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Cost and Profitability Analysis for Trout and Sea Bass Production in the Black Sea, Turkey

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Abstract: The aim of the study is to determine characteristics of the farms and to measure cost and profitability for trout and sea bass productions of the mariculture farms in the Black Sea of Turkey. Farm level data in the 2005-2006 production periods were collected from four monoculture and five polyculture farms which consisted of all the active mariculture farms in the Black Sea by exact counting method by personnel interview method. Results showed that there were differences between culture systems in terms of their social, bio-technical and economic aspects. The yields of trout/m^3 in the monoculture and polyculture farms were measured to be 30.22 and 35.61 kg, respectively. However, the yield of sea bass/m^3 was 22.11 kg. While, feed conversion ratios for trout production in the monoculture and polyculture farms were 1.33 and 1.36, respectively, it was 2.27 for sea bass production. The cost of trout and sea bass production/kg were $2.58 and $4.77, respectively. The share of feed, marketing, juvenile and labor were 45.53, 13.50, 13.07 and 11%, respectively. Feed was the main cost factor (47.73%) in sea bass production. Labor, juvenile and marketing followed it with the share of 23, 10 and 7%, respectively. The net return/kg for trout and sea bass production were $0.16 and $0.48, respectively. The benefit cost ratio in sea bass production (1.10) was higher comparing to trout production (1.06).

Key words: Mariculture, trout, sea bass, productivity, cost benefit analysis

INTRODUCTION

Due to the stagnation on capture fishery production in the world, importance of aquaculture has increased for last decades. Nowadays, aquaculture production reached to 45 million tons and it meets 40% of the world fishery supply (MARA, 2008). To meet future demands for foodfish supplies, aquaculture production needs to increase by 50 million tons by the year 2005 (Tocan and Forster, 2001). Total fisheries production of Turkey was 622 thousand tons in 2006. However, the share of fishery was only 0.4% in the gross national product. In Turkey, aquaculture sector has only two decades history. Although, the first aquaculture farm grown rainbow trout was established in 1972 (Üstündag *et al*., 2000), the first mariculture farms grown gilthead bream and sea bass was established in the Aegean Sea in 1985 (MARA, 2008). There has been noticeable development in this sector especially since the 2nd period of 1990's. Nowadays, there are 1 608 aquaculture farms in Turkey (GDAP, 2008). While aquaculture production was about 3 thousand tons in 1986, it amounted to 129 thousand tons in 2006. During this period, mariculture production increased from 35 tons to 72 thousand tons (TURKSTAT, 2008) and its share in total aquaculture production reached from 1.1-56%. Nowadays, there are 323 mariculture farms which constituted 20.1% of the total aquaculture farms (GDAP, 2008). There was a considerable increase in mariculture production during the last 4 years. Thus, mariculture production has increased at a rate of 81.9% during the period of 2003-2006 and is predicted to continue to grow in the future.

The main marine species grown in Turkey are sea bass (53.2%), gilt-head bream (39.4%), trout (2.3%) and mussel (2.1%). These species constitute 97% of the total mariculture production (TURKSTAT, 2008). Monoculture system is usually made by the mariculture farms. Sea bass and sea bream dominate marine species production in the Aegean Sea and the Mediterranean Sea. The mariculture farms in the Black Sea constitute 3.7% of the total farms and 4.68% of the total physical capacity of the mariculture farms in Turkey (GDAP, 2008). In contrast, the main species is rainbow trout and it has been produced increasingly for the last decade in the Black Sea. Nevertheless, sea bass was less grown in some farms.

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Considering aquaculture and fishery sector, researchers generally tented to focus on productivity and efficiency analysis in the last decade (Sharma and Leung, 1998; Sharma, 1999; Sharma *et al*., 1999; Paul, 2000; Munzir and Heidheus, 2002). In Turkey, some researchers have also conducted several studies on structural and economic analysis of aquaculture sector at the regional and national levels (Üstündag *et al*., 2000; Çetin and Bilgüven, 1991; Yavuz *et al*., 1995; Karli, 2000; Rad, 1999; Sayili *et al*., 1999; Kocaman *et al*., 2002; Bozoglu *et al*., 2005-2007; Cinemre *et al*., 2006). The reason behind selecting mariculture production in the study was that there have been no studies focusing on cost and profitability analysis for trout and sea bass production in mariculture farms of Turkey. Sustainable and profitable operation can be achieved only through better understanding of the relevant elements and of their interrelationships in the entire production process. Therefore, it is essential for development and management of a farm to know the production costs and its evolution and to determine where cost reduction can be achieved. Production cost data also help the farmers in decision making and in adjusting to changes and determine the price level under which the product cannot be sold without losses. Thus, a careful investigation of the economics of fish farming would benefit both producers and policymakers (Ahmed *et al*., 2008). In designing appropriate policy measures enabling Turkish mariculture farms increase their profitability. Therefore, the purposes of the study were to calculate production cost and profitability for the production of trout and sea bass in mariculture farms in the Black Sea.

MATERIALS AND METHODS

The Black Sea is the most important fishery production area in Turkey and constitutes about ¾ of total fishery production (Bozoglu *et al*., 2005). The Black Sea is located in the southern part of Turkey within 46°33'-40°56'N latitudes and 27°27'-41°42'E longitudes. The water surface area of the Black Sea is 432000 km^2. It is connected to the Marmara Sea and the Aegean Sea through the Bosphorus and the Dardanelles. This major inland sea is bordered by 6 countries-Romania and Bulgaria to the west; Ukraine, Russia and Georgia to the north and east and Turkey to the south. Its total shoreline is 4340 and 1400 km of total is bordered of Turkey (http://www.blacksea-commission.org/Geography.htm). In the Black Sea, the mountains generally lie close to the sea. The salinity of the Black Sea varies, associated with depth, from 17-22% pro mil, which is two times less than the Ocean (35%). The reduced salinity is the most important environmental factor influcing marine biodiversity in the Black Sea (http://www.blacksea.orlyonok.ru/e2.shtml). The climate of the Black Sea is predominantly continental. Water temperature of the Black Sea at the surface is the lowest in February (5-8°C) and the highest in August (25°C). High temperature in summer season for trout and low temperature in winter season for sea bass is an important obstacle to develop opportunities for mariculture in the Black Sea (MARA, 2007). Oxygen is the most important gas in the seawater for it supports organic life. In the upper layer of the Black Sea, water temperature reaches 4-7 cc per liter (Kubijovyc and Teslia, 1984).

This study, after identification of survey objectives, used a well-designed, structured questionnaire to capture information that is of great interest and relevance to the questions under study. The data used in this study were collected by using structured survey four monoculture and 5 polyculture farms-which consist of all active mariculture farms-in the Black Sea of Turkey during the production year of 2005-2006. The questionnaire was pre-tested both internally and in a few sessions with producers and refined over several stages based on the comments and suggestions received. Then, data from questionnaire interviews were coded and entered into a database system using Statistical Package for Social Science (SPSS) was used to analyze the data, producing descriptive statistics. Descriptive statistics were used to summarize the characteristics of mariculture farms. The variables analyzed in this study were divided into 3 broad groups: socio-structural, bio-technical and economic characteristics.

The methods for economic analysis used in this study were as follows. In this study, data on yield, costs and returns of prawn farming were collected clarify production costs and to assess the profitability. A comparison of the cost of production and its breakdown to components provides a better understanding of cost structure and relative production efficiency. Total production costs for both trout and sea bass include fixed and variable cost. Variable cost is directly related to the scale of farm operations at any given time. Variable costs in production are cost of feed, juvenile, diesel oil and electricity, medicine and additive matter, interest of credit and marketing. Fixed costs in trout and sea bass farming include labor, sea rent, repair and maintenance, interest of the fixed capital, depreciation and general overhead. The analysis was based on farm-gate prices of harvested trout and sea bass and current local market prices of all other items, expressed in US dollars. Diesel oil expense item includes fuel consumed by boats, trucks and outboard motor. The fuel consumption was estimated from the monthly equipment hour requirements and the average fuel consumption of each piece of equipment. The fuel consumption of truck was computed from the monthly mileage used in the fish farm. Electric expense was considered as the electric bill of the farm. In cases where family labor was used, costs were calculated based on the price of hired labor to mirror the opportunity prices were used for all farmers. Repair and maintenance costs were estimated from replacement cost, repairs as a percent of replacement cost and estimated economic life of farm equipment. Building depreciation cost was calculated based on the purchasing or instruction value of the buildings (Erkus *et al*., 1995). Depreciation was estimated using the straight-line method. Non-proportional depreciation was calculated as the annual sum allocated to the replacement of the farms equipment (boats, cages, pumps) e.g., the value of the equipment divided by its expected life time. Operating capital was calculated by taking into account the amount spent in cash for trout and sea bass production. The amount of money needed to meet the expanse of inputs such as feed, fuel, labor is treated as operating capital in this study. The interest rate on operating capital was estimated at the rate of 17.5% per annum for the duration of the culture period (i.e., 5.5, 6.5 and 22 months). Assets were divided by their useful life expectancies to determine annual costs for depreciation. General overhead expense was assumed to be 3% of the total production cost (Erkus *et al*., 1995). Gross revenue was calculated by multiplying the total amount of production (kg) by its market price ($US/kg). Total costs were subtracted from total gross return to calculate net return. Benefit-cost ratios obtained dividing income from fish sale by total production cost. Profit was the difference between total income form fish sale and total cost of production. Benefit-cost ratio is defined as gross revenue divided by total costs of trout and sea bass.

RESULTS AND DISCUSSION

Based on the research results it was clear that, majority of the mariculture farms were company. Considering total cage size, there was a difference between trout and sea bass farm. The average cage size of the trout farms was about 8 thousand m^3; while that of trout-sea bass farms was almost half of it. About ¾ of the cages in the farms were square wooden cage and the rest were circular plastic cage. The main workforce was hired labor for both the trout farms and the trout-sea bass farms and the trout-sea bass farms used higher labor comparing to trout farms due to longer period requirements of sea bass production. The education levels of farm operators were similar for the trout and sea bass farms. However, the experiences of the respondents at the sea bass farms were lower than that of trout farms. Average distance among the farms was over one kilometer for the trout farms while that of trout-sea bass farms was approximately half kilometers (Table 1).

The farmers bought fingerlings from commercial hatcheries and started to fattening when trout is 220 g in average size. The fattening periods for the trout were 5.5-6.5 months. While, monoculture farms produced 237 thousand tons trout, polyculture farms produced 119 thousand tons trout and 81 thousands tons sea bass during the fattening periods. The farms started fattening when sea bass juvenile 3-5 g in sizes. The fattening periods was 22 months in sea bass production. Feed conversion ratios in trout production for the trout farms and the trout-sea bass farms were 1.33 and 1.36, respectively. These results are parallel with other researches made in the same region (Bozoglu *et al*., 2005, 2006). For sea bass production, feed conversion ratio was 2.27. Harvest densities in trout production for monoculture and polyculture farms were 30.22 and 35.61, respectively, while that of sea bass production was 22.11 (Table 1). The current densities of the farms are also parallel with the reference ratios stated by Atay and Bekcan (2000). There was a difference on trout productivity between monoculture and polyculture farms. Some factors such as farm size, stocking rate, the quality and quantity of feed supply, labor qualifications and management skills.

Monoculture farms conducted their activities much more capital comparing to polyculture farms. However, capital intensity of the trout farms per m^3 was lower than that of the trout-sea bass farms. With these assets, monoculture farms gained $79.5 on a hundred dollars of equity while that of polyculture farms was $92. In terms of income sources, it was clear that polyculture farms were more specialist than monoculture farms. Turkish Government has given the premium of $0.43 and $0.57 kg^{-1} trout and sea bass production, respectively. So, trout farms also gained approximately $103 thousand of premium for their production via subsidies. Credit use pattern of monoculture farms also differed from poly culture farm. The trout farms used more credit than the trout-sea bass farms. The capacity use ratio of the trout farms was higher comparing to the trout-sea bass farms. Considering marketing characteristics, the farms sold their trout when they reached approximately 950-1000 g in size while sea bass were marketed when they reached 405 g in size. In spite of the fact that fish price fluctuates associated with season, average wholesale price/kg for trout and sea bass were $2.75 and $5.24, respectively. The market price of aquaculture products mainly depends

Table 1: Descriptive statistics of some parameters of the mariculture enterprises

	Four monoculture farms (trout)		Five polyculture farms (trout and sea bass)	
Characteristics	Mean	SD	Mean	SD
Social and structural				
Family enterprises (%)	25.00	-	20.00	-
Company enterprises (%)	75.00	-	80.00	-
Total cage size (m^3)	8,368.39	8,023.89	3,794.44	1,922.61
Total personnel (unit)	10.00	7.35	9.00	5.05
Technical persons (persons)	1.75	0.96	1.40	0.55
Education level of respondents (years)	13.50	1.91	13.00	4.47
Experience of the respondents (years)	13.00	4.00	6.20	3.11
Distance to main market (km)	1,375.00	206.16	899.60	173.21
Bio-technical				
Fattening period for trout (month)	6.50	1.00	5.50	1.12
Fattening period for sea bass (month)	-	-	22.00	2.83
Trout production (kg)	237,500.00	188,745.86	119,000.00	7,7491.93
Sea bass production (kg)	-	-	81,200.00	73,261.18
Feed conversion ratio for trout	1.33	0.23	1.36	0.24
Feed conversion ratio for sea bass	-	-	2.27	0.39
Trout productivity (kg m^{-3})	30.22	6.23	35.61	8.43
Sea bass productivity (kg m^{-3})	-	-	22.11	4.73
Economic				
Total assets ($)	717,525.33	517,839.74	347,246.83	151,163.84
Credit use ($)	23,031.68	27,974.52	14 598.54	23,200.34
Capital intensity ($ m^{-3})	85.74	65.19	91.51	27.88
Capacity use ratio for trout (%)	68.75	37.50	78.67	20.53
Capacity use ratio for sea bass (%)	-	-	67.20	33.75
Marketing size of trout (kg $unit^{-1}$)	0.95	-	1.00	-
Marketing size of sea bass (kg $unit^{-1}$)	-	-	0.405	0.312
Wholesale price for trout ($ $unit^{-1}$)	2.8347	0.2480	2.8772	0.3118
Wholesale price for sea bass ($ $unit^{-1}$)	-	-	5.2441	0.8479
Return to equity ratio ($)	79.50	41.00	92.00	17.89
Marketing period (month)	5.75	0.50	5.20	0.84
Mariculture income to total (%)	47.50	15.00	88.00	21.68
Premium taken for trout ($)	102,125.00	81,158.74	51,170.00	12,613.67
Premium taken for sea bass ($)	-	-	46,284.00	28,421.26

depends on size and weight, quality, seasonality, supply and demand and competitiveness (Shang, 1981). Average marketing period for the farms was continued about 6 months (Table 1).

The costs and profitability for the production of trout and sea bass are given in Table 2. Economic analysis of the production systems revealed that the costs of trout and sea bass production per kg were $2.58 and $4.77, respectively. The share of the variable costs in total costs of trout production was 74% while that of sea bass production was 67%. For trout production, feed had the highest share (45.53%) in costs and the costs of marketing (13.50%), juvenile (13.07%) and labor (11%) followed it. Similarly, feed was the main cost factor (47.73%) in sea bass production. Labor and juvenile/fingerling followed it with the share of 23 and 10%, respectively. Marketing had the minimum share with 7%. Once the fixed investments have been made, farmers production decision should be based on the expected returns or income above variable costs. Fixed investments are considered as sunk costs and may not be recovered in the very short-run period of at least one production season (Ahmed *et al*., 2008). The income above variable cost for trout and sea bass production were calculated to be $0,8389 and $2,0277 kg^{-1}, respectively. The net return per kg for trout and sea bass were $0.16 and $0.48, respectively. Similarly, benefit-cost ratio in sea bass production (1.10) was higher comparing to trout production (1.06).

A number of constraints were reported by farmers, including high production costs and lack of capital, lack of sea bass fingerling, water pollution, diseases and poor technical knowledge. Regardless of farming systems, about all respondents identified high production costs as well as lack of capital as the single most important constraint for the farms. In recent years, ascending feed and diesel oil prices have affected negatively this sector. Since, the feed prices highly depend on exchange ratio of New Turkish Liras (NTL) to US $, aquaculture sector negatively affected due to economic crises and devaluation of NTL. All respondents from the sea bass farms identified the lack of sea bass fingerling. Less than half of the respondents complained about some diseases which are caused by bacteria and fungus, causing mortalities and also reducing the value of harvested trout and sea bass. Only 44.4% of the respondents mentioned about poor technical knowledge.

Table 2: Comparative costs and profitability for the production of trout and sea bass

	Trout production		Sea bass production	
Cost item	Quantity ($)	(%)	Quantity ($)	(%)
Variable costs	328,867.86	74.02	261,170.55	67.49
Feed	202,291.94	45.53	184,725.18	47.73
Juvenile	58,084.69	13.07	40,348.17	10.43
Diesel oil and electricity	5,772.33	1.30	5,144.83	1.33
Medicine and additive matter	574.54	0.13	861.81	0.22
Interest of credit	2,167.11	0.49	1,720.77	0.44
Marketing	85,833.33	13.50	28,369.79	7.33
Fixed costs	115,407.69	25.98	125,823.96	32.51
Labor	48,870.80	11.00	87,443.43	22.59
Sea rent	2,934.81	0.66	2,201.10	0.57
Repair and maintenance	7,115.85	1.60	3,365.59	0.86
Interest of the fixed capital	28,299.91	6.37	13,695.76	3.54
Depreciation	18,320.29	4.12	11,285.95	2.92
General overhead	9,866.03	2.22	7,835.12	2.02
Total costs	444,275.47	100.00	386,994.51	100.00
Total production (kg)	171,666.67		81,200.00	
Production cost ($ kg^{-1})	2.5880		4.7659	
Marketing price ($ kg^{-1})	2.7496		5.2441	
Net return ($ kg^{-1})	0.1616		0.4782	
Benefit-cost ratio	1.0624		1.1003	

CONCLUSION

This study examined the socio-structural, bio-technical and economic chrasteristics of mariculture farms and analyzed cost and profitability of the trout and sea bass production. The production systems of trout and sea bass in the farms were completely different. Their input consumptions such as feed, labor and capital were differed from each other, resulting in different structure of bio-technical performances.

In spite of higher production cost in sea bass production, its profitability is higher than trout production. The feed and diesel costs constituted more than three to four of the total costs. In addition, steadily increase in feed and diesel-oil prices would limit developments in the sector. On the other hand, long fattening period is another obstacle for sea bass production comparing to trout production. The trout could be fattened two times during the same period. So, its capital liquidity was higher than sea bass production. Under the light of these analysis results, sharing risks by growing both trout and sea bass made the farms more economically efficient. Sea bass species would be solution for monoculture farms to decrease their production and market risks and increasing their profitability.

This study has shown that increase in yield and decreases in cost are the major means of increasing profit for the trout and sea bass farms. Further development of the sector depends on its profitability. The net income of the farms is affected by the level of production, farm prices and production cost. Increase in farm productivity, reduction in production costs and increase in average farm revenue are major measures to increase net return. The current profit levels of the farms and prevailing government support to the sector may accelerate both trout and sea bass production in the research area. Increases in feed costs and lower feed efficiency also adversly affected the economic viability of trout and sea bass production in the Black Sea. Improving feed formulation and feeding practices will reduce feed costs. Development of a feed based on low-cost, locally produced ingredients would help improve farmer's profit margins. There is also a clear need for decreasing energy costs such as diesel oil. Finding lower feed ratios and alternative renewable energy inputs instead of diesel-oil may contribute to reductions in the costs of main energy items of trout and sea bass production. In addition, farmers and technical person need to extend their basic knowledge and develop better skills about farm management. Training and extension services would help improve profitability and reduce risks. Therefore, further studies are warranted to decrease the production cost and to increase farm income from sale.

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