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Rainbow Trout Farming in İmranlı Dam Lake (Turkey): Knowledge, Constraints and Opportunities

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Abstract— *The Covid-19 pandemic process has clearly demonstrated how important it is to ensure self-sufficiency and sustainability, especially in the production of agricultural and animal products. One of the inland water ecosystems that are important in terms of aquaculture production is dam lakes. In recent years, rainbow trout farming in dam lakes has been widely practiced in Turkey. One of the dam lakes where rainbow trout is grown in cages is İmranlı Dam Lake. The dam lake was built on the Kızılırmak River in Sivas province between 1994-2002. It is very valuable for the country's economy to use the waters of the İmranlı Dam Lake in the cultivation of rainbow trout in cages together with agricultural irrigation. The waters of the İmranlı Dam Lake give an important power to both agriculture and rainbow trout farming. In the İmranlı Dam Lake, 950 tons of rainbow trout and Turkish salmon are grown annually in net cages. The surface of the İmranlı Dam Lake, which has a water capacity of 62.5 million cubic meters and an area of 6.5 square kilometers, located within the borders of İmranlı district, where the air temperature drops to about 25-30 degrees below zero, is completely frozen in the winter season with the effect of cold weather every year. In the İmranlı Dam Lake, which is used to irrigate approximately 11.220 hectares of agricultural land in the summer months and where cage fishing is also carried out, the fish cages are under the ice mass. Rainbow trout can be fed by breaking the ice on the cages. Rainbow trout, which are grown in difficult conditions in the İmranlı Dam Lake, are highly preferred due to both the air and the coldness of the water. The rainbow trout farm, which was established in the İmranlı Dam Lake in 2010, has reached an extremely important position in terms of modern production infrastructure, quality and meeting the animal protein needs of people.*

Keywords— ***Cage Culture, Rainbow Trout, Farm, İmranlı Dam Lake, Turkey.***

I. INTRODUCTION

The aquaculture sector has become a multi-divisional sector that includes many economic actors and takes consumer preferences more into account. It is stated that aquaculture production in the world cannot be increased through hunting, and the maximum amount of catchable stock has been reached. Considering the increasing population and the improvement in the living standards of the societies, the demand for aquatic products will increase and the increasing demand can only be met through aquaculture [1]. The Covid-19 pandemic has adversely affected the global economy, especially in various food production sectors. This health crisis has clearly affected the aquaculture industry around the world. Deadlocks, seed, bait, etc. This has resulted in interruptions in aquaculture operations due to restrictions on the transport of inputs as well as restrictions on fish processing and trade. These quarantine restrictions have negatively impacted small-scale fish farms, which make up the majority of the fish farming industry sector in developing countries [2]. Turkey is a very lucky country in terms of aquaculture production with its seas, lagoons, streams, natural lakes and dam lakes. In Turkey, the number of dam lakes built for energy and irrigation purposes is increasing day by day. With a protocol signed by the Ministry of Agriculture and the General Directorate of State Hydraulic

Works in 1994 in order to develop and expand fish farming, aquaculture started in dam lakes [3]. For this purpose, 1% of the surface area of the dam lakes is reserved for aquaculture in cages. As a result, interest in the aquaculture sector has increased and rainbow trout breeding farms have been established in cages in many dam lakes. Rainbow trout are raised in cages in approximately 250 farms in dam lakes located in 34 provinces of Turkey [4]. Technological and economic advances in aquaculture have developed rapidly in recent years. In this context, aquaculture was supported and inland aquaculture production, which was 43.385 tons in 2000, increased to 128.236 tons in 2020 [5]. The reason for this increase; the state's crediting of aquaculture, the encouragement of aquaculture through research activities financed by the public, and the fact that this kind of aquaculture production is more advantageous than hunting.

Today, the aquaculture sector has become a sector that covers many economic actors, is multi-divisional and takes more into account consumer preferences. The foreign trade volume of the aquaculture sector in the world is approximately 307 billion dollars. Export constitutes 52% of the foreign trade volume and imports 48%. The countries that import the most fisheries are the USA, Japan, China, Spain and France, respectively. The largest aquaculture exporting countries are China, Norway, Vietnam, India and USA, respectively. The production value of fishery products in the world has increased by 12.26% in the last 10 years [1]. Turkey's aquaculture foreign trade volume is approximately 1.3 billion dollars. 65% of the trade volume is export value and 35% is import value [6]. The countries to which Turkey exports the most are Netherlands, Italy, England and Germany, respectively. The countries from which Turkey imports the most are Norway, Spain, Morocco, Iceland and China, respectively. Turkey has increased the production value of aquaculture by 7.45% in the last 10 years [7]. There are 2139 facilities engaged in aquaculture in Turkey. 20.2% of these facilities operate in the seas and 79.8% in inland waters [5]. Within the scope of aquaculture, rainbow trout (*Oncorhynchus mykiss*) is the species that provides the most important economic return, which has high protein quality among trout species, especially in aquaculture. The total production amount of rainbow trout obtained by aquaculture in inland waters and seas in Turkey has reached 144.182 tons according to 2020 data [5]. Rainbow trout is a globally traded species produced by small and large scale aquaculture in Turkey. Farms that raise rainbow trout earn a net income of 12% of their total capital invested. In Turkey, 1.12 kg of feed is used to produce one kilogram of trout [8]. Rainbow trout farming is an integral part of the rural economic structure. Sivas province has a very favorable climate and geographical structure in terms of rainbow trout production. In addition to 4 natural lakes, there are Kızılırmak River and other streams and 24 dam lakes and 38 ponds that are in operation in Sivas province. One of the dam lakes where rainbow trout is grown in net cages is İmranlı Dam Lake. This study was carried out to evaluate the current socio-economic situation and sustainability of rainbow trout culture in net cages in İmranlı Dam Lake.

II. MATERIALS AND METHODS

2.1 Background of Study Area

The study area İmranlı Dam Lake is located within the borders of İmranlı district of Sivas province in the Central Anatolia Region. İmranlı Dam Lake is approximately 110 kilometers from Sivas city center. İmranlı Dam Lake is about two kilometers from İmranlı district center. İmranlı Dam Lake was built on the Kızılırmak River in Sivas between 1994-2002 for irrigation and energy generation. The height of the dam, which is an earth body fill type, from the river bed is 49 meters and the lake area at normal water level is 6.5 square kilometers. (Table 1). İmranlı Dam Lake provides irrigation service to an agricultural area of 11.220 hectares [9].

Table 1: Some technical info about İmranlı Dam Lake.

Country	Turkey
Province	Sivas
Build Start Year	1994
Build Completion Year	2002
Goal of the Dam	Energy, Irrigation
River	Kızılırmak River
Body Fill Type	Soil
Height	49 m
Lake Volume	62.5 hm^3
Lake Area	6.5 km^2
Irrigation Area Gross	11.220 ha

The district of İmranlı, which has the same name as the İmranlı Dam Lake, is located in the east of Sivas province. The area of the district is 1.229 square kilometers and its height from the sea is 1650 meters. İmranlı is adjacent to Refahiye district of Erzincan province in the east, Divriği in the south, Zara in the west and Suşehri and Akıncılar districts in the north. It is known that İmranlı and its surroundings remained under the rule of the Hittite, Persian, Alexander, Roman and Byzantine Empires throughout the historical process. Again, in historical

sources, it is recorded that the region was taken over by Muslim Arabs from time to time, and after the Battle of Malazgirt, this region came under Turkish rule. With a law enacted on January 01 in 1948, İmranlı gained the status of district [10].

2.2. Geographical Features

İmranlı has a mountainous structure compared to the province in general. The land is generally steppe and consists of hills. The mountains descend in an inclined manner towards the Kızılırmak Valley from the north and south. Located in the northeast of İmranlı, Kızıldağ is the highest mountain of Sivas province with an altitude of 3025 meters, the intersection of Central Anatolia, Eastern Anatolia and the Black Sea Regions, and the birthplace of the Kızılırmak River, the longest river of our country [10]. The Kızılırmak River is the longest river of our country, which originates within the borders of Turkey and empties into the sea again within the territory of Turkey, with a length of 1151 kilometers. The Kızılırmak River rises from the southern slopes of Kızıldağ Mountain in the east of İmranlı in three branches. These three branches converge near Çukuryurt village, 6 km from İmranlı, and merge into the İmranlı Dam Lake, taking the name Kızılırmak. Since the waters of İmranlı Dam Lake are close to the source, they are cold, clean and clear.

2.3. Geological Structure

The study area is located in the region called the Upper Kızılırmak River valley, 6 kilometers east of the İmranlı district of Sivas province. The rock units outcropping in the study area are composed of Kösedağ formation (Eocene), Zöhrep formation (Pliocene), alluvium and talus (Quaternary) from older to younger [10].

2.4. Socio-Economic Profile

The population of İmranlı, which showed a normal development after becoming a district, has increased in the past, but has decreased in recent years due to various reasons. The total population, which decreased to 21649 in the 1990 census, was determined as 13.883 in the 2000 census. According to the latest 2021 Turkish Statistical Institute data, the population of İmranlı district is 7.412 people. The mountainous and rugged nature of İmranlı district has scattered the cultivation areas. The amount of land suitable for agriculture is 11.447 hectares, and mostly wheat, barley, meadow and pasture crops are cultivated. The predominant economic fields of activity in the district center and its villages are agriculture, animal husbandry and beekeeping. Due to high altitude of İmranlı, short summers and long winters, economic development has not been achieved much. İmranlı is a resting place with its natural beauty, water and air. There are no industrial establishments, factories or similar facilities in the district [12]. The majority of the people of the district go to other cities and abroad to find a job.

2.5. Climate and Vegetation

The climate of İmranlı is in a structure that shows transition characteristics from the Steppe climate to the Continental climate. Due to the fact that the district is at the intersection of the Black Sea, Eastern Anatolia and Central Anatolia regions, it shows very different seasonal differences within the district. The part of the district facing Kızıldağ Mountain is very cold for 9 months of the year, and only 3 months of the year show the feature of spring. Winter months are snowy and very cold. Summer months are short, hot and dry. In the district, abundant precipitation falls in the spring and autumn months. The vegetation of İmranlı is steppe. For this reason, 12.700 hectares of land suitable for agriculture and 4.635 hectares of forest areas are available. Due to the severe climatic conditions, tree species other than poplar and willow are difficult to grow. There is hardly any fruit growing. Vegetables grown are also for winter needs. Beekeeping is very advanced. Turkey's most beautiful and natural honey is produced in this region [10]. The coldest place in Sivas is İmranlı. The average temperature of İmranlı in winter is below zero degrees Celsius. Therefore, the surface of İmranlı Dam Lake freezes in winter.

2.6. Methodology of the Study

This study was carried out based on literature review to evaluate the current socio-economic situation and sustainability of rainbow trout culture in net cages in İmranlı Dam Lake. In addition to this, scans made through social media and internet resources are also included. No reference has been made to the information compiled from social media and internet resources. At the beginning of the study, the aim was to collect primary data by interviewing those cultivating rainbow trout in net cages in the İmranlı Dam Lake, but collecting such data was too risky and dangerous due to pandemic conditions. Therefore, the study was based on literature review. Basic data was obtained from the reports of Sivas Provincial Directorate of Agriculture and other institutions.

III. RESULTS

İmranlı Dam Lake was opened for fish farming in 2010, and there is a farm that produces rainbow trout in 42 net cages designed by Sivas Agriculture and Forestry Provincial Directorate. This farm is located in the immediate vicinity of the İmranlı dam embankment. This farm has an annual production capacity of 950 tons of rainbow trout. In this farm, portioned rainbow trout weighing 250-300 grams, and Turkish salmon reaching 1-5

kilograms in weight by enlarging the rainbow trout are raised in net cages. This rainbow trout, which is grown under the name of Turkish salmon, is increasing its importance in the aquaculture sector. Since the water of the İmranlı Dam Lake is cold in the summer, this rainbow trout farm provides excellent aquaculture in cages. Because rainbow trout is one of the fish that likes cold waters. In addition, climatic conditions, water flow and similar conditions in İmranlı Dam Lake are more suitable for rainbow trout farming in summer. Juvenile rainbow trout of 1 gr, 2 gr and 5 gr are brought to the net cages in the İmranlı Dam Lake and raised. Since the surface of the İmranlı Dam Lake is frozen by freezing in the winter season and the water temperature drops below 10 degrees Celsius, there is no development in rainbow trout. Because, in the İmranlı Dam Lake, the net cages remain in the water under the ice.

Although İmranlı Dam Lake is a good place for rainbow trout breeding, it is always a problem to feed in cages since it usually freezes in winter every year. The net cages, which can be reached by boat in the summer, can be reached by walking approximately 150-200 meters on the ice in winter. In order to feed the rainbow trout in the net cages in the İmranlı Dam Lake, which freezes in the winter months every year due to the intense winter conditions in the region, approximately 25-30 cm of ice is cut with a chainsaw and the trout are fed once a week. In İmranlı Dam Lake, the ice on the net cages is cut in the form of approximately 50 centimeters square, and the manual feeding process of rainbow trout continues for about two or three months. Thus, it is tried to make continuous production in net cages in İmranlı Dam Lake. In any case, rainbow trout in net cages are not given much food in winter. Since the movement and metabolic rate of rainbow trout in cages is slow, they do not consume much energy.

Since the water of the İmranlı Dam Lake is very cold, the taste of the cultured rainbow trout is also different. Rainbow trout, which are grown in an average of one year elsewhere, are raised in an average of two years in the İmranlı Dam Lake. The reason for this is that because the İmranlı Dam Lake freezes in winter, the development of rainbow trout is very slow for about five or six months. Because it grows slowly, rainbow trout grown in net cages in İmranlı Dam Lake are more delicious. For this reason, almost one hundred percent natural rainbow trout farming can be done in the cold and clean waters of the İmranlı Dam Lake.

The place where the coldest temperatures are seen in Sivas is İmranlı. İmranlı has a different position. The winter season is very effective in İmranlı. In the winter season when freezing cold is experienced, the approximate air temperature around İmranlı Dam Lake is 25 degrees below zero, and the air temperature can be as low as minus 30 degrees Celsius. The surface of the İmranlı Dam Lake is covered with ice due to the effect of freezing temperatures. In the İmranlı Dam Lake, where the ice thickness is approximately 25-30 centimeters, rainbow trout is farmed under very difficult conditions during the winter months.

Until the tenth or twelfth month of the year in İmranlı Dam Lake, rainbow trout remain as they are grown and developed. Because, after the tenth or twelfth month, the temperature of the water drops in the İmranlı Dam Lake. In winter, a little feeding can be done by piercing the ice on the cages. Rainbow trout in net cages in İmranlı Dam Lake can only be fed normally starting from the spring season. For this reason, it takes about two years for rainbow trout to be reared and marketed in net cages in the İmranlı Dam Lake. In addition, there is a problem in feeding rainbow trout in net cages in İmranlı Dam Lake. In the aquaculture sector in Turkey, feed raw material is expensive because it comes from abroad in US dollars and Euros. On the other hand, Farm owners complain about the high gasoline and diesel prices. However, despite all the difficulties experienced in rainbow trout farming in net cages in İmranlı Dam Lake, production continues.

Since rainbow trout farming cannot be done efficiently due to the freezing of the water of İmranlı Dam Lake in winter months, some of the rainbow trout raised until the tenth and eleventh months are shipped to the net cages in Keban Dam Lake in Elazığ province and production continues. However, Keban Dam Lake is beautiful in winter and the water temperature rises in summer, and because it is not suitable for rainbow trout farming, farm owners prefer İmranlı Dam Lake because its waters are cold and clean in summer. The owners of the farm jointly raise rainbow trout in İmranlı and Keban Dam Lakes. In other words, they raise the baby rainbow trout, which are raised in the İmranlı Dam Lake during the summer season, in the Keban Dam Lake in the winter and offer them to the market.

Rainbow trout raised in İmranlı Dam Lake are sold as wholesale and retail under the name of Kızıldağ Trout Company. Rainbow trout raised in İmranlı Dam Lake are sold in bulk in the tenth and eleventh months. In addition, portioned rainbow trout and salmon are sold at the stock cages located on the shore of the İmranlı Dam Lake as retail throughout the year. There is no difficulty in marketing and sales of rainbow trout cultured in net cages in İmranlı Dam Lake. Produced rainbow trout are given to the domestic market. In general, rainbow trout produced for large companies such as Gümüşdoğa and Kılıç Seafood are sold wholesale. The companies that own these large fish processing facilities market their rainbow trout and Turkish salmon both domestically and abroad. In addition, some of the rainbow trout and Turkish salmon farmed are

sold wholesale to Turkey's southeastern provinces such as Batman and Diyarbakır. Wholesale and retail prices of rainbow trout and Turkish salmon vary. For 2020, rainbow trout for 25 Turkish Liras per kilogram is sold to customers who come to the sales point on the shore of the İmranlı Dam Lake in retail. The kilogram price of Turkish salmon is 30 Turkish Liras. In the years when the first production was started in net cages in the İmranlı Dam Lake, there was a problem in the people of İmranlı, since they did not have the habit and culture of consuming rainbow trout. In other words, there were people who did not consume rainbow trout in İmranlı even though it was offered at a very low price. Later, in İmranlı, over time, people got used to the taste of rainbow trout by going and buying rainbow trout. Today, retail fish sales in the İmranlı Dam Lake are in good condition.

IV. DISCUSSION

The aquaculture sector has been a growing area in the world and in Turkey. Especially the decrease in natural stocks due to global warming and environmental pollution has increased the interest in aquaculture. Trout farms have an important place in Turkey's aquaculture production, and the economic input they provide is significant for the country's economy [13]. Within the scope of aquaculture, especially rainbow trout farming, which is a cold water fish, is carried out under wide environmental conditions in many countries of the world. Rainbow trout is the most produced species among the species cultivated in Turkey. Because of the many advantages of raising rainbow trout in net cages compared to other systems, this system has become increasingly widespread in Turkey's dam lakes. Sivas province has an important place in rainbow trout farming in Turkey [14]. According to the 2019 data of Sivas Provincial Directorate of Agriculture and Forestry, the total project capacity of 43 trout breeding and breeding farms is 5,482 tons per year. The total capacity of hatchery trout fry production of Sivas province is 25.640.000 per year [15]. One of the 43 farms breeding rainbow trout in Sivas province produces 950 tons of net cages per year in the İmranlı Dam Lake. According to this, 17.33 percent of the amount of rainbow trout raised in Sivas is provided from the net cages in the İmranlı Dam Lake. From this point of view, rainbow trout farming carried out in net cages in İmranlı Dam Lake has a significant proportion in the total trout production in Sivas province.

According to Karataş et al. 2008 determined that the largest share in the operating costs in Sivas province belongs to the feed expenses (51.48%). Ready-made feed is used in the feeding of rainbow trout in the farms in Sivas. In other words, pellets are used in adult rainbow trout and granule feed is used in juvenile rainbow trout. Farms in Sivas province feed rainbow trout; they mostly meet from feed factories in Kayseri (57.15%), Erzurum (28.57%), Samsun (7.14%) and İzmir (7.14%) [16]. The main input elements of the operation in the İmranlı Dam Lake are fry fish and feed costs. The need for juvenile fish in the farm is outsourced and there is foreign dependency in the supply of feed raw materials. In particular, the production cost of feed companies is increasing due to the foreign dependence of the supply of fish meal and fish oil. The fact that the farm feeds more generally increases the production costs of rainbow trout.

The fact that the farm is located in the immediate vicinity of the İmranlı Dam embankment brings with it some environmental advantages. The height of the İmranlı Dam embankment is 49 meters. (Table 1). Accordingly, the water exchange and water depth of the cages are good, especially in the İmranlı Dam Lake. Good water change minimizes the accumulation of residues under the cages and all the problems that may cause this. For these reasons, water change is essential for intensive cage farming. In addition, the fact that the feeds produced with the extruder technology used in the mesh cage operation in İmranlı Dam Lake are water resistant and have a slow sinking rate, both prevent feed losses and reduce environmental pollution. Depth is one of the important factors in the practice of cage fishing. In other words, it is quite economical to do cage fishing at a suitable water depth.

The logistics connection between the net cages of the farm in İmranlı Dam Lake and the land is provided by boat. There is one landing point on the shore of İmranlı Dam Lake, where the boat will dock and which provides infrastructure for activities such as loading and unloading. However, in winter, when the İmranlı Dam Lake freezes, it is possible to reach the cages by walking approximately 150-200 meters on the ice. As a result, there is a risk of slipping on the icy ground and falling into the water.

The 21.43% of the rainbow trout raised in Sivas are sold to intermediaries and 21.43% to restaurants. 78.57% of the farms stated that their rainbow trout sales were cash and the rest were mixed (cash+deferred). Companies that sell on credit stated that they collect the price of rainbow trout within 1-2 months at the most [16]. At the end of the cultivation period in the İmranlı Dam Lake, the product is sold in the cage as juicy and fresh before it goes ashore. Wholesale sales to intermediary firms are seen as an obstacle to the branding of the farm in the İmranlı Dam Lake. For this reason, the farm in the İmranlı Dam Lake should invest in branding in the production of fresh rainbow trout and increase its traceability in all the steps from the supply of fry to the sales stage. Rainbow trout grown in the domestic market are sold to restaurants and

fish markets through different marketing channels, supermarkets or brokers. The sales prices of rainbow trout in the domestic market increase in line with the demand, with fishing bans and the start of the tourism season. In order to increase the amount of fish consumed per capita in the domestic market and to prevent seasonal price instability, arrangements should be made to increase domestic demand.

Rainbow trout farming industry; It has economic functions consisting of very important issues such as increasing national income and exports, enabling new employment opportunities, reducing the development differences between regions with a balanced development to be provided between sectors, and ensuring national development in a stable manner. In addition, meeting the demand for rainbow trout and sustainable production, creating added value with advanced product processing services, fast, widespread and technological marketing mechanism, stable growth trend and export potential, opportunities created within the scope of new investments, and consequently reducing migration, contribute to both rural development and rural development. It makes an important contribution to the development of both regional and national economy. In the light of all these data, rainbow trout farming in cages in dam lakes, with its modern and dynamic structure, has an important position among other aquaculture sub-sectors, especially the national aquaculture sector, and it is thought that it will strengthen and maintain this position in the coming years. While the rainbow trout, which is grown intensively in the inland waters of Turkey, is 126.101 tons according to 2020 data, the rainbow trout production in the Turkish seas is 18.182 tons [5]. According to the 2020 data of the Turkish aquaculture sector, the production amount is 421.411 tons and its economic value is 10.859.581.980 Turkish Liras [5]. The main export countries of rainbow trout, which are raised in production farms established in the inland waters of Turkey, especially in dam lakes, are Romania, Poland, Lithuania, Germany, Saudi Arabia, Kuwait, Lebanon, Qatar, Russia, Azerbaijan, Georgia, Kazakhstan, Iraq, Iran, United States, Japan and Canada. İmranlı Dam Lake has become an important commercial area after rainbow trout farming started in dam lakes in Turkey. Considering the current situation of the waters of the İmranlı Dam Lake, it is recommended to increase the number of farms that raise rainbow trout in cages. In addition, rainbow trout processing and storage infrastructure should be established near the İmranlı Dam Lake.

A large part of the fishery products produced in Turkey, covering about 75 percent, are consumed fresh. [17]. According to GDF [5] data, per capita consumption of seafood in Turkey is 6.7 kilograms. This value is considerably lower than the European Union and world average. While the annual per capita consumption of aquaculture is 16 kilograms in the world and 22 kilograms in EU countries, it is very thought-provoking that it is 6.7 kilograms in Turkey on average. The most important advantages of fish and aquatic products are that they have higher quality fatty acids compared to red meat, that they contain high amounts of calcium, phosphorus and iodine, and that they can maintain body balance, and that they can meet the balanced nutritional needs of people with their A, B1, B2 and D vitamins [17]. Despite this, in the years when the first production in net cages in the İmranlı Dam Lake was started, there was a problem because the people of İmranlı did not have the habit and culture of consuming rainbow trout. In other words, there are people who do not consume rainbow trout in İmranlı even if it is given at a very low price. Over time, some people in İmranlı gained the habit of consuming rainbow trout thanks to this rainbow trout farm. But this is not sufficient. It is of great importance to increase public service announcements, advertising and promotion activities, especially in order to break the prejudice against rainbow trout consumption and to encourage consumption.

Fish farming is important for the country's economy due to its contribution to human nutrition, employment, raw material supply to the industry and high export potential. The decrease in fish stocks, which is a very important food source for the increasing world population, has brought the evaluation of resources in the seas and inland waters to the agenda. Therefore, aquaculture today is growing faster than any other field of agriculture [18]. In rainbow trout farms in Sivas province, the amount of labor varies between 1.00-4.75 according to the farms, and a worker works an average of 10 hours a day [16]. Rainbow trout production is carried out intensively in İmranlı Dam Lake. In the İmranlı Dam Lake, there is a hard and constantly intense work in the rainbow trout farm, especially in the winter months. Depending on the season, at least four to eight workers work on this high-capacity farm on the İmranlı Dam Lake. While it is easier to work in the summer conditions in the rainbow trout farm in İmranlı Dam Lake, the working conditions in the winter season are more difficult.

Fish such as barbel, bleak, carp, chub, freshwater perch, khramulya and rainbow trout live in İmranlı Dam Lake. For this reason, angling is also carried out in the İmranlı Dam Lake. While intensive breeding of non-native rainbow trout in cages in the İmranlı Dam Lake is of indispensable importance, it also poses very high risks to natural biodiversity as rainbow trout escaping from cages can become invasive. Although the people involved in rainbow trout farming in İmranlı Dam Lake want to

prevent the fish from escaping from the cages, it is known that rainbow trout actually do. Rainbow trout escapes from this farm can both harm native species and reduce the farm's income. For this reason, people involved in rainbow trout farming in İmranlı Dam Lake should take more stringent measures to prevent rainbow trout from escaping from cages. In addition, considering the current situation of rainbow trout production obtained from the inland waters of Sivas province, it is very important to scientifically reveal the carrying capacity of the İmranlı Dam Lake and the biological structures of the fishery products and to carry out fishing without damaging the stocks. However, since İmranlı Dam Lake is subject to rainbow trout escapes, it is recommended to prioritize monitoring of natural populations in the near future.

In addition to many natural lakes in Sivas province, fisheries are carried out in many spring waters feeding Kızılırmak River, other streams and ponds and dam lakes built on these water resources [15]. Considering the negative effects of some fishing activities carried out in Turkey's inland waters, it is recommended to be careful about the vaccination and stocking of fish in the İmranlı Dam Lake.

It should not be forgotten that the waters of İmranlı Dam Lake are also used in fields such as agricultural irrigation, energy and recreation, apart from rainbow trout farming and angling. In order to ensure environmental sustainability, it is recommended to investigate the carrying capacities of the İmranlı Dam Lake areas allocated to the mesh cage operation and to consider the ecosystem balances at every stage of production. In this context, there is a need to carry out studies on quality monitoring, protection and sustainability of water resources in the waters of the İmranlı Dam Lake.

V. CONCLUSION

Rainbow trout culture in net cages is an increasingly important practice in İmranlı Dam Lake. It is a highly productive aquaculture variety with important social and economic benefits such as creating employment for the local people around the İmranlı Dam Lake. Although cage culture practices in İmranlı Dam Lake started in 2010, it has reached a good point in rainbow trout production in a short time. It is seen that rainbow trout farming in İmranlı Dam Lake is a profitable production branch. When this situation is evaluated from an economic point of view, it becomes clear that encouraging policy measures should be taken to expand rainbow trout farming in the İmranlı Dam Lake. However, since the rainbow trout culture provides economic benefits, researches should be carried out to solve the problems encountered in the İmranlı Dam Lake. The Turkish aquaculture sector has provided significant developments from the past to the present and has turned into a fishery industry by getting rid of a traditional structure. Fisheries supply chain has been established. The increase in the competitiveness of Turkey in the aquaculture sector in recent years is very promising for the future. It is expected that Turkey's aquaculture production will increase in the future and this increase will be met by aquaculture. The inadequacy of domestic production of fish meal and oil, which is an input for aquaculture, and our being a net importer, will bring the risk of foreign dependency on feed, which will increase in the future, which is the main input for fish farming. The cost of feed, which is the basic input of fish farming, is very important. In rainbow trout farming in net cages in İmranlı Dam Lake, expensive feed prices and foreign dependency on raw materials create risks and difficulties. Therefore, efforts should be made at the district, provincial, regional and national level to reduce the cost of rainbow trout feed. Since time is the most valuable resource in today's rapid developments, focusing on bio-economy studies in rainbow trout culture in İmranlı Dam Lake will contribute positively to the sustainable development of the aquaculture sector.

REFERENCES

[1] FAO, “State of fisheries and aquaculture in the world 2018 summary-implementation of sustainable development goals,” Food and Agriculture Organization of the United Nations, 191TR/1/01.19, Rome, Italy, pp. 1-26, 2019.

[2] M.R.R. Romana-Eguia, M.P. Rutaquio, R.C. Gutierrez and N.D. Salayo, “Assessment of tilapia-freshwater prawn co-culture schemes in tanks and lake-based cages for increased farm production,” Sustainability, 13, 13574, 2021.

[3] SPO, “Eighth five-year development plan. Fisheries and aquaculture industry specialization commission report,” State Planning Organization of Turkey, SPO: 2275-SC: 588, Ankara, Turkey, pp. 1-142, 2001.

[4] Ş. Yıldırım, “Fish farming in net cages in dam lakes,” Workshop report on farming alternative inland fish species, pp. 1-30, 2016.

[5] GDF, “Fisheries statistics,” Ministry of Agriculture and Forestry, General Directorate of Fisheries, Ankara, Turkey, pp. 1-21, 2021.

[6] FAO, “Yearbook of FAO, fishery and aquaculture statistics 2017,” Rome, Italy, pp. 1-109, 2017.

[7] TÜİK, “Fisheries Statistics,” http://www.tuik.gov.tr/PreTablo.do?alt_id=1005, Date of access: 24.11.2019.

[8] M. Aydoğan, O. Uysal, S. Candemir, T. Beşen, F.T. Çöteli et al, “Analysis of the effects of fisheries support,” Ministry of Agriculture and Forestry, Project Final Report, Black Sea Agricultural Research Institute Publications, 2019-3, ISBN: 978-605-2207-24-6, 2019.

[9] URL-1, "http://www.imranli.gov.tr/imranli-baraji," Republic of Turkey, İmranlı District Governorate, İmranlı Dam. Date of access: 01.02.2022.
[10] URL-2, "http://www.sivas.gov.tr/imranli," Republic of Turkey, Sivas Governorship, Districts, Date of access: 04.02.2022.
[11] A.T. Arslan, "Engineering geology study of İmranlı (Sivas) dam site and lake area," Cumhuriyet University, Graduate School of Natural and Applied Sciences, Department of Geological Engineering, M.Sc. Thesis, pp. 1-81, 1994.
[12] URL-3, "http://www.imranli.gov.tr/imranli-genel-gorunum," Republic of Turkey, İmranli District Governorate, İmranli general view. Date of access: 04.02.2022.
[13] B. Verep, H. Hasanoğlu and T. Mutlu, "A case study on physicochemical water quality effects of river discharged from trout farms wastewater," J. Anatol. Environ. Animal Sci., 2(2): 38-42, 2017.
[14] S. Dirican, "Cage aquaculture in Çamlıgöze Dam Lake (Sivas-Turkey): challenges and opportunities," Int. J. Agric. Nat. Sci., 14(3): 247-254, 2021.
[15] SAFAR, "Sivas Provincial Directorate of Agriculture and Forestry 2018 annual report," Republic of Turkey, Sivas Governorship, Provincial Directorate of Agriculture and Forestry, Sivas, Turkey, pp. 64, 2019.
[16] M. Karataş, M. Sayılı and B. Koç, "Structural and economic analysis of rainbow trout farms in Sivas province," J. Biol. Sci. Res., 1(2): 49-55, 2008.
[17] C. Hecer, "An overwiev to Turkish sea foods sector and consumption habits of Turkish consumers," Uludağ Univ. J. Fac. Vet. Med., 31(2): 45-49, 2012.
[18] A. Aydın and M. Sayılı, "Structural and economic analysis of trout farms in Samsun province," J. Gaziosmanpaşa Univ. Fac. Agric., 26(2): 97-107, 2009.