



Insight into the economy of aquaculture production in Czechia: assessment of aquaculture enterprises

Antonín Vavrečka¹ · Petra Šánová² · Lukáš Kalous¹ 

Received: 8 November 2018 / Accepted: 7 August 2019 / Published online: 21 August 2019
© Springer Nature Switzerland AG 2019

Abstract

We provide a general overview of spatial distribution and the economic situation of aquaculture enterprises in Czechia (the Czech Republic) in terms of revenues, profitability, work productivity, indebtedness and grants. We analysed data available in the State Veterinary Administration and information system of the State Agricultural Intervention Fund. The most significant fish producers (enterprises) are located in the regions of South Bohemia. Aquaculture sector profitability and enterprises profits have been moderately rising since 2010. The profitability in 2015 is roughly the same as that in 2005. The amount of provided grants showed a higher value than the generated average annual profits. The enterprises were not able to generate sufficient resources to finance investments without grants resources. Enterprises that realised financing for larger investments from bank credits showed relatively high levels of indebtedness (micro-enterprises at 95.5%). On the contrary, work productivity was the highest for micro-enterprises. Micro-enterprises had the largest share of revenues in relation to the number of employees. Each group of enterprises is considerably specific and needs an individual approach for the subsequent evaluation.

Keywords Pond aquaculture · Czech Republic · Enterprises · Revenues · Profitability · Work productivity · Indebtedness · Grants

Abbreviations

BMEL	Federal Ministry of Food and Agriculture of Germany
CFFA	Czech Fish Farmers Association
EUMOFA	The European Market Observatory for fisheries and aquaculture
IS SAIF	Information system of the State Agricultural Intervention Fund
MoA	Ministry of Agriculture of the Czech Republic

✉ Lukáš Kalous
kalous@af.czu.cz

¹ Department of Zoology and Fisheries, Faculty of Agrobiological, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 957, 165 00 Praha 6 – Suchbát, Czech Republic

² Department of Trade and Finance, Faculty of Economics and Management, Czech University of Life Sciences Prague, Kamýcká 957, 165 00 Praha 6 – Suchbát, Czech Republic

STECF Scientific, Technical and Economic Committee for Fisheries
SVA State Veterinary Administration

Introduction

Global aquaculture production has been increasing steadily since the early 1950s. The outcome is that 50% biomass of total global food fish nowadays originates in aquaculture (Subasinghe et al. 2009; FAO 2016). The total world aquaculture and fisheries production volume has been constantly increasing since 2012 moving from around 182 million metric tonnes (t) to 195 million t. From aquaculture originate 101 million t and 94 million t from catches (EUMOFA 2016a).

EU countries represent about 3.2% of the world's production and aquaculture production generates 1.28 million t of fish and other aquatic organisms (EUMOFA 2016a). Freshwater production accounts for about 25% of EU aquaculture output (Bostock et al. 2016) and the most important species in freshwater aquaculture are rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792) and common carp (*Cyprinus carpio* L.) (Lane et al. 2014; FAME 2016). EU trout production reached in total 191,000 t with a value of EUR 604 million in 2014. Common carp is produced almost solely in pond aquaculture, which has been present in Central Europe for centuries. Indeed, carp production stood almost flat, totalling 80,000 t. The main EU carp producers in 2014 were Poland and Czechia, accounted for 19,000 t worth EUR 38 million and 18,600 t worth EUR 37 million, respectively (EUMOFA 2016a), followed by Hungary with a total 13,000 t (EUMOFA 2016b). The EU production of other freshwater fishes amounted to 16,000 t and it is composed of European catfish (*Silurus glanis* L.), European eel (*Anguilla anguilla* L.), arctic char (*Salvelinus fontinalis* Mitchell, 1815) and various species and hybrids of sturgeons (*Acipenser* sp.) (FAME 2016).

The aquaculture has already become of multifunctional nature since the production is also an important socio-economic factor influencing many people in various countries (Lynch et al. 2016; FAO 2016).

Czechia is a landlocked country where there are no lakes and large rivers but more than 24,000 ponds are situated throughout the territory and cover an area of about 52,000 ha (Adámek and Kouřil 2000; MoA 2014). In the last years, the annual production of market fish has reached nearly 21,000 t (CFFA 2015). The production of common carp dominates with about 87% of total production followed by salmonids with approx. 6%, herbivorous fishes (*Hypophthalmichthys molitrix* Valenciennes, 1844; *Ctenopharyngodon idella* Valenciennes, 1844) are represented by 4% and tench (*Tinca tinca* L.) as a traditional export species of about 2%. The production of highly demanded predatory fishes (*Sander lucioperca* L., *Esox lucius* L., *Silurus glanis* L.) is limited by the type of management and the pond area. Although the proportion of predatory fishes is represented only by approximately 1% of the total fish production in Czechia (MoA 2014; CFFA 2015), their role in the export market is unreplaceable due to marketing connection with common carp sales (Nebeský et al. 2016).

Pond aquaculture is far more dominant in the whole aquaculture sector in Czechia and forms a basis of many other activities including fish stock management of various water bodies mainly for recreational fishing (Kalous et al. 2018).

The majority of ponds were built in the fifteenth and sixteenth centuries, and besides its production role, they fulfil a range of non-production functions in the cultural landscape as water retention and flood control, and they represent important landscape-forming elements

(Pokorný and Hauser 2002; Pokorný 2015a). Pond aquaculture plays an important role in cultural, socio-economic and recreational activities of the whole society (Adámek et al. 2012). Additionally, the presence of ponds has a proven positive effect on local biodiversity (Williams et al. 2004).

Maintaining this multifunctional aquaculture is crucial for sustainability from a landscape level to a social-economic level.

Therefore, it is necessary to identify important pond aquaculture regions within Czechia and monitor the economic development in basic indicators in relation to the size of the enterprise and their focus.

The objective of this paper is to assess the current economic situation of production enterprises within the aquaculture according to indicators as enterprise revenue, profits (EBIT), obtained grants, number of employees, work productivity and indebtedness.

Materials and methods

An enterprise was considered to be any entity engaged in economic activity, irrespective of its legal form. Both individual and legal persons were represented in the sample. Given the need to categorise enterprises for analyses, enterprises were sorted into three groups: micro-, small- and medium-sized enterprises according to recommendation 2003/361/EC of 6 May 2003. The category of micro-, small- and medium-sized enterprises (SME) consists of those employing fewer than 250 persons and having an annual turnover not exceeding 50 million EUR. Within the SME category, a small enterprise employing fewer than 50 persons and its annual turnover, and/or annual balance sheet, does not exceed EUR 10 million in total. Additionally, the micro-enterprise within the SME category is defined as an enterprise, which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet does not exceed EUR 2 million in total. The exchange rate provided by the Czech National Bank (CNB) was applied to the first business day of 2017 (1 EUR = 27.020 CZK to date 2 January 2017). The exchange rate thus used was fixed.

We employed data from the register of the State Veterinary Administration (SVA), which maintains information (location) about production enterprises in Czechia (not including Czech Fishing Union). The number of enterprises in the unit was used for the evaluation of administrative regions (NUTS III). The number of enterprises was monitored between 2015 and 2018. The data collecting began on 31 December 2015 and ended on 31 May 2018. Two data collecting took place in 2016 on 12 September 2016 and 15 November 2016 and two data collecting took place in 2017 on 16 May 2017 and 10 November 2017.

The second source of data was the information system of the State Agricultural Intervention Fund (IS SAIF), which ensures the collection of information on projects and beneficiaries from the Operational Program for Fisheries 2007–2013 and the Operational Program for Fisheries 2014–2020. Through the information system of IS SAIF, all the grant applications in the mentioned programmes are administrated.

We used quantitative analytical methods to evaluate the economics of aquaculture enterprises in Czechia including financial analysis, comparative analysis and analysis of trends development according to Guillen et al. (2015). The financial and comparative analyses were based on the values reported by an enterprise in the financial statements and the tax return. The financial analysis uses indicators such as enterprise revenue, profits (EBIT), obtained grants, a number of employees, work productivity and indebtedness following Guillen et al. (2015) and

Yuan et al. (2017). Work productivity was determined as a share of revenues in relation to the number of employees (FTE). Indebtedness was measured by the number of assets of the enterprise covered by foreign sources. A comparative analysis was applied to intercompany comparisons for selected indicators and benchmarking by enterprise size. Samples for these analyses were 9 micro-enterprises, 7 small enterprises and 4 medium enterprises. A total of 20 enterprises were selected in the sample, i.e. 7% sample of approved establishments in the Czechia by the SVA. All data in the outputs of these analyses were from the closed accounting period of 2015. Analysis of development trends was applied in the evaluation of changes in the monitored indicator in the 10-year interval from 2005 to 2015. The indicator of the achieved profits of enterprises (EBIT) and work productivity was selected for the analysis of trends development.

The following criteria were established for the selection of enterprises in the research sample. Only enterprises with over 65% of revenue from aquaculture in the entity's total revenue were included in the sample. The share of revenue from aquaculture (RA) from the total revenue of the entity was calculated as the sum of revenue from sales of live fish (RLF), sales of processed fish (RPF), sales of angling allowances (RAA), received compensation and grants for non-production functions (NPF) of ponds related to the enterprises total revenue (TR). According to the formula:

$$RA = \frac{RLF + RPF + RAA + NPF}{TR} \times 100$$

Selected enterprises were located through the whole territory of Czechia and they were focused on traditional pond aquaculture and they also usually operate own fish hatcheries (Table 1).

The results were processed in the program Microsoft Excel, using descriptive statistics as the arithmetic mean and standard deviation. The statistical evidence of differences between groups was tested in the program STATISTICA by variance analysis (ANOVA) with a 95% significance level (by the Scheffe test). The Scheffe test compares the pairs of means and it is universal (suitable for an unbalanced model) (Budíková 2006).

Results

In medium-term (between 2015 and 2018), there were 285 ± 18 aquaculture enterprises registered in Czechia (Table 2). The standard deviation shows the change over the years. Most of them were concentrated in the South Bohemian Region (89 ± 12) (for details regarding all regions (NUTS III) of Czechia and the corresponding number of aquaculture enterprises, see Fig. 1 and Table 2).

The revenues for the sale of live fish, total revenues of the enterprises, the achieved profits made of the enterprises (EBIT), obtained grants, the number of employees (FTE), work

Table 1 Characteristics of aquaculture enterprises included into the sample

Indicator	The size of the enterprise		
	Micro	Small	Medium
Managed water area (ha)	2–130	260–1540	1250–1600
Production of common carp in live weight per year (t)	1–40	140–640	500–1100

Table 2 The number of aquaculture enterprises in the administrative regions (NUTS III) during the period 2015–2018

Administrative regions NUTS III	Number of enterprises	Code of the region
Prague	13 ± 2 ^c	CZ010
Central Bohemian Region	34 ± 3 ^a	CZ020
South Bohemian Region	89 ± 12 ^c	CZ031
Plzeň Region	19 ± 1 ^{a,b,c}	CZ032
Karlovy Vary Region	13 ± 1 ^c	CZ041
Ústí nad Labem Region	4 ± 1 ^c	CZ042
Liberec Region	4 ± 1 ^c	CZ051
Hradec Králové Region	18 ± 2 ^{a,b,c}	CZ052
Pardubice Region	14 ± 1 ^{b,c}	CZ053
Vysočina Region	29 ± 6 ^{a,b}	CZ063
South Moravian Region	12 ± 1 ^{c,d}	CZ064
Olomouc Region	15 ± 2 ^{b,c,d}	CZ071
Zlín Region	5 ± 1 ^c	CZ072
Moravian-Silesian Region	18 ± 1 ^{a,b,c}	CZ080
Czech Republic	285 ± 18	

The same superscript letters mean a statistically inconclusive difference (statistical significance at the 5% level). The statistical evidence of differences was tested for each year separately by Scheffe’s test

productivity and total indebtedness, all divided by the size of enterprises, are given in Table 3. Revenues for sale of live fish, total enterprise revenues, the profit of enterprises and obtained grants were statistically different from the medium-sized enterprises (ANOVA, Scheffe’s test).



Fig. 1 NUTS III regions of the Czech Republic. The major region in aquaculture is indicated by a star

Table 3 Selected indicators of enterprises depending on their size

Indicator	The size of the enterprise		
	Micro	Small	Medium
Revenues for the sale of live fish in thousands of EUR per enterprise	61.58 ± 51.95 ^a	786.6 ± 381.14 ^a	2376.02 ± 1464.82 ^b
Total revenues of the enterprise in thousands of EUR per enterprise	67.57 ± 56.52 ^a	1039.99 ± 450.83 ^a	4286.31 ± 1583.41 ^b
Profits made of the enterprise in thousands of EUR (EBIT)	15.04 ± 11.15 ^a	82.76 ± 78.06 ^a	500.2 ± 342.81 ^b
Obtained grants in thousands of EUR per enterprise	52.25 ± 49.61 ^a	258.71 ± 116.89 ^{a,b}	506.85 ± 164.88 ^b
Number of employees per enterprise (FTE)	2.1 ± 1.8	24.7 ± 9.3	108 ± 37.7
Work productivity in EUR per employee	151.4 ± 105.8 ^a	48.2 ± 6.35 ^a	51.7 ± 7.78 ^a
Total indebtedness in %	95.5 ± 49.57 ^a	44.71 ± 21.3 ^{a,b}	31.83 ± 9.82 ^b

The same superscript letters mean a statistically inconclusive (statistical significance at the 5% level). The statistical evidence of differences was tested for each year separately by Scheffé's test

All enterprises in the sample were recipients of grants of both national and European programmes. The amount of provided grants showed a higher value than the generated average annual profits (EBIT).

In the case of micro-enterprises, revenues for the sale of live fish accounted for at least 80% of total revenues. For small enterprises, revenues for the sale of live fish accounted for at least 60% of total revenues and for medium enterprises this share was at a minimum of 25%.

The indicator of the achieved profits of enterprises (EBIT) and work productivity was selected for the analysis of trends development. Comparing the development curves of the profits achieved by micro, small and medium enterprises (Fig. 2), it is clear that enterprises showed significant year-on-year fluctuations in profits. Each group of enterprises had a completely different trend. Micro-enterprises had the lowest fluctuation, sometimes falling into negative numbers. Small enterprises had a growing trend in the last analysed years and the medium enterprises had the greatest profitability.

The profitability of the aquaculture sector is shown in Fig. 3 as the arithmetic mean calculated from all enterprises. The number of enterprises in the group (9 micro-enterprises,

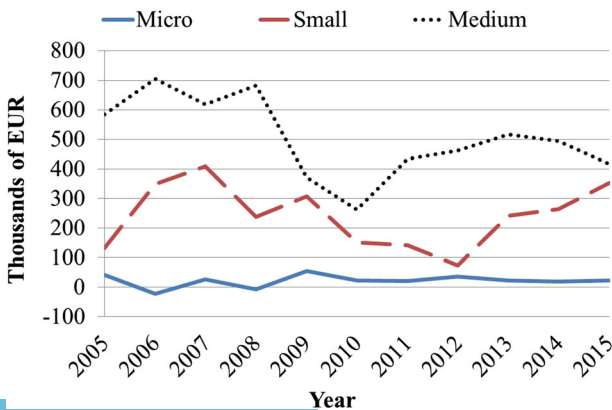


Fig. 2 Average profitability per a type of enterprises in Czech aquaculture in thousands of EUR within the period 2005–2015

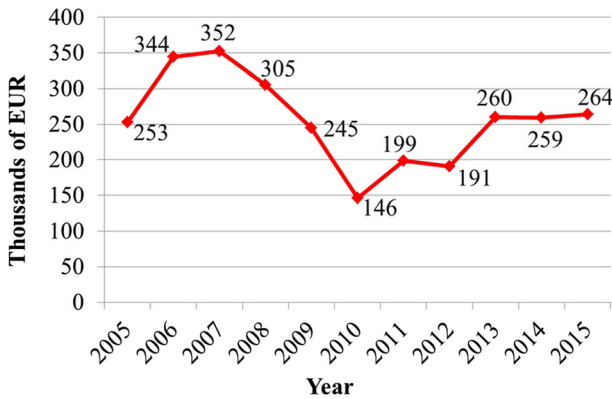


Fig. 3 Total average profitability per enterprise in Czech aquaculture in thousands of EUR within the period 2005–2015

7 small enterprises and 4 medium enterprises) corresponded to the proportion of enterprises across the sector. The year-on-year growth rate of profitability in the sector recorded a decrease of about 59% in 2010 compared with 2007. The growth rate has been increasing since 2010. The aquaculture sector profitability in 2015 was almost the same as that in 2005.

Work productivity was the highest for micro-enterprises (Table 3). Comparison of the development curves of the work productivity achieved by micro, small and medium enterprises is seen in Fig. 4. Micro-enterprises had the largest share of revenues in relation to the number of employees and can be considered more efficient.

The productivity of the aquaculture sector (Fig. 5) slightly increases from 2005 to 2015. The increase was caused mainly by the increase in the productivity of micro-enterprises. The year-on-year growth rate reached about 38% in 2015 compared with 2005.

Discussion

The number of aquaculture enterprises could be considered as one of the measurements of aquaculture activity in a specific area. In total, there are about 285 aquaculture enterprises

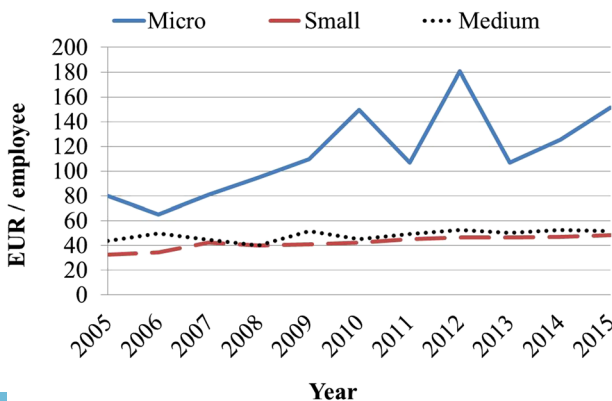


Fig. 4 Average work productivity per a type of enterprises in Czech aquaculture in EUR within the period 2005–2015

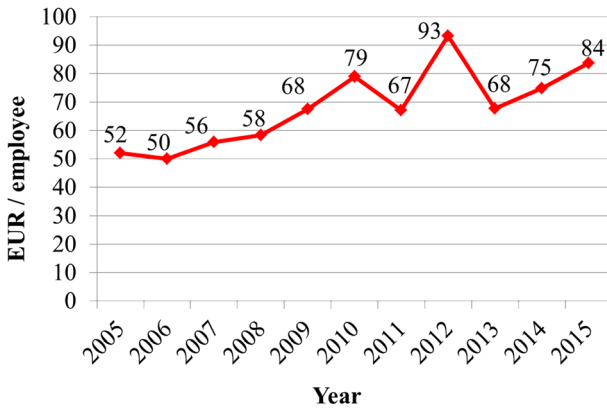


Fig. 5 Total average work productivity in Czech aquaculture in EUR within the period 2005–2015

operating in Czechia. When we compare it with other central European countries, similar numbers are reached by Hungary with about 260 registered enterprises with slightly lower production of common carp (EUMOFA 2016b). The highest number of aquaculture enterprises is in Poland with approx. 1250 enterprises, dominated by small ones with less than 5 employees (70% of total) (STECF 2016). Traditional pond aquaculture is also situated in German neighbouring areas to Czechia, namely in Bavaria and Saxony (BMEL 2014). In Bavaria, there is a prevalence of smaller family-run pond farms, and in Saxony, there are somewhat larger pond management enterprises (Centenera 2014) but the minority of enterprises (less than 10%) produce more than 5 t per year (STECF 2016). In Austria, the situation is similar to Bavaria: fishpond areas are located prevalently in Upper Austria and Styria (Matzinger 2014).

According to our results, most of the aquaculture enterprises in Czechia are concentrated in the South Bohemian Region (89 ± 12 enterprises). The region has its importance to aquaculture also in terms of history (Pánek and Tůma 2018), pond area concentration (Pokorný 2015a) and contribution of aquaculture to the regional economy (MoA 2014). In the South Bohemian Region, more than 7000 ponds and small water reservoirs of a total area of almost 23,000 ha are situated. It represents a half of the total pond area of the whole country (MoA 2014). The region is also characterised by the presence of large ponds (out of 10 largest ponds, 8 can be found in South Bohemia) (Adámek et al. 2012; Pokorný 2015a). The actual number of enterprises resulting from our analyses supports the generally accepted dominant position of South Bohemian Region within regions (NUTS III) of Czechia. In contrary, the South Moravian Region, which is also generally associated with pond aquaculture (Křivánek et al. 2012), resulted in only 12 ± 1 enterprises. Interestingly, the second highest number of enterprises (34 ± 3) is in the Central Bohemian Region. These discrepancies could be attributed to the difference between regions in regard to the spatial structure of enterprises, which are not always in accordance with the production or number of ponds. Moreover, some larger enterprises operate in more regions but their headquarters are always situated in only one. This assumption is supported by the fact that 13 aquaculture enterprises are located in the capital city of Prague but it is unlikely that their fish production is localised only on the territory of Prague.

Besides the spatial distribution of enterprises, our main target was the evaluation of the economic situation of the aquaculture sector in Czechia. Enterprises profits and the

profitability of aquaculture sector show a more pronounced decline since 2007 to the lowest value in the year 2010 and then the profitability slightly increases. Financial/economic crisis belonged among the influences that had a significant effect on the reduction of profits in the years 2009 to 2012 at the national level (Terazi and Şenel 2011). Based on the impact of the financial/economic crisis, the prices of inputs in the sector (feed, electricity, fuel, water, gas, etc.) increased, but output prices of aquaculture products were stagnating (MoA 2014; CFFA 2015).

The obligation of enterprises in the production aquaculture sector to meet the requirements of demanding legislation, especially in the field of environmental protection during this period (protection of cormorant (*Phalacrocorax carbo*) or obligation to monitor water quality) (CFFA 2015) also belongs among the reasons that had a significant effect on the reduction of profits in the years 2009 to 2012. In addition, other substitutes of freshwater fish were imported to the domestic market and imports of freshwater fish from third countries were launched in Czechia too (Berka 2015). In this period, the Czech currency (CZK) also strengthened, which diminished the direct gain from export due to unfavourable currency exchange rates (Nebeský et al. 2016).

Interestingly, our results pointed out that the amount of provided grants showed a higher value in total than the generated average annual profits. The enterprises were not able to generate sufficient resources to finance investments without grants resources during the reporting period. Medium-sized enterprises had a relatively high volume of grants and they were able to secure their share of co-financing of investments without long-term bank credit. Enterprises that realized financing for larger investments from bank credits showed relatively high levels of indebtedness (Holečková 2009).

The greatest economic uncertainty was seen in micro-enterprises because the period from the first investment (into production equipment) to the first harvest is considerably capital demanding. Micro-enterprises starting from scratch and companies without a strong capital base are dependent on external financing. Banks are usually looking for low-risk business opportunities and the sector needs to have a certain size to be banks willing to invest in it. As could be expected, banks are commonly reluctant to engage in aquaculture activities of new micro-businesses (EUMOFA 2019).

The long-term aquaculture strategy in Czechia is to maintain or slightly increase production, which seems to be reasonable (MoA 2014). Aquaculture production based solely on traditional fish production in ponds has considerable limits with regard to environmental protection (MoA 2014). Regarding the very high investment costs, new ponds without state subsidies are built only to a very limited extent since the return from investment is at a very low level of around 25 years or more (Pokorný 2015b). According to our empirical estimation, the constructing costs of 1 ha of the pond vary from 80,000 to 110,000 EUR and the costs of removing sediment from 1 ha (for the pond renovation purpose) from 44,000 to 62,000 EUR. In the absence of bank financing, many enterprises that wish to expand or take advantage of new technology rely on EU or governmental grants (EUMOFA 2019).

Aquaculture in Czechia and especially pond aquaculture is strongly linked to history, culture and social aspects (Adámek and Kouřil 2000). Small- and medium-sized enterprises that diversify their activities seem to be more stable, more competitive and able to cope better with unexpected environmental situations (droughts, floods). This is in accordance with Berka (2015) who mentioned that the diversification of economic activities of aquaculture production enterprises in Czechia is needed. This diversification, besides increasing income, may have a positive impact also on local employment (Martín 2011).

The future of traditional Czech aquaculture seems to be in both fish production of high-quality products and ecosystem and social services. The sustainability of the current model of traditional aquaculture will need continuous grant support to fulfil non-production activities of ponds in the landscape. It is also obvious that ponds without fish production would result in the disappearance of a typical pond landscape.

Conclusions

The number of aquaculture enterprises in Czechia is about 285.

Most of the enterprises are situated in the South Bohemian Region.

Enterprises profits and the profitability of aquaculture in Czechia show a decline from the year 2007 to the lowest value around the year 2010 and since the profitability slightly increased.

The amount of provided grants showed a higher value than the generated average annual profits.

Micro-enterprises had the largest share of revenues in relation to the number of employees. Work productivity of the aquaculture sector slightly increases from 2005 to 2015.

Each group of enterprises, micro, small and medium, is considerably individual resulting in the recommendation that each group will need an individual approach and an individual economic strategy for the subsequent evaluation.

Funding information The research for this paper was financially supported by the Ministry of Culture of the Czech Republic, grant NAKI II no. DG18P02OVV057.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with animals performed by any of the authors.

References

- Adáamek Z, Kouřil J (2000) A long aquaculture tradition in the Czech Republic. *European Aquaculture Society, Magazine Aquaculture Europe* 25:20–23
- Adáamek Z, Linhart O, Kratochvíl M, Flajšhans M, Randák T, Polícar T, Masojídek J, Kozák P (2012) Aquaculture in the Czech Republic in 2012: modern European prosperous sector based on thousand-year history of pond culture. *European Aquaculture Society, magazine Aquaculture Europe* 37:5–17
- Berka R (2015) Improving the fish market. In: Urbánek M (ed) *Our fishery*. Czech Fish Farmers Association, České Budějovice, pp 121–141
- BMEL - Federal Ministry of Food and Agriculture of Germany (2014) *Multiannual national plan for the development of sustainable aquaculture*, Berlin, p 89
- Bostock J, Lane A, Hough C, Yamamoto K (2016) An assessment of the economic contribution of EU aquaculture production and the influence of policies for its sustainable development. *Aquac Int* 24:699–733. <https://doi.org/10.1007/s10499-016-9992-1>
- Budíková M (2006) *Statistics II*. Masaryk University, Brno, p 91
- Centenera R (2014) *Fisheries in Germany*. Directorate-General for Internal Policies, Policy Department B, *Structural and cohesion policies – Fisheries*, p 33
- CFFA - Czech Fish Farmers Association (2015) *Aquaculture in the Czech Republic*. The information brochure of Czech aquaculture. Nakladatelství Typ, České Budějovice, p 28

- EUMOFA (2016a) The EU fish market. Directorate – General for Maritime Affairs and Fisheries of the European Commission, European Commission, p 86
- EUMOFA (2016b) Case study - price structure in the supply chain for fresh carp in Central Europe. European Market Observatory for fisheries and aquaculture products, European Commission, p 34
- EUMOFA (2019) Factors affecting cross-border investments in EU aquaculture. European Market Observatory for fisheries and aquaculture products, European Commission, p 20
- FAME SU (2016) Summary of the Multiannual National Aquaculture Strategic Plans – final draft. European Commission – Directorate-General for Maritime Affairs and Fisheries, p 14
- FAO (2016) Aquaculture big numbers. United Nations Food and Agriculture Organisation, Fisheries and Aquaculture Technical Paper No. 601, Rome, Italy, p 60
- Guillen J, Natale F, Fernández Polanco JM (2015) Estimating the economic performance of the EU aquaculture sector. *Aquac Int* 23:1387–1400. <https://doi.org/10.1007/s10499-015-9891-x>
- Holečková J (2009) Financial analysis of debt influence on profitability and value of enterprise, vol 3. Czech Financial and Accounting Magazine, University of Economics, Prague, pp 37–48
- Kalouš L, Nechanská D, Pettrýl M (2018) Survey of angler's internet posts confirmed the occurrence of freshwater fishes of the genus *Ictiobus* (Rafinesque, 1819) in natural waters of Czechia. *Knowl Manag Aquat Ecosyst* (419):29. <https://doi.org/10.1051/kmae/2018019>
- Křivánek J, Němec J, Kopp J (2012) Pond aquaculture in the Czech Republic. Ministry of Agriculture of the Czech Republic, Prague
- Lane A, Hough C, Bostock J (2014) The long-term economic and ecologic impact of larger sustainable aquaculture. Directorate-General for Internal Policies, Policy Department B, Structural and cohesion policies – Fisheries, p 96
- Lynch AJ, Cooke SJ, Deines AM, Bower SD, Bunnell DB, Cowx IG, Nguyen VM, Nohner J, Phouthavong K, Riley B, Rogers MW, Taylor WW, Woelmer W, Youn S, Beard TD (2016) The social, economic, and environmental importance of inland fish and fisheries. *Environ Rev* 24(2):115–121. <https://doi.org/10.1139/er-2015-0064>
- Martín IJ (2011) Fisheries in Poland. Directorate – General for Internal Policies, Policy Department B, Structural and cohesion policies – Fisheries, 57
- Matzinger T (2014) Ponds in the landscape - meaning, function and threat. A series of publications by the Federal Bureau of Water Management, Vol. 36, 34
- MoA (2014) Multi-annual national strategic plan for aquaculture. Ministry of Agriculture of the Czech Republic, Prague, p 96
- Nebeský V, Polícar T, Blecha M, Křišťan J, Svačina P (2016) Trends in import and export of fishery products in the Czech Republic during 2010–2015. *Aquac Int* 24:1657–1668. <https://doi.org/10.1007/s10499-016-0066-1>
- Pánek J, Tůma O (2018) History of the Czech lands. Charles University in Prague, Karolinum Press
- Pokorný J (2015a) Ponds and the concentration of pond area. In: Urbánek M (ed) Czech ponds and fisheries in the 20th century. Czech Fish Farmers Association, České Budějovice, pp 25–35
- Pokorný J (2015b) Construction and revitalization of ponds. In: Urbánek M (ed) Czech ponds and fisheries in the 20th century. Czech Fish Farmers Association, České Budějovice, pp 166–173
- Pokorný J, Hauser V (2002) The restoration of fish ponds in agricultural landscapes. *Ecol Eng* 18(5):555–574. [https://doi.org/10.1016/S0925-8574\(02\)00020-4](https://doi.org/10.1016/S0925-8574(02)00020-4)
- STECF (2016) Economic report of the EU aquaculture sector (EWG-16-12). Publications Office of the European Union, Luxembourg, European Commission, 483
- Subasinghe R, Soto D, Jia J (2009) Global aquaculture and its role in sustainable development. *Rev Aquac* 1:2–9. <https://doi.org/10.1111/j.1753-5131.2008.01002.x>
- Terazi E, Şenel S (2011) The effects of the global financial crisis on the central and eastern European Union countries. *Int J Bus Soc Sci* 2(17):186–192
- Williams P, Whitfield M, Biggs J, Bray S, Fox G, Nicolet P, Sear D (2004) Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. *Biol Conserv* 115(2):329–341. [https://doi.org/10.1016/S0006-3207\(03\)00153-8](https://doi.org/10.1016/S0006-3207(03)00153-8)
- Yuan Y, Yuan Y, Dai Y, Gong Y (2017) Economic profitability of tilapia farming in China. *Aquac Int* 25:1253–1264. <https://doi.org/10.1007/s10499-017-0111-8>

Reproduced with permission of copyright owner.
Further reproduction prohibited without permission.