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#### ■ Keywords

Analytical hierarchy process, commercial laying enterprises, egg, organic system, traditional cage system.



## Analysis of Different Production Systems in Laying Hen Enterprises with Analytic Hierarchy Process in Turkey

### ABSTRACT

The present study aimed to evaluate the enterprises engaged in conventional cage, enriched cage, free-range and organic egg production in Turkey in terms of four different criteria (profit, investment cost, animal welfare/health and sales/marketing) using the Analytical Hierarchy Process (AHP). For this purpose, the questionnaires through face-to-face interviews were conducted with a total of 64 producers who had been determined by random sampling method from 5 different regions included 17 Provinces between November 2016 and March 2019, and primary data were obtained. As a result, it has been found strategically significant that enterprises, to be engaged at the level of 47.0%, 20.0%, 18.0% and 15.0% in conventional, enriched, free-range and organic cage systems, respectively, in the market in terms of profit, investment cost, animal welfare/health and sales /marketing criteria. In addition, in the enterprises within the scope of the research, the profit, investment cost, sales/marketing and animal welfare/health criteria were determined as the dominant criteria at the level of 53.5%, 22.0%, 13.5% and 11.0% respectively. In conclusion, the conventional cage system is dominant with the rates of 55.0% for profit and 53.0% for investment cost criteria, and both of the conventional and enriched systems in terms of sales/marketing criteria are 38.5% dominant and the organic system in terms of animal welfare/health is 46.0% dominant.

### INTRODUCTION

Egg is accepted as an animal reference product due to its high protein content and digestibility. In this respect, it is seen as a good alternative to overcome animal protein deficit in developing and underdeveloped countries, as well as it is much consumed in developed countries. Despite the increasing population in the world, it has become imperative to increase the amount of production and productivity per animal in order to mention a healthy and balanced diet. In order to achieve these targeted increases, it is necessary to take advantage of developing technologies, and production should be diversified in line with consumer demands. Commercial (industrial) cage poultry farming has intensified with the advances in the fields such as breeding, hatching and operating capacities thus egg production has increased in the world, especially, since the middle of the 20<sup>th</sup> century. However, in recent years, the interest in egg production made with alternative production systems such as enriched cage, free-range and organic farming has increased due to the criticisms to the traditional cage system particularly regarding animal welfare/health, as well as more savory and natural egg expectations of the consumers. When the egg production systems applied in the European Union (EU) countries are analyzed, 14.0% of commercial egg laying enterprises use conventional cage system,



21.0% barn system, 36.0% enriched cage system, 11.0% free-range, 3.0% organic and 15.0% use other production systems TEPA (2017). In EU countries, the highest cage system (more than 97.0%) is in Spain, whereas the egg production system without cage is implemented in Austria with the highest rate of 96.0% CIWF (2013).

In Turkey, more than 95.0% of egg production systems still consist of commercial enterprises engaged in production with conventional cage system. There are 3,063 flocks containing 108,689,236 laying hens in 994 commercial laying farms operating with this system. Production quantity regularly rises every year in Turkey and the egg production was fulfilled at 20.2 billion eggs (GGs, 2017; Sarica, 2017)

In recent years, legislative changes regarding animal welfare have played an important role in the development of alternative egg systems in many countries, especially in EU countries. The animal welfare rhetoric, which is getting stronger day by day with the pressure of the public, gains a new meaning with the consumer's demand for more natural, savory and healthy eggs, and leads the shifting in the production trend from conventional to this alternative production system.

In the EU, since January 1, 2012, 51 millions of hens have been kept in conventional cages that do not comply with Directive 1999/74. Thus, 14.0% of the EU's total egg production is not currently produced according to the new animal welfare and enriched cage system (Sarica, 2017; WP, 2012)

In Turkey, interest in the animal and environment friendly alternative egg production systems has increased in parallel with the growth of the sector in the recent years. However, the determination of the positive and negative aspects caused by the transition to these alternative production systems is an important research topic. Furthermore, selecting the criteria to be taken into consideration, when comparing these alternative production systems with each other, is the second step in this process. At this point, animal welfare criterion is the main topic of the discussion in alternative production systems. In addition, in the preliminary interviews with the producers prior to the research, the producers operating in the egg industry, especially the conventional cage system, have reported that profit, investment cost and sales/marketing are the other criteria that they took into consideration mostly when comparing the alternative production systems.

It is necessary to consider various criteria when making a choice among alternative production systems

in the egg industry. Srdevic (2003) reported that commercial decisions in the egg industry cannot be made on the basis of optimization of only one criterion, but multidimensional sectorial evaluations such as rational use of inputs, environmental protection and business sustainability are needed. Grootkoerkamp *et al.* (1998) reported that versatile comparisons, which include primarily animal welfare criterion as well as economic, ecological and social aspects, are required in researching alternative commercial egg production systems.

Crcan *et al.* (2018) evaluated the parameters such as profitability and efficiency under the title of 'economic criterion'; the parameters such as market price and market risks under the heading of 'market criterion' and finally the parameters such as animal welfare, effective use of plants and production risks under the heading of 'technology criterion', using analytical hierarchy process (AHP), and they listed the production systems, according to their advantages, as indoor system for housing hens (31.7%), free-range (24.2%), cage (23.7%) and organic (20.2%) systems.

There are many studies in the literature comparing alternative production systems especially in terms of egg costs, Boer (2018). However, to the best of authors' knowledge, there is no study that analyzes the egg poultry industry with AHP in terms of animal welfare/health, profit, investment cost and sales/marketing criteria when making a preference decision among alternative production systems.

In the process of deciding the production system (conventional cage, enriched cage, free-range and organic) in egg poultry production, we encounter many criteria such as costs, profit, animal health/welfare and sales/marketing. When there are many criteria and options, the AHP method provides more accurate and quantitative evaluation opportunities for reaching the decision because of including both objective and subjective evaluation criteria, providing the opportunity for simultaneous evaluation and comparison, testing the consistency of the evaluations and determining the priorities of the options evaluated according to numerous criteria and provides more interpretable results (Soner & Onut 2006; Felek *et al.*, 2007; Önüt *et al.*, 2008; Ömürbek & Tunca, 2013). The evaluation of the commercial enterprises involved in the conventional cage, enriched cage, free-range and organic production in layer poultry industry in Turkey, concerning the animal welfare/health, profit, investment cost and sales/marketing criteria was aimed with this study. This study was performed to



evaluate the commercial enterprises involved in the conventional cage, enriched cage, free-range and organic production in layer poultry sector in Turkey, concerning the animal welfare/health, profitability, investment cost and sales/marketing criteria.

## MATERIAL AND METHOD

In Turkey, commercial layers enterprises are intensified in five geographic regions due to their closeness to major markets. Therefore, study sampling was made from these regions Dinler (2003).

According to official figures TURKSTAT (2019), considering a total of 994 operating laying enterprises in Turkey (main mass), the following formula was used to calculate the sample size in the 90.0% confidence interval.

$$n_0 = \frac{Nt^2 pq}{d^2 (N - 1) + t^2 pq}$$

N = Population size; t = t-table value for 90.0% confidence interval= 1.96; q = frequency of occurrence of the event in question, from being factor (+) and being factor (-) p = 0.5, q = 0.5; d = Deviation according to the frequency of occurrence of the event.

Thus, the sample size was calculated as 64 enterprises and enterprises were selected by stratified sampling method to represent all regions (Table 1).

**Table 1** – Sample size according to regions and selected provinces within the scope of the research.

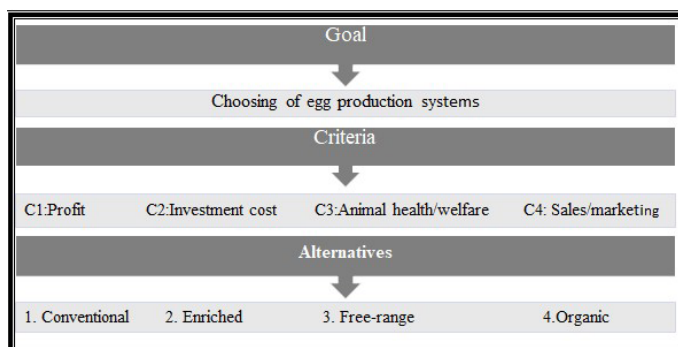
Geographical Region	Selected province	Sample size
1.Black Sea Region	Çorum, Samsun, Amasya, Bolu	12
2.Central Anatolia Region	Ankara, Konya, Karaman	4
3.Mediterranean region	Burdur, Isparta	8
4. Aegean Region	Denizli, Afyon	12
5. Marmara Region	Izmit, Bursa, Yalova, Adapazarı, Edirne, Tekirdağ	28
TOTAL		64

The enterprises selected within the scope of the study were divided into 4 categories (Conventional cage, Enriched cage, Free-range and Organic) according to the different production system. Between November 2016 and March 2019, flock owners were interviewed face-to-face, informed about the study and information was obtained from volunteers.

The preference of the producers for choosing the production system among the Conventional cage, Enriched cage, Free-range and Organic systems by taking into consideration the Profit (K1), Investment cost (K2), Animal Health/Welfare (K3), Sales/Marketing (K4) criteria, was analyzed with Analytical Hierarchy

Process (AHP), which is one of the multi-criteria decision making methods.

The created AHP diagram is given in Figure 1.



**Figure 1** – The diagram of AHP

Profit (K1), investment cost (K2), animal health/welfare (K3) and sales/marketing (K4) criteria were compared with each other simultaneously with the face-to-face surveys conducted with the business owners, then alternative production systems were evaluated in terms of these four criteria. In the research, the mentioned transactions were scored between 1 and 9 according to the importance scale used in the AHP scoring system Saaty (1990).

## RESULTS

The demographic characteristics of the owners of enterprises in the scope of the research are given in Table 2.

**Table 2** – Demographic characteristics of the owners of enterprises.

Age	Mean ± Standard deviation	Min.; Max.
Age	38.9 ± 11,2	18; 62
Education level	Number	Percentage (%)
University graduate	30	-46.9
High School graduate	26	-40.6
Primary school graduate	8	-12.5
Marital status	Number	Percentage (%)
Single	52	-71.2
Married	12	-18.8
Side (additional) job	Number	Percentage (%)
Present (+)	33	-51.5
Absent (-)	30	-48.5

In Table 2, it has been seen that generally the education level of the owners of the layer hen enterprises in Turkey is high. Here, the first, second or even third generation owners of enterprises were the owners of the egg enterprises at the same time. Depending on this issue, because the surveys were generally conducted with young business owners, the level of education was found high.



Within the scope of the research, according to the findings of the duration of the enterprises in the egg industry, 16 (25.0%) of the enterprises were established before 1990, 20 (31.2%) were established between 1991 and 2000, and 28 (43.8%) were established after 2001. It is seen that the enterprises are experienced companies with a long history. In addition, more than half of the owners (51.5%) were found to be involved in an additional work other than egg poultry production. The 55.0% of these additional jobs were in an area related to the livestock sector (fattening, dairy etc.).

Data related to the capacity and scales of the enterprises are given in Table 3.

**Table 3** – Scales and capacity utilization rates of the enterprises.

Production system	Number	Small (1-9,999)	Medium (10,000-29,999)	Large (30,000 and over)	Capacity utilization rate (%)
Conventional cage	36	3	11	22	78
Enriched cage	3	3	-	-	76
Free-range	23	21	2	-	84
Organic	2	2	-	-	100

system. Of these enterprises, 28 enterprises having up to 1-9,999 laying hens were small scale, 14 enterprises with 10,000-29,999 laying hens were medium scale and 22 enterprises with 30,000 and above were large scale. All of the enterprises that having free-range and organic production systems were small-scale enterprises. The 63.0% of the enterprises producing with conventional cage system were large scale and 37.0% of them were medium scale.

Within the scope of the research, it has been observed that these enterprises are involved in this sector for different reasons. The reasons why enterprises prefer the egg production are given in Table 4.

**Table 4** – Reasons of enterprises to prefer egg production.

Reasons of preference	Number	%
To be profitability	19	29.7
Additional job	9	14.1
Family profession	29	45.3
Interest in production (hobby)	8	12.5

In this study, 29.7% of the producers involved in the egg industry have reported that they prefer this sector because of the profitability; 12.5% of them as additional work; the 45.3% of the producers due to family profession thus they have no other choice and 12.5% of the producers as a hobby because of their interest in egg production.

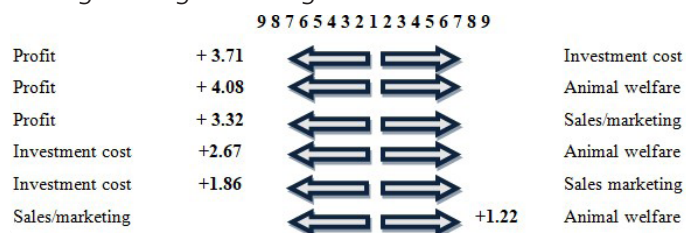
### AHP Application Steps

In this study, the preferences of the enterprises in the egg industry was determined using the Analytical

Accordingly, within the scope of the research, it was found that 36 (56.3%) of the 64 enterprises operate in the conventional cage system, 3 (4.7%) in the enriched cage system, 23 (35.9%) in the free-range and 2 (3.1%) in the organic system. Under normal conditions, transition from one operating system to another is limited. However, it has been determined that 39.0% of the enterprises producing with conventional cage system have conventional cage system that can be converted into enriched cage system when necessary. Capacity utilization rates of the enterprises were determined as 78.0% in conventional system, 76.0% in enriched system, 84.0% in free-range system and 100.0% in organic

Hierarchy Process Method (AHP), which is one of the decision making techniques based on multiple criteria. Based on this, it was aimed to determine the parameters that affect the producers in deciding among the different production systems. In the present study, it was aimed to analyze the decision-making processes of the enterprises among the different production systems and to guide the public regulations and long-term sectorial rehabilitations in the egg sector.

In addition, the mutual positive and negative aspects of different production systems for enterprises that intend to enter the market in the egg industry were analyzed in terms of profit, investment cost, animal welfare/health and sales marketing criteria. Here, primarily the decision-making problem should be defined. The flow diagram for this is given in Figure 1. The criteria considered within the scope of the research were compared with AHP scales and the geometric averages are given in Figure 2.



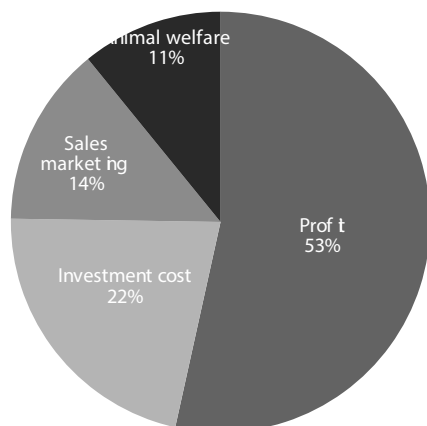
**Figure 2** – Binary comparison results of egg production systems.

Profit was seen to be 3.71, 4.08 and 3.32 more dominant criterion over the other criteria namely investment cost, animal welfare/health and sales-





marketing respectively (Figure 2). The result of the matrix analysis of the mentioned scores is given in Figure 3.



**Figure 3** – Relative importance of criteria in preferences of egg production system.

According to matrix analysis, the most dominant criterion was found as profit with 54.0% significance, which was followed by investment cost criterion with 22.0%, sales/marketing with 14.0% and finally animal welfare/health criterion with 11.0%. It was determined that profit and investment cost criteria, together have 76.0% prepotency, whereas animal welfare / health was found to be the most impotent criterion (Figure 3).

Within the scope of the research, 4 production systems, which are alternatives of each other, were compared with the help of binary comparison data concerning four criteria using the AHP scoring scale (Figure 4).

9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9									
Conventional	Profit	4.76	←	→		Profit			
	Investment cost	4.88	←	→		Investment cost			
	Animal Welfare		←	→	3.55	Animal welfare			
	Sale marketing	1	←	→		Sales marketing			
Conventional	Profit	3.19	←	→		Profit			
	Investment cost	3.11	←	→		Investment cost			
	Animal welfare		←	→	3.37	Animal welfare			
	Sales marketing	3.00	←	→		Sales marketing			
Conventional	Profit	3.50	←	→		Profit			
	Investment cost	2.85	←	→		Investment cost			
	Animal welfare		←	→	4.06	Animal welfare			
	Sales marketing	4.00	←	→		Sales marketing			
Enriched	Profit	1.19	←	→		Profit			
	Investment cost	1.31	←	→		Investment cost			
	Animal welfare		←	→	1.28	Animal welfare			
	Sales marketing	3.00	←	→		Sales marketing			
Enriched	Profit	1.54	←	→		Profit			
	Investment cost	1.51	←	→		Investment cost			
	Animal welfare		←	→	2.35	Animal welfare			
	Sales marketing	4.00	←	→		Sales marketing			
Free-range	Profit	1.67	←	→		Profit			
	Investment cost	2.43	←	→		Investment cost			
	Animal welfare		←	→	2.39	Animal welfare			
	Sales marketing	2.00	←	→		Sales marketing			

**Figure 4** – Binary comparison results of options for each criterion.

The results obtained in Figure 4 are interpreted below with respect to 4 criteria.

### Profit criterion (K1)

In terms of profit, with AHP scoring, the conventional cage system was found to be 4.76 superior to enriched cage system; 3.19 to the free-range system and finally 3.50 AHP score superior to the organic production system. In other words, conventional cage system seems to be more advantageous than other cage systems in terms of profit. Within the scope of the research, when matrix analysis of AHP scoring was performed in terms of profit criterion for 64 enterprises, it was found that conventional cage system is statistically significant at 55.0 %, enriched cage system 16.0%, free range system 17.0% and finally organic system 12.0% profitable.

### Investment cost criterion (K2)

In terms of investment cost, the conventional cage system was found to be 4.88, 3.11 and 2.85 more advantageous than the enriched, free-range and organic systems respectively with AHP scoring. Within the scope of the research, when the matrix analysis of investment cost AHP scores was made, it has been determined that the conventional cage system is 52.5%, the free-range system is 19.0%, the enriched cage system is 16.5% and finally the organic system is 12.0% advantageous in terms of investment cost.

### Animal welfare / health criterion (K3)

When animal welfare in enterprises was taken into account in terms of AHP scoring, it was seen that organic production system has more obvious advantage with 4.06, 2.35 and 2.39 points from the conventional, enriched and free-range systems, respectively. Thus, it has been determined that the traditional cage system, which is the dominant production method in the market, is the most disadvantageous in terms of animal welfare, and the organic production is the most advantageous production system. When matrix analysis of AHP scores was performed, the conventional cage system was found to be 8.0%, the enriched cage system to be 22.0%, the free-run system to be 24.0% and finally the organic system to be 46.0% strategic for animal welfare.

### Sales and Marketing (K4)

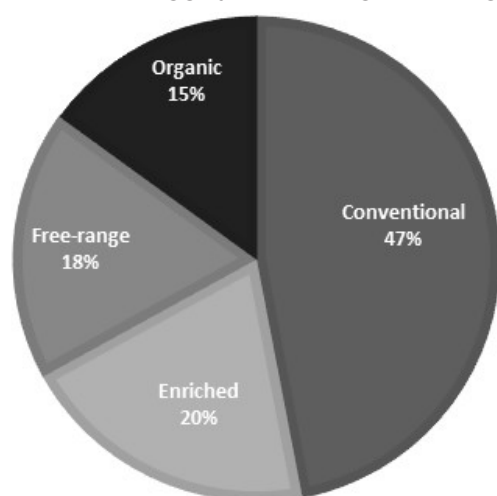
Concerning sales and marketing, enterprises operating in conventional cage system was found more feasible than enriched, free-range and organic system with 1, 3 and 4 AHP scores, respectively. When



matrix analysis of AHP scoring was done, in terms of sales and marketing, the conventional cage system was found to be 38.5%, the enriched cage system to be 38.5%, the free-floating system to be 14.0%, and finally the organic system was 9.0% strategic.

### Evaluation of the Distribution of Results at AHP Decision Points

In the study, the matrix analysis of the binary comparison results of the determined criteria was done. The results for distribution of strategic preferences between different egg systems are given in Figure 5.



**Figure 5** – Percentages of result distribution at AHP decision points.

The distribution of results at decision points was converted into selection weights for enterprises within alternative production by analyzing the binary comparison results of the decision options for each criterion in Figure 3, and the result distribution in Figure 5 was calculated as 0.47, 0.20, 0.18 and 0.15, respectively. Accordingly, considering the four criteria, it was determined that egg producers find it meaningful to prefer conventional, enriched free-range and organic production systems with the probability rate of 47.0%, 20.0%, 18.0% and 15.0% respectively. Considering multiple qualitative and quantitative criteria, the distribution of results at decision points in the AHP analysis, strategically the most meaningful production system was determined in this study.

## RESULTS AND DISCUSSION

In this study conducted across Turkey, it was targeted to obtain the results to guide future investments in the egg industry, public regulations and long-term rehabilitation by analyzing decision-making processes in the different production systems as conventional cage, enriched cage, free-range and organic.

Although the AHP method has been used in some researches in the livestock sector, there are very limited studies, Crncan, (2018) in egg poultry and especially in the preference of the producers for alternative egg production system. Also, in the literature, no previous studies regarding the use of AHP method in the egg industry in Turkey were encountered. With this aspect, it is thought that this study will contribute to the elimination of the deficiency in the field.

In this study, alternative production systems in the egg industry in Turkey were compared from multi aspects with each other in terms of criteria such as "profit", "investment costs", "sales/marketing" and "animal welfare/health" by AHP, and in the first stage, the weights of the criteria were determined as 53.5%, 22.0%, 13.5% and 11.0%, respectively. In the second stage, according to these criteria, the level of strategic significance for conventional cage, enriched cage, free-range and organic production systems was determined as 47.0%, 20.0%, 18.0% and 15.0%, respectively. Considering the four criteria here, it was determined that the most superior production system among conventional production systems is the traditional cage system with a weight of 47.0%. Asselt *et al.* (2015) assessed the Dutch egg industry to determine 4 criteria (social, environmental, economic and food safety) and reported that the enriched cage, barn, free-range, and organic egg production systems as 61, 49, 42 and 38, respectively over 100 scores. Accordingly, in parallel with the findings obtained in this research, the enriched cage system received the highest score of 61.

The first criterion considered in the present study was the profit criterion. Oladeebo *et al.* (2012) investigated the factors that affect the profit criteria in the egg industry in their study conducted in Nigeria. These authors have found that there is an important relationship between profits and scales of egg-producing enterprises, and medium-sized enterprises are more profitable with the rates between 40.0% and 73.0% than small-scale enterprises. Szollosi *et al.* (2009) investigated the change in profits in the egg industry according to technology and scale size. Thus, it has been reported that the enterprises with cage systems that have 1000 and above hens are more profitable compared to the systems without cage due to the scale size and intensive use of technology, and that the systems without cage are more profitable in the small production systems having below 1000 hens.

Although this study carried out in Turkey and the study in Netherlands (Asselt *et al.* 2015) have shown that the cage system seems as the most advantageous



production systems, barn system (without cage) in Croatia was reported as the most advantageous system, Crncan *et al.* (2018). The criteria used in the researches are thought to play an important role in the production system preference. In addition, in the study performed by (Crncan *et al.*, 2018), the largest enterprise scale for the cage-free system, which is considered to be the most advantageous, was 5,500 hens, and 220,000 hens for the cage system. Here, although the level of profit in the barn system appears to be proportionally high, considering the high number of egg sales, the total profit in the cage systems may be higher. Similarly, in Turkey, it was determined that the small capital investors find free-range and organic production systems more profitable, consequently prefer to invest these systems whereas investors who enable to large scale investments prefer cage systems because of advantages due to the large scale size and high sale. Depending on these issues, enterprises found the conventional system 55% more profitable than other systems due to the advantage of scale economy.

The second criterion considered within the scope of the research is the investment cost criterion. Considering this criterion, since large-scale enterprises, which are generally focused on the relationship between investment cost and profit as well as having the advantage of large capital, found the investment into conventional egg production system as advantageous and gave high scores to this system. On the contrary, it has been observed that investors with less capital, on a small scale, find the cage-free systems such as free-range and organic systems more advantageous and gave high scores to these systems. In fact, the difference is due to the different capital sizes of investors. In particular, starting with a small scale investment for free-range and organic production systems then increasing the scale over time is related to the financial situation, and it is a general strategic attitude formed over time.

One of the important parameters for the investment criterion in the egg sector is the return on investment. Ahmadu *et al.* (2019) have found that the return period of investment in Nigeria is on average three years. The return period of investment for organic egg production systems in Turkey was detected to be 2.3 years by ORAN, (2015). In Turkey, the conventional cage, enriched cage, free-range and organic systems have been found to be advantageous at the rate of 52.5%, 19.0%, 16.5% and 12.0%, respectively when the egg producers was analyzed in terms of investment cost. The conventional cage system was superior over

the other production systems in terms of investment cost and return period of investment. Here, it should be emphasized that at the time of the survey in Turkey, especially, egg exports and consequent price increases in the eggs produced in the cage system resulted in a reduction in the return time of the investment, which provides advantages for enterprises engaged in production in the conventional system. However, this situation may change with the decrease in export figures in the future.

The third criterion in the research was the sales/marketing criterion. Here, the conventional cage system that has the largest scales among the alternative production systems faces to a fragile market structure. Depending on the fact that the eggs produced in conventional cage systems subjecting to sales and marketing within an export-oriented structure result in fluctuations in egg prices as well as difficulty in sales and marketing, thus leads to large income imbalances in the traditional cage system. In this case, sometimes the price of eggs increases in favor of the producers who produce in the cage system depending on the increases in exports, whereas sometimes the price level and consequently the income level decreases due to the effects of export-induced supply shocks, which has a destructive effect. The 71.0% of the eggs produced in Turkey has been exported to Iraq since 2017. Approximately 75.0% of the egg production has been sold in domestic market, and the remaining 25.0% has been exported. However, in some periods, eggs that cannot be exported increases the fragility in the traditional cage system by causing excess supply and low price in the domestic market. In order to reduce this fragility, many large enterprises producing eggs in the domestic market buy eggs, from other small producers at wholesale with low prices in addition to their own eggs, and generate a second income as an intermediary by selling to retail outlets such as markets and bazaars.

Large and supplier firms are intermediaries that make more or less but constantly profit in both situations, whether egg prices are falling or rising. For example, in these unstable periods, an enterprise may produce only 10.0% of the eggs it sells and supply the remaining 90.0% from outside. These enterprises have succeeded in benefit from or to be protected from price volatility in the market by using sales and marketing more efficiently. For this reason, it is an important strategic step to use the marketing efficiently, especially in eggs produced in a cage system that has a volatile price structure.





Sales and marketing are two integrated concepts. In a business, marketing is a customer production department, and sale is the last ring of marketing that turns it into profit. Within the scope of this study, producers were asked to make a thorough assessment not only in terms of sales, but also in terms of market network and customer portfolio management. Despite these price fluctuations, enriched and conventional cage systems were found to be 38.5% strategic in both of sales and marketing. These rates were determined as 14.0% in the free-range system and 9.0% in the organic system.

In Turkey, the cage egg market constitutes a deep-rooted market that provides a faster supply while free-range and organic production systems are relatively new systems. Thus, in recent years, the egg market has gained a significant progress with professionalized and institutionalized companies. Some consumers in the market mostly prefer cage system eggs by acting with the motive of price, while others prefer eggs without cage considering that they are more savory and natural. The obvious market disparity that arises here is an important research topic.

The last criterion considered in the research is animal welfare/health. In recent years, animal welfare has made steady progress both in the national and international markets. Jeremy (2015) has reported that researches related to animal welfare, which was very limited in egg poultry in the 1990s, showed significant increases, especially, in the last 10 years. Mench *et al.* (2011) have reported that their expectations in alternative egg production systems in USA are largely driven by concerns about animal welfare.

In egg production systems, quality, price, taste and brand criteria for consumers are among the effective motives known in the industry for many years. However, in recent years, organic production and animal welfare have attracted the attention of consumers in addition to these motives. Animal welfare and organic production are two main motives that feed on each other. But, animal welfare regulations lead to different results in terms of producer and consumer. William *et al.* (2010) have reported that animal welfare arrangements in California, despite the advantages such as flavor and health etc., lead to a loss of welfare for consumers by increasing the costs of animal friendly systems. According to this, it is obvious that animal welfare caused cost increases in the producer aspect and economically loss of welfare in the consumer aspect. As a result, the relationship between the alternative production systems and costs is very important.

Mench *et al.* (2011) determined that, compared to the traditional cage system, the free system in the barn increased the egg variable costs by an average of 12.0% and the total costs by 26.0% in the USA. It was determined that variable costs in the free-range system were 22.0% higher and total costs 45.0% higher than the conventional cage system. Matthews & Sumner (2015) have also reported that compared to conventional cage systems, the free system in the barn increased the variable costs by 23.0% and total costs by 46.0%. In a study comparing the different egg production systems in the UK, Leinonen & Kyriazakis (2013) have determined that in order to produce 1000 kg eggs, 51.2, 52.6, 53.8 and 56.3 laying hens are needed in cage systems, free system in barn, free-range system and in organic systems, respectively. These studies have shown that egg cost increases with the increasing of animal welfare. This situation shows that animal welfare also has a cost and this cost should be reflected into prices. Chang *et al.* (2010) examined state-backed egg premiums in the USA between 2004 and 2008, and reported that it was realized as \$ 0.15 ( $\pm$  0.03) in the conventional cage system; as \$ 0.25 ( $\pm$  0.03) in the free system in the barn and \$ 0.35 ( $\pm$  0.03) in the organic production system. Accordingly, higher rates of premium are given to animal friendly systems in the USA. These premiums serve for the formation and diversity of different price structures of eggs produced in different systems in the USA egg market. In Hungary, Szollosi *et al.* (2019) found that cage-free systems increased costs by 39.0% over cage systems between 2003 and 2015. These cost differences cause different prices in different production systems. Crncan *et al.* (2018) have reported that the cost differences, which are reflected in the sales prices, result in 20.0% higher egg price in the production in the free system in barn, and 28.0% higher market prices in free-range system than the cage system in Croatia.

It has been determined that there are different price structures depending on the differences between alternative egg production systems concerning cost, taste and quality. According to this, the prices of the eggs produced in the conventional and enriched cage system were ranged from 0.24 TL to 0.48 TL; the eggs produced in the free-range system were between 0.55 TL- 0.95 TL; The eggs produced in the organic production system were offered for sale in the retail market in the range of 0.90 TL-1.35 TL in 2018. These values indicate that the egg price increases with the increasing of animal welfare in Turkey as in other countries mentioned above.





The reaction of the consumer to the price difference in egg sales prices is an important discussion topic for the sector. Considering the studies on this issue, Ekelund (2007) reported that 26.0% of consumers in Sweden agree to pay 50.0% more for organic foods than the market price. Millock *et al.* (2002) reported that this rate was 35.0% in Denmark. Armağan & Özdoğan (2005) reported that consumers in Turkey prefer the organic food products with the increasing education level and they are willing to pay 30.4% more money for organic chicken meat and 30.6% more money for organic eggs. This situation (demand) is the main basis of the growth in the organic egg sector and of the fact that organic products are effective in the market.

In a study carried out in England, Fearn & Lavelle (1996) pointed out that price and animal welfare are the two most important motives in consumers' egg preferences and this situation switches the organic product market into a rapidly growing structure. Oberholtzer *et al.* (2006) have reported that the organic egg market in the USA grew by 19.0% in 5 years. In Turkey, the number of certified organic enterprises, which was 77 in 2017, rose to 100 in 2018, and the organic egg production has increased from 161,893,080 eggs in 2017 to 174,675,362 eggs in 2018. This situation has indicated that there has been a 7.3 % increase in organic egg production, in just one year, between 2017 and 2018. In addition, it has been determined that many enterprises that produce in the free-range system make an attempt by applying to obtain an organic certificate. These enterprises reported that they preferred the organic production system because of a lower investment cost and more stable price structure when compared to the conventional cage system. In addition, because almost all of the organic eggs are consumed in the domestic market, it has a more stable price structure compared to the price changes in the eggs produced in cage systems. This issue is due to the fact that organic egg production is not directly affected by the structure of general exports, unlike cage eggs.

It is aimed to protect the eggs produced in different production systems with a "Turkish food codex egg notification" that requires different numbering (0 = organic, 1 = free-range, 2 = free-caged and 3 = cage in the house) in order to sell the eggs produced in different production systems at different prices and envisaging a gradual transition until 2018 to increase the sustainability of alternative systems in the sector. With this communiqué, making unfair profits in the market by sellers is prevented through the product

transition between alternative egg systems. This will serve to ensure price stability for alternative egg production systems and the sustainability of enterprises in the sector TOG (2011).

In the egg sector, fundamental changes in sectorial rehabilitations and legal regulations have been realized consecutively in recent years. The strategic differences between alternative production systems in egg poultry will be evaluated in detail with the increasing further academic studies in this field. This research will allow investors planning to invest in the egg sector to evaluate alternative egg production systems in terms of profit, investment cost, sales and marketing, animal health and welfare criteria.

In conclusion, in this study conducted with AHP in egg poultry in Turkey, investment cost, profit and sales/marketing criteria were prominent for the producers who prefer conventional and enriched cage system whereas animal welfare/health was the prominent criterion for the producers who prefer the cage-free production such as free-range and organic production. Considering the determined criteria, profit was shown as the most prominent criterion (54.0%), and the traditional cage system was the most preferred egg production system with 47.0% preference rate, and the least preferred system was the organic system with 15.0% by egg producers.

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