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Inland aquaculture of carps in Poland: Between tradition and innovation

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Abstract :

This paper examines how the traditional carp sector in Poland developed during the recent period, paying a particular attention to the different forms of innovations that have been implemented. Mostly based on first-hand, face-to-face interviews, the paper shows that despite the fact that aquaculture of carp is still characterised by strong traditional and cultural features, different categories of economic agents along the value-chain engaged in various kinds of technical, market and institutional innovations. These innovative strategies could be further replicated and developed through collaborative process, where policy makers have a potential role to play. The research results showed the existence of huge potential for innovation in traditional carp sector in Poland, especially in terms of alternative ways of marketing products for small and medium scale farms.

Highlights

► The research considers the role of innovation along the carp aquaculture value-chain in Poland. ► The research is mostly based on the Schumpeterian theory of innovation, where the entrepreneur enhances economic processes via adaptation of innovations. ► While carp aquaculture mostly remains traditional by nature, various innovations were observed at each stage of the value chain. ► Market-oriented innovations (new products, new outlets, etc.) appear to be the most promising ones. ► Further collaboration and cooperation can be needed to further develop and replicate innovative processes, including in other production system. ► Public authorities have a role to play to facilitate the dissemination and adoption of innovative processes, including through structural funds (EMFF; coordination; empowerment).

Keywords : Innovation, value-chain, competitiveness, carp, aquaculture, expert interviews

1. Introduction

In Europe, inland aquaculture (e.g. trout, carp) only represents a very low share of the seafood production, and is hardly known by most of the consumers. However, in some areas, traditional land aquaculture has a central cultural, historical and societal importance. This is the case of the carp sector in Barycz Valley, part of Lower Silesia Province in Poland, one of the most important and the biggest European carp breeding regions.

Fisheries and aquaculture, as parts of the primary sector, are often considered as old-fashioned and declining activities, facing competitiveness challenges. However, in these sectors too, there have been remarkable developments for the past decades, in order to maintain or improve the competitiveness situation. This is for example reflected by the OECD work on monitoring innovations, in which the so-called "*Fisheries & Aquaculture Innovation Platform*" compiles the patents registered in fisheries and aquaculture technology, as well as the patents related to new products and markets[1]. In the same vein, a recent publication from the OECD Green Growth and Sustainable Development forum considered around 15 types of innovations in the fisheries sector (Girard and Du Peyrat, 2017). Additionally, innovation and competitiveness were at the heart of the recently finalized Horizon 2020 research SUCCESS[2]. Around 15 types of innovation developed in Europe were indeed documented in the synthesis report dedicated to the impact assessment of technological and regulatory innovations (Friðriksson and Haraldson, 2018), organised in 4 key innovation categories:

- Regulatory innovations,
- Technological innovations,
- Marketing innovations, including labeling, branding, new outlets and consumer preferences,
- Market structure and value-chain management, including e.g. the vertical integration of fish feed activities.

These four key innovation categories will be referred to when considering the case of carp aquaculture in Poland, which is the central topic of the paper. The term “innovation” derives from latin word *‘innovare”* and means "doing something new", which gives a wide spectrum of its interpretation. The concept of economics *”innovation" was* introduced by Joseph Schumpeter (1934; 1942), for whom innovation is one of the most important features for company wishing to maintain a high position in the market. Here, the economic approach is perceived as a dynamic process of crisis and balance, where the “Unternehmer” (entrepreneur) enhances economic processes via the adaptation of innovations.

Schumpeter’s work was mostly influential in unorthodox economics, whereas in mainstream economics, economic growth and innovation were determined by exogenous factors not influenced by public policy. In the 80's, there was an effort to address these shortcomings with so-called endogenous growth models. This was an effort to find what factors led to more efficient use of labor, capital, natural resources and other factors of production, such as investments in human capital and innovation (Romer, 1994). In the past decade, innovation has been much more in the spotlight. This renewed interest seems to have been driven more by practical consideration rather than scientific interest, at least in the beginning. Both policy makers and the private sector have been seeking ways to increase

[1] OECD, www.oecd.org/fisheries-innovation.

[2] E.g. see the Newsletter number 2 on the SUCCESS webpage (http://www.success-h2020.eu/media-center/newsletters/).

productivity through innovation. Most firms seem to believe that innovation is a key factor in becoming, or remaining competitive (Churstin et al. 2017). However, according to the innovation theory literature (e.g. Ryan and Gross, 1943), innovations should be perceived as a neutral phenomenon.

The tradition of pond fish farming in Poland dates back to the eleventh and twelfth centuries. It was connected with the activities of the Cistercian Order, which played a crucial role in the organization and operation of ponds during this period. Along with the strengthening of Polish territory with the Christian religion, there was a need to comply with a number of fasts (more than 200 days a year (Guziur, 2008)), thereby increased the demand for fish. This period, until the turn of the sixteenth and seventeenth century, is often considered *the Golden Era* of Polish carp farming, due to the fact that huge ponds with the unit area from a 100 ha to even more than 1000 ha were built then. Even though they were truncated, they survived until the present time (especially in the Barycz Valley, located in the south-western part of Poland on the border of the Lower Silesia Province and the Greater Poland Province). Currently in the Barycz Valley operates the largest carp breeding centre in Poland and the whole Europe (Milicz Ponds).

Over the centuries, although the method of fish farming slightly evolved with the use of mechanization, the fish production preserves its traditional character (e.g. in terms of feeding, harvesting). Its specificity still rests on low intensification of production (up to 1500 kg /ha), a large share of natural food (growing in the pond) in fish diet (half of the fish growth comes from plankton), or the use of unprocessed, natural cereals in fish feeding, which greatly increases their taste (and the perceived quality (Raftowicz-Filipkiewicz, 2013)). Additionally, all agro-fishing farms which breed carps apply the so-called Dubisch system (Rice, 2003), which facilitates fish farming of the high quality and desired generic features.

The changes associated with the transformation of the Polish economy influenced the structure of the fish farms in a crucial way. The dominant (before 1989) monopolists (national budget entities) in the field of freshwater fish farming in the Lower Silesia Province (especially carp) soon had to face new competitors (in the form of small and medium-sized farms, for which it was easier to adapt to rapidly changing environmental conditions). Their flexibility and relatively low share of fixed costs in total production gave them a stronger, competitive position on the market.

The structure of the supply chain over the years has also changed radically. The supply chain as defined by Harrison and Van Hoek (2014)[3]means "*network of partners, who in a joint operation transform the basic raw material (the supply phase) into the final product (the distribution phase) of a specific value for the end customers and manage the returns on each stage. Each partner in the supply chain is directly responsible for the process, which increases the product value. As a part of this*

process, the input of materials and information is converted into products in the form of goods and services".

The paper explores how the traditional carp sector developed during the recent period, paying particular attention to the different forms of innovations that have been implemented. The section 2 presents the materials and methods, with firstly a description of the carp aquaculture production system in the Lower Silesia Province, and then a presentation of the approach developed to understand the structuration of the value-chains. The section 3 presents the results of the survey, considering some key economic agents along the value-chain. A discussion is then proposed in section 4 and a conclusion in section 5.

2. MATERIALS AND METHODS

2.1. Description of the carp aquaculture sector in the Lower Silesia Province

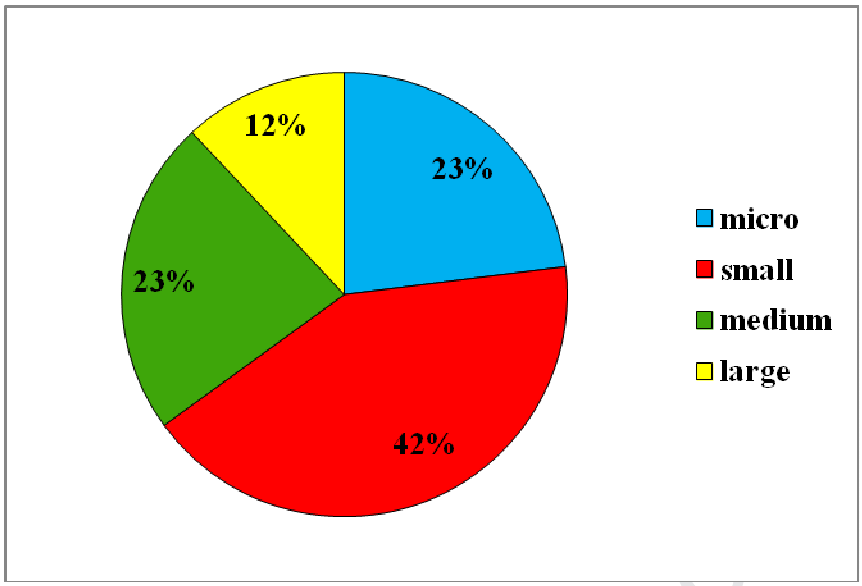
In 2011 there were 36 farming areas with a total area of 9375 hectare (ha) on the territory of the Lower Silesia Province. However, the surface structure was still dominated by the complex Milicz Ponds – of which the current owner is the local government of the Lower Silesia Province - including 5 large areas of 7.3 million ha (more than 78% of all areas). In the following years, there was a dynamic increase in issuing permits required by the Water Law Act, which resulted in the fact that by 2015 there were 48 farming areas registered, as shown in Appendix 2.

Despite the increase in the number of farming areas, the total area decreased since 2011 by 9.4% to 8.5 million ha. It is worth noting that between 2011 and 2015 there were more than 327 hectares of new farming areas built, owned by small, private investors.

Analysing the quantitative structure of breeding farms, they were grouped into 4 categories, as shown in Figure 1:

- micro up to 10 ha,
- small from 10 to 80 ha,
- medium from 80 to 300 ha
- and large, over 300 ha.

Figure 1. The quantitative structure of farming areas in the Lower Silesia Province (in % of the number of farms)



Source: own study based on the list of the farming areas established by the Lower Silesia Marshal Office, Decisions of the Governor of the Lower Silesia Province in the years 2002-2005, 2006-2010 and 2006-2014.

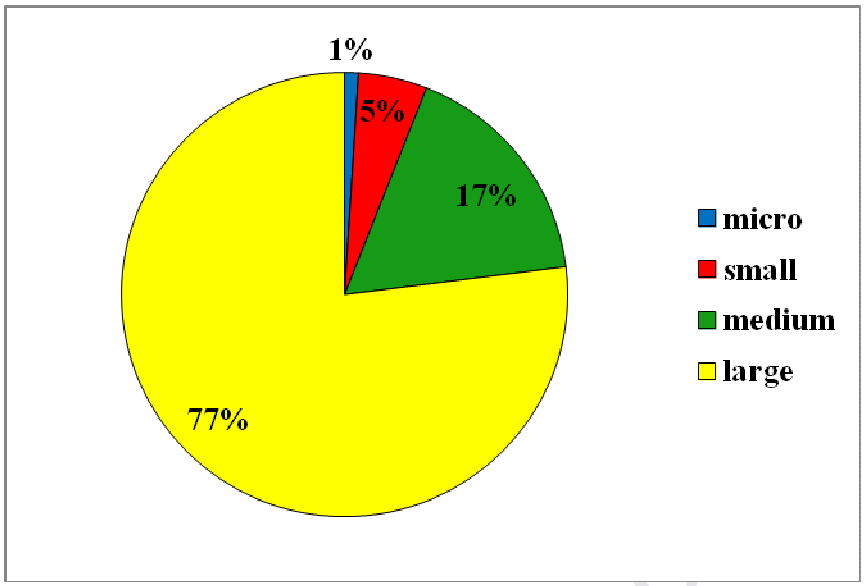
From such perspective, it is clear to see that from 48 farming areas, most belong to the group of micro and small farms. However, those areas represent only a small part of the total area of fish farms, as shown in Table 1.

Table 1. The structure of farming areas in the Lower Silesia Province

categories	scale [in ha]	amount	Area [in ha]
micro	<10	11	74
small	10-80	20	464
medium	80-300	11	1404
large	>300	6	6550
	Total =	**48**	**8493**

Source: own study based on the list of the farming areas established by the Lower Silesia Marshal Office, Decisions of the Governor of the Lower Silesia Province in the years 2002-2005, 2006-2010 and 2006-2014.

Figure 2. The structure of farming areas in the Lower Silesia Province (in % of the total farming area)



Source: own study based on the list of the farming areas established by the Lower Silesia Marshal Office, Decisions of the Governor of the Lower Silesia Province in the years 2002-2005, 2006-2010 and 2006-2014.

While analysing the situation of aquaculture sector in the Lower Silesia, the specific environmental conditions in which it operates cannot be disregarded. It should be stressed that this activity is located in natural and valuable areas, which since 2004 i.e. since the accession of Poland to the European Union, are included in the *Natura 2000* network. Currently, there are 99 areas under the *Natura 2000* protection in the Lower Silesia, including:

- 11 areas of a birds special protection with total area of 0.3 million ha,
- 88 special areas of habitats protection with total area of 0.4 million ha.

Location of fish farms in the natural and valuable areas often leads to conflicts between ecological and economical objectives. The growing population of protected piscivorous birds seems to be the biggest threat to the industry. Fishery sector also strongly depends on the hydro and weather conditions and exposure to diseases (especially KHV virus). As a result, most of the breeding farms are struggling with the problem of insufficient fish production, and they are facing competitiveness issues (Lasner et al., 2017).

2.2. Description of survey

The research was anonymous and was conducted in July and September 2016 by expert interviews, based on a prepared questionnaire (see Appendix 1) according to the methodology of Bogner et al. (2009) and group discussions with a focus group. The respondents were participants in the supply chain on the carp market in the Lower Silesia. At each stage of the supply chain, four entities were interviewed. At the producers' level, 4 out of 48 were selected for conducting the research following

the typical farm approach, which consists in five steps (Lasner et al., 2017). Table 2 is presenting the way the typical farm approach has been applied in the case of carp aquaculture in Lower Silesia:

Table 2. Research scheme of the typical farm approach

Steps	State of Play	Comments
Selection of markets and species	Done	As from the start of the research
Selection of the regions	Done	The biggest centre of carp breeding in Europe – Barycz Valley in the Lower Silesia Province
Definition of production systems	Done	Contribution to the Carp Case study of the H2020 SUCCESS project[4]
Focus group (pre-panel) with farmers, consultants and researchers	Done	June 2016
Interviews	Done	July 2016

Source: own elaboration from Lasner et al., 2017

The biggest one (leader), two medium farms and one small farm - using the same water resource - to get a reliable cross-section of data. These four farms cover more than 81% of fish farming areas in the Lower Silesia Province and can be considered representative of the different strategy production, including when considering intensification level.

In order to collect first-hand information and investigate the structure of the value chain of the Lower Silesia carps sector, direct interviews were conducted with several other categories of economic agents: 4 fish restaurants (only 4 out of 5 existing within 40 km), the 4 biggest trading networks in Lower Silesia Province, excluding retail customers, 4 fishmongers (4 out of 4 specialised only in fish selling) and 4 processing plants (4 out of 4 existing in Lower Silesia Province). In addition, interviews were conducted as well with a local Non-Governmental Organisation (NGO), "Partnerstwo dla Doliny Barycz", which also function as a Local Fishery Action Group (FLAG) and which, for instance, promotes year-round consumption of carp (see below). Altogether, 25 interviews were thus conducted, with the exception of micro farms, because the usual profile of fishing activities did not constitute their core business, and besides, most of the production is allocated to its own consumption.

3. RESULTS

3.1. Description of the current value-chain

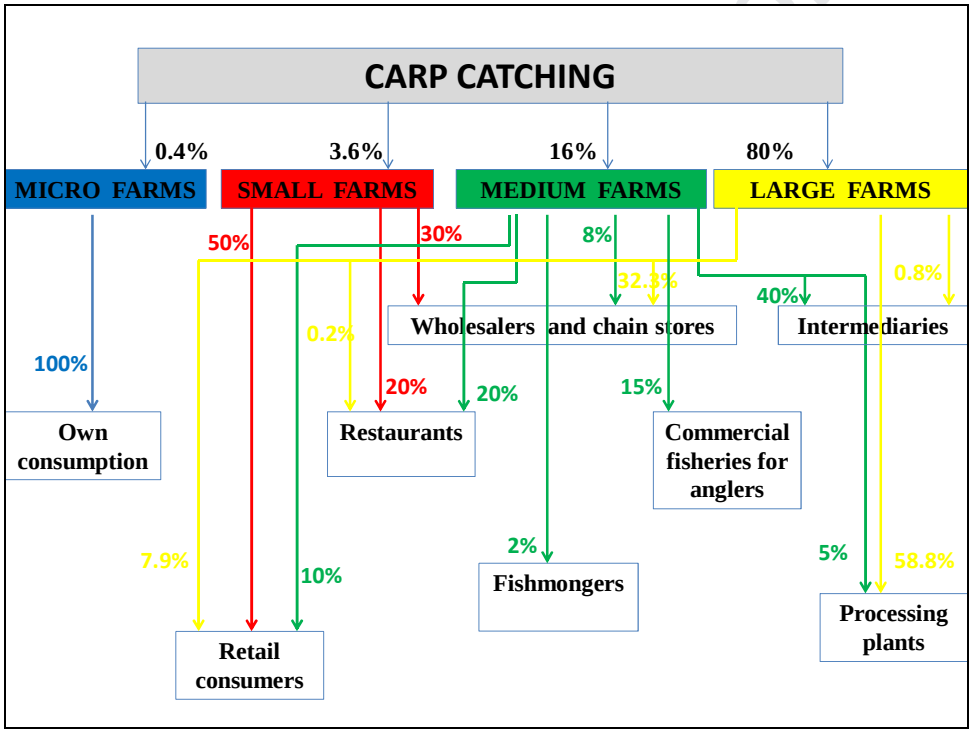
One of characteristics on the carp market in the Lower Silesia is the fact that the bulk of sales (80-90%) takes place in the period of the Christmas, where carp is the main dish on the table. This custom

[4] http://www.success-h2020.eu/case-studies/carp/

shaped the specific carp supply chain starting from fish farms, through intermediaries, fish shops and ending up with the final customers.

Before analysing the different innovative practices identified (3.2), a description of the full value chain can be proposed (Figure 3), in line with the economic theory developments (e.g. Porter, 1980, 1985; Kaplinsky, 2000; Gereffi et al., 2005; Knútsson et al., 2008). Such an approach, based on the interviews conducted, enables in particular to capture the respective importance of each production system to the global supply of carp, as well as the main market strategies implemented consequently. For each production system, the average prices obtained for the different value-chain are described.

Figure 3. Presentation of the value chain



Source: own elaboration from the survey.

In the case **of small fish farms** (10-80 ha), direct sales to retail customers is the most popular, as shown in Table 3.

Table 3. The supply chain of carp in the case of small fish farms.

	Market share - in [%]	Selling price in euro per kg
Retail Customers	50	2.8 - 3
Restaurants	20	2.4
Wholesalers and chain stores	30	2.4

Source: own study from the survey.

The supply chain for **medium-sized farms** is completely different, as illustrated in the value chain presented in Figure 3. The impacts differences in prices can be seen in the Table 4 below.

Table 4. The Supply chain, in the case of medium carp farms in the Lower Silesia Province

	Market share - in [%]	Selling price in euro per kg
Retail customers	10	3.2
Fishmongers	2	2.3-2.8
Restaurants - own + other	20	2.8
Own fisheries for anglers	5	2.3
Commercial fisheries for anglers	10	2.3
Processing plants	5	2.1
Wholesalers and chain stores	8	1.8
Intermediaries	40	1.8-2.1

Source: own study from the survey.

In this type of farms, the supply chain is considerably varies, which can be explained by the fact that they produce many more fish. Their real output level ranges from 60 to 120 tons of carp per year and the potential can reach even the value of 150 tons.

A completely different supply chain model was presented by **large farms**, as shown in Table 5.

Table 5. The supply chain for large carp farms in the Lower Silesia Province.

	Market share - in [%]	Selling price in euro per kg
Retail customers	7.9	3.1
Supermarkets	31.3	1.6
Own restaurant	0.2	-
Processing plants	58.8	1.6
Wholesalers	1.0	1.6
Intermediaries	0.8	1.6

Source: own study from the survey.

In that case, most carps are sold to wholesalers and supermarkets throughout Poland. The lowest selling price of carp is 1.6 euro par kg (net of VAT), and the highest selling price of carp is 3.1 euro par kg.

As described, the price obtained can strongly vary between the different productive systems and the type of clients targeted. The following section analyses the actual and potential role of innovation in this development.

3.2. Alternative and innovative initiatives

In order to improve the competitiveness of the full carp value-chain, some key initiatives that can be implemented by the different categories of economic agents are described below.

3.2.1. Development of direct selling

In general, engaging in direct selling and shortening the value chain can be a way to increase the unit value obtained for each fish, and then the total revenues of the firm. In our case, engaging in direct selling could result in an increase of 0.4-0.6 euro per kg. Most often the owner of the farm, in the period around Christmas, becomes a salesperson on his own and personally sells fish at the street market in the centre of the nearest city, thus promoting the brand of his farm and inviting to use the services of rural tourism, which is run during the summer. With direct sales, there is also an incredible opportunity to track the carp market trends. Most frequently, the customers are local residents of Lower Silesia and Greater Poland. As such a strategy is only possible when limited quantities are involved it is mostly relevant for small size aquaculture facilities.

3.2.2. Expanding the period of sales

The concentration of the consumption around the Christmas period has some adverse effect on both the prices and the cash-flows of the farms. In order to avoid this several outcomes of the survey suggest that carp could be proposed on a yearly basis.

It has been reported by farms that every year they could see more retail customers who would like to buy fish not only in December, particularly those farms which have their own restaurants or commercial fisheries. Farms are thus becoming open to the needs of tourism, recreation and gastronomy - especially with respect to regional products (see below).

In this context, an important but relatively new link in the supply chain of carps relates to local restaurants specializing in serving dishes made of carp. These restaurants adventure with carp - as a regional product, was launched in 2005, thanks to the initiative of the association: "Partnerstwo dla Doliny Baryczy", which organizes the mentioned "*Carp days"* in late September and October. One of the event ideas is to promote a year-round consumption of carp. The association strongly solicited to

make the carp identified with the region and to add it to the menus of local restaurants. Only a decade ago, the restaurateurs were not interested in serving carp - but agreed to an experiment, of which the idea was to serve fish dishes - supplied by the association, which took on the role of searching for customers willing to visit the restaurants. The aim of this action was to change culinary habits and to promote year-round consumption of carp from surrounding farms - not only during the Christmas period. The experiment turned out to be a spectacular success, as now, in each of the surveyed restaurants, carp is the main dish on the menu (including different forms of commodities - such as dumplings of carps), and they have lots of customers willing to try their specialties, especially at the weekends.

Such trend can be also observed at the retailing level. One of the surveyed retail chains, located in the Lower Silesia, had in its full year offer both live and gutted carps. While carps sold there were not breed in the Lower Silesia Province, or not even in Poland, this new approach suggest that a demand exists for carps even outside the traditional Christmas period. In the same vein, another retailing chain proposes a full-year offer of gutted carp - whole or fillets, while another key retailer just started to supply smoked carps on a regularly basis as from September 2018.

3.2.3. Making the promotion of locally produced products.

The origin of seafood product can play a role in differentiating local products from other conventional or imported products. Examples of such schemes include for instance protected Geographical Information (PGI) for mussels in Spain and Italy[5], the Pescaderias scheme in Galicia, or the Seabass liners from the edge of Brittany label[6]. This research shows that such a local label has also been created here, with the development of the '*Milicki carp from Lower Silesia' label*, inscribed in 2006 on the List of Traditional Products by the Ministry of Agriculture and Rural Development, and two years later submitted for registration in the EU system of regional products protection as a Protected Geographical Indication.

The increased consumers interest in issues connected with regional products in the Lower Silesia region can be explained by the increasing attitude of consumer ethnocentrism, which in Poland is seen especially in relation to food products, and affects as many as 40% of the population (Raftowicz-Filipkiewicz, 2014). All surveyed restaurateurs indeed emphasised that the main criterion for choosing suppliers is the quality of the fish, confirmed with certification.

In this context, an interesting initiative was taken recently by the Fish Producers Association, which plans to start a partnership, uniting its members and, as an intermediary, to buy up the carp on

[5] In the EU, 21 aquaculture products were marketed under a PGI / PDO scheme ; EUMOFA, 2018.
[6] E.g. see Eurofish magazine, 2017, for an overview ('Finding a formula for Success ; pp.56-57)

the basis of contracts. This project, which would allow reducing the atomicity of the farmers and facilitating the market-driven approach, is in the preliminary stage of negotiations[7].

Another interesting link in the supply chain of carp in the Lower Silesia is the association: '*Partnerstwo dla Doliny Baryczy*' acting also as the Fishery Local Action Group (FLAG). It does not participate directly in the search for customers, but promotes integration, establishment of new contacts and exchange of associated farms views. The association played an important role in obtaining EU funds under the Operational Programme and promoting year-round consumption of carp in the studied area (see also above).

Such a collective, regional branding approach is also fostered by the fact that surveyed medium and large farms are also members of the Lower Silesia Fish Breeders Cluster. The Cluster, created in 2012 and which consists of a group of nine fish farms and local governments, has indeed possibilities to effectively promote regional product, the Milicki carp.

Majority of respondents acknowledged that the sale of certified carps (e.g. The sign "*Barycz Valley recommend*s" awarded by the jury of the association: 'Partnerstwo dla Doliny Barycz') is an asset at the sale, and customers (especially retailers) very often ask for the certificate. However, it does not affect the negotiation of prices - especially for the large customers, for whom the price is still a key part of the transaction. All the surveyed farms are certified with the *Barycz Valley recommends* sign that highlights the relationship with the region, traditionalism, environmental friendliness, sustainability, uniqueness, high quality and ability to intra-sectorial cooperation of the fish farm.

3.2.4. Vertical integration

In order to ensure both the quality and the regularity of the feed, at least one fish farm innovated in the supply chain, through the cultivation of part of their ingredients. While such an alternative approach is not always feasible, it is reported to also reduce the feed and transaction costs, and make the product more local, as feed ingredients also have a local origin. Also, the development of cooperative feed production organisation could be envisaged.

Downstream integration initiatives include several types of alternative and innovative practices, which can also contribute to the development of direct selling (see above).

For instance, most of the surveyed farms manifest their innovation through the usage of modern, specialist fish transport regardless the size of their farms territory. These vehicles were mostly purchased with the contribution of the EU funds (in particular the European Fisheries Fund - EFF), so that the same farms can deliver the product to the customer without any loss during the transport, loading and unloading.

[7] A similar case, related to the Fasolari fisheries in Italy, has been identified as part of the H2020 SUCCESS project (Malvarosa and Cozzolino, 2016).

At least one of surveyed farm indicated having diversified into the establishment of their own restaurant, directly located on the farm facilities. In addition to the restaurant, the farm also invested into a smokehouse, a processing plant and a recreational fishery, so it can achieve a higher price for fish, keeping the full-year liquidity. This farm can indeed organise a whole-year selling of carps, and can capture part of the margins otherwise collected by intermediaries. Also, such an innovative initiative improves the traceability regarding the origin of the product, and can improve the regularity of the quality. Here again, the farm benefited from EFF and EMFF axis 4 contribution, which strongly reduced the investment cost for the farm, and thus the risk occurred.

This research has shown that there is a challenge related to regular supplies of fish, due to the fact that there is a lack of live carp on the market during the summer time. Restaurateurs can buy carp only from the farms which have rinsers on their premises. The rinser is a device for storing live fish in the flowing clean water. With the rinser, year-round storage and fishing out on demand is possible. At least two farms indicated having invested in such facilities.

3.2.5. Other promising innovative developments

3.2.5.1 Marketing innovation – pre-payment.

All tested fish farms also confirmed that customers pay for the deliveries without delays. Only in some particularly special cases (small and medium-sized farms) there is a possibility of credit - but only for friends and trusted customers. In the period ‘after the harvest’ (i.e. October / November) and before the Christmas time, in this group of farms, there is a possibility of advance payment, which allows to get a reduction in the fish price at the delivery in December.

However, none of the examined farms have a signed contract for the regular supply of fish. It is complicated because only ‘after the catches’ it is possible to accurately assess the volume of the carp supply. During this period, large farms sign ‘framework agreements’ with retail chains or the processors, as those entities want to have a guaranteed supply of carp in December.

Although, the farms declare the best customer is a regular customer, each of them tries to become independent from one recipient. No signed procurement contracts create the risk that existing customers, especially the wholesale, may not collect their fish orders. Therefore, diversification of sales is preferred, in order to prevent the formation of any kind of monopsony structure.

3.2.5.2 Market structure innovation – new (export) market.

In the recent period, more and more clients are asking about the possibilities of exporting carps to Great Britain and Ireland before Christmas time. This new situation can be explained by the

high number of Poles, who migrated there since 2004, i.e. just after the accession of Poland to the EU. Unfortunately, the medium farms without a processing plant and additional workforce cannot face up to this increasing export demand. While being a promising development, some collective actions are required to enable the fragmented aquaculture sector reaping the benefits of it (e.g. through the development of a producer organisation export-oriented; the investment in dedicated storage facilities, etc.).

3.2.5.3 Market structure innovation – change in the value-chain.

A new feature also concerns the fact that live carp can be now sold in the hypermarkets during the Christmas period, while even a decade ago, a live fish could have been only purchased directly from the manufacturer or through intermediaries at the markets and bazaars, or in specialized fish shops. This new structuration of the value chain can thus facilitate the access to raw product, especially for middle class people living in big cities.

4. DISCUSSIONS

Our findings suggest that there is a discrepancy in the structure of the fish farms in terms of factors determining the competitive advantage in the supply chain, which implies that differentiated strategies might be relevant. For small farms, the distance and reliability of supply, the quality of fish - certification, the acquaintanceship with suppliers and the reputation are essential. For medium-sized suppliers additional factors to these important elements are the mobility, flexibility and adaptability to customer needs. For large farms the main advantage is the size and knowledge of the brand. In order to address these differences, our research shows that diverse innovative answers have been developed. More than 10 types of innovation have indeed been identified at different levels of the value chain to improve the competitiveness of the economic agents. In general, these innovations enable to increase the whole value of the carp production, including through the development of new consuming trends, such as the development of year-round consumption, the direct selling to final consumers or restaurants, the promotion of the origin of the products or the rise in exports. Other innovative approaches aim at limiting the production costs, e.g. by integrating the feeding process.

Interestingly, it seems that most of these innovations can be replicated, whether in the carp sector or in other cases of inland aquaculture. This can be indeed reflected by some recent work in the carp sector in other regions of Poland (Farnet Magazine, 2018) or elsewhere[8]. It most countries for instance, the local origin of the products tend to become an important competitiveness factor (Zander and Feucht, 2018). However, the dissemination of the innovations can face some challenges. One of them is a mental and cultural barrier, which strongly reveals the lack of willingness to share knowledge and a deficit of trust between partners, especially from the leader (Raftowicz-Filipkiewicz,

[8] E.g. in Germany with the Aischgrund FLAG and the 'Carpland', European Commission, 2017. FARNET.

2014). Another challenge relates to access to financial resources. As indicated above, it appears that the European Fisheries Funds has facilitated the development of some innovations during the recent period. There is a clear policy implication here, as both national and local authorities have a role to play to overcome these challenges. Although the relationship between public policy, regulatory frameworks, innovation and economic growth can be complex (Dimos and Pugh, 2016), financial supports for innovation might generate some benefits for the society as a whole (Radicic et al., 2015). Moreover, not all the innovative strategies are necessary seen as relevant by all the economic agents, e.g. the development of direct selling for large farms. This can explain why some innovation are not adopted by the all fish farmers, or why some innovations fit better to smaller farms than to larger farms for instance (e.g. Rogers, 2003). It is all about the perceived relative advantage on entrepreneur level, although this advantage needs to be well understood and disseminated.

The novum is also (unprecedented before) the diversification of fish farming activities by putting emphasis on direct selling, catering and recreation development such as angling. These activities shorten significantly the supply chain and can also facilitate the links between the aquaculture sector and tourism, having in mind that tourism is one of the most dynamic economic sectors in the recent years (UNWTO, 2018).

Some future developments, such as the potential exports of carps to United Kingdom and Ireland because of the massive migration of Poles, would be required collective answers from the sector in order to let the economic agents located along the value-chain reaping the benefits of it. For instance, this would require the development of processing activity, which is practically non-existent currently in the Lower Silesia Province, as well as the development of export-based producers' organisation. However, this potential is likely to be limited or impeded by the Brexit, which might result in drastic changes in the trade in seafood between the EU-27 and the United-Kingdom (Le Gallic et al., 2017).

This analysis shows that the diffusion of the described carp innovations spread slightly, not as a radical change as Schumpeter described it in his theory of the renew process of economics (sub) systems. Such a development is indeed more in line with the concept of incremental innovation (e.g. see Dewar and Dutton, 1986, for an overview), as in the case described by Harsen for an application to the seafood sector (Harsen, 2014).

5. CONCLUSION

The research shows that, over the centuries, the carp supply chain in the Lower Silesia Province in Poland was strongly determined by historical, geo-political and even religious factors. This implicates why about 80-90% of carp sales (especially wholesale) takes place in the period of Christmas. Fortunately the situation slowly but surely is changing primarily thanks to recent development such as the new cooperative devices like "*Lower Silesia Fish Breeders Cluster*", the

supplying of carp products in restaurants and the role of the local FLAG. They are all related to the promotion a year-round consumption of carp, cooperation and information exchanging. While the research showed the existence of a mental barrier in the form of deficit of trust between some partners, several other promising innovative initiatives were identified to increase the creation of wealth generated from the carp traditional production sector, including the upstream and downstream integration of some activities. To recapitulate, the research showed that in Poland, there is a huge potential for innovation in this sector, which could be fostered by the use of some E(M)FF measures. Also, some schemes are currently being developed to promote a greater cooperation between the economic agents and the institution located in the Lower Silesia region, aiming, among other things, at developing new carp products (e.g. fish and chips) and alternative supply chain (e.g. school canteens).

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583 Appendix 1. Survey for fishing farms:

584 1. Please specify the percentage of sales directions for carp (2-3 years)
585 2. Is production planning in the long term?
586 3. Have the distribution channels changed over the last 10 years? Are other sales channels
587 considered in the future?
588 4. What are the main selling problems for individual customers?
589 5. Which customers are preferred and why?
590 6. Are you looking for fish clients on your own or are they themselves are reporting to you?
591 7. Do you use marketing tools to increase sales?
592 8. Is the certificate "carp milicki" as a regional product an asset in the sale? It raises the price
593 of fish?
594 9. Are payments regulated on an ongoing basis?
595 10. Do you have a contract for regular fish supply?
596 11. Does the activity of the Local Fisheries Group help in searching for clients?
597 12. Who is responsible for transaction costs (eg. transport and risks when selling)?
598 13. Do you have your own stocking material?
599 14. Do you have in offer a fry? If so, who is the client?
600 15. Do you cooperate with other farms? or as part of the Cluster? in cooperation with research
601 centres?
602 16. What constitutes the competitive advantage of your farm in the supply chain?
603 17. How is the percentage of fish losses during storage, loading, transport?
604 18. How do you solve the problem with overproduction - if it exists?

605

606 Appendix 2. The list of farming areas in the Lower Silesia Province

Names of farming area	area (ha)	District
Complex of ponds inPracze	2.8	Milicz
Drogoszowice	4.9	Oleśnica
Complex,, Polny" in Żeleźniki	5.3	Milicz
Krzydlina Mała	5.4	Wołów
Obora	5.7	Lubin
Complex of five ponds in Uskorz Mały and Uskorz Wielki	7.0	Wołów
Godnowa	7.2	Milicz
Ponds in Brzeźnica	7.8	Ząbkowice Śląskie
Complex of ponds in Krzydlina Mała	8.9	Wołów
3 ponds in Dębno	9.3	Wołów

Bogatynia – Opolno Zdrój	9.7	Zgorzelec
Cieśle	10.2	Oleśnica
Jawor I Góry	10.4	Milicz
Modlikowice	11.2	Złotoryja
Raków	12.2	Wrocław
Trzebicko Dolne	12.5	Milicz
Milicz	12.9	Milicz
Jaśkowice Legnickie	14.0	Legnica
Nowy Folwark	14.9	Milicz
Wilka	15.4	Zgorzelec
Cieśle	16.2	Oleśnica
Mierczyce	19.0	Jawor
Ponds: Henrykowskie	19.7	Ząbkowice Śląskie
Four ponds in Pierstnica	21.8	Milicz
"RYBIEŃ"	22.3	Jelenia Góra
Kaszowo, Milicz	23.6	Milicz
Complex of ponds ,,Wszewilki”	27.7	Milicz
Miłkowice	41.9	Legnica
Complex of ponds ,,Wszewilki”	43.0	Milicz
Complex of ponds,,Senne’’	44.2	Zgorzelec
Complex of ponds "Urocze"	71.2	Bolesławiec
Szczodre, Domaszczyn, Pruszowice	88.9	Wrocław
Complex of ponds ,,Syczków’	93.6	Zgorzelec
Ponds in Nowy Dwór	94.0	Oława
Wrzosy, Rudno	103.7	Wołów
Complex of ponds,,Paulinki”	112.3	Legnica
Bieniowice, Reszotary	115.3	Legnicki
Complex of ponds in Podgórzyna	125.2	Jelenia Góra
Raszowa Mała,Buczynka	126.1	Lubin
Complex of ponds,,Dębowe’’	153.2	Zgorzelec
Ruda Żmigrodzka	175.0	Trzebnica
Complex of ponds ,,Stare’’	217.1	Zgorzelec
Complex Zamienice, Kompleks Goliszów, Niedźwiedzice	435.7	Legnica
Complex of ponds: Ruda Sułowska Północna and Ruda Sułowska Południowa	770.5	Milicz
Complex of ponds: Potasznia, Bartniki, Gądkowice	791.6	Milicz
Complex of ponds: Krośnice, Żeleźniki, Goszcz I, Goszcz II i Goszcz III	1273.3	Oleśnica i Milicz
Complex of ponds: Niezgoda, Stary, Jelenie, Jamniki, Kokoty, Koniowskie, Przytockie, Zielony Dąb, Sanie, Raki and Ruda Żmigrodzka	1581.4	Trzebnica
Complex of ponds: ,Milicz, Stawno, Stawno – Grabownica, Raków	1697.8	Milicz i Wrocławski
Total	**8493.3**	

607 Source: own study based on the list of the farming areas established by the Lower Silesia Marshal
608 Office, Decisions of the Governor of the Lower Silesia Province in the years 2002-2005, 2006-2010
609 and 2006-2014.
610

- The research considers the role of innovation along the carp aquaculture value-chain in Poland.

- The research is mostly based on the Schumpeterian theory of innovation, where the entrepreneur enhances economic processes via adaptation of innovations.

- While Carp aquaculture mostly remains traditional by nature, various innovations were observed at each stage of the value chain.

- Market-oriented innovations (new products, new outlets, etc.) appear to be the most promising ones.

- Further collaboration and cooperation can be needed to further develop and replicate innovative processes, including in other production system.

- Public authorities have a role to play to facilitate the dissemination and adoption of innovative processes, including through structural funds (EMFF; coordination; empowerment).