SemeAd 2023
XXVI Seminários em Administração

07, 08, 09 e 10 de novembro de 2023
ISSN 2177-3866

THE CONTRIBUTION OF EACH BRAZILIAN STATE TO THE COMPETITIVENESS OF THE COUNTRY´S RICE EXPORTS (1999-2021)

ISADORA BRAND FABRIZIO
UNIVERSIDADE FEDERAL DE SANTA MARIA (UFSM)

ALINE BEATRIZ SCHUH
INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO RIO GRANDE DO SUL (IFRS)

RODRIGO ABBADE DA SILVA
FUNDAÇÃO UNIVERSIDADE FEDERAL DO PAMPA - UNIPAMPA (UNIPAMPA)

DANIEL ARRUDA CORONEL
UNIVERSIDADE FEDERAL DE SANTA MARIA (UFSM)

Agradecimento à orgão de fomento:
CNPQ

THE CONTRIBUTION OF EACH BRAZILIAN STATE TO THE COMPETITIVENESS OF THE COUNTRY´S RICE EXPORTS (1999-2021)

1 INTRODUCTION

Brazil is one of the largest grain producers and exporters in the world, as highlighted by Aragão and Contini (2020), from the Brazilian Agricultural Research Corporation (Embrapa). Data from the trade balance corroborate the importance of this commodity for the country´s production and trade sector, by revealing that the export basket of Brazilian agribusiness is concentrated in five sectors, namely: soy complex; meat; forest products; sugar and alcohol complex; and preparations of cereals and flours (Brasil, 2022).

Despite the prominent position that Brazil occupies in the world market of grains, it is also noteworthy that rice, which plays an important economic and social role[1], does not occupy a relevant position in Brazilian exports, especially when compared to other cereals, such as wheat, for example. This is mainly because rice production in Brazil is still aimed at the domestic market (Aragão & Contini, 2020).

According to Sato et al. (2021), Brazil has been self-sufficient in rice production since 2004, but it still needs to improve the competitiveness of the sector, especially in relation to Mercosur countries. Similarly, other studies reveal that, despite its self-sufficiency, Brazil imports a considerable amount of rice, mainly from Paraguay, due to price, since production in the neighboring country has lower costs, and also due to tax incentives to bloc´s member countries – this finding coincides with the perception of leaders in the segment in Brazil, who question the volume of imports and the current lack of incentives, which discourages local production as it makes it more expensive[2].

In search of productivity gains to improve competitiveness, some Brazilian regions have invested and specialized in the cultivation of irrigated rice, especially the South Region, which currently has the largest extension of irrigated rice crops in the country, followed by other states, such as Tocantins, Goiás and Mato Grosso do Sul, according to a study conducted by the National Water and Sanitation Agency (AGÊNCIA NACIONAL DE ÁGUAS E SANEAMENTO BÁSICO (ANA), 2020). The entity's survey also points out that producers in these areas have constantly invested in new technologies, which resulted in significant increases in productivity.

These investments and the increase in productivity, however, are not observed homogeneously in the producing states, which have different cultivation profiles, as highlighted by Ferreira, Wander & Silva (2021). While some Brazilian states are leaders in rice production, generating surpluses, others do not produce enough for domestic consumption. The authors, however, argue that, despite the difficulties, Brazil has the potential to gain more space in the international market.

Given the importance of rice production in the global context and considering the potential of this sector for Brazilian international trade, as well as the characteristics of the rice producing states and the difficulties faced by producers, this study aims to identify the contribution of each state for the competitiveness of Brazilian rice exports. To this end, a performance matrix of the rice exporting states was built for the period from 1999 to 2021, following the model proposed by Farias et al. (2018), which is based on the Revealed Comparative Advantage index (RCA) and on the Relative Position index (RPI).

---

[1]In the study "Economic and social importance of rice", Silva, Wander & Ferreira (2021) demonstrate the relevant role that rice plays in Brazil and in other developing countries.

[2]According to an article entitled "Brazil imports rice from Mercosur even without needing it", by Essig (2018), published on the *Canal Rural* website.

From the elaboration and analysis of this matrix, the present study contributes to deepen the discussions on the competitiveness of the Brazilian rice sector, and to elucidate the representativeness of each state for the international trade of this important commodity. Furthermore, this study innovates by applying to the rice sector, the tool developed by Farias et al. (2018) for the fish sector.

To achieve the proposed objective, this paper is structured in five other sections, in addition to this introduction. The second and third sections comprise the theoretical framework and the literature review on international trade and on the Brazilian rice sector; the fourth section details the methodological aspects of the work; and the fifth and sixth sections present the analysis and discussion of the results, as well as the conclusions.

2 THEORETICAL FRAMEWORK

The importance of international trade is related to its ability to expand consumer markets for the population of a country, to the mitigation of internal risks through the diversification of internal markets, and to the possibility of obtaining new raw materials, technologies and new alternatives for production. Considering its relevance, commercial relations have been the object of study of economic sciences since its inception.

The classical school of economics, fundamental for the development of the reasoning behind international trade and economics, is characterized by the understanding of the natural forces of supply and demand. Adam Smith's *The Wealth of Nations* is considered the forerunner of studies in economic, and, according to Gennari (2009), Smith's reasoning starts from the idea that the increase in wealth and labor productivity begins with processes linked to the social division of labor. The authors also consider that Smith's theory of value paved the way for both neoclassical analyses, based on the utility theory of value, and for the Marx´s school of thought, which is based on the labor theory of value.

In addition, the entire basis of international trade is based on Adam Smith's Theory of Absolute Advantages, in which the absolute advantage of a country in the production of a good will result in greater productivity through a decrease in costs and productive inputs; thus, the country will not need to obtain surpluses from foreign trade for international trade to be advantageous (Coutinho, de Vilhena Lana-Peixoto, Ribeiro Filho, & Amaral, 2005). Parallel to this idea, David Ricardo in *Principles of Political Economy and Taxation* formulated the Theory of Comparative Advantages in international trade, which was the basis for the development of many indices and macroeconomic concepts, and filled the gaps left by Adam Smith – from Smith's perspective of absolute advantages, it was not possible to justify international trade, since a country would have an absolute advantage in all goods. On the other hand, Ricardo advances this idea, justifying that there would always be international trade, as a country cannot have a comparative advantage in all goods.

In this sense, David Ricardo's theory considers that each country naturally specializes in sectors in which it has greater advantages, that is, those with lower production costs in comparison to its partners (Ricardo, 1982). In the international division of labor, each country has natural or artificial advantages; thus, the main beneficiaries of international trade are consumers from importing countries, as they can have products from all over the world at lower prices (Ricardo, 1982).

Later, using Ricardo's theory as a basis, John Stuart Mill in *Principles of Political Economy* addressed the question of the distribution of gains between countries. According to Gennari (2009), Mill highlighted the need for diversification of the production, even if a sector does not have a maximum comparative advantage or if it has a minimum comparative disadvantage.

In the 20th century, the limitations of Ricardo's theory of comparative advantages were overcome by the Heckscher-Ohlin Theory, which is focused on the relationships between the relative endowments of production factors and international trade patterns (Carvalho & Silva, 1999). This understanding differs from the Ricardian theory, as it takes into account two production factors: labor and capital, while Ricardo's assumes only the labor production factor and considers the supply factor irrelevant for determining the pattern of trade (Hidalgo & Feistel, 2013).

In addition to the classical studies on international trade, it is also essential to analyze contemporary perspectives. In this sense, Michael Porter's theory, described in *The Competitive Advantages of Nations*, advances in studies on international production and tries to relate the competitiveness of companies to that of the nation-state. For this, his theory involves several complex aspects, such as production factors, market demand, industry structure and technological development. Thus, the theory of national competitiveness emphasizes quality, innovation and differentiation, as these factors are central to the development of comparative advantages (Nunes, 2007).

Considering the previously discussed theories, this study will be based on the Revealed Comparative Advantage index, formulated by Balassa in 1965, which measures the competitive level or comparative advantages of a country. According to Siqueira et al. (2011), this index is a revealed measure, in which its calculation is based on observed data, *ex-post* to trade, that is, trade "reveals" comparative advantages. Thus, it allows to identify existing trading patterns, but it does not allow to check whether these patterns are optimal.

3 LITERATURE REVIEW

Seeking to elucidate aspects related to the Brazilian rice agribusiness and also to contribute to the formulation of long-term commercial strategies, (Ferreira et al., 2021) analyzed conjunctural data on imports, exports and production costs of rice in Brazil, Argentina and Uruguay, and observed that Brazilian exports increased from 2004 onwards; however, the study also showed that the production of rice in the county has competitive disadvantages in relation to its neighbors Uruguay and Argentina.

Similarly, Marion Filho et al. (2008) evaluated the competitiveness of Brazilian irrigated rice in relation to Uruguay and Argentina, through a comparative analysis of production costs, agricultural policies, exchange rates and tariff barriers in these countries. The results show that rice produced in Argentina is the most competitive when compared to the other two countries in the region, followed by Uruguay and Brazil. Regarding agricultural policy in the region, it was discovered that Argentina has a market economy without state subsidies. In Uruguay, the policies aim at research services, advisory services, inspection services, as well as campaigns against diseases and pests. In Brazil, the instruments used are focused on credit and short-term actions; there is also protection for family farming and a reduction of subsidies for commercial farming. Finally, the study showed that there is a relationship between the exchange rate policy and changes in the common external tariff, which may affect rice prices in the region and harm competition.

In a more in-depth study, Sato et al. (2021) analyzed how Brazilian rice exports behaved over a period of 22 years (from 1997 to 2018), and the sector´s competitiveness in relation to Mercosur countries. The research was based on the calculation of three indices: the Revealed Comparative Advantage index (RCA), the Coverage Rate and the Regional Orientation index. The results demonstrate that the rice produced in Argentina and Uruguay is directed to the Brazilian market, and it is also more competitive. Despite this, according to Sato et al. (2021), Brazil evolved in rice exports and improved the competitiveness of the sector, acquiring self-sufficiency after 2004.

The study by Souza et al. (2016) also evaluated the competitiveness, economic efficiency and possible impacts of levels of protection or subsidies in the processed rice chain in Rio Grande do Sul, using the Policy Analysis Matrix. The results confirmed that the rice chain in the analyzed state is competitive at both private and social prices, even with the high tax burden and opportunity cost of capital (Souza et al., 2016).

Table 1 summarizes the review of the main studies regarding the competitiveness of rice production and exports in Brazil, according to authors, the methodology used and the main results that were found.

Table 1 - Summary of national literature review

Authors	Period/Method	Results
(Wander, 2006)	From 1999/2000 to 2004/2005. Survey of the evolution of conjunctural indicators (area, production and productivity) and imports and exports of rice from Brazil.	Increase of Brazilian rice exports from 2004. National production of rice presents competitive disadvantages in relation to Uruguay and Argentina.
(Marion Filho & Einloft, 2008)	From 2003/04 and 2004/05. Comparative analysis of production costs, agricultural policies, exchange rates and tariff barriers between Brazil, Argentina and Uruguay.	Argentine rice is the most competitive (Brazilian is last). The relationship between the exchange rate policy and changes in the common external tariff can affect rice prices in the region and harm competition.
(Sato et al., 2021)	From 1997 to 2018. Analysis of the competitiveness of Brazilian rice in relation to Mercosur, through the Relative Comparative Advantage index, Coverage Rate, and the Regional Orientation Index.	Rice produced in Uruguay and Argentina is more competitive compared to Brazil´s.
(Souza et al., 2016)	From 2011/2012. Policy Analysis Matrix.	The rice chain in the state of Rio Grande do Sul is competitive at both private and social prices.

Source: Elaborated by the authors.

Based on this section, it is evident that the literature on the performance of the Brazilian rice sector, regarding competitiveness indicators, has evolved. However, this study seeks to fill in some of the gaps regarding the contribution of Brazilian rice exporting states, through the methodology proposed by Farias et al. (2018).

4 METHODOLOGY

This section contemplates the procedures used in this research. Initially, the theoretical and methodological aspects necessary to obtain the Revealed Comparative Advantage (RCA) and the Relative Position (RPI) indices are detailed. Subsequently, the steps required for the construction of the performance matrix by Farias et al. (2018) for the rice sector are presented, as well as a description of the data used.

4.1 Revealed Comparative Advantage Index (RCA) and Relative Position Index (RPI)

In order to identify the contribution of each state to the competitiveness of the Brazil´s rice exports, the performance matrix developed by Farias et al. (2018) was used as a central point. This matrix, which relates the RCA and the Relative Position indices, was constructed by the authors to analyze the performance of fish exporting countries in international trade. In the present study, this tool was applied to the Brazilian rice sector. Before detailing the

performance matrix elaboration process, it is necessary to understand how the RCA and IPR are obtained.

As discussed in the theoretical framework, the RCA was formulated by Balassa in 1965, aiming to measure the competitive level or the comparative advantages of a given country. Since then, many studies have emerged, applying this indicator to different contexts.

According to Balassa et al. (1989), the RCA index is defined as "the ratio of a country's exports in a particularly commodity category to its share in total merchandise exports". That is, to obtain the RCA, Equation (1) must be used:

$$RCA_{ij} = \frac{\frac{X_{ij}}{X_j}}{\frac{X_{iw}}{X_w}}, \quad (1)$$

Where: *i* represents the product (rice), in US$; *j* refers to the analyzed Brazilian states; *w* indicates the analyzed country (Brazil); X_{ij} corresponds to the exported monetary value of product *i* (rice) by the state *j*; X_j concerns the total monetary value exported by the state *j* ; X_{iw} represents the export balance of product *i* (rice) from country *w* (Brazil); and X_w corresponds to the total amount exported by country *w* (Brazil).

The results of this equation are analyzed according to the following classification: if RCA > 1, the state presents a revealed comparative advantage in the export of rice; if RCA < 1, the state has revealed comparative disadvantage; and if RCA = 1, the state has neither advantage nor disadvantage in exporting the product in question. Also, regarding the interpretation of the indicators, Alves et al. (2022) explain that the higher the RCA result, the greater the revealed comparative advantage of the state in exporting the product under analysis, since the index varies, in this case, from 1 to infinity.

In addition to obtaining the RCA, it is necessary to calculate the IPR. This index was formulated by Lafay (1999), and its main function is to demonstrate the performance of the trade balance of a given location in relation to world trade. More specifically, according to Farias et al. (2018), the IPR results are able to reveal whether exports from the analyzed location grow at higher (or lower) rates than those of international trade, that is, it is also a comparative analysis. The IPR is calculated using Equation (2):

$$IPR_{ij} = 100 \times \frac{X_{ij} - M_{ij}}{X_{jw} + M_{jw}} \quad (2)$$

Where: *i* represents the product (rice), in US$; *j* refers to the state; *w* is the country (Brazil); X_{ij} is the exported monetary value of product i (rice) by the state *j*; M_{ij} represents the imported monetary value of product *i* (rice) by state *j* ; X_{jw} corresponds to the total exported amount of commodity *i* (rice) by country *w* (Brazil); and M_{jw} is the total monetary value of imports of product *i* by country *w*.

Regarding the interpretation of the results, Coronel et al. (2011) explain that the value obtained reveals the degree of intensity of the analyzed commodity in world trade. This means that a positive result from the equation indicates that the analyzed state is a net exporter; a negative result means that the location is a net importer.

4.2 Farias & Farias performance matrix (2018)

According to the methodology developed by Farias et al. (2018), after obtaining the RCA and the IPR, it is necessary to analyze the linear trend of the series of these indices for each location, in order to classify them as ascending (positive), descending (negative) or stable. For this, each series must be adjusted using the Ordinary Least Squares (OLS) method.

On the issue of trends, Wooldridge (2015) reinforces that this recognition is fundamental for the analysis of time series. According to the author, a formulation capable of capturing the temporal trend is commonly described by Equation (3).

$$y_t = \alpha_0 + \alpha_1 t + e_t \quad (3)$$

Where: $e_t$is the independent and identically distributed error term (iid), with $E(e_t) = 0$ and $Var(e_t) = \sigma_e^2$; α_0 is the linear coefficient or intercept of the model; α_1 is the slope, which, when multiplied by time t, results in a linear time trend.

The author adds that a time series with a linear trend can also be written according to Equation (4), whose average value is a linear function of time:

$$E(y_t) = \alpha_0 + \alpha_1 t \quad (4)$$

In this case, if $\alpha_1 > 0$, $y_t$has an increasing (positive) trend; and if $\alpha_1 < 0$, it means that y_t has a decreasing (negative) trend.

Based on this theoretical and methodological support, the regressions of each of the indices, for each of the states, were adjusted as follows:

$$RCA_{ijt} = \alpha_0 + \alpha_1 t + u_{ijt} \quad (5)$$

$$IPR_{ijt} = \beta_0 + \beta_1 t + \varepsilon_{ijt} \quad (6)$$

Where: *i* represents the analyzed product (rice); *j* refers to the state; *t* indicates the time; α_0e $\beta_0$are the linear coefficients, and α_1e $\beta_1$represent the angular coefficients; $u_{ij,t}$ and $\varepsilon_{ij,t}$ are the error terms.

After the adjustment, the next step consisted in carrying out the Student's t-test, considering the a significance level of 5%, according to Wooldridge (2015), and in the same way as performed by Farias et al. (2018). This test allowed identifying the behavior of the angular coefficients of both indices and classifying them according to Table 2.

Table 2 - RCA and IPR trend according to the coefficients

Trend		Angular coefficients	
		RCA	IPR
Stable	Regardless of sign*	$\alpha_1 = 0$	$\beta_1 = 0$
Ascending	Positive sign	$\alpha_1 > 0$	$\beta_1 > 0$
Descending	Negative sign	$\alpha_1 < 0$	$\beta_1 < 0$

Source: Based on Farias and Farias (2018).
*Note: The alpha (α_1) and beta (β_1) angular coefficients can be assumed to be equal to zero.

Table 2 shows that when the alpha alfa (α_1) and beta (β_1) coefficients are equal to zero, it indicates that the RCA and the IPR indices have a stable trend. On the other hand, when the values obtained are different from zero, it is considered that the trends of the indices are increasing (if they are positive) or decreasing (if they are negative).

After this classification, the performance matrix was elaborated, following the model proposed by Farias et al. (2018). For the present study, the purpose of this matrix, illustrated in Table 3, is to classify each Brazilian state according to the performance of its rice sector in the international market.

Table 3- Performance matrix

<table>
<tr><td colspan="2" rowspan="2">Indices and trends</td><td colspan="3">$IPR > 0$</td><td colspan="3">$IPR > 0$</td></tr>
<tr><td>↑</td><td>↔</td><td>↓</td><td>↑</td><td>↔</td><td>↓</td></tr>
<tr><td rowspan="3">$RCA > 1$</td><td>↑</td><td colspan="2">Efficient and positive trend</td><td rowspan="3"></td><td rowspan="3">With external potential and positive trend</td><td rowspan="3">With external potential and stable</td><td rowspan="3">With external potential and negative trend</td></tr>
<tr><td>↔</td><td colspan="2">Efficient and stable</td></tr>
<tr><td>↓</td><td colspan="3">Efficient and negative trend</td></tr>
</table>

$RCA < 1$	↑	With internal potential and positive trend	Inefficient and positive trend
	↔	With internal potential and stable	Inefficient and stable
	↓	With internal potential and negative trend	Inefficient and negative trend

Source: Adapted from Farias and Farias (2018).

From this classification, each state can be considered "efficient", "with internal potential", "with external potential", or "inefficient", regarding rice trade, as follows:

- If RCA > 1 and IPR > 0: the state is classified as "efficient". The RCA index indicates that the analyzed merchandise is relevant to the export basket of the analyzed state, and the IPR indicates that the state is efficient in the commercialization of this commodity to the foreign market.
- If RCA > 1 and IPR < 0: the state is considered "with external potential", as the RCA index indicates that the analyzed merchandise is a relevant to the export basket of the state, but the negative IPR reveals the need to improve efficiency regarding its commercialization.
- If RCA < 1 and IPR > 0: the state is considered "with internal potential". Although the IPR indicates efficiency in the commercialization of the analyzed product to the foreign market, the RCA index reveals that the state is still not competitive in the international trade in this sector, but it has the potential to be so.
- If RCA < 1 and IPR < 0: the state is classified as "inefficient, as the RCA index indicates that the analyzed merchandise is not relevant to the export basket of the state, at the same time in which the IPR reveals the inefficiency in the commercialization of the commodity.

The performance matrix also enables to combine the classifications, grouping the states according to the result of the indices and the linear trend of the series, as detailed in Table 3. With this methodology, each state can be classified within twelve different criteria, which provide greater detail on the competitive performance of each location in rice exports.

4.3 Data source

The data were obtained from the *Comex Stat* – a Brazilian trade statistics portal, maintained by the Ministry of Development, Industry, Commerce and Services - MDIC (2022). The extracted sample includes rice imports and exports from the twenty-seven federative units of Brazil, as well as total exports from these locations, and total Brazilian imports and exports for the period from 1999 to 2021. This interval was defined based on the availability of the data, and on the fact that in 1999 Brazil started to adopt the floating exchange rate.

It should be noted that data on exports and imports of rice for the states of Paraíba and Piauí were not found. As a result, the analyzes focused on the performance of exports from the following states, presented in order according to the average rice exports, in U$ dollars, in the period (from the largest to the smallest exporter): Rio Grande do Sul (RS), Santa Catarina (SC), Roraima (RR), São Paulo (SP), Rondônia (RO), Mato Grosso (MT), Rio de Janeiro (RJ), Paraná (PR), Amazonas (AM) , Goiás (GO), Pará (PA), Mato Grosso do Sul (MS), Espírito Santo (ES), Acre (AC), Tocantins (TO), Maranhão (MA), Minas Gerais (MG), Amapá (AP) , Pernambuco (PE), Bahia (BA), Alagoas (AL), Ceará (CE), Federal District (DF), Rio Grande do Norte (RN) and Sergipe (SE).

5 ANALYSIS AND DISCUSSION OF RESULTS

The first step consisted in the calculation of the Revealed Comparative Advantage index (RCA) and the Relative Position index (RPI) for each of the 27 federative units (states) in Brazil. In addition to the mean and standard deviation, the trends of these indices over time were obtained using the angular coefficient of the regression line (α_1 e β_1), as well as their p-value, as shown in Table 4.

Table 4 – Revealed comparative advantage index (RCA) and relative position index (RPI) of rice exporting states – 1999 to 2021.

	RCA				*IPR*			
State	Mean	Std. Dev.	α_1	p-value	Mean	Std. Dev.	β_1	p-value
AC	4.438	13.467	0.041	0.925	0.000	0.000	0.000	0.906
AL	0.005	0.013	0.001	0.003	0.000	0.001	0.000	0.003
AP	0.040	0.137	0.008	0.048	0.000	0.001	0.000	0.036
AM	0.265	0.771	0.054	0.022	0.001	0.002	0.000	0.026
BA	0.000	0.001	0.000	0.003	-0.004	0.004	0.000	0.765
CE	0.001	0.002	0.000	0.243	-0.009	0.007	0.001	0.000
DF	0.024	0.087	-0.002	0.378	-0.001	0.003	0.000	0.054
ES	0.005	0.016	0.001	0.335	-0.006	0.016	0.001	0.186
GO	0.197	0.828	-0.016	0.554	-0.002	0.006	0.000	0.842
MA	0.011	0.038	0.002	0.037	-0.034	0.039	-0.002	0.040
MT	0.306	0.691	-0.046	0.029	0.002	0.002	0.000	0.194
MS	0.045	0.084	-0.002	0.380	-0.002	0.002	0.000	0.612
MG	0.006	0.012	-0.001	0.065	-0.064	0.046	-0.006	0.000
PA	0.009	0.023	0.001	0.048	0.000	0.001	0.000	0.015
PB	-	-	-	-	-	-	-	-
PR	0.338	1.067	-0.073	0.026	-0.015	0.009	0.000	0.086
PE	0.003	0.008	0.000	0.094	-0.044	0.035	0.004	0.000
PI	-	-	-	-	-	-	-	-
RJ	0.064	0.120	-0.005	0.171	-0.034	0.031	0.004	0.000
RN	0.000	0.002	0.000	0.098	0.000	0.000	-	-
RS	10.173	2.104	0.255	0.000	0.172	0.378	0.047	0.000
RO	5.450	8.523	-0.763	0.002	0.002	0.004	0.000	0.260
RR	18.583	39.021	3.227	0.005	0.003	0.006	0.001	0.000
SC	0.737	0.544	-0.025	0.153	-0.001	0.015	0.000	0.942
SP	0.031	0.036	0.000	0.923	-0.206	0.087	0.010	0.000
SE	0.000	0.000	0.000	0.378	0.000	0.000	0.000	0.098
TO	0.045	0.106	0.009	0.003	-0.003	0.004	0.000	0.203

Source: Elaborated by the authors based on the results.

The data obtained reveal that only three Brazilian states (Rio Grande do Sul, Rondônia and Roraima) presented comparative advantages in rice exports (RCA > 1), and were, at the same time, net exporters, as they had an average IPR > 0. This means that these three states can be classified as "efficient". Acre also had revealed comparative advantages, but the IPR obtained (zero) indicates that the state is still not efficient in the commercialization of rice to the foreign market.

Amazonas and Mato Grosso did not present revealed comparative advantages (RCA < 1), but they showed "internal potential" (IPR > 0). That is, these two states are efficient in the commercialization of rice to the foreign market, but they still need to improve and better explore their potential to gain competitiveness.

The other states are classified as "inefficient". These locations are not efficient in the commercialization of rice to the foreign market (IPR < 0), and this commodity has no relevance in their export basket (RCA < 1). It should also be noted that the classification for the states of

Paraíba and Piauí was not possible due to the unavailability of data. The states of Rio Grande do Norte and Sergipe, whose indicators are at zero, did not export significant amounts of rice in the analyzed period.

In addition to the classification according to the capacity that each Brazilian state has in its commercial rice transactions, temporal trends were analyzed, according to the performance matrix presented in Table 5. This matrix, based on Farias et al. (2018), relates the indices (RCA and IPR) with the trend of their angular coefficients, which can be classified as "stable", "increasing" or "decreasing".

Table 5 - Performance matrix of Brazilian exporting states of rice from 1999 to 2021

	Classification	RCA > 1	IPR > 0	Brazilian states
Efficient	Increasing	↑	↑	Rio Grande do Sul – Roraima
	Stable	↑	↔	-
		↔	↑	-
		↔	↔	-
	Decreasing	↑	↓	-
		↔	↓	-
		↓	↑	-
		↓	↔	Rondônia
		↓	↓	-
	Classification	RCA > 1	IPR < 0	Brazilian states
With external potential	Increasing	↑	↑	-
		↔	↑	-
		↓	↑	-
	Stable	↑	↔	Acre
		↔	↔	-
		↓	↔	-
	Decreasing	↑	↓	-
		↔	↓	-
		↓	↓	-
	Classification	RCA < 1	IPR > 0	Brazilian states
With internal potential	Increasing	↑	↑	-
		↔	↑	-
		↓	↑	-
	Stable	↑	↔	Amazonas
		↔	↔	-
		↓	↔	Mato Grosso
	Decreasing	↑	↓	-
		↔	↓	-
		↓	↑	-
	Classification	IVCR < 1	IPR < 0	Brazilian states
Inefficient	Increasing	↑	↑	Espírito Santo
	Stable	↑	↔	Pará – Tocantins
		↔	↑	Ceará – Pernambuco – São Paulo
		↔	↔	Bahia – Rio Grande do Norte – Sergipe
	Decreasing	↑	↓	Maranhão
		↔	↓	-
		↓	↑	Rio de Janeiro
		↓	↔	Distrito Federal – Goiás – Mato Grosso do Sul – Paraná – Santa Catarina
		↓	↓	Minas Gerais

Source: Elaborated by the authors based on the results.

According to a study conducted by Aragão et al. (2020), Brazil is the 9th largest rice producing country and the 10th largest exporter (by volume) in the world – despite this, the country does not appear in the ranking of the 10 largest exporters of rice in monetary values (billions of dollars), which possibly indicates that the country exports in quantity, but its product has lower added value, compared to the other exporters that are ahead in the ranking. Another important fact, according to the authors, is that in the last two decades, rice production has been stagnant in the country, without significant growth, and exports are not very expressive in the global stage (only 2% of total exports in the world in 2020).

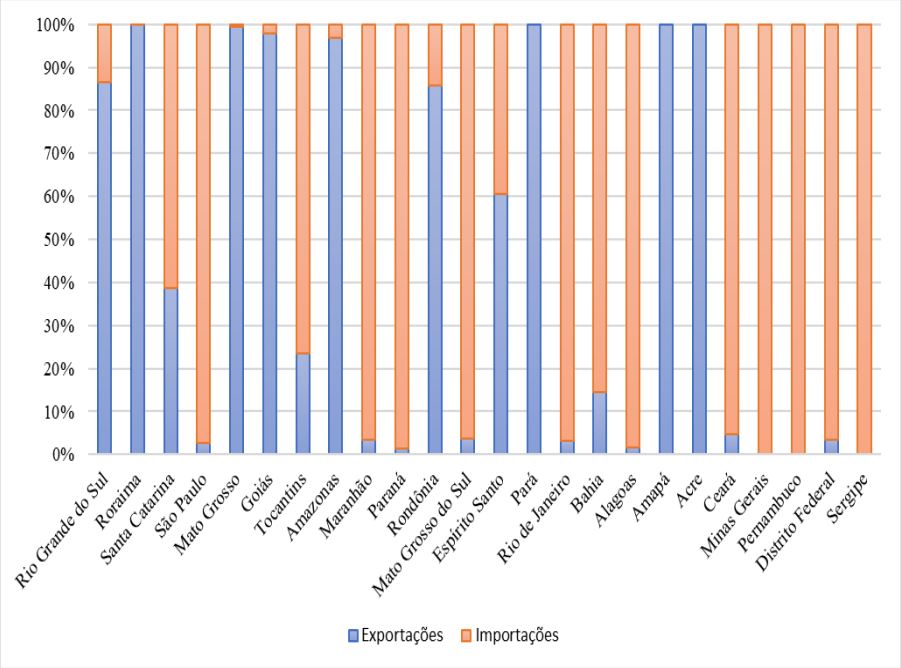
The performance matrix (Table 5) corroborates this scenario, by demonstrating that most Brazilian states still have a long way to go to become competitive in the global rice market. The classification of each Brazilian state, according to the criteria established by this research, can be summarized as follows:

- Efficient, with a positive trend: Rio Grande do Sul and Roraima are efficient in the export of rice, as they presented RCA > 1 and IPR > 0. Furthermore, the increasing long-term trend of the coefficients of the indices indicates strengthening and consolidation, suggesting that these two locations are further developing this sector.
- Efficient, but with a decreasing trend: rice is an important product in Rondônia's export basket (RCA > 1), and the state is efficient in the commercialization of this commodity to the foreign market (IPR > 0). However, the downward trend of the RCA indicates that the state may no longer have a comparative advantage, in addition to running the risk of losing efficiency in the commercialization of this commodity in the long term, which currently has a stable trend.
- With external potential and a stable trend: as mentioned earlier, Acre has comparative advantages in exporting rice (RCA > 1), but it is still not efficient in the commercialization of this commodity to the foreign market (IPR = 0). However, according to the performance matrix, the state has external potential to further improve its relative position in the international market. The stable trend of the IPR coefficient indicates that the state needs to act more decisively to improve efficiency in the international trade of its production.
- With internal potential and a stable trend: Amazonas and Mato Grosso do not have comparative advantages in exporting rice (RCA < 1), but they are efficient in the commercialization of this commodity to the foreign market (IPR > 0). This means that these two states have internal potential to improve the competitiveness of their rice sector, especially Amazonas, which has shown a positive trend for the RCA index. The decreasing trend of the RCA index for Mato Grosso indicates that its possibilities for increasing competitiveness are still limited.
- Inefficient, but with a positive trend: rice is not a relevant product in the export basket of Espírito Santo, and therefore the state is classified as “inefficient” (RCA < 1; IPR < 0). Despite that, the indices show a positive trend, which means that this situation may change in the long term, with promising prospects for the state in relation to the competitiveness of its rice sector.
- Inefficient and stable or inefficient with a negative trend: Pará, Tocantins, Ceará, Pernambuco, São Paulo, Bahia, Rio Grande do Norte and Sergipe also do not have comparative advantages in rice exports and are inefficient (RCA < 1; IPR < 0). In addition, the trend of the indices indicate that they might remain in this situation in the long term, since they were classified as “stable”, which indicates that the rice sector in these locations will not undergo major changes in the coming years. Competitiveness in the rice market for these states is no worse than for Maranhão, Rio de Janeiro, Distrito Federal, Goiás, Mato Grosso do Sul, Paraná, Santa Catarina and Minas Gerais,

which, in addition to being inefficient, also presented a negative trend, that is, these states are not efficient in the commercialization of rice to the foreign market, this commodity does not play a relevant role in their export baskets, and there are no prospects for changing this scenario in the long term.

In order to better understand the reality of the competitiveness of Brazilian states in the export of rice, it is essential to also understand the context of production and consumption, as well as the trade balance of these locations. The ratio between imports and exports of rice from Brazilian states in 2021 (Figure 1) shows that only Rio Grande do Sul, Roraima, Mato Grosso, Goiás, Amazonas, Rondônia, Espírito Santo, Pará, Amapá and Acre have a positive trade balance in this sector.

Figure 1 – Ratio between imports and exports of rice from Brazilian states in 2021.



Source: Elaborated by the authors based on the results.

Rio Grande do Sul, which occupies a prominent position in the agricultural sector in Brazil, is currently the largest producer and exporter of rice in the country. According to data from the National Water and Sanitation Agency (ANA, 2020), the state is the leader in the production of irrigated rice, occupying 72.9% of the cultivated area in Brazil. It should be noted that 90% of rice production in Brazil takes place in irrigated areas, and 96.5% of this area is concentrated mainly in six states: Rio Grande do Sul, Santa Catarina, Tocantins, Paraná, Goiás and Mato Grosso do Sul. The other 3.5% of irrigated rice area is distributed in twelve other states: Alagoas, Ceará, Maranhão, Minas Gerais, Mato Grosso, Pará, Pernambuco, Piauí, Rio Grande do Norte, Roraima, Sergipe and São Paulo (ANA, 2020).

Of these states, attention is drawn to the fact that only Rio Grande do Sul and Roraima are considered efficient, according to the classification by the performance matrix proposed in this study. Santa Catarina, Tocantins, Paraná, Goiás and Mato Grosso do Sul, which are also at the top of the ranking of the largest irrigated rice producers in Brazil (after RS, respectively), are considered inefficient in terms of the international competitiveness of their rice sector.

The explanation for this possibly lies in the fact that most of these states produce rice for domestic consumption. Some of them, as is the case of Mato Grosso do Sul, are not self-

sufficient and need to import rice from other states, or from abroad, to meet domestic demand (ANA, 2020). This is also evident in Figure 1, as the biggest rice producers are not necessarily the biggest rice exporters. Part of this scenario does not differ from the world reality, since, according to Aragão et al. (2020), rice production worldwide is mainly aimed at meeting the domestic demand of producing countries.

Even in the face of numerous challenges, Brazil, especially the southern region, has geographic characteristics and favorable climatic conditions to become a reference in the production of irrigated rice (Ribas, 2019). In addition, the sector has shown constant gains in productivity: there has been a reduction in the area planted in recent years, without a reduction in the quantity produced - this, according to ANA (2020), is due to the intensification of the use of technologies in cultivation, as well as the expansion of irrigated areas, and the better use of water for the planting of irrigated rice.

6 CONCLUSIONS

This study identified the level of competitiveness of Brazilian exporting states of rice, by calculating the Revealed Comparative Advantage index (IVCR) and the Relative Position index (IPR), and by elaborating the performance matrix proposed by Farias et al. (2018). The results show that only Rio Grande do Sul, Rondônia and Roraima have revealed comparative advantages in the export of rice, and are, at the same time, efficient in the commercialization of this commodity in the foreign market. Acre also has revealed comparative advantages, but it is still not efficient in the trade of rice in the foreign market. However, the state has the potential to be so. Amazonas and Mato Grosso do not have comparative advantages, but they have internal potential to improve the competitiveness of their rice sector.

Despite Brazil being the 9th largest rice producer in the world, and the 10th largest exporter (in tons), the results show that the sector still has a long way to go to become more competitive. According to the performance matrix, most of Brazilian states were classified as “inefficient” in terms of international rice trade.

As mentioned earlier, Brazil has favorable geographic characteristics and climatic conditions to expand rice cultivation, and the sector has shown constant increases in productivity. For these reasons and considering that rice is one of the most important cereals in the world, the country could make better use of its productive potential to increase the international competitiveness of its rice sector.

Although the results from this study are consistent, the method employed has certain limitations, since the calculated indicators are static and do not allow intertemporal comparisons. For a deeper understanding, future studies could use other competitiveness indicators, as well as other models, such as Dynamic and/or Gravitational General Equilibrium.

7 REFERENCES

AGÊNCIA NACIONAL DE ÁGUAS E SANEAMENTO BÁSICO (ANA). (2020). *Mapeamento do arroz irrigado no Brasil*. Brasília.

Alves, F. J. de C., Teixeira, F. A., & Pinto, V. H. L. (2022). Competitividade das exportações de milho de Patos de Minas, MG. *Revista de Política Agrícola*, *31*(3), 52. Repéré à https://seer.sede.embrapa.br/index.php/RPA/article/view/1745

Aragão, A. A., & Contini, E. (2020). O agro no Brasil e no mundo: uma síntese do período de 2000 a 2020. Repéré à https://www.embrapa.br/documents/10180/62618376/O+AGRO+NO+BRASIL+E+NO+MU

NDO.pdf/41e20155-5cd9-f4ad-7119-945e147396cb

Balassa, B., & Noland, M. (1989). « Revealed''' Comparative Advantage in Japan and the United States on JSTOR ». Repéré à https://www.jstor.org/stable/23000034

Brasil. (2022). *Ministério da Agricultura, Pecuária e Abastecimento - MAPA. Balança Comercial do Agronegócio de julho de 2022*. Brasilia.

Carvalho, M. A., & Silva, C. R. L. (1999). *Economia Internacional*. São Paulo : Saraiva.

Coronel, D. A., Sousa, E. P. de, & Amorim, A. L. (2011). Desempenho exportador do mel natural nos estados brasileiros. *Pesquisa & Debate Revista do Programa de Estudos Pós-Graduados em Economia Política*, *22*(2(40)), 343-360. Repéré à https://revistas.pucsp.br/index.php/rpe/article/view/11749

Coutinho, E. S., de Vilhena Lana-Peixoto, F., Ribeiro Filho, P. Z., & Amaral, H. F. (2005). De Smith a Porter: um ensaio sobre as teorias de comércio exterior. *REGE Revista de Gestão*, *12*(4), 101-113.

ESSIG, B. (2018). Brasil importa arroz do Mercosul mesmo sem precisar. Canal Rural. *Canal Rural. Porto Alegre*. Repéré à https://www.canalrural.com.br/programas/brasil-importa-arroz-mercosul-mesmo-sem-precisar-72029/

Farias, A. C. da S., & Farias, R. B. A. (2018). Desempenho comparativo entre países exportadores de pescado no comércio internacional: Brasil eficiente? *Revista de Economia e Sociologia Rural*, *56*, 451-466.

Ferreira, C. M., Wander, A. E., & Silva, O. F. (2021). da. Mercado, comercialização e consumo. Cultivo do Arroz. Brasília : Embrapa. Repéré à https://www.embrapa.br/agencia-de-informacao-tecnologica/cultivos/arroz/pre-producao/socioeconomia/mercado-comercializacao-e-consumo

Gennari, A. M. (2009). *História do pensamento econômico*. (S.l.) : Saraiva Educação SA.

Hidalgo, Á. B., & Feistel, P. R. (2013). Mudanças na estrutura do comércio exterior brasileiro: uma análise sob a ótica da teoria de Heckscher-Ohlin. *Estudos Econômicos (São Paulo)*, *43*(1), 79-108. https://doi.org/10.1590/S0101-41612013000100004

Lafay, G. (1999). *Nations et mondialisation*. (S.l.) : Economica, Editions (FR).

Marion Filho, P. J., & Einloft, N. E. (2008). A competitividade do arroz irrigado brasileiro no Mercosul. *Organizações Rurais & Agroindustriais*, *10*(1).

MINISTÉRIO DE DESENVOLVIMENTO INDÚSTRIA COMÉRCIO E SERVIÇOS - MDIC. (2022). Comex Stat: Exportação e Importação Geral.

Nunes, S. P. (2007). O desenvolvimento da agricultura brasileira e mundial e a idéia de Desenvolvimento Rural. *Departamento de Estudos Sócio-Econômicos Rurais, nº157*. Repéré à http://www.deser.org.br/documentos/doc/DesenvolvimentoRural.pdf

Ribas, G. C. et al. (2019). Quanto é a produtividade potencial, a atual, e a lacuna de produtividade de arroz irrigado no Brasil? *Planeta Arroz*, *70*.

Ricardo, D. (1982). *Princípios de Economia Política e Tributação*. São Paulo : Abril Cultural.

Sato, L. K. I., Reis, J. G. M. dos, Lopes, A. C. V., & Formigoni, A. (2021). The evolution of rice Brazilian exports and its competitiveness face on Mercosur countries.

SILVA, O. S. da.; WANDER, A. E.; FERREIRA, C. M. (2021). . *Importância econômica e social. Cultivo do Arroz. Embrapa*. Brasilia : Embrapa. Repéré à https://www.embrapa.br/agencia-de-informacao-tecnologica/cultivos/arroz/pre-producao/socioeconomia/importancia-economica-e-social

Siqueira, K. B., & Pinha, L. C. (2011). Vantagens comparativas reveladas do Brasil no comércio internacional de lácteos. *Boletim de Pesquisa e Desenvolvimento. Embrapa Gado*.

Souza, A. R. L., Révillion, J. P., Waquil, P. D., & Belarmino, L. C. (2016). Análise da competitividade da cadeia produtiva de arroz beneficiado do Rio Grande do Sul: um estudo utilizando a Matriz de Análise de Políticas (MAP).

Wander, A. E. (2006). A competitividade do agronegócio brasileiro de arroz. *Revista Custos e Agronegócio Online*, *12*(2). Repéré à www.custoseagronegocioonline.com.br

Wooldridge, J. M. (2015). *Introductory econometrics: A modern approach*. (S.l.) : Cengage Learning.