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INNOVATION IN HUNGARIAN AQUACULTURE

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Abstract: Before the regime change in Hungary, the aquaculture sector produced one of the largest income values within agriculture in the field of international knowledge and technology transfer. As a result of environmental effects, the strengthening of regulations and their enforcement, as well as the Covid-19 epidemic, marine fish catches decreased by 3.8% in 2020 compared to the average of 2017-2019. In addition, the EU is a net importer of aquaculture products (68% of the aquaculture products consumed in the EU are not produced in the EU). The decline in marine fisheries offers a chance to increase the market share of the freshwater aquaculture sector. However, the recent increase in energy and feed raw material prices makes the situation even more complicated. In the current economic environment, there is an increased need to respond to problems through innovation. The development of the Hungarian aquaculture sector has three target areas: i) traditional pond farming; ii) precision (intensive) fish production; iii) and modernization of fish processing are both priorities and at the same time complex development goals We examined the main challenges of these areas and identified proposed solutions that, can provide a solution to some of the sector's problems thanks to the recent innovative developments. It can be concluded that willingness and susceptibility to innovation are present in the sector. Excellent national and international developments have been made recently. It is a task for national economies to support actors in the aquaculture innovation chain in their renewal.

Keywords: innovation, aquaculture, problem-solving, development

1. Introduction

Aquaculture includes the farming of fish and shellfish and the cultivation of aquatic plants. Aquaculture is one of the fastest-growing food sectors in the world. Currently, about half of the fish consumed by the world's population already comes from aquaculture farms (FAO 2022).

The Hungarian fish farming and aquaculture knowledge, technology, and experience are world-renowned. The name of Professor and FAO expert Elek Woynárovich is synonymous with innovation, and his tradition has led the Hungarian fisheries sector to make and continue to make major and minor improvements in almost every country in the world. It is said that "the Hungarians taught half the world how to breed fish", which is a slight exaggeration, but it can be said that we are one of the nations that have played and continue to play a decisive role in the development of the sector. This is due to a thorough knowledge of the profession and a willingness to innovate, which is reflected in the sector's operators' complex knowledge, expressed in a creative, result-oriented approach that is inventive in all situations. We Hungarians are characterised by our knowledge of the areas for development in the sector, our ability to identify and analyse problems, propose solutions to them, and disseminate the solutions developed through the innovation chain to domestic and international users.

The fact that 65% of the fish and aquaculture products consumed in the EU are produced outside the EU (compared to 40% in 2004) is a worrying fact, and the EU strategy is to reduce this market exposure to 2004 levels by 2030, based on the development of intensive (industrial) fish farming systems and the intensification of pond fish farming (cage farming, pond-to-pond technologies, etc. To achieve this goal, the European Parliament recently decided that the aquaculture sector will be subject to a funding increase of almost 10%, representing EUR 7.74

billion, of which a significant share (almost 30%) will be devoted to the development of freshwater aquaculture, with a priority for innovation (Hogan 2018).

One of the most commonly used indicators to assess the importance of the Hungarian fish farming and aquaculture sector in the national economy is its contribution to output and GDP. Due to its multifunctional role, the fisheries sector is a much more important economic sector of the national economy than the size of its contribution. In view of this, the fisheries and aquaculture sector has a role to play in exploiting natural and ecological assets, in rural development, and in influencing employment and the quality of life of the rural population, and has further potential for development. Before the change of regime, fish farming and aquaculture were one of the agricultural sectors with a steady, dollar-based export income (Urbányi et al. 2013). Today, despite the strong prospects for the sector, it is in crisis: the industry is perceived as lacking innovation, ideas, and problem-solving.

2. Material and methods

A questionnaire survey was used as the basis for the research part of the Communication. The questionnaire survey is a quantitative research method. This method was chosen because it allows us to collect a large number of quantitative data on a large scale (Horváth 2004).

The choice of respondents was straightforward. Since we wanted to interview economic operators, the respondents were enterprises in the for-profit sector. To identify the respondents, we used the list of members of MA-HAL (Hungarian Aquaculture and Fisheries Interbranch Association) (*Table 1*).

Table 1: *List of MA-HAL member organisations* (MA-HAL 2021)

Organisation form	**Number of employees**
micro-enterprise	49
small enterprise	23
medium enterprise	9
large enterprise	2
single company	14
research institute	3
educational institution	2
private individual	6
NGO	4
Total	**112**

The table thus identified 97 potential respondents, of which 53 enterprises completed the questionnaire (54.64%), which provided a broad analysis of heterogeneous-homogeneous responses to get a picture of the innovation potential of domestic aquaculture-fish farming and processing enterprises. The 53 companies cover 91.6% of the domestic pond fish production area, 90.8% of the production volume, 89.8% of the production of intensive (industrial) systems, and 70.1% of our fish processing output.

The questionnaire survey can be classified as a primary research method, as it collects and analyses first-hand information. As a first step, we defined the scope of the information that would be relevant to the research objective. Then, the questions were grouped logically and in terms of content, whereby the questions were divided into 3 groups ("Group A", "Group B" and "Group C"), with a total of 27 questions. In group "A", questions on the respondent's identification and professional background (5 questions) were set up. In group "B", questions

were grouped together which dealt with the respondent's views on innovation (12 questions). In group "C", the respondents were asked about the innovation capabilities of the business they represent (10 questions).

The questionnaire was completed online, in a self-completion version, where the respondent reads, interprets, and answers the questions themselves.

The questionnaire included single- and multiple-choice closed questions as well as open-ended questions. For the closed questions, the respondent selects the appropriate answer from a predefined set of response options. It is important to strive for completeness in this set of questions, thus covering the full range of response options (Adair 1997). The questions in our research material include a higher proportion of multiple-choice and a lower proportion of multiple-choice question types. For multiple-choice questions, the number of answer choices is greater than three. The majority of our questions are closed questions, but there are also open questions. In this type of question, the respondent answers in his/her own words, which is more informative and gives more freedom to form an opinion.

The questionnaire also includes a scale, within which a numerical scale was used. The scale is a straight line with 5 sections, with which, for each question, respondents indicate the intensity of their opinion (Horváthné and Lampek 2015). Responses were converted to Microsoft Office Excel 2016 and sorted. Using filters, responses to open-ended questions were grouped and quantified. The data were used to create charts to visualise the results.

3. Results

Space does not allow us to cover all 27 questions, so we will present the most interesting ones. First of all, the entrepreneurial background of the respondents was analysed. In all cases, it was possible to find respondents who were able to answer the questions listed in the questionnaire in a complex way, with sufficient experience and insight. The respondents' role in the business is presented in *Table 2*.

Table 2: *Categorisation of respondents' positions in the company*

Position in company	**Number of feedback**
owner	6
managing director/CEO	9
both	34
company director	1
branch manager	3
total	**53**

It was considered important to examine the educational background of the respondent, in many cases the manager/owner of the company, and whether he/she could draw on theoretical background knowledge and skills (*Table 3*). It can be said that all respondents have knowledge in the field of agriculture. Even if the respondent did not have an agricultural/agricultural qualification, he/she had completed a course in fisheries engineering, and in several cases, respondents had also obtained a qualification as fisheries engineer after completing tertiary education.

Information was collected on whether respondents had any knowledge of business management, the results of which are shown in Table 4. The majority of entrepreneurs have no

knowledge of business management, and only a small proportion (9-17%) have such knowledge.

Table 3: *Distribution of respondents by level of education*

Respondent's level of education	**Number of people**
agricultural	34
other higher education	9
secondary agricultural education	11
secondary education	7
professional fishery engineer	22
primary agricultural education	0
primary education	0
others	0

Table 4: *Business management knowledge of respondents*

Possesses business management	**Number**
yes	9
no	44
total	**53**

We also asked about the length of time spent in an entrepreneurial environment, which is also seen as an important background for experience and knowledge (*Table 5*).

Table 5: *Distribution of respondents' years in an entrepreneurial environment*

Time spent in the profession	**Number**
More than 30 years	5
20-30 years	27
10-20 years	11
5-10 years	6
Less than 5 years	4
total	**53**

Business management knowledge can also be acquired through experience, therefore, information on how long the respondent had been working in the sector in their current position was asked as well (*Table 6*).

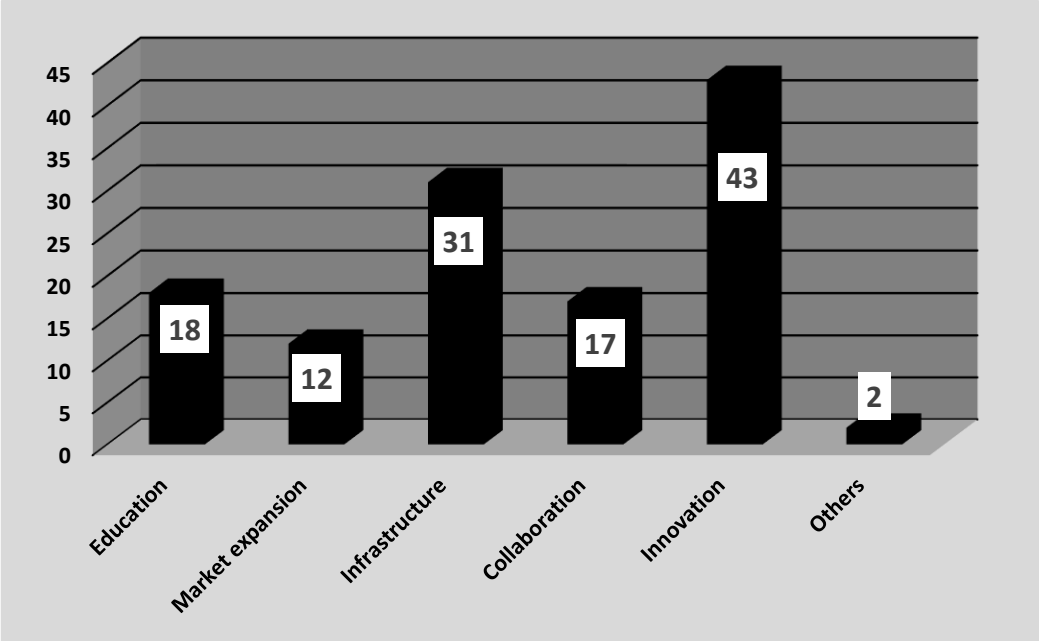
Table 6: *Distribution of time spent in respondents' current position*

Current position	**Number**
Over 30 years	14
20-30 years	14
10-20 years	11
5-10 years	9
Less than 5 years	5
total	**53**

These responses compensated for the result of the question on business management presented in Table 4. Theoretical knowledge of business management can be partially compensated by some experience in the sector of at least 5 years, and a significant proportion of respondents (48-90.6%) have a minimum of this length of experience.

In direct questions, we have sought to identify opportunities for innovation based on sectoral development aspects. Respondents were asked where they saw the sector's development needs to be more successful (*Figure 1*). All respondents could give more than one answer, and most of them (81% of respondents) see innovation as a breakthrough opportunity for the sector.

Figure 1: *Opportunities for the sector to break out*



4. Discussion

The aim of the questionnaire survey was to interview professionals who could give a real and complete picture of the businesses in question, an objective that was met to the maximum. In addition, it was important that the representatives of the responding companies had a level of education that matched their position and profession, which was also achieved by the majority of respondents. This knowledge was further disaggregated by asking about business management skills, but here less than 20% of respondents had such skills. A significant proportion of respondents have serious problems in understanding the concept of innovation. Professional experience and length of time in a managerial position can compensate to some extent for the lack of knowledge of business management, and the proportion of respondents who had been in the profession and in a managerial position for less than 5 years was relatively low.

Respondents identify innovation mainly with research and development. This is a common perception, as they perceive these activities as areas that foster innovation in their environment. However, the actual concept of innovation (idea implemented and brought to the market) is present in the knowledge of a minority of respondents, which implies that a methodological development in the field of education is not necessarily identified with innovation. Both activities that can be categorised as an investment element (e.g. building a fish pond) and

regulations shaped by market processes (e.g. setting the selling price of fish) are classified as innovations by respondents. In conclusion, knowledge of innovation among managers of enterprises is incomplete and their understanding of innovation as an activity is ambivalent.

Despite the lack of a real definition of innovation, the actors in the sector believe that innovation is the first of the breakout opportunities for the sector and its individual sectors. This is partly due to the fact that, as indicated earlier, the construction of a fish pond or the development of a fish price are also considered to be innovations. Using an indirect approach to address the barriers, they see the problems rooted in the motivational diversity of actors in the sector and the lack of cooperation between the for-profit and non-profit sectors, which are also found as concerns in other sectors (Kiss 2014). Following the identification of breakthrough points and barriers, respondents identified the creation of a sectoral innovation strategy to enhance innovativeness, but they also consider the adaptation of good practices and technologies from abroad to the domestic environment to be of high importance. This demonstrates that the sector is aware of the need for practice-oriented RDI programmes, but that it is difficult or impossible to implement them independently. Similar findings were made by EATiP in its EU-wide sector vision as an area for the development of aquaculture innovation through the coordination of autonomous and collaborative activities (EATiP 2012).

To summarise the conclusions from the results, the actors in the sector have the skills to use innovation to help and support the development of the sector both domestically and internationally through their professional knowledge, experience, and the modern technologies they use. However, this requires a major improvement in skills: the lack of modern business management and innovation skills makes it more difficult for businesses to respond to the challenges of a rapidly changing economic environment, which in many cases hinders development and leaves businesses in the sector highly exposed to external economic, market, technological and social factors.

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