DOI https://doi.org/10.30525/2661-5150/2025-1-12

INTERNATIONAL AQUACULTURE CLUSTERS: PROSPECTS OF INTERACTION IN THE CONTEXT OF GLOBALISATION

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Abstract. The article expounds on the conceptual underpinnings that govern the formation and evolution of international clusters within the broader context of globalisation and European integration. The purpose of the article is to study the issues of the formation and development of international aquaculture clusters in the conditions of globalization and European integration, to substantiate the creation of an international aquaculture cluster and the possibility of its integration into European industrial ecosystems. The methodological basis of the research is the investigation of scientists specialising in the formation and development of international clusters. These scientists have studied various aspects of the functioning of the clusters, their structure, interaction among the participants and the impact on economic development. The general scientific techniques and research methods: logical method (to clarify the concept of "cluster", "international cluster", as well as to determine their relationship and clarify the main characteristics of the clusters); historical method (to study the evolution of the concept of clustering, as well as to analyse the development of international clusters in different regions of the world); comparative method (to compare clustering models in different countries and regions, which made it possible to identify the features of successful cluster initiatives and apply the knowledge gained for the development of international clusters); case method (to analyze specific examples of existing international clusters, which allowed a deeper look at the practical aspects of their formation, functioning and development, and to study real cases of successful international aquaculture clusters); structural method (to build the organisational structure of the international aquaculture cluster in Ukraine, which allowed to study the interaction and organisation of all participants, as well as to identify the main elements that will contribute to the effective functioning of this cluster); statistical method (to study the export parameters of fish, fish products and other aquatic bioresources of Ukraine from 2018 to 2023, identify trends, factors affecting exports, and also predict future changes in this area). The advent of methodologies for defining clustering, and their subsequent generalisation, has enabled the identification of international aquaculture clusters as associations of companies, organisations, research institutes and other participants specialising in aquaculture (i.e., the cultivation of aquatic organisms such as fish, molluscs, algae, etc.). The primary objectives of these clusters are the development of innovations, the augmentation of efficiency, the reduction of environmental impact and the improvement of production practices in aquaculture. The author presents a cogent argument for the establishment of an international aquaculture cluster in Ukraine, and the potential for its integration into the European Union. The establishment of an international aquaculture cluster in Ukraine holds considerable potential for the nation's advancement, ensuring economic growth, food security, job creation, increased exports, and the strengthening of international relations. The establishment of such an association would facilitate Ukraine's utilisation of natural resources and facilitate its integration into the global economy, thereby creating opportunities for the sustainable development of aquaculture. The integration of an international aquaculture cluster into EU countries has been demonstrated to hold significant potential and to offer numerous opportunities for the development of the economy, ecology and sustainable production. The integration of the international aquaculture cluster into the EU countries has the potential to yield numerous benefits, including access to high quality standards and environmental certification, joint research and innovation, access to European markets, increased efficiency through co-operation,

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promotion of sustainable development and environmental responsibility, investment and financing, improved education and skills, regulation and political support.

Keywords: cluster, clustering, international aquaculture cluster, globalisation, European integration, international cluster structure, export of aquaculture products.

JEL Classification: Q22, Q17, L22

1. Introduction

In the context of contemporary aquaculture development, the formation of clusters assumes significance for the integration of diverse participants into a unified, effective system. This, in turn, facilitates the enhancement of the competitiveness and sustainability of the sector as a whole. The establishment of an international aquaculture cluster represents a promising area of institutional transformation, particularly in circumstances where financial resources are constrained and there is intense global competition. In consideration of the significance of aquaculture as a substantial constituent of the agricultural sector and food industry, the establishment of international clusters has the potential to serve as a pivotal instrument for ensuring its competitiveness in both domestic and global markets. This is particularly pertinent in the context of European integration and the intense competition that prevails in global markets for aquaculture products.

The scientific community has dedicated significant efforts to the development and formation of clusters, which are regarded as a promising direction for the enhancement of industrial potential (Boiko, 2016; Boiko, 2021; Potapenko, 2018; Ryneiska, 2016; Stanasiuk, 2016). The economic essence and classification of the international clusters are considered in academic papers (Kudriavets, 2020; Chernykh, 2014). Scientists (Samiilenko, 2019; Samborskyi, Hlasov, 2021) studied theoretical aspects, problems and prospects of cluster policy, practical implementation of cluster structures in the regions of Ukraine. The problems of international cluster development in the context of globalisation, the concepts of cluster policy development in EU countries were reflected in the scientific works of (Huzenko, Yefimchuk, 2022; Shevchenko, Khaidarova, Sabirova, 2023).

It is important to acknowledge that, despite the theoretical research and practical assessment of the effectiveness of the formation and development of international clusters, there is a need for more thorough study of promising areas of formation and development of international aquaculture clusters in the context of globalisation and European integration.

The *objective of the article* is to study the issues of formation and development of international aquaculture clusters in the context of globalisation and European integration, to substantiate the creation of an international aquaculture cluster and the possibility of its integration into European industrial ecosystems.

Research tasks:

– To consider theoretical approaches and conceptual foundations of the international aquaculture cluster formation;

– to investigate the trends and prospects for aquaculture sector exports in Ukraine;

– to present the practical aspects of creating an international aquaculture cluster and the possibilities of its integration into EU countries.

Research methods and methodology. The methodological basis of the research is the investigation of scientists specialising in the formation and development of international clusters. These scientists have studied various aspects of the functioning of clusters, their structure, interaction among the participants and the impact on economic development.

The general scientific techniques and research methods: logical method (to clarify the concept of "cluster", "international cluster", as well as to determine their relationship and clarify the main characteristics of the clusters); historical method (to study the evolution of the concept of clustering, as well as to analyse the development of international clusters in different regions of the world); comparative method (to compare clustering models in different countries and regions, which made it possible to identify the features of successful cluster initiatives and apply the knowledge gained for the development of international clusters); case method (to analyse specific examples of existing international clusters, which allowed a deeper look at the practical aspects of their formation, functioning and development, and to study real cases of successful international aquaculture clusters); structural method (to build the organisational structure of the international aquaculture cluster in Ukraine, which allowed to study the interaction and organisation of all participants, as well as to identify the main elements that will contribute to the effective functioning of this cluster); statistical method (to study the export parameters of fish, fish products and other aquatic bioresources of Ukraine from 2018 to 2023, identify trends, factors affecting exports, and also predict future changes in this area).

2. International Aquaculture Clusters: Theoretical Approaches and Conceptual Foundations

The concept of clusters gained widespread traction in the 1990s following the dissemination of Michael Porter's research papers. The application of this concept has been extensively documented in academic studies, particularly in the fields of economic development, regional economics, and competitiveness. It has garnered significant international support, with numerous countries adopting it as a foundation for novel economic policy and industrial development approaches. At the governmental and international organisational levels, the cluster concept has contributed to the development of programmes to support local economies, innovation centres and industrial parks. The utilisation of clusters as a strategic framework for the development of specific industries commenced, thereby enabling enterprises to consolidate resources, reduce infrastructure expenditures, and foster innovation.

The term "cluster" was first coined by Michael Porter, a professor at Harvard Business School, during the 1980s. The term was employed to denote geographically grouped companies, suppliers, organisations, and institutions that have common interests and actively interact with each other, thereby increasing their competitiveness. Porter (1998) considered clusters to be significant elements that contribute to the development of innovations, cost reduction, and increased efficiency in business. According to Porter, companies in the same cluster have significantly more opportunities to share information, technologies and resources, allowing them to respond more quickly to market changes, develop innovations and reduce costs. As a result, clusters help to increase the overall competitiveness of both individual firms and regions or nations as a whole. Consequently, Porter's theories exerted a significant influence on the establishment of cluster policy in various countries across Europe, America and Asia. This influence is evident in the emergence of technology parks, industrial clusters and cluster initiatives, which have emerged as pivotal instruments for enhancing global competitiveness.

In the research paper, a cluster is defined as a network of interconnected entities from related industries that operate on the basis of market mechanisms of competition and co-operation. These mechanisms are mediated by the exchange of new knowledge and innovations, thereby enabling the achievement of synergy. This is defined as a total effect of co-operation that significantly exceeds the result that could be obtained from a simple summation of the efforts of individual participants (Kudriavets, 2020).

The establishment of an international cluster structure within the context of globalisation has the potential to serve as a significant factor in the acquisition of competitive advantages by industrial complexes across multiple nations. The existence of such a structure enables countries to combine their resources, knowledge, technologies and infrastructure, thereby creating more effective conditions for the development of innovations and increasing productivity.

An international cluster constitutes a form of international economic co-operation, whereby a group of independent business entities concentrated in the territory of two or more countries are unified for the purpose of jointly solving strategic problems, increasing the efficiency of production processes, developing innovations and achieving competitive advantages at the international level (Chernykh, 2014).

The strategic importance of clustering for the fisheries and aquaculture sectors in Ukraine is threefold: firstly, it contributes to economic development; secondly, it supports food security and export potential; and thirdly, it promotes the sustainable development of the industry. The analysis enabled the formulation of the author's definition of the concept of an international aquaculture cluster. *International aquaculture clusters are associations of companies, organisations, research institutes and other participants specialising in aquaculture (cultivation of aquatic organisms such as fish, mollusks, algae, etc.), which are aimed at developing innovations, increasing efficiency, reducing environmental impact and improving production practices in aquaculture.* Such clusters may include research and educational institutions, businesses, government agencies, and non-governmental organisations.

Ukraine has been identified as a nation with considerable potential for the development of aquaculture, primarily due to its geographical location, the availability of water resources, and the favourable conditions for the cultivation of various species of fish and shellfish. The establishment of an international aquaculture cluster in Ukraine holds considerable promise for the advancement of this sector, with the potential to attract investments, enhance competitiveness in global markets, and safeguard the sustainable utilisation of water resources.

International aquaculture clusters have the potential to make a significant contribution to the development of a country's export potential, since co-operation among different countries and enterprises within such clusters opens up new opportunities for entering international markets. The aforementioned co-operation enables countries to enhance their production volumes and increase the competitiveness of their products. This is achieved through the exchange of knowledge, innovations, technologies and resources.

3. Analysis of Aquaculture Sector Exports: Trends and Prospects

In the initial phase of the study, an analysis will be conducted of the export of the aquaculture sector. Export of fish products constitutes a significant component of Ukrainian foreign trade. The fisheries sector is a significant employer within the fishing and processing industries, and also constitutes a substantial source of foreign exchange earnings for the country. Ukraine's international trade in fishery products encompasses a diverse range of items, including fish, seafood, and processed goods such as canned fish. Furthermore, the export of fishery products has been demonstrated to stimulate the development of infrastructure, including transportation and storage of products. This is a vital aspect for the strengthening of the country's economy. Export of aquaculture products in Ukraine demonstrated positive dynamics during the period 2018–2021 (see Figure 1).

The observed rise in export volumes, from 10.6 thousand tons in 2018 to 13.2 thousand tons in 2021, signifies a gradual enhancement in production capacity and an escalating demand for Ukrainian fish products in international markets. However, in the context of the war and its ramifications, this positive trend has undergone significant changes. Despite the continued growth in the export of fish and fish products in 2021, the onset of hostilities in 2022 led to a marked shift in the situation, resulting in a decline in export volumes. This decline can be attributed to the destruction of infrastructure, the suspension of logistics chains, and the loss of traditional sales markets.

Exports of aquaculture products are significantly reduced in 2022-2023 due to the war and its consequences. *Firstly*, this is due to the suspension of port operations. Since the beginning of the war, many Ukrainian ports on the Black Sea and the Sea of Azov have become inaccessible or have been damaged as a result of hostilities, which has complicated exports via traditional sea routes, which were the main routes for delivering fish products abroad. *Secondly*, the war has caused serious problems with the transportation of products, both by sea and land. Railway and road routes have also been disrupted due to hostilities, destruction of infrastructure, and security restrictions. *Thirdly,* the decrease in exports of fish and fish products from Ukraine in 2022-2023 is due to a reduction in production, as a result of destruction of production facilities, as well as a shortage of resources for fishing. Many enterprises have experienced significant difficulties, which has led to a decrease in the production of fish products. *Fourthly,* the issues associated with the diminution in exports are concomitant with the erosion of sales markets. The political situation in Ukraine has undergone significant changes, which have had a considerable impact on the economy. The war has had an adverse effect on the demand for Ukrainian fish products in certain countries. Concurrently, numerous established partners imposed restrictions on imports, citing alterations in the global economic landscape or the hazards stemming from the ongoing conflict. *Fifthly,* Ukraine was compelled to explore alternative logistical routes and options for delivering products to international markets, which necessitated additional expenses and time, thereby adversely impacting export indicators. In consequence of the aforementioned factors, there was a substantial decline in the export of fish and fish products from Ukraine during the 2022-2023 period. This decline had grave ramifications for the nation's economy and the manufacturing sector of fish products. However, even in such

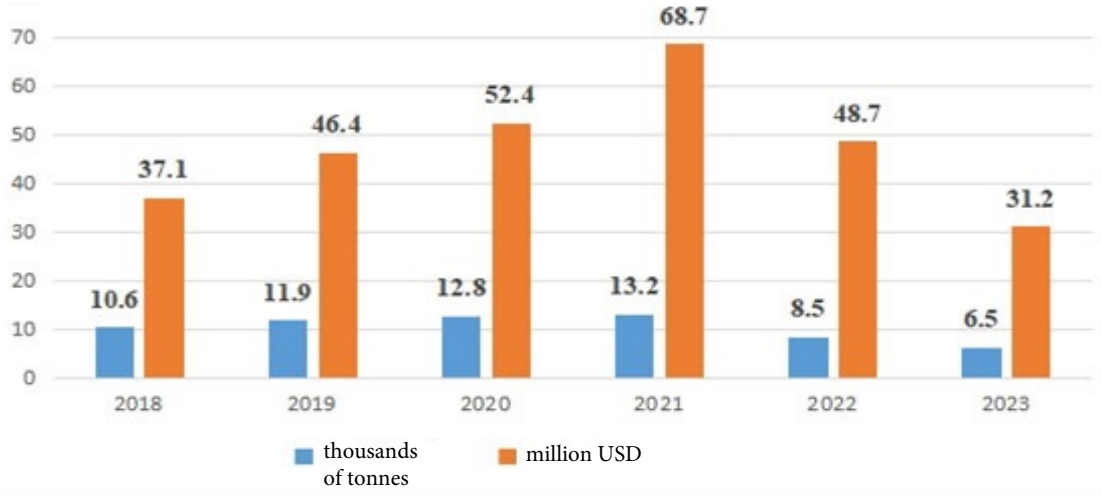

Figure 1. Export of fish, fish products and other aquatic bioresources of Ukraine from 2018 to 2023

Source: prepared under the materials of the State Statistics Service of Ukraine

challenging circumstances, Ukraine persisted in seeking avenues for the restoration and advancement of exports through the establishment of novel markets and supply channels.

Notwithstanding the challenging conditions engendered by the war and its ramifications, in 2023, Ukraine persisted in its exportation of fish products to numerous countries, most notably to the European Union, in addition to other regions worldwide. Despite a decline in export volumes relative to previous years, attributable to logistical challenges and the loss of certain traditional markets, the country successfully sustained its export position through a strategic adaptation to prevailing conditions. European countries continued to be significant partners for Ukrainian fish exports. In view of the elevated demand for fish and seafood, Ukrainian manufacturers persisted in supplying their products to EU countries, notwithstanding the challenges associated with transport and security. The European Union (EU) represents a significant market for Ukrainian fish products, and it is a priority for exporters of these products to target the EU market.

4. Practical Aspects of Creating an International Aquaculture Cluster and the Possibility of its Integration into EU Countries

The European Union constitutes a relatively integrated market for Ukraine, a fact which renders it possible to reduce the costs of product transportation. This is of particular importance in conditions where logistics are becoming difficult due to restrictions caused by the war. Consequently, alternative routes for the export of fish and seafood across the western borders became a viable proposition. Ukraine has entered into accords with the EU, most notably the Association and Free Trade Area Agreement, which facilitates preferential tariff conditions for Ukrainian exporters seeking to penetrate the European market.

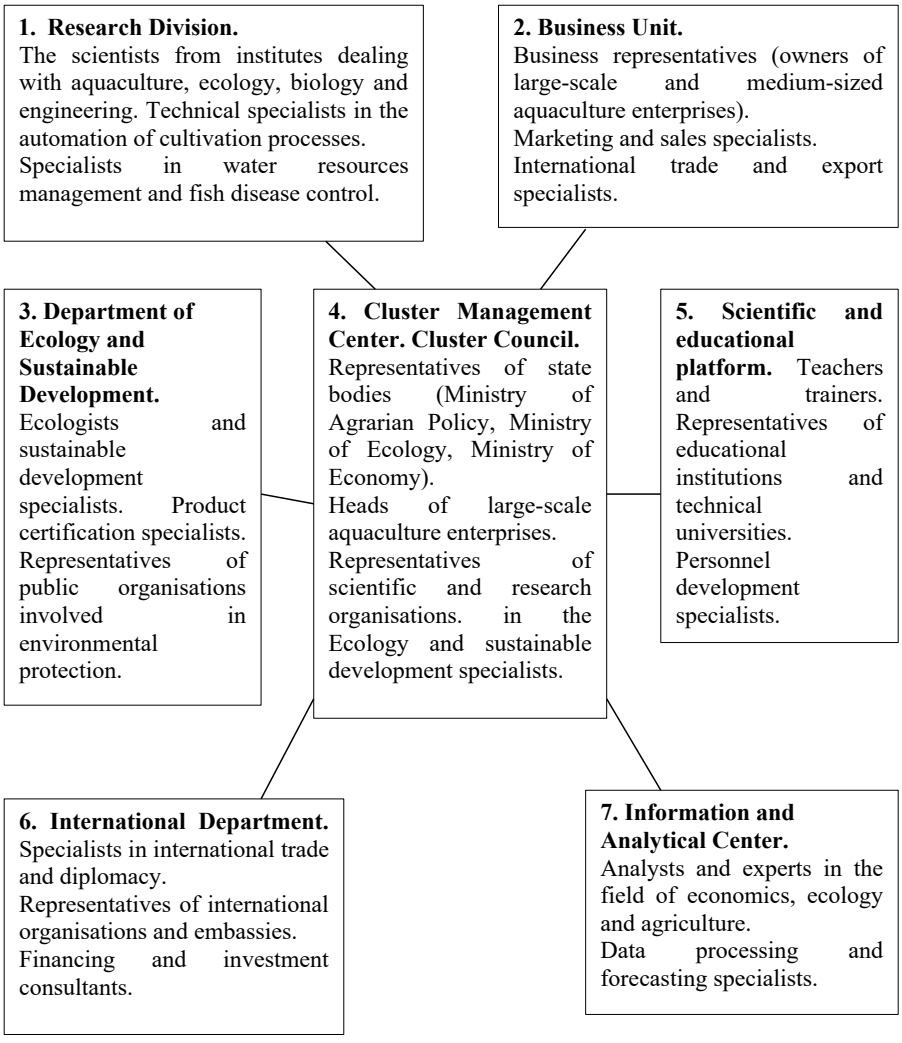

Figure 2. Proposed structure of the international aquaculture cluster in Ukraine

Source: author's own development

This has led to a substantial reduction in tariffs for fish exports, thereby enhancing their competitiveness. Consequently, the European Union market remains a pivotal destination for Ukrainian fish exports, and the country persists in prioritising this market, despite the challenges posed by the war and its ramifications.

The proposal entails the establishment of an international aquaculture cluster in Ukraine, with subsequent integration into the European Union (Figure 2).

The proposed structure of the international aquaculture cluster in Ukraine is intended to ensure effective co-operation among all industry participants, including government agencies, businesses, research institutions and international partners. It is anticipated that this will contribute to the development of innovations, economic growth, increasing the competitiveness of products in international markets and ensuring the sustainability of the industry.

The main functions of the participants of the international aquaculture cluster in Ukraine are presented in Table 1.

A SWOT analysis of the potential for the establishment of an international aquaculture cluster in Ukraine has been conducted (see Table 2). The SWOT analysis of the creation of an international aquaculture cluster in the context of Russian aggression assesses the prospects and challenges for the development of this industry in the context of the war in Ukraine and its consequences for the economy, security, international relations and ecology. In light of the challenging circumstances, the aquaculture sector may encounter novel risks and obstacles. However, it is also poised to benefit from opportunities for adaptation and growth.

In consideration of the merits inherent in the establishment of an international aquaculture cluster, it is evident that such a development has the potential to serve as a pivotal component within the Ukrainian post-war recovery strategy. This is predicated on the premise that the initiative would contribute to the assurance of food security and the sustainable advancement of the agricultural sector. In the context of aggression, the introduction of new technologies has the potential to reduce dependence on external suppliers and increase production efficiency (for example, aquaculture in closed water systems, biotechnology for fish health). Ukraine has a substantial domestic market with the potential

Table 1

Content of the main functions of the international aquaculture cluster participants in Ukraine

International cluster components	Functions of the international aquaculture cluster participants
1. Cluster Management Center. Cluster Council	Coordination of all cluster participants. Development of a cluster development strategy and monitoring its implementation. Co-operation with government bodies, international organisations and other partners.
2. Research division	Research and development of new aquaculture technologies. Study of the environmental aspects of the industry. Selection of new fish species suitable for Ukrainian conditions. Development of water resources management systems that minimise pollution.
3. Business unit	Development and support of aquaculture enterprises. Search for investments and project financing. Establishing trade relations and promoting export opportunities. Implementation of marketing strategies and product branding.
4. Department of Ecology and Sustainable Development	Development of environmental standards for aquaculture. Monitoring compliance with environmental regulations. Raising awareness about sustainable practices in aquaculture. Implementation of the technologies to reduce negative environmental impact (e.g., efficient use of feed, waste management).
5. Scientific and educational platform	Development and delivery of courses and training for specialists in the field of aquaculture. Training of specialists for work in aquaculture enterprises. Co-operation with universities and educational institutions to create educational programs.
6. International Department	Establishing international contacts and partnerships. Coordination with international aquaculture organisations (e.g., Global Aquaculture Alliance, Aquaculture Stewardship Council). Search for international investments and projects for the development of aquaculture in Ukraine. Development of exports of Ukrainian products to the international markets.
7. Information and Analytical Center	Collection and analysis of market data and statistics. Monitoring of economic, environmental and social aspects of aquaculture development. Holding of analytical research and preparing reports for cluster participants.

Source: author's own development

Table 2
The SWOT analysis of the creation of an international aquaculture cluster in the context of Russian aggression

Strengths	Weaknesses
Sustainable development of aquaculture; Innovative potential; Large domestic market; International partnerships; Reconstruction of infrastructure; Environmental sustainability; Investment attractiveness.	Unstable political situation; Destroyed infrastructure; Lack of financial resources; Supply chain disruption; Declining demand; Port closures.
Opportunities	Threats
Support from international partners; Development of new markets; Technological innovation in times of crisis; Environmental responsibility; Attracting investment for restoration.	Continued war and escalation of conflict; Environmental disasters; International trade barriers; Labor shortage; Inflation and economic instability.

Source: author's own development

to serve as a foundation for the advancement of local production and the fulfilment of the population's demand for aquaculture products. Due to its geographical location and the presence of international obligations, Ukraine has the potential to become an important partner within the EU to ensure the supply of fish and other aquatic organisms to the European market. The restoration of infrastructure in the aftermath of war has been demonstrated to result in modernisation and the enhancement of conditions for the development of the aquaculture industry, particularly in coastal and water areas.

The following discussion will explore the potential disadvantages of establishing an international aquaculture cluster. The ongoing war in Ukraine and ongoing territorial conflicts have the potential to engender political instability, which in turn has the capacity to decelerate the development of investments and international co-operation. The large-scale destruction of infrastructure (water supply, transport, energy networks) in Ukraine has the potential to seriously complicate the implementation of the cluster strategy and increase the costs of restoration. In conditions of war, the capacity of the state budget and international financial institutions to provide support to aquaculture projects may be constrained. The obstruction of the provision of feed, machinery, equipment and specialised chemicals for aquaculture has the potential to decelerate the development of the cluster and diminish production volumes. It is anticipated that the ongoing war and prevailing economic challenges will result in a decline in the demand for specific categories of aquaculture products within both domestic and international markets.

The establishment of an international aquaculture cluster has the potential to yield certain outcomes. In the context of the ongoing war, Ukraine has the potential to receive financial and technical support from international organisations such as the EU, the UN, and the World Bank. This support could be instrumental in facilitating the restoration and development of the aquaculture industry. In the post-war period, Ukrainian enterprises have the potential to identify new markets for their products through support for export programmes and the liberalisation of trade relations. In the context of prevailing instability and constrained resources, Ukraine has the potential to transition towards sustainable and efficient production methodologies. This transition would serve to reduce the nation's reliance on imports and enhance the efficiency of domestic enterprises. The restoration and expansion of the cluster has the potential to contribute to the development of environmentally friendly and sustainable aquaculture, which is an important trend in post-war reconstruction and can attract the attention of international investors. In the post-war era, Ukraine is poised to emerge as a lucrative prospect for international investments, particularly in the domains of agriculture and aquaculture. This potential for recovery and growth is a key factor in the country's attractiveness as an investment destination.

The creation of an international aquaculture cluster under the conditions of Russia's aggression poses certain risks. The continuation of Russian aggression may lead to further destruction and loss of production facilities, which will complicate the implementation of cluster initiatives. Aggression can lead to pollution of water resources, blockage of environmentally friendly areas for fish farming, and also to death of fish and ecosystems due to mass destruction. The present analysis suggests that in the event of Russia's aggression, the imposition of sanctions and restrictions on trade may be inevitable. Such measures would inevitably lead to complications in accessing external markets and the disruption of supply chains of raw materials and technologies. The war may lead to significant losses of labour force due to mobilisation,

deaths and emigration, which will complicate the operation of enterprises and their participation in the international cluster. It is evident that armed conflict has the potential to engender substantial inflation and economic turbulence, which in turn has the capacity to diminish the solvency of consumers and enterprises alike. This, in turn, will render it arduous to procure financing for the advancement of the cluster.

A SWOT analysis of the establishment of an international aquaculture cluster in the context of Russia's aggression reveals that, despite the presence of substantial threats and challenges, significant opportunities for the recovery and development of this industry following the cessation of hostilities emerge. The development of an aquaculture cluster has the potential to become an important element in the recovery of the Ukrainian economy, ensuring food security and the country's integration into international economic structures. In order to achieve success, it is necessary to take into account all external and internal factors, adapt development strategies, and attract international investments and support in order to overcome crisis moments.

In the following analysis, the potential integration of an international aquaculture cluster into EU countries will be examined. This integration presents significant opportunities for the development of export potential, innovation and sustainable production in the industry. Firstly, the issue at hand is that of access to high-quality standards and environmental certification. Participation in the international cluster facilitates the acquisition of technologies and practices that meet these requirements, as well as certification to ensure compliance with standards, such as EU Organic Certification or Aquaculture Stewardship Council (ASC). This development facilitates the export of environmentally sustainable products to the European market. Furthermore, the initiative encompasses collaborative research and innovation, as well as facilitating access to European markets. The EU has been proactive in its endorsement of initiatives that promote the sustainable development of aquaculture, notably through the Green Deal and the Farm to Fork Strategy. Integration into an international cluster has the potential to contribute to the development of sustainable fish farming methods that meet EU requirements for eco-efficiency and responsibility. Such methods include the use of renewable energy sources, sustainable feeding methods, and reducing the impact on ecosystems. The EU has a track record of promoting policies that encourage the development of sustainable and environmentally responsible industries, including aquaculture. The EU has the capacity to support international clusters through various policy initiatives that engender favourable conditions for international co-operation, interaction between countries, and the resolution of common problems in the aquaculture sector.

In the EU countries, cluster strategies are frequently a significant component of both national and regional strategies for economic development and competitiveness (Huzenko, Yefimchuk, 2022). The EU countries have recognised the importance of clusters for increasing the competitiveness of national economies, and they include these strategies in general national programmes. The national cluster strategies have been demonstrated to contribute to the development of innovation, increased productivity and sustainable economic growth.

Aquaculture cluster strategies in the European Union are an important tool for developing sustainable production, increasing competitiveness and integrating the different actors in the sector. They aim to optimise technologies, integrate the latest scientific research, support investment and ensure the sustainable development of aquaculture in the face of climate change, new environmental challenges and product quality requirements.

The cluster strategies employed in the context of EU aquaculture have the capacity to encompass a wide range of aspects, including the development of innovations, the mitigation of environmental risks, the enhancement of production efficiency, and the promotion of sustainable practices. These strategies are typically implemented through co-operative endeavours among governments, businesses, research institutions and international organisations.

The following discussion will consider the main directions of cluster strategies in the EU aquaculture:

1. The provision of assistance to initiatives which are innovative in nature and which are focused on technological development. The promotion of novel technologies is a key aspect of the strategy employed by aquaculture clusters in the EU, with notable examples including the development of closed water supply systems (RAS), aquaculture on offshore platforms, and integrated aquaculture and agro-culture systems. These technologies contribute to a reduction in water and energy use, an increase in productivity and a decrease in environmental risks. For instance, the Aquaculture Innovation and Technology Cluster in the Netherlands is a notable example of such a body, as it serves as a nexus for companies specialising in aquaculture innovation, with a particular focus on the development of water purification technologies and the restoration of marine ecosystems.

2. Reducing environmental impact and improving sustainability. Given the current challenges facing aquaculture, such as climate change, water pollution and the threat of biodiversity loss, many clusters focus on developing sustainable and environmentally friendly practices. The EU actively supports aquaculture strategies that help reduce pollution, including the

use of environmentally friendly feed, the protection of marine ecosystems and the prevention of fish diseases. For example, the European Aquaculture Society (EAS) has a large number of projects focused on environmental sustainability, particularly in areas such as restoring the marine environment for aquaculture.

3. Establishing quality product standards. To ensure competitiveness in international aquaculture markets, the EU promotes the establishment of quality standards for products, including certification according to international standards such as Global GAP, ASC (Aquaculture Stewardship Council). An important element is the maintenance of effective product safety standards and fish health monitoring to meet consumer demands and ensure food safety.

4. Increased competitiveness and integration into international markets. Aquaculture clusters help small and medium-sized enterprises to integrate into global supply chains, which is key to increasing competitiveness in international markets. For example, the Aquaculture Business Development Cluster in Spain is helping local aquaculture producers to enter international markets, particularly in South East Asia.

5. Support for small- and medium-sized enterprises (SMEs). One of the key functions of the clusters is to promote the development of small and medium-sized enterprises, which includes the provision of financial support, advice and training for companies starting up or expanding their aquaculture business. An important part is also the provision of support in the form of grants and EU funding programmes such as Horizon Europe, Erasmus for Young Entrepreneurs.

The following discourse will consider examples of aquaculture cluster strategies in the EU.

1. Pôle Mer Méditerranée (France) is a cluster in the southern regions of France that brings together enterprises, research institutions and organisations operating in the field of marine aquaculture, biotechnology and sustainable water management. The cluster fosters the development of novel technologies for the conservation of marine ecosystems, the sustainable cultivation of fish, and the integration of marine aquaculture with other sectors of the economy.

2. The Norwegian Seafood Cluster (NSC) in Norway is a prominent proponent of sustainable fish farming practices, with a particular emphasis on salmon. In addition, the NSC is engaged in the development of novel technologies aimed at enhancing product quality and reducing environmental impact. The cluster also promotes international co-operation and contributes to the development of global markets for seafood.

3. The European Aquaculture Technology and Innovation Platform (EATIP) is a European platform that brings together innovative initiatives in aquaculture. The objective of the initiative is to cultivate novel technologies that will enhance economic efficiency and curtail the ecological footprint of aquaculture in Europe. EATIP is currently engaged in the development of sustainable development standards, and is providing support for the implementation of Horizon Europe programmes for the development of aquaculture.

Consequently, the EU aquaculture cluster strategies have been demonstrated to contribute to the development of innovation, increased competitiveness and sustainability of the industry at the international level. It is possible to combine the efforts of public authorities, businesses and research institutions in order to address key issues such as environmental challenges, climate change and access to international markets. The promotion of active co-operation within clusters is instrumental in ensuring the sustainable development of aquaculture and the preservation of biodiversity in aquatic ecosystems.

5. Conclusions

The establishment of international aquaculture clusters has been demonstrated to engender considerable prospects for the advancement of the industry on a global scale. This is achieved by facilitating the amalgamation of the endeavours of nations and enterprises, thereby fostering innovation, environmental sustainability, competitiveness and economic efficiency. International aquaculture clusters are defined as associations of companies, organisations, research institutes and other participants specialising in aquaculture (i.e., the cultivation of aquatic organisms such as fish, molluscs, algae, etc.). The primary objectives of these clusters are the development of innovations, the increase of efficiency, the reduction of environmental impact and the improvement of production practices in aquaculture. The participants in such clusters have the potential to mitigate risk, achieve sustainable development, and enhance access to international markets and financing.

The establishment of an international aquaculture cluster in Ukraine holds considerable potential for the nation's advancement, ensuring economic growth, safeguarding food security, generating employment opportunities, augmenting exports, and fortifying international relations. The establishment of such an association will enable Ukraine to benefit from natural resources and to integrate into the global economy, thereby creating opportunities for the sustainable development of aquaculture. The integration of an international aquaculture cluster within the EU countries has been demonstrated to hold significant potential and to offer a plethora of opportunities for the development of the economy, ecology and sustainable production. The European Union is a major consumer of fish products and is actively engaged in issues

of sustainable development and environmental responsibility. The opportunities for the integration of the international aquaculture cluster into the EU countries include access to high-quality standards and environmental certification, joint research and innovation, access to the European markets, increased efficiency through co-operation, promotion of sustainable development and environmental responsibility, investment and financing, improved education and skills, regulation and political support.

The prospects for further development include the development of a project for the integration of the international aquaculture cluster into the European industrial ecosystems.

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Received on: 12th of February, 2025
Accepted on: 14th of March, 2025
Published on: 31th of March, 2025