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PROOF

A Comparative Assessment of Turkish Inland Fisheries and Aquaculture Using Economic Sustainability Indicators

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Abstract

This paper aims to shed light on economic dimensions of inland capture fisheries and aquaculture in Turkey and to provide further comparisons of performance and development trends in both subsectors at national level by using some macro-economic and market indicators. To this end, indicators *inter alia* per capita domestic supply, contribution to GDP, ratio harvesting weight and value, mean real price/kg were computed using secondary data from the 1996-2009 period. The outcome of comparative assessment, e.g. supply, per capita supply, contribution to GDP, ratio harvesting weight and value, does provide evidence for increasing economic importance of aquaculture and changes in market dynamics for freshwater aquatic products in Turkey. While inland aquaculture, especially rainbow trout farming, is emerging as a major supplier and player in market for freshwater fish species, inland capture fisheries is also losing ground. Taking into account the importance of inland fisheries from socio-economic perspective, effective policies and management measures are to be implemented to ensure economic sustainability of this subsector. On the other hand, inland aquaculture subsector also has to address challenges such as unregulated single-species supply, species diversification, product diversification/differentiation and image building to ensure its sustainability.

Keywords: Inland capture fisheries, Inland aquaculture, Economic Indicators, Turkey.

Ekonomik Sürdürülebilirlik Göstergeleri Kullanılarak Türkiye'de İç Su Ürünleri Avcılığı ve Yetiştiriciliğinin Karşılaştırmalı Değerlendirilmesi

Özet

Bu çalışmada, Türkiye iç su ürünleri avcılığı ve yetiştiriciliği alt sektörlerinin ekonomik boyutunun ortaya konulması amaçlanmıştır. Ayrıca bazı makro ekonomik ve pazar göstergeleri kullanılarak iki alt sektörün ulusal düzeyde performansı ve gelişme eğilimi karşılaştırılmıştır. Bu amaçla; 1996-2009 dönemine ilişkin ikincil veriler kullanılarak kişi başına düşen arz, GSYİH' a katkı, hasat miktarı ve değeri oranları ile ortalama reel fiyat/kg gibi bazı göstergeler hesaplanmıştır. Toplam arz, kişi başına düşen arz, GSYİH' a katkı ile hasat miktarı ve değeri oranları gibi göstergelerin karşılaştırmalı değerlendirmesi; iç su balıkları yetiştiriciliğinin ekonomik açıdan öneminin arttığını ve pazar dinamiklerini değiştirdiğini kanıtlamaktadır. İç su balıkları ve özellikle Gökkuşağı alabalığı yetiştiriciliği pazarda önemli bir tedarikçi ve aktör haline gelirken; iç su ürünleri avcılığı giderek zemin kaybetmektedir. İç su ürünleri avcılığının sosyo-ekonomik önemi bu alt sektörün ekonomik açıdan sürdürülebilirliğini sağlayacak etkin politika ve yönetsel düzenlemelerin hayata geçirilmesini gerekli kılmaktadır. Diğer taraftan; iç su balıkları yetiştiriciliği alt sektörü de; sürdürülebilirliliğin sağlanması açısından denetimsiz tek tür balık arzı, tür çeşitlendirmesi, ürün çeşitlendirmesi/farklılaştırması ve imaj gibi konuları ele alarak çözüm aramalıdır.

Anahtar Kelimeler: İç su ürünleri avcılığı, iç su balıkları yetiştiriciliği, ekonomik göstergeler, Türkiye.

Introduction

Following the adaptation of Code of Conduct for Responsible Fisheries (CCRF) by Food and Agriculture Organization (FAO) of the United Nations in 1995, sustainability or sustainable development has become the core element of fisheries and aquaculture management policies. CCRF regards fisheries and aquaculture as vital sources of food, income, employment, and more generally a contributor to economic development and underlines the need for data collection, analysis and research on

economic, social, marketing and institutional aspects of fisheries to ensure effective management both sectors (FAO, 1995).

Undoubtedly, formulation of appropriate management schemes to yield the desirable and sustainable social and economic benefits would not be possible without clear understanding and assessments of status and development trends of any system/sector. On the other hand, gaining clear understanding and assessment would require quantitative and qualitative information regarding the status and development patterns of sectors concerned. With increasing concerns regarding the sustainable use of natural resources among public, civil society organizations and scientific communities, the use of indicators as a practical tool to assess existing status, identify development patterns and monitor ecological, economic and social aspects of fisheries and aquaculture sectors is gaining popularity and support among international and national advisory and management bodies (Bonzon, 2000; Hundloe, 2000; Sabatella and Franquesa, 2004; Liu and Ou, 2007; Ünal and Franquesa, 2010). Many indicators have been developed by scientists and/or international organizations to assess and analyze the performance of fisheries and aquaculture sectors from social and economic perspective (Bonzon, 2000; Hundloe, 2000; Sabatella and Franquesa, 2004; Ceriola et.al., 2008).

From a socio-economic perspective, inland capture fisheries and aquaculture play important roles in food security, generation of income, employment and economic growth throughout production and trade in many countries (Payne, 2000; Phuong and Gopalakrishnan, 2004; Welcomme et al., 2010). Turkey, where 3,149 licensed fishing boats and 1,468 farms were engaged in inland fishing and farming activities, producing 115,435 tons of aquatic products in 2009, is no exception. However; it is widely acknowledged that the contribution and benefits of inland fisheries and aquaculture to national economies and food security is usually overlooked and under-valued by policy makers (Welcomme, 1998; Welcomme, 2001; Farrington and Mundy, 2002; De Silva and Moehl, 2003). In his comprehensive works on development and management framework for inland fisheries, Welcomme (1998, 2001) argues that the basis for planning and management of inland fisheries rests on a clear understanding of the sector's place in national interest and economy, *inter alia* production value, employment and its contribution to national diets. De Silva and Moehl (2003) also stress that, the potential role of inland fisheries and aquaculture in the national economies and their contribution to food security has to be made more visible. From a sustainability perspective, Ahmed and Garnett (2010) further emphasize that the long-term continuity in production should also be taken in to consideration when assessing any system.

Characterizing socio-economic dimensions of inland capture fisheries and aquaculture at the national level is certainly an essential step for proper planning and policy development. However; assessing the trends in sectoral performance and the contributions of both subsectors to national economies over time is also crucial for understanding weaknesses and threats, and thereby formulating management practices for economic sustainability. In this context, the present paper aims to shed light on economic dimensions of inland capture fisheries and aquaculture in Turkey and to provide further comparisons of performance and development trends in both subsectors at national level by using some macro-economic and market indicators. An assessment on policy implications for economic sustainability of both subsectors from market perspective is also made to provide some insight for policy and decision makers.

Methodology

Indicators are data or combination of data collected and processed for a clearly defined analytical or policy purpose (Sabatella and Franquesa, 2004). These facilitate the process of assessing the performance of fisheries policies and management. They further promote understanding and communication around key sustainability issues and support decision making and policy setting for sustainable development (FAO, 1999; Potts, 2006). Macroeconomic and market indicators which have been used in this study include some of those developed for marine capture fisheries by FAO (1999); The Scientific, Technical and Economic Committee for Fisheries (STECF)-European Commission (2003); Scientific Advisory Committee of General Fisheries Commission For the Mediterranean (see Sabatella and Franquesa, 2004); Hundloe (2000) and Ceriola et. al. (2008). Financial indicators have not been included in this study because of the lack of consistent time series on financial aspects of inland capture fisheries and aquaculture operations e.g. revenue and production costs at national level.

The following indicators, which were constructed for 1996-2009 period, were used in this study:

Supply

Evolution of supply in inland capture fisheries and aquaculture products was constructed both in terms of volume and value to compare their significances in overall national production of freshwater aquatic products. For an inflation-free set of data, production values in Turkish Lira were deflated.

Per Capita Domestic Supply (kg)

Trends in per-capita domestic supply of inland

fisheries and aquaculture products were estimated to assess the evolution of production of inland capture fisheries and aquaculture products with regard to population growth.

Composition of Landings

Composition of inland capture fisheries landings for 1972 and 2009 were constructed to assess the evolution of catch over time, in terms of most-harvested species.

Contribution to Gross Domestic Product

Trends in contribution of both inland capture fisheries and aquaculture to GDP is estimated to assess their economic significance in national economy.

Number of Harvesting (Fishing Boat/Fish Farm) Units

Number of boats has been proposed as one indicator of harvesting capacity for fisheries sectors by FAO (Sabatella and Franquesa, 2004). For purposes of this study, the number of licensed farms has been treated as an indicator of harvesting capacity of aquaculture. Evolutions of harvest capacitates in both subsectors were constructed to also assess their capabilities in terms of job generation.

Ratio Harvesting Weight and Value

Ratio harvesting value (RHV) and weight (RHW) are among socio-economic indicators which have proposed by GFCM-SAC (Sabatella and Franquesa, 2004) to assess the importance of capture fisheries in comparison to aquaculture in terms of income and weight of production. Here;

RHV = LV / AQV and

RHW = LW / AQW

where

LV and LW are fisheries landings in value and weight and,

AQV and AQW are aquaculture production in value and weight.

Mean Unit Price (TL kg^{-1})

The unit price of fish is regarded as a proxy, which could convey information regarding economic sustainability of fisheries and aquaculture. Price movements over time would shed light on demand and supply patterns for aquatic products and further on gross returns from fishing or farming activities and overall profitability (Hundloe, 2000). To this end, current price-time series for inland capture fisheries and aquaculture products in Turkish Lira (TL/kg) were deflated to obtain inflation-free and comparable data.

Not having access to price- time series for fisheries products prior to 1996 at national level, the year 1996 was chosen as the base year for consistently constructing the indicators used in this study. The time series used in this study include inland capture fisheries and aquaculture production (Volume & value) figures, gross domestic production (GDP), population, number of licensed farms and fishing boats as well as mean prices for inland capture fisheries and aquaculture products are based on official fisheries statistics published by Turkish Institute of Statistics (TURKSTAT, various years) and Ministry of Agriculture and Rural Affairs (MARA, 2004, 2007). To eliminate the effect of inflation, monetary variables e.g. mean prices and value of landings by capture fisheries and production by aquaculture are given in deflated Turkish Lira (TL), using wholesale price index published by Turkish Institute of Statistics (TURKSTAT). 1996 was taken to be the base year.

Background Information on Turkish Inland Fisheries and Aquaculture

Turkey possesses 6,000 km^2 of lakes and reservoirs on which 3,149 licensed fishing boats were engaged in fishing activities in 2009. Cooperatives are mainly localized in Mediterranean, Eastern and Central Anatolia regions where the bulk of the inland capture fisheries products are landed. Overall, small fishing boats of 3-10 m lengths with engines of 10-15 HP are used in fishing activities. In Eğirdir Lake, boat lengths are 4-8 m and engine powers are 4-22 HP (Balık et. al., 2006), whereas longer boats of 6-9 m with more powerful engines (10-32 HP) are employed in fishing activities in Iznik Lake (Doğan, 2009). In 1990's, wooden boats were used in Eğirdir Lake, but these days, metallic or fiberglass-coated wooden one are more common (Balık et. al, 2006). Productivity (catch per unit area) varies between 9.4-27.2 kg/hectare depending on the sizes of reservoirs (Tüfek, 2006). Lake of Van, and Atatürk and Keban dam reservoirs are the major fishing grounds in Eastern Turkey with significant contribution to inland capture fisheries.

Aquaculture in Turkey started with farming of common carp (*Cyprinus carpio* Linnaeus, 1758) and rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792) around 1970's. However, even though rainbow trout farming is now a major supplier of fisheries products in Turkey, carp farming has not been able to flourish. In 2009, portion-sized farmed rainbow trout (75,657 tons) constituted nearly 48.0% of total aquaculture production (158,729 ons) in Turkey and is ranked as number one cultured species. Sea bass (*Dicentrarchus labrax* Linnaeus, 1758) and sea bream (*Sparus aurata* Linnaeus, 1758) are second and third most important aquaculture species in Turkey. Aquaculture production of sea bass and sea bream for 2009 was reported as 46,554 and 28,362 tons, respectively, in

2009. According to the data from Ministry of Agriculture and Rural Affairs, out of 1,468 inland farms in Turkey, in 2009, 1,416 are involved in rainbow trout production. Rainbow trout farms are spread all over Turkey, but the bulk of the production comes from Aegean, Black Sea and Central Anatolia regions. A majority of the farms (1,085) are small-scale family-run enterprises with capacities ranging from 1 to 30 tons. However, the new trend in recent years is the emergence of large-scale operations. There are now over 200 inland rainbow trout farms with annual capacities of 100-2,500 tons. Naturally, the average farm size, which was 26.4 tons/year in 1996 (Rad and Köksal, 2001) increased to 68.5 tons/year in 2009. Rainbow trout farms are mainly land-based facilities using concrete raceways, though a few farms use earthen ponds. There are also cage farms operating in dam reservoirs. Most of the farms operate their own hatcheries during natural spawning season of broodstock, but the use of imported summer eggs and photoperiod techniques are now common practices in many farms. These practices help toward more efficient uses of the facilities (hatchery and raceways) and water, by starting a second production cycle in summer months. On-growing period for fish of 250-300 g varies between 10-12 months, depending on water temperatures. Better feed management and the use of extruder feeds in recent years has improved feed conversion ratios. An FCR of 1.1-1.2 is now the norm in many farms compared to 1.6-1.8 in 1990s. Nearly 90-95% of production in inland trout farms is portion-sized fish. Some farms involved in production of portion-sized fish tend to continue on-growing of fish to more than 750 g, which is then marketed as the so-called "Salmon-Somon". But this practice is not financially feasible for every farm, due to poorer FCR in large fish and delayed cash flows. Therefore, large rainbow trout production in inland farms does not exceed about 5-10% of total production.

On the other hand, production of large rainbow trout in marine farms (Black Sea, 16-18 ppt salinity) using off-shore cages has become popular since 1990's. After Atlantic salmon farming (*Salmo salar*, Linnaeus 1758) failed in Black Sea due to high water temperatures and low oxygen levels during summer months, fish farmers have shifted to farming of rainbow trout in that sea, because it is more tolerant to the local conditions. Fish of 150-250 g. are stocked in cages during September and are on-grown to 750-1,500 g until May or June when they are harvested before water temperature and oxygen levels become critical and are marketed as "Salmon-Somon" in the domestic market.

Common carp is the main carp species commercially farmed in Turkey. However, carp farming has not able to flourish in Turkish aquaculture sector, mainly because the supply from capture fisheries are readily available this species is unpopular in Turkey. The number of farms engaged in common carp production has thus decreased from 66 in 1999 (Anon., 2001) to 32 in 2009. Fry production of grass carp (*Ctenopharyngdon idella* Valenciennes, 1844) for restocking purposes is practiced by State Water Affairs, but the commercial production of this species is yet to be developed.

Development Trends in Turkish Inland Fisheries and Aquaculture

Volume and Value of Landings/Harvest (Supply)

According to TURKSTAT figures, total national landings of capture fisheries and harvest of aquaculture products in Turkey was 623,191 tons, in 2009. Figure 1 clearly reveals the growth in contribution of both marine and inland aquaculture to national supplies of aquatic products in Turkey during 1996-2009, while illustrating fluctuating or declining landings from capture fisheries from both marine and inland waters. Contributions of inland capture fisheries and aquaculture to overall national supply of aquatic products in 2009 were 39,187 and 76,248 tons, respectively (Figure 1). Thank to the rapid development of inland aquaculture, the share of both subsectors (115,435 tons) to national supply of aquatic products corresponded to 18.5% in 2009.

Trends in the supply of inland capture fisheries and aquaculture, in terms of volume and value, during 1996-2009 are presented in Table 1. Two distinctive trends are observed in the supplies from inland capture fisheries and aquaculture. One is the emergence of inland aquaculture as a major contributor to overall production of aquatic products in Turkey, both in terms of volume and value. The other is the stagnant or decreasing contribution of inland capture fisheries to national supplies. While the supply from inland capture fisheries has fallen from 42,202 tons in 1996 to 39,187 in 2009, the supply from inland aquaculture has risen by over 300% in the same period, increasing from 17,960 tons in 1996 to 76,248 tons in 2009. Similarly, the value of farmed products has increased by 276% during 1996-2009, whereas there has been a 5.0% reduction in value of production by inland capture fisheries. Consequently, in 2009, inland aquaculture output constituted nearly 66.0% of supply from inland waters in volume and over 72.0% in value (Figures 2, 3).

Per Capita Domestic Supply

Trends in per-capita domestic supply by inland capture fisheries and aquaculture are shown in Figure 4. Per-capita supply of aquatic products by capture fisheries has been falling since 1999; it was estimated at 0.54 kg in 2009. Regardless of some fluctuations during 2001-2003, the general trend in per capita supply by inland aquaculture is positive, thanks to the rapid growth in production of rainbow trout. Per-

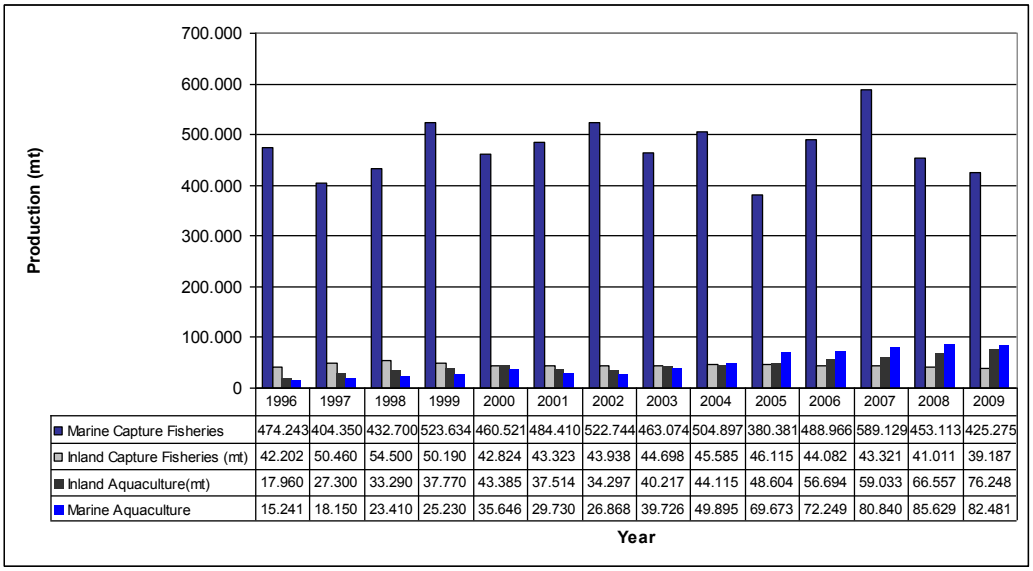


Figure 1. Trends in total supply of fisheries and aquaculture products in Turkey (volume, tons).

Table 1. Volume and value of supply from inland capture fisheries and aquaculture during 1996-2009.

Year	Inland Capture Fisheries		Inland Aquaculture	
	Volume (tons)	Value (TL, 1.000.000)[1]	Volume (tons)	Value (TL, 1.000.000)[1]
1996	42.202	8.153.260	17.960	5.349.000
1997	50.460	10.136.095	27.300	9.065.100
1998	54.500	9.388.280	33.290	11.240.774
1999	50.190	7.520.242	37.770	11.153.295
2000	42.824	7.924.201	43.385	12.417.090
2001	43.323	6.495.780	37.514	10.056.642
2002	43.938	7.763.034	34.297	10.253.702
2003	44.698	6.700.470	40.217	11.823.080
2004	45.585	6.103.757	44.115	10.607.722
2005	46.115	8.133.537	48.604	14.331.456
2006	44.082	8.985.795	56.694	16.854.775
2007	43.321	9.005.290	59.033	18.584.895
2008	41.011	8.451.170	66.557	19.725.076
2009	39.187	7.741.531	76.248	20.118.829

1: Deflated TL, base year=1996.

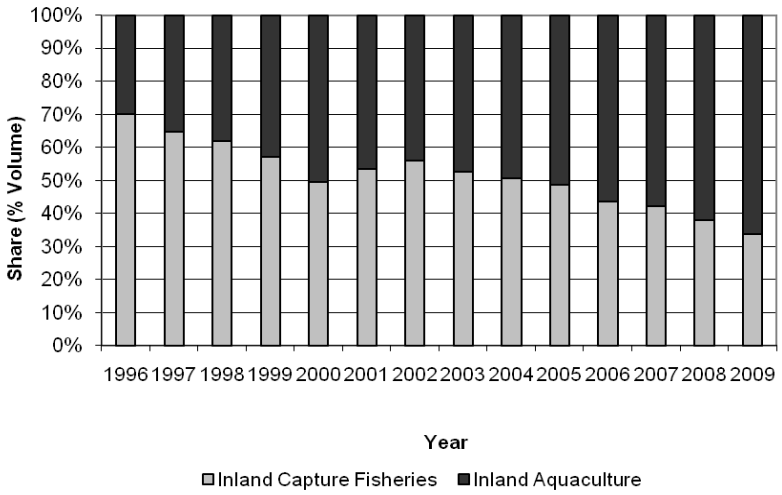


Figure 2. Trends in share of inland fisheries and aquaculture in overall supply of inland aquatic products (%, Volume).

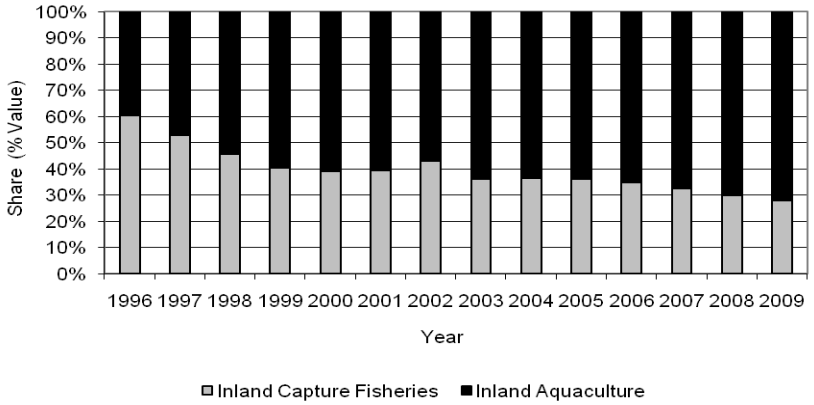


Figure 3. Trends in share of inland fisheries and aquaculture in overall supply of inland aquatic products (%, Value).

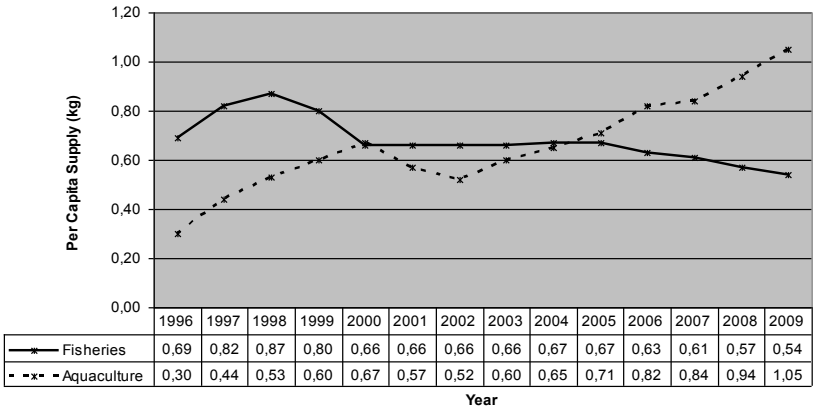


Figure 4. Trends in per capita domestic supply of inland capture fisheries and aquaculture products.

capita supply by inland aquaculture, (dominantly portion-sized rainbow trout) has reached 1.05 kg in 2009. Taking into account that per capita consumption of fisheries products in Turkey is about 8-9 kg, the contribution of inland aquaculture to total national supply of fisheries products is not negligible.

Composition of Landings

Stagnant or declining supplies are not the only outstanding trend in Turkish inland capture fisheries. Catch composition has also changed in recent years due to anthropogenic stressors and resulting ecological imbalances. While common carp (48.0%), wels (*Silurus glanis* Linnaeus, 1766; 13.0%), goby (*Gobidae spp*., 11%), pearl mullet (*Chalcarburnus tarachi* Pallas, 1811; 6.0%) and pike (*Esox lucius* Linnaeus, 1758; 4.0%) were the top 5 species harvested in Turkish inland waters (Figure 4) in 2972, pearl mullet (27.0%), carp (28.0%),, sand smelt (*Atherina boyeri* Risso, 1810; 16.0%), snails (%6.0), tench (*Tinca tinca* Linnaeus, 1758; 4.0%) and pike-perch (3.0%) were ranked as the top 5 species in 2009, constituting 84.0% of the catch of freshwater species (Figure 5).

The most remarkable changes in composition of inland capture fisheries landings are those for goby, sand smelt (highly euryaline species found both in marine and freshwater ecosystems), and tench. Landings of goby have decreased from 1,841 in 1976 to 76,0 tons in 1989 and was reported as 51,0 tons in 2009. While goby is no more a significant contributor to inland capture fisheries production, sand smelt and tench landings are emerging as new contributors. While no landings were reported for tench in national fisheries statistics until 2000, landings of this species have been steadily increasing ever since and recorded as 1,482 tons for 2009. The increase in landings of tench is probably due to the catering sector's demand for cheap fish fillets. Significant increases in landings of sand smelt in recent years seems to be due to accidental or intentional introduction of this species to major freshwater lakes and reservoirs by fishermen or anglers, with substantial negative impact on other fish stocks (for example, pike-perch) in introduced ecosystems, e.g. Beyşehir and Hirfanlı lakes. Landing of this species has increased from 389.0 tons in 1988 to 6,184 tons in 2009 corresponding to 16.0% of landings (Table 2).

The changes in the compositions of top 5 freshwater fish/shellfish species characterizing Turkish inland capture landings are presented in Table 2. Pearl mullet and common carp are clearly the predominant species caught by inland fishing boats, since 1980s, while sand smelt, snails and tench are emerging as other important species caught in Turkish

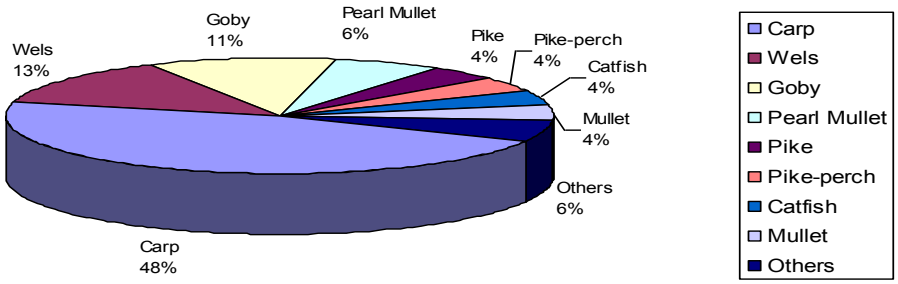


Figure 5. Composition of catch in 1972 (based on data from Mater, 1976).

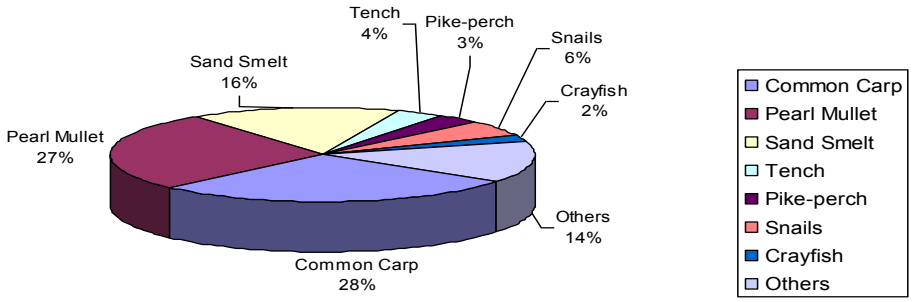


Figure 6. Composition of catch in 2009.

Table 2. Changes in ranking of top five species in Turkish inland capture fisheries

1988		1998		2009	
Species	Share in catch (%)	Species	Share in catch (%)	Species	Share in catch (%)
Carp	41.0	Carp	36.7	Carp	28.0
Pearl Mullet	21.0	Pearl Mullet	36.7	Pearl Mullet	27..0
Trout	4.2	Pike-Perch	5.5	Sand Smelt	16.0
Crayfish*	3.7	Crayfish*	2.7	Snails	6.0
Pike-Perch	3.7	Sand Smelt	2.7	Tench	4.0

* *Astacus leptodactylus*

inland waters.

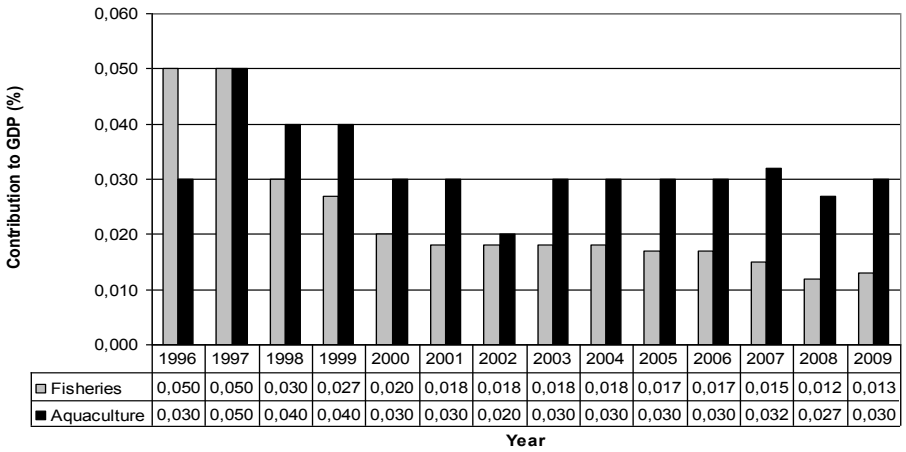
Even though inland aquaculture production has shown a rapid growth in last two decades, this growth predominantly consists of portion-sized rainbow trout. Rainbow trout (75,657 tons) constituted 99.0% of the inland aquaculture output in 2009, the remaining 1.0% being common carp (591 tons). The only form of product diversification in inland aquaculture is on-growing of rainbow trout to ≥0.75 kg "large-trout" (salmon trout).

Contribution to Gross Domestic Product

One of the most important macro-economic indicators for evaluating economic dimension of fisheries or aquaculture is their contribution to Gross Domestic Product (GDP). In general, the overall contribution of capture fisheries and aquaculture sectors (both marine and inland) to GDP in Turkey have remained relatively low, varying between 0.3-0.5% in the last three decades. Consequently; as subsectors, the contributions of inland fisheries and aquaculture to GDP are not significant. However; as far as the trend in contribution to GDP is concerned, it turns out to be relatively stable for inland aquaculture, albeit negative for inland capture fisheries (Figure 7). This relatively stable contribution pattern for inland aquaculture also clearly indicates that, the growth in this subsector has been consistent with national economic growth in recent years.

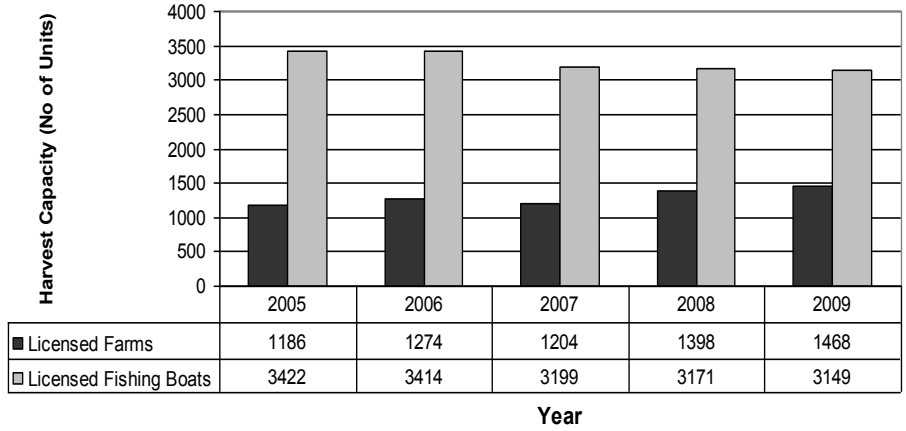
Number of Harvesting Units

The number of harvesting units, i.e. fishing boats and/or fish farms, is not only an indicator of the harvesting capacity of fisheries or aquaculture sector, but it also provides some insights into job-generating potentials of fishing and farming activities. Figure 8 outlines the trend in number of licensed fishing boats and fish farms during 2005-2009. Due to the lack of a consistent time-series on the number of licensed inland fishing boats, a broader assessment in terms of



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fisheries	0,050	0,050	0,030	0,027	0,020	0,018	0,018	0,018	0,018	0,017	0,017	0,015	0,012	0,013
Aquaculture	0,030	0,050	0,040	0,040	0,030	0,030	0,020	0,030	0,030	0,030	0,030	0,032	0,027	0,030

Figure 7. Trends in contribution of inland fisheries and aquaculture to GDP (%).



	2005	2006	2007	2008	2009
Licensed Farms	1186	1274	1204	1398	1468
Licensed Fishing Boats	3422	3414	3199	3171	3149

Figure 8. Trends in harvest capacities in Turkish inland fisheries and aquaculture.

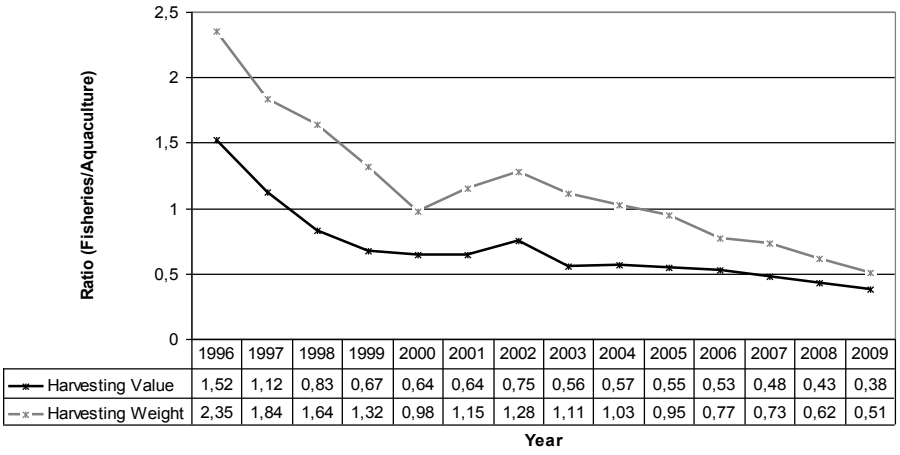
time coverage is not possible. The positive trend in the number of established farms with licenses reveals increasing production and job-generating capacities in inland aquaculture. On the other hand, the negative trend in the number of fishing boats in the 2005-2009 period, discarding other explanations like increases in engine powers or boat lengths, could be an indication of reduction in fishing effort and, therefore, harvesting capacities in inland capture fisheries. Erosion in the number of fishing boats could also be regarded as reduction in the number of fishermen making their livelihood from fishing in inland waters. This would imply that income and thus job generation capacity in inland capture fisheries is weakening.

Ratio Harvesting Value and Weight

Ratio harvest weight (RHW) and ratio harvest value (RHV) were constructed to explore the trend in the relative importance of inland capture fisheries in comparison to inland aquaculture both in terms of volume and value of production for the 1996-2009 period. Both RHW and RHV display downward trends, meaning that, in comparison to inland aquaculture, inland capture fisheries are losing importance, regarding the weight and value of production (Figure 9). The erosion in the importance and contribution of inland capture fisheries to national production of freshwater species is even more severe in terms of RHV, not only due to declining volume of landings during 1996-2009, but also because of lower unit prices for landings during the same period (see Figure 10).

Unit Price

Price evolutions provide insights into changing income from fishing or fish farming activities during a certain period of time; they could also shed light on market dynamics, e.g. supply-demand patterns for wild and farmed aquatic products. Evolution in inflation-free mean aggregated unit prices (TL/kg) of wild and farmed freshwater aquatic products (dominantly farmed portion-sized rainbow trout) in Turkey are presented in Figure 10, for the period of 1996-2009. The emerging picture in price formation and embedded price interactions do deserve statistical assessments and in-depth analyses, which are beyond the scope of this paper. Therefore, only the general picture and the overall trend will be discussed here.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Harvesting Value	1,52	1,12	0,83	0,67	0,64	0,64	0,75	0,56	0,57	0,55	0,53	0,48	0,43	0,38
Harvesting Weight	2,35	1,84	1,64	1,32	0,98	1,15	1,28	1,11	1,03	0,95	0,77	0,73	0,62	0,51

Figure 9. Trends in values of RHV and RHW.

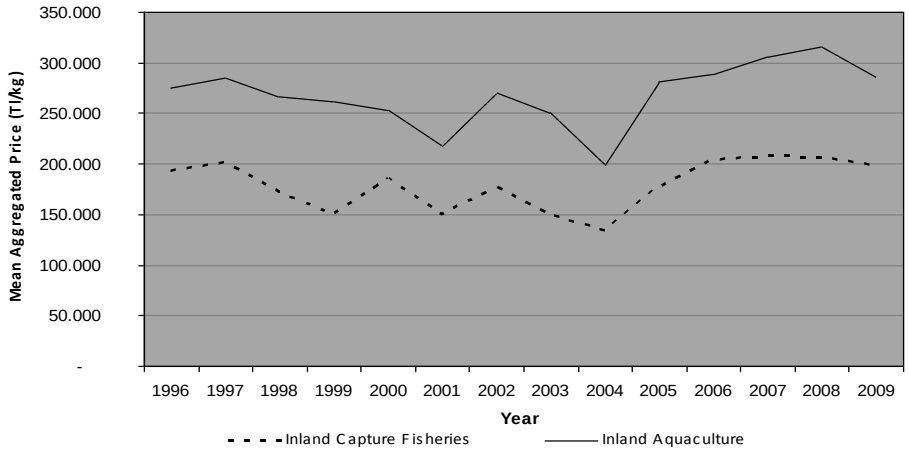


Figure 10. Price evolutions in inland capture fisheries and aquaculture subsectors (In deflated Turkish Lira, 1996=base year).

Deflated prices for 1996-2009 in Figure 10 reveal the trend in real (inflation-free) mean prices for inland capture fisheries and aquaculture products, and facilitates the true interpretation with regard to price evolution. In general, although farmed fish have commanded higher prices during 1996-2009, the trends in price formation seem to follow similar patterns for both wild and farmed fish until 2009, including the sharp falls in prices of both categories in 2001 and 2004. The lower mean aggregated prices for wild species is mainly due to species composition of landings in inland capture fisheries. Major species caught (e.g. pearl mullet, sand smelt, tench) fetch low prices due to unpopularity, insufficient demand and poor marketing. The similar patterns in price formation for wild and farmed species can to some extent be explained by substitution affect. In the case of wild and farmed salmon, Knapp et. al. (2007) argue that the farmed and the wild fish are substitutes and buyers will switch between the two, depending on relative prices of each; thus, their prices will track one another, to some extent. Arnason (2006) also underlines that, the wild and the farmed fish are generally close substitutes in market and a change in the supply of each will affect the price of the other. Obviously, inland aquaculture in Turkey (dominantly rainbow trout) is emerging as a major supplier and player in the domestic market influencing consumption patterns and price formation for freshwater wild species. Regardless of the increasing supply of farmed products in recent years, prices have not fallen behind the 1996 levels. Instead, there has been a 4.0% increase in real prices of farmed products in 2009, compared to the prices in 1996. On the other hand, while supply of wild products from inland waters has fallen by 7.0% from 1996 to 2009, mean aggregated real price has increased by only 2.5% in the same period. This trend clearly indicates that distribution channels and marketing activities in inland capture fisheries sub-sector have worsened, while market organization and penetration for farmed products have improved.

In general, Turks favor wild fish and perceive such products to be tastier, safer and superior, compared to farmed ones. However, falling supplies of capture fisheries of popular species like sea bass, sea bream and trout, as well as ascending prices, have influenced purchasing and consumption patterns for these species in favor of farmed products.

Scarcity of consumer surveys on purchasing

behavior and attitudes of Turks with regard to wild and farmed fish makes it difficult to establish concrete and scientifically based arguments on market segmentation. The existing few studies on consumer's perceptions and attitude towards wild and farmed fish are local or regional in scope but do provide some insights into the broader picture. For example, in Izmir province (Aegean coast), 62.0% of interviewed people preferred wild fish to farmed ones. However; 75.0% found farmed fish cheaper and more affordable while 84.0% believed that farmed fish is more readily available (Saygı et. al., 2006). Preference for wild fish has also been reported for West Mediterranean region of Turkey by Sayın et. al. (2006). In this survey, 56.0% of respondents were found to prefer wild fish to farmed products. However; 66.0% of respondents found fish as an expensive food item. In a survey carried out in Elazığ, a landlocked province where inland fisheries and trout farming is developed, 33.0% of people interviewed preferred freshwater fish species while 16.0% favored marine fish. In the same study, 45% of people interviewed were found to prefer farmed trout to wild freshwater fish species (Şen et.al., 2008). Indeed, availability and price turn out to be the important determinates for the purchasing behavior of Turkish customers, as far as wild and farmed products are concerned.

In this respect, price evolution patterns could be an indication or evidence of the impact of increasing supply from inland aquaculture, namely that of farmed rainbow-trout production on price formation for wild freshwater species.

Discussion

The outcome of comparative assessment of inland capture fisheries and aquaculture in Turkey using certain macroeconomic and market indicators provides evidence for increasing growth in economic importance of inland aquaculture. While rainbow trout farming is emerging as a major player that influences the supply and price formations, inland capture fisheries is losing ground due to inherent disadvantages of capture fisheries.

Anderson (2002) underlines the trend toward aquaculture and/or more controlled fisheries products in US per-capita seafood consumption. Eagle et. al. (2004) argue that aquaculture has some decided market advantages over fisheries, such as the consistency of supply, the ability to predict supply and the capability to meet market demand in the changing context of global markets.

Knapp et. al. (2007) note that, along with many changes, the globalization of the world food market is also transforming seafood (aquatic products) processing, distribution and retailing. Rapid expansion of seafood trade, increased consolidation and market power in the retail and food service, restructured distribution networks, improved standards for handling and food safety, and increased consumer expectations for quality, convenience and lower prices are some of the major features of globalization in trade of aquatic products. Knapp (2002) expresses the fact that, globalization is building opportunities for suppliers who can produce convenient, traceable, and inexpensive products with appealing forms and consistent qualities (From Eagle et. al., 2004).

Indeed, the emergence of large retailers (e.g. supermarket chains) as major outlets for aquatic products in Turkish market, which have strict requirements for consistent supply, quality and price, have created both opportunities and challenges for fisheries sector as a whole. Trout farming has been capable of turning this trend into opportunity by using inherent market advantages of aquaculture, like reliable and consistent supply, consistent product quality and price year round. Farmed trout, along with other farmed species, such as sea bass and sea bream, are available in every super market or retail fish shops throughout the year, with more or less stable prices for standard size categories. This is not the case for capture fisheries products, whether of marine or freshwater origins.

Setala et. al. (2008) also argue that expanding fish farming will probably be a major new challenge for capture fisheries, since seasonal fisheries' products have difficulties in competing with aquaculture products; the latter can be put on sale according to market demand, also fulfilling the other essential requirements of modern fish distribution channels. Welcomme (2001) emphasizes that the dominance of supermarkets with enormous buying power and demand for predictable supplies of standardized product has changed much of fisheries and aquaculture practices. Few fisheries are able to meet the demands of supermarket chains.

Knapp (2002) underlines three basic constraints for commercial fisheries: "production is variable, production is uncertain and production can not be increased" (Eagle et. al. 2004). Indeed, inconsistent and seasonally varying supply and heterogeneity in quality attributes restrict the marketability of wild fish species.

De Silva and Moehl (2003) emphasize that the important difference between inland capture fisheries and aquaculture is the question of ownership. According to Naylor et. al. (2000), the ownership of stock and deliberate intervention in production cycles are the two key criteria between aquaculture and capture fisheries. Anderson (2002) notes that the distinction between traditional fisheries and aquaculture depends on the degree of control over production process e.g. control of input, harvest, growth rate and size, location and control of species harvested. He further argues that this degree of control is largely defined by the strength of property rights. As property rights are strengthened, firms will tend to adopt more efficient technologies, which may include aquaculture. In addition, industrial

organizations will look to enhance habitat and fish stocks, improve marketing efforts and pursue ways to gain control of production and markets.

Along with control over inputs and production process, the most important market advantage of aquaculture is the ability of fish farmers to control the timing of supply, the amount of supply and the quality of fish that they supply. That is because fish farmers have exclusive rights over the stock; they can decide when and what to harvest. This enables a fish farmer to respond to market dynamics and requirements.

From a marketing perspective, a transition towards more controlled and intensified systems is essential for managing inland capture fisheries, so that production can be predicted and harvests can be regulated according to market dynamics. Unlike marine fisheries, whose resources are spread over wide boundaries shared by different states, fisheries resources in inland waters are more confined; they mostly fall under the jurisdiction of a single state/authority. This characteristic would allow a greater deal of control, in terms of intervention in production process in inland capture fisheries. To some extent, inland capture fisheries resemble those of extensive aquaculture (polyculture) where the main interventions in the production cycle regulate the composition of species used, in terms of feeding habits (Herbivorous, omnivorous and sometimes carnivorous), confinement of stock, and protection from predators. Welcomme (2001) reports successful cases of managing whole water-bodies as fishponds for enhancement purposes, in inland capture fisheries of China, West Africa and Bangladesh.

Neither the objective of this paper, nor the expertise of the authors justifies discussing the ecological aspects of decline in inland capture fisheries or proposing any specific management scheme for inland capture fisheries. However, overall negative developments in economic dimensions of Turkish inland capture fisheries, including declines in volume and value of supply, decreasing contribution to GNP and the downward trend in number of harvesting units (fishing boats), indicate that management policies for inland capture fisheries in Turkey need to be reconsidered and revised. Considering the three pillars of sustainable development, a new management policy framework addressing social and economic dimensions of inland capture fisheries need to be formulated. It is clear that, in order to yield social benefits, capture fisheries need to be economically viable. In this regard, policy makers should keep in mind that, economic viability of capture fisheries could not be achieved unless policy formation and management schemes do include provisions for marketing and market dynamics. These provisions include regulation of supply-demand patterns, increased consumer demand for quality and food safety, the emergence of super/mega markets as the main outlet for fisheries products, these outlets' ongoing expectation for consistency in quality and supply, and increased competition from imported fisheries products and aquaculture.

Findings of a study, covering 1,586 fishermen operating in 654 fishing boats in East and Southeastern regions of Turkey, reveal that the main challenge for fishermen is insufficient income. That was, in turn, found to be associated with a) disadvantageous pricing mechanisms leading to low first sale prices, b) the lack of efficient marketing and c) poor management and investment in marketing infrastructure of fishermen cooperatives (Ural and Canpolat, 2009).

In this respect, strengthening control over production, harvesting and encouraging investment in marketing and market related issues should be the core aspects of any management policy framework. Poor marketing infrastructure, insufficient financial resources, lack of knowledge on present fish markets dynamics and structure of fishermen cooperatives; are some of the major constraints which need to be further resolved. Producers Organizations (POs), which are structured and empowered in European Union, could be a tool for addressing these challenges. POs can play a central role in regulating supply, encouraging responsible fishing practices, and management of fishing resources. In order to improve conditions of sales and promote penetration of inland fisheries products into market, POs can become involved in establishing collective quality-control and certification schemes, or in installing fish processing plants to produce value-added products. Establishment of Market Observatory for fisheries sector is also a useful instrument for generating market information on fisheries products, for example, information on price formations along the supply chain or market dynamics. This type of information would enable administrative bodies and policy-makers to formulate appropriate strategies for economic stability and sustainability in fisheries sector, including inland capture fisheries.

On the other hand, aquaculture sector as a whole also has to address some major challenges to ensure its viability and sustainability. The issue of image is one of these challenges. Turkish aquaculture industry has failed to be proactive in addressing prejudiced criticisms on mass media with regard to negative environmental impacts of fish farms, feed and chemicals used and food safety issues. It is generally acknowledged by industry that such criticisms have created a negative public perception of aquaculture in Turkey (Uras, 2009). In a survey carried out in Mersin province, 20.0% of consumers interviewed believed that farmed fish contains either chemicals or hormones, making them less safe than wild fish. And 25% were undecided, regarding the safety of farmed fish (Kütük and Rad, 2008). In a survey conducted by Saygı et. al. (2006) in Izmir, 28% of interviewed persons had positive and 12% had negative attitude towards fish farming (in cages), while the rest were

undecided. Negative perceptions included difference in taste, pollution in water, ecological degradation, and the use of unsafe fish feeds and chemicals. A proactive approach by aquaculture industry for improving its image will not only contribute to promoting domestic demand for farmed fish, but it will also strengthen the position of the industry in political arena, facilitating the resolution of administrative and legislative issues. Such proactive initiatives may include developing voluntary code of practices, bettering the management practices for responsible aquaculture, establishing collective quality norms and certification schemes, and communicating these to the public through well-structured informational and promotional campaigns on popular media channels.

The second challenging issue specifically for Turkish inland aquaculture is unregulated single-species growth patterns. The current aquaculture support policy through premium payment schemes (per kg of fish produced) is focused on production; it has further accelerated unregulated growth in supply of portion-sized rainbow trout, rather than stimulating and promoting the production of new species or products. However, from an economic perspective, the sustainable development of Turkish inland aquaculture requires a market-oriented and demand-enhancing policy. Unregulated supply of portion-sized trout has the potential to lead to price competitions and market failures resulting from overproduction. Such market-oriented policies should contribute to competitiveness, consumer-responsiveness and a better image in trout farming industry. The examples of such policies would be incentives towards promoting the use of environmental and product quality certifications schemes, voluntary code of conducts for responsible aquaculture practices by farms, encouraging enterprises to investment in new farming technologies, product diversification/differentiation and empowering producer organizations for regulating markets.

Species diversification is another crucial issue for sustainable development in inland aquaculture industry. Turkey enjoys a rich ecological diversity, in terms of freshwater fish species and environment, which is not restricted to cold-water species. Exploring this potential and focusing on endemic species with local popularity and market would lead to a new strategy that would promote further development of semi-intensive inland aquaculture in Turkey. Some of endemic warm-water fish species like Ashut (*Tor grypus* Hecekel, 1843, a local species with no English name) and Himri Barbel (*Barbus luteus* Heckel, 1843) are promising candidates for this purpose. Gökçek and Tepe (2009) report promising on-growing results for Himri Barbel. State Water Affairs (DSI) has succeeded in artificial propagation and fry production of Ashut. This new strategy would also create alternative jobs and income for those fishermen who have been fishing these local species and are now faced with declining catches and income.

Product diversification in trout farming has been very limited. Smoked fillets are the only value-added product that is generally for export markets. Product categories for local market include mainly fresh portion-sized rainbow (250-300 g) and partly large trout (1-1.5 kg). Developing new or differentiated products (e.g. organic trout) would contribute to creating new demand segments and thus room for further development of the industry.

Markets and marketing of seafood either wild or farmed are becoming increasingly global, complex and competitive. Globalization of seafood trade and tough competition, restructuring in distribution channels, increasing consolidation and market power in the retailing sector, tighter standards for handling and food safety by retailers, increasing consumer demand for quality, convenience and traceability, biosecurity and animal welfare are some of the major features of today's markets for aquatic products and thus in forefront of any management and development policy for fisheries and aquaculture industries.

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