

## Production and Supply of Rainbow Trout in Iran and the World

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**Abstract:** Rainbow trout, is the endemic fish of North America, which is a successful farmed species, has been worldwide by transferring eyed eggs to all over the world. Nowadays, the portion of 25% of total production of farmed *Salmonidae* (2.3 million) belongs to this species and affects the important portion of world food security, consumption dissemination and increasing the fish consumption per capita in the world. Although it is not in the range of highest consumption, but 69 countries in the world culture it. The USA as the homeland of this species, beside Chile and Norway, Iran has spread the farming of this species of fish. This article reviews the farming of this fish in the most important countries of the world and also Iran. Iran during the past 18 years has approached 32 % production growth and 9 % production increase per plane unit and the farming area has been reached 230 hectares since 1960. For the time being, the value of transaction of this type of fish in the frozen, fresh and live fish has been reached one billion dollars and in Iran the increase of consumption is because of live-selling of this fish.

**Key words:** Rainbow Trout • Fish Culture • Trout Market • Farmed Trout • Aquaculture

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### INTRODUCTION

Salmonidae are one of the most valuable fishes in the world which include 70 species. They mostly are found in streams and cold lakes of North America and Eurasia and a large portion of sport and commercial fishery are focused on this type. Because of fishermen's interest on catching this species and simplicity of reproduction, they are widely found in cold and freshwater of south hemisphere. Trout and salmon fishes as a group are so compatible with cold and roaring water of northern hemisphere. Aquaculture of *Salmonidae* is somehow simple and numerous of reproduction utilities of trout and salmon fishes have been developed [1]. Salmonidae are one of the most important farmed fishes in the world and farming them are being done for centuries among different societies. Among this type, rainbow trout which has the most value because of its meat quality, simple farming and also sport fishing [2]. The rainbow trout is the local fish of North America and is wide spread in Northeast of Pacific Ocean from Mexico up to Kamchatka in Pennsylvania [3]. This species has been introduced to many parts of the world such as Japan, Europe, most southern and central areas of America, Africa, Far East, Austria and New Zealand [4].

The rainbow trout because of compatibly with most conditions and climates could reach this worldwide farming. Beside common carp, probable this is one of the oldest farmed fishes [5] which its rate of production is over than 580 tons per year [6].

In the year of 1998, the American fisheries society named this species as *Oncorhynchus* to separate it from Atlantic salmon and trout fishes. After that, it was argued that rainbow trout is the same species of Kamchatka trout, so the term of “*mykiss*” added to its name and was substitute with *gairdneri* and this name modification was accepted internationally [5]. Although the most biologists introduce the rainbow trout as a spawning fish in spring (February to June), but eggs are available during the whole year, which is because of selective breeding. It seems that the most important factor of spawning season is the photoperiod [7]. Usually the natural habitat of rainbow trout is in fresh water with temperature about 12°C in the summer, which the species can tolerate from zero centigrade up to 25 °C. The best temperature is between 10 up to 12°C and the optimize growing happens in 15 up to 20°C and the best spawning happens in 2 up to 10°C. In the good quality of water and proper temperature and accessibility of food they get mature around 2 till 3 years old [5].

The first restricted parameter in growing system of fish is oxygen. Although the fish can live in low oxygen such as 3 ppm, but for desired farming, the range of oxygen has been advised between 5 up to 7 ppm. The second restricted parameter is ammonia. Ammonia is produced from discharged metabolic materials which contains protein catabolism (Amino acid). By increasing pH and temperature the portion of un-ionized ammonia gets higher which is dangerous to fish [3].

Referring to latest published statistics, more than 822 tons of *Salmonidae* are caught in a year in the world, which the portion of rainbow trout is only 5166 tons.

This quantity has had -1.2 % growth since 1999 up to now and the most fishing belongs to Mexico (2180 t), England (1461 t) and Finland (554 t). But in contrast, nowadays farming the trout has got a high portion of *Salmonidae* farming [6].

**Farming the Trout in the World:** Most probably the rainbow trout is one of the oldest farmed fishes, which its eggs have been available since 1872 and on the other hand this is the only species which has been worldwide through transferring the eyed eggs [8]. Based on reports, green transferred the eyed eggs in the 1879 from McCloud River in the North California one hatchery near Berkeley in California to its personal hatchery in New York kaldonia [5]. Stone also in 1879 established the first spawning station of rainbow trout in California in McCloud River and by supporting the USA, fish and fishing committee; eggs were distributed to all over the America [3]. Today experts believe that the first successful transferring the rainbow trout eggs to out of the America was happened in 1877 to Tokyo, Japan. In the year of 1885 the second part was transited to England and Scotland. In the 1980s, the commercial farming of rainbow trout was started in Denmark. The stored eggs in hatcheries in England, Scotland and Denmark were transferred to all points of the Europe. In the 1970 the first eyed eggs were sent to Turkey by Papilla, from its personal farm in Bilsik (This farm is still working) [8]. Chart 1 and 2 shows quantity of world production of fishing and farmed trout.

The most important countries of production and breeding the trout are Chile, Norway, Italy and Iran (Chart 3). This article studies the situation of production in Iran and some other countries. Based on the latest published statistics, about 576.2 thousand tons of rainbow trout valued 2.4 billion dollars are cultured by 69 countries in the world. This species, after Atlantic salmon is the most important farmed fish among *Salmonidae*.

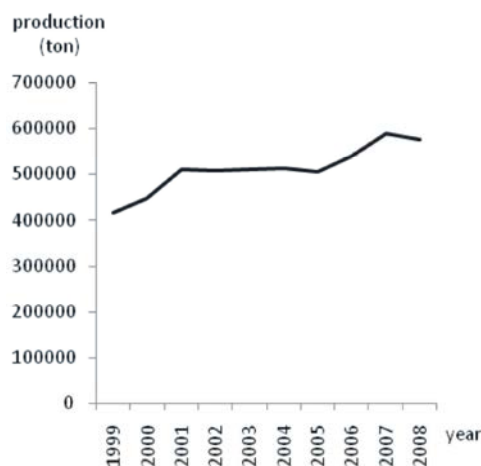


Chart 1: The quantity of world production of farmed trout (ton) [6]

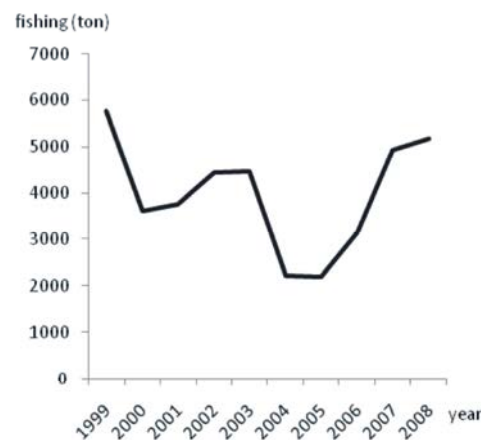


Chart 2: The quantity of world fishing of trout (ton) [6]

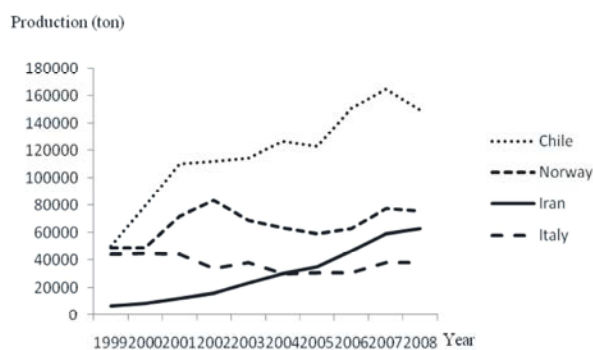


Chart 3: Comparison of the trout production of Iran with other illustrious countries [6]

Norway, England and Chile have the highest range of the production of Atlantic salmon in the world. About 1.4 million tons of Atlantic salmon with the value of 7.2 billion dollars is farmed in the world.

Table 1: Production of farmed trout in some prevailing countries (ton) [6, 9]

country	1981	2008
Denmark	19000	31449
Finland	7000	12639
France	21000	32270
Germany	12000	22005
Italy	21000	37800
Japan	20000	6793
Norway	4000	75316
Sweden	2000	4906
England	5200	13090
United States	20000	16213
Iran		62630
Chile		149411
Spain		21472

Weigh factor of Atlantic salmon is higher than rainbow trout and this species is farmed only in 19 countries in the world. The Table 1 shows Production of farmed trout in some prevailing countries.

**The United States of America:** Considering the age of farming, the production methods of rainbow trout are similar in all the USA and the trout fish is farmed in flowed system such as earthen ponds, raceways and tanks. The quality and quantity of water are important factors in the capacity of production. Access to freshwater and environmental matters such as discharge sewages to other waters resources, are the most important factors for the USA in expanding and developing the farming trout. Providing the initial quantitative and qualitative requirements for water to farm the trout, has limited expanding the facility for farming based on modern technologies. So, the other way is to approach the higher density of farming and improve the production efficiency. Also by developing the breeding vaccination to control the diseases and modern technologies of production, the potential of production growth can be provided [3].

**Turkey:** During many years, the Black sea area has produced 70% fish in Turkey, decreasing the fishing and proper places of fishing caused starting aquaculture in 1971 by rainbow trout. In the 1980s, the farming of *Salmo salar* started in the Black sea, but because of reaching water temperature to 20°C in the summer which is critical temperature for farming of this species, the farming was not successful. Total production of farmed rainbow trout in 1997 in Turkey was 28500 tons, which the portion of the Black sea has been 13875 tons. Also the total production

Table 2: The quantity of export of Atlantic salmon and farmed rainbow trout of Norway (ton) 1982 [4]

Country	Salmon	Rainbow trout	Total
France	2710	260	2970
Germany	1850	350	2200
Denmark	1240	280	1520
Sweden	590	580	1170
United Kingdom	930	110	1040
U.S.A	762	243	1005
Switzerland	350	140	490
Belgium	370	90	460
Spain	270	40	310
Finland	140	40	180
Holland	120	60	180
Japan	40		40
Other	40	5	45
Total	9412	2198	11610

of farmed rainbow trout in the Black sea area increased from 60 tons per year in 1973 to 13875 tons in 1999, which caused highlighting the Turkey aquaculture after joining Turkey to Europe Union [10]. During this period, the number of farms (24.5 %) and the range of farming the rainbow trout (23.3 %) have been increased in the Black Sea area [11].

**Norway:** Atlantic salmon<sup>1</sup> and rainbow trout are two species which are farmed intensively in Norway. During the past years, farming the Atlantic salmon has been prevailed. The most portions of Norway farmed fishes are exported. Atlantic salmon is the most important farmed fish in Norway. Export of rainbow trout is less than Atlantic salmon and consumption of this species in the total market of Norway is not so customary, because it is not the local fish of Norway waters and it is not so known for the people of Norway. Although the production of rainbow trout has been increased from 400 tons per year in 1971 to 4700 tons in 1982, but it is predicted that the production will remain constant in the range of 5000 tons per year. Still it is an important matter that the farmers begin their work by farming the trout rather than the salmon, because farming the trout is simpler than the salmon but farming the salmon has more income. The production of trout of Norway is exported to Sweden, as the largest market, France, Germany and Denmark [4].

The export of Norway salmon fish to the market of western European countries has been fixed and it is moving toward export development to the other markets such as Middle East (Table 2) [4]. The Chart 4 Comparison of farmed salmon and farmed rainbow trout production in Norway. Knowing the target market's requirements and

<sup>1</sup>Salmo salar

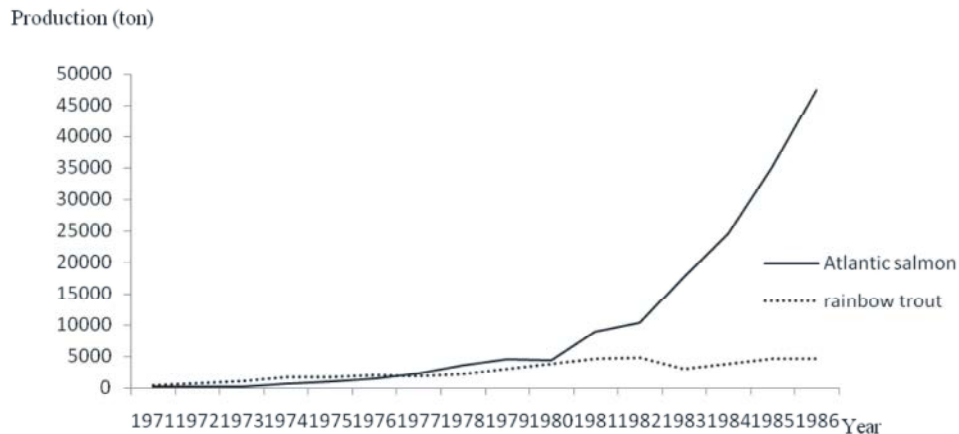


Chart 4: Comparison of farmed salmon and farmed rainbow trout production in Norway[4]

conditions can help the export development. For example, the priority of fillet's request in the USA, meat color in England, skin color in Japan and fresh fish in France and Japan can improve the marketing [12].

Although the USA exports about 135000 tons of *Oncorhynchus* (one of the species of salmon of Pacific Ocean), which is more than export of Norway with 9000 tons of Atlantic salmon fish, but the production of the USA is supplied to the market in a very short period of time in the frozen and canned form, but the Atlantic salmon of Norway is supplied with high quality and fresh in all times of the year [4].

**Chile:** The industry of *Salmonidae* farming is still fresh. This industry started activity in 1978, by farming commercial rainbow trout and Coho fish in cages and developed rapidly till mid 1980s. They could progress the range of production of 500 tons in 1984 and reached the second ranking of the world in salmon production in 1992 by the range of 662.2 thousand tons per year. In the year of 2001 the production range of Chile and Norway got the same level, which was about 500 thousand tons. In the year of 2002 and 2003 the range of aquaculture production declined in Chile, but in 2004 could get a new record by 570 thousand tons per year.

The average growth of this industry during ten years, 1989 till 2009 has been around 42% per year. In the 1990s, the production of trout increased sharply, which could exceed the production of Coho in 1997 [13]. During the recent years Coho fish of Chile has been supplied to Japan in the frozen form and the large portion of *Salmo salar* has been supplied to the USA market in fresh fillet form. Some southern parts of Chile have proper and capable climate to farm the salmon [14] and also provides the good conditions for farming the smolt during the year.

As the Chile is located in southern hemisphere and the seasons are vice-versa of northern hemisphere, so the farmers in Chile can supply the fresh fish during slack seasons in northern hemisphere. For the time being, Chile has the first grade in trout farming by 150 thousand tons [6].

**Farming Trout in Iran:** The endemic species of trout in Iran is *Salmo trutta fario*, but by coming the rainbow trout to Iran, farming of this species started in Iran in 1960 in Karaj farming yard [15] At that period of time this farming yard with capacity of 120 tons, Jajroud farming yard with capacity of 180 tons in 1966 and Fars Yegandasht farming yard with capacity of 300 tons in 1977, were the most important yards in Iran [16]. But nowadays, by governmental support and investments, the farming area has been improved totally and the integrated fish farming area including Palangan and Sirvan in Kordestan, Gamasyab in Hamedan and also personal farming yards in Fars province and Haraz riverside in Mazandaran province has reached 230 hectare under farming. Since the beginning of farming trout in farm, this activity has had great achievement and moreover personal farming in race ways, this industry is being done in other systems such as integrated fish farming, multipurpose water pool reservoirs, paddy fields, recalculating systems, earthen ponds and closed area such as canals, cages and pen culture.

By using these methods the range of production with 835 tons in 1993 has reached 91519 tons in 2010 and the growth has been 31.8% during this period (Chart 5). In this period of time the farming area by 21% of growth has been reached 230 hectare and production per metric unit by 9% of growth has been reach from 9.3 kg/m<sup>2</sup> to 39.8 kg/m<sup>2</sup>, which shows a desirable situation. Its food convert ratio (FCR) is 1:1.3 now.

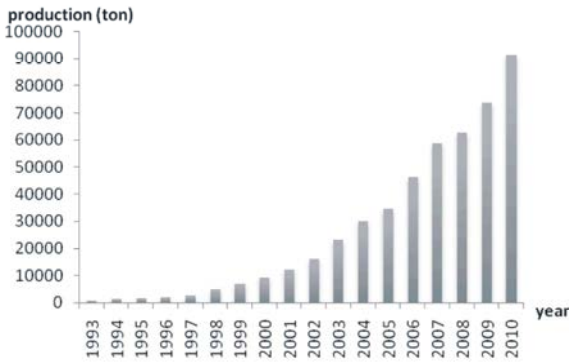


Chart 5: Amount of the trout production in IRAN [17, 18]

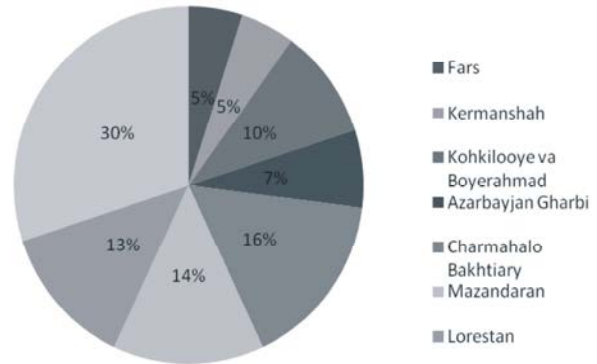


Chart 6: Comparison of trout production portion of provinces in 2010 [17]

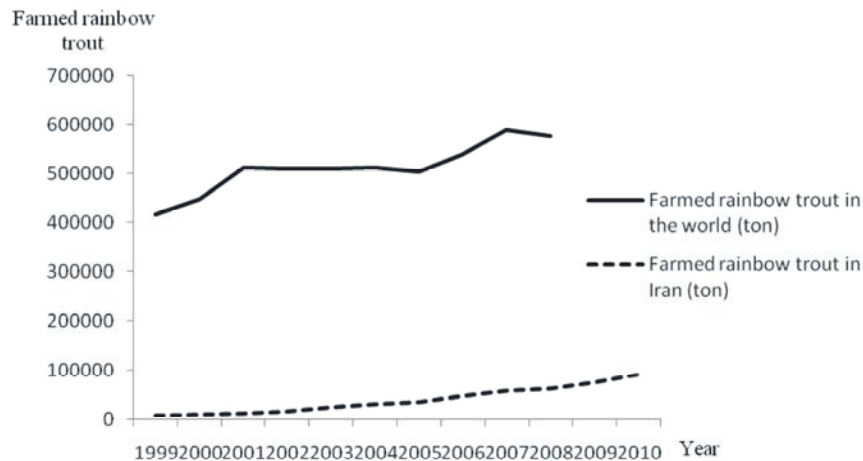


Chart 7: Comparison of farmed rainbow trout of Iran and the world [6]

All over Iran, 28 provinces have farming of cold water fish, which based on latest statistics, the most production is related to Chaharmahal Bakhtiari province (14188 T), Mazandaran province (12456 T) and Lorestan province (11885 T). Also during past ten years the highest growth has been related to khozestan province (113%), Kermanshah province (50.1%) and Zanjan province (36%). The below pie chart (Chart 6) shows the portion of farmed trout production of provinces in 2010. As it is clear in the chart, 70 % of production in Iran belongs to seven provinces [17]. The Chart 7 shows Comparison of farmed rainbow trout of Iran and the world.

**Supplying the Trout in Iran and the World:** The most important portion of import and export of the trout fish (5166 tons fishing + 5762 thousand tons of farming) in the year of 2008 belongs to frozen, cold and fresh and live farm, as it is shown in Table 3. During the years of 2006 till 2008, the export of live fish has decreased and import

increased and the financial turnover has been double for fresh and cold trout and has had average growth of 16 % for frozen trout.

The export of all productions of the trout shows that the weight value of fresh and cold trout which was the highest value among other products in 2006 has no change totally in 2008, but on the other hand, the weight value of frozen trout and live trout has been sharply increased. The import of all productions of the trout shows that the weight value of live trout is not comparable with other types and has been pioneer all the times, so that, even the weight value of frozen type has decreased. The Table 4 shows The most amount of export and import of all types of trout products in 2008.

There is not a specific research in Iran on the supplying the trout, but %36.5 of supplied aquatics in the local market belongs to trout. All types of trout which are available in the world are supplied in Iran, but regarding the supplying of live trout since 1997, it has had the most

Table 3: The world export and import of all types of trout 2006 and 2008 [6]

Production	Export of the world (ton)				Import of the world			
	2006		2008		2006		2008	
	Amount(ton)	Value (thousand USD)	Amount (ton)	Value (thousand USD)	Amount (ton)	Value (thousand USD)	Amount (ton)	Value (thousand USD)
Live trout	15337	60350	14929	74923	15873	101626	15998	121119
Fresh and chilled trout	32721	150296	67488	305687	31728	141807	65243	297703
frozen trout	105044	461214	143197	563021	98663	426037	132015	554427

Table 4: The most amount of export and import of all types of trout products in 2008 [6]

Production	The most export 2008			The most import 2008		
	Country	Value (thousand USD)	Amount(ton)	Country	Value (thousand USD)	Amount(ton)
Live trout	Denmark	23002	4287	Germany	15647	4070
	France	14762	3321	Hong Cong	68566	3328
	Italy	10159	3016	Belgium	7066	2180
Fresh and chilled trout	Norway	190804	42800	Russian Federal	145317	31532
	Sweden	19687	5644	Wetland	21808	6313
	Denmark	24058	4680	Ukraine	12728	2943
Frozen trout	Chile	311168	85780	Japan	222044	53730
	Norway	131938	30983	Russian Federal	123435	27987
	Denmark	44543	7946	Thailand	56618	12930

adoption among people and researches show that 60% of the first priority of purchasing aquatics among Tehran citizens is the trout. So, regarding the local potentials and high request, improvement the production plans is in the governmental prospects [19].

### DISCUSSION AND CONCLUSION

The statistics of FAO showed that the total fishing of the trout in 2008 was 5166 tons, which the countries of Mexico with 2180 tons, England with 1461 tons and Finland with 554 tons have had the highest amount of fishing the trout. But nowadays, by developing the trout in the USA since 1877, farming the trout has got ahead of fishing the trout and has reached 576 tons by the value of 2.4 billion dollars, in the world. The value of farmed trout during a nine-year period till 2008 was 8%. It means that the value per kg with 2.9 dollars in 1999, has reached 4.1 dollars in 2008.

The countries of Chile with 149.1 thousand tons, Norway with 75.3 thousand tons and Iran with 62.6 thousand tons have had the highest range of farming the trout in the world and Italy as one of the most important countries in this field is located after mentioned countries.

Although Iran has the third ranking, but it has the highest growth among other countries with 27.6% growth during the mentioned period, but Chile has the growth of 12.8% and Norway has the growth of 5%. On the other hand, the growth rate of Italy was -1.7%. The decade of 1980 Europe had a constant growth in the fish farming industry and it was worrying that the production remains constant, but by changing the life style and growing the knowledge of people regarding the nutrition facts of aquatic in comparison with other protein resources, the growth rate of production has got a better situation. It was estimated that 16 thousand tons of trout fish in the EU have been sold frozen in 1989. This amount was 10% of total production of the EU. It was found out that the reason of growth of request in Europe, is the supplying the trout in the form of fillet. As the statistic show, the trout is not directed to the high-income of society and still its price is the main parameter in purchasing, but beside that cost and quality should not considered individually. The facility of purchasing is also regarded [20].

In Iran also, referring to people's tendency and people's awareness of fish's nutrition facts, the request for fish consuming, specially trout, is getting improvement. So, by investment in this field and by using production

modern techniques such as farming in integrated fish farming system, multipurpose water pool reservoirs, recirculation systems, paddy fields, raceways, cages, canals and pen, can cover the local markets needs and on the other hand by considering the potential of production of farmed rainbow trout, can go toward export in the level of world standards.

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