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AQUACULTURE IN ROMANIA: AN OVERVIEW OF ECONOMIC DEVELOPMENT

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Abstract

Aquaculture involves the cultivation of aquatic organisms for human consumption, animal feed, or recreational purposes. This practice enhances food availability, protects endangered species, and reduces environmental impact. In Romania, aquaculture has notable potential due to its rich natural resources and increasing demand for sustainable fish products. The sector includes 750 economic operators, generating over €100 million in turnover and €15.8 million in net profit, while employing approximately 2,000 people. Bucharest leads in the number of operators, followed by Ilfov, Braşov, Cluj, and Iaşi. Tulcea County alone contributes over 15% of the sector`s turnover, while Bucharest, Iaşi, and Botoşani concentrate about 25% of the workforce. Tulcea and Constanţa counties are key hubs for freshwater aquaculture, benefiting from favorable geographic and ecological conditions, adequate aquatic resources, and a strong local tradition in aquaculture practices. These regions illustrate the sector's potential for economic growth and sustainability. Freshwater aquaculture represents a distinct component of Romania's economy, with contributions extending beyond local businesses, influencing the national economy while aligning with global efforts to promote sustainable resource management and environmentally friendly food production practices.

Key words*: economic impact, fisheries, freshwater aquaculture, market concentration, Romania.*

INTRODUCTION

Aquaculture, the controlled cultivation and farming of aquatic organisms such as fish, mollusks, crustaceans, and aquatic plants, has emerged as a significant contributor to global food production, food security, employment, and environmental sustainability. According to the Food and Agriculture Organization (FAO, 2020), aquaculture is among the fastest-growing food-producing sectors globally, driven by increasing demand for sustainable and protein-rich foods. The global population, projected to reach 9.7 billion by 2050, underscores the critical role aquaculture can play in addressing future food security challenges and nutritional demands (FAO, 2022).

In contrast to capture fisheries, the global share of aquaculture production has been steadily increasing, largely due to lower production costs and, more critically, the depletion of natural aquatic resources (FAO, 2022).

The aquaculture sector plays a vital role not only as a primary source of animal protein but also as a means of poverty alleviation by generating employment opportunities in low-income and developing countries (Sheikh, 2004).

Over the past three decades, aquaculture has become the main driver of aquatic organism production, recording an average annual growth rate of 5.1% between 2000 and 2020 and reaching a record high of 87.5 million tonnes in 2020. This consistent expansion underscores aquaculture's growing contribution to global food security and sustainable resource management (FAO, 2022).

Romania, a country strategically located in southeastern Europe, holds immense potential for aquaculture development due to its diverse freshwater resources, extensive river networks,

abundant lakes, reservoirs, and proximity to the Black Sea. Notably, Romania is home to the Danube Delta Biosphere Reserve, a UNESCO World Heritage Site, recognized globally for its ecological richness and biodiversity. This unique geographical advantage provides exceptional opportunities for sustainable aquaculture practices that can significantly enhance Romania's economic and environmental outcomes.

Historically, Romanian aquaculture has been integral to local economies, particularly in rural areas, contributing to employment generation, food supply stability, and the conservation of biodiversity. Despite these positive aspects, the sector currently faces numerous constraints, including outdated technology, limited investment, stringent regulatory environments, and volatile market dynamics (Marin & Dobre, 2020). Furthermore, growing consumer awareness and preference for sustainably sourced seafood underscores the urgency for Romania to adopt advanced, sustainable aquaculture practices.

This paper explores Romania's aquaculture sector, focusing on economic indicators such as turnover, profitability, employment rates, regional distribution of aquaculture activities, and sustainability initiatives. The study includes visual aids such as tables, graphs, and images to provide a comprehensive and engaging analysis of the sector's current status and future development potential.

MATERIALS AND METHODS

This study employs a systematic and extensive literature review combined with secondary data analysis. Literature and data were sourced from scholarly databases including Web of Science, ResearchGate, Scopus, and Google Scholar, alongside institutional reports from Romania's National Institute of Statistics and the Ministry of Agriculture and Rural Development. Additional resources included international publications by the FAO and reports from the European Commission on sustainable aquaculture practices.

The review focused specifically on studies published from 2015 to 2023, prioritizing recent and relevant insights into economic indicators such as annual turnover, net profit margins, employment statistics, and the regional distribution of aquaculture enterprises. The collected data were critically analyzed and synthesized, providing a clear economic overview and identifying major challenges and opportunities in the Romanian aquaculture sector. Comparative analyses were conducted across regions and between different aquaculture species to understand better the industry's dynamics and future growth potential.

RESULTS AND DISCUSSIONS

Aquaculture production in Romania has remained relatively stable, with an average annual output of 12,000-14,000 tons. The sector is dominated by freshwater pond systems, particularly for carp, which accounts for over 75% of national production (FAO, 2022). Other cultivated species include sturgeon (*Acipenser* spp.), trout (*Oncorhynchus mykiss*), and catfish (*Silurus glanis*).

The distribution of aquaculture production across continents varies significantly, with over 62% occurring in Asia, 19% in Europe and Africa, and 13% in Oceania. In Romania, aquaculture production between 2010 and 2020 ranged from 9,700 to 12,200 tons (Table 1) (FAO, 2022).

Table 1. Global Aquaculture Production, 2000-2020 (thousand tons) (Source: FAO, 2022)

Region	2000	2010	2015	2020
Global	32 420,3	57 756,4	72 889,0	87 500,9
Africa	399,6	1 286,1	1 778,3	2 250,2
Americas	1 423,4	2 514,6	3 279,2	4 375,2
Asia	28 422,5	51 232,9	64 679,9	77 384,4
Europe	2 052,9	2 533,2	2 967,7	3 262,6
Oceania	121,8	189,7	184,0	228,5
Romania	9,7	9,0	11,0	12,2

The figure 1 illustrates the continuous growth trend of global aquaculture output over the 15-year period. Regarding the dynamics of aquaculture production, the period between 2006 and 2020 shows a steady increase, from 51.3 million tonnes to 87.5 million tons. Data reflect combined production from inland and marine environments, highlighting aquaculture's increasing contribution to global food supply and its strategic importance in

addressing the challenges of overfishing and food security (Shahbandeh, 2022).

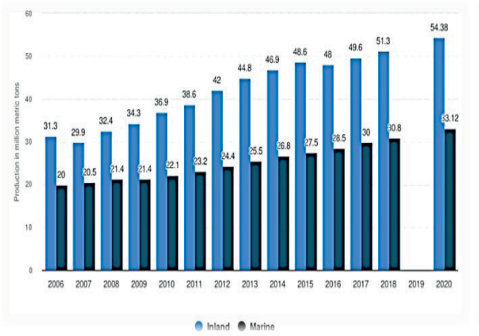

Figure 1. Global Inland and Marine Aquaculture Production, 2006-2020 (million metric tons) (source: Shahbandeh, 2022)

The global aquaculture products market was valued at USD 39.7 billion in 2022, with an annual growth rate of 10%. By 2027, it is projected to reach USD 56.2 billion, corresponding to a growth rate of 7.2%, according to a research report published by MarketsandMarkets (2023).

In recent decades, the development of aquaculture has necessitated the adoption of new technologies that are both environmentally friendly and cost-effective in terms of production. Recirculating aquaculture systems (RAS) have been introduced as efficient alternatives to traditional fish farming systems, aiming to reduce water consumption and increase productivity - particularly in areas where water or land availability is significantly restricted (Gutierrez-Wing & Malone, 2006).

Despite its potential, Romania contributes less than 1% to the total EU aquaculture production, reflecting underutilization of water resources and infrastructure (EUMOFA, 2023). However, the sector has maintained local employment in rural areas and generated significant regional income, particularly in counties such as Tulcea, Galați, and Constanța.

In the figure 2 are presented the key indicators describing the aquaculture sector in Romania for the year 2022, including total production, estimated economic value, total farming area, number of active farms, and contribution to the national agri-food GDP. Data suggest both the current state and development potential of Romanian aquaculture. The aquaculture production system in Romania is characterized by a large number of small- and medium-sized farms, with a significant share of carp ponds, trout farms, and integrated systems combining fish culture with agriculture (Politis et al., 2021). Moreover, there is increasing interest in intensive and semi-intensive production systems such as RAS, enabling higher stocking densities and more controlled conditions.

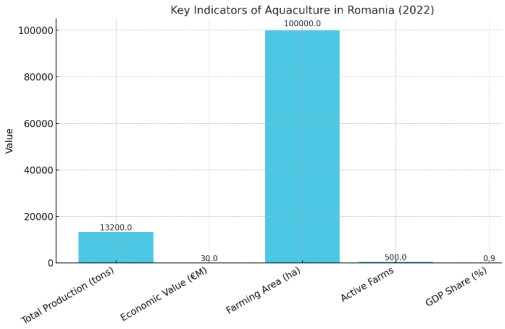

Figure 2. Key Indicators of Aquaculture in Romania in 2022 (source: adapted from EUMOFA 2023)

This figure illustrates both the strengths and the unrealized potential of Romanian aquaculture and provides a visual foundation for further economic and policy analysis.

The national aquaculture output reached approximately 13,200 metric tons, highlighting the sector's moderate scale relative to Romania's natural water resources.

The estimated economic value of aquaculture production was around €30 million, indicating a significant contribution to local and regional economies, particularly in rural areas.

The total surface area dedicated to fish farming - including ponds, lakes, and other managed aquatic environments - amounted to nearly 100,000 hectares, underscoring the country's extensive aquatic resource base.

There are approximately 500 active aquaculture farms across the country, ranging from traditional pond-based systems to modern recirculating aquaculture systems (RAS).

Share in Agri-Food GDP (%): The contribution of aquaculture to the agri-food sector's gross domestic product is currently less than 1%, which suggests considerable room for development through innovation, investment, and policy support.

Romania's aquaculture sector currently comprises approximately 750 economic

operators, generating significant economic outcomes with an annual turnover exceeding €100 million and a net profit of approximately €15.8 million (MADR, 2022). The sector employs around 2,000 individuals, highlighting its role in regional employment. Table 2 presents the Detailed Regional Distribution of Aquaculture in Romania.

Table 2. Detailed Regional Distribution of Aquaculture in Romania

Region	Operators	Employees	Turnover Contribution (%)
Bucharest	120	450	18%
Ilfov	95	300	14%
Brașov	80	250	10%
Cluj	70	200	9%
Iasi	65	180	8%
Tulcea	60	150	15%
Constanta	55	140	12%
Galați	50	130	6%
Timișoara	45	120	4%
Sibiu	40	110	2%
Botoșani	35	100	2%

Tulcea County, notably situated in the Danube Delta region, significantly contributes to the national aquaculture sector, accounting for over 15% of its total turnover. This region is favored due to its ecological conditions and traditional aquaculture practices. Additionally, Constanța County supports freshwater aquaculture extensively, underlining regional economic strengths (Figure 3).

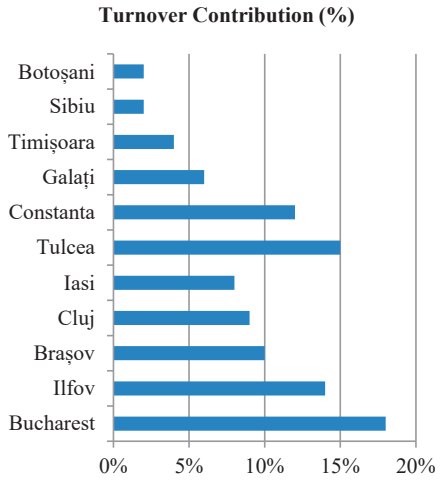

Figure 3. Regional Contributions to Aquaculture Turnover (source: original)

Romania predominantly cultivates species such as carp, and sturgeon, aligning increasingly with EU sustainability directives (Popa et al., 2022). Nevertheless, constraints like outdated facilities, limited market access, and regulatory challenges restrict growth potential (Table 3).

Table 3. SWOT Analysis of Romanian Aquaculture

Strengths	**Weaknesses**
Abundant natural water resources	Outdated infrastructure
Established aquaculture traditions	Limited technology
Favorable ecological conditions	Regulatory complexity
Significant regional knowledge	Market volatility
Opportunities	**Threats**
Growing consumer demand for sustainable products	Environmental regulations and restrictions
EU funding and support mechanisms	Economic instability
Potential for technology adoption	Competition from imported products
Expansion into new markets	Climatic and ecological changes

Carp (*Cyprinus carpio* Linnaeus, 1758) farming predominantly takes place in ponds and lakes across southern and eastern regions. This species is economically valuable and holds cultural significance within Romanian cuisine (Figure 4 a).

Figure 4 a. Common Species Cultivated in Romanian Aquaculture (*Cyprinus carpio* Linnaeus, 1758) (source: original)

Sturgeon (*Acipenser* spp.) are primarily farmed for high-quality meat and caviar. While wild sturgeon fishing is banned to conserve stocks,

aquaculture provides sustainable alternatives, concentrated in regions like the Danube Delta, despite their long growth cycles and high investment requirements (Figure 4 b).

Figure 4 b. Common Species Cultivated in Romanian Aquaculture (*Acipenser stellatus* Pallas, 1771) (source: original)

The sector also promotes biodiversity conservation and sustainable resource management practices, aligning with EU sustainability frameworks. However, barriers such as technology access, high operational costs, and regulatory complexity hinder broader economic benefits and sustainability improvements.

European funding mechanisms such as the European Fisheries Fund (EFF) and the European Maritime and Fisheries Fund (EMFF) have played an essential role in supporting farm modernization, construction of RAS systems, and restocking programs. Between 2014-2020, Romania absorbed over €80 million for aquaculture-related investments (MADR, 2021).

Technological innovation remains limited to a few pilot projects, particularly in RAS for high-value species like sturgeon. The limited adoption of modern systems is linked to high costs, lack of technical knowledge, and limited access to long-term financing (Cristea et al., 2013).

However, realizing the full economic potential of aquaculture in Romania requires addressing current challenges (Table 4). Investments in technological innovation, modernization of infrastructure, and streamlined regulatory frameworks are vital. Policies aimed at market expansion and sustainability can facilitate further economic and environmental gains.

Table 4. Recommendations for Future Development in Romanian Aquaculture

Recommendations	Anticipated Outcomes
Technology integration and infrastructure modernization	Enhanced productivity and reduced costs
Simplified regulatory environment	Increased sector attractiveness and investment
Expanded market access	Increased revenues and sector growth
Sustainability-focused practices	Long-term environmental and economic benefits

CONCLUSIONS

The Romanian aquaculture sector faces several constraints like the bureaucratic obstacles in licensing and land use, lack of skilled workforce and aquaculture-specific education and the environmental challenges such as water scarcity and climate variability.

On the other hand, Romania holds considerable potential due to its abundant inland waters (lakes, ponds, and rivers), market proximity, and growing demand for local, traceable, and sustainable fish products.

Aquaculture is a crucial economic and ecological sector in Romania, characterized by significant potential for growth and sustainability. Key regions such as Tulcea and Constanța exemplify the integration of traditional practices with modern economic strategies, highlighting effective models for sectoral growth.

In conclusion, sustained efforts from government agencies, industry stakeholders, and research institutions are essential to leverage aquaculture's economic potential, ultimately supporting national food security and sustainable economic growth.

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