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# ECONOMIC ANALYSIS OF RAINBOW TROUT CAGE FARMS DIFFERING IN SIZES

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***Abstract***

*This study aims to conduct an economic analysis of the farms breeding rainbow trout in cages in Türkiye. The study was carried out at Karacaören-I Dam Lake in the Western Mediterranean Region of Türkiye. The primary material of the study was the data gathered using the survey approach from all 21 farms. The farms were divided into three groups according to their capacities. According to the results, it was determined that as the size of the farm increased, the production costs per tonne decreased, and the gross and net profits, as well as the relative return, increased. In Groups I, II, and III, production costs per tonne were determined as $1,975.57, $1,703.01, and $1,384.23, respectively, and net profit was $514.21, $724.60, and $1,388.31. It was found that the profit margin of 1 kg of trout and the ratio of profit margin to sales price increased as the farm groups grew. Accordingly, farms in Group III made a profit of 48.90% from each kg of trout they sold, while farms in Group I earned 18.33% and in Group II made a profit of 28.23%. With these results, it was established that large farms were more advantageous from an economic standpoint.*

***Key words*****:** c*age farms, rainbow trout, cost, profitability, Türkiye*

## INTRODUCTION

Fisheries, one of the largest animal protein sources in the world, are an important sector that provides continuous input to the economies of all countries today. The world's population is increasing day by day, and this increase causes both a decrease in food resources and a decrease in the rate of access to healthy food. According to the data from the United Nations Food and Agriculture Organization (FAO), it is stated that the world population is increasing by 78 million annually and will reach the level of 12–13 billion in the 2050s. This will also increase the demand for aquatic products. The aquaculture sector is expressed by FAO as the fastest growing and most constantly developing sector among all food sectors [8].
Day by day, people pay more attention to their nutrition and take care to choose foods suitable for their health. Fish in these foods, with their rich protein content and polyunsaturated fatty acids in their structure, meet the body's basic nutritional needs and are among the most important nutrients in maintaining a healthy life with their positive effects on human physiology and metabolic functions [15].
Türkiye has significant potential in terms of the sea, inland waters, lakes, ponds, and aquaculture resources. She is surrounded by the sea on three sides and has 8,333 km of coastline, 177,714 km of rivers and 342,377 hectares of dammed lakes. The surface area of the sea and inland waters is 25 million hectares. It is important to protect and effectively use the fishing resources of Türkiye [3].
Fishery production is carried out in two ways: hunting (sea and inland water) and aquaculture (sea and inland water). According to the data for 2020, fishery production in Türkiye is 785,811 tonnes, of which 53.63% is obtained from aquaculture and 46.37% from hunting [24]. In recent years, significant progress has been made in Turkish aquaculture systems, and the transportation of

fish farms in the sea to open and deep waters has demanded the application of new techniques appropriate for these conditions. As a result, advances in cage sizes and constructions, net systems, and feeding systems have been developed by employing technology that exceeds global standards [6]. The amount of seafood produced in Türkiye by the aquaculture method is 421,411 tonnes, of which 69.57% was produced in the seas and 30.43% in inland waters. The fish species that are grown intensively within the scope of aquaculture in Türkiye are trout (Rainbow trout and Black Sea trout), sea bream and sea bass. According to 2020 data, the amount of trout produced in inland waters in Türkiye is 127,905 tonnes [24].

The amount of fishery products produced by the fishing method in Türkiye is 364,400 tonnes, 90.91% of which is obtained from the seas and 9.09% from inland waters. Marine fish constitute 71% of the seafood production obtained from the seas. Anchovy is the most important species caught from the sea [24].

The Karacaören-I Dam Lake, where this study was conducted, is located in Türkiye's Western Mediterranean region at the intersection of the provinces of Burdur, Isparta, and Antalya. 2/3 of the lake is located in Burdur, and 1/3 is within the borders of Isparta Province [13]. In Karacaören-I Dam Lake, rainbow trout are raised in cages. This study aims to make an economic analysis of the farms that raise rainbow trout in cages in Karacaören-I Dam Lake. In the study, the general characteristics, production costs, gross production values, gross profit, net profit, and relative return values of the farms producing rainbow trout according to different size groups and the profit margin of one kg of trout were determined, and comparisons were made between the groups, and it was specified which farm group was more advantageous. Studies have been carried out on the technical aspects of trout farming in Türkiye. The number of studies on the economic aspect of trout farming has remained limited. It is expected that the results obtained from this study will be beneficial to policymakers, trout producers, farmers who want to invest in this field, researchers, and other relevant institutions.

## MATERIALS AND METHODS

The main material of the study was the data obtained via the survey method from the farms breeding rainbow trout in cages in Karacaören-I Dam Lake. Data was collected through face-to-face interviews with the farmers. In addition to this data, similar studies, reports, and statistics on the subject were also used. The survey data covers the production period of 2021.

A list of farms that raise rainbow trout in cages in Karacaören-I Dam Lake was obtained from the Burdur and Isparta Provincial Directorates of Agriculture and Forestry. According to the records, it was determined that there were a total of 26 farms in the research area. However, since five producers stopped production in 2021, data was collected by interviewing 21 producers. Since the cage capacities of the farms were very different, the trout farms were examined by dividing them into groups to make the population homogeneous. The farms were divided into three groups depending on their frequency of distribution, taking into account their cage capacities. According to this, farms with a capacity of 1–50 tonnes (6 farms) are in Group I, farms with a capacity of 51–100 tonnes (6 farms) are in Group II, and farms with a capacity of 101+ tonnes (9 farms) are classified as Group III. The data collected by the survey method from the chosen farms was transferred to the computer environment, where calculations were made in Microsoft Excel and SPSS programs, and tables were created and interpreted. The General Linear Model (GLM) approach of the SPSS program (SPSS 2017) was used to determine the significance levels of the dependent variables. $P<0.05$ was considered statistically significant in terms of the significance level.

A depreciation expense for tool-machine and building capital was calculated: 12.5% for boats, vaults, chains, anchors, and buoys; 20% for grading machines, nets, and rope; 25% for the pickup truck; 15% for the generator; and

10% for the ice machine; 6.66% for feed storage and containers [2].

The following formulas were used in the calculation of interest on equipment, machinery, and building capital [16].

Interest = (Machinery or building worth) / 2 * Interest rate …….(1)

The real interest rate was used since the year-end values of equipment, machinery, and building capital were taken into account [12]:

i = (1+r) / (1+f) - 1 …….(2)

where:
i: the real interest rate
r: the net nominal interest rate
f: the inflation rate (WPI- Wholesale Price Index)

At the time of the survey, the annual nominal interest rate was 18.42% and the inflation rate was 14.55%. Thus, the real interest rate was calculated as 3.38%.

General administrative expenses were computed by taking 3% of the variable costs [16]. During the period from the beginning to the end of the aquaculture, the interest in the expenditures made for the aquaculture inputs should also be calculated. This interest, called the revolving fund interest, represents the opportunity cost of the capital invested in the production activity. The revolving fund interest was calculated by using half of the interest rate (2.67%) applied by Ziraat Bank to government-supported aquaculture loans to variable costs [23].

The gross production value was calculated by multiplying the amount of trout obtained as a result of the production activity and the sales price. Gross profit was calculated by subtracting the variable costs from the gross production value, and net profit was calculated by subtracting the production costs. The relative return was also found by the ratio of the gross production value to the production costs [22].

## RESULTS AND DISCUSSIONS

General information about the farmers is given in Table 1. It was determined that the average age of the producers varied from 33.33 to 41.56 years, and their education levels varied between 8.67 and 12.17 years. Also, the experience period of trout farming was between 9.17 and 14.78 years, according to the farm groups. All of the producers were found to be members of the aquaculture producers' association. It was discovered that the family population varied between 3.06 and 4.22 people depending on the group, with an average of 3.71 people across all farms. Furthermore, the producers in the large farm group were older, more experienced, and had a larger population. The difference between Groups I and III in terms of the number of individuals in the family was statistically significant ($P < 0.05$).

Table 1. Descriptive statistics about producers by farm groups

| | Farm Groups | | | |
|---|---|---|---|---|
| | Group I | Group II | Group III | **Mean** |
| Age (years) | 33.33 | 40.17 | 41.56 | 38.81 |
| Education level (years) | 12.17 | 8.67 | 11.22 | 10.76 |
| Trout farming experience (years) | 9.17 | 14.50 | 14.78 | 13.10 |
| Membership in the aquaculture producers' association (%) | 100.00 | 100.00 | 100.00 | 100.00 |
| Number of people in the family (persons) | 3.00[a] | 3.67[ab] | 4.22[b] | 3.71 |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

Table 2 provides descriptive statistics about trout farming. The amount of fish produced per farm increased in direct proportion to farm size. In Groups I, II, and III, the amount of fish produced was 33.86, 63.33, and 518.72 tonnes/farm, respectively. The average amount of fish produced by all farms was 250.07 tonnes/farm. There was a statistically significant difference between Group III and Groups I and II. All of the fish produced were rainbow trout, and the majority of them were exported. Similarly, the number of cages and

average cage capacity increased in parallel with the size of the farm. The average cage capacity ranged between 5.35 and 24.83 tonnes, and the number of cages per farm ranged between 6.33 and 20.89. The number of cages per farm and the average cage capacity were higher in Group III than in other groups ($P < 0.05$). According to the overall average, the number of cages per farm was 13.86, with a cage capacity of 18.05 tonnes. The feed conversion ratio (FCR) is an important parameter for measuring fish development performance because it is the ratio at which feed is transformed into flesh. It is calculated by dividing the amount of feed consumed by body weight growth [17]. The feed conversion ratio varied between 1.05 and 1.11 according to the farm groups, and the average of all farms was 1.09. Accordingly, 1.09 kg of feed was consumed for 1 kg of live weight gain. In terms of feed costs, this ratio was significant because feed costs (55.10%) accounted for the majority of total production costs. In their study, Diken et al. [7] determined the feed conversion ratio for rainbow trout to be 1.02, 1.0, and 0.97 for the 2016–2017, 2017–2018, and 2018–2019 production periods, respectively. In another study, Bilguven and Baris [5] discovered that the feed conversion ratio for rainbow trout was 1.24 and 1.35 for Groups I and II, respectively. The weight of fingerlings raised on the examined farms ranged between 20.00 and 26.44 gram depending on the farm group, with an average of 22.76 gram calculated for all groups. The average weight of the caught fish varied between 325.00 and 472.22 gram, and the average of all farms was 389.29 gram. Fingerlings and harvest weight in Group III were higher than in Groups I and II ($P < 0.05$). The mortality rate ranged from 2.00% to 5.22% depending on farm group, with an overall average of 3.45%. Group III had greater mortality rates than Groups I and II ($P < 0.05$). The distance of the cages to the shore varied between 133.33 and 491.67 metres, and it was 249.52 metres, according to the average of all farms. It was observed that the examined farms produced once a year in the period of November-June and that all of the producers received aquaculture support from the Republic of Türkiye Ministry of Agriculture and Forestry.

Table 2. Descriptive statistics about trout farming by farm groups

| | Farm Groups | | | Mean |
|---|---|---|---|---|
| | Group I | Group II | Group III | |
| Amount of production (tonne/farm) | 33.86[a] | 63.33[a] | 518.72[b] | 250.07 |
| Number of cages (unit/farm) | 6.33[a] | 10.83[ab] | 20.89[b] | 13.86 |
| Cage capacity (tonne/cage) | 5.35[a] | 5.85[a] | 24.83[b] | 18.05 |
| Feed conversion ratio (FCR) | 1.05 | 1.11 | 1.10 | 1.09 |
| Fingerling weight (gram) | 20.00[a] | 20.00[a] | 26.44[b] | 22.76 |
| Weight of caught fish (gram) | 329.17[a] | 325.00[a] | 472.22[b] | 389.29 |
| Mortality rate (%) | 2.00[a] | 2.25[a] | 5.22[b] | 3.45 |
| The distance of the cages to the shore (metres) | 491.67[a] | 133.33[b] | 165.56[b] | 249.52 |
| The proportion of farms receiving aquaculture support (%) | 100.00 | 100.00 | 100.00 | 100.00 |
| The number of annual harvests (pieces) | 1.00 | 1.00 | 1.00 | 1.00 |
| Production period | November-June | | | |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

Cost calculations are significant for many farm functions, such as farm analysis, preparation of farm budget plans, and profitability analysis. Furthermore, cost calculations aid in the formulation and implementation of macro-level price policies and other agricultural policies (subsidies of agricultural inputs, etc.) [9]. The cost items for trout production were classified as fixed and variable costs. Variable costs are costs that rise or fall depending on the volume of production. These costs are incurred during production and vary according to the amount of production. Fixed costs, on the other hand, are costs that do not vary with production volume or whether production is carried out or not [11]. Production costs consist of the sum of fixed and variable costs. Trout

production costs according to farm groups are given in Table 3. It was discovered that as the size of the farm increased, so did the production costs per farm. Production costs per farm were calculated as $66,892.75, $107,851.79, and $718,028.48 for Groups I, II, and III, respectively. The difference between Group III and the other groups was found to be statistically significant ($P < 0.05$).

Table 3. Production costs by farm groups ($/farm)

| Cost items | Farm Groups | | | | | | Mean | |
|---|---|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | | | |
| | $ | % | $ | % | $ | % | $ | % |
| Feed | 34,647.68[a] | 51.80 | 57,442.20[a] | 53.26 | 398,115.85[b] | 55.45 | 196,932.47 | 55.10 |
| Fingerling | 14,195.67[a] | 21.22 | 21,738.44[a] | 20.16 | 176,294.65[b] | 24.55 | 85,821.74 | 24.01 |
| Veterinary-medicine-disinfectant | 741.56[a] | 1.11 | 1,716.19[ab] | 1.59 | 4,915.51[b] | 0.68 | 2,808.87 | 0.79 |
| Tool-machine oil-fuel | 578.84[a] | 0.87 | 1,546.69[a] | 1.43 | 10,664.41[b] | 1.49 | 5,177.76 | 1.45 |
| Electric | 165.26 | 0.25 | 222.47 | 0.21 | 2,648.45 | 0.37 | 1,245.83 | 0.35 |
| Tool-machine and cage repair maintenance | 1,695.01 | 2.53 | 2,235.29 | 2.07 | 4,449.39 | 0.62 | 3,029.82 | 0.85 |
| Other | 868.69 | 1.30 | 635.63 | 0.59 | 3,298.20 | 0.46 | 1,625.39 | 0.45 |
| Revolving fund interest | 1,412.24[a] | 2.11 | 2,283.84[a] | 2.12 | 16,030.32[b] | 2.23 | 7,926.16 | 2.22 |
| (A) Variable costs | 54,304.95[a] | 81.18 | 87,820.74[a] | 81.43 | 616,416.77[b] | 85.85 | 304,568.03 | 85.21 |
| General administrative expenses (3%) | 1,629.15[a] | 2.44 | 2,634.62[a] | 2.44 | 18,492.50[b] | 2.58 | 9,137.04 | 2.56 |
| Rent | 335.82[a] | 0.50 | 213.99[a] | 0.20 | 1,437.93[b] | 0.20 | 773.35 | 0.22 |
| Permanent labour | 2,235.29[a] | 3.34 | 4,322.26[a] | 4.01 | 13,863.73[b] | 1.93 | 7,815.18 | 2.19 |
| Tool-machine depreciation | 7,222.20[a] | 10.80 | 11,453.20[a] | 10.62 | 61,483.18[b] | 8.56 | 31,685.76 | 8.86 |
| Tool-machine capital interest | 690.94[a] | 1.03 | 1,038.72[a] | 0.96 | 5,714.13[b] | 0.80 | 2,943.10 | 0.82 |
| Building depreciation | 381.29 | 0.57 | 296.63 | 0.28 | 498.50 | 0.07 | 407.33 | 0.11 |
| Building capital interest | 93.10 | 0.14 | 71.61 | 0.07 | 121.74 | 0.02 | 99.24 | 0.03 |
| (B) Fixed costs | 12,587.79[a] | 18.82 | 20,031.04[a] | 18.57 | 101,611.71[b] | 14.15 | 52,861.01 | 14.79 |
| (A+B) Production costs | 66,892.75[a] | 100.00 | 107,851.79[a] | 100.00 | 718,028.48[b] | 100.00 | 357,429.03 | 100.00 |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

The production costs per farm were determined to be $357,429.03 based on the average of all farms. The share of variable costs in total production costs was found to range between 81.18% and 85.85%, depending on the farm group, and was 85.21% for the average of all farms. The share of fixed costs varied between 14.15% and 18.57% and was calculated as 14.79% for the average of all farms. Afero et al. [1] found the share of variable costs was 75.3% and the share of fixed costs was 24.7% of total production costs. The most important variable costs were the purchases of feed and fingerlings. Feed costs ranged from 51.80% to 55.45% of total production costs, depending on the farm group, and the cost of procuring fingerlings ranged from 20.16% to 24.55%. For the average of all farms, the proportions of feed and fingerling purchase costs in total

production costs were 55.10% and 24.01%, respectively. Other research has yielded similar results. In Erman and Kucuk's [10] study, feed expenses accounted for 58.8% of total production costs and 53.67% in Karabulut et al.'s [14] study. Pangemanan et al. [21] emphasized that feed costs have become an important problem in fish farming due to high feed prices. Barbosa et al. [4] found that the main cost factor in family trout farming was feed, and the share of feed cost in total costs was 60.61% for small-scale farms and 62.80% for medium-sized farms. The most important fixed cost elements are tool-machine depreciation, general administrative expenses, and permanent labour costs. These three cost elements accounted for 13.61% of production costs on the total farm average.

Gross production values according to farm size groups are given in Table 4. In the trout farming activity branch, the gross production value consists of fish sales and government support. According to the average of all groups, the gross production value per farm was $684,373.44, and it was determined that it increased in parallel with the size of the farm. In Groups I, II, and III, the gross production value was calculated to be $84,303.73, $153,740.55, and $1,438,175.17, respectively. The difference between Group III and Groups I and II was statistically significant ($P < 0.05$). Fish sales accounted for a large portion of the gross production value. The share of fish sales in the total gross production value ranged from 96.83% to 98.10% according to the farm groups, and it was determined as 97.98% on average. Support for trout farming is given to producers by the Republic of Türkiye Ministry of Agriculture and Forestry. The share of the subsidies in the gross production value varied between 1.90% and 3.17% according to the farm groups, with an average of 2.02% for all farms.

Table 4. Gross production values by farm groups ($/farm)

| Income items | Farm Groups | | | | | | Mean | |
|---|---|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | | | |
| | $ | % | $ | % | $ | % | $ | % |
| Fish sale | 81,627.68[a] | 96.83 | 149,068.69[a] | 96.96 | 1,410,896.18[b] | 98.10 | 670,583.04 | 97.98 |
| Supports | 2,676.05[a] | 3.17 | 4,671.86[a] | 3.04 | 27278.99[b] | 1.90 | 13,790.40 | 2.02 |
| Gross product value | 84,303.73[a] | 100.00 | 153,740.55[a] | 100.00 | 1,438,175.17[b] | 100.00 | 684,373.44 | 100.00 |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

Table 5 shows the farm group's profitability indicators per farm and tonne. Calculations of the gross profit, net profit, and relative return were made to determine the profitability of farms. In terms of the use of scarce production factors, gross profit is a significant indicator of success for assessing the competitiveness of farm production operations. In a nutshell, gross profit is an important measure for determining a farm organisation's performance [9]. According to the average of all farms, the gross profit per farm was $379,805.41, which increased in direct proportion to the size of the farm. The average gross profit in Groups I, II, and III was $29,998.78, $65,919.80, and $821,758.40, respectively. Group III's difference from Groups I and II was statistically significant ($P < 0.05$). Net profit was calculated by deducting production costs from gross production value. The average net profit per farm was calculated as $17,410.98 in farms in Group I, $45,888.76 in Group II farms, $720,146.69 in Group III, and $326,944.40 for the all farm average. Accordingly, as the farm groups grew, it was seen that the average net profit per farm also increased. Group III differed from Groups I and II by a statistically significant margin ($P < 0.05$). Relative return is another indicator of farm success. A relative return shows the income obtained for a unit cost in a production line. Similar to the gross profit, the relative return increased in tandem with the size of the farm for the average of all farms, and it was 1.91. In Groups I, II, and III, the average relative return was 1.26, 1.43, and 2.00, respectively. The difference between Group III and the other groups was

statistically significant ($P < 0.05$). According to the average of all farms, revenue of $1.91 was obtained in exchange for a cost of $1 in trout farming. Concerning these findings, it can be stated that as farm size groups increase, the farms become more profitable for trout farming.

Table 5. Profitability indicators by farm groups

| Profitability indicators | Farm Groups | | | Mean |
|---|---|---|---|---|
| | Group I | Group II | Group III | |
| Gross product value ($/farm) | 84,303.73[a] | 153,740.55[a] | 1,438,175.17[b] | 684,373.44 |
| Variable costs ($/farm) | 54,304.95[a] | 87,820.74[a] | 616,416.77[b] | 304,568.03 |
| Production costs ($/farm) | 66,892.75[a] | 107,851.79[a] | 718,028.48[b] | 357,429.03 |
| Gross profit ($/farm) | 29,998.78[a] | 65,919.80[a] | 821,758.40[b] | 379,805.41 |
| Net profit ($/farm) | 17,410.98[a] | 45,888.76[a] | 720,146.69[b] | 326,944.40 |
| Relative return | 1.26[a] | 1.43[a] | 2.00[b] | 1.91 |
| Gross production value ($/tonne) | 2,489.77[a] | 2,427.61[a] | 2,772.55[b] | 2,736.73 |
| Variable costs ($/tonne) | 1,603.81[a] | 1,386.72[a] | 1,188.34[b] | 1,217.93 |
| Production costs ($/tonne) | 1,975.57[a] | 1,703.01[a] | 1,384.23[b] | 1,429.32 |
| Gross profit ($/tonne) | 885.97[a] | 1,040.89[a] | 1,584.20[b] | 1,518.80 |
| Net profit ($/tonne) | 514.21[a] | 724.60[a] | 1,388.31[b] | 1,307.41 |
| Relative return | 1.26[a] | 1.43[a] | 2.00[b] | 1.91 |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

In the research region, the amounts per tonne of cost and profitability indicators were calculated, as well as the amounts per farm. It was discovered that the production costs per tonne decreased in direct proportion to farm size in the farms studied. Production costs per tonne were determined as $1,975.57, $1,703.01, and $1,384.23 in Groups I, II, and III, respectively. It was discovered that as the farm's size increased, so did the gross and net profits, and the relative return per tonne. Gross profit per tonne was determined as $885.97, $1,040.89, and $1,584.20, respectively, and net profit was $514.21, $724.60, and $1,388.31, respectively, for Groups I, II, and III. The difference between Group III and Groups I and II in terms of production cost per tonne, gross profit, net profit, and relative return was found to be statistically significant ($P < 0.05$). Other studies on the subject had similar results. According to Musaa et al. [19] and Erman and Kucuk [10], large-scale cage farms were more profitable for fish farming. According to Miao et al. [18], the scale of production in cage culture and cobia breeding was cost-effective, and cobia production would be more profitable due to positive economies of scale.

Table 6. The profit margin of 1 kg of trout by farm groups

| | Farm Groups | | | Mean |
|---|---|---|---|---|
| | Group I | Group II | Group III | |
| Production costs ($/kg) | 1.98[a] | 1.70[ab] | 1.38[b] | 1.43 |
| Sales price ($/kg) | 2.42[a] | 2.37[a] | 2.71[b] | 2.53 |
| Profit margin ($/kg) | 0.44[a] | 0.67[a] | 1.32[b] | 1.10 |
| The ratio of profit margin to the sales price (%) | 18.33[a] | 28.23[a] | 48.90[b] | 43.51 |

Note: [a, b] Means with a different superscript in the same row differ ($P < 0.05$).

The profit margin per kg of trout and the ratio of profit margin to sales price by farm group are given in Table 6. The profit margin was calculated by subtracting the production cost of one kg of trout from the selling price of one kg of trout. It was determined that the profit margin of one kg of trout increased as the farm groups grew in size. The profit margin for one kg of trout was $1.10 on average across all farm groups, and it was $0.44, $0.67, and $1.32 in I, II, and III Group farms, respectively. The ratio of profit margin to selling price (profit margin/sales price*100) criterion was calculated to determine proportionally how much of the sale price of trout was cost and how much was profit. It was discovered that the ratio of profit margin to sales price increased as the farm groups

expanded. When compared to the average of all farms, the profit margin to sales price ratio was 43.51%, and it was calculated as 18.33%, 28.23%, and 48.90% in Groups I, II, and III, respectively. According to these results, farms in Group III profited 48.90% on each kg of trout they sold, while farms in Group I made a profit of 18.33% and farms in Group II profited 28.23%. In terms of profit margin and the ratio of profit margin to the sales price, the difference between Group III and Groups I and II was found to be statistically significant ($P < 0.05$). In their study, Navy and Bun [20] determined the profit margin rate in fish production as 56.03%, emphasizing that the fishing activity was profitable and the producers should continue production.

## CONCLUSIONS

As a result, the fish produced were all rainbow trout in the research region, and the majority of them were exported. It was determined that each farm produced an average of 250.07 tonnes of trout. The feed conversion ratio varied between 1.05 and 1.11 depending on the farm group, and the average of all farms was 1.09. The farmers produced once a year between November and June, and all producers received aquaculture support from the Republic of Türkiye Ministry of Agriculture and Forestry. It was determined that as the farm's size increased, so did the production costs per tonne. The most significant cost items among the total production costs were the purchase costs of feed and fingerling. The share of feed costs in total production costs varied between 51.80% and 55.45%, and the cost of purchasing fingerlings varied between 20.16% and 24.55%, depending on the farm group. It was discovered that as the size of the farm expanded, so did the gross and net profits, as well as the relative return. In Groups I, II, and III, the average net profit per tonne was \$514.21, \$724.60, and \$1,388.31, respectively. Similarly, when the farm's size increased, it was determined that the profit margin of one kg of trout and the ratio of profit margin to sales price increased. The profit margin of one kg of trout was \$0.44, \$0.67, and \$1.32 in Groups I, II, and III, respectively. Also, the ratio of profit margin to sales price was 18.33%, 28.23%, and 48.90%. According to the profit margin to sales price ratio, farms in Group III profit 48.90% from each kg of trout sold, while farms in Group I make a profit of 18.33% and those in Group II make a profit of 28.23%. According to these findings, large farms are more beneficial in terms of profitability and cost criteria. Therefore, policy measures should be developed to increase the capacity of farms in the research region. Furthermore, incentives and support for lowering feed costs in trout farming should be increased.

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