higher feed costs (+6%) was observed compared to the EU average in 2021 (van Horne and Bondt, 2023). However, all these factors create a competitive disadvantage for the EU producers.

According to calculations by van Horne and Bondt (2023), the per egg costs of egg production are 14% higher in aviary/barn housing systems, 32% higher, in free-range housing systems and 110% higher in organic housing systems compared to the enriched cage housing system based on data from 2021. A previous study by van Horne (2019) found that aviary and barn together have an average 17% higher egg production costs than in enriched cage systems.

The study by van Horne and Bondt (2023) compared the production costs of barn and free-range eggs to the cage housing system in several EU countries, the largest increase in production costs for eggs produced in the barn housing system was observed in France (+27%), while the smallest increase was in Hungary (+18%). Where eggs were produced in free-range housing systems, the most significant increase in production costs compared to the cage housing system was in the Netherlands and France (+39%) in 2021.

Molnár and Szőllősi (2020) stated that economically (also in social and environmental aspect), non-cage housing systems are not the most favourable for production conditions. According to a previous study (Szőllősi *et al.,* 2019), in Hungary, the unit cost per egg in barn housing system was approximately 39% higher compared to the cage housing system, referring to the average of the period from 2012 to 2015. However, in relation to this, a subsequent Hungarian case study based on data from the years 2016-2017 (Erdős *et al.,* 2019) revealed that the farm using the barn housing system managed to produce one egg at about 30% higher production costs, while the farm applying aviary housing systems had approximately 33% higher production costs compared to the cage housing system.

On a per hen basis in the Hungarian enriched cage housing system had one of the lowest production costs and one of the highest gross margins (Erdős *et al.,* 2019; Szőllősi *et al.,* 2019). However, a similar gross margin can also be achieved by the farm applying barn housing system, if sales are made directly to consumers (Erdős *et al.,* 2019).

During the transition to cage-free housing systems investment costs also change. Based on van Horne and Bondt (2023)'s study, while the investment costs for barn,

Table 2: The evolution of investment costs in different housing systems

Denomination	Enriched cage	Barn/ Aviary	Free-range	Organic
Housing (euro per hen housed)	8.50	13.53	13.43	20.31
Inventory (euro per hen housed)	16.80	17.50	17.50	28.00
Total (euro per hen housed)	25.30	31.03	30.93	48.31
Total (Enriched cage =100%)	100	123	123	191

Source: own compilation based on van Horne and Bondt (2023)

aviary, and free-range housing systems are 23% higher, the investment costs for the organic housing system surpass the cage housing system by 91% (Table 2).

Methodology

In collaboration with the Hungarian Poultry Product Board (HPPB), an online questionnaire survey was carried out in 2022 based on 2021 data among 42 producers using enriched cage systems, representing around half of the average annual population of hens in enriched cages. Furthermore, in-depth interviews were conducted with producers of barn and aviary eggs, as well as a consultancy firm specialising in housing systems' design and implementation. Based on the chosen technology-dependent physical and economic indicators, a deterministic simulation model was developed to quantify the effects of parameters (egg production per hen, price of class "A" eggs, share of class "A" eggs, mortality rate, permanent workers, feed conversion ratio, price of pullet, stocking density). The model's primary outputs were the indicators characterising the cost and income situation of producers using enriched cages, barns, or aviaries. To prioritise among the available technologies, the marginal cost of production was listed per egg per unit area and per hen, as these are widely accepted measures. The following main cost items were identified in our analysis:

- *Pullet cost:* The difference between the purchase value of the pullets and the value of the culled breeding stock, adjusted for the length of the production cycle.

- *Feed cost:* Determined by the market price of the compound feedstuffs. In cases of in-house production, the opportunity cost was also considered alongside the overhead costs.

- *Variable labour costs:* Egg production typically requires a significant proportion of man-hours, mainly seasonal, which was classified as a variable cost. Related taxes and social contributions were also included.

- *Other variable costs:* All additional variable costs related to egg production (e.g., veterinary costs, carcass removal costs, energy costs, packaging material costs).

- *Permanent labour costs:* The cost of labour that consistently supervises the layer stock. Related taxes and social contributions were also included.

- *Other fixed costs:* All fixed costs not previously listed, such as building maintenance costs.

Depreciation, general costs, and the cost of capital were not considered in estimating incomes.

Calculations were based on the survey questionnaire to typify the three main types of laying hen housing technologies in Hungary in 2021. Based on in-depth interviews and van Horne (2019) the stocking density was estimated to be 26 hens/m^2 for enriched cages, 17 hens/m^2 for aviaries, and 9 hens/m^2 for barns. The parameters for enriched cages served as the benchmark against which the alternative technologies were evaluated in the model. Indices adopted in the literature included various physical and economic parameters, such as egg production per hen, share of class "A" eggs, price of class "A" eggs, mortality rate, permanent labour cost, energy cost, feed consumption, price of pullets, and stocking density.

Additionally, the economic efficiency parameters of egg production were determined per egg, per hen and per square metre for the enriched cage, aviary, and barn housing systems. In-depth interviews and literature sources (Table 3) were used to establish real investment costs. For the calculation of investment costs, a 20-year fixed-term government bond was used as the reference interest rate (3.62%) for 2021. A useful life of 20 years was assumed for the investment. For the analysis of the return on investment, the most important indicators (NPV and IRR) were used (Szűcs and Szőllősi, 2008). When calculating operating cash flows, future increase in egg prices was anticipated and production costs based on past trends. To express the results in euros, the official average exchange rate for 2021 (358.52 HUF/EUR) was used.

Investment alternatives were evaluated under three different scenarios that varied in terms of support levels (equity – using only own equity; 30% or 50% investment support intensity). Based on our assessment, the barn technology was excluded as it generates no income without subsidies. We calculated the cumulative net present value and the internal rate of return for each year within a 20-year useful life.

A limitation of the study is that the results are only relevant for the year 2021. However, this year is considered more transparent in the sense that it rejects the extreme economic and natural conditions in 2022 and 2023. From 2022 onwards, geopolitical factors, extreme drought, price volatility would have an impact on the cost-income situation and investment economics calculations.

Table 3: Range of sources used to derive the indices for each factor.

Indicators	Index – Aviary (Enriched cage=1)	Sources	Index – Barn (Enriched cage=1)	Sources
Egg production per hen	0.93	in-depth interviews and Bouzidi (2021)	0.88	in-depth interviews
Price of Class "A" egg	1.23	FADN (2020)	1.23	FADN (2020)
Share of Class "A" egg	0.98	in-depth interviews	0.96	in-depth interviews
Mortality rate	1.60	in-depth interviews	1.80	in-depth interviews
Permanent worker	1.66	in-depth interviews; Bouzidi (2021), van Horne and Bondt (2017); van Horne (2019)	1.75	in-depth interviews; Bouzidi (2021), van Horne and Bondt (2017); van Horne (2019)
Feed conversion ratio (FCR)	1.09	in-depth interviews; Bouzidi (2021), van Horne and Bondt (2017); van Horne (2019); Szőllősi (2013) cit. Castello, (2011)	1.09	in-depth interviews; Bouzidi (2021), van Horne and Bondt (2017); van Horne (2019); Szőllősi (2013) cit. Castello, (2011)
Price of pullet	1.13	in-depth interviews, van Horne and Bondt (2017); van Horne (2019);	1.13	in-depth interviews; van Horne and Bondt (2017); van Horne (2019);
Energy cost	0.90	in-depth interviews, Bouzidi (2021), van Horne (2019)	0.90	in-depth interviews, Bouzidi (2021), van Horne (2019)
Stocking density	0.67	in-depth interviews, van Horne (2019)	0.33	in-depth interviews, van Horne (2019)
Investment cost	0.80	in-depth interviews, van Horne (2019)	0.40	in-depth interviews, van Horne (2019); Szőllősi (2013) cit. Castello, (2011)

Source: own compilation

Results and Discussion

Based on the results of the questionnaire survey, in enriched case housing system, the average flock size was around 57 000 birds in 2021, with an extremely low relative standard deviation (0.70%). While the smallest farm had around 600 birds, the largest company had almost 500 000 laying hens in the same year. The average number of eggs produced per hen was 291.

Based on the respondents, the average production cycle was 59 weeks. The annual mortality rate was 4.16%, with a high relative standard deviation (31.18%). The average daily feed consumption per hen was 122.4 grams, almost identical to the median value (122.5 grams). The feed conversion ratio (FCR) recorded an average of 2.5 kg/kg, with a low relative standard deviation (0.35%). The number of laying hens per full-time worker was approximately 8,000 in the examined year (Table 4).

Table 4: Descriptive statistical analysis of the most important parameters related to enriched cage eggs production (n=42)

Indicators	Mean	Median	Relative standard deviation
Average number of hens (birds)	57 137	15 703	0.70
Egg production (eggs/average number of hens per year)	291	300	0.64
Average share of class "A" eggs (%)	93.51	95.00	5.20
Length of production period (weeks)	59	61	2.64
Average annual mortality (%)	4.16	4.00	31.18
Average feed consumption (g/hen per day)	122.41	122.50	1.45
FCR (kg/kg)	2.48	2.49	14.32
Hens per permanent worker	7 992	3 553	0.90

Source: own calculations

The results of the online questionnaire survey and the experience of the in-depth interviews

If enriched cages were banned, more than half (52.4%) of the egg producers surveyed in Hungary would stop their production. A further quarter (26.2%) would switch to aviary housing system, almost one-fifth (19.0%) would diversify, and the remainder (2.4%) would choose barn, free-range, or organic housing systems.

During the in-depth interviews, a range of risk factors were identified that require thorough consideration before the enriched cage housing system can be phased out:

- In buildings currently using enriched cage housing systems, transitioning to aviary housing system may often be unfeasible, requiring greenfield investments.
- Direct monitoring of animals and increased dust levels could negatively affect working conditions, leading to a reduction in labour supply.

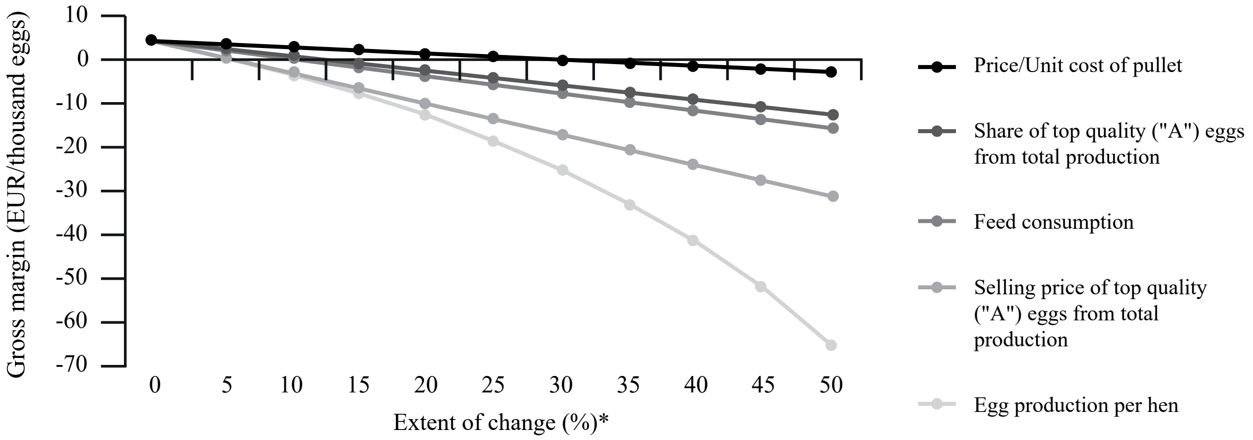

Figure 1: Sensitivity analysis of the most important factors on the gross margin/farm income of egg production

* Direction of change based on Table 5: Egg production per hen: (–), Selling price of class "A" eggs: (–), Feed consumption: (+), Share of class "A" eggs: (–), Price/Unit cost of pullet: (+)
Source: own calculations

- Sufficient supplies of pullets are crucial when shifting to alternative housing systems (barn and aviary).
- In cage-free rearing, the absence of individual data collection, aggressive bird isolation, and safeguarding the health of birds and workers will be challenging.

These challenges not only affect the breeding process but also have indirect negative consequences for pullet rearers. The deterministic model is allowed to quantify the effect of a unit change of any of the input parameters on the per egg income using sensitivity analysis. For example, a 1% decrease in the producer price of class "A" eggs, the gross margin changed from 4.83 EUR/thousand eggs to 4.11 EUR/thousand eggs. This reduction decreased profitability by 0.07 eurocents per egg (-14.95%). Accordingly, the technology-dependent factors that have the most significant effect on the per egg profitability were the annual egg production per laying hen, followed by the selling price of class "A" (top quality) eggs, the daily feed consumption per hen, the proportion of class "A" eggs and the value of pullet put into production. Figure 1 illustrates the effect of any departure on each of these items.

A 1% decrease in the number of eggs per hen, the gross margin changed from 4.83 EUR/thousand eggs to 4.13 EUR/thousand eggs. This reduction decreased profitability by 0.07 eurocents per egg (-14.63%). The performance of the layers in alternative systems could reach the standard in cage systems, however the proportion of litter eggs is higher. Some of the eggs laid outside the nest break, which ultimately reduces the marketable egg production per hen. Our data collection confirmed the literature's assumptions (Bouzidi (2021); van Horne (2019)), namely: the number of eggs per hen was typically lower in the aviary (-7%) and barn systems (-12%) with respect to the enriched cages. Thus, the projected income per egg in the alternative systems decreased by 0.5 and 0.9 eurocents, respectively.

The third significant factor influencing profitability is feed consumption. As a result of 1% increase in daily feed consumption per hen, the gross margin changed from 4.83 EUR/thousand eggs to 4.42 EUR/thousand eggs. This reduction decreased profitability by 0.04 eurocent per egg (-8.47%). There was a consensus among the interviewees that the chosen technology has ultimately a significant bearing on feed consumption. More movement and the associated increase in energy demand leads to higher feed consumption. In the two investigated alternative technologies, feed consumption increased to a similar extent compared to the enriched cage technology (8.66% for the aviary and 8.97% for barn), which led to a loss of 0.4 eurocents per egg.

In 2021 the selling price of class "B" eggs (for industrial use) was roughly half of class "A" eggs (top quality ready for direct human consumption). The average selling price of the eggs directly depended on the proportion of class "A" and "B" eggs, which therefore had a considerable effect on the overall profitability. For example, a 1% reduction in the proportion of class "A" egg led to a change in the gross margin from 4.83 EUR/thousand eggs to 4.48 EUR/thousand eggs. This decline in the ratio caused 0.04 eurocent per egg loss in gross margin (-7.27%). According to our data, the proportion of class "A" eggs was on average 93.5% using the enriched cage technology. This ratio was 2.3% points lower in aviaries and 3.7% points lower in barns. The gross margin decreased by 0.09 and 0.14 eurocents per egg, accordingly.

As the purchase price of pullets or the internal cost of in-house pullet production increased by 1%, the gross margin changed from 4.83 EUR/thousand eggs to 4.68 EUR/thousand eggs. This reduction caused 0.02 eurocent loss per egg in gross margin (-3.15%). The ban on enriched cage farming would also affect the production costs of raising pullets, since the technology used for their rearing needs to align with the housing systems of keeping layers. A particularly relevant problem is that alternative technologies do not allow individual data collection on the breeding stock, thereby impairing the pace and efficiency of genetic selection. This could have ripple effect across the entire poultry sector. In accordance with the literature, we assumed a moderate, 13.14% increase in the price of pullets, which translates to a loss of 0.2 eurocents per egg.

Labour input is an issue that deserves special attention when evaluating the competitiveness of laying hen farming. Based on our results, a full-time staff member took care of an enriched cage operation of the size of 8,110 animals, while this number dropped to 4,874 in the case of aviary and 4,636 in the case of barn technology. Given the 66% to 75% increase in labour costs, the gross margin per egg would be 0.3 to 0.4 eurocents lower in the alternative systems. Therefore, the rise in time commitment resulting from technological changes had a negative impact on profitability comparable to the impact of increased feed consumption.

In the alternative systems, issues such aggression, parasitic transmission, or suffocation from overcrowding are more common, making them difficult to manage even with adequate care and expertise. A rise in the mortality rate impacts various cost factors. It decreases the operation's throughput, increases the cost of carcass removal, and decreases the income from the sale of cull hens. The 2.49-3.31 percentage points higher mortality rate eroded profitss by 0.04-0.06 eurocents on each egg.

The physical efficiency indicators of table egg production deteriorate significantly when moving from enriched cage housing systems to aviary and barn housing systems (Table 5). The egg production per hen is 270 in the aviary housing system and 256 in the barn housing system. Consequently, the egg yield per unit is 7% and 12% lower in the alternative systems (aviary and barn). The mortality rate is 2.49 to 3.31 percentage points higher in the non-cage housing systems. While the daily feed intake is approximately 8.1 to 8.7% higher, the FCR is 17% to 24% higher in the alternative housing systems (barn and aviary) compared to the enriched cage housing system. There is a significant difference in stocking density. There are 35% fewer birds in the aviary system and 65% fewer in the barn housing system compared to the enriched cage housing system.

The production cost per hen is 13% to 15% higher in the alternative housing systems (aviary and barn) compared to the enriched cage housing system (Table 6). In comparison, according to Szőllősi *et al.* (2019), the production cost was only 2% higher for the barn housing system (averaged over the years 2012-2015). However, Erdős *et al.* (2019) observed slightly higher differences. The production costs per hen in the barn housing systems were 7% higher. On the other hand, this difference was 39% in the case of the aviary and cage housing systems. According to van Horne and Bondt's (2023) calculation the difference of the production cost (without general costs) was 10% between the enriched cage housing system and alternative housing systems (aviary and barn).

The largest cost component is feed (55-58%), followed by pullets (20-21%), and then labour costs (12-15%). Feed and pullet costs are higher by 9% and 17% in the aviary and barn housing systems. In comparison, there are more significant differences in permanent labour costs (+66-75%) and other fixed costs (+57-191%) in the non-cage housing systems.

Despite the fact that, in the aviary and barn housing systems, there is a higher producer price but a lower egg production per hen, the production value is 12% and 5% higher in the case of aviary and barn housing systems compared to the enriched cage housing systems. However, higher production costs reduce profitability. Consequently, in the case of aviaries, a 9% lower unit gross margin is achieved compared to the enriched cage housing system. In contrast, based on our calculations, the barn housing system results in a loss of production. However, those producers who sell directly to consumers can still be profitable. According to Szőllősi *et al.* (2019) the enriched cage housing system is the best farming method for large scale producers (due to the economies of scale achieved); however, barn and aviary housing systems are more suitable for smaller scale table egg producers.

While the aviary hosuing system achieves a 1.34 percentage points lower cost-profitability ratio (5.58%), this difference is more pronounced in the barn hosuing system, where the cost-profitability ratio (-2.34%) is 9.26 percentage points lower than in the enriched cage housing system.

The per-egg cost and income data are outlined in Table 7. The production cost per egg is 22% higher in the aviary housing system and 31% greater in the barn housing system compared to the enriched cage housing system. In contrast, the

Table 5: The change of the most important parameters in different housing systems, 2021.

Production indicators	Unit of measurement	Enriched cage	Aviary	Barn
Egg production	eggs/average number of hen per year	291	270	256
Mortality rate	%	4.16	6.65	7.47
Feed utilisation	g/hen per day	122.00	132.56	132.95
Feed conversion ratio (FCR)	kg feed/kg egg	2.46	2.88	3.05
Hens per permanent worker	hens/worker	8 110	4 874	4 636
Stocking density	hen/m^2	25.50	16.53	8.98

Source: own calculations

Table 6: Cost and gross margin per hen in different housing systems, 2021.

Denomination	Enriched cage	Aviary	Barn
	EUR/hen	EUR/hen	EUR/hen
Pullet cost	4.10	4.78	4.82
Feed cost	11.92	12.95	12.99
Variable labour cost	0.93	0.93	0.93
Other variable cost	1.84	1.82	1.83
Fix labour cost	1.47	2.45	2.58
Other fix cost	0.11	0.17	0.32
Total direct cost	20.38	23.11	23.47
Production value	21.79	24.40	22.91
Gross margin	1.41	1.29	-0.55

Source: own calculations

Table 7: Cost and gross margin per egg in different housing systems, 2021.

Denomination	Enriched cage	Aviary	Barn
	eurocent/egg	eurocent/egg	eurocent/egg
Pullet cost	1.41	1.77	1.88
Feed cost	4.10	4.79	5.07
Variable labour cost	0.32	0.35	0.36
Other variable cost	0.63	0.67	0.72
Fix labour cost	0.51	0.91	1.01
Other fix cost	0.04	0.06	0.12
Total direct cost	7.00	8.55	9.16
Production value	7.49	9.02	8.94
Gross margin	0.48	0.48	-0.22

Source: own calculations

Table 8: Investment profitability in different housing systems.

Denomination	Indicators	Enriched cage	Aviary
Own equity	NPV (EUR/m^2)	343.95	83.78
	IRR (%)	4.54%	1.53%
30% investment support intensity	NPV (EUR/m^2)	525.10	227.32
	IRR (%)	8.87%	5.30%
50% investment support intensity	NPV (EUR/m^2)	645.87	323.01
	IRR (%)	13.82%	9.50%

Source: own calculations

production value is 21% larger in the aviary housing system and 20% greater in the barn housing system compared to the enriched cage housing system. In terms of gross margin per egg, the aviary housing system approaches the profitability of the cage housing system, while the barn housing system shows losses.

Our research was completed with an investment profitability analysis, based on the production cost and production value per square metre. Comparing the different housing systems, the production costs per square metre in the enriched cage housing system are 36% and 147% higher than the production costs for the alternative housing systems (aviary and barn). In the enriched cage housing system, due to the significantly larger stocking density per unit area, a much higher amount can be achieved, with an increase of 69%.

The investment cost of the enriched cage housing system is the highest (604 EUR/m^2), exceeding the investment profitability analysis of the aviary housing system by 26%, and that of the barn housing system by 149%. In the investment cost analysis, we considered different scenarios for both the enriched cage and aviary housing systems, assuming a useful life of 20 years (Table 8). The net present value for each case is positive for both the enriched cage and aviary housing systems. In one case (own equity), the internal rate of return is lower than the applied discount rate applied, suggesting that risk-free investments (3.62%) could be more favourable. The payback period varies between 7 and 14 years for the enriched cage housing system investment, and between 10 and 18 years for the aviary housing system investment, depending on the level of support.

Comparing the investment analyses of enriched cage and aviary housing system at 50% subsidy intensity, the enriched cage housing system pays for itself in 7 years, while the aviary housing system pays for itself in 10 years. The net present value realised with the enriched cage housing system investment is twice as large as that of the aviary housing system (Figure 2).

Conclusions

The study analysed the economic impacts of phasing out the enriched cage housing system in Hungary. Overall, the aviary and barn housing systems showed lower physical effi-

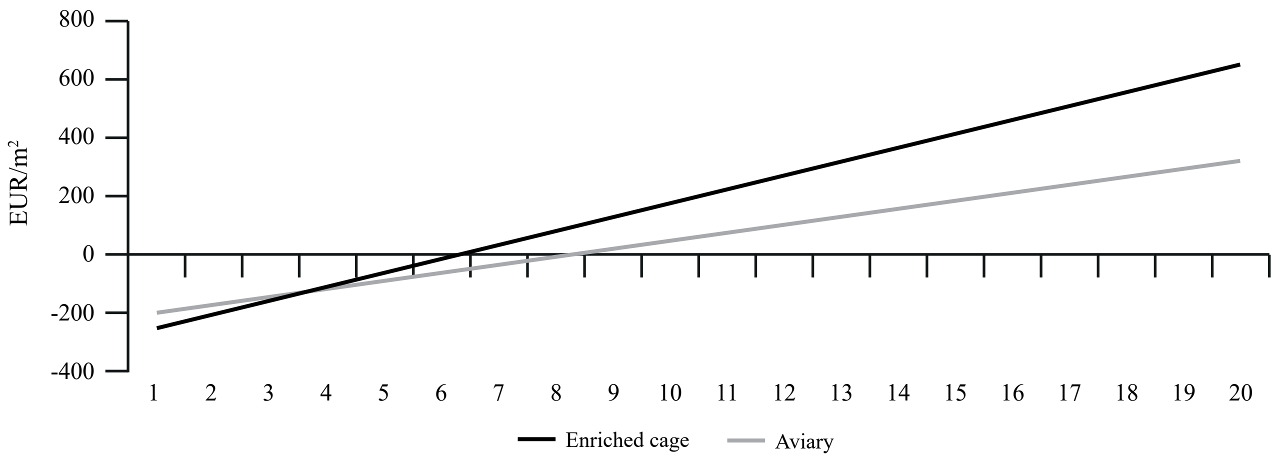

Figure 2: Cumulative net present value in enriched cage and aviary housing system (50% investment support intensity)

Source: own calculations

ciency and economic indicators compared to the enriched cage housing system. The egg production per hen was lower by 7% in aviary and by 12% in barn housing systems. The FCR was higher by 17% (aviary) and 24% (barn). Labour efficiency (hens per permanent worker) fell by 40% in both cases. The unit gross margin per hen was lower by 9% in aviaries compared to the enriched cage housing system. In barn housing system the production was not profitable. However, by selling directly to consumers egg production still can be profitable in barn housing system. The investment payback period was 7 years in the enriched cage housing system and 10 years in the aviaries housing system (with a 50% subsidy intensity).

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