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CHALLENGES AND PERSPECTIVES RELATED TO CLIMATE CHANGE AND FOOD SECURITY IN BRAZIL

DESAFIOS E PERSPECTIVAS RELACIONADOS ÀS MUDANÇAS CLIMÁTICAS E À SEGURANÇA ALIMENTAR NO BRASIL

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Abstract

The article explores the relationship between climate change and food security, emphasizing the challenges confronting the global agricultural sector, with a particular focus on Brazil. Climate change has intensified extreme events such as droughts, floods, and heatwaves, adversely affecting agriculture and quality of life. The research utilized the Science Direct database to analyze peer-reviewed articles related to climate change and food security. Direct impacts of climate change on the productivity of crops such as rice, soybeans, and maize were identified, influenced by factors like temperature, precipitation, and solar radiation. Deforestation and land-use changes also contribute to alterations in rainfall patterns, reducing agricultural productivity. Consequently, forest preservation is highlighted as essential for food security, as it regulates microclimates and hydrological cycles. Policies that promote forest conservation and agricultural adaptation are critical to addressing climate challenges, protecting biodiversity, and ensuring sustainable food production.

Keywords: Agriculture; Sustainable Development; Deforestation.

Resumo

O artigo aborda a relação entre mudanças climáticas e segurança alimentar, destacando os desafios enfrentados pelo setor agrícola global, com foco no Brasil. As mudanças climáticas têm intensificado eventos extremos, como secas, inundações e ondas de calor, impactando negativamente a agricultura e a qualidade de vida. A pesquisa utilizou a base de dados Science Direct, analisando artigos relacionados ao tema. Assim, foram identificados impactos diretos das mudanças climáticas na produtividade de culturas como arroz, soja e milho, influenciados por fatores como temperatura, precipitação e radiação solar. O desmatamento e as mudanças no uso do solo também contribuem para alterações nos padrões de chuva, reduzindo a produtividade agrícola. Desse modo, a preservação florestal é apontada como essencial para a segurança alimentar, regulando o microclima e os ciclos hidrológicos. Políticas que promovam a conservação das florestas e a adaptação agrícola são fundamentais para enfrentar os desafios climáticos, proteger a biodiversidade e sustentar a produção de alimentos.

Palavras-chave: Agricultura; Desenvolvimento Sustentável; Desmatamento.

1. Introduction

Climate can be defined as the long-term atmospheric conditions that characterize a region, being influenced by economic, social and environmental activities, especially those of agribusiness which in all phases of agricultural development are affected by climate interference (Werndl, 2016; Tol, 2018;

Palinkas and Wong, 2020).

In recent decades climate change has become a central topic in public debate, primarily from the perspective of sustainable development due to its significant importance for society. In this context, the agricultural sector represents a globally concerning scenario, as sufficient food production and supply are threatened by irreversible climate variability. In turn, this is challenging global food patterns, particularly in countries where agriculture is an integral part of their economy and total productivity such as Brazil. Therefore, mitigating the impacts of climate change must be of utmost importance and this global threat requires commitment to address its dire implications in order to ensure global livelihood (Otto et al., 2019; Abbass et al., 2022).

Climate change is a global reality with noticeable impacts across all continents due to temperature variations. These changes have intensified the occurrence of extreme events, particularly affecting urban environments and their inhabitants. Examples of these phenomena include floods, droughts, wildfires and heatwaves or cold spells, all of which negatively influence the quality of life and human health (Salvalaio et al., 2023).

Since the mid-20th century extreme heat events have become more frequent while cold events have been decreasing. With the continuous rise in global temperatures the occurrence of heatwaves is expected to increase further, even if warming is limited to levels considered acceptable to avoid severe impacts. If the temperature increase reaches higher values such as 3°C above pre-industrial levels, the intensity of these heat extremes could multiply significantly exacerbating the climate challenges faced worldwide (IPCC, 2014).

Global climate changes, which are likely to intensify economic disparities between countries, highlight the need for adaptation in cities to cope with the impacts of these phenomena. Developing nations such as Brazil may be particularly affected, as climate change could result in higher costs for housing, food, and healthcare. Additionally, it is essential to consider climate impacts from the perspective of human issues, analyzing the vulnerability of populations in the face of these challenges (IPCC, 2014).

In this context, research indicates that climate change negatively impacts

food security. These impacts are related to various factors such as poverty, education levels, unemployment, rising food prices, difficulty accessing food, lack of land or property rights, poor working conditions and climate or environmental issues. The severity of these effects will depend on the ability to adapt and respond to the new circumstances (Ziska, et al., 2009).

Since the early 1990s the number of extreme climate events such as heatwaves, droughts, floods and storms has doubled with an average of 213 occurrences annually between 1990 and 2016. Among the observed risks, the increase in rainfall variability stands out, resulting in more frequent and severe floods and droughts, changes in river runoff, reduced agricultural productivity, a global temperature rise between 1.8°C and 4°C, alterations in soil composition and changes in disease vector cycles, which have directly impacted public health. In this context, some crops show greater sensitivity to climate change such as wheat, which is more susceptible to temperature variations compared to rice for example (Myers et al., 2017; Jaime et al., 2018).

In this context, the aim of the present article is to conduct a literature review providing an overview of the relationship between climate change and food security to elucidate the current challenges and perspectives in Brazil.

2. Material and methods

The research was conducted in the Science Direct database (https://www.sciencedirect.com/) from November to December 2024 using the combination of the descriptors: [climate change and food security] in the title.

Considering that this review article aims to bridge the topic of climate change with food security, we chose to use only Science Direct, as it is one of the leading databases for scientific articles worldwide in the environmental and climate fields.

The inclusion criteria were: (1) only original articles; (2) articles in English; (3) direct relevance to the established topics. Abstracts, monographs, dissertations, theses, and book chapters were excluded.

For the development of the review, titles were initially assessed, followed by the reading of abstracts and, subsequently, the full texts of the studies. Based on

the search criteria for the year 2023, a total of 10,849 articles were found. Then, review articles were selected, resulting in 7,385 articles. Subsequently, articles in the environmental science field were identified, totaling 360 articles (Figure 1).

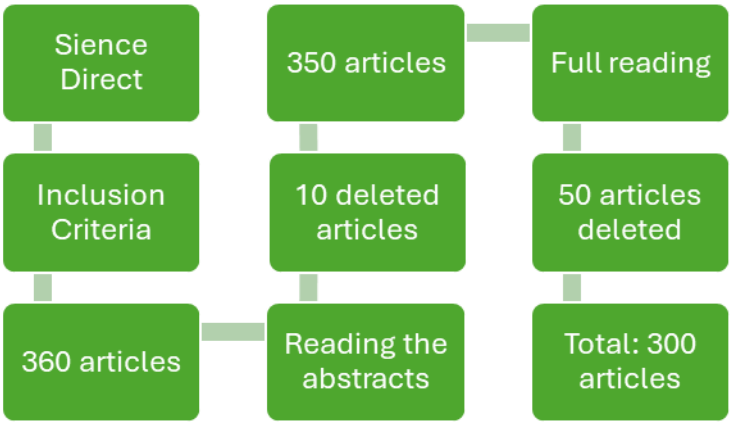


Figure 1. Representative scheme of the search for scientific articles for the development of this study. Source: Author (2024).

3. Results and discussion

After analyzing the studies, it was observed that climate change can influence the productivity of various agricultural crops, as elucidated in the study by Zhan et al. (2023), in which temperature was identified as the primary factor affecting rice productivity across all regions under the analyzed climatic scenarios. However, other factors such as precipitation, solar radiation, and relative humidity also had significant impacts, and in some cases, prevailed. These results highlight the varied and sometimes contradictory responses of rice productivity to climate change in different contexts. The conclusions of the study may inform future policies aimed at ensuring food security at both regional and national levels in the country.

The impacts of climate change vary across regions of the world, but in Brazil, they have primarily manifested through the increased frequency of events such as droughts and floods. These phenomena bring about significant consequences including damage to agriculture, an increase in disease incidence, the occurrence of wildfires and burns in deforested areas, as well as the intensification of flooding in urban areas. In this context, it is crucial that

adaptation and mitigation processes be considered urgent, especially in municipalities with higher social and economic vulnerability (Silva et al., 2023).

It is important to highlight that a crucial service related to food security is the preservation of ecosystems and the maintenance of precipitation provided by forests. Forests play this role through various mechanisms, including evapotranspiration which releases water vapor into the atmosphere and their influence on cloud formation and the hydrological cycle. Furthermore, forests regulate microclimate and contribute to the recycling of moisture, which is essential for the continuity of rainfall, especially in tropical regions (Batista et al., 2023).

Several studies project that the agricultural sector in Brazil faces implications related to changes in land use and land cover, such as reduced rainfall, increased temperatures and shorter rainy seasons. However, there is still a limited understanding of the exact impact that deforestation has had in recent decades on the agricultural sector due to changes in rainfall patterns. Filling this knowledge gap is essential to guide both the agricultural sector and policymakers on the importance of forests in regulating rainfall and their consequences for food security. It is crucial for farmers to understand that the expansion of agricultural production, achieved through the conversion of new land areas, has already led to reduced rainfall, which in turn has contributed to the decline in agricultural productivity (Batista et al., 2023).

Agriculture is closely linked to climatic conditions. In the study by Batista et al. (2023), soybean and maize yields could have been 6.6% and 9.9% higher annually if precipitation patterns had not been altered by deforestation. Furthermore, this study emphasizes the vital role of forest preservation for agricultural resilience and food security.

Climate change intensifies the challenges related to food security. If greenhouse gas emissions continue at the current rate, the global average temperature could rise by 1.5°C above pre-industrial levels before 2030, reaching 2°C by 2050. This warming leads to profound impacts on agricultural production, such as reduced productivity, decreased available land for cultivation, increased pest proliferation, rising prices, and instability in food supply. These factors not

only threaten food security but also hinder efforts to reduce poverty and inequality. These effects are already observable, with the global temperature increase ranging from 1.1°C to 1.2°C (Domene et al., 2023).

The increase in global temperature intensifies the occurrence of extreme climatic events, such as heatwaves, droughts, and floods. These phenomena generate greater water stress on plants and can alter soil composition, severely compromising the production of essential cereals for global food security, such as wheat, maize, and rice. Furthermore, global warming affects marine ecosystems, with estimates of a loss of 1.5 million tons of ocean-derived food if the temperature increases by 1.5 °C, and up to 3 million tons with a 2 °C rise (Marschalek, 2023; Hadley et al., 2023).

Climate change not only compromises food availability but also destabilizes food systems, which can result in severe economic crises. In the case of Brazil, this vulnerability is further accentuated, as in 2021, the entire agricultural production chain represented 27.6% of the national GDP. Any instability in this sector affects employment, income and food prices, exacerbating food insecurity in the country (Subedi et al., 2023; Pixley et al., 2023).

Although food production is deeply affected by climate change, it also plays a significant role as a contributing factor. Brazil ranks fifth among the world's largest greenhouse gas emitters, with 27% of these emissions coming from agriculture in 2020, 75% of which is associated with cattle ranching. Additionally, 46% of emissions resulted from land-use changes, primarily due to deforestation and the conversion of native vegetation into agricultural areas and pastures (Mirzabaev et al., 2023).

In the past 30 years, approximately 60 million hectares of native vegetation have been converted into pastureland in Brazil, releasing large quantities of greenhouse gases into the atmosphere. These dynamic places the Brazilian agri-food system at the center of climate discussions, both at the national and global levels (Sultana et al., 2023). In the Brazilian Amazon, in the state of Pará, large areas have been deforested, mainly for pasture use (Miranda et al., 2021; Paiva et al., 2024, Santos et al., 2024).

Climate change represents an increasing threat to global food security,

compromising the availability, access, and stability of food supply in various regions. This phenomenon exacerbates the challenges related to achieving sustainable development goals, particularly those focused on eradicating hunger and promoting sustainable agriculture. Studies indicate that changes in climate patterns, such as rising average temperatures, increased frequency of extreme weather events, and changes in water resource availability, significantly impact agricultural production, leading to reductions in yields of essential crops such as wheat, maize, and rice (Qiao et al., 2023).

Furthermore, these changes create a cascading effect, directly affecting food consumption, nutritional quality, and food prices, thus worsening economic and social inequalities, especially in developing countries. As a result, the vulnerability of the poorest populations, who are heavily dependent on agriculture, becomes even more evident, necessitating urgent and coordinated strategies to mitigate these impacts and adapt food systems to new climatic realities (Qiao et al., 2023).

The impacts of climate change on Brazilian agriculture must always be assessed and quantified, since the agricultural sector contributes to the country's gross domestic product (GDP). Furthermore, this sector also accounts for 38.5% of total national exports, making the country the third largest exporter of agricultural commodities in the world (Santos et al., 2023).

It is essential to mention that reducing the impacts of climate change and preserving biodiversity represent two important environmental challenges that must be effectively addressed in this century, along with the need for food supply security for the growing population. In view of this, it is possible to observe how important it is to establish strategies regarding global climate change, since, as the literature has pointed out, this directly influences food security (Silva et al., 2023).

Research such as that by Zachow et al (2023) indicates that wheat productivity in Brazil is strongly influenced by climate conditions and can often only be known accurately at the time of harvest. Thus, the authors seek to improve an existing model to predict wheat productivity, considering historical trends and using monthly temperature data and occurrences from seasonal

climate models (SCM). The analysis focuses on the three months preceding the harvest, offering more reliable estimates. The results obtained support strategic decisions by farmers, traders and policy makers, promoting better management and planning in the production chain. Thus, it is possible to note that climatological studies are fundamental to understanding the impacts of climate change on agriculture and, consequently, on food security.

The article by Furtak and Wolińska (2023) discusses the effects of extreme weather events, such as floods and droughts, on the soil microbiome and their consequences for agriculture. It is explored that changes in soil moisture play a crucial role in regulating the microbiome, directly influencing crop growth and productivity. These effects have significant implications for global food security, highlighting the importance of understanding and mitigating the health impacts of climate change.

Figure 2 represents the relationship between climate change and hydrological events, soil fertility and agriculture. These in turn have a strong relationship with the water cycle. In this context, mitigating climate change is essential for food production (Furtak and Wolińska, 2023).

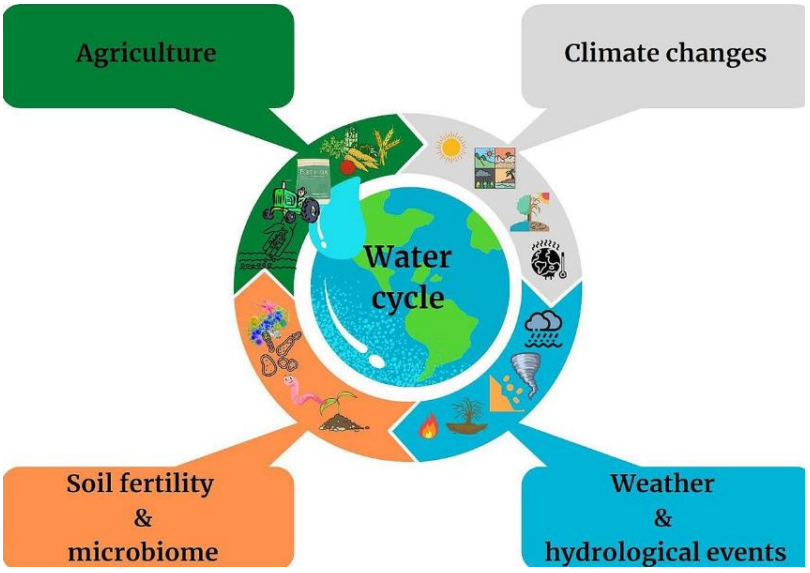


Figure 2. Representation of factors that influence the water cycle. Source: Furtak and Wolińska (2023).

4. Conclusion

Based on this review, it can be concluded that climate change represents a global challenge with profound implications for food security, particularly in developing countries like Brazil, where agriculture plays a central role in the economy. Extreme weather events associated with rising temperatures and rainfall variability have compromised agricultural productivity, intensified social and economic costs, and worsened the vulnerability of the most affected populations.

In this context, deforestation and land-use changes emerge as exacerbating factors, highlighting the urgent need for measures that promote forest preservation and sustainable natural resource management. Forests, in addition to being essential for maintaining hydrological cycles, play a crucial role in mitigating climate impacts and ensuring the stability of agricultural production.

The article emphasizes the importance of integrated strategies that combine adaptation to climate change with environmental conservation actions. These strategies should be guided by public policies based on scientific evidence to ensure the resilience of the agricultural sector and the food security of populations, contributing to sustainable and inclusive development in Brazil and globally.

References

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. Environmental Science and Pollution Research, 29(28), 42539-42559. https://doi.org/10.1007/s11356-022-19718-6

Batista, F. S, Duku, C., & Hein, L. (2023). Deforestation-induced changes in rainfall decrease soybean-maize yields in Brazil. Ecological Modelling, 486, 110533. https://doi.org/10.1016/j.ecolmodel.2023.110533

Change, I. C. (2014). Synthesis Report. Contribution of working groups I. II and III to the fifth assessment report of the intergovernmental panel on climate change, 151(10.1017).

Domene, S. M. Á., Agostini, K., Almeida, G. N. P. D., Camargo, R. G. M., carvalho, A. M. D., Corrêa, F. E., ... & Saraiva, A. M. (2023). Segurança alimentar: reflexões sobre um problema complexo. Estudos Avançados, 37(109), 181-206. https://doi.org/10.1590/s0103-4014.2023.37109.012

Furtak, K., & Wolińska, A. (2023). The impact of extreme weather events as a consequence of climate change on the soil moisture and on the quality of the soil environment and agriculture–A review. Catena, 231, 107378. https://doi.org/10.1016/j.catena.2023.107378

Hadley, K., Talbott, J., Reddy, S., & Wheat, S. Impacts of climate change on food security and resulting perinatal health impacts. (2023). In Seminars in Perinatology (p. 151842). WB Saunders, p. 151842. https://doi.org/10.1016/j.semperi.2023.151842

Jaime, P. C., Delmuè, D. C. C., Campello, T., Silva, D. O., & Santos, L. M. P. (2018). Um olhar sobre a agenda de alimentação e nutrição nos trinta anos do Sistema Único de Saúde. Ciência & Saúde Coletiva, 23, 1829-1836. https://doi.org/10.1590/1413-81232018236.05392018

Marschalek, R. (2023). Manias do consumidor, mudanças climáticas, melhoramento genético e suas implicações na segurança alimentar. Agropecuária Catarinense, 36(2), 5-6.

Miranda, R. S. de; Nogueira, L. da R; Rodrigues, M. S, Alves, A. M., Costa, M. S; Amador, M. F. (2021). Análise do desmatamento nos períodos de 2016 a 2020 na Mesorregião Sudeste Paraense. Revista Ibero-Americana De Humanidades, Ciências E Educação, 7(5), 498–517. https://doi.org/10.51891/rease.v7i5.1209

Mirzabaev, A., Kerr, R. B., Hasegawa, T., Pradhan, P., Wreford, A., von der Pahlen, M. C. T., & Gurney-Smith, H. (2023). Severe climate change risks to food security and nutrition. Climate Risk Management, 39, 100473. https://doi.org/10.1016/j.crm.2022.100473

Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., ... & Huybers, P. (2017). Climate change and global food systems: potential impacts on food security and undernutrition. Annual review of public health, 38(1), 259-277. https://doi.org/10.1146/annurev-publhealth-031816-044356

Otto, D., Caeiro, S., Nicolau, P., Disterheft, A., Teixeira, A., Becker, S., ... & Sander, K. (2019). Can MOOCs empower people to critically think about climate change? A learning outcome based comparison of two MOOCs. Journal of Cleaner Production, 222, 12-21. https://doi.org/10.1016/j.jclepro.2019.02.190

Paiva, R. S; Rodrigues, M. S, Ribeiro, R. M. R; Olinda, D. R (2024). Alterações na cobertura e uso do solo por atividades de pastagem e dendeicultura em Concórdia, estado do Pará. Revista Multidisciplinar Do Nordeste Mineiro, 11(1). https://doi.org/10.61164/rmnm.v11i1.3001

Palinkas, L. A., & Wong, M. (2020). Global climate change and mental health.

Current opinion in psychology, 32, 12-16. https://doi.org/10.1016/j.copsyc.2019.06.023

Pixley, K. V., Cairns, J. E., Lopez-Ridaura, S., Ojiewo, C. O., Dawud, M. A., Drabo, I., ... & Zepeda-Villarreal, E. A. (2023). Redesigning crop varieties to win the race between climate change and food security. Molecular Plant. 16(10), 1590-1611. https://doi.org/10.1016/j.molp.2023.09.003

Qiao, C., Cheng, C., & Ali, T. (2023). How climate change and international trade will shape the future global soybean security pattern. Journal of Cleaner Production, 422, 138603. https://doi.org/10.1016/j.jclepro.2023.138603

Salvalaio, R. C. N, Bussolotti, V. M., Pellegrini, I. U., Santos, J. S. A., & Alvarez, C. E. de (2023). Mudanças climáticas e envelhecimento populacional: uma necessária revisão sistemática de literatura. PARC Pesquisa em Arquitetura e Construção, 14, e023024-e023024. https://doi.org/10.20396/parc.v14i00.8671221

Santos, G. G. dos; Olinda, D. R.; Neris, J. P. F.; Rodrigues, M. S.; Narusawa, Ítala D. S.; Silva, W. R. da; Souza, I. N. G.; Santos, G. G. dos; Santos, M. G. dos. (2024). Análise do uso e cobertura do solo utilizando Índice de Vegetação por Diferença Normalizada (NDVI) no município de Nova Ipixuna, Pará, Amazônia. Observatório de la Economía Latinoamericana, 22(10), e7345. https://doi.org/10.55905/oelv22n10-179

Silva, S. S. da, Brown, F., Sampaio, A. de O., Silva, A. L. C., Santos, N. C. R. S. dos, Lima, A. C., Aquino, A. M. de S., Silva, P. H. da C., Moreira, J. G. do V., Oliveira, I., Costa, A. A & Fearnside, P. M. (2023). Amazon climate extremes: Increasing droughts and floods in Brazil's state of Acre. Perspectives in Ecology and Conservation, 21(4), 311-317. https://doi.org/10.1016/j.pecon.2023.10.006

Subedi, B., Poudel, A., & Aryal, S. (2023). The impact of climate change on insect pest biology and ecology: Implications for pest management strategies, crop production, and food security. Journal of Agriculture and Food Research, 14, 100733. https://doi.org/10.1016/j.jafr.2023.100733

Sultana, F., Wahab, M. A., Nahiduzzaman, M., Mohiuddin, M., Iqbal, M. Z., Shakil, A., ... & Asaduzzaman, M. (2023). Seaweed farming for food and nutritional security, climate change mitigation and adaptation, and women empowerment: A review. Aquaculture and Fisheries, 8(5), 463-480. https://doi.org/10.1016/j.aaf.2022.09.001

Tol, R. S. (2018). The economic impacts of climate change. Review of environmental economics and policy. https://doi.org/10.1093/reep/rex027

Werndl, C. (2016). On defining climate and climate change. The British Journal for the Philosophy of Science. https://doi.org/10.1093/bjps/axu048

Zhan, P., Zhu, W., Zhang, T., & Li, N. (2023). Regional inequalities of future climate change impact on rice (Oryza sativa L.) yield in China. Science of The Total Environment, 898, 165495. https://doi.org/10.1016/j.scitotenv.2023.165495

Ziska, L. H., Epstein, P. R., & Schlesinger, W. H. (2009). Rising CO2, climate change, and public health: exploring the links to plant biology. Environmental health perspectives, 117(2), 155-158. https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.11501

IPCC, I. P. O. C. C. Climate Change 2014: Synthesis Report. In: Contributions of Working Group I, II, IIto the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [S.l.: s.n.], 2014

Santos, R. S., Zhang, Y., Cotrufo, M. F., Hong, M., Oliveira, D. M. S., Damian, J. M., & Cerri, C. E. P. (2023). Simulating soil C dynamics under intensive agricultural systems and climate change scenarios in the Matopiba region, Brazil. Journal of Environmental Management, 347, 119149. https://doi.org/10.1016/j.jenvman.2023.119149

da Silva, R. F. B., Millington, J. D., Viña, A., Dou, Y., Moran, E., Batistella, M., ... & Liu, J. (2023). Balancing food production with climate change mitigation and biodiversity conservation in the Brazilian Amazon. Science of The Total Environment, 904, 166681. https://doi.org/10.1016/j.scitotenv.2023.166681

Zachow, M., Júnior, R. D. S. N., & Asseng, S. (2023). Seasonal climate models for national wheat yield forecasts in Brazil. Agricultural and Forest Meteorology, 342, 109753. https://doi.org/10.1016/j.agrformet.2023.109753