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Technical and Economic Analysis of Marine Finfish Hatcheries of Turkey

Dilek İŞGÖREN-EMİROĞLU*1, Osman ÖZDEN*1 and Ahmet KAYA*2

Abstract

The first marine finfish hatchery of Turkey was built in 1985 in Çeşme. There are presently 19 hatcheries in Turkey according to the official records. However, no data is available on their production, technologic and economic situations. The aim of this study was to carry out a technical and economic analysis of marine finfish hatcheries of Turkey and to develop appropriate solutions to their related problems. The original data was gathered from marine finfish hatcheries. This research revealed that there are presently only 10 marine finfish hatcheries in operation. A full counting method and a questionnaire were utilized in order to obtain accurate and reliable data. Hatchery data, which was gathered for the period between 1997 and 2002, was analyzed through the use of a simple regression analysis method, and some estimations for approximate production values for the period between 2004 and 2010 were carried out. The software used for the statistical data analysis was SPPS 9.05.

1. INTRODUCTION

Fishery production has long been improved through capture fishery. However, the decrease of the production due to over fishing, uncontrollable natural conditions and water pollution, and also the seasonal changes implied the importance of aquaculture as an alternative. Therefore, increasing prices depending on increasing demand throughout the year augmented the given importance of aquaculture in the field of fisheries.

Experimental works on culturing sea bass and gilt-head sea bream was first initiated in Italy and France in 1970's, and in the following years similar aquacultural trials had been conducted successfully in the other European countries (1).

Turkey, a Mediterranean country, rich in water resources, is the 31st among all the countries in terms of fishery production, the 7th among the European countries and the 3rd among E.U. countries (6).

Previous fry culture operations in Turkey were merely dependent on catching fry and growing them up by feeding in fishnets or ponds. Gilt-head sea bream (*Sparus aurata* L. 1758) and Seabass (*Dicentrarchus labrax* L. 1758) were the most common species in the fish farms. Production in Europe and Egypt has also intensely been on these two species.

Marine aquaculture is a branch of total fisheries production improving especially during the last 17 years in Turkey. The first hatchery was built in 1985 in Çeşme, Turkey. There are presently 19 hatcheries in Turkey according to official records. However, there is information on their production, technologic and economic situations. The aim of this study was to carry out a technical and economic analysis of marine finfish hatcheries of Turkey and to develop appropriate solutions to their associated problems.

2. MATERIAL and METHODS

The official records released from the state indicate that there are 19 hatcheries in Turkey. During the interviews with hatcheries it was found out that 6 of them were closed and 3 of them were not producing fish larvae anymore. Interview request was not replied by one of the 10 active hatchery establishments. Therefore, data was obtained by visiting 9 hatcheries directly. A full counting method and a questionnaire were utilized in order to gather both accurate and reliable data. The questionnaire consisted of questions aimed for determin-

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*1　Faculty of Fisheries, Ege University, İzmir, Turkey.
*2　Tire Kutsan College, Ege University, İzmir, Turkey.

ing fry rearing systems and the economic status of the establishments. Some questions about the market share and related issues were also included. Seven of these hatcheries surveyed are located in İzmir; three of them are in Muğla, one in Adana, Çanakkale and in Aydın. The hatchery data gathered for a period between 1997 and 2002 was analyzed using a simple regression analysis method in order to obtained some empirical relations to estimate hatchery production for a period between 2004 and 2010. The data for year 2003 was not considered in regression analyses. The dependent variable was production estimation value and the independent variable was time (years). Even though, the hatchery data seems to be insufficient, a relation with a confidence level of 90% was obtained. Therefore, the estimations were supported by the test parameter values and the desired results were reached. The software SPPS 9.05 was used for statistical analysis of data.

3. RESULTS

The production of larvae in Turkey was determined to be increasing as a function of years according to the results of the survey as noted in Table 1. While the

Table 1. Fry Production Amounts in Hatcheries of Turkey (1997-2002)

Name of Hatchery	Capacity of Project (000 fry/year)	1997 (000 fry/year)	1998 (000 fry/year)	1999 (000 fry/year)	2000 (000 fry/year)	2001 (000 fry/year)	2002 (000 fry/year)
Pınar	11000	4800	5000	6500	6000	10000	11000
Elektrosan	2500	750	750	800	1150	1500	1500
Akvatek	5000	2500	2800	2800	3250	3250	3500
Güven	2500	650	900	1250	1350	0	0
Mordoğan	1500	525	800	850	0	0	0
İlknak	20000	5500	6150	6500	7250	8000	10000
Hatko	2000	850	850	1000	1150	1500	2500
OMP	1250	525	800	850	1000	900	0
Kılıç	25000	10250	10750	12000	13250	13000	24000
Egemar	12000	6000	7750	9000	10500	11250	13000
Turkuaz	6000	2000	2000	3250	4250	5000	6000
İda Gıda.	20000	0	0	0	0	700	1500
Akvatur	20000	2500	4500	6000	9000	8000	8000
TOTAL	**128750**	**36850**	**43050**	**50800**	**58150**	**36100**	**81000**

Table 2. Estimation of Fry Production in Hatcheries of Turkey.

Name of Hatchery	Number of Data	2004 (000 fry/year)	2005 (000 fry/year)	2006 (000 fry/year)	2007 (000 fry/year)	2008 (000 fry/year)	2009 (000 fry/year)	2010 (000 fry/year)
Pınar	6	13067	14367	15667	16967	18267	19567	20867
Elektrosan	6	1033	1214	1395	1576	1757	1938	2119
Akvatek	6	3318	3512	3706	3900	4094	4288	4482
Güven	4	4389	4635	4881	5127	5373	5619	5865
Mordoğan	3	698	860	1022	1184	1346	1508	1670
İlknak	6	11222	12045	12868	13691	14514	15337	16160
Hatko	6	3212	3508	3804	4100	4396	4692	4988
OMP	5	1290	1385	1480	1575	1670	1765	1860
Kılıç	6	24029	26222	28415	30608	32801	34994	37187
Egemar	6	15912	17255	18598	19941	21284	22627	23970
Turkuaz	6	7321	8178	9035	9892	10749	11606	12463
İda Gıda.	2	Nd*	Nd*	Nd*	Nd*	Nd*	Nd*	Nd*
Akvatur	6	10746	11917	13088	14259	15430	16601	17772
TOTAL	**6**	**142146**	**150001**	**157856**	**165711**	**173566**	**181421**	**189276**

Nd: No estimation since only two data was available.

larvae production was 36,850,000 fry/year in 1997, it was 81,000,000 fry/year in 2002 (Table 1).

Although the total project capacity of hatcheries in Turkey were 128,750,000 fry/year, the actual amount of production in 2002 was 81,000,000, which leads to the conclusion that the percentage of potential capacity used in the region was 62.9%. When the hatcheries are evaluated individually, their production amounts are generally observed to be increasing every year. However, since 2002 it was found that 67% of the hatcheries could not reach the production capacity, which was estimated previously. It was estimated that total production amount would be 147,233,000 fry in 2004 and 196,811,000 fry in 2010 (Table 2).

50.3% of produced fish species is *D. labrax* and 43.2% of these are *S. aurata*. Remaining percentage includes White Grouper, Dentex, Red Sea Bream, Pandora, Sole, Mullet, Striped Bream and Amber Jack. Production of these new species is based on experimental studies and the production rates are aimed to be expanded in future. Hatcheries in Turkey consist of four units, namely, broodstocks, incubators, larvae and adaptation units. In the broodstock units, egg production is made via adaptation of broodstocks, providing gonadal development. In the broodstock units of some hatcheries, decalage is applied to obtain eggs before or after its natural spawning season. It was determined that the size of broodstock tanks ranges between 10-30m³ and cylindrical tanks were mostly preferred (Table 3).

It was noticed that 10-40% of the broodstocks were replaced every year in the all hatcheries considered in the research. 71% of the hatcheries culture their own broodstocks in their plants (Figure 1).

Optimal water conditions are achieved by filtering water used in incubators of the all hatcheries researched through a cartridge filter (1 μ) (Table 4). Size of incubators is generally between 0.5 and 2m³. Materials used in incubator units of the facilities are 60% polyester and

Table 3. Comparison of Broodstock Tanks used in Hatcheries of Turkey.

Name of Hatchery	Number of Tanks (piece)	Volume (m³)	Types of Tanks	Material of Tanks	Stock Density (m³/kg)
Kılıç	18	15	Cylindrical	Metal	9.5
Egemar	17	30	Cylindrical	Metal	7.5
Pınar	15	27.5	Cylindrical	Metal	8
İlknak	10	25	Cylindir-conic	Polyester	7
Akvatek	8	20	Cylindrical	Metal	6
Turkuaz	10	10	Cylindir-conic	Polyester	7.5
Elektrosan	6	22.5	Cylindir-conic	Polyester	5
Hatko	6	25	Cylindrical	Metal	8
İda-Gıda	Nd*	Nd*	Nd*	Nd*	Nd*

Nd* This enterprise doesn't have broodstock units. Fry Production is made via purchasing eggs from abroad.

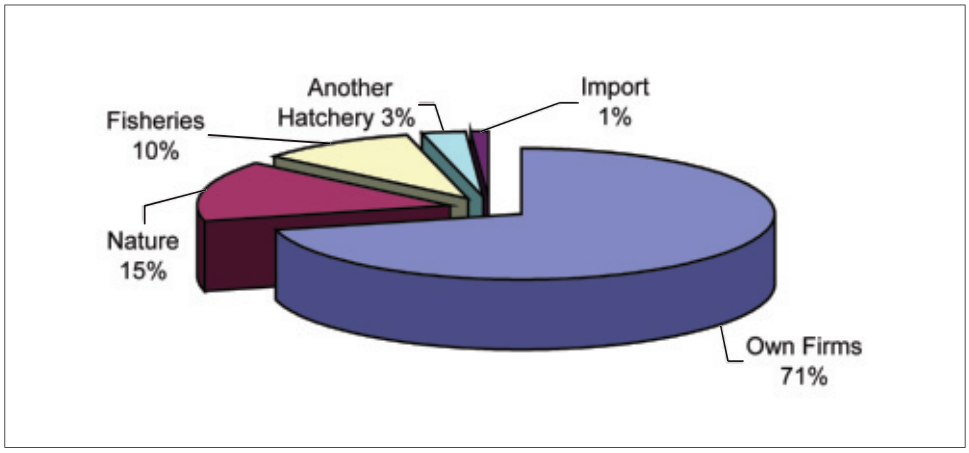

Figure 1. Broodstock obtaining methods in the hatcheries of Turkey.

Table 4. Comparison of the incubators used in the hatcheries of Turkey

Name of Hatchery	Number of Tanks (piece)	Volume (m^3)	Types of Tanks	Material of Tanks	Stock Density (larvae/m^3)
Kılıç	14	1.5	Prismatic	Fiber-glass	6000
Egemar	12	0.9	Prismatic	Glass-glass	5000
Turkuaz	8	0.5	Prismatic	Polyester	6000
Pınar	12	1.75	Prismatic	Glass-glass	5000
İlknak	10	1	Cylindir-conic	Polyester	4000
Akva-Tek	10	1	Cylindir-conic	Glass-glass	5000
İda-Gıda	10	2.5	Cylindir-conic	Polyester	5000
Elektrosan	8	1.15	Cylindrical	Polyester	6000
Hatko	6	1	Prismatic	Polyester	4000

40% fiberglass facilities (Table 4).

Larvae rearing time in 0.5–2 m^3 tanks is about for 35 or 40 days. This period continues till the end of larvae growing and sorvage (after feeding with live feed passing to dry feeding). Stocking amount depends on water parameters and varies in each hatchery. In this research, it was found that stocking amount ranges between 100–200 larvae/l (Table 5).

Subsequently, larvae are taken to the tanks of the adaptation units and adaptated to marine environment and powder feed is given for a period of 35–40 days. Larvae fed to 1–2cm in these tanks are either sold or taken to the feeding cages of the integrated facilities. It was found that the stock density in adaptation tanks of the examined establishments ranges between 4000–6000 fry/m^3 and that 55% of the establishments stocked 5000 fry/m^3 (Table 6).

In 64% of the hatcheries, closed recirculation systems are applied while 36.5% of them had open circulation systems. 46% of the establishments examined found to have automation systems and their capacity is determined to be over 5,000,000 fry/year. Firm management software systems are also used in two integrated establishments. A total of 148 people are employed in the hatcheries located in the area and 38% of them are aquaculture engineers. Aquaculture engineers are employed in the all facilities. In addition, 71% of working engineers have an experience of 1–3 years and are young and fresh graduated individuals. Main technical problems encountered are cannibalism and high percentages of mortality because of illnesses. Managers stated that they discriminated the stocks by size in order to solve this problem. Feed costs take the largest proportion among the expenses constituting the production costs of the hatcheries (Figure 2).

55% of researched hatcheries were found to determine fry price according to their production costs by ignoring the prices of the other companies while 27% by forming a partnership with other hatcheries and considering domestic and foreign market conditions and lastly 18% by independently considering market demand (Figure 3).

Table 5. Comparison of the larvae tanks used in the hatcheries of Turkey.

Name of Hatchery	Number of Tanks (piece)	Volume (m^3)	Types of Tanks	Material of Tanks	Stock Density (larvae/m^3)
Kılıç	20	4	Cylindir-conic	Glass-glass	200
Egemar	18	5	Cylindir-conic	Glass-glass	150
Pınar	16	5	Cylindir-conic	Glass-glass	150
Turkuaz	32	12.5	Cylindir-conic	Polyester	200
İlknak	12	3	Cylindir-conic	Polyester	200
Akva-Tek	10	3	Cylindir-conic	Glass-glass	150
İda-Gıda	9	20	Cylindrical	Polyester	100
Elektrosan	8	4	Cylindir-conic	Polyester	100
Hatko	8	3.5	Cylindir-conic	Polyester	150

Table 6. Comparison of the adaptation tanks used in the hatcheries in Turkey.

Name of Hatchery	Number of Tanks (piece)	Volume (m^3)	Types of Tanks	Material of Tanks	Stock Density (fry/m^3)
Kılıç	28	35	Cylindrical	Metal-Polyester	5000
Egemar	24	40	Cylindrical	Metal-Polyester	5000
Pınar	22	35	Cylindrical	Metal-Polyester	5000
Turkuaz	45	22.5	Cylindrical	Metal-Polyester	6000
İlknak	18	30	Cylindrical	Metal-Polyester	4500
Akva-Tek	16	30	Cylindrical	Metal-Polyester	4500
İda-Gıda	22	20	Octagonal	Steel-aluminum Polyester	5000
Elektrosan	12	32.5	Cylindrical	Metal-Polyester	5000
Hatko	10	30	Cylindrical	Metal-Polyester	4000

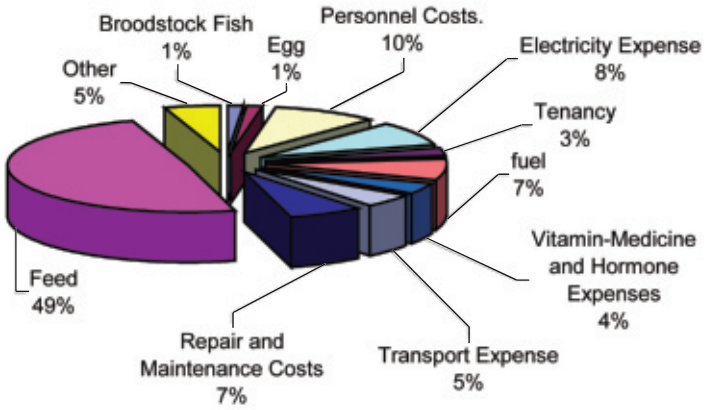

Figure 2. Rational Distribution of Production Costs in the Hatcheries of Turkey.

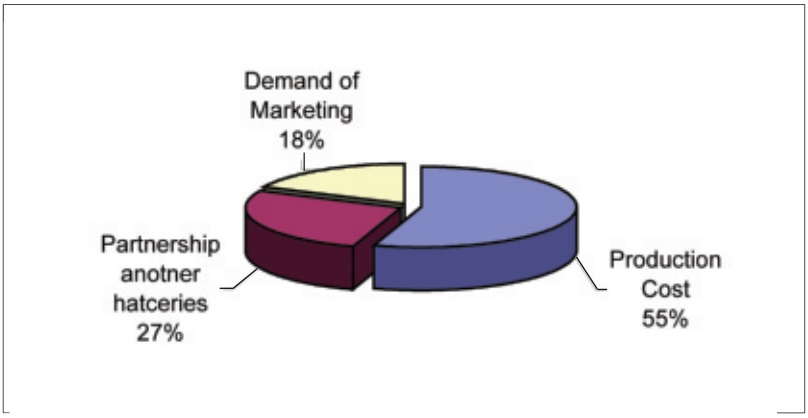

Figure 3. Assessment methods for the sale prices in the hatcheries of Turkey.

When the average prices of aquacultured fish in the hatcheries for 2001 were examined, it was found that sea bream and sea bass which are mostly reared in hatcheries were sold at 280,000 TL /fry (0.22$) and 260,000 TL/fry (0.21$), respectively. The evaluations that 63,100,000 fry accounted for 19,346,460,000,000 TL (13,251,000$) in 2001. Only one company exported and the exportation was only to Greece. The facilities including also feeding units were found to prefer exporting the fry more than other marketing choices. In 45.5% of the enterprises, presentation activities are performed. These activities are involving participation in related fairs and distribution of brochures.

4. DISCUSSION and CONCLUSION

In this study, the marine fish production of Turkey was determined as 63,100,000 fry in 2001. Greece is the largest fry producer among European countries with a production of 235 million juvenile, followed by Italy (85 million), Spain (65million) and Turkey. Technical equipments utilized in the hatcheries examined were found modern, and also employed educated staff. Innovations introduced to the sector continuously followed by the improvements. Besides, the fact that hatcheries are fundamental organizations in progressing aquaculture industry, triggers the development of this branch of production. Within the scope of this research, broodstock, incubation, larvae and adaptation units of the hatchery enterprises were examined. Dimensions of broodstock tanks ranged between 20-30 m^3. The adopted system in the facilities is similar to the small-scale systems used in European (tanks 15-30m^3) and Mediterranean countries (tanks 10-20m^3). However, larger broodstock tanks with a volume of 50-100m^3 are preferred in Asian countries and also in Japan (12).

The reason why mostly cylindrical or cylindir-conical broodstock tanks are employed in Turkey's hatcheries is that water circulation is better. Stock density in broodstock units was established to be 3-14 kg/m^3. Johnson and Kataniç reported in their research that the ideal stock amount was 3kg/m^3. Ranges for stock density amounts in our country are found to be relatively higher. This wide range for stock values can be elucidated by the fact that various types of production methods are conducted in the enterprises. Managers have a common point of a view that employment of younger broodstocks instead of older ones clearly increases the productivity. Girin and Devauchelle (1978) emphasize on the assumption that the quality and quantity of eggs provided from broodstocks is directly related to the egg releasing methods. This statement supports the common opinion that enterprises agree with each other. During the investigations, it was clarified that water in incubator units of all the hatcheries is continuously replaced with fresh water and optimum water conditions that provide the most favorable environment is achieved. Replacement of water is of vital importance in order to prevent bacterial contamination of eggs (5).

Incubators used are found to be small-scale units. The preference of smaller units results from the fact that they can readily be manipulated and controlled. Nevertheless, polyester and fiberglass tanks are preferred for their portability, durability and also cleanability. Cylindir-conic type of tanks are used in larvae rearing units of overall hatcheries due to the easiness of removing feces and excess material that accumulate at the bottom of the tank. Stock densities preferred in the plants range between 100-200 fry/l. Recommended stock density is generally 100 fry/l (3).

Values of 50-70 fry/l stock amounts are suggested in another preference study (11).

89% of hatcheries in Turkey employ a stock density greater than 100 fry/l.

Open circulation systems are used in 36.6% of the hatcheries in Turkey. Closed recirculation units are generally preferred as the degree of sensitivity is high in the larvae rearing and adaptation units of establishments compared to that in open circulation systems. In closed recirculation systems, due the water replacement by 10%, an energy saving is provided and optimal water conditions is maintained as an advantage.

Live food units and control systems are of great importance to all the hatcheries. Live food has an extensive role in the first feeding period of post larvae. Artemia and rotifera are particularly produced in live food units of the enterprises. Water temperature and oxygen should be controlled to maintain to be constant at any moment as larvae are sensitive to even minor fluctuations. The significance and difficulty of manual control has led major enterprises to use automation systems. Firm management software systems are also used in two integrated establishments. The utilization of softwares is a great progress in this scope as these programmes assist the management of the facilities in making appropriate decisions on time and also by providing labor saving, and increasing the profitability of the establishment. Modernization of an enterprise is of great significance for its continuity and success (7).

Employment of aquaculture engineers in all the enterprises is a proof of the awareness of managements about the technical information required on the fry production. Also, the fact that aquaculture engineers are paid at an average salary of 335.1 US dollars in 2001 plays a major role for their employment to be preferred.

Percentages of mortality are significantly high in the larval stage. Cannibalism and illnesses are found to be the main causes for the mortality at this stage. Barnabe (1991) reported in his research that, major problems encountered in this period were cannibalism, illness and low survival rates (2). In this respect, man-

agers have been trying to prevent mortalities due to cannibalism by discriminating fry according to their size. This is a very appropriate counter-measure. Discrimination of fry is performed to stop cannibalism and provide an optimum benefit from feed (4).

When sea bream and seabass prices of the hatcheries are compared, prices for sea bream fry were ascertained to be higher than that of seabass. This situation results from the higher costs and more difficult technical issues and consequently obtaining less amount of larvae included in rearing sea bream fry. Sea bream aquaculture is harder to carry out than that of seabass due to the small larvae size and small mouth size causing difficulties in feeding and greater area requirement.

Feed costs were found to account for the largest part among the expenses in the examined hatcheries. All the enterprises conduct studies on reducing production costs and give particularly attention to regular documentation by controlling work. In this respect, cost and profitability analyzes are periodically performed in the enterprises and performances are attentively observed. When hatchery companies increase their partnership with each other and act together with an organization principle, they can be more effective in both input and product markets. In this case, costs would able to be decreased by supply of low priced input and they would play a major role in ascertaining product prices as they would be able to act as a single organization. Consequently, by the increase in sale revenues, maximum profitability would be provided.

Improvement in training and Research & Development activities in the structure of hatcheries and in related establishments are of great importance for a healthy and rapid development of the sector at issue. Government support by supplying technical equipment and providing fund for feed assuring has great significance in terms of the future of the aquaculture sector.

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Dilek İŞGÖREN-EMİROĞLU, Osman ÖZDEN and Ahmet KAYA

要　旨

トルコにおける海水魚の人工孵化場の技術的および経済的解析

トルコにおける最初の海水魚の人工孵化場は，1985年チェッシュシメに造られた．国の統計資料によると，現在トルコには19ヵ所の人工孵化場がある．しかし，それら人工孵化場の生産量，技術水準や経済状態に対する正確な情報の把握はなされていない．本研究の目的はトルコでの海水魚の人工孵化場の技術面，経済面に関する問題点を統計学的に解析することである．本論文で使用したデータは海水魚の人工孵化場から直接収集したものである．その結果，現在実際に操業している海水魚の人工孵化場は10ヵ所であることが明らかになった．信頼できる正確なデータを得るためフール・カウンティング手法とアンケート法を利用した．1997年と2002年の人工孵化場のデータは逆解析手法で解析し，その解析結果に基づいて2004年から2010年までの各人工孵化場の生産量を推定した．データの統計的な解析に関して統計処理ソフト SPPS 9.05を使用した．