Fish farming participated in the economic growth of rural areas in Brazil
G12. (ONSITE) Economic development in rural places

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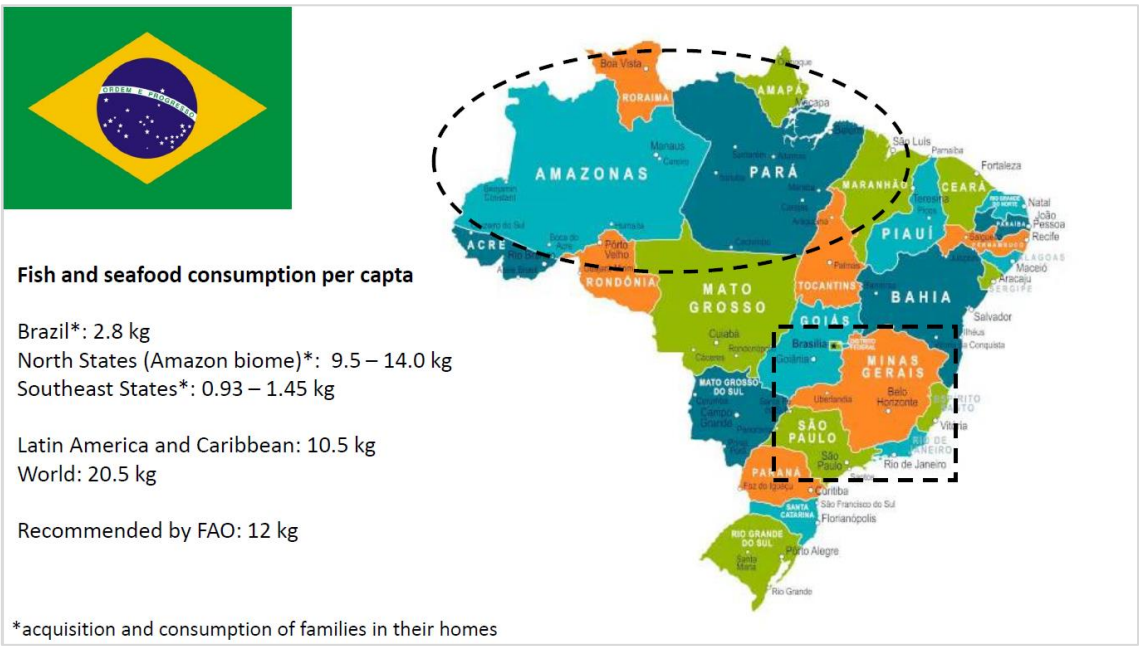
INTRODUCTION

Brazil is a continental country with low fish consumption. The exception is the North Region (Amazon) because to the local culture and people's relationship with rivers and fishing.

Recent results of a survey by the Brazilian Institute of Geography and Statistics (IBGE) on household budgets (2017-2018) showed that Brazilians household fish consumption was 2.8 kilograms per capita annual. This number is much lower than that indicated by the FAO-UN of 12 kg/per capta/year.

While the North Region (Amazon) has fish consumption ranging from 9.5 to 14 kg/per capta/year. But Southeast Brazil (where 45% of the population is concentrated) has problems with fish availability and has low per capita consumption rates (0.93 to 1.45 kg/ha/year).



Fresh Tambaqui is an important product purchased by families that alive in the North, Northeast and Central-West regions. However, in the Southeast, Fresh Tilapia and Frozen Tilapia Fillets are the main type of fish consumed by families in the 'Freshwater Fish' category.

Aquaculture production has increased every year in the last decade, especially fish farming (50% growth in 10 years) while the supply chain and product offering to consumers have also expanded. Tilapia is the main type of fish raised in Brazil and our country is currently the fourth largest producer in the world (579 thousand tons).

Although still far from its production potential, Brazilian aquaculture is on its way to reaching a new level in the international market with the increase in exports of shrimp and fresh tilapia.

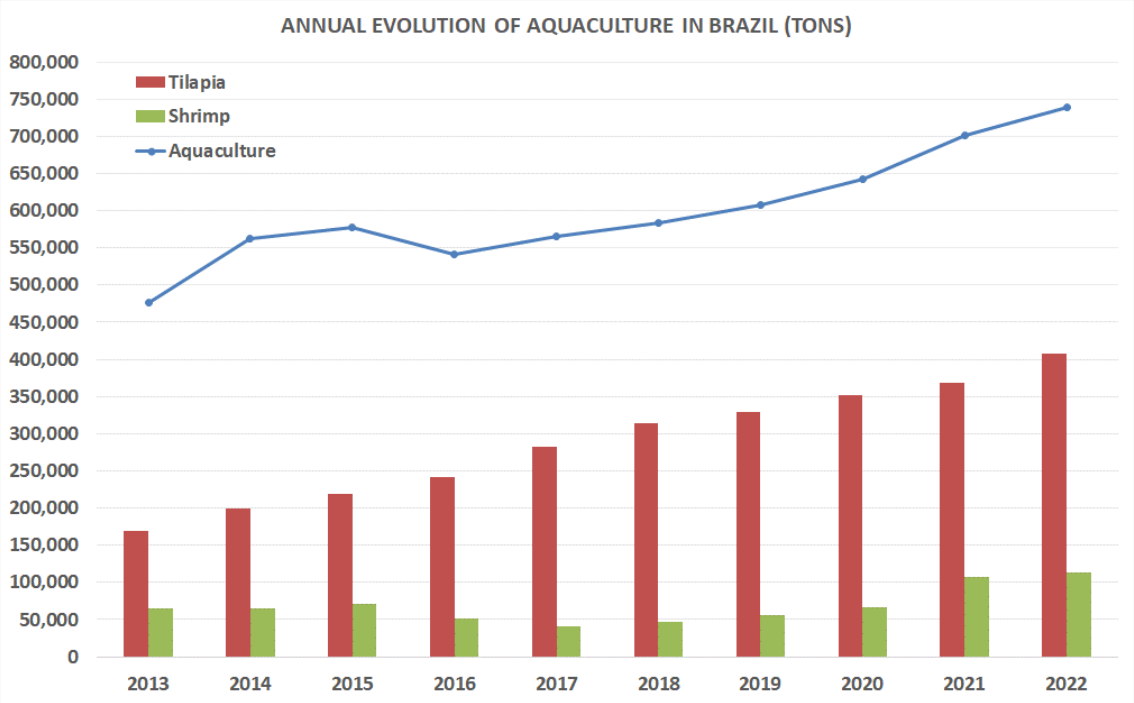


Figure 1. Annual evolution of aquaculture production in Brazil (tons).

Brazil has 200,000 freshwater fish farms, around 3,000 marine shrimp farms and around 100 Aquaculture Research Institutions, and a large domestic market is available for edible fish and shellfish, ornamental fish, bait fish and young fish raised in incubation for "bio mitigation" purposes. The biggest challenge for Brazil is to develop production

protocols that support a perennial industry, in addition to expanding its production capacity and sustainability.

The fish farming agrifood system has undergone a consistent expansion motivated by institutional and, mainly, organizational changes, which stimulated the increase in the production and commercialization of tilapia in the form of fillets and other cuts, but also of other fish species, such as Tambaqui, Brasilina Catfish, Pacu, Pirarucu, American Trout and Pangasius.

In addition to Tilapia, we have great potential for the production of tropical native fish and also the American Trout (USA) [1].

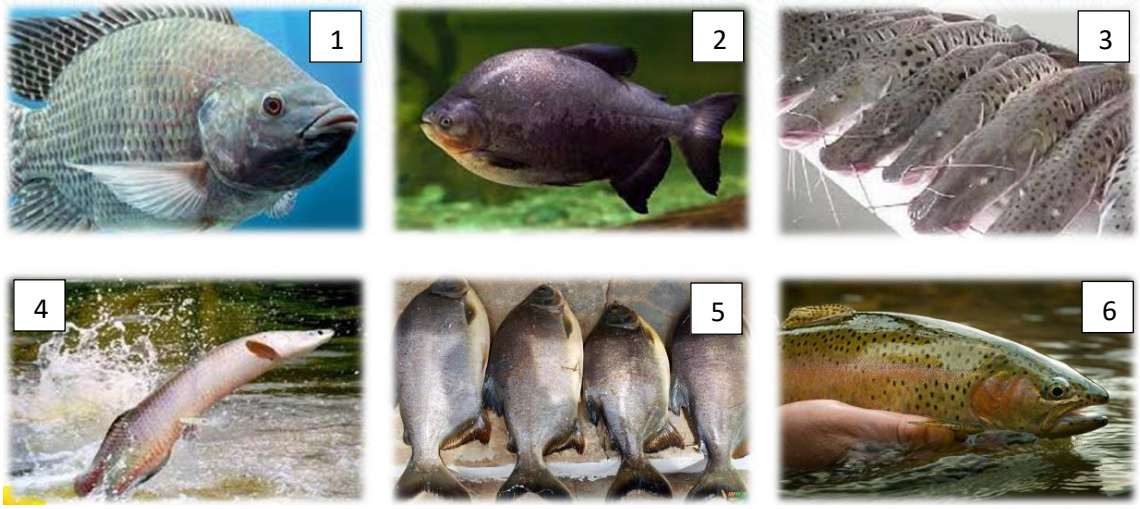


Figure 2. Species in Brazilian fish farming.

The young forms are raised in excavated tanks and RAS. The growth and fattening phases of these fish are carried out in net cages in the reservoirs of large national rivers (up to 60 kg/m3) and in excavated tanks using oxygen supplementation (up to 16 kg/m3). They are fed with nutritionally complete extruded feed. Brazil does not have marine aquaculture of fish, but only of oysters, scallops and mussels.

[1] 1. Tilapia (*Oreochromis niloticos*); 2. Tambaqui (*Colossoma macropomum*); 3. Brasilian Catfish (*Pseudoplatystoma corruscans*); 4. Pirarucu (*Arapaima gigas*); 5. Pacu (*Piaractus mesopotamicus*); Amercan Trout (*Oncorhynchus mykiss*).

Figure 3. Ways production in Brazil: cages or excavated tanks.

Fish farming represents only 1% of the Brazilian rural economy, but it adds value in the form of animal protein in areas with ample water availability in rivers and hydroelectric dams in the interior.

Like the agriculture and livestock farming, Brazilian fish farming is spatially concentrated in well-defined urban agglomerations. These agglomerations are distributed throughout the interior of Brazil and are far from large cities. Another important factor is that the “regional specificity of production” is always associated with a structuring of the supply chain, processing, distribution, cooperation, interaction and innovation.

Thus, this study analyzed the participation and relative importance of fish farming in the economy of rural areas in Brazil.

METODOLOGY

This analysis essentially uses the index of spatial specialization of production called “locational quotient” (LQ). In Brazil, this indicator was used in studies related to industrial concentration and also on specialization in rural production.

The mathematic model was used to calculate the LQ:

$$QL = \frac{(PV\_Fish\ Farming_j \div PV\_Fish\ Farming\ \_BR_{\square})}{(Agriculture\ GVA_j \div Agriculture\ GVA\_BR)}$$

Were:

$PV\_Fish\ Farming_j$ = value of fish farming production in the geographic middle region “j”;

$PV\_Fish\ Farming\ \_BR$ = value of fish farming production in Brazil;

$Agriculture\ GAV_j$ = gross value added of agriculture[2] in the meddle region “j”;

$Agriculture\ GAV\_BR$= gross value added of agriculture in the Brazil.

The LQ value was obtained based on the relationship between the ratio of the values of fish farming production in a given meddle region and the value of national fish farming production; and the ratio between the gross value added of agriculture in a given meddle region and the total gross value added of agriculture in Brazil. This is only for the year 2021.

The 15 main meddle regions producing fish from aquaculture in Brazil were analyzed, namely: West Parana, East Rondonia, San Francisco Pernambuco, North West Sao Paulo, South-Central Mato Grosso, East Mato Grosso do Sul, Central Minas Gerais, North Mato Grosso, South/Southwest Minas Gerais, East Alagoas, East Tocantins, Northwest Rio Grande do Sul, South Santa Catarina, North Maranhao and Southeast Para. These locations correspond to 54% of the Value of Production from fish farming in Brazil.

Then, the results of middle regions with LQ≥2.0 will be used with other variables that composed the mathematical calculation of LQ (PV_Fish Farming_j and PV_Fish

[2] This term includes the production value of the agriculture, livestock, planted forest and fish farming.

Farming _BR) to support a tree clustering analysis. The agglomeration algorithm chosen was Complete Linkage using the Euclidian Distance measure. To graphically represent the obtained clusters, a dendrogram displayed in the vertical diagram model was used.

RESULTS

The LQ results cannot be compared with each other, because despite having two common variables, the other two distinct variables make each QL result unique and directly related to its geographic space of origin. Therefore, they deal with the level of geographic specificity of fish production to the detriment of other agricultural and livestock activities in that analyzed territory.

Meddle regions with LQ≥2.0 have a relationship between the value of fish farming production and the value of rural production more than twice as high as that presented by Brazil as a whole, distinguishing them in the research as geographically specialized.

Among the 15 rural areas analyzed, 09 of them presented LQ ≥2.0 with a large difference in relation to the participation of fish farming in the local economy (2.2 to 12.6%).

The highest index was that of San Francisco Pernambuco (QL=14.19) located in the Northeast region. The rural areas of North Maranhao (7.90), East Rondônia (6.65) and East Tocantins (2.45) located in the Amazon biome, as well as the others, are far from the most developed region with the highest population density in Brazil (southeast).

Another 06 rural areas did not present significant QL because the fish farming was not considered an important economic activity locally.

Table1. Participation of the value of fish farming production in the gross added value of agriculture in nine specialized middle regions (2021).

	LQ	Agriculture GAV *	PV_Fish Farming *	Participation in Add Value
West Parana	8,19	1,829,654	133,096	12,6%
East Rondonia	6,65	1,315,974	77,661	7,3%
North West Sao Paulo	4,04	845,032	30,311	7,0%
East Tocantins	2,45	784,867	17,109	5,9%
South Santa Catarina	3,35	543,676	16,149	5,0%
South-Central Mato Grosso	5,59	433,272	21,502	5,0%
Central Minas Gerais	5,59	407,720	20,228	3,6%
Sao Francisco Pernambuco	14,19	266,145	33,524	3,0%
North Maranhao	7,90	214,124	15,029	2,2%

* 1,000 EUR; 1 EUR = R$6.00 (BRA)

Source: survey results

The results confirmed the relative importance of the medle regions of West Parana (Tilapia) and East Rondonia (Tambaqui), with respectively 12.6% and 7.3% of participation in the gross added value of agriculture in these territories, but also of the production activity of Tilapia and its fry in the mesoregion of North West Sao Paulo (7%) which has a gross added value above EUR $1 billion.

The cluster analysis shows us the formation of three main and well-defined clusters formed by the localities of West Parana and East Rondonia, which are the main producers of fish from fish farming in Brazil; localities of North West Sao Paulo and East Tocantins with an intermediate participation of fish farming in the local rural economy; and the other five meddle regions that form the third cluster.

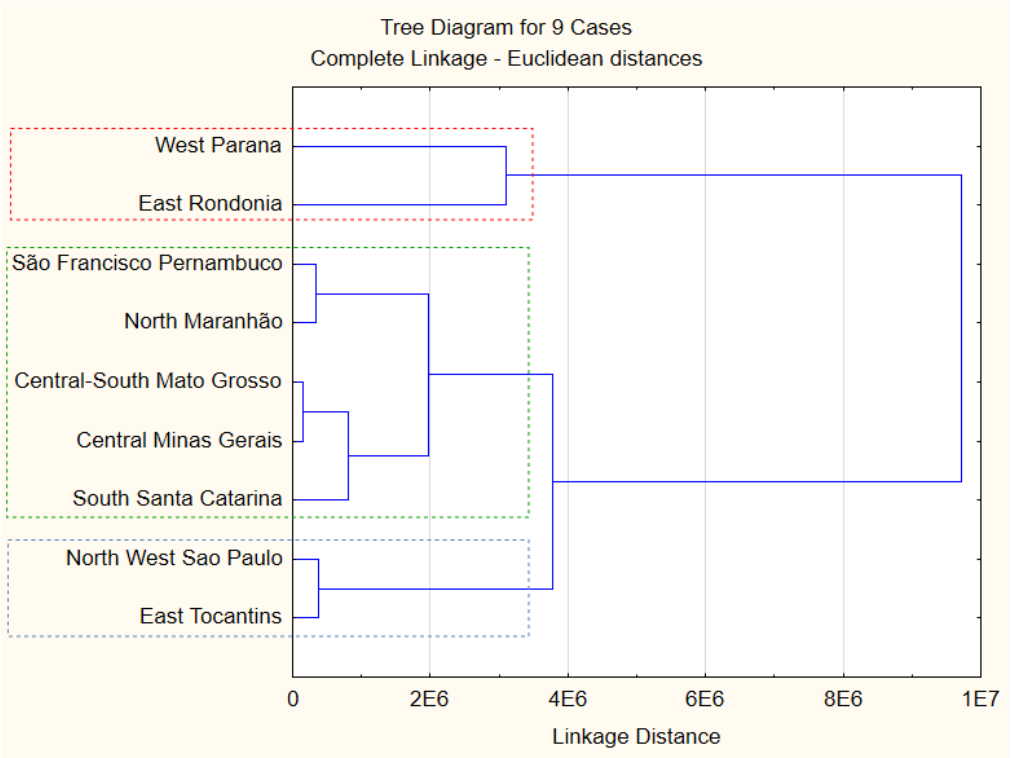


Figure 4. Cluster analysis (tree diagram) for 9 middle regions in Brazil with three clusters.

Figure 5. Geographic distribution of the three clusters in Brazil.

CONCLUSION

Fish farming has contributed to the economic growth of peripheral rural areas in Brazil.

The expansion of fish farming, supported by increased consumption by people in Brazil and increased exports, combined with the strengthening of specific complementary activities in the locations analyzed, may contribute to increasing the relative participation of this business in the local economies of several rural areas in Brazil.

ACKNOWLEDGEMENTS

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