

THESIS OF THE DOCTORAL (PhD) DISSERTATION

**POSSIBILITIES OF MULTIFUNCTIONAL POND FISH FARMING TO  
INCREASE FISH CONSUMPTION AND SOCIAL ACCEPTANCE OF  
AQUACULTURE**

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## **1. BACKGROUND AND OBJECTIVES OF THE RESEARCH**

It is a scientifically proven fact that aquaculture is playing an increasing role in providing healthy food to the world's growing population, but also in employment and the responsible use of resources. The fast development of aquaculture is unique in world food production, however it also has negative effects. These include degradation of the natural environment, overexploitation of water resources, introduction of non-native species, and non-compliance with criteria expected in the use of human resources (NAYLOR et al., 2000). Therefore, sustainability has become increasingly important in the planning and implementation of aquaculture development programs. Of the three basic criteria for sustainability, environmental and economic sustainability have received special attention, but only recently has more attention been paid to social sustainability. It can also be stated that the economic, environmental and social issues of aquaculture development and their complex evaluation have not been addressed so far by research institutions, producers- and governing organizations to the extent that would have been justified. This finding is also relevant to the Hungarian aquaculture, where pond fish farming, which is dominant in the sector, is at a crossroads, because pond fish production technologies commonly used today cannot be applied in a sustainable way in the long run. On the one hand, there is an increasing competition for the use of valuable freshwater resources, in which recreation and habitat conservation are becoming increasingly important, and on the other hand, traditional pond fish farming has significant constraints in supplying the market with modern fish products in a programmed way. In view of the above, efforts in research and management have also intensified in recent decades to ensure that pond fish farming meets the main challenges outlined above using new systems and technologies. In the spirit of these aspirations, multifunctional pond fish farming is a form of fish farming that can be environmentally, economically and socially sustainable. My choice of topic was strongly motivated by the fact, that despite the known advantages of multifunctional pond fish farms, the possibilities by which these farms can serve even more effectively to meet environmental and social needs have not been sufficiently explored especially for increasing fish consumption, improvement of sustainability, and promoting the social recognition of pond fish farming and aquaculture in general, which is one of the basic criteria for the development of aquaculture worldwide today.

To provide scientific support to development, there is also a need to apply methods that are new to aquaculture research. For example, one of the multi-criteria decision methods is the Analytic Hierarchy Process (AHP), which is especially justified in the development of a complex system, the successful operation of which is based on the systematic organisation of several functions. In line with the topic detailed above, the objectives of my scientific work can be summarized as follows:

- Establish a targeted organisation of the functions that determine the successful operation of multifunctional pond fish farming using a multi-criteria decision-making method, the Analytic Hierarchy Process (AHP).
- Using the AHP method, based on the expert opinions, the examination of the economic, environmental and social functions of the Hungarian multifunctional pond fish farms, their role within a complex system, and their impact on each other.
- To study how the results of multifunctional pond fish farming in Hungary can be applied in international aquaculture development programs, especially in those regions (Eastern Europe and Asia) where Hungarian participation in the implementation of freshwater aquaculture development programs is traditional.
- Analysis of the situation and possibilities of increasing domestic fish consumption, especially with regard to the results of fish consumer surveys conducted in the last decade, and taking into account the related professional materials, analyses and strategies, how multifunctional fish farms can contribute to increasing fish consumption.

## 2. DATABASE AND APPLIED METHODS

Regarding the complexity of the topic, it was necessary to apply several methods to conduct my research successfully according to the followings.

### 2.1. Analytic Hierarchy Process (AHP)

I examined the role of specific functions of multifunctional pond fish farming within a complex system and their effect on each other using the AHP method. The main feature of the method is to break down the elements of a complex problem and then compare the individual components of the elements so that we can give an answer to the original problem (SAATY, 1977). The AHP method therefore makes it possible to rank the answers given by fish producers to certain questions concerning farming. A hierarchical model created for this purpose allowed me to perform my questionnaire analysis based on the AHP method. During the analysis, I had to create a pairwise comparison questionnaire after the complex decision problem was broken down into elements. In addition to 6 general questions, I compiled another 16 special questions in the questionnaire, creating a so-called matrix. In the questionnaire, I used a scale from 1 to 9 to compare items in pairs (Table 1).

**Table 1: Scale for pairwise comparison of AHP**

Degree of importance	Definition
1	One output has very little importance over the other
3	Moderately higher importance of one output compared to the other
5	Both outputs are equally important
7	One output has demonstrably higher importance than the other
9	One output is definitely or absolutely more important than the other

*Source: Own research*

Such a comparison is easier for respondents to understand or perform than for all elements to be compared at the same level of the structure at the same time. In the case of a pond fish-farm, the problem to be addressed can be understood by examining the elements of multifunctionality and the hierarchical structure of potential outputs. I developed three levels of hierarchical structure: multifunctional outputs at the highest (most general) level

of the decision structure; certain functions of fishponds (types of outputs) at two intermediate levels; and the main outputs of the various functions form the basis of the structure. Thus, I assigned additional importance criteria to each output, on the basis of which it was possible to assess the weight of each output within the system even more accurately, for example in assessing the importance of output „1.1. Production of healthy and safe fish product” evaluators were able to choose from the criteria „1.1.1. Production of live fish for human consumption” or „1.1.2. Production of high value-added products”. Thus, for the 12 outputs of the three main functions, the leading experts of the pond farms participating in the evaluation could choose from 44 importance criteria. During the evaluation, each respondent completed 16 matrices. Twelve fish farmers took part in the evaluation, representing 51.2% of the fishpond area operating in Hungary and 62.7% of the carp production in 2017. I analysed a total of 192 matrices and checked their fill consistency. I used the software based on the originally developed method, Expert Choice, in my research work to evaluate the results of the questionnaire survey.

During the application of the method, I set up a model in which I examined the correlations of the outputs of multifunctional pond fish farming, taking into account the specificities of economic, environmental and social functions. This three-level structure is presented in Table 2 for a “complex output model”.

**Table 2: Outputs from a multifunctional pond fish farm - “complex output model”**

<b>Outputs from a multifunctional pond fish farm</b>	<b>1. Economic/production function and outputs</b>	1.1. Producing healthy and safe fish products	1.1.1. Producing live fish for food
			1.1.2. Producing high added-value fish products
		1.2. Guaranteeing safe and healthy food, compliance with animal welfare and ethical criteria	1.2.1. Consideration of animal welfare and ethical standards
			1.2.2. Improvement of technological discipline
			1.2.3. Improvement of technological conditions (e.g. dredging of ponds and harvesting pits)
		1.3. Ensuring adequate income and competitiveness of farms	1.3.1. Maximizing profit by increasing productivity
			1.3.2. Proportional income sharing in the sector or within the companies
			1.3.3. Maintaining national and international competitiveness through innovation
			1.3.4. Development using own sources
			1.3.5. Development using external sources (e.g. project funds)
			1.3.6. Application of marketing communication tools (own products/brands, certified varieties, logo, website, social media)
		1.4. Conservation of genetic resources, production of broodstock	1.4.1. Maintenance of own land-race (in situ gene bank)
			1.4.2. Fingerling production
		1.5. Production of natural materials (reed, algae, shellfish, molluscs etc.)	1.5.1. Production for human consumption
			1.5.2. Production for animal feed
1.5.3. Production for energy generation			

<b>Outputs from a multifunctional pond fish farm</b>	<b>2. Environmental function and outputs</b>	2.1. Conservation, maintenance and protection of natural values / resources / ecosystems, biodiversity and valuable natural habitats (considering the good environmental and nature conservation practices)	2.1.1. Providing appropriate environmental conditions for fish production
			2.1.2. Conservation of habitats for water-related animals and plants
			2.1.3. Preservation of good quality of surface waters
			2.1.4. Scare birds and reduce bird damage
		2.2. Regulatory functions (microclimate, organic waste, gas, water, diseases)	2.2.1. Improvement of microclimate (e.g. air humidity)
			2.2.2. Reduction of the emission of organic matters to the environment
			2.2.3. Water retention (water saving by water recycling)
			2.2.4. Ensuring appropriate oxygen level in the aquatic environment
			2.2.5. Prevention diseases (maintaining healthy fish stock)
		2.3 Conservation and improvement of the rural landscape	2.3.1. Conservation of diversity of natural elements and semi-natural conditions (importance of the preservation of the "green land")
2.3.2. Preservation of water bodies (possible increase of water areas)			

<b>Outputs from a multifunctional pond fish farm</b>	<b>3. Social function and outputs</b>	3.1. Recreation and tourism	3.1.1. Recreational fisheries/angling, services for anglers
			3.1.2. Bird watching
			3.1.3. Gastronomy
			3.1.4. Hiking (other nature-related recreation)
		3.2. Dissemination (of knowledge) in connection with the water/aquatic environment and fish	3.2.1. Information/education on fish for adults
			3.2.2. Information/education on aquatic environment for adults
			3.2.3. Information/education on fish for children
			3.2.4. Information/education on aquatic environment for children
		3.3. Maintenance and improvement of the quality of rural life	3.3.1. Employment in fish production
			3.3.2. Employment in fish processing
			3.3.3. Employment in services
			3.3.4. Corporate Social Responsibility (improve the quality of life in rural communities)
		3.4. Conservation of rural cultural heritage	3.4.1. Preservation of cultural heritage
			3.4.2. Organisation of exhibitions and events
			3.4.3. Participation in ethnography research
			3.4.4. Publications (printed and electronic)
			3.4.5. Enhancement of professional knowledge (aquaculture and fisheries journals, conferences, study tours)

Source: Own research

## **2.2. Primary data collection - Questionnaire survey of the international situation of multifunctional pond fish farming**

The primary research required for this chapter of my dissertation was performed using a quantitative method. Within the quantitative method, I used a questionnaire survey. From the questionnaire methods of the quantitative technique, I chose the most optimal one for my research, the personal interview. In the case of quantitative research, it is not expected to ensure the representativeness of the sample during the investigation, if this is not possible (BONCZ, 2015), however, as a result of the method, I obtained easily comparable data from which I could easily draw conclusions. With the help of primary data collection, I was able to take into account the opinions of the leading experts interviewed from different countries. The aim of my research was to collect information from the international experts of my choice, through which I can gain a broader view of the development opportunities of multifunctional fish farming at the international level as well. To analyse the international situation of multifunctional pond fish farming, I chose two regions where pond fish production is dominant, so there is opportunity to apply multifunctional farming. One region is the Eastern European region, which mainly includes non-EU countries. As another region, I chose a region that includes three neighbouring Asian countries. To investigate the issue, I also prepared a questionnaire filled out by experts from Eastern Europe (from 5 countries: Bulgaria, Lithuania, Moldova, Russia and Ukraine) who participated the NACEE Workshop held in Szarvas in 2018. On the Asian side, I got the questionnaires completed in 2019 with leading researchers from three aquaculture research institutes (FFRC - China, RIA1 - Vietnam and LARReC - Laos) that have outstanding importance for pond aquaculture research in the region. The questionnaire consisted of 10 questions, containing topic-specific questions, in which it was possible to write one's own opinion on each question as well as the answers that could be marked. I evaluated the questionnaires with a descriptive evaluation.

## **2.3. Secondary research - Evaluation of domestic fish consumption**

To prepare my dissertation, I also conducted a secondary research, which provided a greater insight into the topic of surveying Hungarian fish consumption habits. My research goal is to review source works relevant to the topic and gather broader information. This method also provided an opportunity to collect data or information that had already been

summarized. Thus, to examine how multifunctional pond fish farming contributes to increasing fish consumption as well as the social acceptance of aquaculture, I collected the results of related research from the 12 - year period 2007–2018. I grouped these documents according to a pre-defined system of criteria, which is a part of the secondary research, including document analysis (CHIKÁN, 2008; BONCZ, 2015). This meant the systematization and re-analysis of the data of the sectoral situation analyzes and strategic summaries related to the Hungarian fish consumption survey collected at other times for other purposes in accordance with my current research goal. I compared the previous results with the results of the latest studies made in Hungary. I supplemented the tested materials with an overview of two more recent European specific materials published at the beginning of 2020 and organized the main findings of all tested materials on fish consumption into a metadatabase. And then, based on these, I made a situation assessment using the SWOT analysis method for the Hungarian fish farming sector, focusing on the factors influencing the domestic fish consumption and fish consumption habits. For a SWOT analysis, it is essential to take into account all the essential factors for a given target area, in this case domestic fish consumption, that are necessary to get a complete picture of where the sector is now and how the situation could be better (THOMPSON- STRICKLAND, 1984; CZEGLÉDI, 2011; CSÓTI et al., 2011). In this connection, I examined the followings:

- the opportunities facing the sector;
- the potential dangers lurking in it;
- what is well in it; what you do poorly in;
- what you can / should change and what you can't.

In the SWOT analysis, I focused not only on a simple listing of factors and impacts (strengths, weaknesses, opportunities and threats), but also weighted them on a scale of 1-5. In addition to answering the questions, I also tried to draw conclusions about how multifunctional pond fish farming in Hungary could better serve the increase fish consumption and what factors are closely related to the achievement of these goals.

### **3. MAIN FINDINGS OF THE DISSERTATION**

#### **3.1. Investigation of the role of specific functions of multifunctional pond fish farming within a complex system and their effect on each other**

It is increasingly accepted in professional circles, but is increasingly known widely, that pond farms, which are part of the rural economy, in addition to producing fish, act as valuable aquatic habitats, contribute to preserving and enriching ecosystem quality, play an important role in water- and landscape management, provide services for various recreational activities and contribute to the preservation of cultural values. The validity of this finding has also been confirmed by my research. The Hungarian experience related to the operation of multifunctional fish farms clearly shows that the diversification of fish farming activities represents a good opportunity for the development of sustainable pond fish farming. Pond fish farming contributes to the preservation of natural values, the improvement of the environmental condition and the increase of fish consumption by strengthening environmentally conscious farming and the use of environmentally friendly fish production methods. The operation of well-managed pond farms can be considered sustainable due to efficient use of natural resources, minimizing negative environmental impacts, producing social goods and generating profits for fish farmers. However, a very important question in the development of pond fish farming is how to preserve the benefits of traditional pond fish production while increasing production and employment without compromising sustainability. My research has confirmed that multifunctional pond fish farming is a possible answer to the question of systematically integrating the traditional and innovative functions of a pond economy into a complex system that applies, among other things, the principles of resource efficiency in its operation. Therefore, greater encouragement of these methods remains a priority for the future. One of the directions for the development of pond management continues to be the diversification of activities and the exploitation of the potential of multifunctionality.

Based on the results of the multi-criteria decision method, it can be said that farm managers considered economic functions to be the most important at level 1 of the evaluation of the complex output model (Table 3).

**Table 3: Priority of outputs from multifunctional pond fish farms:  
Level 1**

<b>Order of importance</b>	<b>Type of multifunctional output</b>	<b>Normalised generic weighing Result (W)</b>	
1	Output of economic/production function	A1	0,632
2	Output of environmental function	B1	0,258
3	Output of social function	C1	0,110

*Source: Own research*

Farm managers consider the order of importance of certain functions of a pond farm based on the specific revenues of pond fish farming and not on the results of theoretical calculations, even if they are aware of, for example, the role of ecosystem services and their environmental and social value. It would probably change the proportions if the ecosystem service provided by the pond farm received financial recognition. I consider the entrepreneurial efforts aiming at the increase of the consumption of fish as a healthy and environmentally friendly food to be of paramount importance and value. The complex assessment rankings of the economic, environmental, and social emissions of all three areas of Level 2 of the model are shown in Table 4. Preservation and enrichment of natural values / resources / ecosystems, biodiversity and valuable natural habitats is the second most important function in the ranking ( $W_{final} = 0.161$ ) after fish production ( $W_{final} = 0.248$ ), ahead of, for example, a production function such as providing an adequate income and increasing competitiveness ( $W_{final} = 0.135$ ). At the same time, the regulatory function was ranked sixth in the overall ranking ( $W_{final} = 0.065$ ), ahead of, for example, a function such as recreation and tourism. Like fish farmers, society is increasingly recognizing the role of pond fish farms in, among other things, conserving aquatic and wetland habitats and enriching biodiversity.

**Table 4: Priority of outputs from multifunctional pond fish farms:****Level 2**

<b>Order of importance</b>	<b>Type of multifunctional output</b>	<b>Final W</b>	
1	Producing healthy and safe fish products	A11	0,248
2	Conservation, maintenance and protection of natural values / resources / ecosystems, biodiversity and valuable natural habitats (considering the good environmental and nature conservation practices)	B21	0,161
3	Guaranteeing safe and healthy food, compliance with animal welfare and ethical criteria	A12	0,143
4	Ensuring adequate income and competitiveness of farms	A13	0,135
5	Conservation of genetic resources, production of broodstock	A14	0,069
6	Regulatory functions (microclimate, organic waste, gas, water, diseases)	B22	0,065
7	Production of natural materials (reed, algae, shellfish, molluscs etc.)	A15	0,037
8	Dissemination (of knowledge) in connection with the water/aquatic environment and fish	C32	0,034
9	Conservation and improvement of the rural landscape	B23	0,033
10	Recreation and tourism	C31	0,032
11	Maintenance and improvement of the quality of rural life	C33	0,031
12	Conservation of rural cultural heritage	C34	0,012

*Source: Own research*

At Level 3 of the evaluation, in the ranking of production functions within the category production of safe fish products, live fish production is clearly the most important aspect for fish farmers ( $W_{pn} = 0.737$ ), followed by maintenance of own fish land-races within the category of conservation of genetic resources ( $W_{pn} = 0.592$ ).

In terms of eigenvector values, the fish produced for human consumption in this category ( $W_{pn} = 0.527$ ) is the third most important sub-function, which also justifies the efforts of fish farmers to meet the changing needs of consumers as much as possible. Consideration of animal welfare and ethical standards ( $W_{pn} = 0.514$ ), profit maximization with increased productivity ( $W_{pn} = 0.410$ ), and fingerling production ( $W_{pn} = 0.408$ ) are also given more weight in this ranking. Reviewing the ranking of environmental functions at the third level, it appears that the preservation of the natural-like state and the diversity of landscape elements ( $W_{en} = 0.813$ ) leads high in the ranking, followed by the function of ensuring appropriate environmental conditions for fish production ( $W_{en} = 0.514$ ). This result supports the fact that fishpond farmers also contribute to the maintenance and enrichment of biodiversity and the improvement of the environmental condition through environmentally conscious farming and the use of environmentally friendly fish production methods.

Analyzing the ranking of social functions at level 3, it turns out that employment for fish production ( $W_{sn} = 0.513$ ) is the most important aspect for entrepreneurs. The second most important aspect was fishing, followed by dissemination of information on the aquatic environment and fish ( $W_{sn} = 0.353$  and  $W_{sn} = 0.338$ ). This fact supports the recognition of fishpond farmers to promote interest in the aquatic environment and fish, as well as increasing knowledge of nature, is a priority not only for adults, but also for children. In this way, they contribute to the greater social acceptance of the fish production sector, as ecological services in multifunctional pond farms are also linked to the dissemination of scientific knowledge. My research has proven the existence of innovation skills and development aspirations of pond fish farmers, but there is a need to improve the conditions of multifunctional farming, to implement targeted subsidies, and to better understand its characteristics and the connections between different functions. The results of my dissertation can be used in the development of programs and support systems for the development of multifunctional pond fish farming.

In connection with the objectives of my research work, the following specific findings and conclusions can be formulated.

*Establish a targeted organisation of the functions that determine the successful operation of multifunctional pond fish farming using a multi-criteria decision-making method, the Analytic Hierarchy Process (AHP).*

#### Conclusions and recommendations:

- I was the first who applied the analytical hierarchy process (AHP) method in Hungarian aquaculture research, and I found that the AHP method can be well applied to study a complex aquaculture system, however, it was necessary for preparatory work to thoroughly explore the specifics of the system under study, as no such systematic analyzes of multifunctional pond fish farming have been conducted so far.
- As a result of an exploratory analysis involving literature review and interviews, I developed a “complex output model” that is a matrix in which I arranged economic, environmental, and social outputs at three levels. The application of the output model in the framework of the AHP method made it possible to identify the so far insufficiently recognized features of multifunctional pond fish farming and to confirm certain assumptions.
- During my research, I gained useful experience about the limitations of the application of the AHP method and the possibilities of its development.

*Using the AHP method, based on the expert opinions, the examination of the economic, environmental and social functions of the Hungarian multifunctional pond fish farms, their role within a complex system, and their impact on each other.*

#### Conclusions and recommendations:

- Using the AHP method, I have shown that multifunctional pond fish farming is a segment of freshwater aquaculture that fits well into the processes of sustainable exploitation of freshwater resources.
- Based on literature data, interviews and analyses, it can be stated that the growing demand for fish will no longer be met by extensive and semi-intensive fish production technologies such as traditional pond fish farming, but it is important that pond fish

farms will remain important players in sustainable freshwater development and rural development. Multifunctional pond farms can meet this goal.

- The AHP analysis also proved that in the field of pond fish farming, entrepreneurs are consciously trying to adapt to changing conditions and take advantage of the new opportunities offered by multifunctional pond fish farming. However, entrepreneurial decisions are in many cases contradictory, that makes necessary improved communication between research and the business community.
- Based on the experience of my research, it can be stated that there is a need for specific research for the development of multifunctional pond fish farming, among which the socio-economic research aiming at the determination of the value of fishpond ecosystem services can be highlighted.
- The results of the AHP analyses and interviews also confirm the need to further develop support and incentive methods in such a way that they give priority to the development of multifunctional pond fish farming.

### **3.2 International situation and opportunities for the development of multifunctional pond fish farming, especially in Eastern Europe and Asia**

The outlook for the international situation of multifunctional pond management and the development opportunities is justified by the fact that Hungary is at the forefront of innovation in this field of aquaculture and the Hungarian results and experience can be used in other regions where there are opportunities for developing multifunctional pond fish farming. Hungary has been actively participating in international aquaculture development programs for decades and Hungary's achievements in the field of fish breeding, development of fishpond production technologies and carp farming have been recognized worldwide. Existing relationships can provide a good basis for new areas of cooperation to be joined by new ones such as multifunctional pond management. The evaluation of the questionnaire survey was based on the exploration of the similarities and differences arising from the answers, and the understanding of the connections between them.

It can be stated that in Eastern Europe the opportunities offered by multifunctionality are less recognized by fish farmers and there are few examples of successful and consciously

developing multifunctional pond management. However, the positive effect of multifunctional pond fish farming is clearly seen by the respondents to the fact that by diversifying the activities of a pond fish farm, the economic stability of the farm and also the profit increases. It can be stated that social acceptance in aquaculture development is not as important in Eastern Europe (e.g. Russia) as in the EU or other economically developed regions. The beneficial impact of multifunctional pond fish farming on fish consumption is also acknowledged by respondents through both extensive information on fish and the aquatic environment and increased diversification of fish products. Overall, however, all respondents believe that multifunctional pond fish farming will play an increasing role in aquaculture in the future. There is also a clear view that in order to increase the efficiency of multifunctional pond fish farming, there is a need to study the structure and function of this type of farming and to conduct research in this area.

The survey in the Asian region shows that in China, where pond aquaculture plays a significant role in aquaculture that is an economically strong sector, the multifunctional use of ponds is not considered as an important factor that can strengthen the sector, while in Vietnam and Laos, the multifunctional use of ponds is considered an opportunity to strengthen pond fish farming. However, all three countries were united in their view that the diversification of activities provided by multifunctionality („standing on several legs”) is the biggest driving force for the development of multifunctional pond fish farming. It is noteworthy, however, that Asian respondents consider the need for harmony between fish production and the natural environment to be at least as important as increasing profits. Regarding the future role of some elements of multifunctional pond fish farming, respondents indicated the strengthening of new types of pond fish production technologies that adapt to the specificities of a given aquatic ecosystem, and considered that the ecosystem service functions of the ponds will be strengthened in the future. The answers were also clear in the sense that multifunctional pond fish farming strengthens the social acceptance of aquaculture and also contributes to the growth of fish consumption.

The following specific findings and conclusions can be summarized related to the objectives of my research on this field.

*To study how the results of multifunctional pond fish farming in Hungary can be applied in international aquaculture development programs, especially in those regions (Eastern Europe and Asia) where Hungarian participation in the implementation of freshwater aquaculture development programs is traditional.*

#### Conclusions and recommendations:

- Literature data and the results of my questionnaire survey clearly indicate that multifunctional pond fish farming is a promising development direction for freshwater aquaculture in all countries / regions with significant pond fish production sector, including Eastern European and Asian regions.
- Based on my analyses and experiences, it can be stated that the lack of knowledge is an important factor hindering the exploitation of the potential of multifunctionality in the studied regions, which is a good opportunity to utilize domestic knowledge and technology. Hungary can actively participate in international programs and projects for multifunctional pond fish farming (mainly in Eastern Europe and some Asian countries) considering its achievements and experience in this field.

### **3.3 The contribution of multifunctional pond fish farming to increase fish consumption**

One of the special functions of multifunctional pond fish farming is to contribute to the increase of fish consumption, not primarily by providing a commodity base, but by raising awareness and increasing the acceptance of fish and fishing. During the period between 2007 and 2018, the changes in the domestic fish consumption and the factors influencing it were basically based on the analysis of consumer surveys, studies, strategies, as well as comprehensive domestic and international professional papers and documents. I supplemented the examined materials with an overview of two major European documents published in 2020, the “European Green Deal” and the “Farm to Fork Strategy”. The main findings on fish consumption of all tested papers and documents were systematically compared and organized into a metadatabase (Table 5).

**Table 5: Metadatabase of the professional materials involved in the analysis**

	<b>Title</b>	<b>Source</b>	<b>Year of publication</b>
<b>1</b>	<b>Hungarian National Fisheries Strategic Plan (NHST) for the 2007-2013 planning period</b>	<b>Mandatory accompanying document of the EFF for the period 2007-2013</b>	<b>2007</b>
	<p><b>Main findings on fish consumption:</b> The first pillar of the strategy is an objective already formulated before accession to the EU and defined in the framework of Hungary's use of the Financial Instrument for Fisheries Guidance (FIFG) 2004-2006, according to which our very low fish consumption should be increased compared to the EU and world average. The strategic goal is to increase the fish consumption in terms of live weight to 4.7 kg / person / year to 6 kg / person / year, and to increase the quantity and share of domestically produced products.</p>		
<b>2</b>	<b>Complex Studies on Consumer Attitude</b>	<b>Barramundi project</b>	<b>2010-2012</b>
	<p><b>Main findings on fish consumption:</b> A significant proportion of respondents to the questionnaire survey (67.9%) were open to buy fresh unknown fish products. It is a general finding that consumer expectations regarding product quality are increasing, that consumers demand credible information on the origin of fish, the method of production, the time and place of production, and that product traceability is important.</p>		
<b>3</b>	<b>Sectoral Analysis</b>	<b>Aquaculture and Fisheries Strategic Coordination Committee (HASKOBI)</b>	<b>2012</b>
	<p><b>Main findings on fish consumption:</b> Following domestic statistical methodology, domestic fish consumption is around 4 kg, about half of which is imported fish products. Due to international comparisons, it would be appropriate to follow international standards (live weight projection). One of the reasons for the low level of domestic fish consumption may be that the knowledge of Hungarian consumers of fish species and fish products is low and incomplete.</p>		
<b>4</b>	<b>White Paper for the National Aquaculture Strategy of Hungary for the period between 2014-2023.</b>	<b>WHITE PAPER</b>	<b>2013</b>
	<p><b>Main findings on fish consumption:</b> One of the important missions of the sector is to educate people on healthy eating in order to increase fish consumption. Stakeholders of the Hungarian fish farming sector can also play a significant role in developing an environmentally conscious consumer approach, which contributes to increasing fish consumption. One of the most important areas for fish consumption is children's catering. Among the strategic goals of the Hungarian Aquaculture and Fisheries Operational Program (MAHOP), innovative, competitive and sustainable aquaculture and processing industries it have a crucial role to play in contributing to the increase in fish consumption.</p>		

5	<b>Fish consumption habits in Hungary. Supporting the development of a community marketing strategy</b>	<b>Marketing Inspiration Consumer Behaviour Research Institute Trend Inspiration Team</b>	<b>2013 - 2014</b>
<p><b>Main findings on fish consumption:</b>  There are also strong traditions attached to food consumption - so consumer needs and habits are also influenced by these motives. In order to encourage consumption, it must be possible to afford it (the barriers included the price in turn), a wide range of products (so that every consumer segment can find the right goods for their needs and opportunities). There is a clear increase in the need for transparency, so that customers are making an increasingly determined demand for product information in their choices and purchases.</p>			
6	<b>National Aquaculture Strategy Plan (NAS)</b>	<b>Mandatory accompanying document for the 2014-2020 Hungarian Fisheries and Aquaculture Operational Program (MAHOP) under the EMFF</b>	<b>2015</b>
<p><b>Main findings on fish consumption</b>  Marketing campaigns to increase fish consumption have so far not been successful enough to achieve a significant increase in fish consumption. In the next period, efforts should be stepped up to promote the consumption of processed domestic fish products in addition to encouraging fish consumption. One of the most important areas for fish consumption is children's catering (regular school meals). One of the new appearances of fish products may be public catering, where the role of fish may increase spectacularly compared to the previous period. Fish processors need to produce easy-to-prepare, ready-to-cook products.</p>			
7	<b>EU consumer habits related to fishery and aquaculture products</b>	<b>EUROPEAN COMMISSION, Special issue of Eurobarometer Hungary</b>	<b>2016</b>
<p><b>Main findings on fish consumption:</b>  Regarding the frequency of fish purchase, it can be stated that on average in the EU the proportion of buyers of fish once a week is 37%, while in Hungary it is only 3%. At the same time, the proportion of those who never buy fish is much higher in Hungary (49%) than in the EU (17%). As far as the origin of the product is concerned, EU consumers consider it much more important that it comes from their own region or country. For example, the fact that the product comes from one's own country is considered important by 37% of EU consumers, while in Hungary only 26% of consumers consider it important. In the EU, 39% of consumers prefer products from the sea, 7% from freshwater, while in Hungary, 38% of consumers prefer products from freshwater and 14% from the sea.</p>			

<b>8</b>	<b>Fish consumption per capita in 2014-2017</b>	<b>Implementation of MAHOP Data Collection Framework (DCF) tasks for the period 2014-2018. Research Institute of Agricultural Economics (NAIK AKI)</b>	<b>2017</b>
	<p><b>Main findings on fish consumption:</b> Annual fish consumption per capita in Hungary by 2017 has increased by 0.92 kg since 2014. Domestic fish consumption per capita in 2017 was 6.3 kg. In 2017, 77% of domestic fish consumption was accounted for by imported fish. Most people like fish, so this is not the main reason for low consumption. Most of all, the reasons are the price sensitivity of the population, their taste, the availability of the product, personal factors, and the labour intensity of processing at home, as well as the connection to the festive seasonal occasions. Another reason for the low domestic fish consumption is that modern fish products do not reach smaller settlements.</p>		
<b>9</b>	<b>Possibilities to promote fish consumption</b>	<b>Research Institute of Agricultural Economics (NAIK AKI)</b>	<b>2017</b>
	<p><b>Main findings on fish consumption:</b> Encouraging fish consumption and promoting the growth of fish consumption is a complex issue. By working closely together in several areas, only truly significant results can be achieved. We use marketing tools in vain if the product itself is not of good quality or if a good quality product does not reach consumers in the right form. There should be a serious collaboration, a coordinated, multi-sectoral marketing activity that can encourage all consumer groups (whether broken down by generation or cluster).</p>		
<b>10</b>	<b>The EU Fish Market</b>	<b>European Commission, EUMOFA</b>	<b>2017</b>
	<p><b>Main findings on fish consumption:</b> Annual per capita fish consumption (in live weight) was the lowest in Hungary among the 28 EU countries in 2015 (4.8 kg / capita), although the increase was 7% compared to 2014, which is one of the highest in the EU. EU consumers spend on average four times more on meat than on fish. The greatest inequality was found in the case of Hungary, where in 2016 customers spent twenty times more on meat than on fish.</p>		
<b>11</b>	<b>Communication and promotional campaign to promote fish consumption</b>	<b>Controll Holding Consulting Zrt.</b>	<b>2018</b>
	<p><b>Main findings on fish consumption:</b> One of the problems that determines domestic fish consumption is the lack of a product chain (well-structured product chain). Another significant problem is that the current domestic market lacks premium quality Hungarian fish products in addition to highly processed domestic fish (reaching the level of ready-to-eat products). Public catering, especially for children, is a good opportunity to increase fish consumption. A youthful, new impetus needs to be given to fish marketing following the food industry changes that poultry or pork have gone through.</p>		

<b>12</b>	<b>The EU Fish Market</b>	<b>European Commission, EUMOFA</b>	<b>2018</b>
	<p><b>Main findings on fish consumption:</b>  Annual per capita fish consumption (in live weight) was the lowest in Hungary among the 28 EU countries in 2016 (5.2 kg / capita), a decrease of 2% compared to 2015. EU consumers spend on average four times more on meat than on fish. The biggest inequality was in the case of Hungary, where in 2017 customers spent twenty times more on meat than on fish. Consumption of fresh fish products by households decreased significantly in Hungary between 2016 and 2017, by 18% in volume and 10% in value. In the EU, consumption of fresh fish products increased only in Italy and Greece between 2016 and 2017.</p>		
<b>13</b>	<b>European Green Deal</b>	<b>European Commission</b>	<b>2019 -2020</b>
	<p><b>Main findings on fish consumption:</b>  One of the important objectives of the European Green Deal is to protect, conserve and develop the EU's natural capital and to protect the health and well-being of its citizens against environmental risks and impacts. The European Green Deal offers an opportunity to bring our food system into line with the needs of our planet and to respond positively to Europeans' aspirations for healthy, fair and environmentally friendly food. An important element of the European Green Deal is the development of a fair, healthy and environmentally friendly food system as part of a producer-to-consumer strategy.</p>		
<b>14</b>	<b>The Farm to Fork Strategy</b>	<b>European Commission</b>	<b>2020</b>
	<p><b>Main findings on fish consumption</b>  Europe's food supply is already secure and abundant in comparison to other regions of the world, and European food is nutritious and of good quality. However, the current structure of food consumption is unsustainable from both a health and environmental point of view. Excessive red meat consumption is a problem. The importance of aquaculture can be increased by the fact that farmed fish and seafood result in a lower carbon footprint than terrestrial livestock. Increasing the availability and source of food, marine and insect-based proteins and meat substitutes from the oceans (waters), among others, will be key issue.</p>		

*Source: Own research*

Based on the performed analyses, it can be stated that even if there are inaccuracies in the data on consumption, export and import, we have a better overview of domestic consumer habits, preferences, market segments, trends and factors influencing fish consumption. In addition to fact-finding work, Hungarian studies have made well-founded, and in many cases novel, suggestions for ways and means of increasing fish consumption. Efforts to increase fish consumption have a dual purpose, on the one hand to contribute to the health of the Hungarian population with high-quality, healthy and safe fish products with a high nutritional value, and on the other hand to utilize domestic resources (natural, knowledge and technology). In my opinion, fish consumption will continue to increase, but its pace cannot be significantly changed, so efforts should be focused primarily on getting as much of the fish consumed as possible from domestic sources. This means reducing imported products is the basic interest of domestic fish farming to be able to produce competitive fish products.

Taking into account the above, I prepared a SWOT analysis of the Hungarian fish farming sector, focusing on the factors influencing domestic fish consumption and fish consumption habits, given that consumer demand has an impact on production along the value chain. The analysis does not primarily examine how domestic fish consumption can be increased, but how the largest possible share of fish consumption, which is moderately increasing and largely influenced by external factors, can be met from domestic sources. In connection with the objectives of my research work, the following specific findings and conclusions can be summarised.

*Analysis of the situation and possibilities of increasing domestic fish consumption, especially with regard to the results of fish consumer surveys conducted in the last decade, and taking into account the related professional materials, analyses and strategies, how multifunctional fish farms can contribute to increasing fish consumption.*

#### Conclusions and recommendations:

- My research shows that a small increase in fish consumption is disproportionate to the extent of significant efforts to increase it, so a qualitative change is needed in measures to increase fish consumption, which should not only promote but increasingly expand the range of processed products.

- Multifunctional pond fish farms can help increase fish consumption not only by participating in fish production and processing, but also by marketing fish and fish products in their restaurants, and by providing information on fish and making fish more popular through various programs.
- Based on the results of my research, it can be clearly concluded that the efforts to make fish popular food for children needs to be further strengthened, in which multifunctional pond farms have excellent opportunities, but promotion need to be better linked to similar EU projects.
- Multifunctional pond fish farms can make a fundamental contribution to increasing the social recognition of aquaculture, which is not only in the interest of multifunctional pond fish farms, but also in sectoral and national interests. However, there is a need for well-thought-out and specific programs that deserve support.

#### 4. NEW AND NOVEL RESULTS OF THE DISSERTATION

In my research work, for the first time in Hungary I examined in a complex way the situation of multifunctional pond fish farming and the possibilities of its development, on the other hand, the international situation and development directions of multifunctional pond fish farming. I analyzed the conditions provided by fish consumption habits, using new methods related to the demand side, which are of paramount importance for the development of Hungarian fish farming. The new and novel results of my work are summarized below.

- 1.) In my program I was the first in Hungarian aquaculture research to examine the application of the analytical hierarchy method (AHP). I created a “complex output model”, with the help of which I determined the role of the economic, environmental and social outputs of Hungarian multifunctional pond fish farms within a complex system and their impact on each other.
- 2.) Using the AHP method, I ranked the value judgment of pond fish farmers related to multifunctional farming by obtaining the following new results (giving the importance factors specific to each function).
  - Although fish farmers considered the production function to be the most important ( $W_p = 0.632$ ), in addition to which the environmental function ( $W_e = 0.258$ ) and the social function ( $W_s = 0.11$ ) were considered less important, they are aware of the importance of ecosystem services but are aware of the importance of ecosystem services and are ready to strengthen this function if they receive measurable financial recognition.
  - Within the fish production function, fish farmers consider the production of healthy and safe fish products to be the most important ( $W_{pn} = 0.39$ ), but are aware of the importance of animal welfare and ethical functions ( $W_{pn} = 0.23$ ), which indicates the need to meet consumer needs at the highest possible level.
  - Analysing the ranking within the environmental functions, it can be seen that the function conservation, maintenance and protection of natural values / resources / ecosystems, biodiversity and valuable natural habitats was considered by farmers to

be by far the most important ( $W_{en} = 0.62$ ) in the regulatory ( $W_{en} = 0.25$ ) and landscape preservation ( $W_{spec} = 0.12$ ) functions.

- Examining the significance of social functions, it can be stated that fish farmers considered the dissemination of knowledge about the aquatic environment and fish to be of paramount importance, the specific significance of which ( $W_{sn} = 0.307$ ) even preceded the recreation and tourism function ( $W_{sn} = 0.291$ ), recognizing that raising interest in fish also serves their business interests.

3.) For the first time in aquaculture research, an international analysis of freshwater pond fish farming has provided basic information on and evaluation of multifunctional pond fish farming in eight countries in two of the world's leading regions in pond aquaculture (Eastern Europe and Asia).

- I have found that in Eastern European and Asian countries where freshwater pond fish farming plays an important role in aquaculture, the role of multifunctionality will increase.
- The development of multifunctional pond fish farming is basically driven by the stability and profit growth inherent in the diversification of activities, but it is also important (especially in Asia) to create harmony between farming and the natural environment.

4.) The findings of the surveys, sectoral situation analyses and strategic papers (2007-2018) examining the domestic fish consumption habits presented in my dissertation have not been systematically compared and organized into a metadatabase in the Hungarian fish farming sector, which is suitable for evaluating company and sectoral results.

- I found that the data obtained with the calculation method of domestic fish consumption in line with international methodology are clear, allow good comparison and contribute to a more accurate analysis of fish consumption trends, but it is important to coordinate it at the domestic and international level and publish any corrections in the data.
- In terms of the annual amount of fish consumption and its frequency, there has been a positive trend in recent years according to the survey results. Through the activity

of multifunctional pond fish farms, this can be further increased in the future, but this should be aimed primarily at consuming domestic fish products.

5.) Based on the results of the secondary database, I prepared a SWOT analysis of the Hungarian fish farming sector, focusing on the factors influencing domestic fish consumption and fish consumption habits, given that consumer demand has an impact on production along the value chain. An analysis for this target area has not yet been made in the Hungarian aquaculture research.

- Programs to increase fish consumption did not clearly serve to increase consumption of domestic fish products, and most of the increase in fish consumption continued to come from imports. I found that the sector did not take advantage of the benefits offered by multifunctional pond fish farms and proven by my research in the promotion and acknowledgement of the values of Hungarian aquaculture and domestic fish products.
- I found that as a result of previous surveys, Hungarian consumer needs and customer habits are known at an appropriate level, but no comprehensive marketing strategy, program or action plan has been prepared that gives priority to domestic products and takes into account the domestic and international realities of aquaculture development.
- Looking at the 2007-2018 time series, ad hoc marketing programs have contributed to a small increase in fish consumption, but maintaining and increasing the growth rate through the consumption of domestic products is only possible if combined with technology and product development, as there are some good examples, but it has not become an essential element of domestic fish farming, especially in the case of fish and fish products originated from pond fish farms.

## 5. PRACTICAL APPLICABILITY OF THE RESULTS

My research also confirmed that there is an entrepreneurial skill to introduce and apply multifunctional pond management, and that Hungarian pond farms are at the forefront of exploiting the benefits of multifunctional pond management. Utilizing the results of the research can make the most of the opportunities.

- It is essential to disseminate the research results to the industry through professional articles, publications, videos, practical presentations and thematic professional meetings written for the practice, which can be done also at international level.
- It must be made known and accepted in the domestic and international profession, as well as in politics and decision-making circles, that multifunctional pond management is almost the only way to preserve the values of freshwater pond management.
- At sectoral level, efforts should be made to ensure that multifunctional pond fish farming is recognized and supported in accordance with its importance. This work should build on research findings.
- Given the nature of multifunctionality, the application of research results can be greatly helped by the strengthening of co-operation with professional organizations related to certain special functions, as well as co-operation with research institutions operating in these fields.
- Cooperation between research institutes, which includes joint research and innovation programs, demonstrations and professional events, can be integrated into national and international projects for the development of pond fish farming, and such can be taken into account in the development of future projects (e.g. Horizon Europe).
- The results can also be applied in the framework of international projects aimed at the innovative development of freshwater pond fish farming, especially in the Eastern European and Asian region, where Hungarian professionals and technologies are known and recognized.
- In my further professional work aimed at the development of multifunctional pond fish farming, in addition to carrying out the proposed studies, I would like to assist the widest possible practical application of the method in Hungary and also at international level.

## 6. LIST OF PUBLICATIONS RELATED TO THE DISSERTATION



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Registry number: DEENK/332/2020.PL  
Subject: PhD Publication List

Candidate: Emese Békefi  
Doctoral School: Károly Ihrig Doctoral School of Management and Business  
MTMT ID: 10045394

### List of publications related to the dissertation

#### Books (1)

1. Váradi, L., Lane, A., Harache, Y., Gyalog, G., **Békefi, E.**, Lengyel, P.: Regional Review on Status and Trends in Aquaculture Development in Europe - 2010. FAO, Róma, 257 p., 2011. (FAO Fisheries and Aquaculture Circular ; 1061/1.) ISBN: 9789250068688

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Total IF of journals (all publications): 13,267

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The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of Web of Science, Scopus and Journal Citation Report (Impact Factor) databases.

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