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Brazil's agricultural powerhouse under threat

Since the second half of 2020, the Center-South region⁽¹⁾ has experienced weather disruptions⁽²⁾ with scarce rainfall and severe drought. Compounding the dryness, an unusual succession of polar air masses has moved over swaths of territory in recent months, pushing the temperature below zero in some places. The hydrological cycles have been disrupted since 2013, but the last twelve months are considered the worst drought period in 91 years. This situation creates problems in all economic sectors. Several regions are at risk of electricity supply disruption as 70% of the national grid depends on hydroelectric power. The 2020/2021 climatic disturbances have obviously affected agriculture. They could recur and worsen in the future.

Root causes of weather disruptions

These disturbances stem from the combined action of three factors. The first one is a natural phenomenon called *La Niña*, whose main consequence is a decline of sea-surface temperatures in the central and eastern tropical Pacific Ocean that impacts global weather patterns (alteration in the volume of rainfall)⁽³⁾. In Brazil, the effects of *La Niña* vary from region to region. They are not necessarily the same each time the phenomenon appears or from one year to another if the phenomenon lasts longer than usual. The most frequently observed effects are an amplification and multiplication of cold fronts that sweep across the south of the country in winter, the rise of these cold fronts towards the north (the Midwest and North-East can be affected), winter temperatures below seasonal norms in the South-East and the Midwest, a decrease in rainfall in the Center-South of the country and dry spells in the

summer period, an increase in rainfall in the North and the North-East.

A second crucial factor in the deterioration of rainfall and the recurrence of droughts in Brazil's Center-South is deforestation of the Amazon rainforest. It is now well known : deforestation reduces the capacity of large tropical forests to capture CO₂ from the atmosphere and release oxygen into the air. The destruction of the rain forest has also other consequences. The forest guarantees the rainfall of a large part of the South American continent. In the central-western and south-eastern states, rainfall depends on processes that begin in the Amazon biome.



(1) The term Center-South here refers to the set of regions formed by the Southern States, the South Eastern States and the Midwest States.

(2) In most regions, rainfall is normally particularly heavy and intense during the so-called wet period, which extends from spring to the summer months (between October and April in the Center South). In the South, rainfall is more uniform throughout the year. Winter is often marked by significant drops in temperature (with frost) due to the upwelling of polar fronts from the Antarctic. Cold spells rarely extend beyond the region and are time-limited. On the north-eastern states coast (from Bahia to Paraíba), rainfall is concentrated in autumn and winter.

(3) *La Niña* is the opposite of the so-called *El Niño* phenomenon, which causes a rise in surface water temperatures in the Pacific Ocean over the tropics. In general, *La Niña* disrupts the weather for an entire year. When the phenomenon is strong, the disturbances can last for two years.

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The Amazon rainforest is located in a tropical zone, i.e. in latitudes where there is neither winter nor summer but a dry and a wet season. The wet season begins in December, when temperatures rise, both on the ocean and on land. Water-laden clouds move from the ocean to the coast, driven by the trade winds. They pour rain fall over the Amazon rainforest and fill its subsoil with water. On land, a real ocean of fresh water is formed and renewed. The trees of the dense forest have deep roots that can capture this water (there are trees in the Amazon rainforest whose root systems go down dozens of meters into the subsoil). The trees take up this water and, when the atmosphere dries out, they transpire and return this underground water to the air as vapor. This evapotranspiration process does not provide tiny amounts of water. In total, every day, all the trees in the Amazon rainforest would return twenty billion tons of water to the atmosphere (at the same time, the Amazon River and its tributaries return "only" seventeen billion tons of fresh water to the Atlantic Ocean). The millions of tons of moisture released into the atmosphere form real "flying rivers." The role of forests in the formation of "flying rivers" is not just linked to the evapotranspiration process. Trees also emit aerosols, airborne micro-particles that help cloud formation. They rise into the atmosphere and aggregate above the forest to form microscopic grains that have a great capacity to attract water vapor in the air. Condensation nuclei form a drop, then another and, little by little, a cloud.

The clouds formed over the Amazon rainforest are pushed westwards by the winds but encounter the Andean Mountain range, the longest continental mountain range in the world (and one of the highest). Some of the moisture that is transported in this way then flows into the region and feeds the springs of the tributaries of the Amazon River. The other part (about 50%) is transported southwards, parallel to the Cordillera, by the winds. These "flying rivers" play a decisive role in feeding the rainfall systems of central-western and south-eastern Brazil, as well as the entire basin formed by the Paraná and Rio de la Plata rivers⁽⁴⁾. The good rainfall in central-western areas such as Mato Grosso and Goiás is linked to the formation of these "flying rivers." In the south-east, the states of São Paulo, Minas Gerais and Rio de Janeiro are located at the same latitude as Namibia, the Australian deserts and northern Chile. Yet they form the only well-watered region at this latitude because they are reached by "flying rivers." In southern Brazil and throughout the Paraná-Rio de la Plata basin, these "flying rivers" feed a very important rainfall system for the winter rains. Throughout this region, during

the winter season, the dry period is short. The contrast between the maximum and minimum flows of the rivers is relatively small.

The annual deforestation rate of the Brazilian Amazon rainforest calculated by the National Institute of Space Research (INPE, which monitors the area by satellite) had been significantly reduced between 2008 and 2012, from 27,800 km² to 4,600 km². The trend has been upwards since 2013. In 2020, this rate has reached 11,000 km². With deforestation, there are fewer and fewer trees that send water back into the air in the form of vapor. As a result, there is less and less moisture for the winds to carry, and less and less rainfall in the Central West, South-East and South. In many cases, deforested areas are replaced by pastureland or annual crops such as soyabean. These crops cannot develop deep root systems and play the same role as the forest. Studies conducted by Brazilian universities have already shown that in areas directly south of the Amazon rainforest, established agricultural activities are already penalized by the scarcity of rainfall.

A third factor in the deterioration of climatic conditions has been identified by the scientific community: global warming. The rise in temperatures and the alteration of the hydrological cycle on a global scale are having a strong impact on Brazil. These two phenomena are contributing to a decrease in rainfall, mainly in the north-east and center of the country. All the climate models used today show that the rise in global temperatures is reducing rainfall in central Brazil.

Short term impacts on agriculture...

Unprecedented drought and water scarcity in the Center-South for the last twelve months starting in September 2020, an exceptionally frosty winter season in the South-East and part of the Centre-West: these extreme climatic phenomena have obviously affected agricultural production, often leading to a drop in yields. On several agricultural areas, the drought led to low water levels in rivers used for the transport of inputs and crops. This is particularly the case for the Paraná River. It has become impossible to use barges. It was therefore necessary to revert to road transport, which is much more expensive.



(4) The Rio de la Plata Basin is the fifth largest river basin in the world. It covers an area of 3.1 million km² and extends over the territories of Argentina, Brazil, Paraguay, Uruguay and Bolivia.

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A comparison of the production results achieved over two seasons shows a sharp drop in the harvests of coffee, cotton, maize, sugar cane and oranges, crops for which the Centre-South is a key supplier (see table below). In the South-East coffee-growing areas, the succession of drought and exceptional cold spells prevented flowering and reduced or destroyed production. Brazil manages to harvest three corn crops in one year. The most important is winter corn. The sowing is done in the first months of the calendar year and harvest takes place between July and August. In 2021, because of the drought, farmers in some provinces planted a month or more later than normal, but then the frosts in July killed the corn at a crucial stage of growth.

Brazil is the number two exporter of corn. The contraction of domestic output in the context of a recovery in world demand has obviously contributed to the sharp rise in international prices observed until May 2021. It also led to a marked rise in prices on the domestic market. This trend has been reinforced by another factor. The extreme weather has also reduced pasture for grazing, increasing reliance on corn-based animal feed. This, in turn, has driven up domestic beef, milk, poultry and pork prices. Reduced harvests of black beans, vegetables and fruit⁽⁵⁾, also contributed to a food inflation that weakens the purchasing power of the poorest social groups.

What can we expect over the next months? Agricultural experts are increasingly worried that the recurrence of *La Niña* could extend the drought conditions into the new crop year (starting in October) and affect soybean planting and the development cycle of this crop. This recurrence would further penalize the summer corn harvest, the next coffee harvest and sugarcane production. Insufficient or irregular rainfall could also limit the upcoming rice and wheat crops.

Beyond the question posed by an extension of *La Niña*, climate experts point out that the historic drought episode that has just occurred in a large part of the country is not an isolated accident in time. It corresponds to a trend observed for several years. It is a harbinger of what Brazil's climate will be like in a few decades. Even if the world manages to limit the temperature rise to 1.5°C⁽⁶⁾ (which would reduce the risks and consequences of climate change), Brazil will experience shorter rainy seasons and longer dry seasons over most of its territory. It will also experience higher average temperatures and the recurrence of extreme weather events (harsher winters). This scenario will have a profound impact on lifestyles, on the electricity supply system and.... on agricultural production.

Long-term concerns

This major challenge is totally ignored by a significant sector of the agricultural world that has been trying for

Weather disruptions impacts on agriculture

Crop year	Planted area (millions ha)		Average yields in tons per hectare		Production in millions of tons		
	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	Variation in percentage
Soyabeans	36.949	38.532	3.379	3.527	124.845	135.912	8.86
Rice	1.666	1.677	6.713	7.004	11.183	11.747	0.15
Other grains*	4.19	4.564	2.9	2.99	12.178	13.69	12.41
Corn (total)	18.527	19.867	5.537	4.316	102.586	85.749	-16.41
Winter corn	13.756	14.935	5.456	3.982	75.053	59.471	-20.76
Coffee**	1.884	1.801	33.5	26.0	63.078	46.878	-25.68
Sugarcane	8.616	8.243	75.965	71.821	654.528	592.031	-9.54
Cotton	1.665	1.371	1.802	1.72	3.002	2.357	-21.48
Black beans	2.927	2.923	1.104	0.977	3.222	2.856	-11.35
Oranges***	0.371	0.355	1045	756	386.79	268.63	-30.55

* Includes wheat and other summer and winter field crops (oats, barley, rye, sorghum, triticale, rape, sunflower)

** In 60kg bags per hectare and in millions of bags.

***In 40.8kg cases and in millions of cases



(5) The drought that affected the south and south-east of the country in 2020/21 also led to the sharpest contraction of production in the citrus sector. The state of São Paulo and southern Minas Gerais form one of the world's largest orange production basins. The fall in production is estimated at 30.5%.

(6) This is the aim of the Paris Agreement adopted by 196 countries at COP 21 in Paris on 12 December 2015 and entered into force on 4 November 2016. Its objective is to limit global warming to well below 2, preferably 1.5 degrees Celsius, above pre-industrial levels.

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decades (and not only under the Bolsonaro administration) to thwart the government's modest efforts to preserve the environment and protect biodiversity. This retrograde agrarian elite lobbies strongly in Congress by supporting an influential group of parliamentarians at its service: the so-called *bancada ruralista* (rural caucus). Facing these forces, new organizations led by younger and better trained farm leaders are arguing that the future of agribusiness depends on preserving the environment and biodiversity. Based on scientific knowledge and data, these leaders point out that the destruction of biomes (Amazon rainforest, cerrado savannah, wetlands) and global climate change will weaken the entire agribusiness.

Brazil is in danger of losing its status as an agricultural powerhouse, a major supplier of food, if the world fails to contain global warming and if deforestation is not quickly halted. The new generation of farmers is convinced by recent studies by scientists. These studies have shown that in the North, rainfall has decreased in areas of heavy deforestation. The dry seasons have become longer. In areas close to the Amazon biome, the periods of the year without rain have increased by three to four weeks, the total volume of rainfall has decreased and the average temperature has risen by 3°. Where forest cover has been destroyed, the ability to recycle water is reduced or lost, and droughts are intensified. There is less vegetation and roots to absorb rainwater. Evapotranspiration and release of moisture into the atmosphere is much lower. The more the forest recedes, the drier the climate will be in the medium and long term.

The regions of Brazil most affected by prolonged droughts will be the North, Centre-West and North-East. In the North, in the Amazon, if deforestation continues, the point of no return to savanization will be passed in a few decades, when 50% to 70% of the forest will become degraded tropical savannah due to global warming, the impacts of deforestation and the increased vulnerability of the forest to fire. Today, deforestation stands at 16-17% of the initial forest. If it exceeds 20 to 25% of the area, savanization will become irreversible. Unique animal and plant species will be permanently lost with this development. The dry season will become longer and phases of severe drought will recur more frequently⁽⁷⁾.

In the Amazon, the forest is retreating to open land used for intensive livestock and field crops. In other regions of the north, modern mechanized agriculture has been developed over the past few decades on land previously occupied by the Cerrado savannah. Large areas are now dedicated to field crops (soy, maize, cotton). Large farming structures have been set up west of Bahia, on the Tocantins, in the south of the states of Piauí and Maranhão. These new poles are referred to as MaTo-PiBa. In recent years, a marked irregularity in yields has been observed on land dedicated to the cultivation of soya, maize or cotton due to the increase in the temperature of the winds coming from the Amazon and the decrease in rainfall.

In the North-East, if global warming is not limited, more than half of the territory that is currently semi-arid will become semi-desert. This prediction is confirmed by the latest report of the Intergovernmental Panel on Climate Change (IPCC) published last August. According to these experts, the Northeast of Brazil is the most populated region in the world that is already affected by recurrent episodes of drought. The anticipated worsening of this phenomenon will directly affect the lives of at least ten million people who live from agriculture and livestock. In semi-deserted areas such activities will no longer be possible. According to scientists, only the land along the São Francisco River will remain suitable for agriculture.

In a few decades, the Central West has become one of the world's main grains (soya, maize, cotton) and meat producing areas. Droughts may become more frequent and longer. The region could experience a rise in average temperature of 5.5°C and a drop in precipitation of almost 30% by the end of the century. Such a scenario means that localities in the Central West that are involved in soybean production and extensive cattle breeding will be faced with the need to make costly investments (in irrigation, crop treatment, and varietal choices) within 10, 20 or at most 30 years, which will strongly affect the competitiveness of local production. Research efforts to develop soybean, corn or cotton varieties that are more resistant to water stress and better adapted to prolonged periods of drought and high temperatures will no longer be able to respond to climate change.



(7) Fifteen years ago, experts predicted a major drought once every twenty years in the region. Today, they estimate that the phenomenon may return twice in each decade. Last July, a study published in the journal Nature showed that due to the advance of deforestation and the fires it has caused, the Amazon is already emitting more CO₂ than it absorbs

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While the center and north of Brazil should anticipate lower and lower rainfall, the scenario will be different in the south and part of the southeast region. According to experts, on average, these areas should experience an increase in precipitation over the next few decades. However, this does not mean that these two poles will experience a boom in agricultural production that will compensate for losses elsewhere. They will be exposed to the devastating effects of extreme weather events such as torrential rains, prolonged droughts or heat waves. In the North and Midwest, there is a risk of reduced productivity and lower yields. Prolonged dry spells can disrupt crop development, prevent grain filling and deteriorate pasture quality. In the South East and South, farmers will face extreme difficulties in scheduling their production. These are normally organized according to the rhythm of the seasons and the predictable changes in weather conditions. Extreme weather events make any planning exercise exceedingly difficult.

Time is running out

This is the biggest challenge Brazil has faced since it became an independent state: halting the process of deforestation in the Amazon, eradicating forms of agriculture that destroy biodiversity and contribute to climate change. The longer these emergencies are delayed, the more the threats mentioned here will become prohibitive obstacles to agricultural activity. In recent years, several farmers and agribusinesses organiza-

tions have joined forces with environmental NGOs to promote agricultural development that preserves biodiversity and contributes to the fight against global warming⁽⁸⁾. This convergence has obviously accentuated the existing conflict with the traditional farming lobby.

Two new elements now give the advocates of responsible agribusiness a capacity for political influence that they did not have until recently. Firstly, there is the recent climate crisis, which is affecting agricultural production in many regions and is also affecting urban populations (threatened by the risk of electricity rationing). All Brazilians are suddenly aware of the importance of the climate issue. Then there is the prospect of the election in 2022 of a new President who will have to make a clean break from the policy of ignoring environmental emergencies practiced by the Bolsonaro administration. The real "agro-suicide" that the archaic rural forces are promoting with the support of the current President is not an inevitable outcome. But there is no more time to waste... ●

(8) The organization *Coalizão Brasil Clima, Florestas e Agricultura* brings together more than three hundred partners (organizations representing the agricultural and agro-industrial sector, environmental NGOs, representatives from the world of research and academia, industry associations and leading companies from the wood, cosmetics, steel, paper and cellulose sectors).