

## Inter-annual dynamics (2001-2020) of a cashew crop in the municipality of Jacaraú, Paraíba, Brazil

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### ABSTRACT

Cashew farming is an activity of great economic importance for many areas of the Northeast of Brazil. In the state of Paraíba, the seventh-largest producer of cashew nuts in Brazil, a municipality of prominence in cashew culture is Jacaraú, known regionally for its production of cashew nuts. In this sense, this study aimed to analyse the productive dynamics of cashew production in Jacaraú in the period from 2001 to 2020, seeking to analyse the performance and the factors that interact in this production chain. The data were obtained from the database of the Municipal Agricultural Survey of the Brazilian Institute of Geography and Statistics (IBGE), from which five variables were extracted: harvested area – the percentage of the total, harvested area, quantity produced, productivity, and value of production. The cashew culture is an agricultural activity of great relevance for Jacaraú, with strong participation in the total percentage of the areas harvested with permanent crops in this municipality; however, a strong reduction in the area harvested with this crop was registered, as well as in the quantity produced. The results together show improvements in the production variables in the last two years of the period under analysis, derived mainly from improved productivity and that are a consequence of government efforts to strengthen this production chain. However, these actions need to be continuous and focus on the introduction of more productive and early materials, as well as management strategies suitable for this crop.

**Keywords:** *Anacardium occidentale* L., Cashew nuts, Permanent crops.

## Dinâmica Interanual (2001-2020) da Cajucultura no Município de Jacaraú, Paraíba

### RESUMO

A cajucultura é uma atividade de grande importância econômica para muitas regiões do Nordeste do Brasil. No estado da Paraíba, sétimo maior produtor de castanha de caju do Brasil, um município de destaque na cajucultura é Jacaraú, conhecido regionalmente pela produção de castanha de caju. Nesse sentido, este estudo teve como objetivo analisar a dinâmica produtiva da produção de caju em Jacaraú no período de 2001 a 2020, buscando analisar o desempenho e os fatores que interagem nessa cadeia produtiva. Os dados foram obtidos do banco de dados da Pesquisa Agropecuária Municipal do Instituto Brasileiro de Geografia e Estatística (IBGE), de onde foram extraídas cinco variáveis: área colhida – percentual do total geral, área colhida, quantidade produzida, produtividade e valor da produção. A cajucultura é uma atividade agrícola de grande relevância para Jacaraú, com forte participação no percentual total das áreas colhidas com lavouras permanentes neste município; no entanto, registrou-se uma forte redução da área colhida com esta cultura, bem como da quantidade produzida. Os resultados em conjunto mostram melhorias nas variáveis produtivas nos dois últimos anos do período analisado, decorrentes principalmente da melhoria da produtividade e que são consequência dos esforços governamentais para fortalecer essa cadeia produtiva. No entanto, essas ações precisam ser contínuas e focar na introdução de materiais mais produtivos e precoces, bem como em estratégias de manejo adequadas para essa cultura.

**Palavras-chave:** *Anacardium occidentale* L., Castanha de caju, Lavouras permanentes.

## 1. Introduction

*Anacardium occidentale* L. (Anacardiaceae), the cashew tree, is native to the Brazilian North and Northeast regions and has been introduced in other countries (Leitão et al., 2013). In the cashew tree, the true fruit is the nut, which is an achene composed of the pericarp and the kernel. The peduncle, commonly known as the fruit by consumers, is a pseudofruit, varying from yellow to red. Both the chestnut and the peduncle are edible products, but the chestnut must be processed for shell removal since it has corrosive compounds (Brito et al., 2018).

This fruit production has great economic value for both large and small farmers in emerging countries, such as Brazil. It also has a high potential for expanding its production chain, especially by using cashew by-products, which can add value to this segment (Oliveira et al., 2020).

The cashew tree provides four products: the nut, the pseudofruit, the starch, and the wood. The nut is the main value-added product and it is marketed to consumers and companies around the world. The nut or its processed form is an ingredient in a wide variety of food. The pseudofruit produces juices and sweets, attracting great interest from several production chains. The starch has new applications and can be extracted from the cashew trunk and sold to the food industry. The renewal of the cashew orchards also produces wood, which can be consumed as firewood in industrial processes (Figueirêdo et al., 2016).

Cashew farming is an important commercial crop and source of income for several people, especially in Northeastern Brazil. In general, these people handle growing the plant, harvesting the nut, processing, and marketing the products (Freire et al., 2002). In this region, in 2020, cashew production occupied an area of more than 400,000 hectares (SIDRA, 2021). This represents the areas cultivated with cashew in Brazil. The harvest period requires intense labor and takes place in the dry season, which is an important strategy to reduce fluctuations in the number of farmworkers (Morais et al., 2017).

Traditional cashew orchards in Northeastern Brazil are heterozygous tree crops and scattered tall trees. They do not receive any management technique, such as pruning, fertilization, or chemical spraying (Freire et al., 2002). The cashew tree has genetic variability divided into two types based on the size of the plant: the common cashew and the dwarf cashew. The common cashew tree is still the most cultivated, growing to a height of 8-15 m and a crown up to 20 m wide (Almeida et al., 2017), demanding more effort in the harvest stage (Silva et al., 2018).

In the Northeastern Brazil cashew crop, approximately

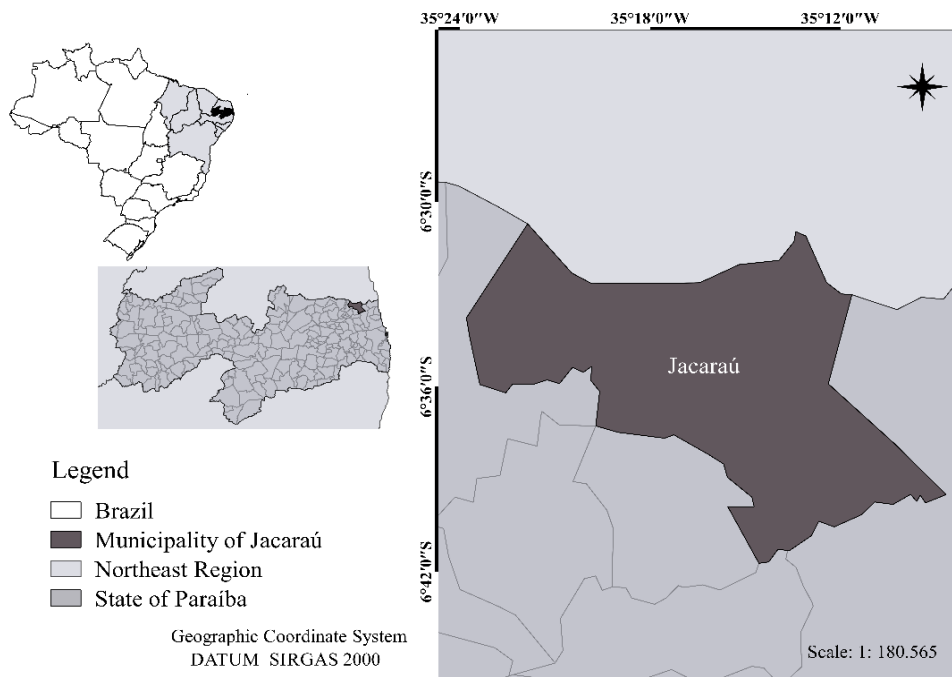
75% of producers are family farmers, who grow the fruit in areas of less than 20 hectares. However, they generate a considerable number of jobs, which directly and indirectly reaches 250 thousand individuals. Moreover, cashew production allows intercropping with other crops such as rice, beans, cassava, and corn (Alencar et al., 2018a). Cashew farming also fosters a multi-product industry, with approximately 30 by-products derived from cashew. This reinforces the national and international growth outlook, due to the range of products processed from the raw material (Almeida et al., 2017).

In Paraíba, the seventh-largest producer of cashew nuts in Brazil (SIDRA, 2021), the municipality of Jacaraú is regionally known for its production of cashew nuts and as “The Land of Cashew Nuts”. However, several environmental factors and agricultural management influence the production of permanent crops such as cashew. In this sense, this study analyzes the dynamics of cashew production in Jacaraú from 2001 to 2020, considering the performance and the factors that interact in this production chain.

## 2. Material and Methods

The municipality of Jacaraú (Figure 1) is located in the Mata Paraibana Mesoregion, an approximate area of 256.845 km<sup>2</sup>. It is predominantly in the geoenvironmental unit of the Coastal Tablelands and the hydrographic basins of the Camaratuba and Curimataú rivers. All local watercourses have a perennial flow regime and a dendritic drainage pattern (CPRM, 2005). Jacaraú is in a transition area between Caatinga and Atlantic Forest (IBGE, 2021) and presents an average annual rainfall of 1424.5 mm (AESA, 2021). In 2021, the population was about 14,467 inhabitants (IBGE, 2021).

The soil in the municipality is composed of Latosols and Podzolics soils in the plateau tops and residual tops; Podzolics soil in the small depressions in the tablelands and dissected areas and slopes; and Gleysols and Alluvial soils in the floodplain areas (CPRM, 2005). The data considered in this research were based on the Municipal Agricultural Survey (PAM) of the Brazilian Institute of Geography and Statistics (IBGE) database. For this purpose, we accessed table 1613, which has information about permanent crops. The production of cashew nuts in the municipality of Jacaraú, in Paraíba, was selected for the period between 2001 and 2020. The data were extracted by using an Automatic Data Retrieval System (SIDRA, 2021) and were organized into tables and figures using Microsoft Excel® software.



**Figure 1.** Location of the municipality of Jacaraú, Paraíba, Brazil.

Five variables related to the production of cashew nuts were evaluated: (a) the total percentage of the harvested area (%), representing the cashew nuts harvested areas in the total harvested areas with permanent crops in the municipality; (b) harvested area in hectares (ha), indicating the total annual area effectively harvested with this crop; (c) quantity produced in tons (t), corresponding to the annual quantity of cashew nuts harvested in the municipality; (d) average yield in kilograms per hectare (kg/ha), obtained by the ratio between the quantity produced and the harvested area; and (e) the production value (in thousands of R\$), calculated by the weighted average of the quantity produced and the average of the current price paid to the producer.

In recent years, Information and Communication Technology (ICT) has been consolidated as an efficient technological resource and a strategy for any productive sector development. This better integrates and enables information dissemination among stakeholders. Among the various ICT technological resources, the IBGE System of Automatic Recovery (SIDRA) is relevant to understanding Brazilian agribusiness, as it releases several data relating to national agriculture and livestock (Alencar et al., 2018a).

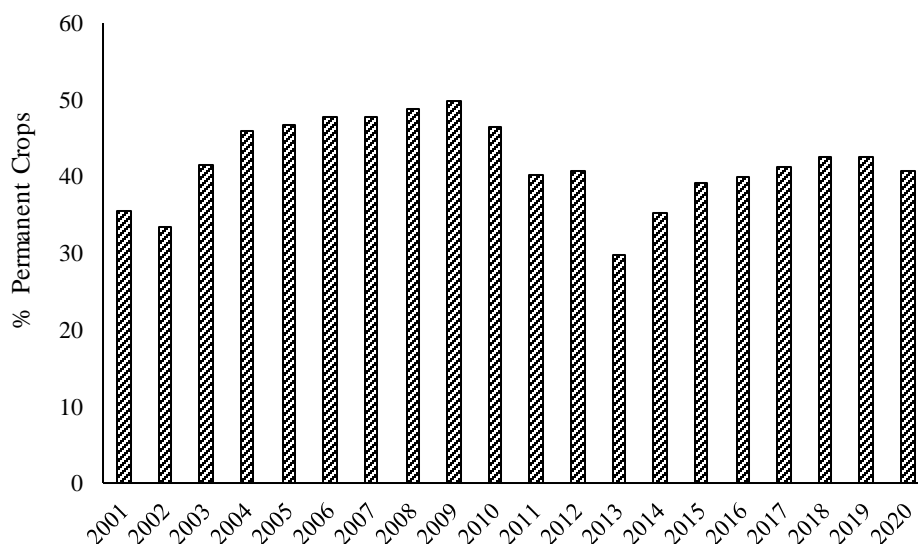
After being extracted, the data were organized into tables and figures using Microsoft Excel® software. Subsequently, this data matrix was also submitted to a Principal Component Analysis (PCA). The use of PCA is an important tool for analyzing the interannual dynamics of agricultural crop production, facilitating the joint interpretation of the original data matrix (Araújo et al., 2021). The PCA was obtained from the FactoMineR

package (Factor Analysis and Data Mining with R) (Lê et al., 2008) in the R software version 3.6.1 (R Core Team, 2019).

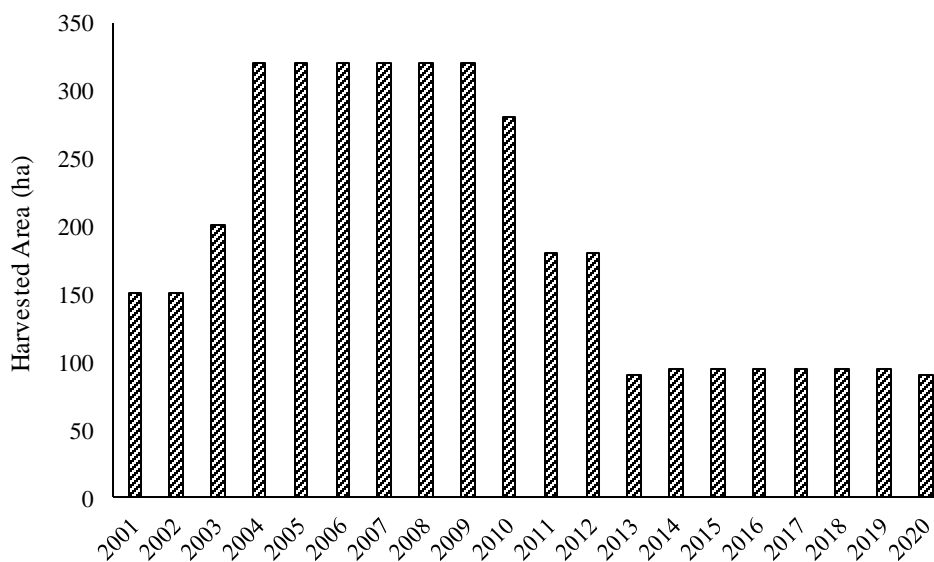
### 3. Results and Discussion

Cashew farming is an important agricultural activity in Jacaraú, presenting a high total percentage of the harvested areas with permanent crops. During the studied period, this crop reached a maximum value of 49.84% in 2009 and a minimum value of 29.61% in 2013 (Figure 2). This crop has great socio-economic importance in the regions where it is produced, due to the production system applied, based on small farmers. It generates jobs during the harvest period, which occurs in the off-season of other crops, and contributes to the permanence of the farmers in the field (Almeida et al., 2017).

The cashew harvested area in Jacaraú presented strong oscillations. The harvested area increased from 2003 onwards and achieved the maximum values (320 ha) in the period 2004-2009. Later, this variable significantly decreased, especially from 2013 onwards, when the crop harvested area was less than 100 hectares (Figure 3). Other producing regions in Northeastern Brazil also reported a decrease in the cashew harvested area, such as the cashew production areas in Piauí, where the decrease was higher than 50% (Farias et al., 2018). This decrease directly affects the amount of nuts produced, which is the main economic product of this sector. Several factors could cause this decrease, such as the extended periods of drought that lead this crop to suffer a strong water deficit, the lack of tax incentives for small farmers, and the advanced age of the crops (Alencar et al., 2018a).



**Figure 2.** Share of cashew nut harvested area in the total harvested area with permanent crops in Jacaraú, Paraíba, Brazil



**Figure 3.** Cashew nuts harvested area (ha) in Jacaraú, Paraíba, Brazil, between 2001 and 2020

The cashew harvested area has presented a significant decrease in the last eight years (Figure 3), but this same trend was not observed for this crop in the total harvested area with permanent crops in Jacaraú (Figure 2). These results indicate that the other temporary crops produced in the municipality also showed a decrease in their harvested areas during the same period. The dry season, which started in 2012, has severely impacted the permanent crops, especially those grown in rainfed regimes, such as cashew (Nascimento et al., 2021).

Based on the harvested area results, the studies also showed the highest values of cashew nut production in the period 2004-2009 (Table 1). In the following years, this variable has significantly decreased, reaching the production of only 5 tons in 2015. Other regions of

Paraíba, such as the municipality of Boqueirão, also reported decreases in cashew production in this period (Farias et al., 2017). However, the quantity produced has improved at the end of the period investigated, which indicates a recovery in the cashew production in Jacaraú.

The average yield for cashew nut production presented a strong variability, with a maximum value of 700 kg/ha in 2001 and a minimum value of 53 kg/ha in 2015 (Table 1), i.e., it reduced up to 92.4%. However, the local productivity has recovered in recent years and showed promising results. In 2020, for example, the average yield was 500 kg/ha, which was higher than the average yield for cashew nut production in Brazil (328 kg/ha), the Northeast (327 kg/ha), and Paraíba (258 kg/ha) (SIDRA, 2021).

However, the local productivity could be even higher by the massive use of more adapted varieties with higher yields. For example, some varieties developed by the Brazilian Agricultural Research Corporation (EMBRAPA), such as the clones CCP76, EMBRAPA51, BRS274, and BRS275, can achieve yields greater than 1,200 kilograms of nuts per hectare and still present the potential for marketing cashew as table fruit (Bomtempo and Silva, 2018). The production value for cashew nuts in Jacaraú also showed strong inter-annual variability (Table 1). The highest values were in 2004, 2005, 2008, and 2009. Like the quantity produced and the average yield, the study reported the lowest production value in 2015. However, in the following years, this variable increased, especially in the last two years analyzed, in which the production value reached levels close to its best performance for the period analyzed.

This production value comes only from raw product marketing. The economic impact of cashew farming in Jacaraú is even greater, especially considering the marketing of fresh cashew pseudofruit or its pulp and the processed cashew nuts. Cashew production has presented a significant social and economic impact in the Northeast region. Since the 1970s, cashew nuts have been a source of livelihood for many families in this region (Silva et al., 2018). The pseudofruit can generate good added value, such as juice, jams, and jellies, and its use should be encouraged. However, nationally, less than 10% of the pulp produced from the pseudofruit is consumed (Cefali et al., 2020). Despite the lack of data about the production

of cashew pseudofruit in the IBGE database, it is possible that in regions where the agro-industries process the pulp, the production of pseudofruit has become economically more important than the nut (Alencar et al., 2018b).

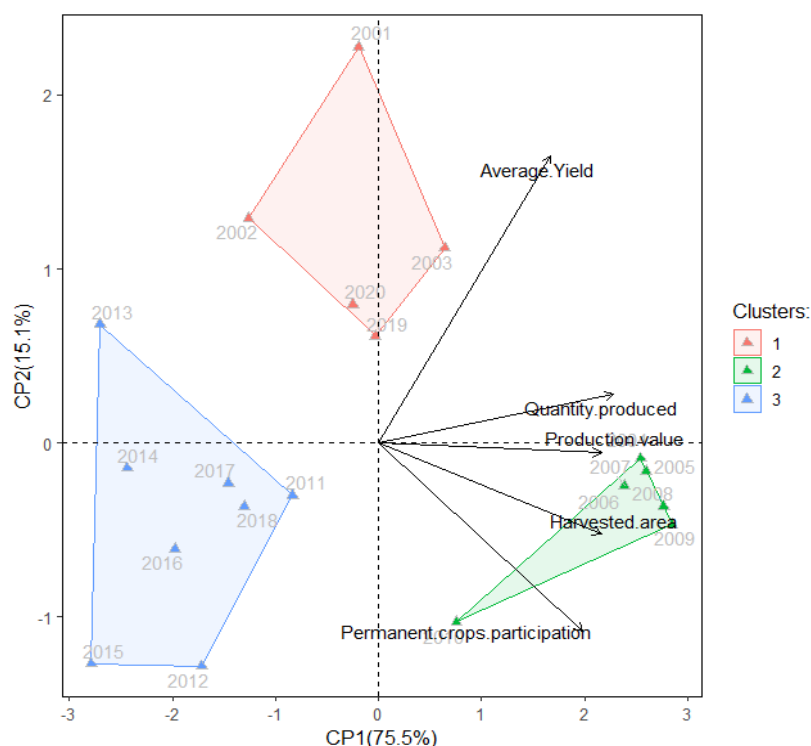
The results of the cashew nut harvested area strongly decreased from 2013 and remained at this level. In contrast, improvements in the production variables were achieved in the last two years of the period investigated. These results derive from higher productivity and governmental efforts to strengthen the production chain in Jacaraú. However, these actions must be continuous and introduce more productive and precocious materials and proper management strategies for this crop.

The principal component analysis (PCA) explained 90.6% of the original variance of the data in its first two axes (CP1 and CP2) (Figure 4). In axis 1, which gathers 75.5% of the data explanation, a significant association ( $p < 0.001$ ) is observed between quantity produced ( $r = 0.96$ ), the value of production ( $r = 0.91$ ), and harvested area ( $r = 0.91$ ), demonstrating strong participation of these variables for this axis. Thus, in Jacaraú, better production and economic results are associated with larger harvested areas, a scenario that in recent years has shown a tendency to change, with an increase in the role of productivity as an actor for the dynamism of this product segment in the municipality. Thus, it indicates the beginning of a migration to more technified production models, which is an essential requirement for the achievement of better production rates locally (Silva et al., 2018).

**Table 1.** Productive and economic variables to produce cashew nuts in Jacaraú, Paraíba, Brazil, between 2001 and 2020.

Year	Quantity Produced (t)	Average Yield (kg/ha)	Production Value (thousand R\$)
2001	105	700	47
2002	70	466	39
2003	120	600	71
2004	160	500	160
2005	160	500	160
2006	160	500	128
2007	160	500	128
2008	160	500	160
2009	160	500	160
2010	90	321	90
2011	54	300	65
2012	22	122	35
2013	23	256	39
2014	19	200	34
2015	5	53	9
2016	19	200	44
2017	29	305	52
2018	29	305	58
2019	48	505	130
2020	45	500	131

Source: SIDRA (2021).



**Figure 4.** Principal Component Analysis (PCA) of the productive and economic variables of cashew nut production in Jacaraú, Paraíba, in the period 2001-2020.

The PCA also allowed the formation of three clusters (C1, C2, and C3) with distinct characteristics. C1 grouped the years that, although they did not have the largest harvested areas, showed good average yield values. In C2, the years that together presented the best metrics related to harvested area, the value of production, the quantity of cashew nuts produced, and the participation of this activity in the total of permanent crops were grouped. In C3, the years with the worst production performance during the sample period are observed.

In axis 2, which gathers 15.1% of the original variance of the data, there is a significant ( $p < 0.05$ ) and antagonistic association between average yield ( $r = -0.69$ ) and participation of this culture in the total of permanent plantations ( $r = -0.45$ ). Thus, it is evident that years with good productivity do not necessarily generate greater participation of cashew in the total permanent crops, for example, the year 2001, which, although it presented the highest average yield among the years analyzed, presented lower participation in permanent crops when compared to other years that presented a lower yield.

#### 4. Conclusions

Cashew production in the municipality of Jacaraú, Brazil, has a high inter-annual production variability. This is partly due to the local vulnerability of this crop to long drought events, as well as to the low level of the techniques applied. At the end of the period analyzed,

some variables presented better results for this productive sector. However, given the cashew production importance for Jacaraú, continuous actions to encourage this sector are still necessary.

#### Authors' Contribution

Silvio Lisboa de Souza Júnior contributed in the data collection, analysis and interpretation of results, writing of the manuscript and final correction of the manuscript. Daniel Duarte Pereira contributed to analysis and interpretation of results, writing of the manuscript and final correction of the manuscript. Paulo Henrique de Almeida Cartaxo contributed to analysis and interpretation of results, writing of the manuscript and final correction of the manuscript.

José Rayan Eraldo Souza Araújo contributed in the data collection, analysis and interpretation of results, writing of the manuscript and final correction of the manuscript. João Paulo de Oliveira Santos contributed to analysis and interpretation of results, writing of the manuscript and final correction of the manuscript.

#### Bibliographic References

AESA. AGÊNCIA EXECUTIVA DE GESTÃO DAS ÁGUAS DO ESTADO DA PARAÍBA. 2021. Meteorologia. <http://www.aesa.pb.gov.br/aesa-website/meteorologia-chuvas/>. (accessed October 05, 2021).

- Alencar, N.S., Gonçalves, J.F., Oliveira, E.A.F., Lucena, T.C., Sousa, R.M. 2018a. Produção da Castanha de Caju nas microrregiões do Ceará no período de 1993 a 2016. *Revista Eletrônica Competências Digitais para Agricultura Familiar*, 4(1), 103-116. <https://owl.tupa.unesp.br/recodaf/index.php/recodaf/article/72/131>. (accessed October 05, 2021).
- Alencar, P.G., Espindola, G.M., Carneiro, E.L.N.C. 2018b. Dwarf cashew crop expansion in the Brazilian semiarid region: Assessing policy alternatives in Pio IX, Piauí. *Land Use Policy*, 79(1), 1-9. DOI: <https://doi.org/10.1016/j.landusepol.2018.07.042>
- Almeida, L.H.F., Cordeiro, S.A., Pereira, R.S., Couto, L.C., Lacerda, K.W.S. 2017. Viabilidade econômica da produção de caju (*Anacardium occidentale* L.). *Nativa*, 5(1), 09-15. DOI: <https://doi.org/10.31413/nativa.v5i1.4115>
- Araújo, J.R.E.S., Silva, J.H.B., Batista, M.C., Sabino, B.T.S., Almeida, I.V.B., Abreu, K.G., Araújo, E.F.B., Santos, J.P.O. 2021. Agricultura de sequeiro e variabilidade produtiva de uma cultura de subsistência em Gado Bravo, Semiárido da Paraíba. *Diversitas Journal*, 6(3), 2905-2918. DOI: [https://doi.org/10.48017/Diversitas\\_Journal-v6i3-1862](https://doi.org/10.48017/Diversitas_Journal-v6i3-1862)
- Bomtempo, D.C., Silva, E.B. 2018. Cajucultura cearense: a produção familiar em Beberibe-CE. *Revista GeoNordeste*, 29(1), 145-159. <https://seer.ufs.br/index.php/geonordeste/article/view/7573>. (accessed October 05, 2021).
- Brito, E.S., Silva, E.O., Rodrigues, S. 2018. Caju—*Anacardium occidentale*. In: *Exotic Fruits*. Academic Press, p. 85-89. DOI: <https://doi.org/10.1016/B978-0-12-803138-4.00012-5>
- Cefali, L.C., Vazquez, C., Ataíde, J.A., Figueiredo, M.C., Ruiz, A.L.T.G., Foglio, M.A., Mazzola, P.G. 2020. In vitro activity and formulation of a flavonoid-containing cashew pulp extract for the topical treatment of acne and the protection of skin against premature aging. *Natural product research*, 35(23), 5243-5249. DOI: <https://doi.org/10.1080/14786419.2020.1747454>
- CPRM. COMPANHIA DE PESQUISA DE RECURSOS MINERAIS. 2005. Diagnóstico do município de Jacaraú, estado da Paraíba. CPRM/PRODEEM, Recife. [https://rigeo.cprm.gov.br/jspui/bitstream/doc/16085/1/Rel\\_Jacaraú.pdf](https://rigeo.cprm.gov.br/jspui/bitstream/doc/16085/1/Rel_Jacaraú.pdf). (accessed October 05, 2021).
- Farias, A.A.D., Sousa, F.D.A.S.D., Moraes, J.M., Alves, A.D.S. 2017. Secas e seus impactos no município de Boqueirão, PB, Brasil. *Revista Ambiente & Água*, 12(2), 316-330. DOI: <http://dx.doi.org/10.4136/ambi-agua.2004>
- Farias, J.C., Batista, M.L.P., Andrade, I.M. 2018. Impactos das mudanças climáticas na agricultura e na produção de caju (*Anacardium occidentale* L.), na região Nordeste do Brasil. *Educação Ambiental em Ação*, 17(66), 1-14. <https://www.revistaea.org/artigo.php?idartigo=3496>. (accessed October 02, 2021).
- Figueirêdo, M.C.B., Potting, J., Serrano, L.A.L., Bezerra, M.A., Silva Barros, V., Gondim, R.S., Nemecek, T. 2016. Environmental assessment of tropical perennial crops: the case of the Brazilian cashew. *Journal of Cleaner Production*, 112(1), 131-140. DOI: <https://doi.org/10.1016/j.jclepro.2015.05.134>
- Freire, F.C.O., Cardoso, J.E., Santos, A.A., Viana, F.M.P. 2002. Diseases of cashew nut plants (*Anacardium occidentale* L.) in Brazil. *Crop Protection*, 21(6), 489-494. DOI: [https://doi.org/10.1016/S0261-2194\(01\)00138-7](https://doi.org/10.1016/S0261-2194(01)00138-7)
- IBGE. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. 2021. Cidades. <https://cidades.ibge.gov.br/brasil/pb/jacarau/panorama>. (accessed October 02, 2021).
- Lê, S., Josse, J., Husson, F. 2008. FactoMineR: an R package for multivariate analysis. *Journal of statistical software*, 25(1), 1-18. DOI: <https://doi.org/10.18637/jss.v025.i01>
- Leitão, N.C.M.C.D.S., Prado, G.H.C., Veggi, P.C., Meireles, M.A.A., Pereira, C.G. 2013. *Anacardium occidentale* L. leaves extraction via SFE: Global yields, extraction kinetics, mathematical modeling and economic evaluation. *The Journal of Supercritical Fluids*, 78(1), 114-123. DOI: <https://doi.org/10.1016/j.supflu.2013.03.024>
- Morais, S.M., Silva, K.A., Araujo, H., Vieira, I.G., Alves, D.R., Fontenelle, R.O., Silva, A. 2017. Anacardic acid constituents from cashew nut shell liquid: NMR characterization and the effect of unsaturation on its biological activities. *Pharmaceuticals*, 10(1), e31. DOI: <https://doi.org/10.3390/ph10010031>
- Nascimento, J.M., Alencar, N.S., Alves, D.F., Lima Júnior, F. 2021. Estudo dos efeitos da seca sobre a produção e a exportação das principais frutas cearenses (2012 a 2015). *Práticas Educativas, Memórias e Oralidades-Rev. Pemo*, 3(3), e337168. DOI: <https://doi.org/10.47149/pemo.v3i3.7168>
- Oliveira, N., Mothé, C.G., Mothé, M.G., Oliveira, L.G. 2020. Cashew nut and cashew apple: a scientific and technological monitoring worldwide review. *Journal of Food Science and Technology*, 57(1), 12-21. DOI: <https://doi.org/10.1007/s13197-019-04051-7>
- R Core Team. R: A language and environment for statistical computing. 2019. R Foundation for Statistical Computing, Vienna, Austria.
- SIDRA. SISTEMA IBGE DE RECUPERAÇÃO AUTOMÁTICA. 2021. Produção Agrícola Municipal. <https://sidra.ibge.gov.br/pesquisa/pam/tabelas>. (accessed October 02, 2021).
- Silva, M.E., Pereira, S.C., Gold, S. 2018. The response of the Brazilian cashew nut supply chain to natural disasters: A practice-based view. *Journal of Cleaner Production*, 204(1), 60-671. DOI: <https://doi.org/10.1016/j.jclepro.2018.08.340>