



Exploring the potential for organic aquaculture in Sivas Province, Turkey: A pathway to sustainable development

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Organic aquaculture is an environmentally, socially and economically sustainable form of agriculture. Although organic aquaculture principles and standards have been established in the world and in Turkey, there are no established and operating facilities related to organic aquaculture in Sivas province. This study suggests optimistic and positive hopes for the start of organic aquaculture in Sivas province. There are suitable and untapped water resources in Sivas province where organic aquaculture can be carried out. Establishing and starting organic aquaculture facilities in Sivas province has the potential to create new employment opportunities and make a significant contribution to the socio-economic development of Sivas province and therefore Turkey.

Keywords: Organic aquaculture, reliability, sustainability, traceability

INTRODUCTION: The world has been in a constant state of change and renewal since its existence. This renewal is a process that constantly progresses with technological developments, research and development activities and the adaptation of new ideas to the period we live in. There is no limit to the technological developments made and they progress comprehensively enough to touch every point of daily life. While the progress of technological developments enables different sectors to develop and change within themselves among many countries, it also plays a role as a force that increases competition in market areas. The development of technology starts with a new idea, and technological development and change is completed with the innovation that emerges as a result of research and development (Zerenler *et al.*, 2007).

The process in which environmentally friendly techniques are used in all stages of production is called organic agriculture. Organic production does not only have a product-focused approach. In this context, the concept of organic production includes the entire process from the production of the product to its delivery to the end consumer. When viewed from a broader perspective, organic agriculture is a production system that takes into account the ecological balance, ensures the sustainability of soil fertility, supports the survival of organisms in nature by controlling plant pests and diseases, and obtains the most appropriate yield with the most appropriate use of natural resources and energy. Organic agriculture can be considered as a system that takes into account all living things, especially humans, and their environment, and addresses economically sustainable agricultural production as a whole (Ak, 2004). At the same time, organic agriculture is a dynamic alternative production method that aims not only to increase the quantity in cultivation but also to increase the quality of the product. Products produced with organic production methods are called "organic food" or "organic products". It is stated that organic products are not visually very attractive, but they are more delicious and useful. The aim of organic agriculture is to produce quality and healthy products instead of increasing yields. Therefore, lower yields are obtained per unit area in organic products. This situation also causes the price of organic products to increase. In addition, the risk of harming nature and human health decreases with the decrease in external inputs in organic agriculture (Gökçe and Usta, 2013). Organic agriculture is emerging as an alternative production system. The basic principle of organic agriculture is to protect natural resources and to produce safe and healthy food in terms of human health. Organic agriculture, which does not use any chemical fertilizers, hormones and drugs, is seen as an important application in the production of safe food with the use of modern tools and techniques that do not disrupt the naturalness of the product in irrigation, fertilization, harvesting and processing of the product. The benefits that organic agriculture provides for countries in terms of both social, economic and environmental aspects have led developed and developing countries to switch to organic agriculture more and more intensively. The importance of organic farming in Turkey is better understood every day. Considering that the number of organic farming producers and consumers is increasing every day, it is possible to say that the number of people employed in organic farming will increase. Since the increasing number of organic farming in the world and in Turkey will increase the number of people to be employed in the sector, the demand for a trained workforce will also increase with organic farming. The first employment area in organic farming is people working in the soil

and water, farmers, and the second employment area is consultancy. Farmers will need consultancy while implementing the applications (Yolcu, 2013).

The organic farming movement in Turkey started in the Aegean Region in the mid-1980s in response to the demand of European importers and spread to all of Turkey from there (Gündüz and Kaya, 2007). Although farmers pioneered the development of organic farming in most European countries and the USA, in Turkey organic farming was introduced to farmers and adopted by staff of European private organic farming companies. While the structuring of organic farming in Europe and the USA is bottom-up, starting from the producer, in Turkey there is a top-down structuring from companies interested in organic farming to the producer. In short, while the structuring of organic farming in Europe and the USA is supply-driven, the structuring of organic farming in Turkey is demand-driven. Therefore, organic farming, which started in Turkey in the mid-1980s based on a contracted production model with representatives of foreign companies, began to grow rapidly over time with the entry of local companies into this market (Demiryürek, 2009). The developing organic agriculture market in terms of demands is an important turning point in determining consumer behaviour towards organic products. It has been concluded that the attitudes of consumers towards organic agriculture are formed due to past experiences and beliefs. It can also be considered as the positive or negative thoughts of consumers towards a product. A consumer who has a positive view towards an object is more likely to buy the product. The development of organic agriculture practices in Turkey, which has many advantages for organic agriculture, towards foreign markets and the fact that the domestic market is still small-scale today, have revealed the necessity of examining the tendencies of consumers in the domestic market towards organic agricultural products (Merdan and Kaya, 2013).

Organic agriculture has its own applications and principles in the process from production to marketing of products grown in soil and water conditions. Organic agriculture applications are increasing in developed countries as well as in developing countries. The reason for this situation is that consumers, especially in developed countries, are increasingly giving importance to protecting their own health and the environment. In parallel with this, organic product consumption and market are increasing especially in Europe, North America and Oceania main lands. The high demand for organic products that are not produced or grown by developed countries has led to an increase in organic product trade at the international level. Therefore, developing countries such as Turkey, whose ecology is suitable for organic agriculture, are becoming organic product producers and exporters in order to meet the demands from developed countries (Demiryürek, 2011).

Organic agriculture is increasingly important today. The increase in demand for organic agricultural products has increased noticeably in Turkey as well as all over the world. Organic agricultural production in the world is used as an important tool in achieving goals such as eliminating the supply-demand imbalance caused by excess agricultural production, whether in the field of plant, animal or aquaculture, and ensuring balance, protecting the environment and all kinds of natural resources, and establishing organic balance (Aydın, 2023). In Turkey, regions where intensive agriculture and aquaculture are not practiced, and where there has not been much use of synthetic fertilizers and chemical pesticides in the past, have

great potential in terms of organic agriculture. With the increasing population in the world, the demand for aquatic products is constantly increasing. Globally, aquaculture is becoming increasingly important. Efforts to solve environmental problems related to aquaculture in the world are aimed at protecting health and water resources. In this context, organic aquaculture practices come to the fore. The increasing interest in organic aquaculture is due to factors such as increasing environmental and health concerns. Organic aquatic products are aquatic creatures that are grown under natural living conditions, without the addition of any synthetic or natural preservative additives, without genetic modification, in accordance with organic aquaculture standards, fed with feed prepared entirely from natural raw materials, and certified (Ötles *et al.*, 2010). Organic aquaculture production consists of living things such as fish, aquatic plants, sponges, molluscs, crustaceans and mammals grown with organic farming method in seas, inland waters, pools, net cages, dams, lakes, ponds, lagoons and farms, and the products produced from them, human food. It covers production activities for stock reinforcement, sports, medical and scientific purposes, each stage of which is controlled and certified under the supervision of an organization authorized in accordance with the regulation (İlbaş, 2009). Organic aquaculture is an ecosystem-based approach that combines good environmental practices, produces quality aquatic products, protects water resources, does not harm biodiversity and produces healthy food (Ahmed *et al.*, 2020).

Accordingly, organic aquaculture is a practice that is environmentally friendly, healthy, compatible with nature, and uses natural products without the use of harmful synthetic chemicals. Organic aquaculture aims to protect water resources without harming the environment, human and living health. Organic aquaculture is an agricultural production method that establishes traceability and sustainability and ensures food safety. Aquaculture grown with this method is perceived as healthier and more valuable. For these reasons, organic aquatic products are marketed at higher prices in the export market. The importance of organic aquaculture is recognized all over the world and especially in developed countries. The first organic aquaculture in the world started in 1994 with the cultivation of carp (*Cyprinus carpio*) produced according to organic principles. Subsequently, organic aquaculture of Atlantic salmon (*Salmo salar*), rainbow trout (*Oncorhynchus mykiss*) and similar trout species was carried out. Afterwards, shrimp (*Penaeus monodon* and *Penaeus vannamei*), mussel (*Mytilus edulis*), oyster (*Magallana gigas*), catfish (*Pangasius pangasius*) and microalgae were cultured organically. Following this, tilapia farming was carried out organically. Organic sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) cultivation has been carried out in Mediterranean countries (Kayhan, 2015).

Total production from organic aquaculture worldwide in 2016 was around 415 thousand tonnes. However, since the share of organic aquaculture in the total amount of aquaculture worldwide is around 0.5%, organic aquaculture remains in absolute low volumes (Gambelli *et al.*, 2019). According to 2020 data, 51% of the total production in organic aquaculture is carried out in the Asian continent, followed by the European continent with 31%. The country with the highest amount of organic aquaculture is China, followed by Ecuador and Ireland (Taşbozan, 2023). The number and production amounts of organically grown aquaculture species in the world are constantly increasing. The total amount of organic aquaculture in the world is expected to reach 1 million tons in 2030 (Kayhan and Olmez, 2014).

Considering the structural characteristics of many water resources and facilities in Turkey, it has been reported that they are suitable for organic aquaculture production and that other facilities can adapt to organic aquaculture production if their infrastructures are arranged appropriately. In a study conducted in the Eastern Black Sea region, especially in the higher parts of Rize, Gümüşhane and Artvin provinces, the waters of facilities that were expected to potentially produce organic aquaculture products were analysed and the results obtained showed that the waters in most facilities met the criteria required for organic trout cultivation (Arslan and Akhan, 2018). For the first time in Turkey, organic aquaculture was carried out in Rize province in 2010, with a total of 456 tons of rainbow trout (*Oncorhynchus mykiss*) and Black Sea trout (*Salmo trutta labrax*). A significant part of this capacity, namely 431 tons/year, is rainbow trout, and 25 tons/year is Black Sea trout, a

local species (Çavdar, 2011). In 2013, organic sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) breeding work was started in Muğla province. As a result of this initiative in 2015, a total of 559 tons, including 317.2 tons of organic sea bream and 241.8 tons of organic sea bass, were produced and marketed in Turkey (Arslan and Akhan, 2018). Organic aquaculture in Turkey is continued successfully in Rize and Muğla provinces. Additionally, there is an organic trout feed facility in Rize province. This study is about Sivas province in Turkey and organic aquaculture.

OBJECTIVES: The objectives of this study were as follows: (1) to assess the status and sustainability of organic aquaculture in Sivas Province (2) to make recommendations regarding its sustainability, reliability and traceability.

MATERIALS AND METHODS: Sivas, a Central Anatolian province (figure 1), is the second largest province in Turkey after Konya province, with a surface area of 28619 km².



Figure 1: The location of Sivas Province in Turkey.

Sivas province is located in the Upper Kızılırmak Basin of the Central Anatolia Region. Although most of the provincial territory is located in the Central Anatolia Region; Suşehri, Gölova, Akıncılar districts fall within the borders of the Black Sea and Eastern Anatolia Regions, and some lands of İmranlı and Divriği districts fall within the borders of the Eastern Anatolia Region. Sivas province lies between 35° 50' - 38° 14' eastern longitudes and 38° 32' - 40° 16' northern latitudes. Sivas province is generally located in a high and mountainous area due to its geographical structure. The average altitude of the Sivas province varies between 1000-1500 meters. Sivas province generally has a land structure consisting of high plains, mountains and deep valleys. The distribution of Sivas provincial lands is as follows; Plateau 47.6%, mountain 46.2% and plain 6.2%. The heights increase as you move from the western part of the Sivas province to the east. The eastern parts are steeper and higher. The Sivas province, which generally has a steep and high structure, also has important valleys. These are Kızılırmak Valley and Tecer Valley. The most important river of the Kızılırmak Basin is Kızılırmak. The length of the Kızılırmak River within Sivas Province is approximately 250 km. The Kızılırmak River, which has fresh water up to Zara District, becomes salty as it passes through gypsum and salty lands in this region. The most important rivers of the Yeşilirmak Basin are Kelkit Stream and Tozanlı Stream. In the Euphrates Basin, there are Çaltı Stream and Tohma Stream and small streams that feed these streams. In addition, there are many natural lakes, dam lakes and ponds in Sivas province. Sivas province is one of the coldest provinces of the Central Anatolia Region. The biggest factors in this are the higher altitude compared to neighbouring provinces, the ruggedness of the landforms and the fact that the pressure is low in summer and high in winter. In general, winter months are extremely cold for long periods, and summer months are hot and dry for short periods. Continental climate prevails in Sivas province. The temperature rises up to 40 °C in summer and drops to -34 °C in winter. Thus, the temperature difference between summer and winter seasons reaches a large rate. The hottest months are July-August, and the mean temperature is around 20 °C. The mean temperature of January, the coldest month, is around -2.5 °C in Sivas province (SSP, 2019). According to address-based population registration system data, the population of Sivas province is 634924 in 2022. Of this population, 318018 are

men and 316906 are women. In terms of percentage, 50.09% are male and 49.91% are female. Sivas province is among the top 15 among a total of 81 provinces in Turkey with 5503.5 tons/year rainbow trout cultivation (Dirican, 2021).

In this study, information on whether there are facilities engaged in organic aquaculture in the Sivas province of Turkey was obtained as a result of the data of the Ministry of Agriculture and Forestry of the Republic of Turkey and interviews with the Sivas Provincial Directorate of Agriculture and Forestry.

RESULTS AND DISCUSSION: According to the findings, there is no facility established and operating in organic aquaculture in Sivas province. Although the province of Sivas is in a good place among the 81 provinces in Turkey in rainbow trout cultivation, it has not yet made any progress in organic aquaculture. Some of the water resources and facilities in Sivas province are suitable for organic aquaculture. In addition, some of the rainbow trout facilities operating in Sivas province will be able to adapt to organic aquaculture if their infrastructure is transformed appropriately. Organically grown aquatic products, which are certified to be healthy and safe food, are marketed without any problems and at higher prices. For these reasons, first of all, the transition of some of the aquaculture facilities in Sivas province from traditional rainbow trout production methods to organic rainbow trout production practices will make significant contributions to the development of the aquaculture sector in Sivas province. For this purpose, a transition period of approximately two years should be applied to transform a traditional rainbow trout farming facility into an organic rainbow trout farming facility in Sivas province. However, for organic aquaculture, the focus should be on the unused cold water resources in the higher elevations of Sivas province.

Organic aquaculture should be encouraged for sustainable and traceable use of existing water resources in Sivas province. Encouraging organic aquaculture in Sivas province will ensure the protection of the quality and bio-ecological structure of water resources. Organic aquaculture in the world is still in its early stages of development. However, there is a positive trend towards further development of organic aquaculture in the world. The main reason for the adoption of organic aquaculture is that it is more environmentally and economically profitable than traditional aquaculture (Gambelli *et al.*, 2019). Organic aquaculture was developed as an alternative to the potential environmental impacts faced by conventional aquaculture. Organic aquaculture is an ecosystem-based environmentally friendly practice. However, the transition from traditional aquaculture to organic aquaculture is a multidimensional, complex and somewhat expensive process. However, the transition to organic aquaculture provides a wide range of health, environmental and economic advantages. Increasing organic aquaculture will be very beneficial in reducing the environmental footprint of aquaculture. In organic aquaculture, the species that can be created using the polyculture method can be diversified (Ahmed *et al.*, 2020). Some of the water resources and facilities in Sivas province are suitable for organic aquaculture. In addition, the fact that the water resources are very cold, unpolluted and clear is a great advantage for the province of Sivas. This situation creates a great opportunity for organic aquaculture in Sivas province. For these reasons, this study suggests optimistic hopes for the start of organic aquaculture in Sivas province. These expectations are quite hopeful, optimistic and positive for the province of Sivas. Supporting the development of organic aquaculture should be expanded by Turkish policy. Organic aquaculture in Turkey stands out as an important sector with development and growth potential. Action plans should be prepared for the development and dissemination of organic aquaculture. Scientific studies should be carried out to initiate and expand the positive effects of organic aquaculture in Sivas province. Because the environmental impacts of organic aquaculture are less than other aquaculture practices.

Climate change caused by global warming is a significant problem for all countries in the world. The aquaculture sector is one of the sectors most affected by the global warming problem. In global meetings, some studies are presented to reduce the impact of climate change, and discussions are held and decisions are made on the subject. The most obvious of the decisions is to be able to create sustainable aquaculture and to ensure that the productivity is sustainable. In organic aquaculture, not using pesticides during the production phase is environmentally friendly and increases the

productivity rate. In addition, the rate of damage to the ecological order will be very low in this direction. In this context, the meticulousness and detail of the work done in the process of obtaining the output of the production in order to ensure sustainability of productivity is also of great importance. Organic aquaculture is also important in this regard.

Considering the surplus production resulting from agricultural production and the damage caused to nature and all living beings by the use of chemical substances and pesticide control systems in agriculture, the European Union countries and other developed countries have decided to restrict this type of agricultural production and take the necessary legal measures (Atsan and Kaya, 2008). Organic agricultural practices in agricultural production support the sustainability of agriculture in order to leave a legacy to future generations, as well as the reliability of the product quality obtained as a result of stopping and avoiding the use of chemical inputs. The products obtained as a result of conventional agricultural practices of organic agricultural practices have higher taste and quality. In addition, organic agriculture, which is considered a new development because it also protects the natural balance, releases less carbon dioxide into the atmosphere compared to other agricultural methods. In addition to the air, the use of chemical inputs in the agricultural production process causes pollution of both groundwater and surface water resources, as well as the death of beneficial minerals in the soil and erosion of the soil, thus causing soil pollution (Gülgör, 2017). Organic aquaculture, in addition to sustainability, also has a positive impact on animal and plant production. Improving the habitats of aquatic animals and feeding them in areas protected from chemical inputs increases efficiency and quality in production.

As the discussions on the sustainability of the world are becoming increasingly global, innovative solutions are needed more than ever. Biotechnology stands out as an important alternative in the search for a greener future, with the hope of revolutionizing various industries. In this search process, biotechnological innovations in the field of food and agriculture are particularly noteworthy and offer various alternatives for more sustainable applications. In aquaculture, biotechnology improves plant and animal breeding processes using genetic engineering and biotechnology methods. Biotechnology solutions serve the purposes of increasing efficiency in the aquaculture sector, creating resistance to diseases in food products, protecting from diseases and pests and minimizing their effects, reducing chemical use, strengthening vaccine content, and improving the quality of products. Biotechnology has unlocked many tools and techniques that transform the way food is produced and consumed. Today, there are rapid developments in the field of biotechnology, and as a result of these developments, new information is being obtained about the benefits and risks of biotechnology applications. In the light of this information; It is seen that biotechnology applications, as a concept consisting of the combination of society, science and technology and interacting with each other, lead to discussions on social and ethical issues (Soğukpınar and Karışan, 2020). Tittonell (2014) concluded that unless ecological innovations are supported in agricultural production and a transition to organic production is achieved, the damage to the environment cannot be reduced and healthy product output cannot be achieved because the products are grown with the support of chemicals. The proposed solution for this problem is to ensure a transition to organic agriculture with ecological innovations by designing multifunctional ecological systems that are both sustained by nature and sustainable by nature with the support of policy managers (Tittonell, 2014). Zaks and Kucharik (2011) reported that the data obtained from the installation of monitoring systems in production facilities helps to intervene in the needs of the product at the right time and to provide the required amount of nutrients. In addition, the installed monitoring systems have a cost-reducing effect, and it has been determined that the product output is prevented due to the wrong production technique applied to the products.

Organic aquaculture provides the most efficient use of nature without disrupting the natural structure of water so that people can live their lives in a healthy way. This situation is known as a strategic attitude that opposes the use of foods produced in environments far from health conditions that endanger human and animal health. Organic aquaculture is a production method that includes human and environmentally friendly production systems aimed at

preventing the disruption of the natural balance as a result of wrong practices within the ecological system, and suggests that cultural measures such as organic and green fertilization, agricultural struggle, prevention of erosion, and use of healthy plants and animals should be taken in order to ensure sustainability, along with the prohibition of the use of pesticides and chemical fertilizers, and aims to increase the quality of the product and ensure continuity rather than increase the product in production. Organic aquaculture differs in many points when compared to other agricultural systems. It supports renewable resources, recycling and the transformation of nutrients in waste into water. It is based on health principles and the use of natural feeds in plant and animal production. Organic aquaculture respects the environment's natural systems in combating pests and diseases and rejects the use of synthetic pesticides, chemical fertilizers, growth hormones, antibiotics or genetic modification practices. Instead, organic producers use techniques that help preserve ecosystems and reduce pollution. Control and certification of the cultured product in organic aquaculture is a significant challenge. However, the price of organic feed constitutes the largest part of production costs in organic aquaculture (Mente *et al.*, 2011).

In organic aquaculture, the harmony between production and marketing needs to be improved and further encouraged and supported. The design and structure of aquaculture facilities should be compatible with the species-specific needs of aquaculture products and ensure their health and welfare. The physical, chemical and biological parameters and flow rate of the water must provide adequate flow rates and respond to the natural needs of the species. Feeding in aquaculture should be determined according to conditions such as water temperature, health of the organism produced, high product quality and low environmental impact. In order to grow an aquaculture species organically, it is important to feed it with organic feed. A feed ration suitable for the species grown organically should be used. Organic feed should be obtained from licensed feed mills. Records showing the details of the additives contained in the feed should be kept and readily available in the facility. As feed ingredient prices increase, the cost of feed also increases. Stock density in organic aquaculture is lower than in traditional production. Necessary precautions must be taken to prevent pollution from the facility from harming the environment. Every stage of organic aquaculture, from eggs to the water in which it is grown, to harvesting and packaging, must be inspected and certified. Control and certification costs are high in organic aquaculture. Therefore, increasing government incentives and support in control and certification processes will facilitate the increase in the number of producers in organic aquaculture. In organic aquaculture, the health status, welfare and waste of the species produced must be taken into account. The aim in the organic aquaculture is to sell healthier, higher quality and more reliable water products to the consumer. The prohibition of the use of chemical inputs in organic aquaculture cultivation and processing is an important sign that organic aquatic products are reliable and of high quality. Organic aquaculture must be sustainable, traceable and reliable. In organic aquaculture, resources should be used effectively and dependency on production inputs from outside the facility should be kept to a minimum.

CONCLUSION: Factors such as health, food safety, environmental awareness, sustainability and traceability are increasing the interest in organically grown aquatic products. Despite this increasing interest, organic aquaculture has not developed sufficiently in Turkey and the province of Sivas. It is of great importance to resolve this situation. Organic aquaculture should be expanded in Turkey and in the province of Sivas. Awareness and reliability of organic aquaculture products should be increased among consumers by providing adequate promotion to consumers about organic aquaculture. Although there are suitable and unused water resources for organic aquaculture in the Sivas province of Turkey, there are no established and operating facilities related to organic aquaculture in the Sivas province. There is currently no supply of certified organic aquaculture in Sivas province. Establishing and starting operations of organic aquaculture facilities in Sivas province will enable new employment opportunities and socio-economic development. Efforts should be made and encouraged to start organic aquaculture in Sivas province. In order to start organic aquaculture in Sivas province and increase its production, correct organic aquaculture policies should be followed, adequate support

should be given to producers, and inspections should be carried out effectively. For this, entrepreneurs, non-governmental organizations, voluntary organizations, universities and government institutions need to carry out and follow the necessary studies for organic aquaculture.

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