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Economic Analysis and Sustainability of Turkish Marine Hatcheries

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Abstract

The economic analysis was performed and sustainability was evaluated for 7 leader Turkish marine hatcheries which have 61.5% of Turkish total marine fish fry production. For this purpose, the fixed cost including investment and operational costs including feed, labor, energy, fuel, water, oxygen, and medicament costs were determined by face to face interview for each hatchery. Also, production methods, species cultured and marketing techniques of each hatchery were investigated and conflicts, opportunities, projections, structuring and sustainability of the sector were evaluated by questionnaire designed in the scope of SUSTAINAQ, a FP6 Project supported by EU.

As a result, it was seen that the ratio of total cost to total income changed between 22% and 97.8%. Although the RAS requires high operation and initial investment costs and highly qualified technicians, it is seen that it will be very important for sustainability of Turkish marine hatcheries because of land, quality and quantity of water and environmental approaches.

Keywords: Turkish marine aquaculture, sustainable development, economy.

Türkiye Deniz Balıkları Kuluçkahanelerinin Ekonomik Analizi ve Sürdürülebilirliği

Özet

Çalışmada, Türkiye deniz balıkları yavru üretiminin %61,5'ini karşılayan 7 lider kuluçkahane için ekonomik analiz gerçekleştirilmiş ve sürdürülebilirlikleri değerlendirilmiştir. Bunun için, yatırım masraflarını içeren sabit gider ile yem, işçilik, enerji, yakıt, su, oksijen ve ilaç giderlerini içeren işletme giderleri, her bir işletme için yüz yüze görüşmelerle belirlenmiştir. Ayrıca, AB FP6 fonlarınca desteklenen SUSTAINAQ akronimli proje kapsamında düzenlenen anket çalışmasında, her bir kuluçkahanenin üretim metotları, üretilen türler ve pazarlama teknikleri incelenmiş ve sektörün darboğazları, fırsatları, mevcut durumu, yapılanması ve sürdürülebilirliği değerlendirilmiştir.

Çalışma sonunda, toplam gelir gider oranının %22,0 ile %97,8 arasında değiştiği gözlemlenmiştir. Kapalı devre balık üretim sistemlerinin yüksek miktarda işletme ve yatırım masrafları ile kalifiye teknik personel ihtiyacı gerektirmesine karşın, arazi kullanımı, kullanılan suyun niteliği ve niceliği ve çevresel yaklaşımlar açısından Türkiye deniz balıkları kuluçkahanelerinin sürdürülebilirliği için öneminin yüksek olduğu görülmüştür.

Anahtar Kelimeler: Türkiye deniz balıkları yetiştiriciliği, sürdürülebilir gelişme, ekonomi.

Introduction

Turkey is currently the third largest farmed finfish producer in EU and the second largest producer of both sea bass and sea bream. Turkish aquaculture development was driven by availability of sheltered sites and good water quality, governmental supports, high private sector interest, rapid development of specific marine hatchery technologies, rapid biotechnical developments in live feed, pathology, artificial food, cages, self rationalization of sector and transformation from the production driven strategy to a market oriented strategy, and low labor cost (Okumuş and Deniz, 2007).

Although the total production was realized as 646,000 tons, aquaculture production in total was 152,000 tons in 2008. Marine aquaculture production corresponds to 59%, 55%, 57.8% and 56.3% of the total aquaculture production in 2005, 2006, 2007 and 2008 respectively. Aquaculture sector can be characterized by limited species and system diversity, small scale farms, a production oriented approach and export dependent (EU) market. While the total

Turkish aquaculture production was increased 2.5 times, sea bass and sea bream production were increased by 3.3 and 4.8 times, respectively from 1986 to 2007 (Anonymous, 2009; Deniz, 2007; Okumuş and Deniz, 2007).

Marine aquaculture in Turkey is located mostly in the Aegean Region, where geographical and hydrographical conditions are suitable for the cultured species. There are 60 on land earth ponds and 229 cage farms in the Aegean Region, and 12 farms in the Mediterranean and the Black Sea Regions (Okumuş and Deniz, 2007).

Whereas marine fish hatchery reproduction number was 200–250 million fry in 2005 (Okumuş and Deniz, 2007), total fry production has been reached to number of 348 million in 2007 (Deniz, 2007).

Liu and Sumaila (2007) showed that net-cage systems are more financially profitable than sea-bag systems when environmental costs are either not or only partially considered. Sea-bag systems can be financially profitable only when they produce fish that achieve a price premium. An economic analysis of a hypothetical small-scale marine recirculating aquaculture system (RAS) is conducted for on-growing small, wild the Black Sea sea bass *Centropristis striata* by Copeland *et al*. (2007).

While improvements in the performance efficiency of system components did not greatly affect fish production costs, reductions in feed costs and improvements in the feed conversion ratio caused the greatest reduction of production cost of all of the operational variables investigated. The greatest gains to be realized in improving profitability are those associated with increasing the productive capacity or decreasing the investment cost of a recirculating fish production system (Losordo and Westerman, 1994).

Yang *et al*. (1989) summarized the economic aspects of production models and discusses the economic feasibilities. Burbridge *et al*. (2001) presented a critical review of current social, economic and policy issues relevant to marine aquaculture (mariculture) in Europe. Tools for identifying the full range of social, economic and environmental issues that influence the sustainable development of mariculture are examined.

Sustainability and sustainable development are complex issues that are difficult to define and apply in aquaculture. According to Black (2001), sustainability is where environmental effects meet socio-economics and markets. Some European countries have already developed legal frameworks and policies for managing aquaculture development. Aquaculture is frequently regulated by many agencies under a variety of laws (e.g., Greece, Portugal, and Finland), though in some countries there is an integrated legal framework (e.g., UK). Developing a comprehensive regulatory framework for the sector is often legally and institutionally complex (Henderson and Davies, 2001). It has been argued that existing administrative and legal frameworks need to be reviewed and adjusted to address the changing characteristics and needs of the sector, and to set out clearly the privileges and responsibilities of aquaculturists (Henderson and Davies, 2000). Also, Mc Causland *et al*. (2006), Tisdell (1999), Bailly and Willmann (2001), Chopin *et al*. (2001), Beveridge *et al*. (1997) and Whitmarsh *et al*. (2006) were conducted sustainability studies for aquaculture sector.

Despite the rapid growth of aquaculture and the growing awareness of environmental issues, few studies which address these issues objectively have been made. The experience shows repeatedly that without some form of intervention, short term financial perspectives will tend to dominate development decisions to the detriment of environmental and social objectives.

Ideally, the technical and economic assessment as described above should be summarized in the form of overall “sustainability” profiles of alternative development options and technologies, so that rational comparisons can be made, trade-offs assessed, and planning and management decisions made. This information is essential for any kind of environmental assessment, cost benefit analysis, or participatory decision making (GESAMP Report, 2001).

Materials and Methods

The seven leading Turkish marine hatcheries which have 61.5% of Turkish total marine fish fry production were analyzed in this study. All data relating with production capacity, all the fixed cost including investment cost and the operational costs including feed, labor, energy, fuel, water, oxygen, and medicament costs were obtained. Also, production methods, species and marketing techniques of each firm were investigated; and conflicts, opportunities, projections, structuring and sustainability of the sector were evaluated by questionnaire designed in the scope of SUSTAINAQ Project.

The economic analysis of facilities was conducted depending on fixed investment cost, and operating costs such as feed, labor, energy, fuel, water, oxygen, medicament, etc. The production methods, species, amount of production, marketing, production volumes, total capacities of production, fish farm area and building or specialized installation were taken in to account.

The economic analysis also includes fixed and indirect operating costs, such as salary, insurance, maintenance, interests and depreciation which are usually independent from the level of production and variable cost such as seed, feed, fertilizer, chemical and drugs, labor, water and energy and miscellaneous costs, which vary with output. Also, total production, total cost of production, gross revenue, net return, benefit cost ratio (net return / total cost), cost of input per unit of output and value of unit of output were evaluated.

Data collection, classification and analysis consist of the year of 2007. For this purpose, seven marine fish hatcheries which have higher juvenile production capacity in Turkey were selected for survey. All data were obtained through face to face interviews with owners and experts (mostly responsible person from operations). Data relating with the harvesting and stocking rates, species, labor, feeding, consumption of water and energy, maintenance, individual production of species, selling prices, fish production activities and marketing were recorded.

The investment cost (€)per fish is given as;

$$IC_{PF}(€) = \left(\sum_{i=1}^{4}(IC)_i/(YA)_i\right)/TNF,\ i = \begin{cases}1-building/office\\2-system/pond/cage\\3-installation/infrastructure\\4-processing/storage\end{cases}$$

where IC, YA and TNF are investment cost, year amount and total number of fish.

The operational cost (€)per fish is defined as;

$$OPC_{PF}(€) = \begin{bmatrix}\left(\sum_{j=1}^{n}(AF_{PF})_j \times (NF)_j \times FP \times PPK\right) + \left(\sum_{k=1}^{n}(NS)_k \times (SS)_k \times 12\right)\\ +\left(\sum_{\kappa=1}^{6}\sum_{p=1}^{12}(\kappa)_p\right) \begin{vmatrix}\kappa=1, EC\\ \kappa=2, FUC\\ \kappa=3, WC\\ \kappa=4, OC\\ \kappa=5, MC\\ \kappa=6, OTC\end{vmatrix}\end{bmatrix}/TNF$$

where OPC, AF, FP, NF, PPK, j, NS, SS, k, EC, FUC, WC, OC, MC, OTC and κ are operational cost, amount of feed, feeding period, number of fish, price of per kilogram, species of fish, number of stuff, salary of stuff and group of salary, energy cost, fuel cost, water cost, oxygen cost, medicament cost, other costs and kind of operational cost, respectively.

The total cost (€) per fish is formulated as;

$$TC_{PF}(€) = IC_{PF}(€) + OPC_{PF}(€)$$

The investment cost (%) per fish is given as;

$$IC_{PF}(\%) = IC_{PF}(€) \times 100 / TC_{PF}(€)$$

The operational cost (€) per fish is defined as;

$$OPC_{PF}(\%) = OPC_{PF}(€) \times 100 / TC_{PF}(€)$$

The total cost (€) per fish is formulated as;

$$TC_{PF}(\%) = IC_{PF}(\%) + OPC_{PF}(\%)$$

The total income is calculated as follows,

$$TI(€) = \sum_{j=1}^{n}(PAL)_j \times (PL)_j + \sum_{j=1}^{n}(PAMS)_j \times (PMS)_j + \sum_{j=1}^{n}(PAE)_j \times (PE)_j$$

where, PAL, PL, PAMS, PMS, PAE and PE are production amount of fry, price of fry, production amount of market size, price of market size, production amount of egg and price of egg, respectively.

Results and Discussion

Economic Analysis

The investment cost for per fish (%) is presented in Table 1 for seven marine hatcheries. It is seen that the total investment cost-per fish varies from 4.02% to 35.08%.

Figure 1 shows the operating cost for per fish (%) in seven Turkish marine hatcheries. The outgoings of feed, labor, energy, fuel, drinkable water, oxygen, insurance, fees, medication and other costs are considered to determine the operating cost for per fish (%). It is observed that the total operating cost for per fish (%) changes between 15.90% and 92.19% when the seven facilities are taken into consideration. It was observed that the lowest operating cost takes place for facility II in which the fuel is 7.43% as maximum outgoings of operating cost for per fish (%). The highest operating cost for per fish (%) is obtained for facility I in which the fuel is 24.49% as maximum expenditure of operating cost and also labor and feed outgoings are 23.81% and 16.67%, respectively. It seems that the feed expenditure has the highest ration inside of operating cost as the seven facilities are considered. Also, labor, fuel and energy outgoings have high ratio inside of operating cost for per fish. However, it is obvious that when the facility has suitable water resource with regard to temperature for production, the fuel cost, which has an important ratio of operating cost, decreases considerably. It is observed that the lowest

Table 1. Investment cost per fish (%)

	I	II	III	IV	V	VI	VII
	cost share % per fish	cost share % per fish	cost share % per fish	cost share % per fish	cost share % per fish	cost share % per fish	cost share % per fish
Building/Office	0.45	0.71	0.60	0.51	0.00	2.51	0.29
System/pond/cage	1.94	0.36	2.62	2.23	5.08	15.03	1.75
Installations/Infrastructure	2.98	2.95	4.03	3.43	20.31	5.01	0.59
Processing/Storage	0.30	0.00	0.40	0.34	0.00	12.53	1.46
Total	5.67	4.02	7.65	6.51	25.39	35.08	4.09

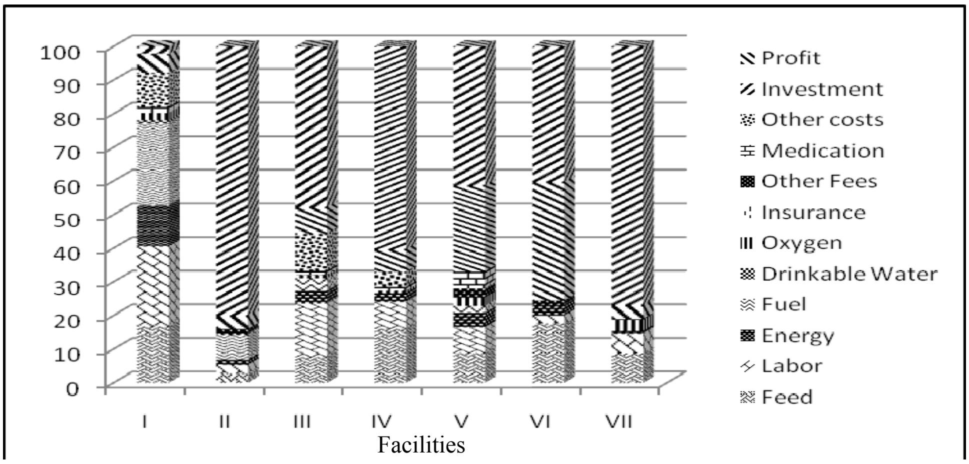

Figure 1. Operating cost per fish (%).

operating cost is insurance and only one facility spends as 0.07% of operating cost for insurance.

The distribution of incomes and outcomes for seven Turkish marine hatchery facilities is given in Figure 2 and Figure 3. It is seen that the profit of the facilities changes between 36.158 € (facility I) and 13.152.150 € (facility VII) while the ratio of total outcomes to total incomes varies from 22.0% (facility II) to 97.28% (facility I). Also, the ratio of total expenditures to incomes is 23.1%, 38.4%, 52.0%, 59.1% and 61.1% for facilities VII, IV, III, VI an V, respectively.

Table 2 presents the production of the species for seven hatcheries. As shown in Table 2, ten species as sea bream (*Sparus aurata*), sea bass (*Dicentrarchus labrax*), common dentex (*Dentex dentex*), sharpsnout seabream (*Diplodus puntazzo*), two banded sea bream (*Diplodus vulgaris*), common sea bream (*Pagellus erythrinus*), corb (shi drum) (*Umbrina cirrosa*), blue spotted sea bream (*Pagrus caeruleostictus*), meagre (*Argyrosomus regius*) and white grouper (*Epinephelus aeneus*) are produced by seven facilities. Almost 96% of Turkish marine hatchery production is sea bass and sea bream (Table 2). The sea bass is the highest cultured specie as 119,800,000 fry /year and it is produced by all facilities. Also, the sea bream is produced by all facilities except facility III as 88,950,000 fry/year. It is seen that the facility II produces seven different species as 7,600,000 fry and 200 kg eggs in year 2007. The facility IV grows six different species as 25,000,000 fry/year, while the facility VI produced three species which are sea bream, sea bass and sharpsnout sea bream as 60,000,000 fry and 240,000 kg market size fish in year 2007. The facility VII producing sea bream and sea bass has the highest production capacity as 90,000,000 fry in 2007. The total fry production capacity of fifteen Turkish marine hatcheries was 348,000,000 (Okumuş and Deniz, 2007), while the total production capacity of the seven facilities was 214,100,000 in 2007.

The price of fry, egg and market size fish can be found in Table 2 for each facility and species. It is seen that the prices of sea bream, sea bass, sharpsnout seabream and corb (shi drum) change depending on facilities. The facility V has the lowest price for sea bream and sea bass, which has the highest production capacity as 208,750,000 fry/year, while the facility I and facility VII have the highest price for sea bream and sea bass, respectively. Also, it is observed that the each facility producing fry apart from sea bream and sea bass has the same price for all species but the price of each species changes depending on facility.

Sustainability

There have been many definitions of sustainable development. One of the most widely quoted and agreed is: "Development that meets the needs of the present without compromising the ability of future generations to meet their own need" (GESAMP Report, 2001). Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (GESAMP Report, 2001). Phillips *et al*. (2001) argued that sustainability could be split into three separate components; social, economic and environmental sustainability.

The production capacity (fry/m^3/year), land usage, production systems and production type which are important for sustainability of Turkish marine hatcheries are given in Table 3. The total production capacity varies between 4,210 fry/m^3/year (facility III) and 21,635 fry/m^3/year (facility VII). When production capacity for unit tank volume rises, the total production capacity (fry/m^3/year) increases. This is very important for facilities which have land constraint in favor of the sustainability. The areas of

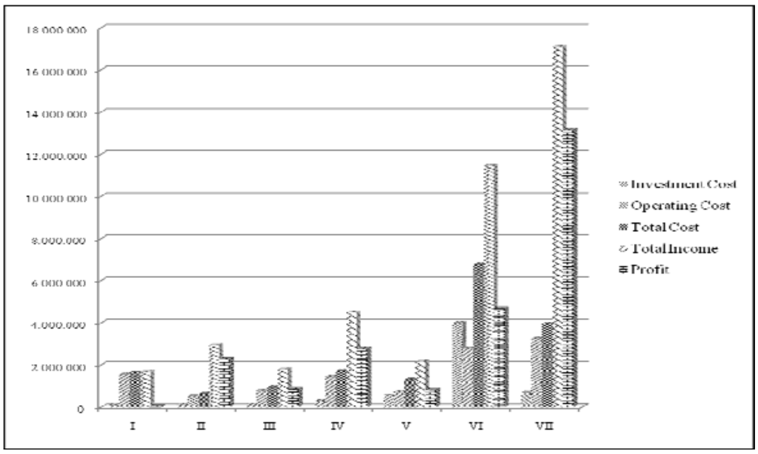

Figure 2. Economic parameters of facilities in Euro.

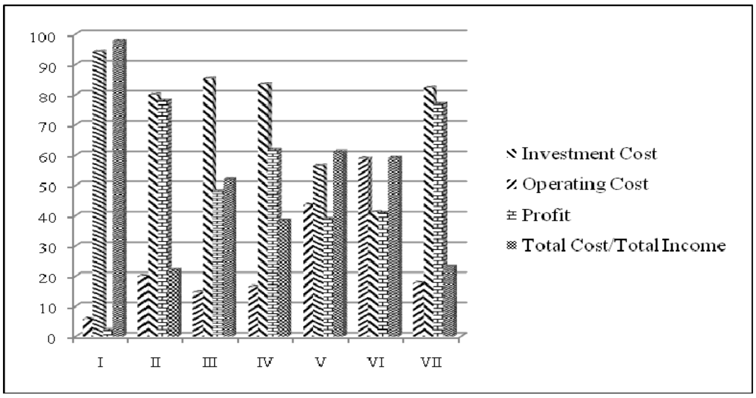

Figure 3. Economic parameters of facilities as percentage.

Table 2. Production amounts, price of eggs, fry and market size fish of species for facilities

Species	I	II	III	IV	V	VI	VII
	fry/year- € kg/year-€	fry/year- € kg/year-€	fry/year- € kg/year-€	fry/year- € kg/year-€	fry/year- € kg/year-€	fry/year- € kg/year-€	fry/year- € kg/year-€
Sea bream	6,000,000-0.225	3,750,000-0.22	-	10,000,000-0.20	5,000,000-0.17	19,200,000-0.19	45,000,000-0.20
	-	-	-	-	-	76,800-4.4	-
Sea bass	2,000,000-0.165	3,000,000-0.16	12,000,000-0.15	10,000,000-0.15	10,000,000-0.13	37,800,000-0.16	45,000,000-0.18
	-	-	-	-	-	151,200-4.3	-
Common dentex	-	200,000-0.275	-	-	-	-	-
	-	-	-	-	-	-	-
Sharpsnout sea bream	-	200,000-0.275	-	-	-	3,000,000-0.25	-
	-	-	-	-	-	12,000-5	-
Two banded sea bream	-	150,000-0.275	-	-	-	-	-
	-	-	-	-	-	-	-
Common sea bream	-	150,000-0.275	-	-	-	-	-
	-	-	-	-	-	-	-
Corb (shi drum)	-	100,000-0.275	-	1,500,000-0.20	-	-	-
	-	-	-	-	-	-	-
Blue spotted sea bream	-	50,000-0.275	-	-	-	-	-
	-	-	-	-	-	-	-
Meagre	-	-	-	2,500,000-0.20	-	-	-
	-	-	-	-	-	-	-
White grouper	-	-	-	1,000,000-0.20	-	-	-
	-	-	-	-	-	-	-
Egg (kg)	-	200	-	-	-	-	-
Egg (kg/€)	-	7000	-	-	-	-	-

Table 3. Production capacity, land usage, production systems and production types

	Facilities						
	I	II	III	IV	V	VI	VII
Total capacities of production (fry/m^3/year)	8.800	13.636	4.210	6.493	7.800	12.900	21.635
Fish Farm Area (m^2)	6.000	12.000	14.000	5.500	20.000	25.000 on land 460.000 on sea	100.000
Tank Volume (m^3)	Total 2.336 (1.136 in use)	550	Total 5.250 (2.850 in use)	3465	1.920	4.650	4.160
Building or specialized installation (m^2)	5.400	4.000	5.000	3850	2.860	15.000	20.000
Closed	Yes	Yes	No	Yes	No	Yes	Yes
Semi-closed	Yes	Yes	Yes	Yes	No	Yes	Yes
Open	Yes	No	No	Yes	Yes	Yes	Yes
Earth pond	No	No	No	No	No	No	Yes
Off-shore	No	No	No	No	No	Yes	No
Broods	Yes	Yes	No	Yes	No	Yes	Yes
Eggs	Yes	Yes	Yes	Yes	No	Yes	Yes
Fry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Market size	No	No	No	No	No	Yes	No

fish farms change from 5,500 (facility IV) to 100,000 m^2 (facility VII) on land and only facility VI has 460,000 m^2 on the sea, in which this facility produces sea bream, sea bass and sharpsnout seabream as market size. Because the aquaculture sector conflicts with tourism and construction sectors, the land problem will be important in near future. The marine fish hatcheries have become intense in the Muğla, Aydın and İzmir which are located in the Aegean Region. However, same region is densely used for summer sea tourism. The social, cultural and economical expectations of allocation units from tourism are considerably high in this region. The tourism sector assuming the economic center of this century employs the media against to other sectors especially aquaculture sector. Therefore, there are serious conflicts among aquaculture sector and tourism and other sectors expecting income. It seems that the land problem has a negative effect on the sustainability of Turkish marine hatcheries. Also, the environmental problems restrain the aquaculture sector. In the recent years, approaches relating with the protection of environment negatively affect the aquaculture sector. Especially, the marine fish production cage systems installed in costal zone have negative effects on the biological environment and have to be transferred to the open sea where the environmental interaction is lower than the costal zone. On the other hand, it is a very well known fact that the operational cost is comparatively high in open sea facilities. So, fully-controlled and environment-friendly aquaculture systems could be preferred by producers and should be supported by the government. Recirculation aquaculture systems (RAS) can be used where suitable land or water is limited, or where environmental conditions are not ideal for the species being cultured (Hutchinson *et al.*, 2004). Also, the RAS reduces the cost of water heating or cooling and labor requirements, and improves the feed conversion rate. However, the RAS requires high operation and initial investment costs and highly qualified technicians. In this regard, the advantages of the RAS can be enumerated as follows (Hutchinson *et al.*, 2004): All aspects of the production environment may be controlled to achieve the optimum growth; low water consumption per tone of fish produced; impact on the external environment minimized by containing and treating wastewater, and the production facility can be operational all year round. In fact, RAS represents relatively new technology with a wide variation in system design and quality available. It is seen that the closed system will be important for sustainability of Turkish marine hatcheries in near future. Semi-closed and closed systems are used for marine fish fry production in Turkey. However, because of the high investment and operating costs and low cost production systems such as cages and earth pond supplied salty-underground water, the RAS has not been used for market size fish production yet. As seen in Table 3, five facilities (facility I, facility II, facility IV, facility VI and facility VII) use recirculation aquaculture system. Semi-closed and flow through systems are usually used in Turkish marine hatcheries (Table 3). However, earth ponds and off-shore production systems are rarely used together with Turkish marine hatcheries (Table 3). Also, production type is important for the sustainability of Turkish marine hatcheries. Only one facility (facility VI) uses all production type (broods, eggs, fry and market size) (Table 3). Facility I, facility II, facility IV and facility VII produce broods, eggs and fry. While the facility III obtains the eggs from broods collected from nature, the facility V provides from other facilities. From the sustainability point of view, the genetic diversification of species should be protected. For this purpose, the broods used for reproduction should be possibly provided from nature. If the hatchery-based broods are used for reproduction, healthy broods should be selected. It can be said that production of different species is another important factor for sustainability of Turkish marine hatcheries. Producing different species provides different tastes and alternatives to the consumer and thus farmers can reach to the different markets. As seen in Table 2, facility II, facility IV and facility VI produce eight species (sea bream, sea bass, common dentex, sharpsnout sea bream, two banded sea bream, common sea bream, corb (shi drum) and blue spotted sea bream), five species (sea bream, sea bass, corb (shi drum), meagre and white grouper) and three species (sea bream, sea bass and sharpsnout sea bream), respectively. However, it is important to get eggs during the year for sustainability of aquaculture sector. Facility III has constrains to get eggs during the year. The fully controlled Recirculating Aquaculture Systems (RAS) can be used as wide spread season reproduction performance and for the best quality and quantity production.

The main constrains of the Turkish marine hatcheries given in Table 4 were determined with a questionnaire study by face to face interviews with farmers and experts. As seen in Table 4, water and land problem is the most constraint for the Turkish marine hatcheries. When the water quality and quantity are not suitable for any species, the treatment of the water is necessary. This is achieved by mechanical filter used to remove the solid particles, by biological filter used to achieve the biological filtration process, by heating and cooling systems used to provide suitable temperature for species and by UV system used for disease control. Moreover, to find qualified employee is another constraint of the Turkish marine hatcheries according to the farmers and experts.

Facilities I and II have been established in Çandarlı Bay in the north of İzmir. Çandarlı Bay has been fed by middle size rivers transferring the alluvium to the gulf. Also, Çandarlı Bay is environmentally under threat because of petro-chemistry and ship recycling industries installed in the south of gulf. Facility I, which has open, semi-closed and closed production systems, is highly affected by the negative environmental variation of Çandarlı Bay. Also, this facility directly discharges the waste water of the system to the gulf. From the viewpoint of sustainability, this kind of facilities has disadvantages because of irregular flow chart, environmental effects and high operating cost. Facility II intensively uses closed system, so the water provided from the Çandarlı Bay is so limited. Thus, facility II is slightly affected by the negative environmental variation of the Gulf. This facility has limited land and uses high ratio of land, so this is a negative effect the point of view sustainability. When the technological applications are taken into account, this facility has more advantages than other facilities. Facility III is established in Anatolian side of the Dardanelles and the water is directly provided from the Dardanelles by pump. Although the facility has advantage because it has focused only production of sea bass, it is important to add new species having economic value, to the production from the viewpoint of sustainability. Facility IV has disadvantages such as quality and quantity of water and land and advantages such as five species production and technological applications. Facility V and facility VII have used the salty-underground water and used water has been directly discharged to the Bafa Lake. In the short time period, it can be seen that this kind of facilities has advantages; but in long period of time they have disadvantages because of environmental concerns. If the facilities do not use discharge water treatment and completely recirculating aquaculture systems, they

Table 4. The main constrains of Turkish marine hatcheries

	Facilities						
	I	II	III	IV	V	VI	VII
Water (Quality, Quantity)	High	High	Less	High	No	No	No
Land	Little	High	Less	High	No	High	No
Knowledge About the Species/Technical Aspects	No	No	Middle	No	No	No	No
Availability/Quality of Fry	No	Less	High, We couldn't get eggs in September	No	Middle, Brodstock management and spawning are done another hatchery	No	No
The Market	No	No	No	No	No	No	No
The Capital	No	No	High	No	No	No	No
Rights of Production	No	No	No	Less	Little	High, (sea surface renting is so high)	No
To Find Employees	No	High	High	Middle	Middle	High	No
Administrative Rules	No	Middle	No	No	No	No	No
Competition with Other Activities	No	No	No	No	No	No	No
Financial Inputs	No	No	Middle	No	No	No	No

will come across with environmental reactions. The advantages of the facility VII are that it has research and development unit and integrated facility. These advantages are more important for the sustainability of facility VII. Facility VI has the highest production type such as broods, eggs, fry and market size and RAS has been used for broods stocking and eggs and fry production. The most important advantage of the facility is that it has hatcheries, cages and feed plant and fish processing units. The discharge water has been directly transferred to the sea medium. At the moment, there are no pollution sources and this can be seen as an advantage but the bay, which the facility is installed, is very close to the tourism region and is open the tourism investments. The facility can come across with conflict with tourism sector in near future or mid term because of waste water transferring directly to the sea without treatment. Nevertheless, it seems that this facility has the most advantages among the all facilities because of location and structure.

The below remarks were obtained from face to face interviews with farmers and experts:

86% of the facilities exchanges information with universities, institutions and experts relating with the Aquaculture.

57% of the facilities belongs to one or several professional organizations such as Aquaculture Federation, Aquaculture Union, Aquaculture Association and Chamber of Agriculture.

71% of the facilities has their own Research and Development Unit or collaborations with the Universities and Institutes for Research and Development.

57% of facilities does not have head or local representative.

All facilities have been controlled by the Ministry of Agricultural and Rural Affairs, the Ministry of Environment and Forestry and the Local Administrations.

According to 43% of the facilities, the aquaculture sector has not been strictly controlled when it is compared to other sectors and there is no auto control into the aquaculture sector.

86% of the facilities think that local policies affect the aquaculture sector via restrictions relating with to waste management, tourism and environment subjects.

According to the facilities, some regulations relating to aquaculture should be introduced such as: Bureaucracy must be decreased, potential aquaculture production areas must be previously determined, government should be pathfinder and neutral among the all sectors, ministerial units to relating with the aquaculture must be collected under a unit, Aquacultural Unions should be effective and authorized, self-control should be provided into the aquacultural sector and the public should be informed about aquaculture.

The facilities fear from the laws, which are becoming stricter, and relating to the pollution, water uses, market, impacts on biodiversity and work contracts.

According to the facilities, increase of the quality standards on the production, objective arrangements among the sectors, scientific investigation of the all investment projects about aquaculture sector, supporting the cage production systems and extending the processing facilities will develop their activities.

All facilities agree on the fact that upgrading of the quality standards will increase their incomes and rate of market.

The facilities estimate that the farms with high technology and high capacity, RAS, any marketing size fish production models, cage production, new species production and processing will be valuable in future.

Conclusion

The economic analysis was performed and sustainability was evaluated for 7 leading Turkish marine hatcheries. The ratio of total cost to total income changed between 22% and 97.8%. The production capacity (in m^3), land usage because of the serious conflicts between aquaculture sector and other sectors, using the same site, production systems, production types and environmental problems are highly important for sustainability of Turkish marine hatcheries. Although the RAS requires high operation and initial investment costs and highly qualified technicians, it is seen that it will be very important for sustainability of Turkish marine hatcheries because of land, quality and quantity of water and environmental approaches. Also, bureaucracy must be decreased, potential aquaculture places must be previously determined, ministerial units relating to the aquaculture must be collected under a Unit, Aquacultural Unions should be effective and authorized, and self-control should be provided into the aquaculture for sustainability of Turkish marine hatcheries.

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