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Impacts of climate changes on food production in Brazil: what are we going to eat?

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Introduction

Climate change is one of the most complex challenges of this century, and no country is immune to the possible impacts that may arise, being defined by the IPCC as any change in climate over time, whether due to natural variability or as a result of human activity (Assad *et al*, 2013). Climate change is expected to cause environmental, social, economic and cultural changes. In the food sector, it could affect the entire food chain, leading to changes in food practices and food safety (Mesquita; Bursztyn, 2018).

The fact that Brazil is one of the largest food producers on the planet raises its level of importance in global discussions (Azevedo, 2016). Global warming could put food production in this country at risk if no mitigation and adaptation measures are taken. The agricultural scenarios point to a reduction of the "low risk, high potential" arable area: Brazil could lose about 11 million hectares of land suitable for agriculture due to climate change by 2030 (Assad *et al*, 2013).

Climate change scenarios point to an average temperature change above 2ºC, which includes major imbalances in ecosystems that are fundamental for the survival of humanity. As the planet warms, rainfall and temperature patterns change and extreme weather events such as droughts, storms, floods, cold and heat waves become more frequent, with major impacts in all regions of the planet. These impacts will make social inequalities more accentuated, tending to generate food insecurity, due to the drop in food production, with a consequent lack of food for the populations directly exposed to climate adversities, and will be concentrated, mainly, in the poorest regions of Brazil (Assad *et al*, 2013).

Material and Methods

An exploratory research was carried out on articles in Google Scholar, in order to elucidate the main impacts of climate changes on food production in Brazil.

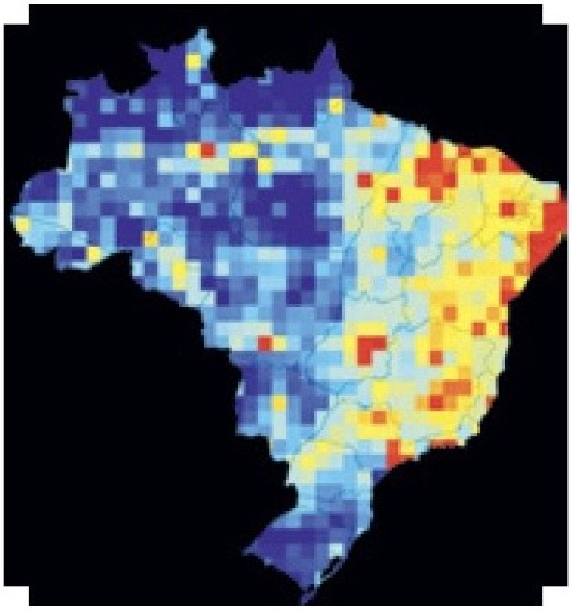
Results and Discussion

Springmann *et al* (2016) estimate a global reduction in individual food availability of about 3.2% by 2050, with a 4.0% reduction in fruit and vegetable consumption and 0.7% in red meat consumption, resulting in increased mortality associated with climate change impacts on agriculture and eating patterns. Such impacts can lead to a decrease in the quantity and diversity of food produced, with local price increases, possible changes in diet, and impacts on morbidity and mortality levels. Limitations in the supply of affordable and healthy food items can influence the migration to a lower quality diet based on cheaper ultra-processed foods with higher energy content (fat and sugars) and less nutritional value (Mesquita; Bursztyn, 2018).

Changes in the agroindustrial policies and food standards in most countries, especially in economically emerging ones such as Brazil, have occurred over the decades and mainly involve the substitution of fresh foods, as well as those of plant origin (grains, roots, and vegetables) and culinary preparations fundamentally made of them, for industrialized products ready for consumption. Therefore, there is an imbalance in the supply of nutrients and an inadequate intake of calories. In addition, forecasts indicate that the global redistribution and contraction of marine biodiversity in vulnerable regions will be a challenge to the productivity of fisheries and associated services (Brandão, 2020).

The Northeast Region of Brazil, due to its high social vulnerability, and the states of Mato Grosso and Mato Grosso do Sul, due to the concentration of agricultural production in soy, would be affected in relevant intensities in their economies. The expected drops would be greater than 5% of Gross Domestic Product (GDP) for most of the mentioned regions (Assad *et al*, 2013). As for socioclimatic vulnerability, the figure below shows the Brazilian regions most susceptible to climate change, according to each region's socioclimatic vulnerability index. The areas most susceptible to climate change are in red, corresponding to the areas of highest population density:

Figure 1 – Brazilian regions most susceptible to climate change, according to each region's socioclimatic vulnerability index



Source: Assad *et al*, 2013

Due to the impact caused by temperature rise, of the nine crops responsible for 85% of Brazil's agribusiness GDP (rice, beans, corn, sugarcane, cotton, manioc, soybeans, coffee and sunflower), only sugarcane is expected to increase its potential cultivation area by 2050. If no significant technological innovations occur, all other crops are expected to lose something like 15% of their cultivated area. The worst case scenario would be for soybeans, with losses of approximately 35% of usable area (Azevedo, 2016).

According to Félix *et al* (2020), climate change will affect plant production, influencing the adaptation of some crops, with negative impacts, such as coffee with an estimated loss of 40%, and positive impacts, such as sugarcane. Among the most productive products in Brazil, sugar cane and manioc are not expected to suffer reductions in area. The following table shows the estimated impact of the greenhouse effect on the reduction of the area for planting the main crops produced in Brazil, for the years 2020, 2050, and 2070:

Table 1 – Estimate of the greenhouse effect in the reduction of area suitable for planting:

Crops	**2020**	**2050**	**2070**
Cotton	11%	-	16%
Rice	9,7%	12,5%	14%
Coffee	9,48%	17,1%	33%
Beans	4,3%	10%	13,3%
Sunflower	14%	16,5%	18%
Corn	12%	15%	17%
Soybeans	23,59%	34,1%	40%

Source: Albuquerque; Silva (2008), *apud* Félix *et al*, 2020

In this scenario, the areas that are currently producing grains may no longer be suitable for planting before the end of the century, where manioc may disappear from the semi-arid region (Northeast region) and coffee will have few conditions for survival in the Southeast region. On the other hand, the South region, which today is more restricted to crops adapted to the tropical climate because of the high risk of frost, should experience a reduction in this extreme event, becoming suitable for the planting of manioc, coffee and sugarcane, but no longer soybeans, since the region should become more subject to water stress. Sugarcane, on the other hand, may spread across the country to the point of doubling its area of occurrence (Félix *et al*, 2020).

This information is in agreement with the study by Assad *et al* (2013), according to which much of the Northeastern agricultural sector, especially the crops of manioc, cotton, soybeans, rice, corn and beans, would be strongly impacted by climate change. Manioc will suffer a drastic reduction in its planting and may even disappear from the Northeastern semi-arid region. Regarding the rural activity, according to some projections, in a few decades the South Region may have a new geographical conformation of agriculture and livestock, without emphasizing a possible suitability of crops hitherto restricted by the cold in detriment of others, such as fruit trees adapted to temperate climate. Semi-perennial crops such as sugarcane may replace soy and corn.

Brandão (2020) also confirms such perspectives: the areas cultivated with corn, rice, beans, cotton and sunflower will suffer a strong reduction in the Northeast Region, with a significant loss in production. There are concerns and threats to agricultural production, regarding the uncertainty of maintaining the production of two essential foods: corn and beans.

Pelegrino, Assad and Marin (2007), in turn, bring estimates for the most pessimistic scenario, which show area losses of around 18% for rice, 11% for beans, 39% for soybeans, 58% for coffee and only 7% for corn. These percentages of area losses indicate different levels of impacts on the different crops, with corn suffering less from high temperatures, because it has an increase in photosynthesis rate for temperatures of up to approximately 30ºC. Preliminary estimates for sugarcane, for the states of São Paulo, Mato Grosso and Goiás also point in this direction.

Azevedo (2016) points the history and high degree of involvement of the Brazilian government, economy, society and productive environment with conventional agriculture and its products, and the slow and insufficient pace at which the process of transition to the agroecological model is taking place. For this reason, there are strong indications that in the short and medium term the environmental horizon in Brazil will remain uncertain, with real threats to the climate, biodiversity and the environment, which directly influences food production in the country and the world.

Conclusions and Outlook

The impacts of climate change are not only likely to hit food production in Brazil, but also provoke a change in habits in current and future generations. A reduction in the availability of food per person is expected, as well as a reduction in the consumption of fruits and vegetables and red meat around the year 2050.

There is also likely to be a substitution of natural foods by ready-to-eat industrialized products, since only sugar cane will be able to maintain its cultivation area, unlike the other crops produced in Brazil and that move 85% of the national GDP: rice, beans, corn, cotton, manioc, soybeans, coffee and sunflower.

In Brazil, the most socioclimatically vulnerable regions are the most populated, with the Northeast region being the most impacted by climate change, with potential reduction in the production of rice, beans, corn and soybeans, and possible disappearance of cassava crops.

In addition, the slow transition to the agroecological model indicates that the environmental horizon in Brazil will remain uncertain, with real threats to the climate, biodiversity and the environment, which directly influences food production in the country.

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