AQUACULTURE OVERVIEW - BRAZIL

Tilapia Farming – Furnas Reservoir (MG) ; Source: MPA

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1 Executive Summary

Brazil is believed to be a promising market in aquaculture and fishing in the near future. Traditionally, the country has been one of the world’s largest producer of poultry, beef and pork. But the demand for fish is growing, encouraged by the Brazilian government. Compared to fish consumption worldwide (close to 18 kg/person/year), consumption by the average Brazilian is low. And the aim of the government is to have the average citizen consume 14 kg of fish per year.

However, the fishing activities have not been increasing. Meaning that the increase in demand and supply for fisheries are mainly related to increases in the aquaculture activity and imports. Brazil is the largest importer of fish in the Latin American region. And to satisfy demand, the country imports fresh, frozen, dried/salted fish and mollusks.

Opportunities for suppliers of both services and equipment for aquaculture in Brazil will increase and to monitor the market is very important in order to guarantee a prominent position as trusted partner.

The following Market Report has as its objective to give an overview of the Brazilian aquaculture, including available information about the production and types of species farmed in different parts of the country. It is important to mention that Brazil lacks an accurate system for collecting information in the field. The last official data available for the aquaculture segment was published by MPA in 2010, and the market players believe that the result mostly did not reflect the actual market characteristics. Different sector associations and consultancy companies have been publishing data and studies to verify the production informed by producers and technicians for some production areas. By using their own methodology to try to reflect the segment reality, the survey results most of the time exceed official estimates. An accurate and official picture of the market is so far a challenge. This report has used data from different sources to clarify general questions, in special the studies published by Panorama da Aquicultura Magazine and performed by Aqua Imagem.

Along Section 3, IN Brazil concisely describes the Brazilian production with estimates of farmed species. Data considering the regional concentration by major species provide information on production sites of the different species. Details of the Brazilian fish farming and its systems are described on Section 4. Since tilapia is the main species fish farmed in Brazil, special attention is given to data concerning the characteristics of tilapia fish farming production. Also, Section 4 shortly describes farming of other fish, fresh water and shrimp species.

Section 5 gives information on limiting factors for the fish farming activity and its technical challenges. Specific important data of shrimp and fish farmers is revealed. It is interesting to notice that these producers tend to have different opinions and give different importance to different limiting factors for their production. For Section 6, ther report briefly describes the R&D mains players and the need to improvement on research conditions in Brazil. It outlines the main species and the subjects/areas where there is active research participation. The interaction between academia and industry is also addressed and judged not to be satisfactory by both researchers and Professors. And all market players affirm that limited cooperation does not create an optimum application of resources and that there is an immediate need to change this.

IN Brazil believes that the information offered along this report shall give basis for analysis of the Aquaculture market in Brazil. IN foresees a need to a second phase report to describe more in details certain opportunities for the Norwegian industry. In Brazil, aquaculture offers the largest potential to increase fish supplies and definitely technology development will be needed.
2 Introduction

Brazil has experienced a decade of economic and social progress from 2003-2013 in which over 26 million people were lifted out of poverty and inequality was reduced significantly. However, recently the country is going through a challenging period both in economic and political terms. The year 2015 is marked by recession and small growth is expected for 2016 and 2017.

Different sectors of the Brazilian economy have shown signs of stagnation. Nevertheless when it comes to the aquaculture sector, fish farmers expect increase in production despite of water shortage in the Northeast and Southeast Brazil and not favorable economic conditions.

Brazil has very positive conditions for the development of aquaculture. It is a country of tropical climate with a strong domestic market – largest market in Latin America. It has a large and well developed agriculture sector, occupying a special position when it comes to production of grains, and a solid feed production industry. And in addition, the country has a large supply of fresh water and areas for pond construction, there are 8.500 km of coastal line and 4.2 million hectares of reservoirs that can be used for aquaculture.

Historically, the country has been one of the world’s largest producer of poultry, beef and pork. In 2014, Brazil produced 12,7 million ton of poultry, 8,2 million ton of beef and 3,4 million ton of pork. However the fishing activities have not been increasing. Meaning that the increase in demand and supply for fisheries are mainly related to increases in the aquaculture activity and imports.

- Brazilian Aquaculture Production – 2007 to 2014:

![Graph of Brazilian Aquaculture Production](image)

Source: Seafood Brasil - MPA and PEIXEBR

Considering the average annual growth rate of the animal protein industry in Brazil for the period of 2004 to 2014, the aquaculture production has experienced the fastest growth with an annual rate of 8%. And Tilapia is the most important species cultivated with an average growth of circa 14% for the same period.
Brazil is currently considered an attractive market for the years to come, and consequently the sector has received national and international investors looking for opportunities both in fish farming but also in all directly related activities such as fish feed production, vaccines and medication, genetics and supply of equipment and services.

3 Aquaculture – Brazilian Production

Aquaculture in Brazil is the second largest in South America, being Chile the largest producer.

Until 2008 the official statistics produced in Brazil were organized and published by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources), but since 2008 the responsibility was transferred to MPA (Ministry of Fishing and Aquaculture), recently extinguished. The most recent official statistics produced by the MPA are from 2010.

According to the official statistics, fish farming production is estimated to total 479,400 tones. And from this total, 82% come from fresh water aquaculture. It is believed that during the last 10 years there has been an average increase of 8% per year on the Brazilian fish farming activity.

Based on the fact that official statistics in Brazil do not reflect the real production of the aquaculture sector, some efforts from private consultancy firms on estimating the farming production need to be considered. For example, it is interesting to mention that the consultancy firm Acqua Imagem has along the years conducted a research with aquaculture producers. The numbers for 2014 show that freshwater finfish aquaculture was estimated at 486,000 ton, marine shrimp production of 90,000 ton, production of mussels of 20,000 ton, in addition to an estimated 4,000 ton of other aquatic animals such as oysters, freshwater shrimp, marine finfish and seaweeds. Meaning that Aqua Imagem estimates a Brazilian aquaculture production of around 600,000 ton in 2014.
• Estimates of species farmed in Brazil – 2014 (t):

![Pie chart showing species farmed in Brazil](chart.png)

Source: Aqua Imagem

Considering that Brazil is a country of continental size, production sites of different farmed species can be found in different regions of the country.

• Aquaculture – Regional Concentration by Major Species:

![Map showing aquaculture areas in Brazil](map.png)

Source: Aqua Imagem

When it comes to freshwater finfish, its farming can be found all over the country, Tilapia still the main fish farmed species – accounting for 54% of the total. The largest Tilapia production clusters are concentrated in the west region of the State of Paraná (excavated ponds) and in large reservoirs located on the Southeast and Northeast of Brazil (net cage). In the Southeast the cages are more concentrated in the reservoirs along the course of São Francisco (Sobradinho, Itaparica, Moxotó and Xingó) and along the Jaguaribe River (Lake Castanhão and Lake Orós).
The culture of roundfish is expanding rapidly and major producers are located in Midwest (State of Mato Grosso) and North (States of Rondónia, Tocantins, Roraima, Amazonas, Acre and Pará) Regions of Brazil. In addition to these States, you can also find some production site of less importance in terms of volume in the States of: Maranhão, São Paulo, Piauí, Bahia and Mato Grosso do Sul. The States of Mato Grosso and Rondónia account for almost 50% of the Brazilian production. It is interesting to mention that Rondónia is a State with large water supply and availability of grains due to its proximity to Mato Grosso which is the main producer of soybean and corn in Brazil.

The marine shrimp farming is mainly concentrated on the Northeast along the coast (States of Ceará, Rio Grande do Norte, Bahia and Piauí), and inland on low salinity areas (States of Ceará, Rio Grande do Norte, and Paraíba).

- Fish Farming Production in Brazil – Region and State indicators:

<table>
<thead>
<tr>
<th>REGION/STATE PRODUCTION 2014</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH</td>
<td>123,500</td>
</tr>
<tr>
<td>Rondônia</td>
<td>40,000</td>
</tr>
<tr>
<td>Acre</td>
<td>5,000</td>
</tr>
<tr>
<td>Amazonas</td>
<td>23,000</td>
</tr>
<tr>
<td>Roraima</td>
<td>20,000</td>
</tr>
<tr>
<td>Pará</td>
<td>15,000</td>
</tr>
<tr>
<td>Amapá</td>
<td>500</td>
</tr>
<tr>
<td>Tocantins</td>
<td>20,000</td>
</tr>
<tr>
<td>NORTHEAST</td>
<td>113,500</td>
</tr>
<tr>
<td>Maranhão</td>
<td>20,000</td>
</tr>
<tr>
<td>Piauí</td>
<td>13,000</td>
</tr>
<tr>
<td>Ceará</td>
<td>33,000</td>
</tr>
<tr>
<td>Rio Grande do Norte</td>
<td>3,000</td>
</tr>
<tr>
<td>Paraíba</td>
<td>1,000</td>
</tr>
<tr>
<td>Pernambuco</td>
<td>10,000</td>
</tr>
<tr>
<td>Alagoas</td>
<td>2,500</td>
</tr>
<tr>
<td>Sergipe</td>
<td>6,000</td>
</tr>
<tr>
<td>Bahia</td>
<td>25,000</td>
</tr>
<tr>
<td>SOUTH</td>
<td>123,000</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>25,000</td>
</tr>
<tr>
<td>Espírito Santo</td>
<td>11,000</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>4,000</td>
</tr>
<tr>
<td>São Paulo</td>
<td>50,000</td>
</tr>
<tr>
<td>Paraná</td>
<td>75,000</td>
</tr>
<tr>
<td>Santa Catarina</td>
<td>30,000</td>
</tr>
<tr>
<td>Rio Grande do Sul</td>
<td>18,000</td>
</tr>
<tr>
<td>MIDWEST</td>
<td>128,800</td>
</tr>
<tr>
<td>Mato Grosso do Sul</td>
<td>20,000</td>
</tr>
<tr>
<td>Mato Grosso</td>
<td>75,000</td>
</tr>
<tr>
<td>Goiás</td>
<td>33,000</td>
</tr>
<tr>
<td>Distrito Federal</td>
<td>800</td>
</tr>
<tr>
<td>TOTAL</td>
<td>578,800</td>
</tr>
</tbody>
</table>

Source: Seafood Brasil – Anuario (PEIXEBR data from 2014)

4 Aquaculture Activities in Brazil

Along this section, IN Brazil aims to present a concise description of the Brazilian Market and its main fish farming production. General market features, including last official statistics and inferred numbers from existing research studies are presented. Special attention is given to data concerning the characteristics of Tilapia fish farming production including geographical area of Brazil, since it is the largest farmed species in terms of volume.

On the last subsection of this chapter, it is presented an overview of types of systems used on fish farming in Brazil. Please note that the result is from Aqua Imagem study produced in 2010/2011. There are no official studies on this.
4.1 Fish Farming: Tilapia

Tilapia is the main species fish farmed in Brazil – accounting for 54% of the total – and its commercial production can be found all over Brazil, both in net cages and in excavated ponds. According to Aqua Imagem, in 2014 Brazil produced 260,000 ton of Tilapia - 31% increase from 2011 estimates.

The massive production of male fingerlings, the introduction of net cages, the usage of brood stock with genetic potential, the development of higher quality fish feed, the utilization of larger reservoirs and the supply of high added value products such as fillets have become important factors for the expansion of Tilapia fish farming in Brazil.

- Percentage of Production by Fish Farmed Species in Brazil:

![Percentage of Production by Fish Farmed Species in Brazil](image)

Source: MPA - 2010

The official Brazilian numbers consider as main producing regions for Tilapia the South and Southeast of the country. These two regions would account for 61% of the total national production. The Northeast and Midwest Regions total together 30% of the national production, and the North Region has the smallest participation with 9%.

Tilapia has been initially introduced in Brazil through the Northeast Region, but the rational creation developed in Paraná (South). For some years Paraná had been the main producer of Tilapia in the country, and still today one of the leading fingerling suppliers for the other regions of the country.

Different Regions/States of Brazil have along the years been large producers of Tilapia. However, even if the Northeast is currently the largest producer, it is important to mention that Brazil as a whole has been constantly increasing its production.

- Aquaculture by Region of Brazil (%):

<table>
<thead>
<tr>
<th></th>
<th>MIDWEST</th>
<th>NORTHEAST</th>
<th>NORTH</th>
<th>SOUTHEAST</th>
<th>SOUTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilapia</td>
<td>30,8</td>
<td>82,9</td>
<td>11,1</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Round Fishes</td>
<td>46,2</td>
<td>17,1</td>
<td>72,2</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Catfish</td>
<td>19,2</td>
<td>0</td>
<td>5,6</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Carp</td>
<td>0</td>
<td>0</td>
<td>5,6</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Other Species</td>
<td>3,8</td>
<td>0</td>
<td>5,6</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Acqua Imagem – online Research 2011
The Tilapia aquaculture is the most consolidated fish farming type in Brazil. And following the same trend of the general aquaculture industry, it has increased along the last 10 years.

- Production of Tilapia in Brazil 1996-2013 (1000 tonnes):

![Graph showing production of Tilapia in Brazil 1996-2013](image)


When it comes to the national production of Tilápia, there are basically 3 main areas in Brazil: Northeast Region, Northwest Region of São Paulo State and West of Paraná State.

Considering the State of São Paulo, it is possible to say that it has definitely a prominent position in the recent years. In special the Northwest region of the State, mainly Santa Fé do Sul. In 2014, it is expected that 80% of the total production of São Paulo will come from the Northwest (66,000 ton).

The region has a favorable climate with water temperature ranging from 22 to 28°C, clean water from 3 large rivers (Tietê – 3 Reservoirs: Promissão, Nova Avanhadava e Três Irmãos / Grande – 2 Reservoirs: Marimbondo and Água Vermelha / Paraná – 2 Reservoirs: Ilha Solteira and Jupiá), and is close to large consumer markets and universities dedicated to technology development. In 2013, the industry located in Santa Fé do Sul stated a production of 15,000 ton along the year.

For the Northeast Region of Brazil there are two main production areas: the reservoirs of the São Francisco River, in special Paulo Afonso (BA), and the State of Ceará (Castanhão, Orós and Sítios Novos). Ceará is currently the largest producer and consumer of Tilápia in Brazil.

It is relevant to mention that there are Tilápia production in other northeast States of Brazil but not as expressive as the ones present in Ceará and Paulo Afonso/BA.

In the South region, Tilápia can be found in Paraná and more recently in Santa Catarina State.

The State of Goiás, Midwest of Brazil, has also been increasing its production. The most important area located in Lake of Serra da Mesa. In addition, Minas Gerais state has shown potential through its reservoirs of Furnas and Três Marias. It is believed that soon these new areas may become a 4th major area in the Tilapia production map of Brazil.

Each production area has its own characteristics. Methods that can be applied to one region may not function well in another one. There are differences in climate, water availability, price of fish feed, final sale price, logistics and consumer habits. And each region seems to have found its ways to adapt to the conditions and the producers seem to be relatively satisfied with their activities.
Small producers are developing activities in all the 3 main regions. The large producers have been in its majority increasing its numbers and sizes of net cage. Investment in technology, turning the process more mechanical, is noticed in special in the Northwest region of SP.

- 3 Main Production Areas of Tilápia in Brazil:

When it comes to prices, fish feed is what makes the northeast production more expensive. In many cases the cost of freight to send the finished product from the southeast region to the northeast is equivalent to the difference of price to buy the raw material in the northeast.

In terms of production systems, until the end of the 90s, the aquaculture activity of Tilapia in Brazil used to follow a semi-intensive model with excavated ponds and ponds located in reservoirs. Since the year 2000, fish farmers started to produce in net cages, especially in waters belonging to the Union - inside large hydropower plant reservoirs. And since then, the production of Tilapia has been increasing.

In the Northeast Region of Brazil and the Northwest Region of SP the tanks are usually from 6 to 20 m³. However, it is also more common now to find net cages from 240-300 m³ as used for the salmon aquaculture in Chile. Or even the larger ones of 1,600 m³. In Santa Fé do Sul/SP, it is possible to see a tendency for usage of this type of large volume cages. Cages can be found at Ilha Solteira, Jupiá, Água Vermelha, Marimbondo, Nova Avanhandava, Três Irmãos and Promissão.

When it comes to the production of Tilápia in Paraná, the excavated ponds are the predominant method. Nonetheless, in the north of Paraná the net cage is very much used in the hydropower plant reservoirs along the Paranapanema River.
Main Brazilian Production Areas – estimated value (ton):

<table>
<thead>
<tr>
<th>Area</th>
<th>State</th>
<th>System</th>
<th>Volume per 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservatório de Itaparica</td>
<td>BA/PE</td>
<td>Net-cage</td>
<td>24,000</td>
</tr>
<tr>
<td>Reservatórios de Castanhão e Oró</td>
<td>CE</td>
<td>Net-cage</td>
<td>18,500</td>
</tr>
<tr>
<td>Oeste do Paraná</td>
<td>PR</td>
<td>Excavated pond</td>
<td>16,500</td>
</tr>
<tr>
<td>Reservatório de Ilha Solteira</td>
<td>SP</td>
<td>Net-cage</td>
<td>14,000</td>
</tr>
<tr>
<td>Furnas</td>
<td>MG</td>
<td>Net-cage</td>
<td>6,500</td>
</tr>
</tbody>
</table>

Source: AP-Tilapia and MPA- Aqua Imagem

It is important to mention that the year 2014 has been very challenging for the companies located in the State of São Paulo, due to the lack of rain. According to researchers it has been the worse in the last 100 years. The lack of rain together with the traditional winter dryness has produced a negative scenario in the reservoirs used for tilapia production. In Santa Fé do Sul, the activity dropped circa of 30% and can generate a loss up to R$ 30 million. Some of the producers of the region that were planning to increase its production capacity along the year have been experiencing exactly the opposite. The expectations foresee the production level reaching its normal level again only in 2016.

Therefore, it is relevant to bear in mind that the dry period for the fourth consecutive year in the Northeast Region of the country and the low level of the water in the Southeast Region reservoirs have been compromising the rate of expansion of the tilapia aquaculture in Brazil.

4.2 Fish Farming: Other Species

Freshwater Species

Colossoma and Piaractus (including tambaqui, pacu, pirapitinga and hybrids) are currently fish farmed in Brazil and have been increasing its farmed volume dramatically over the last 3 years. In 2011, the total production was estimated in 97,000 ton.

Most of the production and consumption are located in the North, Midwest Regions and in some states of the Northeast Region of Brazil. The largest consumer market for tambaqui is the city of Manaus – Amazon State.

However, estimates for the year 2014, account a total production of 186,000 ton. This dramatic increase is mainly due to the production of Rondônia and Mato Grosso. Mato Grosso started to implement a strategy of large production sites, taking into account large already existing ponds that permitted the increase of production area with minimum extra investment. In addition, other regions of Brazil expanded its production, such as the States of: Roraima, Tocantins and Maranhão.

In Brazil, these species are mainly farmed in excavated tanks and feeding activities depend on tractors, barges or boats. The harvesting activity is usually done by seine nets.

Marine Shrimps

When it comes to Marine shrimps (*Litopenaeus vannamei*), the Brazilian production has been oscillating among the last 10 years between 65-90,000 ton. The industry has gone through difficult periods facing challenges such as: diseases, flooding in important production areas, and etc. However, the year of 2014 estimated total produced volume is of 90,000 ton - finally reached the level of 2003 production.

Most of the marine shrimp farming is concentrated in the Northeast Region of Brazil followed by small scale production along the coast of Santa Catarina and Paraná States in the South Region of Brazil.
the country. The State of Ceará, Northeast Region, is the main producer accounting for almost 50% of the total production - 42,000 ton, followed by the State of Rio Grande do Norte.

In Brazil, despite of the presence of few large farms, most of the shrimp farming activity takes places in small and medium sized farms. The farming takes place in ponds and also can be found in low salinity waters. The fattening period of the farmed shrimp is performed in ponds with or without aeration, and usually the shrimps feed contains 35% protein. The feed can be placed in feed trays or simply be thrown in the areas. The harvesting is done by a combination of bag nets and water drainage of the ponds.

**Other Fish Species**

With a total production estimated in 40,000 ton, Carps, catfishes, Arapaima and Trout have also contributed to the Brazilian fish farming activity.

Mussels, mainly farmed in Santa Catarina State, accounted for 20,000 ton. And other species such as oysters, a small volume of marine fish (in special Cobia), freshwater shrimp (*M. Rosenbergii*) and seaweed accounted for 4,000 ton.

### 4.3 Fish Farming: Type of Farming System in Brazil

According to Aqua Imagem online study among fish farmers in Brazil, 55% of all the fish farmers that have answered the questionnaire use excavated tanks and ponds as their production method. Followed by 41% using net cages. Other 3% mentioned different production systems such as: water recirculation tanks or raceway tanks in a small production scale.

The roundfish farmers, mostly all use excavated tanks and ponds, even if it is known that net cages is also a method found in Brazil nowadays. Among Tilapia farmers, net cages can be found in special in the States of São Paulo, Minas Gerais, Ceará, Bahia and Pernambuco. However there still a large number of tilapia farmers using excavated tanks, mostly located in the States of Paraná and Santa Catarina.

Therefore it is possible to say that in general terms, the Midwest, North and South Regions mostly use the excavated tanks and ponds as methods of production. While in the Northeast and Southeast it is possible to find more net cages.

- Fish farming system by Region (%):

    ![Fish farming system by Region (%)](source: Aqua Imagem – online questionnaire)
5 Limiting Factors for the Fish Farming Activity in Brazil

There are a few different factors that are appointed by producers as limiting the increase of the aquaculture activities in Brazil.

Aqua Imagem has done a research with 350 producers willing to increase their production. The research was done in 2010 but the results can be very enlightening. Among the limiting factors for increase of production, the challenges to have an environmental license, the high cost of production, the lack of technical assistance and the not enough qualified labor force can be mentioned. An additional factor is the low interaction/union among producers, not making it able for them to have strong demands for specific policies of the sector – including common benefits like discounts in price of raw material and technical support. The importance of the mentioned factors varies according to each region of Brazil.

- Main limiting factor for expansion of Aquaculture in Brazil (scale from 0 to 5 in terms of importance):

```
<table>
<thead>
<tr>
<th>Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses from Diseases</td>
<td>2,1</td>
</tr>
<tr>
<td>Low Supply of High Quality Feed</td>
<td>2,45</td>
</tr>
<tr>
<td>Regional Market Limitations</td>
<td>2,54</td>
</tr>
<tr>
<td>Difficult Access to Technology</td>
<td>3,00</td>
</tr>
<tr>
<td>Low Prices paid to Producers</td>
<td>3,18</td>
</tr>
<tr>
<td>Few Credit Lines</td>
<td>3,19</td>
</tr>
<tr>
<td>Low Qualification of Labor</td>
<td>3,37</td>
</tr>
<tr>
<td>Insufficient Technical Assistance</td>
<td>3,40</td>
</tr>
<tr>
<td>High Production Costs</td>
<td>3,42</td>
</tr>
<tr>
<td>Challenges for Environmental Licensing</td>
<td>4,09</td>
</tr>
</tbody>
</table>
```

Source: Acqua Imagem – online research 2011

It is interesting to mention that shrimp and fish farmers tend to have different opinions about the importance of different limiting factors. Shrimp farmers see among the 5 most important limiting factors of expansion of shrimp culture in Brazil: the occurrence of diseases and the risk of shrimp imports. Therefore it is relevant to keep such factors in mind considering the amount of the efforts that the shrimp producers will spend lobbying against imports of shrimps from outside Brazil.

When it comes to fish farmers, high production cost is their main concern, and diseases do not play such an important role among their considerations. The limited water supply factor has recently began to be considered as important by producers. In special, the Tilapia producers located in the Northeast and Southeast regions of Brazil. The marine shrimp farmers producing in areas with low salinity waters have also expressed their concern with the actual and future availability of water since the lack of rain during the last 4 winters have occurred and contributed to consecutive years of drought.
Factors limiting the expansion of Aquaculture in Brazil – Marine Shrimp and Fish (scale from 0 to 5 in terms of importance):

Source: Acqua Imagem – 2015

6 Destination of Brazilian Aquaculture Products

Brazil, with its large population and limited fish farming activities, has become a net importer of seafood. Nowadays, more than 90% of the farmed species in Brazil are used to supply the internal market. Even with lack of official information, it is possible to see a decline of captured fisheries in Brazil. The increasing market demand is to be supplied by both the domestic aquaculture and the import of fisheries.

According to the official statistics (Secex/MDIC), in 2014 the country imported approximately 425,000 ton of fisheries and only exported 32,000 ton, that contributed to a deficit of US$ 1.3 billion in its international trade balance. The main suppliers of seafood to Brazil are Chile, followed by China, Vietnam, Argentina and Norway.

Brazilian Import of Fisheries by Country of Origen - Jul14/Jun15:

<table>
<thead>
<tr>
<th>Country</th>
<th>Volume (kg)</th>
<th>Country</th>
<th>Volume (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>92,624,992</td>
<td>Spain</td>
<td>5,587,869</td>
</tr>
<tr>
<td>China</td>
<td>82,879,902</td>
<td>Peru</td>
<td>5,224,114</td>
</tr>
<tr>
<td>Vietnam</td>
<td>43,638,157</td>
<td>USA</td>
<td>2,612,807</td>
</tr>
<tr>
<td>Argentine</td>
<td>36,449,505</td>
<td>Equator</td>
<td>1,382,162</td>
</tr>
<tr>
<td>Norway</td>
<td>25,485,507</td>
<td>Iceland</td>
<td>1,273,758</td>
</tr>
<tr>
<td>Portugal</td>
<td>11,953,567</td>
<td>Singapore</td>
<td>828,271</td>
</tr>
<tr>
<td>Oman</td>
<td>9,524,080</td>
<td>Japan</td>
<td>709,075</td>
</tr>
<tr>
<td>Taiwan</td>
<td>7,843,337</td>
<td>New Zeland</td>
<td>573,660</td>
</tr>
<tr>
<td>Morocco</td>
<td>6,877,919</td>
<td>South Africa</td>
<td>221,889</td>
</tr>
<tr>
<td>Uruguay</td>
<td>6,781,554</td>
<td>Canada</td>
<td>22,481</td>
</tr>
</tbody>
</table>

Source: Secex/MDIC
Today the small aquaculture producers usually make direct sales of fish or shrimp to the local consumers or wholesalers that make up a full truck load and distribute the products to regional traders or to processing plants. Larger aquaculture farmers sell their products directly to wholesalers or to processing plants. Some aquaculture companies have their own processing infrastructure and deliver their products directly to supermarkets, restaurants and fish markets. Farmed fish is also sometimes sold alive to companies generally located near large urban areas.

Brazil being a large and multicultural country also presents differences among its geographical regions when it comes to market preferences. And consequently it affects the type of supplied products. The South and Southeast region of the country demand premium products with higher aggregated value, such as: fillets and fish steaks. While in the North and Northeast Regions both farmed shrimps and fishes are sold mostly as a whole.

The demand for high aggregated value products have been increasing in large cities, what requires investments from the aquaculture companies to increase their production processing capacity or even pay to process their products in other plants. Due to the fact that the fishing activities have declined along the years, many processing units have spare capacity and as so are now depending on aquaculture products or even imported fish to reach a minimum volume of production to be economically viable.

The processing of aquaculture by-products into fish meal, fish oil and protein concentrates are expected to contribute more and more as source of protein, energy and essential nutrients to the feed industry – especially for the fish feed industry itself.

7 Aquaculture R&D in Brazil

R&D in Brazil usually involves as main stakeholders the MCTI (Ministry of Science, Technology and Innovation) and the MEC (Ministry of Education). These Ministries act through agencies such as CNPq (National Council for Scientific and Technological Development), FINEP (Funding and Financer of Studies and Projects) and CAPES (Coordination of Improvement of Higher Education Personnel).

CNPq works directly with scholarships grants and projects. FINEP as the Brazilian innovation agency is involved in funding programs and research projects (research proposer in specific research areas) and CAPES gives scholarships to undergraduate and postgraduate students and training for researchers – international scientific cooperation.
In addition, to Universities located in different areas of the country, an extremely important R&D player in Brazil is EMBRAPA (Brazilian Agricultural Research Corporation). It was founded in 1973 under the MAPA to be a technological innovation enterprise focused on generating knowledge and technology for Brazilian agriculture, fisheries and agricultural systems. It is distributed in 15 Central Units located in Brasília, 47 Decentralized Units in all regions of Brazil, 4 Virtual Laboratories Abroad (Labex), in the USA, Europe, China and South Korea and 3 International Offices in Latin America and Africa. Embrapa Fisheries and Aquaculture is one of the decentralized units and was created in 2009. Its headquarter is currently under construction and shall be located 8km north of Palmas (Tocantins State) and is over 6,000m² of constructed area that include offices, laboratories and etc. A team of 90 employees will be working at this new facility.

The last official sensus of 2012 done by the former MPA shows a total of 246 research projects in fisheries and aquaculture supported by public calls between 2003 and 2010. And according to CAPES data from 2012, there are a total of 195 research groups in aquaculture and fisheries in Brazil.
The recent research conducted by Aqua Imagem interviewed 188 researchers and professors working in the aquaculture sector. Based on the results of this research it is possible to affirm that most of the researchers are located in the Southeast and South Regions of Brazil. This fact seems to be correlated to the fact that most of the research and education institutions are geographically located in these regions.

- Researchers and Professors by Region of Brazil – 188 participants:

The conducted research appointed that there is a need for improvement on research conditions in Brazil. Researchers located in different regions of the country tend to evaluate their working conditions differently. The Regions of South and Southeast tend to concentrate traditional universities and research centers and as so have reasonable number of available resources for research activities These regions are leading in the scientific production.

However, other regions of the country need to be considered depending on the species to be researched. The Northeast has been investing a lot on working conditions for professionals of research institutions.

When it comes to the subjects/areas where the participants claim to have active research participation, more than 60% are dedicated to subjects related to the commercial fish farming in fresh waters. Marine commercial fish farming and shrimp farming are the following most mentioned segments.

Most of the researches are related to Tilapia and Tambaqui, and it is believed to reflect the economic importance of such species in Brazil. Among the research, among other mentioned species are: pintado, jundiá (Rhamdia quelen), pacu, pirarucu and bijupirá (marine species). When it comes to species of shrimps, the most mentioned are: the white pacific shrimp (Penaeus vannamei), the amazon shrimp and the Malaysian shrimp. Also, enw species have also been mentioned to be subject of research, such as: Pirarucu (mostly concentrated in the States of the North Region) and the Jundiá Cinza (cultivated in Rio Grande do Sul and Santa Catarina States).

It is interesting to mention that there is research taking place on reproduction of marine fishes with potential for commercial farming, such as: robalo (Centropomus sp.) and garoupa (Epinephelus marginatus).
Main species researched by the study participants:

Source: Aqua Imagem – Research 2012

Taking into account the areas of research, nutrition was mentioned 20% of the total times. Followed by production systems (17%) and patology of aquatic organisms (13%).

Main research areas mentioned by the study participants:

Fish feed has been one of the main research areas and considerable development has been achieved along the years. The quality of the supplied fish feed has definitely improved based on achievements on the fabrication process, knowledge of nutritional needs of the main species and larger understanding about the quality and formulation of the feeds (combination and usage of ingredients). The feed has in particular developed to fulfill the needs of fish farming in intensive production systems (like tilapia in net cages) and to make possible the farming of new species such as carnivorous fishes like pintado and pirarucu.

In terms of pathology for aquatic organisms, improvements have been achieved in production and also in the number of professionals active in the segment (research, laboratorial services and technical assistance).

The development of equipment, recirculation systems, larviculture and limnology are areas identified as where more resources can be dedicated. In addition to a special need for research on genetics and improvement of native species like tambaqui, pintado and pirarucu.
Interaction between academia and industry is judged not to be satisfactory by all participants from different regions of Brazil (ranging from 69-96% of total participants depending on the region). It seems that all agree that there is an immediate need for such actors to interact more in a professional basis.

- Evaluation of Researchers and Professors about the integration between the industry and the research institutions – by region of Brazil:

![Bar chart showing evaluation results by region]

Source: Aqua Imagem – Research 2012

The limited cooperation does not create an optimum application of resources. Research lines could be more efficiently dedicated to real needs of the industry creating a gain-gain situation. The industry could benefit from technology transfer.

Based on this observation it is possible to mention a few actions that could contribute to build an effective interaction between the academia and the industry:

- Investment in Research and Infrastructure: resources to finance research and lab Infrastructure in regions where there is a large potential for development of aquaculture (Midwest, North and Northeast Regions). In addition to public calls with focus on aquaculture, and increase of number of scholarships offered. It is also necessary to increase the investments on human resources to give support to researchers, such as: lab technicians and field technicians.

- Need to bridge the gap between the industry and the research centers: there is a need of focused research in order to solve real industry problems. Demands of the industry need to be taken into account and research results need to be accessible to the industry players.

- Integration between universities and research centers: this interaction is extremely necessary to increase the quality of the researches by promoting exchange of experience between different institutions. It is necessary to avoid parallel research projects on the same subject. There is a need for an integrated databank for national researchers.

- Straight the cooperation towards the governmental bodies: nowadays there are challenges in the interaction among industry players, research representatives and the different State and Federal
institutions. There is a need to development a continuous public policy to incentive the sector and to coordinate regional activities.

- Actions that can improve the development and the quality of the research in Brazil:

Source: Aqua Imagem – Research 2012

8 Conclusion

The future of the aquaculture in Brazil is dependent on many different factors. Historically, changes in economic and political factors create challenges for the productive sector in Brazil. The purchasing power of the population oscillates according to the policies adopted and its final consequences. For example, different exchange rates and inflation rates directly affect the choice of seafood products done by the consumers.

In general terms, in times of high inflation, depreciated exchange rate and unemployment, products of higher price, with higher aggregated value such as shrimps, tilapia fillet, Chilean salmon and codfish tend to be substituted for fishes and even meat of more competitive prices.

However, it is interesting to mention that opinions concerning such consequences can diverge among the market players due to the fact that the current supply of fisheries in Brazil still under the optimum level demanded by the domestic market. And even because of the different characteristics of the consumer market.

It is believed that will always be a market for certain premium products and also challenging economic times can bring different opportunities. For example in case of depreciation in the exchange rate, prices of imported seafood get more expensive, compensating the increase in costs of Brazilian aquaculture products. So cultured fish and shrimp in Brazil may even become more competitive against imported seafood products. In addition, such exchange rate fluctuation may bring good perspectives for exporting aquaculture products.

Recently it is also necessary to consider the water crisis of the Southeast and Northeast region of Brazil and its impact in the national aquaculture industry. There have been 4 years of water drought.
The reservoirs of the Southeast region of Brazil have been heavily affected by the lack of rain. Lake of Furnas and Lake Ilha Solteira had their reservoirs activities suspended and even the lakes of Minas Gerais and São Paulo states are operating in reduced water levels.

In reservoirs of the Northeast, the expansion of fish farming activities is quite challenging, especially in the states of Ceará, Piauí, Rio Grande do Norte and Paraíba. Nowadays most of the Ceará production ended up being concentrated in the Lake Orós and Lake Castanhão due to the fact that other reservoirs have dried up. For the States of Pernambuco and Bahia, the production has not been affected so far in the reservoir of the São Francisco River. However, it is important to pay attention to the water levels of the lower reservoirs of São Francisco Valley that can be soon impacted.

Considering that the Brazilian government has not implemented so far a strategy to diversify its dependence on the hydropower to generate energy. Both agriculture and aquaculture will need to look for alternative production methods that shall be less dependent of water and consider more efficient use of it.

Aquaculture producers have started to recognize the value of discharged water from ponds in conditions of reduced water availability. They see the need to adequate its traditional cultivation methods adopting practices and structures that enable a more efficient usage of discharged water, even considering its reuse. It is believed that more intensive system with treatment and recirculation of water will become more popular. In the long and medium term, sea farming may become a more attractive alternative.

It is strongly believed that changes in the fisheries and aquaculture sector are happening and in short term, Norwegian technology will be able to be applied to the aquaculture industry in Brazil, in special for Tilapia. Also, the future development of Brazilian marine fish farming may bring Norwegian players together with tilapia and tambaqui Brazilian fish farmers to work on such aquaculture diversification.

R&D is an area of continuous development and innumerable possibilities and there are already a few examples of cooperation between Brazil and Norway. The need of interaction between the academia and the private industry is clearly demonstrated by Brazilian researches. The R&D in Brazil needs to happen based in industry demands. At least it is clear that both the industry and the scientific community see the need of working together.

And last is the fact that the Ministry for Fisheries and Aquaculture has been extinguished in September 2015 in order to level public financing. Now its activities have been incorporated by the Ministry of Agriculture, Livestock and Food Supply (MAPA) and it is necessary to wait and see the power that such department will be able to attain inside a larger structure. Before its dissolution, MPA launched the Development Plan for Aquaculture 2015-2020. And if such ideas and activities will take place in the near future is too early to tell at this point (PDA details see Annex).
9 Acronyms and Abbreviations – Species Scientific Names

ABCC: Brazilian Association of Shrimp Farmers
CAPES: Coordination of Improvement of Higher Education Personnel
CNPq: National Council for Scientific and Technological Development
DIA: Farming Industrial District
EMBRAPA: Brazilian Agricultural Research Corporation
FINEP: Funding and Financer of Studies and Projects
IBAMA: Brazilian Institute of Environment and Renewable Natural Resources
IBGE: Brazilian Institute for geography and Statistics
MAPA: Ministry of Agriculture, Livestock and Food Supply
MCTI: Ministry of Science, Technology and Innovation
MEC: Ministry of Education
MPA: Former Ministry of Fishing and Aquaculture
PDA: Development Plan for Aquaculture 2015-2020
PeixeBR: Association of Fish Farmers and Fish Processors
UD: Demonstrative Unit

Species Scientific Names:
Tambaqui - Colossoma Macropomum
Jundiá - Rhamdia quelen
Pintado - Pseudoplatystoma sp.
White Pacific Shrimp - Litopenaeus vannamei
Pacu - Piaractus mesopotamicus
Pirarucu - Arapaima gigas
Bijupirá - Rachycentron canadum
Curimatãs - Prochilodus sp.
Surubim - Steindachneridion sp.
Rã-Touro - Lithobates catesbeianus
Lambari - Astyanax sp.
Carp - Cyprinus carpio
Amazon Shrimp - Macrobrachium amazonicum
Robalo - Centropomus sp.
Piraputanga - Bricon orbignianus
Malaysian Shrimp - Macrobrachium rosenbergii
Matrinxã - Brycon amazonicus

The extinct MPA announced in August 2015, the Development Plan for Aquaculture 2015-2020 (PDA). The Plan main objective is to increase the aquaculture production in Brazil aiming to reach 2 million tons of fisheries by the year 2020. According to the PDA, the different species are expected to achieve the following total production: Fish - 1,750.00 t; Shrimps - 200.000 t; Mussels - 40.000 t; and Oysters 10.000 t.

The PDA requires investments of BRL 500 million in its different projects for the period of 2015-2020. The expectations of the Brazilian government is to generate from this investment BRL 8 billion by increasing the aquaculture production in 1.5 million t.

<table>
<thead>
<tr>
<th>Farmed Specie</th>
<th>Production – ton (2013 MPA)</th>
<th>Production Goal for 2020 – ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>393.493</td>
<td>1.750.000</td>
</tr>
<tr>
<td>Shrimp</td>
<td>64.669</td>
<td>200.000</td>
</tr>
<tr>
<td>Mussels</td>
<td>19.360</td>
<td>50.000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>476.522</strong></td>
<td><strong>2.000.000</strong></td>
</tr>
</tbody>
</table>

In order to reach the goals of production, MPA has defined that a few activities should take place:

- Work towards the different State governments and its environmental entities in order to simplify/speed the process of acquisition of environmental license for aquaculture;
- Speed the process for concession of water usage under the domain of the Union for aquaculture purposes;
- Create a network of institutions for environmental monitoring of the aquaculture activities performed in Union waters;
- Create mechanisms that can manage aquaculture areas and parks that enable active group management of such enterprises;
- Review the Decree 4895 – 25Nov2003, that rules the “authorization to use waters under the domain of the Union for aquaculture purpose”
- Support entities responsible for technical assistance and aquaculture extension;
- Perform work towards financial institutions in order to facilitate access to credit for the aquaculture production chain;
- Give support to the sector in terms of educating producers, technicians and workers in terms of Good Practices in Biosecurity – handling and measures;
- Foment the production chain in order to increase the participation and integration of SMEs and large producers, for the purpose to make possible access to technology, and in special credits for investment and commercialization of products;
- Give support to shrimp farming inland by identifying priority areas for production;
- Give support to research in areas such as: genetics, nutrition, reproduction, control of diseases, new production technologies, management and commercialization of productive units;
- Establish demonstration units of new technology for fish and shrimp farming with less usage of water, bioflocs and usage of alternative sources of energy;
- Establish demonstration units for algae farming (micro and microalgae), ornamental fisheries, aquaponic, frog farming, shrimp farming in inland waters of different regions of the country, that shall work as training center for interested public;
- Implement the PDA under the Programs of Amazonia Legal and Semiárido Brasileiro through:
Identification and diffusion of experiences and technology for fish farming adequate for the regions;

Implementation, development and follow up of demonstrative projects in fish farming specific developed for the reality of the regions;

Performance of exchange among producers, managers and technicians of the regions; and

Implementation of the Development Program of Aquaculture Industrial Districts (PDI).

The PDA has a total of seven programs that include all the national production profiles:

1 – Program for Development of Aquaculture in Continental and Marine Waters under the domain of the Union: aims to give new concession areas for aquaculture with capacity to produce 1.130.000t of fisheries per year. The program shall increase fish farming (Union waters), mussels farming (along the coast of Santa Catarina and Rio de Janeiro States) and oysters farming (Santa Catarina, Alagoas, Sergipe, Rio Grande do Norte and Pará States). Also, the program shall create management mechanisms of parks and aquaculture areas, and create an environmental monitoring network to supply information for the environmental licensing process.

2 - Program for Development of Fish Farming in Net Cages and Excavated Ponds: foresees the use of hours/machinery for implementing 3.000ha of new areas for net cages and excavated tanks to be used in fish farming with production capacity of 60.000 t of fisheries. The total production capacity is distributed among different regions of the country as following: Midwest – 750ha (15.000t/year), North – 750ha (15.000t/year), South – 500ha (10.000t/year), Northeast – 500ha (10.000t/year) and Southeast – 500ha (10.000t/year).

3 – Program for Development of Shrimp Farming: aims to implement new areas for shrimp farming. The Northeast region of Brazil shall install 30.000 ha with production capacity of 125.000t/year of shrimps.

4 – National Program for Technical Assistance and Aquaculture Extension: aims to finance activities to 50.000 producers per year from different regions of the country as following: North – 15.000, Northeast – 15.000, Midwest – 10.000, Southeast – 5.000 and South – 5.000.

5 – Program for Development of Aquaculture under the Programs of Amazonia Legal and Semiárido Brasileiro: aims to implement 40 demo projects suitable for the reality of the States of Amazon, Pará, and Amapá in the Amazonian Region. And in the semiarid States of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco and Alagoas.

6 – Program for Development of New Technologies for Aquaculture: aims the implementation of 20 Demonstrative Units (UD) of new technology with focus on fish and shrimp farming that will require less usage of water, bioflocs and alternative energy sources. And more 20 UD for algae farming, ornamental fish farming, aquaponic, shrimp farming and frog farming in inland waters of different regions of Brazil.

7 - Program for Development of Industrial Districts: supports the implementation of five Farming Industrial Districts (DIA).
PDA Budget Overview by Program:

<table>
<thead>
<tr>
<th>Program</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program for Development of Aquaculture in Continental and Marine waters under the domain of the Union</td>
<td>BRL 125 million</td>
</tr>
<tr>
<td>Program for Development of Fish Farming in Net Cages and Excavated Ponds</td>
<td>BRL 120 million</td>
</tr>
<tr>
<td>Program for Development of Shrimp Farming</td>
<td>BRL 165 million</td>
</tr>
<tr>
<td>National Program for Technical Assistance and Aquaculture Extension:</td>
<td>BRL 70 million</td>
</tr>
<tr>
<td>Program for Development of Aquaculture under the Programs of Amazonia Legal and Semiárido Brasileiro</td>
<td>BRL 10 million</td>
</tr>
<tr>
<td>Program for Development of New Technologies for Aquaculture</td>
<td>BRL 10 million</td>
</tr>
<tr>
<td>Program for Development of Industrial Districts</td>
<td></td>
</tr>
</tbody>
</table>

Plan Fishes and Aquaculture – Credit Lines

Source: MPA