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INTEGRATION OF FARMERS AND PROCESSING INDUSTRY IN THE AQUACULTURE VALUE CHAIN IN TOCANTINS, BRAZIL

Manoel Xavier Pedroza Filho[1*]
ORCID: 0000-0003-4144-0654

1 Empresa Brasileira de Pesquisa Agropecuária – Embrapa, *Embrapa Pesca e Aquicultura*, Palmas, Tocantins, Brasil.

Maurício Araujo Castilho[2]
ORCID: 0000-0001-7048-9161

2 Faculdade Católica do Tocantins, Palmas, Tocantins, Brasil.

* manoel.pedroza@embrapa.br

ABSTRACT

Most of the fish farmed by small scale fish farmers in Brazil is sold directly to local markets without passing through a processing industry. The integration between small-scale fish farmers and the processing industry is restricted to few cooperatives, mainly at the southern region of Brazil. Although many fish processing plants are operating in different regions, most producers do not have access to these industries. As a result, the lack of integration creates many problems, including low quality of fish due to the absence of sanitary control, informality, impossibility to access supermarkets due to the lack of sanitary requirements and low added value. The present work is based on a case study of aquaculture in the state of Tocantins, Brazil, by using the Global Value Chain approach. The methodology consists of a qualitative process based on face-to-face interviews with value chain agents. The main results indicate that the processing industries are increasing their own production and implementing supply contracts with large producers. More vertical governance is emerging with a high level of control by the industries. As a consequence, many small-scale fish farmers are being excluded from the value chain.

Key words: Aquaculture; Industry; Governance; Global Value Chain.

RESUMO

A maior parte do pescado cultivado por pequenos piscicultores no Brasil é vendido diretamente aos mercados locais, sem passar por uma indústria de processamento. A integração entre os pequenos piscicultores e a indústria de processamento é restrita a poucas cooperativas, principalmente na região Sul do Brasil. Embora muitas indústrias de processamento de pescado operem em diferentes regiões, a maioria dos produtores não tem acesso a essas indústrias. Como consequência, essa falta de integração gera muitos problemas, tais como a baixa qualidade do pescado devido à ausência de controle sanitário, informalidade, impossibilidade de acesso aos supermercados por falta de requisitos sanitários e baixo valor agregado. O presente trabalho é baseado em um estudo de caso da aquicultura no estado do Tocantins, Brasil, utilizando a abordagem da Cadeia de Valor Global. A metodologia consiste em um processo qualitativo baseado em entrevistas presenciais com agentes da cadeia de valor. Os principais resultados indicam que as indústrias de processamento estão aumentando a produção própria e realizando contratos de fornecimento com grandes produtores. Mais governanças verticais estão surgindo com um alto nível de controle por parte das indústrias. Consequentemente, muitos piscicultores de pequena escala estão sendo excluídos da cadeia de valor.

Palavras-chave: Aquicultura; Indústria; Governança; Cadeia de Valor Global.

JEL Code: Q10; Q13.

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INTRODUCTION

Aquaculture is a dynamic and complex industry in Brazil, spread throughout all regions of the country and presents a great diversity in terms of farmers' profile and market.

In the last decades, socioeconomic and cultural changes such as income increase and urbanization have been reflected in the fish market. Fish consumers have increased their demand for products that are easier to prepare, for example, cuts, ready-made dishes, products with more functional packaging, and smaller portions. The supermarkets were able to meet this new demand and consolidate their position as the main fish retail channel in Brazil (SEBRAE, 2015; Pedroza et al., 2014). The Brazilian fish market has followed a global trend regarding the role of supermarkets in meeting new consumer demands (Hatanaka et al. 2005; Reardon and Timmer 2012; FAO 2014; Lem et al. 2014; Phillips et al. 2016).

The consolidation of the supermarkets in the Brazilian fish market has impacted the entire value chain, especially concerning higher requirements in terms of sanitary certification, large volumes, and regularity in fish supply (Pedroza and Routledge, 2016).

These requirements impose the need for essential capabilities from the fish farmers in terms of production scale, logistics, and fish processing structure – which are difficult to be reached by small producers working individually (FAO, 2020; Flores and Pedroza, 2014).

Despite the rise of large companies and cooperatives in Brazilian aquaculture over the last 20 years, most of the fish farmers are composed of small-scale ones. The participation of these small-scale fish farmers in this market depends on their capacity to be integrated into the other segments of the value chain, principally the processing industry.

This article shows the case study of Tocantins state, as a representative situation verified in several regions in Brazil. According to SEAGRO (2017), Tocantins has about 1.000 fish farmers, mostly small-scale ones. Despite the presence of four fish processing plants, most of the producers are not integrated into these industries. As a result, these producers sell the fish informally in the local market without any sanitary control or processing. In addition to health issues, this situation highlights the economic and legal vulnerability of these producers related to their exclusion from the value chain.

To understand the key factors behind this scenario, this article aims to analyze the main elements of the local aquaculture value chain with special attention on the governance structure concerning fish farmers and the processing industry. This article can contribute significantly to the emergent research in the aquaculture value chain with the focus on the economic inclusion of small-scale producers in developing countries.

AQUACULTURE INDUSTRY TRANSFORMATION IN BRAZIL

In Brazil, aquaculture has grown significantly in the last years, reaching a volume of 780,000 tons in 2017, according to the PEIXEBR (Brazilian Fish Farming Association, 2018) and mostly composed of tilapia and Amazonian fishes as *Colossoma Macropomum* (Tambaqui), catfishes and *Arapaima Gigas* (Pirarucu). Tilapia is the most important species accounts for 370.000 tons, which represents 47% of the total production (Figure 1). Henceforth, tilapia production places Brazil as the fourth major world producer of this species.

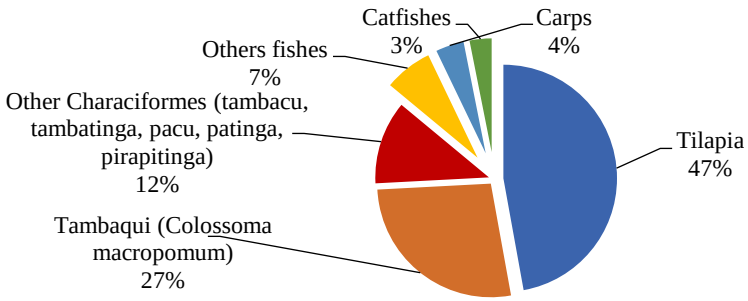

Figure 1. Main species of fish farmed in Brazil (2017).

Source: IBGE/Brazilian Institute of Geography and Statistics.

Like most developing countries, in Brazil, a great number of fish farmed by small scale producers is sold directly to local markets without passing through a processing industry. This situation highlights some legal issues as minimal fish processing (i.e., fish cleaning and evisceration) in a certified plant is mandatory in Brazil[1]. Besides problems related to sanitary and informality issues, this situation highlights the low added value obtained by fish farmers.

There is no official data concerning the quantity of farmed fish marketed directly to consumers bypassing a certified processing industry. However, according to experts' estimation regarding the 780,000 tons of aquaculture production in Brazil, just about 40% is processed (Figure 2). The rest of the production is sold directly to the market without passing through the processing industry.

[1] For further information about the Brazilian regulation on sanitary certification of animal products see the Decreto Nº 9.013, de 29 de Março de 2017 issued by the Ministry of Agriculture.

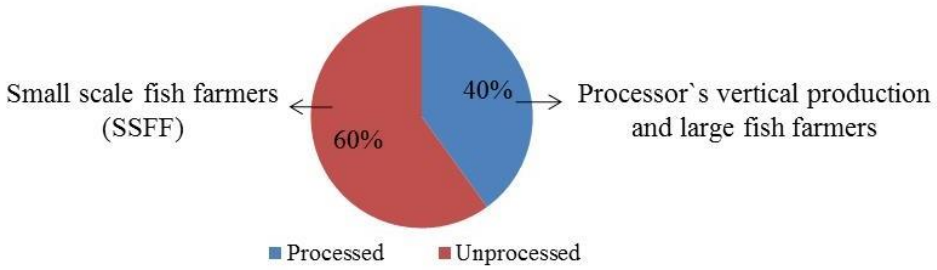

Figure 2. Processing rate of farmed fish in Brazil and the main origins (2017).

Source: The authors (based on personal information from experts).

The situation affects the small-scale producers, particularly; as the vast majority of these producers do not have processing plants, and therefore, they need to be integrated into a third-party industry. Nevertheless, in Brazilian aquaculture, these partnerships are not common, and the integration between small-scale producers and the processing industry is restricted to few cooperatives, principally in the southern region of Brazil[2].

Although many fish processing plants are operating in different regions across the country, the majority of fish farmers do not have access to these industries. Brazil accounts for 251 fish processing plants certified by the Federal Sanitary Service. In reality, most of these plants are supplied by their own production, with a low volume of fish from third-party suppliers.

The fish processing plants are spread everywhere in the country, but it is mostly concentrated in the south and southeast, which are the most developed and industrialized regions in Brazil. The present case study relates to the state of Tocantins, in northern Brazil, which accounts for four fish processing plants (Figure 3, highlighted in red).

[2] The states in Southern Brazil, especially Paraná, account for a large number of agricultural cooperatives working principally with grains (i.e., soybean, corn), pork and poultry. According to specialists, the reason behind the success of the cooperatives in this region is related to socio-cultural aspects linked to the European heritage of these communities, especially German and Italian, because of the great number of immigrants arriving there in the early century 21.

Figure 3. Fish processing plants certified by the Federal Sanitary Service in Brazil.

Source: Authors.

Tocantins presents an excellent potential for aquaculture production because of competitive advantages such as water availability (i.e., several rivers and three large hydroelectric reservoirs), warm climate and expressive grain production (i.e., soybean and corn). The state accounts for four fish processing plants oriented for farmed fish. The main species produced are Tambaqui (*Colossoma macropomum*) and catfishes, both natives of the Amazonian basin.

According to State Agricultural Agency (SEAGRO, 2018), in 2017 the aquaculture production in Tocantins was 14.500 tons of which 4.800 tons were processed by the processing plants, i.e., just 33% of the total. Tocantins accounts for approximately 1.000 fish farmers, mostly small-scale ones, who sell in the local market through middlemen or traditional retailers as street vendors and fishmongers, bypassing the processors. This situation is prevalent in other regions throughout Brazil.

This lack of integration between fish farmers and the industry results in several problems as follows: (a) low fish quality due to the absence of sanitary control; (b) great informality and non-payment of taxes; (c) impossibility to access supermarkets due to the lack of sanitary and fiscal requirements; (d) low added value to fish.

This situation is harmful to both fish farmers and processors. The fish processing plants face many difficulties concerning the underutilization of its industrial capacity, due to the lack of fish. Moreover, the industries face losses in terms of competitiveness as their fish costs are higher than those sold informally by the small-scale fish farmers. On the other hand, the small-scale fish farmers suffer due to the low added value for their fish and

because of the difficulties in accessing supermarkets and other markets with higher quality standards.

The integration of producers and processing plants is crucial in order to assure aquaculture development since the industry segment is a fundamental part of its value chain. It is based on the premise that the orientation towards industrialization is a fundamental aspect to enable the sustainable commercialization of aquaculture products in large consumer centers, which demands greater volumes and higher standards of quality. In addition to the economic benefits of raising workers' incomes, industrialization enables the qualification of the actors, contributing to the insertion of local products in more demanding or distant markets, which gives dynamism to the activity.

Thus, considering the importance of processors as a feasible alternative to process fish from small scale producers, this article aims to understand the bottlenecks hindering the integration between these actors in Tocantins state, northern Brazil; as aquaculture structure in this state is very similar to many others across the country. Therefore, to reach this goal, a case study has been chosen to evaluate the aquaculture value chain in Tocantins..

METHODOLOGY

The present article is based on the case study of the aquaculture sector in the state of Tocantins (Brazil) by using the Global Value Chain (GVC) approach. This research was carried out in partnership between the Brazilian Agricultural Research Corporation (EMBRAPA) and the Regional Development Postgraduate Programme of the Federal University of Tocantins.

The methodology consists of descriptive research based on qualitative data gathered through face-to-face interviews with value chain agents (i.e., processing plants, fish farmers and institutions). The theoretical framework used was the GVC approach, which is defined by Gereffi and Stark (2016) as a productive system with six main dimensions: input-output structure, geographical structure (territoriality), institutional context, governance structure, upgrading and industry stakeholders.

The GVC approach is instrumental in order to understand how industries are organized by analyzing the value-added sequences, from conception to production and end-use. It concerns aspects as job descriptions, technologies, standards, regulations, products, processes and markets, offering a holistic view of industries, which can include different activities such as research and development (R&D), production, marketing and distribution. In this context, Bush et al. (2018) highlighted a growing number, especially in developing countries, of studies focused on governance analysis of aquaculture value chains.

The GVC approach is not limited to analyzing the problems related to a firm by linking geographically dispersed economic activities, because it also study the issues of control and coordination of these activities between buyers and producers. Thus, GVC analysis favors the dynamics of relations

between firms and their forms of governance (Humphrey et al., 2001; Gereffi, 2016).

The GVC approach has been increasingly used in aquaculture development studies in several countries as shown in the works of Bush et al. (2018), Belton et al. (2018), Bjorndal et al. (2014), Little et al. (2018) and Hernandez et al. (2018). The methodology has also been used to analyze several other production chains around the world such as services (Rabach, Kim, 1994), shoes (Schmitz, 1999), automobilist (Kaplinsky, Morris, 1999), textile (Gereffi, Mamedovic, 2003; Palpacuer et al., 2005). Particularly regarding agrobusiness chains, there are a great number of studies that are based on GVC like flowers (Hughes, 2000; Wijnands, 2005; Mather, 2007), wheat (Hughes, 2000; Wijnands, 2005; Mather, 2007), fruits and vegetables (Reynolds, 1994; Dolan, Humphrey, 2004; Bijman, 2006; Mather, 2007; Walter e Ruffier, 2007; Tozanli, El Hadad Gauthier, 2007); among several others. Likewise, there are authors whose studies were focused on the GVC in specified areas like the Inclusion of Small and Medium Producers in Agricultural Projects in Latin America (Fernandez-Stark et al. 2012), shrimp at Vietnam (Tran, 2013); Egypt Aquaculture (El-Sayed, Dickson, El-Naggar, 2015) among others as cited by Castilho (2017).

The study is based on the GVC approach by focusing on the main bottlenecks of the researched chain holistically, while seeking to interpret the scenario in a more colloquial language, without the rigor and rigidity of learned analytical currents. This versatility of the GVC allows the research to be comprehensive to the point of making numerous concepts compatible in its field of analysis, and in the search for possible arrangements and trends that direct or strangle movements or links within the chain, according to the sensitivity and perception of the agents who experience it (Castilho, 2017).

The present methodology used the four main steps as described below:

(a) Analysis of secondary data and exploratory interviews with experts and policymakers: as proposed by Yin (2009) this phase aimed to identify the key-agents and to obtain a preliminary overview of the value chain in terms of structure and governance, which helped to developed interview guides posteriorly..

The analysis focused on bottlenecks in the industrialization of private fish processing companies in the state. It sought to contextualize the players through secondary data analysis, technical and scientific research works, as well as exploratory interviews with local institutions that work directly in the production chain mentioned above (rural extension agency, healthy and disease agencies, State Secretariats, local research institutions, supervisory bodies, private production and processing companies).

(b) Framework construction for data collection and treatment: Semi-structured interviews were the main source of primary data. They were conducted face to face and were based on guides prepared according to each type of actor in order to standardize the information gathering instrument, as mentioned by Blanchet and Gotman (2007). Despite certain

adaptations made according to the type of actor, the guides were designed to feed the research questions asked concerning the conceptual framework mobilized (GVC), then followed by the refinement of the consultations made with experts.. A grid was used as the basis for the construction of the interview guides. Both construction of interview guides and analysis grids were based on the six dimensions of the GVC approach, especially concerning the governance between the value chain agents.

Individually, the interviews were conducted with the chief of the leading fish warehouse companies in the state and with other agents in the chain, such as retailers, institutional agents and producers.

(c) Sampling: The sampling was based on a sequential and oriented process, as mentioned by Miles & Huberman (2003). According to Miles & Huberman (2003), qualitative samples tend to be "oriented" rather than random because the definition of the universe to be studied is limited compared to the quantitative samples, but also because the social processes follow logic and coherence that are difficult to exploit in the case of random sampling. In addition, random sampling on a small number of cases can be unreliable and skew the results. The present research favored the sequential sampling modality, whereby samples were not fully pre-specified but defined during the search, based on information that allowed chaining of recommendations to build a relevant sample. The sampling process began with the identification of institutional agents, followed by an interview with each of them. This phase made it possible to define the panorama of the sector and thus build a network of contacts with other actors in the sector. The use of experts proved to be an essential step in the selection process of the actors surveyed.

(c) Data collection: In total, 113 agents were interviewed, including fish farmers, institutions and all four fish processing plants located in Tocantins. The interviews were carried out in two time periods, 2015 and 2017, via face-to-face meetings with main value chain agents. In most interviews, only one interlocutor was present, and the average duration of their interviews lasted one hour. For the fish processing plants and institutions, the interviews were conducted mainly with the purchasing sector managers and aquaculture officer, respectively. Concerning the fish farmers, the interviews were carried out only with the producers. The interviews were recorded in order to retain the information for later examination if necessary.

(d) Analysis and validation of collected information by triangulation: The qualitative data processing was based on the thematic analysis proposed by Miles & Huberman (2003), Blanchet & Gotman (2007), which define this type of analysis as a method to overcome the singularity of the discourse. This method ignores the individual coherence of each interview, referring to a thematic coherence between interviews. Miles & Huberman (2003) state that the thematic analysis aims to dissect the interviews into a smaller number of more synthetic themes or conceptual elements. After the transcript of the interviews, the most relevant extracts were classified following the analysis grid constructed according to the research problem.

This step aims, in particular, to reduce the volume of data to be processed by eliminating spurious or superfluous information. Unlike the interview guide, which is an exploration tool for collecting data, the analysis grid is an explanatory tool designed to produce results. Finally, the validation processes were carried out by crossing results with different sources like interviews, secondary data and experts.

The validation of the collected information was carried out through the triangulation of the sources. As Prodanov and Freitas (2013) affirm, in situations where the researcher is faced with several sources of evidence, these pieces of evidence need to converge, in order to offer conditions to achieve reliability and validation of what is found. The triangulation was carried out within the analysis grid: the grid makes it possible to cross the information from the GVC dimensions and the extracts of each interviewed agents, aiming at the interpretation and general understanding of the chain, allowing holistic and not just punctual observations.

RESULTS AND DISCUSSION

Most of the production from the small-scale fish farmers in Tocantins is sold informally in the local market through middlemen or retailers such as street vendors, public markets and fishmongers, bypassing the processing plants (Figure 4).

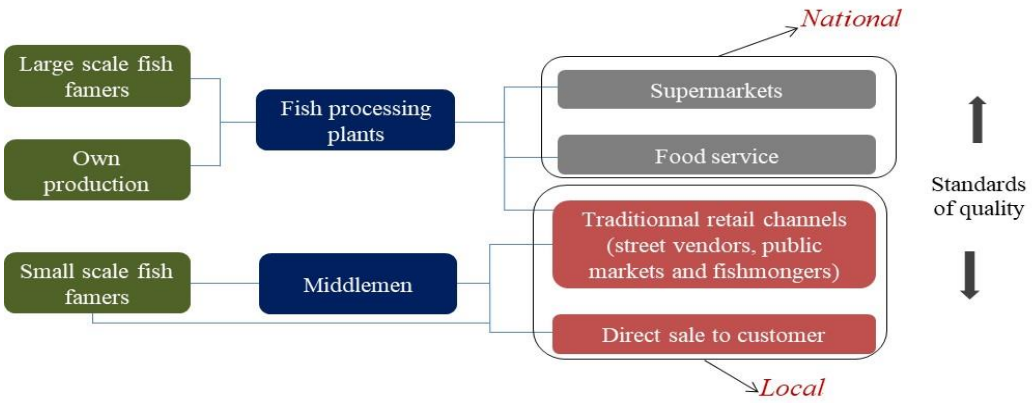

Figure 4. Market channels for farmed fish in Tocantins.

Source: Adapted from Castilho (2017).

Because of the lack of processing and sanitary certification, the small-scale fish farmers have limited their sales only to the local market as traditional retailers (i.e., street vendors, public markets and fishmongers), instead of supermarkets, thus presenting lower standards of quality. In this case, sanitary certification is not necessarily required. Moreover, the control by sanitary agencies at states borders requires sanitary certification in order to allow fish transit (and other animal products) between the states. Therefore, this situation forces the small-scale fish farmers to distribute their products in the local market.

The processed and certified fish can reach supermarkets and food services located either in the local market or in more distant regions as it meets the sanitary requirements of these retailers and sanitary authorities at states borders.

In order to overcome the lack of processing and sanitary certification, the Ministry of Fisheries and Aquaculture has implemented 27 public fish processing plants in Brazil, including one in Tocantins. The small-scale fish farmers should operate these plants under collective organizations like cooperatives, associations, consortiums, etc. However, because of several problems related to management and lack of financing to cover operational costs (i.e., electricity, maintenance) all of the plants are currently out of service, including the one located in Tocantins.

In this context, the integration between small-scale fish farmers and private fish processing plants emerges as a viable alternative to assure processing and certification for these producers. However, some barriers have prevented the partnership between these actors, and currently, the small-scale fish farmers do not operate with the fish processors in Tocantins.

Little et al. (2018) suggested that sustainable intensification of the production of farmed aquatic animals cannot be understood on the farm alone but requires a comprehensive value chain approach. The authors suggested a holistic perspective to value chain analysis, in order to explain trade dynamics and the impacts on livelihoods.

The main reasons behind the non-integration between producers and the industry include:

- The added value along the different market channels explain the advantages for fish farmers selling to a middleman (Figure 5). The low price of fish paid by processors (US$ 1.30/kg) compared to a middleman or local retailers (US$ 1.68/kg) makes the transaction less attractive, as small-scale fish farmers have high production costs due to their small-scale production and low technological level. Despite being informal, the price paid by middlemen is 29% higher than the processor´s price. These prices were consolidated among the several interviews realized during the study and from data collected directly at the markets. The transaction's prices of each local chain actor came from different moments as per the nature of the GVC approach, and the prices converged precisely to the same range of values, confirming the veracity of the information obtained.

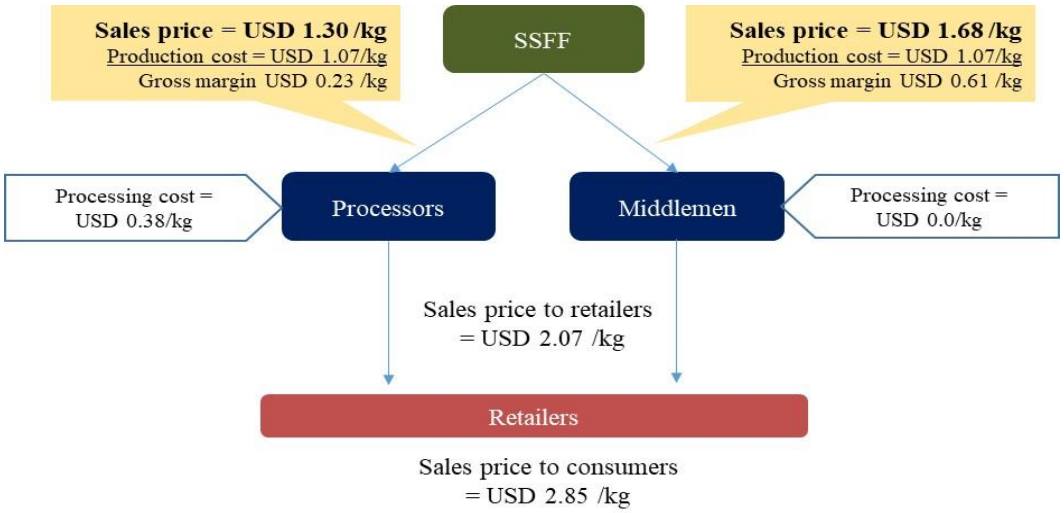

Figure 5. Comparison margins in the two fish market channels in Tocantins.

Source: The authors. (*)USD 1 = BRL 3.86

- According to State Agricultural Agency (SEAGRO, 2018), the production cost average was USD 1,12/kg, and prices from producers to retailers USD 1,37/kg – values similar to those obtained by this study methodology;
- The geographic dispersion of fish farmers and their small-scale production makes transportation logistics expensive and complex. On the other hand, the small-scale fish farmers face huge difficulties to establish cooperatives or other forms of producer organizations aiming to increase volumes to meet industry demands or to enable the operation of their own processing plant.
- The low scale of production of small-scale fish farmers creates difficulties for the processors to optimize transport and industry operation as the small volumes of fish results in high logistics cost. This situation is critical as small-scale fish farmers work individually and are not able to establish cooperatives or producer organizations in order to increase quantities to meet processors demands by volume.
- Despite being mandatory according to sanitary laws, the control by local agencies concerning minimal fish processing in a certified plant (i.e., washing, evisceration, cooling) is still weak, which encourages the informality by small-scale fish farmers. However, there is a tendency to reinforce this type of control in the future, which represents a legal risk for fish farmers.

This situation has reinforced the emergence of new governance structures led by the processing plants, who are increasing their own production and implementing vertical supply contracts with large producers. It results in more vertical and hierarchical governances with power control in the industry hands. This type of governance, in the case of the informal market, aims to enable industries to keep the margins that would remain with the fish farmers and middleman to themselves. These new governance structures highlight the role of the private actor in structuring the

aquaculture value – without public governance – as found by Hernandez et al. (2018) in Bangladesh, where wholesalers have implemented vertical relations by providing working capital to secure fish supplies.

This lack of integration is harmful to the development of the aquaculture value chain in Tocantins state because it results in several problems such as:

- Diminution in the fish demand from small-scale producers: the local consumers are increasingly more conscious about the sanitary quality of fish. The local fish processors are making several advertisement campaigns aiming to inform the consumers about the importance of sanitary certification for fish quality and food safety. Therefore, the consumers are increasing their preference for fish with sanitary certification.
- Stagnant production quantity: the total volume produced within the state has not changed between the years 2015 and 2017 (SEAGRO, 2018), which increases uncertainty to SSFF.
- Sanitary risks for consumers related to poor hygienic standards and rising doubts regarding the absence of an adequate cold chain logistics for fish bypassing processing plants: the lack of correct processing and cold chain increase the risk of sanitary problems as contamination and deterioration of fish. It is particularly serious in the Tocantins as that region presents a very warm temperature throughout the year.
- The impossibility for small-scale fish farmers to access supermarkets and other more developed markets due to lack of sanitary certification: as a result, there is a saturation of the local market and, therefore, fish prices has stagnated due to increasingly offer by small-scale producers, which cannot reach more distant markets or supermarkets. This scenario is particularly worrying as Brazilian fish consumers are expected to be increasingly concerned about sanitary issues and traceability of seafood products (LEM et al., 2014).
- Underutilization of industrial capacity of the processing plants: All fish processing plants in Tocantins were planned to be partially supplied by a third-party production from small-scale fish farmers, in addition to their own production and vertical contracts with large fish farmers. Consequently, the processors do not reach the full capacity of the industries due to the lack of fish from small-scale fish farmers.

This scenario harms both the producers and industries and compromises the development of the entire chain. On one hand, the industries face losses in terms of competitiveness as their costs are higher than those of the fish sold informally. On the other hand, the small-scale producers suffer with the low added value for their fish and because of the informality that surrounds their transactions, which brings impossibilities in accessing supermarkets and other more structured markets. This situation found in Tocantins state is representative of small-scale aquaculture in other developing countries. As mentioned by FAO (2020), in low-income countries, 51 per cent of farmed fish is sold in live or fresh form, without any industrial or semi-industrial processing.

As a result, more vertical governance structures have emerged with power in the processors' hands, which are increasing vertical production and strong partnerships with large producers to overcome the lack of fish. This governance enables the processors to assure quantity and quality, which allows reaching more demanding markets (e.g., São Paulo, Brasilia, Rio de Janeiro). According to PEIXEBR (2020), the integration between small-scale producers and processing industries have been the success driver in the production of tilapia in the Paraná state. In opposition, tilapia producers are working individually without any organizational structure (i.e., cooperatives, vertical integration, association), and are facing huge challenges to assure their position in the market.

The results found from the present research are convergent to those of Belton et al. (2018) in a study about the aquaculture value chain in Myanmar. Among their conclusions is the fact that the majority of farmed fish in Myanmar goes to the domestic market, and it has been sold whole and fresh with very little value-added. They also found that the high transaction costs of obtaining permission to expand their production areas and the risks of doing any informality is discouraging small farmers.

CONCLUSIONS

The informality of fish production in Tocantins state is representative of several regions in Brazil and reveals the failure of public policies aiming to insert the small-scale fish farmers in the value chain.

The small-scale fish farmers assume an institutional and sanitary risk because the tolerance of traditional retailers concerning the absence of processing, and sanitary certification relies on the lack of control from local sanitary agencies. Nevertheless, public policies are reinforcing sanitary regulation for fish but do not offer alternatives to process production from small scale producers.

Moreover, the legal requirements in the absence of processing can result in sanitary risks for the consumers because of poor hygienic standards, and the absence of an appropriated cold chain.

This situation puts in evidence two “aquacultures” in Brazil, one industrialized and capitalized, which is oriented to the consolidated market; and another informal (and illegal), with low capital and technology and oriented to local markets caused by the difficulties to access supermarkets and more demanding markets due to the lack of sanitary certification. The initiatives carried out by the government aiming to implement collective/public fish processing plants for small-scale producers has failed. On the other hand, small-scale fish farmers working individually have no output and capital to enable and own fish processing plants.

However, the alternatives to overcome these problems are based on the productive organization of fish farmers to increase the scale and meet processors' demands in terms of quality and volume. Another measure

concerns the access to technical assistance by fish farmers in order to improve capabilities in terms of production efficiency. According to Belton et al. (2018), there is a need for research to improve simple and low-cost techniques so as to enhance production efficiency in Myanmar. As the authors affirm, research is needed to understand farmers' attitudes and disseminate results and recommendations to users.

The successful model of vertical integration utilized by poultry and pork sectors in Brazil could be adapted to the aquaculture sector. Large agricultural cooperatives are implementing successful initiatives with tilapia in southern Brazil.

The work presented weaknesses, such as the lack of quantitative data. This fact does not impact the conclusions, but it could bring greater robustness to the analysis if there were a greater number of sources for comparisons and triangulations. The small number of papers or similar works in this area and location represents a limitation of data, and it is also a clue to the informality that surrounds the subject.

In the empirical perspective, the paper aims to collaborate and to cover a gap of knowledge regarding the real reasons as to why fish production does not expand in Tocantins state, and why small producers are struggling to survive. The considerable local demand and the willingness of consumption combined with the natural production conditions and local production of fish feed main ingredients are being under-explored and could generate greater income and increase food production.

In terms of theoretical contributions, the paper offers the basis for further studies on governance structures and new organizational arrangements between fish farmers and the processing industry in Brazil or other developing countries. Interactions with similar research conducted on other protein value chains (e.g., Poultry, pork) can be instrumental in developing comparative studies.

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