SÃO FRANCISCO VALLEY: VITIVINICULTURE ACTIVITIES IN THE BRAZILIAN UNTHINKABLE SEMIARID CLIMATE AND ITS CHALLENGES

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Abstract

Located at the northeastern region in Brazil, the São Francisco Valley has recently drawn a great deal of attention from the world wine industry, due to its successful activities regarding the unthinkable latitude and weather conditions for wine business. This single case study investigates the challenges, pitfalls, and the success of the São Francisco Valley economic acitivites, such as the transposition of the São Francisco river infrastructure project, here highlighted as a Brazilian development model for the northeast agriculture. Usually, winemakers are concentrated in the north and south temperate zones (latitudes of 34° to 45°N, and 31°a 38° S, respectively). The São Francisco Valley is located between Pernambuco and Bahia States, in a semiarid climate (*caatinga*), at 8^{o} S latitude. Against all odds, the São Francisco Valley was responsible for 95 % of the table grapes exported from Brazil in 2015, with a production of 7 million liters of still wine (70% or 2,8 million liters, sparkling wines), within 700 hectares of cultivated area. It is also responsible for 15% of the Brazilian still wine production. with the incredible milestone of five crops produced each two years. The principal grape varieties cultivated are *Pinot Noir, Chardonnay, Syrah, Malbec, Cabernet Franc, Cabernet Sauvignon, Alicante Bouschet, Tannat, Touriga Nacional, Chenin Blanc, Sauvignon Blanc* (*vitis vinifera),* among others, generating over 30,000 direct and indirect jobs since 2002.

Keywords: Wine business, São Francisco Valley, Brazil

Introduction

The present work is a descriptive single case study that investigates the challenges faced by wine business industry located at the São Francisco Valley, Northeastern Brazil, in particular the city of Petrolina and Lagoa Grande, at Pernambuco state.

The grapevine cultivation, vineyards are ancestral and date from approximately 6.000 b. C. (Philips, 2003), and it has been one of the driven forces in agricultural economic activity throughout the ages (Borges, 2004; Pacheco, 2008; Santos, 2003). In Brazil, the activity started in XVI century, as explained ahead. Wine is a word that comes from Ancient Greek *oenos*, after adapted to Latin *vinos*, *vinho* in Portuguese, *Wein* in German (with capital W), *viño* in Spanish, *vino* in Italian and *vin* in French (Saldaña, 2012).

The biggest challenge faced today is the transposition of the São Francisco River project. Since the success of the grapes cultivation is controlled irrigation, abundant water supply is mandatory. Since 2007, Brazilian Federal Government is transposing the Rio São Francisco, to attend 12 million people, and therefore decreasing the water supply in almost a third to the region.

The main objective is to throw more light on the challenges and the critical factors that makes the region responsible for 95% of the table grapes exported to other countries, threatened by the reduction of the water supply and its impacts on production and distribution.

Methodology

The present research encompasses an interpretive approach, combining in-depth interview, archival research, direct observation, and descriptive case study (Yin, 1988). Primary data was collected through a qualitative interviews (Goffman, 1959, 1961). The chosen unit of analysis is Petrolina municipality and its vitiviniculture economic activity (Yin, 1988).

Two in-depth key qualitative interviews were conducted through semi-structured questionnaires. One of the interviewees was invited by phone, and the second one, face to fac, with 100% response rate. Primary data were collected by audio recording, documented by photos and field notes. All respondents answered one hundred percent out of four questions posed. All interviews were conducted in Portuguese. Quoting was not formally allowed, therefore, names are kept confidential, in order to respect privacy and disclosure information of the oenologists interviewed. Data gathered were transcribed and coded through In Vivo coding. Primary data were then analyzed through content analysis. Secondary data came from archival research.

Research limitations

This study is limited to the city of Petrolina and Lagoa Grande, Pernambuco and to the wine business activity, including still, fortified, sparkling, and table wines made with *vitis vinifera* or *vitis lambrusca* grapes. Other wines, such as brandies or whiskies, for instance, are not the scope of the present research.

Still wine is defined by Law no. 7,678 / 88, as "drink obtained by the alcoholic fermentation of the simple grape must, fresh and ripe" (BRASIL, 1988, article 3, our translation), being classified as: (a) class: table , Light, fine, sparkling, semi-sparkling, aerated, liqueur and composite; (b) color: red, rosé or white; (c) sugar content: nature, brut, extra but, dry , medium sweet, and sweet (BRASIL, 1988, art.8, paragraphs I, II and III).

The present research is limited to the winemaking activities of the region, not to the winemakers, with the main focus on the distribution of the finished and packaged product, not in its manufacture (or vinification process). It is also a limiting factor the type of grape analyzed here, restricted to: (a) *vitis vinífera*s, or noble grape varieties (families) of grapes suitable for wine cultivation, in accordance with Law 7,678 / 1988 and Law 10,970 / 2004 . The said, law also authorizes (b) the use of the family of American grapes, or *vitis labrusca* (*vitis americana*) for the production of Brazilian wines (Law 7,678 / 1988; Law 10,970 / 2004).

Background

In 2015, global wine production, excluding juice and musts, reached 275.7 million hl (hectolitres), presenting an increase of 2% in comparison with 2014 (OIV, 2016). Brazil occupied in 2015 the 15th place in worldwide wine-production, with approximately 2,7 million hl, as shown in Figure 1, as follows:

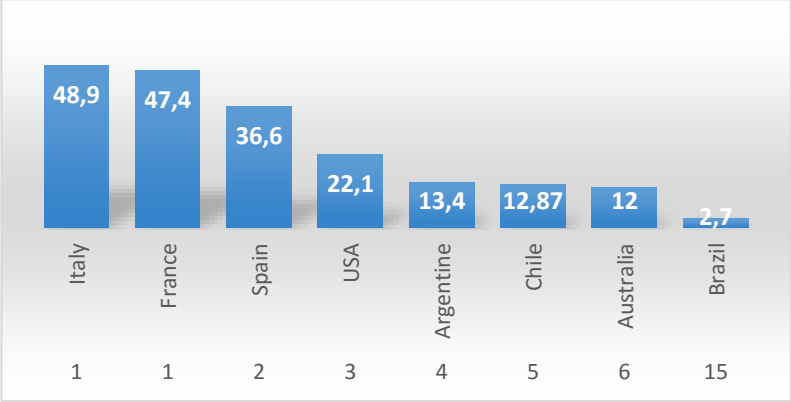

Figure 1 - Worldwide wine-production in 2015. Source: Adapted from OIV (2015)

As Figure 1 depicts, even in South America, Brazilian production is almost six times smaller than Argentine or Chile. The most important producers in Brazil are Rio Grande do Sul, South Brazil, with approximately 2,1 mhl and the rest of the country produces 0,6 mhl. Chile had a remarkable increasing production in 22.6% in comparison with 2014 and Argentina had a decreasing production -12.1% in the same period (OIV, 2015). Figure 2 depicts the worldwide trend production, from 1999 to 2015, as follows:

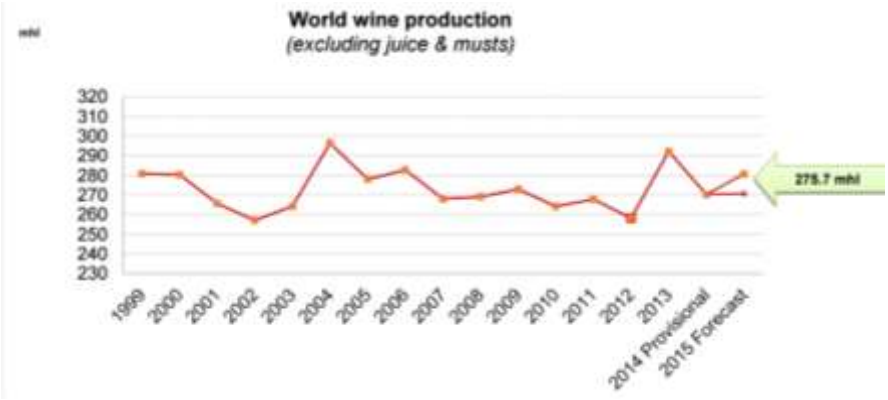

Figure 2 - *World wine production (excluding juice & musts. Source: OIV, 2015.*

Also in 2015, Brazilian exports in the wine sector were US $ 81.81 million, down 8.32% from those in 2014 (IBRAVIN, 2015). Usually, winemakers worldwide are located in latitudes of 34° to 45°N, and 31°a 38° S, respectively. Rio Grande do Sul state is located at latitude 30º S, within the regular vitiviniculte activity throughout the world.

However, against all possibilities of success, grapes are successfully cultivated, still and sparkling wines are produced in Brazil, in the the San Francisco Valley, at the latitude of 8ºS, unthinkable and unlikely region to the vitiviniculture activity, because of its semiarid climate. One of the critical success factors is the drip system irrigation with water coming from the San Francisco River, as discussed ahead.

Winemaking activity in Brazil

The winemaking activity in Brazil started when Martim Afonso de Souza arrived in Brazil in 1532 (Ferreira & Ferreira, 2016; Borges, 2004), together with the specialist Brás Cubas, who planted the first Brazilian vineyard in the São Paulo *capitania*[1], in the city of Tatuapé (today São Paulo state), and later proved inadequate for The Pernambuco *capitania*, where today the State with the same name is located (Ferreira & Ferrreira, 2016; Pacheco, 2008).

In 1626, the first winemaking experience in southern Brazil, more specifically in the present state of Rio Grande do Sul, was successful with the Jesuits, but it was only in the 1870s, under the empire of Dom Pedro II, that the Italian migratory cam Was successful in planting vines, especially in the Serra Gaúcha (Pacheco, 2008). In 1870, the city of Petrolina was founded, four kilometers away from the city of Juazeiro, State of Bahia. The winemaking activity of the city of Petrolina started in the 1980s (EMBRAPA, 2016), although the pioneering activity dates back to 1960, when Cinzano bought an area of 250 hectares and established itself in the region to produce vermouth (Ferreira & Ferreira, 2016).

However, in addition to the historical factors, we have the climatic factors preponderant for the success of growing the grape. Here we will analyze only the climatic factors related to the city of Petrolina (PE), here studied, as follows.

[1] First land division adopted by king of Portugal D. João I (Dias, 2014)

The San Francisco Valley: Northeastern Brazil

The São Francisco Valley is a region served by the São Francisco River and its afluents, which crosses the states of Minas Gerais, Sergipe, Alagoas, Bahia and Pernambuco, through 521 municipalities. It flows initially from in the Serra da Canastra in Minas Gerais, passing through Bahia, Pernambuco, and is also the border dividing between the States of Alagoas and Sergipe, draining into the Atlantic Ocean, draining a geographic area of 641,000 km^2 (IBGE, 2016), as shown in Figure 3, as follows:

Figure 3 - San Francisco River (in yellow) and hidrologicalc basin. Source: InfoEscola, 2016

The main economic activity of the area is irrigated drip system agriculture, being the main producer pole of the country of table grapes. The production of the São Francisco Valley is exported through the Petrolina airport and the Suape port in Pernambuco and the Port of Aratu in Salvador, Bahia. (EMBRAPA, 2016). Traditionally, investments of the Brazilian Federal Government translated into irrigation projects, especially the cities of Juazeiro in Bahia and Petrolina and Lagoa Grande, in Pernambuco (EMBRAPA, 2016).

Its total population is approximately 17 million inhabitants, including the study area, the municipality of Petrolina, in the State of Pernambuco, with approximately 337 thousand inhabitants, and Lagoa Grande roughly six thousand inhabitants, according to a recent population estimate (IBGE, 2016). The winemaking activity investigated here is part of the *Mango and Grape Integrated Production Project* (EMBRAPA 2016).

Petrolina, Pernambuco

The cities of Petrolina and Lagoa Grande are located in the State of Pernambuco, separated each other for 52 km, at 8^o S latitude (See Figure 3), therefore, near the Equator, a place traditionally unusual for *vitis vinifera* cultivation, concentrated between the parallels 30 and 50 degrees north and 30 and 50 degrees South latitude (PACHECO, 2008), i.e. regions of

temperate climates of planet Earth. It was founded in 1870 and its winemaking activities date back to the 1980s (EMBRAPA, 2016).

Petrolina's and Lagoa Grande's principal economic activity has been throughout the years related to agriculture (IBGE, 2016). Moreover, beside grapes' production - scope of the present research, both cities also cultivated other sorts of fruits/vegetables, such as mango, banana, guayaba, sugar cane, tomato, onion, asparagus, watermelon, *acerola*[2], and pumpkins (EMBRAPA, 2005).

For instance, Petrolina has an altitude of 376 m, and in 2005, had a demographic occupation tax of eight inhabitants per km^2 (EMBRAPA, 2005). Figure 4 depicts both cities geographical localization and the traditional winemaking zones on Earth, as follows:

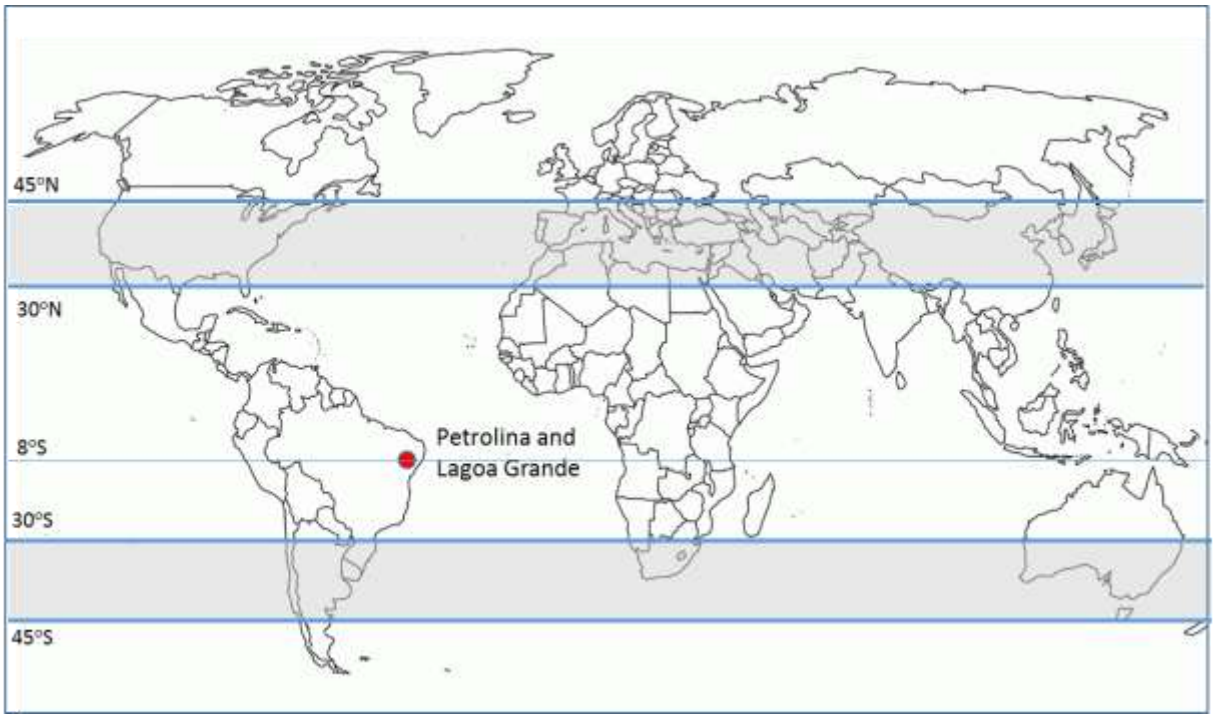

Figure 4 - Petrolina and the worldwide traditional wine making zones

The climate of Petrolina and Lagoa Grande is semi-arid (caatinga). Such climate encompasses approximately 1,000,000 km^2, with low rainfall and concentrated between three and five months, between 750 and 500 mm / year. The average annual sunshine is 300 days a year, or 2,800 h/year, approximately (EMBRAPA, 2016). According to de K*oppen index, Petrolina and Lagoa Grande are classified as BSwh (EMBRAPA, 2005). The semi-arid climate usually presents 9 to 11 months mostly dry, with the temperature fluctuating between 35ºC and the minimum 15ºC, occasionally in winter, as depicted in Figure 5, as follows:

[2] *Acerola*, or *Malpighia glabra* is a tropical fruit-bearing shrub or small tree in the family *Malpighiaceae*.

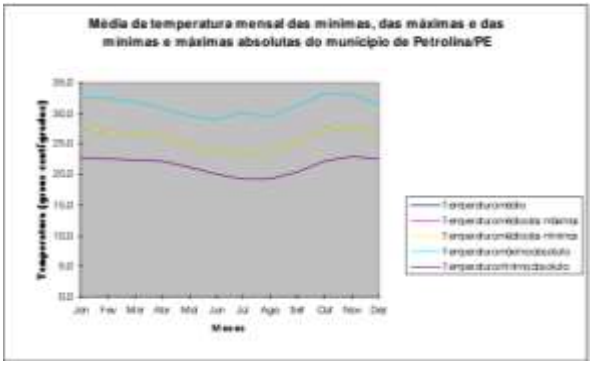

Figure 5 - Petrolina's annual temperature variation. Source: EMBRAPA, 2005.

Their soil is composed, from the geomorphological point of view, embedded in the Depression Country of the São Francisco Valley, with large surface of *pediplanos* and with *inselbergs*. The soil dates from the Pre-Cambrian period, including *granites, amphibolites, micaxies, phyllites, quartzites*, and small sedimentary *holocene*, following the water courses. In sum, Petrolina's soil is roughly granitic, low in nutrients, acidic, essentially limestone and clay, reaching thicknesses of 10 or more meters (EMBRAPA, 2005). One example from the Petrolina's limestone and clay soil is shown in Figure 6, as follows:

Figure 6 - Example of the region limestone and clay soil. Source, EMBRAPA, 2005.

Viticulture activities and techniques employed

In 2015, Petrolina and Lagoa Grande had a production of approximately 4 million liters of wine (70% or 2,8 million liters, sparkling wines), within 400 hectares of cultivated area, with

five crops produced each two years. It is possible due to an irrigation-controlled system, with water coming from the San Francisco River (IBRAVIN, 2015).

The principal grape varieties cultivated are *Pinot Noir, Chardonnay, Syrah, Malbec, Cabernet Franc, Cabernet Sauvignon, and Sauvignon Blanc* (*vitis vinifera),* generating over 46,000 direct and indirect jobs since 2002. Syrah is best adapted to the region, according to one of the interviewees, according to the oenologist from one of the largest farms in Santa Maria farm.

Since the grapevine is a shrub (vine), a long life cycle climbing plant, cultivated in Petrolina in two basic trellising systems, through drip systems: (a) *latada* (pergola or trellised), where the vines are planted far from each other and grow on a single trunk, approximately 2 m high (Saldanha, 2012), suitable for white wine grapes cultivation. Varieties such as *Isabel*, best suited for table grapes, not for still wines (not a *vitis vinifera* grape). The same technique is applied to other varieties such as Chardonnay, in which grapes are with pergola or trellises system, protected from the sun beams (more appropriated to red wine grapes), shown in Figure 7, as follows:

Figure 7 - Irrigated vineyard, pergola or trellised grape vine cultivation. Observe the black tubes one feet above root: it is the irrigation drip system.Source: author's photo.

The second form of trellising system adopted in the region for grapevine cultivation is called (b) *espaldeira* (espalier), which name comes from the Latin *espalda*, meaning "shoulder". This term was first used in France (Saldanha, 2012). *Espalier* is an agricultural practice of controlling the plant growth, especially used in Petrolina for the production of the red wine grape (Leão & Possidio, 1999). It consists in tying and pruning branches into a frame following a pattern, flat against a trellis (Saldanha, 2012). This arrangement allows the grape to receive the maximum exposure to sunbeams and are best suited to red wine grapes, such as the varieties *Syrah,* and *Cabernet Sauvignon*, for instance. The espalier trellising system is shown in Figure 8, as follows:

Figure 8- Irrigated vineyard, espalier grape vine cultivation. Observe the black tubes one feet above root: it is the irrigation drip system Source: author's photo.

As shown in Figures 6 and 7, there is a black plastic tube, one foot from the root, connecting all grapevines. It is the vineyard irrigation, through drip system. The water comes from the San Francisco River.

The most cultivated varieties are, in the following sequence: *Syrah* and *Cabernet Sauvignon*, almost 80% of the wines produced in the region. Also *Alicante Bouschet, Tannat, Rubi Cabernet*, and *Touriga Nacional* to red still wines. To white still wines, the varieties most cultivated are: *Chenin blanc* and *Moscato Canelli*, almost 85% of the still wines, plus *Sauvignon blanc*. To sparkling wines, the varieties most cultivated are Itália, *Chenin blanc* and *Syrah* in sparkling rose wines (Pereira, 2016).

Petrolina and Lagoa Grande: winemaking activities

In this research, only still and sparkling wines are under investigation. Petrolina is the second center in wine production in Brazil. Approximately 25% of the Petrolina's GDP is composed of agricultural and cattle farming activities (IBGE, 2016).

There are two major companies producing still and sparkling wines at Petrolina: Miolo Wine Group, responsible for almost 40% of the entire Brazilian production. Miolo at Petrolina produced in 2015, approximately 4 million liters of wines.

Miolo Wine Group was founded in 1897 by Giuseppe Miolo, who came from the Veneto region, Italy with his family, to live and work in Rio Grande do Sul, established at the city of Bento Gonçalves, along with thousands of Italian immigrants in search for opportunities overseas. After 2004, Miolo made strategic alliances with other companies, partners, such as Lovar Company, RAR – Raul Anselmo Randon, including the journalist Galvão Bueno.

In 2006, Miolo became Miolo Wine Group (MWG). Today, MWG eight business units: Vinícola Miolo, Fazenda do Seival Vineyards, RAR, Lovara, Viasul, the Spanish Osborne, Los Nevados (these three international partnerships) and Fazenda Ouro Verde, at Petrolina Pernambuco In 2015, the Fazenda Ouro Verde has produced near 2 million liters of wines. Their target is to produce 12 million litres of wines, in the near future (MWG, 2016).

Located 52 km from Petrolina, the farm Santa Maria, at Lagoa Grande produces sparkling and still wines, named Rio Sol, which uses French oak barrels to produce good quality wines, such as Paralelo 8, one of the best wines produced in Brazil, result of blending *Aragonez, Alicante Bouschet, Touriga Nacional, Syrah* and *Cabernet Sauvignon* grapes, with eight months staged in French oak barrels of first use.

Located at Lagoa Grande, ViniBrasil winemaker has been the result of the joint venture between the Portuguese winemaker Dão Sul – Sociedade Vitivinicola SA, one of the largest producers from Portugal, and the Brazilian Expand. In 2008, Dão Sul acquired 100% of the business from Expand and now is the owner of Santa Maria Farm. Their production surpassed 2 million liters of sparkling wines in 2015.

Their wine production is transported in two basic ways: 250 km of roads until Luis Eduardo Magalhães, or 610 km inland waterway until Ibotirama, and then, to the entire country and to exportation.

The San Francisco Transposition

The Brazilian Government project named "Projeto de Integração do Rio São Francisco com Bacias Hidrográficas do Nordeste Setentrional" (Northeastern integration Project between San Francisco River and regional rivers), or "Transposição do Rio São Francisco" (San Francisco River Transposition), is an 8 billion BRL project, building more than 477 km of artificial channels to deviate the course of San Francisco River. The original idea was to irrigate the entire semi-arid region at the Northeast Brazil (MIN, 2016), as shown in Figure 9, as follows:

Figure 9 - San Francisco Rio Transposition. Source: MIN, 2016

The project was first idealized by the emperor D. Pedro II in 1847 and revisited during the first Getulio Vargas Government (1930-1945). It was conceived as a project in 1985 by the extinct *DNOS – Departamento Nacional de Obras e Saneamento* (Sanitation and Construction National Depatrment – our tranalation), according to Aveiro (2014). It has been officially started in 2007 and was planned to finish in 2014. In 2016, only 86.3% of the project was concluded (MIN, 2016). The idea was to bring water to 12 million people within 390 municipalities, including the states of Pernambuco, Ceará, Rio Grande do Norte e Paraíba, were droughts are frequent (MIN, 2016).

The project encompasses the construction of 13 aqueducts, nine pumping stations, 27 reservoirs, 270 kilometers of high-voltage transmission lines, nine 230-kilowatt substations, and four tunnels, generated 10.394 direct jobs and demanded 3.221 machinery equipment (MIN, 2016), as shown in Figure 10, as follows:

Figure 10 - San Francisco Valley Aqueduct. Source: MIN, 2016

Consequences, future challenges and discussion

The winemaking activity at Petrolina and Lagoa Grande may be seriously compromised due to the reduction of the water flow, and consequently, reduction or water supply to irrigate the grape cultivation. In theory, the project is a 170 years' dream coming true. In practice, however, it has been controversial.

One of the first direct impacts was the reduction of the river flow, since the river transposition implies in water distribution. For instance, the river flow of the Amazon river is 209.000 m^3/s, while San Francisco River was 2.943 m^3/s, almost 70 times lesser than the former, 1,58% of the National average flow, which is 179.516 m^3/s (ANA, 2016). According to the Brazilian San Francisco Basin Committee (CBHSF), the San Francisco river flow in October 2016 was only 900 m^3/s, almost one third (1/3) of the former flow (CBHSF, 2016).

There is also an important consequence of the San Francisco river transposition: reduction of the capacity of production outlet through inland navigation, which impact is direct related to the river flow and depth to navigation.

The River San Francisco was reduced from to 1.5m (1.2m during the drought period). According to the DNIT – National Department of Transport Infrastructure, the navigation in the San Francisco River, between Juazeiro and Petrolina perform 560 km, with two convoys of 120m each, 1,5 m depth, transporting 2,000 or 3,000 ton, max (DNIT, 2016).

Since the irrigation is limited to the San Francisco river flow capacity, once it is reduced, the grape's cultivated area might be shortened throughout time, due to the reduction of the available water supply, implicating in decreasing production, and increase of distribution costs, more expensive by road than by inland navigation, over the years.

Finally, it is recommended to keep water levels monitored, to avoid losses, to optimize and to control the water usage and, for future research, to revisit the subject, regarding the San Francisco River water supply and its great importance to the Northeastern region economic development and to the Brazilian economy, as well.

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