Planet Tracker

Brazil's fertiliser risks

Identifying innovation and investment opportunities

April 2025

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Executive Summary

This report examines the climate and nature impacts of Brazil's 2022 National Fertiliser Plan (Plano Nacional de Fertilizantes or PNF). While this Plan aims to reduce the country's dependence on imported synthetic fertiliser by increasing domestic production, this analysis highlights that it lacks clear targets for reducing synthetic fertiliser use and fails to outline a transition to a sustainable, regenerative agribusiness sector.

Brazil is one of the largest producers and exporters of agricultural commodities. The success of its agribusiness sector is built on the largescale use of synthetic fertiliser, 86% of which was imported in 2021.[1] While these fertilisers have driven Brazil's agribusiness expansion, they also contribute to significant negative climate, nature and health impacts. The reliance on imported fertiliser also exposes the country's agricultural sector to supply chain disruption, price spikes, currency fluctuations and geopolitical risks.

This report estimates that synthetic fertiliser use in Brazil emits a total of 79 Mt CO_2e – 83 Mt CO_2e each year, equivalent to 7% of national emissions in 2021.[2] Nearly half (47%) of these greenhouse gas (GHG) emissions are from producing imported fertiliser, which are not captured in national carbon accounting systems.

Fertiliser run-off from farmland is a major cause of eutrophication, causing algal blooms and which can destroy freshwater and marine ecosystems. It also causes nitrous oxide air pollution, leading to acid rain and smog, impacting human and ecosystem health.

Demand for Brazil's agricultural products is set to rise with a growing global population. If current agricultural practices persist, synthetic fertiliser use will also increase, along with the negative climate, nature and health impacts.

This analysis estimates that Brazil's fertiliser-related GHG emissions could increase by 89% by 2050 compared to a 2021 baseline, in a scenario where there is high demand for synthetic fertiliser (increasing by 3% per year). This would make it more difficult for Brazil to achieve its net zero ambitions and would result in increased fertiliser-related pollution, harming human health, ecosystems and the country's economy. A change of approach is required.

This report sets out an alternative vision that would enable Brazil to significantly reduce its dependence on synthetic fertiliser and support more sustainable agricultural production. It finds that Brazil's fertiliser-related GHG emissions could be reduced by up to 86% in 2050 compared to 2021, by investing in GHG emissions mitigation and demand-reduction measures such as regenerative agriculture techniques and technologies such as green ammonia production and bio-inoculants – see Figure 1.

Reducing synthetic fertiliser use would also reduce fertiliser-related pollution, improving the health of Brazil's ecosystems and its population and could also significantly reduce input costs for farmers.

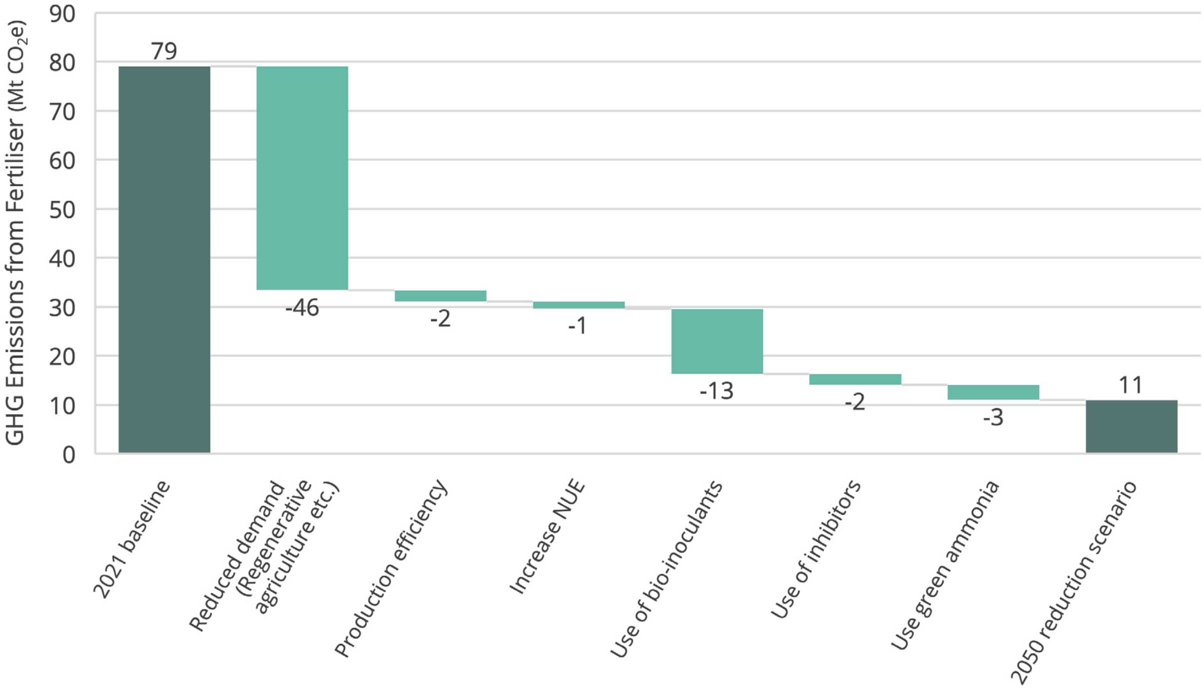

Figure 1: The potential impact of demand-reduction and GHG emissions mitigation measure to reduce fertiliser-related GHG emissions in Brazil. Source: Planet Tracker.

Planet Tracker call to action

Brazil's environmental wealth depends on its environmental health which is increasingly threatened by the GHG emissions and pollution caused by the overuse of synthetic fertilisers. This environmental degradation increases risks and reduces returns for Brazil's sovereign bond investors, as well as for financial institutions funding companies across the Brazilian economy.

Financial institutions therefore have a crucial role to play in encouraging Brazilian food system companies to address the negative impacts associated with the overuse of synthetic fertiliser. They can also help international food system companies with Brazilian suppliers to support the transition away from the overuse of synthetic fertilisers, enhancing the resilience of their Brazilian supply chains. This will help to protect and enhance Brazil's natural capital base, increase the resilience of the economy, and could create significant investment opportunities as Brazil transitions to more sustainable agricultural practices.

How financial institutions can support a sustainable fertiliser transition

Outlined below are some key ways in which financial institutions can support the transition to more sustainable fertiliser use in Brazil:

Sovereign bond investors should:

- Engage with the Brazilian government, and specifically the Ministries of Agriculture and Enviornment to submit an updated National Biodiversity Strategy and Action Plan[a] before the end of June 2025. This should include ambitious 2030 targets aligned with the Kunming-Montreal Global Biodiversity Framework to:
    - Reduce fertiliser-related pollution by 50%.
    - Ensure that at least 20% of agricultural production is based on regenerative practices.
- Engage with the Ministry of the Economy – Industry, Foreign Trade and Services to update the PNF to include specific target to reduce synthetic fertiliser use by 20% by 2030, and by at least 70% by 2050. This should include 2030 targets to:
    - increase Nutrient Use Efficiency.
    - promote the use of bio-inoculants and chemical inhibitors.
    - invest in green ammonia production capacity.
    - encourage regenerative agriculture practices.

Financial institutions should:

- Engage with Brazilian food producers and their international customers to include Scope 1 and 3 fertiliser emissions in their GHG emissions disclosures and net zero plans and targets by 2026.
- Commit to channel 20% of direct and indirect funding for agricultural production to support regenerative agriculture practices by 2030.

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[a] National Biodiversity Strategy and Action Plan – a requirement for each country under Article Six of the Convention on Biological Diversity. *https://www.cbd.int/convention/articles/default.shtml?a=cbd-06*

Introduction

Since the ‘green revolution’ of the 1960’s, the use of synthetic fertilisers has been fundamental to growing sufficient crops to feed an increasing global population. However, this approach is reaching its environmental limits and both nitrogen and phosphorus have already exceeded their planetary boundaries.

Concerns about the effects of fertiliser pollution on the environment[3] [4] and on human health[5] are increasing. Synthetic fertiliser is a leading cause of eutrophication of freshwater and marine ecosystems, where fertiliser run-off from farmland causes nutrients to build up in waterways, leading to algal blooms and excessive plant growth which can destroy aquatic ecosystems. Synthetic fertiliser production and use is also responsible for approximately 5% of global greenhouse gas (GHG) emissions, and fertiliser use leads to nitrous oxide (N_2O) air pollution causing acid rain and smog, impacting human and ecosystem health.

Brazil is one of the world’s top producers of agricultural commodities, partly driven by the extensive use synthetic fertilisers, leaving it highly exposed to significant environmental and social impacts. In addition, the country currently imports 86% of its fertilisers, exposing it to geopolitical risks and imported inflation.

Brazil’s PNF aims to decrease reliance on synthetic fertiliser imports, mainly by increasing domestic production. While this may address the geopolitical risks, it still leaves the country exposed to negative climate, nature and social impacts of synthetic fertiliser use.

This report analyses Brazil’s position as an agribusiness powerhouse and the climate and nature consequences of implementing its PNF. It sets out an alternative vision that would enable Brazil to significantly reduce its dependence on synthetic fertiliser and support more sustainable agricultural production.

If Brazil invests in this sustainable future, its sovereign bond investors stand to benefit from its increasing sovereign health. This report outlines multiple opportunities for equity and bond investors to support this transition both within Brazil’s agribusiness sector and its wider economy.

Synthetic fertiliser fuel Brazil's agribusiness boom

Brazil: an agribusiness powerhouse

Agribusiness is estimated to have made up 24% of Brazil's GDP in 2023,[6] including farming, processing, and agricultural services. The World Trade Organisation estimated that Brazil was the second largest exporter of agricultural products globally in 2022, with 9% of the global total, behind the USA (13%) and well ahead of China (5%).[7] Brazil ranks in the top three global producer and exporter of several, key agricultural commodities – see Table 1.

Table 1: Brazil's world ranking among producers and exporters by volume (2022).
Source: FAOSTAT, Planet Tracker analysis.

Commodity	Production (tonnes)	Exports (tonnes)	Global Production Rank	Global Exports Rank	Production (% of Total)	Exports (% of Total)
Coffee, green	3,172,562	2,132,063	1	1	29%	27%
Maize (corn)	109,420,717	43,389,331	3	2	9%	21%
Soya beans	120,701,031	78,932,118	1	1	35%	50%
Sugarcane	724,428,135	24,165,295	1	1	38%	57%
Wheat	10,343,182	3,072,779	16	14	1%	2%

The value of Brazil's agricultural exports, including processed products, are estimated to have grown an average of 9.4% a year from 2000 to 2021 and accounted for 37% of Brazil's total exports.[8] With a growing population this the demand for Brazil's agricultural exports is likely to continue to grow.

Synthetic fertiliser imports have fueled Brazil's agribusiness boom

Brazil's agribusiness success is heavily reliant on synthetic fertiliser imports, importing 86% of the fertiliser that was applied to farmland in 2021 – see Figure 2.

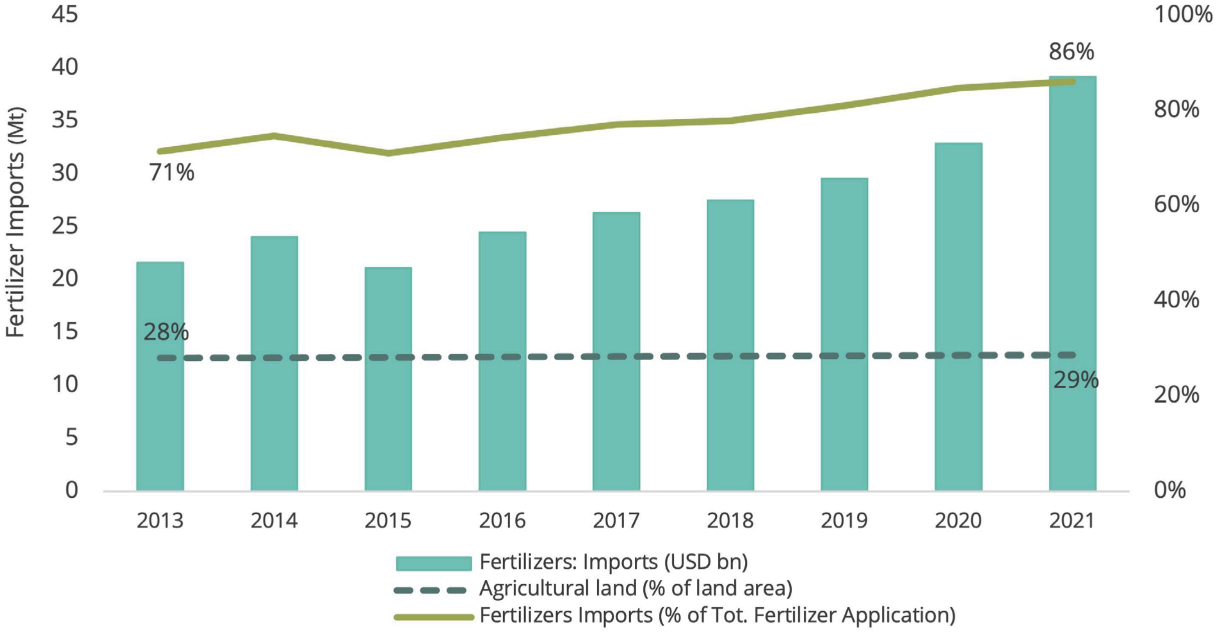

Figure 2: Fertiliser imports in Brazil since 2013 and as a proportion of total fertilisers used in Brazil, compared to the proportion of Brazil's land used for agriculture. Source: ANDA, World Bank.

The proportion of imported synthetic fertiliser has grown steadily over the last ten years, driven by Brazil's focus on soft commodity exports – see Figure 3.

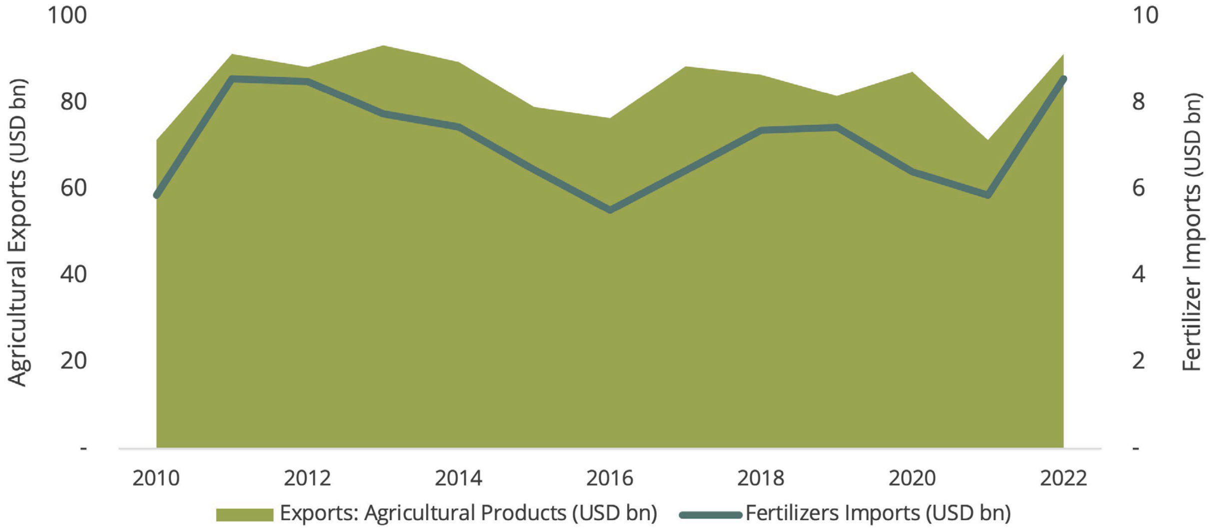

Figure 3: Agricultural exports & fertiliser imports in Brazil, for the period 2010-2022. Source: COMTRADE.

Brazil's dependence on imported fertiliser is even more extreme when individual fertiliser categories are considered. In 2021, 91% of Brazil's synthetic nitrogen fertiliser was imported and 97% of its potassium – see Figure 4.

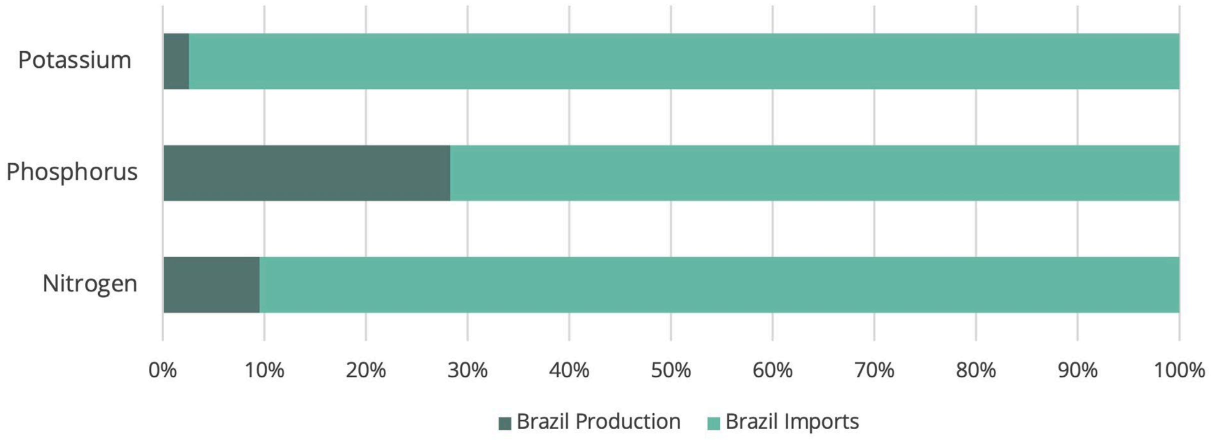

Figure 4: Brazil's 2021 fertiliser imports vs domestic production. Source: FAO, Planet Tracker analysis.

Soy, maize and sugarcane dominate fertiliser use

Soy, maize and sugarcane, Brazil's three main export crops, currently use three quarters of Brazil's total nutrients budget[9] – see Figure 5.

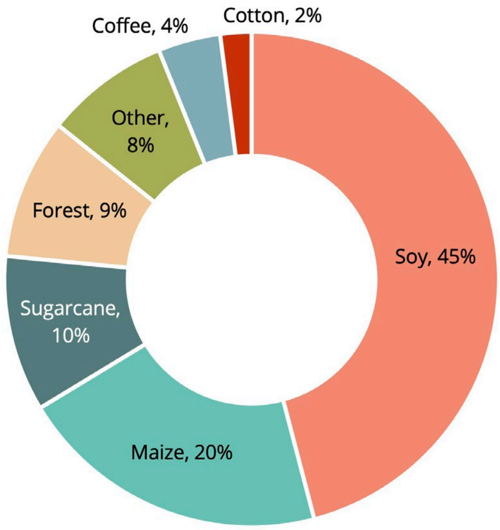

Figure 5: Nutrient use by crop in Brazil, 2024. Source: GlobalFert.

Implications of Brazil's fertiliser import dependency

Brazilian dependence on imported fertilisers has several potential implications:

Economic vulnerability

Being significantly tied to global synthetic fertiliser markets makes its agricultural sector – and the broader economy – highly vulnerable to supply chain disruptions and price spikes.

This was the case in 2021, following the Ukraine war, which triggered widespread inflationary pressures. This can be illustrated by the increase in the quantity of maize, soy and sugarcane required to buy a ton of fertiliser that year, highlighting the fact that commodity prices lagged the rising cost of inputs putting pressure on farmers who have to buy fertiliser before selling their harvest - see Figure 6.

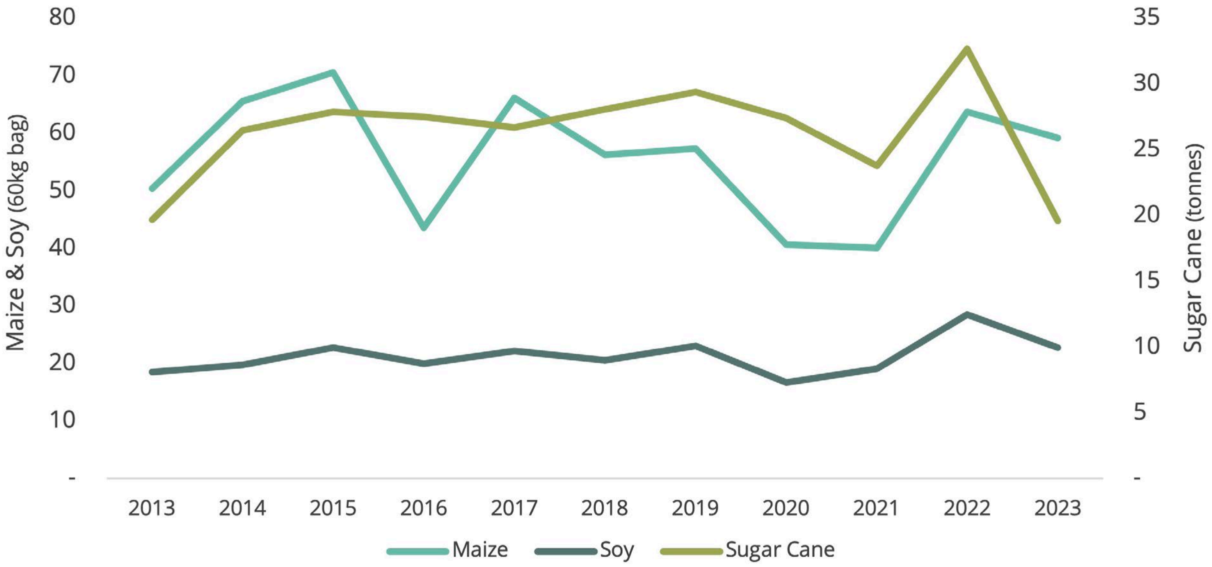

Figure 6: Quantity of Maize, Soy and Sugar Cane required to buy a ton of fertiliser. Source: ANDA.

The need to purchase large quantities of synthetic fertiliser on the international market also exposes Brazil to currency fluctuations. A weakening of the Brazilian Real could significantly increase the cost of these essential inputs for farmers.

Geopolitical risks

Brazil's dependence on synthetic fertiliser imports could potentially be leveraged by other countries in international negotiations or disputes, particularly because 90% of its total synthetic fertiliser imports came from only 15 countries[10] - see Figure 7. In 2022 23% of Brazil's synthetic fertiliser imports came from Russia, 15% from Canada, and 10% from China.[9]

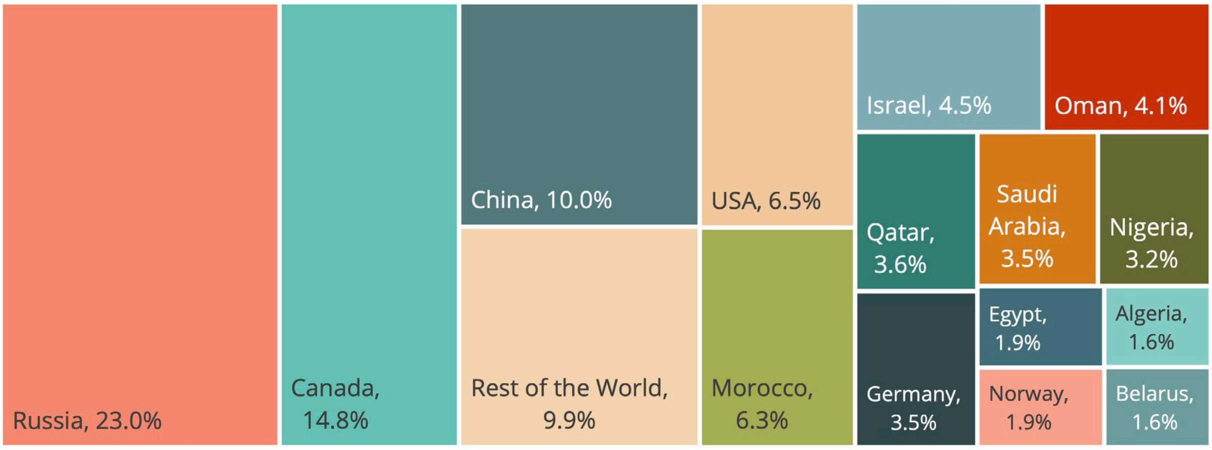

Figure 7: Brazil fertiliser imports in 2022 - source countries. Source: World Bank, WIT.

Brazil's Fertiliser use may be approaching its limits

There is growing evidence that Brazil's use of synthetic fertiliser to boost agricultural productivity, supporting its status as an agronomic superpower, is reaching its limit.

The production-to-fertiliser ratio is declining for some crops

By combining Food and Agriculture Organization (FAO) and The United States Department of Agriculture (USDA) statistics, Planet Tracker has calculated a *production to fertiliser* ratio, which represents the amount of synthetic fertiliser used per hectare of production. Comparing this ratio with the amount of synthetic fertiliser used to produce a tonne of crop provides an insight into the extent to which synthetic fertiliser may have impacted yields. It is important to note that crop yields are impacted by a variety of factors such as area of land under cultivation, weather events and longer-term climate.

Sugarcane – a significant decline in the production:fertiliser ratio

The amount of synthetic fertiliser used per hectare to produce sugar cane has steadily increased over the years, up by over a quarter from 2010 to 2021. However, production per unit of applied fertiliser has fallen by 56% from 2010 to 2021 – see Figure 8.

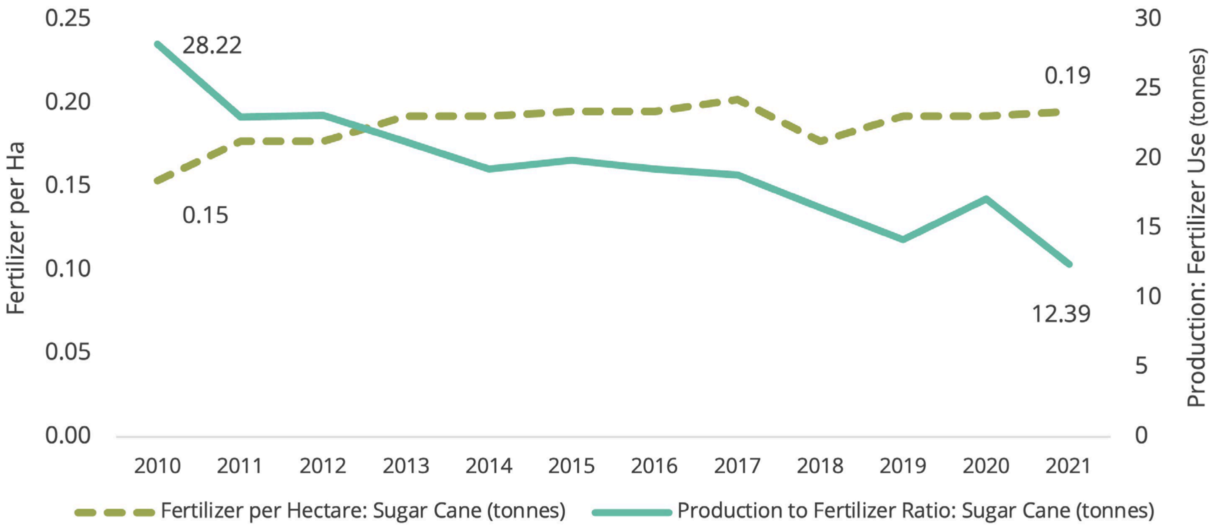

Figure 8: fertiliser per hectare in Brazilian sugar cane cultivations, compared to productivity per unit of applied fertiliser. Source: Planet Tracker, FAO, USDA.

This suggests that continuing to devote more synthetic fertiliser to sugarcane may not change the decade long trend of falling sugarcane production compared to fertiliser inputs.

Nutrient Use Efficiency is also showing signs of approaching limits

Aside from the effectiveness of using synthetic fertilisers to boost productivity, there are increasing signs of leakage into the environment coming from the inefficient application of nutrients.

Using figures from the FAO, Planet Tracker has analysed Nutrient Use Efficiency (NUE) for nitrogen, phosphorus and potassium fertilisers since 2010. The NUE indicates the extent to which a tonne of fertiliser will be used by the crop to which it is being applied. An NUE of less than 100% shows that some of the fertiliser being applied is not being absorbed by the crop concerned. The difference between 100% and the NUE assessed indicates the extent to which fertiliser is likely to be polluting the environment and represents a drain on producer profitability.

Potassium use efficiency has declined since 2010

The NUE for potassium fertilisers has declined from 67% in 2010 to 62% in 2021. The NUE of potassium fertilisers has been volatile over the decade, as demonstrated in Figure 9.

Sugar cane is one of the key crops requiring potassium fertiliser, and as noted earlier, fertiliser use per hectare has increased steadily over the decade by an average of 2.2% per year. This highlight that increased fertiliser use may not be contributing to increased productivity while also driving increased pollution.

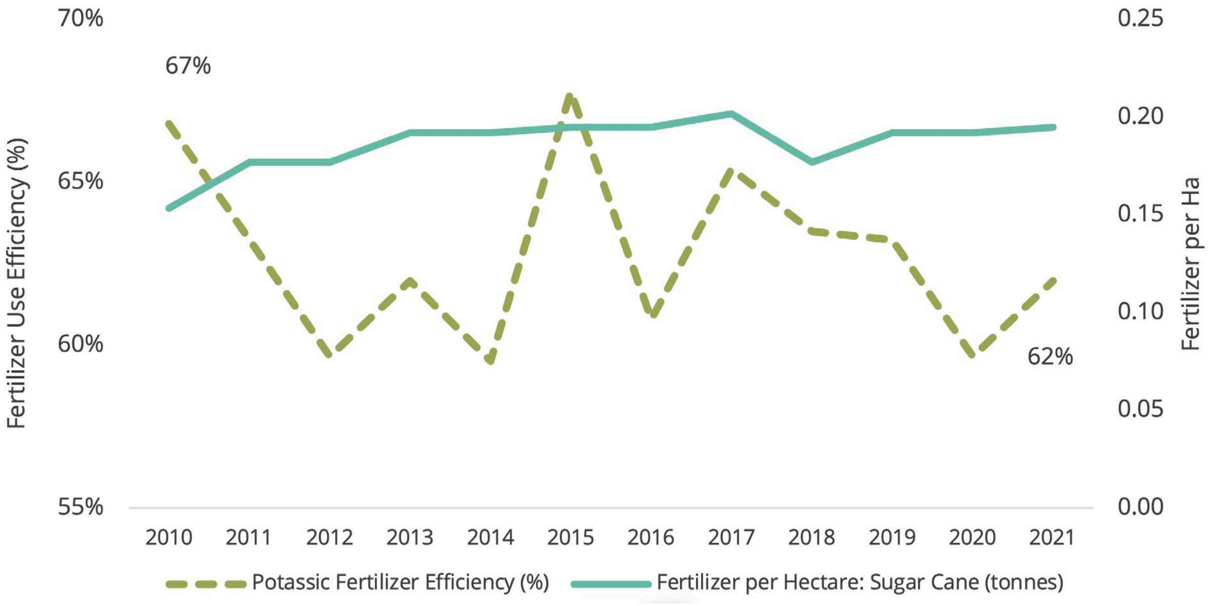

Figure 9: Potassic applications' efficiency, compared to fertiliser per hectare in Brazilian sugar cane cultivations. Source: FAO.

Brazil's GHG emissions from fertiliser

In the context of global GHG emissions from fertiliser

Fertiliser production and use account for approximately 5% of global GHG emissions, equivalent to 1.3 billion tonnes CO_2e in 2019.[11] Not only is Brazil's heavy dependence on imported fertiliser a potential risk from an economic and food security perspective, but it also a significant contributor to GHG emissions.

FAO data suggests that synthetic fertiliser use drives a higher proportion of GHG emissions (55%) globally than production (45%) – see Figure 10.

Figure 10: Comparison of global GHG emissions from fertiliser production and use. Source: FAO, Planet Tracker analysis.

Five countries make up over half of global fertiliser-related GHG emissions. China makes up 24% of the global total, followed by India (13%), the United States (10%), and Brazil (5%) – see Figure 11.

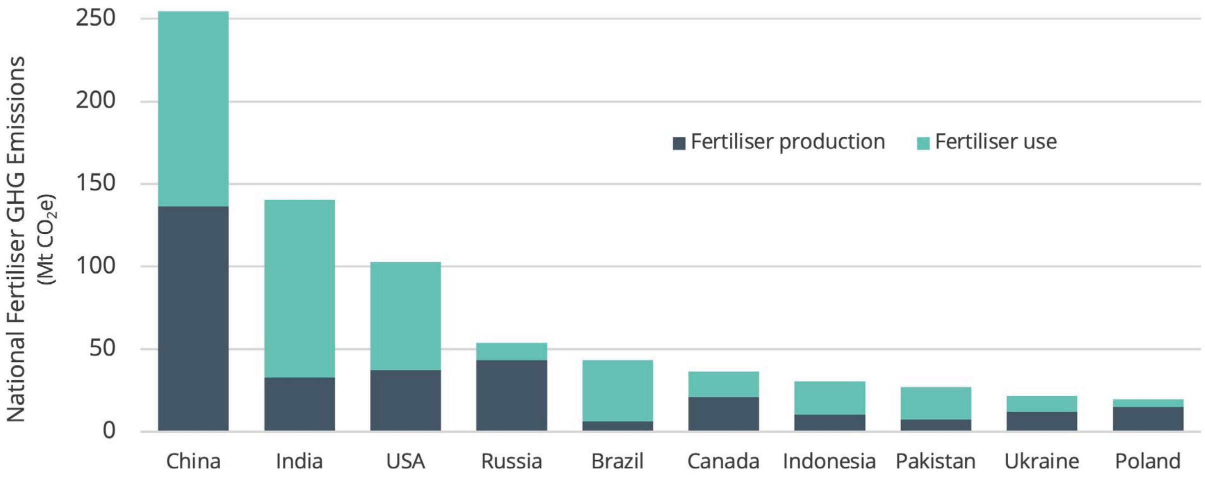

Figure 11: National fertiliser GHG emissions, 2021. Source: FAO[12], Planet Tracker analysis.

Brazil’s reported fertiliser emissions omit imports

As Figure 11 shows, in a number of countries GHG emissions from synthetic fertiliser use constitutes a significantly higher proportion of their overall fertiliser emissions than emissions from producing fertiliser. In part this difference is driven by GHG accounting conventions since the emissions embedded in imported fertilisers are not captured in national carbon accounting systems.

As Brazil imports most of its synthetic fertiliser, GHG emissions from fertiliser use account for the majority of its reported fertiliser carbon footprint as emissions from producing imported fertiliser are excluded.

Estimating Brazil’s real fertiliser-related GHG footprint

To generate a more comprehensive picture of the GHG emissions associated with synthetic fertiliser use in Brazil, Planet Tracker combined the GHG emissions figures reported by Brazil for domestic production and fertiliser use with an estimate of the emissions embedded in the fertilisers imported into Brazil.

Two alternative methods to estimate the GHG emissions embedded in Brazil’s fertiliser imports were used:

- Method 1 – average emission factors for nitrogen, phosphorus and potassium fertilisers were calculated based on the review of academic papers analysing fertiliser production emission factors published in Walling E, and Vaneeckhaute C.’s 2020 paper.[13]
- Method 2 – a weighted average emissions factor for Brazil’s imports was calculated by comparing FAO data on country GHG emissions from fertiliser production with World Bank data on Brazil’s fertiliser imports (analysed by source country).

Method 1 differentiates between different fertiliser types, whereas Method 2 treats all fertilisers the same. However, the overall result is very similar – see Table 2.

Table 2: Calculated emission factors using Method 1 and Method 2. Source: Planet Tracker calculations.

Emission factor (Kg CO2e / Kg of fertiliser)	Method 1 – Walling E, & Vaneeckhaute C (2020)	Method 2 – FAO data
Nitrogen	3.83	N/A
Phosphorous	2.36	N/A
Potassium	0.20	N/A
Domestic	N/A	2.22
Imports	N/A	1.76
Overall result	2.01	1.82

When these emission factors are applied to the 2021 fertiliser import data published by the FAO, Method 1 produces an estimate of 39 Mt CO_2e for imported fertiliser emissions, and Method 2 results in a slightly lower figure (35 Mt CO_2e).

Brazil reports the GHG emissions relating to domestic fertiliser production. For 2021, the GHG emissions figure was 6 Mt CO_2e. Combining this figure with our estimates for imported fertiliser emissions results in an overall import and production estimate of 41 Mt CO_2e - 45 Mt CO_2e – see Table 3.

Table 3: Estimated GHG emissions resulting from fertiliser imports and domestic production in 2021 (kt CO_2e). Source: Planet Tracker calculations.

Estimation method	Imported fertiliser – total emissions	Domestic fertiliser – total emissions	Total pre-application emissions
Method 1 – academic data	38,851	6,327	45,178
Method 2 – FAO data	34,655	6,327	40,982

Emissions associated with fertiliser use in Brazil

As Figure 13 illustrates (page 14), once nitrogen fertiliser is applied to a field it results in both direct and indirect emissions. Direct emissions of nitrous oxide (N_2O) are caused by bacteria reacting with the nitrogen fertiliser immediately after application; indirect emissions can be caused by 'volatilization' (where nitrogen fertiliser breaks down releasing ammonia into the atmosphere) and/or 'leaching' or run-off where nitrogen and other fertilisers are washed out of the soil into groundwater or surface water.

In contrast, the main pollution mechanism for phosphorus and potassium fertilisers is leaching or run-off, contributing to water pollutions the extent of these emissions will vary widely depending on soil conditions, weather conditions and climate conditions more broadly.

The FAO collects country estimates for direct and indirect N_2O emissions from using nitrogen. The latest overall reported figure for N_2O emissions from fertiliser use in Brazil was 139.5 kt N_2O in 2021. Converting these emissions into CO_2e using the GWP100[b] ratio from IPCC AR6 (273[c]) produces an estimate of GHG emissions from fertiliser use in Brazil of 38 Mt CO_2e.

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[b] GWP100 - Global Warming Potential over a 100 year time period, the standard national carbon accounting method for converting other greenhouse gasses into CO_2 equivalent units.

[c] 273 is the IPCC recommended GWP100 ratio - see methodology explanation earlier in this report.

Overall estimates of fertiliser-related GHG emissions in Brazil

Brazil's total estimated fertiliser-related GHG emissions amount to 83 Mt CO_2e (or 79 Mt CO_2e if average emission factors are used), combining Planet Trackers estimates of emissions from imported fertiliser production with the FAO figures for domestically produced fertiliser emissions and those caused by using nitrogen fertilisers in the field. This is equivalent to 7% of Brazil's total annual GHG emissions in 2021 (1,136 Mt CO_2e, excluding land use change and forestry)[14] – see Figure 12.

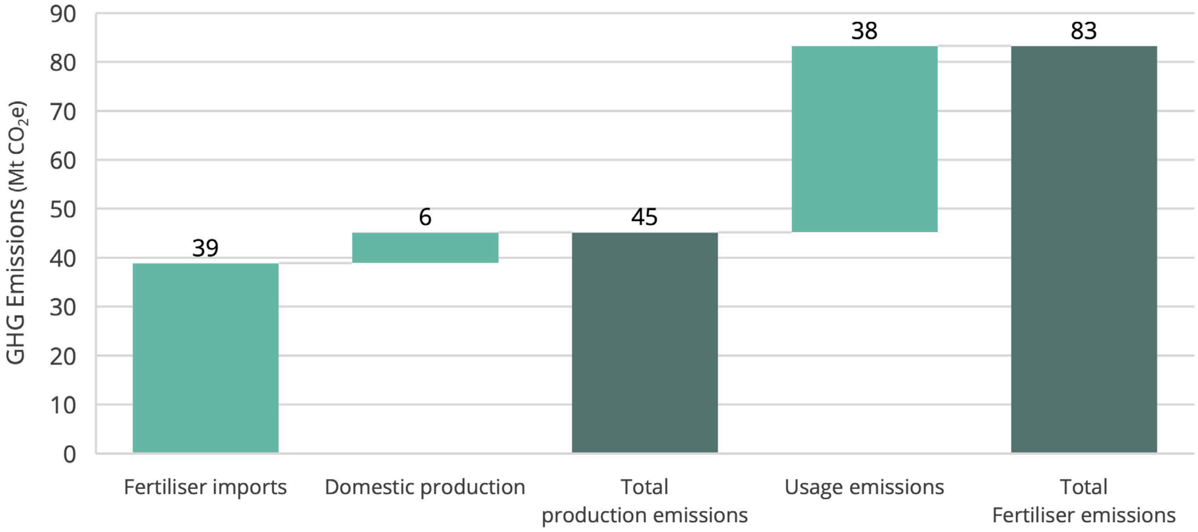

Figure 12: The components of Brazil's estimated fertiliser-related GHG emissions. Source: Planet Tracker analysis.

Based on this analysis, the GHG emissions relating to imported fertiliser amount to between 44% and 47% of total fertiliser emissions, with domestic production contributing 7% - 8%. Post-application emissions account for just under half (46%) – see Figure 13 – which is lower than the global average (55%).

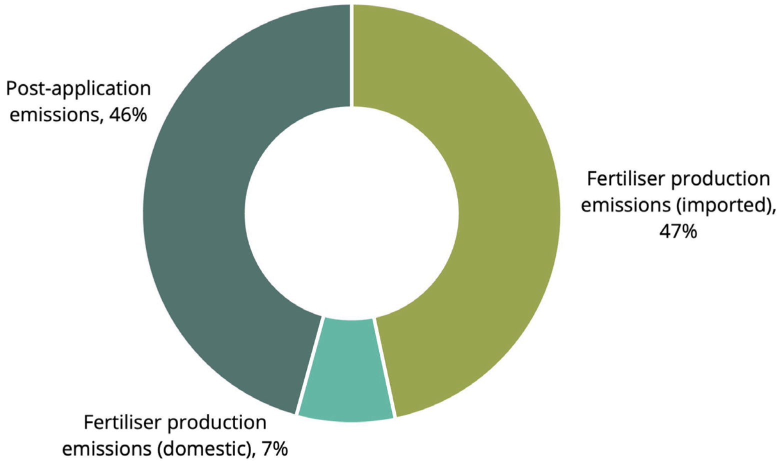

Figure 13: Fertiliser-related GHG emissions by source using average emission factors for GHG emissions relating to fertiliser imports (Method 1). Source: Planet Tracker analysis.

On-shoring fertiliser production will increase GHG emissions

Brazil's National Fertiliser Plan

As a result of this heavy dependence on imports, in 2022, the Brazilian federal government enacted the 2022 - 2050 PNF.[15] The PNF target is to reduce Brazil's dependency on imported fertiliser by increasing domestic production to meet 45% - 50% of Brazil's requirements by 2050, including an assumed doubling of demand in Brazil.[16] This would require a significant increase in the quantity of fertiliser produced domestically.

There are obvious practical challenges associated with such a dramatic shift. The USDA estimated that Brazil's capacity for producing synthetic nitrogen fertilisers in 2021 could only meet 18% of the country's demand and its capacity for producing phosphorus depended on only five producers and one potash producing unit.[17]

There are technical and financial challenges associated with building new nitrogen fertiliser plants. However, these can be overcome with knowledge and finance, but both phosphorus and potassium would require the establishment of new mines with all the associated permitting and environmental challenges associated with such operations. The PNF envisages 60 new regional potassium and phosphorus mining projects by 2050 without proposing any actions to mitigate their environmental impact.

To illustrate the challenges, in the high demand scenario set out in the PNF, Brazil's fertiliser demand increases by 122% compared to 2021. That would imply a total fertiliser requirement of 50 Mt in 2050 and a domestic production target of 27.5 Mt. The PNF high demand scenario includes volume assumptions for different categories of fertiliser in 2050. Table 4 illustrates the potential impact on domestic production – an increase compared to 2021 of over 800%, an average annual growth rate of 8%.

Table 4: Scenario analysis of Brazil's 2050 domestic fertiliser production targets under PNF.
Source: Planet Tracker analysis.

2021 (reported)

Tonnes of fertiliser	Nitrogen	Phosphorus	Potassium	Total
Brazil Production	704,574	1,925,998	213,028	2,843,600
Brazil Imports	6,715,006	4,886,938	8,038,853	19,640,796
Total	**7,419,580**	**6,812,936**	**8,251,881**	**22,484,396**

Brazil Production	9%	28%	3%	13%
Brazil Imports	91%	72%	97%	87%
Total	**100%**	**100%**	**100%**	**100%**

Estimated impact of PNF

Assume demand increases	122%
Overall demand in 2050 (tonnes)	49,827,000
Assume domestic production proportion	55%
Domestic production in 2050 (tonnes)	27,530,000

2050 (scenario) – High demand, strong domestic production

Tonnes of fertiliser	Nitrogen	Phosphorus	Potassium	Total
Brazil Production	3,695,000	9,237,000	14,598,000	27,530,000
Brazil Imports	5,848,000	2,989,000	13,460,000	22,297,000
Total	**9,543,000**	**12,226,000**	**28,058,000**	**49,827,000**

Increase in Brazil Production (by 2050	424%	380%	6753%	868%
Annual growth rate (domestic)	6%	6%	16%	8%
Annual growth rate (all)	1%	2%	4%	3%

Brazil’s fertiliser imports have a lower GHG footprint

At an aggregate level, Planet Tracker’s analysis has found that overall Brazil’s synthetic fertiliser imports produce fewer GHG emissions per tonne than those generated by producing fertilisers domestically.

The FAO publishes data on the amount of fertiliser produced by countries and the GHG emissions associated with this fertiliser production. By combining these figures with the fertiliser import data from the World Bank it is possible to calculate a weighted average GHG emissions figure for Brazil’s imported fertiliser. This was described as ‘Method 2’ in the previous section estimating Brazil’s imported fertiliser-related GHG emissions.

This analysis shows that the weighted average GHG emissions intensity per kt of fertiliser across all the countries exporting to Brazil is 1.76 kt CO_2e/kt fertiliser compared to Brazil’s domestic production figure of 2.22 kt CO_2e/kt fertiliser – see Figure 14.

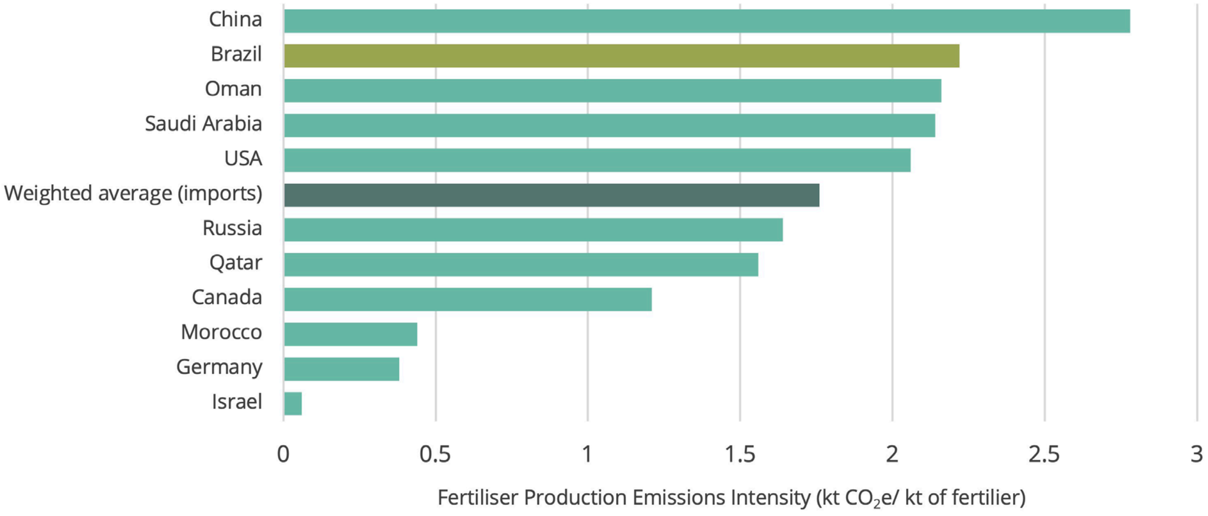

Figure 14: Fertiliser production emissions intensity - Brazil compared to top 10 import source countries. Source: FAO, World Bank, Planet Tracker analysis.

By applying these average figures to the volume scenario outlined in Table 5 it is possible to estimate the GHG impact of Brazil’s National Fertiliser Plan in 2050.

As Brazil’s domestic fertiliser production is more GHG emissions intensive than imports overall, fully implementing the PNF will significantly increase Brazil’s fertiliser-related GHG emissions compared to their current level.

Excluding the impact of the assumed increase in fertiliser demand within Brazil by 2050 and simply focusing on the relative GHG footprints, adopting the PNF would increase Brazil’s GHG emissions by 6%. If the proportion of Brazil’s domestic synthetic fertiliser production remains at current levels and the GHG emissions intensity of imports does not change, then Brazil’s fertiliser-related GHG emissions would increase by 77% due to the increase in demand.

Adopting the PNF in full, including the expected demand increase and the onshoring of 55% of synthetic fertiliser production, would increase fertiliser-related GHG emissions by 89%, assuming post-application emissions increase in line with increased demand – see Figure 15.

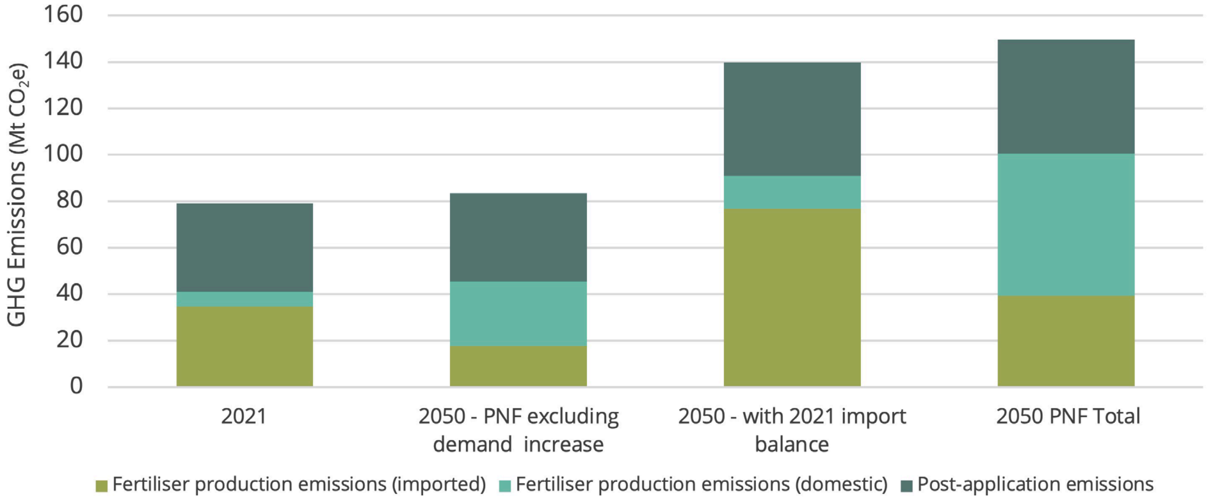

Figure 15: Estimated GHG emissions impact of Brazil's National fertiliser Plan. Source: Planet Tracker analysis.

Increasing domestic fertiliser production will increase GHG emissions

When reporting their GHG emissions countries usually use the 'National Territory' approach[18] which does not include the emissions relating to imported goods or services. As a result, the 35 Mt CO_2e of GHG emissions that this analysis estimates relates to Brazil's fertiliser imports are not included in the national reported GHG emissions. If Brazil increased domestic fertiliser production, then the associated emissions will need to be reported.

Based on the PNF scenario above which assumes that Brazil's GHG emissions intensity for fertiliser production remains the same, this analysis finds that Brazil's overall fertiliser-related GHG emissions would increase to 110 Mt CO_2e in 2050, a 155% increase on its current reported figure – see Figure 16.

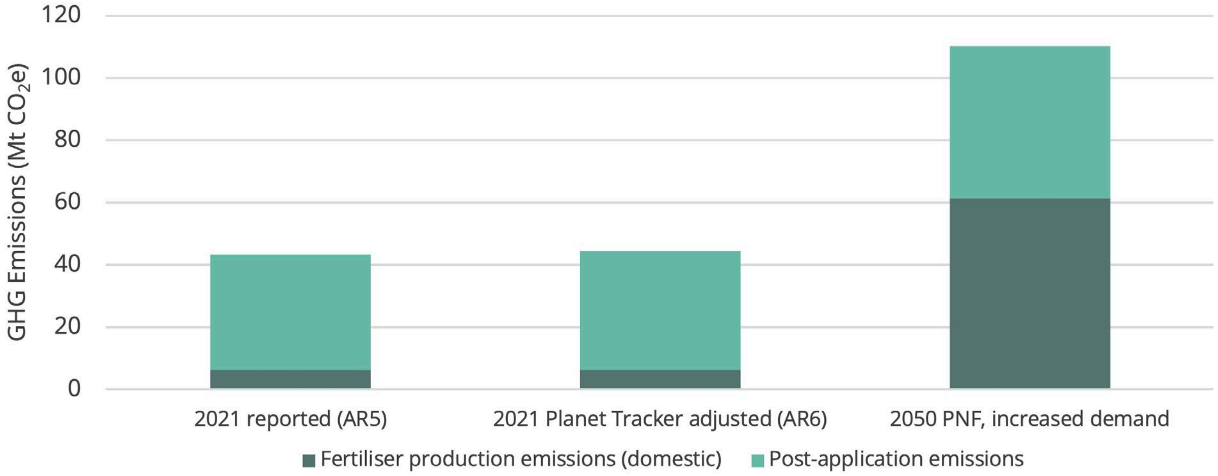

Figure 16: Brazil's estimated reported fertiliser-related GHG emissions in line with increased domestic fertiliser production under PNF. Source: Planet Tracker analysis.

Fertiliser overuse impacts nature and human health

Brazil's synthetic fertiliser use is contributing to the GHG emissions that drive climate change and will threaten its agribusiness sector and its wider economy.[d] Fertiliser over use and misuse is also a significant source of pollution, releasing nitrous oxide (N_2O) a GHG with a global warming potential 273 times higher than carbon dioxide , nitric oxide and nitrogen dioxide[19] (collectively, 'NO_x'), and ammonia (NH_3). These gases collectively result in particulate pollution,[20] smog and acid rain, as well as the formation of ground-level (tropospheric) ozone, all of which are harmful to human health (contributing to reduced lung function, respiratory diseases, asthma, and lung cancer among other impacts).

In addition, fertiliser overuse and misuse causes eutrophication through direct run-off from fields after application or leaching from the soil into freshwater courses. Here, an excess of nutrients in the water leads to the growth of algae and other microorganisms that use up the available oxygen killing other aquatic life. This in turn can cause human health problems. In contrast to data on GHG emissions from fertiliser use, data regarding the environmental and health impact of fertiliser use in Brazil is hard to come by.

It is clear from the Nutrient Use Efficiency analysis discussed earlier in this report that significant quantities of fertiliser in Brazil are not being absorbed by crops and are entering the environment as pollution.

Academic studies highlight the threat to Brazil's water courses

Estimating the impacts of fertiliser runoff on Brazil's rivers, lakes, and coastal areas is beyond the scope of this report but a number of academic studies have highlighted the impact that agriculture is having on water quality in particular parts of Brazil:

- Kaline et al. (2020)[21] highlights that *'agriculture and urban areas are the main [land-use related drivers] responsible for water quality degradation in Brazil.'*
- The ResourceWatch 'eutrophication and hypoxia' dataset[22] includes 13 coastal sites in Brazil that show evidence of eutrophication and/or hypoxia (both indicators of the effects of fertiliser pollution further inland).

Fertiliser impacts on human health is difficult to quantify

The impact of fertiliser misuse and overuse on human health in Brazil is also difficult to quantify but the risks are illustrated by the poisoning of 116 haemodialysis patients at a clinic in Caruaru, Pernambuco State, Brazil in February 1996 caused by cyanobacteria present in the water supply as a result of eutrophication. As a result of this incident, 100 of the patients developed acute liver failure and 52 had died by December of that year.[23]

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[d] These effects are discussed in more detail in *Destroying Brazil's Aircon*

As noted earlier, fertiliser use causes air pollution, contributing to ground-level ozone and the formation of particulate matter in the atmosphere. The gases and particulates negatively impact human health in a number of ways, all of which reduce worker productivity, increase healthcare costs and can lead to premature death.

A review of the academic literature did not reveal any studies that identified the extent to which fertiliser contributes to the overall level of air pollution in Brazil. However, a number of studies highlight the overall socio-economic impacts of air pollution in Brazil:

- A study by Custodio et al.[24] estimates that 50,000 people in Brazil die each year on average due to illnesses linked to air pollution.
- Lima et al.'s[25] estimated that in the city of Manaus (Amazonas), the average hospitalisation related to respiratory diseases cost of more than BRL 19,000 (approximately USD 3,900) per patient.
- Santana et al.[26] identified 302,000 hospitalisations for respiratory diseases between 2008 and 2017 in the city of Sao Paulo with an estimated total cost of USD 111 million.

In overall terms, Brazil's air pollution problem is less significant than many of its neighbours. The Pan American Health Organisation assessed Brazil's overall PM2.5 concentration level in 2016 as 11.49, 10% above WHO guidelines but in the lowest pollution quartile compared to its Americas peers.[27]

Increased fertiliser use will exacerbate negative health impacts

Given the lack of comprehensive data, and the relatively small numbers of people apparently impacted, it could be argued that other environmental and social issues should take priority.

However, in the context of Brazil's plan to increase domestic fertiliser production and use, it is clear that the associated pollution and health impacts will potentially double by 2050. On that basis, a plan to reduce synthetic fertiliser use will have clear environmental, social, and economic benefits, in addition to reducing GHG emissions.

Brazil's PNF lacks focus on sustainability

Brazil's PNF has five 'Guidelines', none of which mention sustainability or the environmental impact of fertiliser (refer to Appendix 3 for a summary of the Guidelines and selected goals). Similarly, the PNF's 12 strategic objectives do not include any measures designed to ensure the sustainable use of fertilisers nor to limit pollution arising as a result of fertiliser use.

However, the environmental impact of fertiliser production and use is acknowledged in the detailed discussion and analysis contained in the PNF document, and there are a number of specific goals and actions set out under Guidelines 3 and 4 which are designed to encourage a shift to more sustainable fertiliser practices, including:

- encourage and disseminate good practices in the production and use of fertilisers and plant nutrition inputs, both domestic and imported, that minimize greenhouse gas emissions by at least 30% by 2050.
- increase the production and supply of organic and organomineral fertiliser by at least 500% by 2050.
- improve nutrient use efficiency by increasing the adoption of 'bio-inputs for plant nutrition' to cover 75% of Brazil's planted area by 2050, and to increase the contribution of 'biological fixation by at least 100% by 2050.

Under the heading of 'Environmental Sustainability' the Plan includes a comment as part of its vision for 2040 where *'biological inoculants for the management of biological nitrogen fixation in major crops … will reduce the need for mineral nitrogen sources by 50% compared to 2020'*. This ambition is supported by the National Bio-inputs Program established in 2020 (refer to Appendix 3 for more details). However, none of the scenarios set out in the PNF indicate any such reduction in nitrogen use.

Given that Brazil's existing 'Plan for Adaptation and Low Carbon Emission in Agriculture (ABC+)[28] which runs from 2020 to 2030 has the overall objective of *'consolidating Brazilian agriculture as a sustainable powerhouse, firmly based on sustainable, resilient and productive farming systems'*, the lack of a clear overall objective in the PNF to reduce synthetic fertiliser use appears to be a missed opportunity.

Opportunities to reduce Brazil's synthetic fertiliser use

Reducing the agriculture sector's reliance on synthetic fertiliser is essential to tackling the negative climate, nature and health impacts described in this report. There are a number of ways that synthetic fertiliser use can be reduced, and a holistic approach requires multiple solutions to be developed and integrated into the agricultural system.

Increasing Nutrient Use Efficiency

As noted in this report and in Brazil's PNF, Nutrient Use Efficiency (NUE) across Brazil could be significantly improved. Doing so would achieve similar, or even better, yields while reducing the quantities of fertilisers applied to specific crops and decreasing post-application GHG emissions and pollution.

Studies agree that improving NUE has the greatest potential to reduce fertiliser-related emissions, For example, Gao and Serrenho (2023) estimate that if NUE globally was to increase from 42% to 67%, reduced demand for nitrogen in 2050 would reduce GHG emissions by 48% in 2050.[29] Zhang et al (2015), suggest NUE target for Brazil of 70%,[30] however, as noted earlier in this report, Brazil's nitrogen efficiency use is at 74%, but is much lower for potassium (62%) and phosphorous (48%).

However, this analysis shows declining NUE across all three fertiliser categories in Brazil, suggesting that improving NUE will not be simple and will require detailed, crop and location specific data and analysis, combined with careful application of the 4R nutrient management principles (right source, right rate, right timing, and right placement). Brazil's industrial and research strengths, and increasing use of technology on many larger farms, suggest there are significant technology opportunities associated with this mitigating action.

Biological nitrogen fixation including bio-inoculants

Brazil's PNF includes 'developing new sources of inputs for plant nutrition, in a competitive and sustainable manner' as one of its strategic objectives.[31] Various biological techniques can be used to fix nitrogen in the soil including adding crops such as legumes which naturally capture and store nitrogen in crop rotation plans or applying nitrogen fixing bacteria to seeds prior to sowing, referred to as using microbial or biological inoculants.

This latter technique has been successfully used by some soy farmers in Brazil for years. A variety of studies in Brazil provide strong evidence that using nitrogen fixing bacteria is as effective at raising soy yields in Brazil as using synthetic fertilisers, Led by Dr Mariangela Hungria, senior researcher at EMBRAPA, among others.[32] This demonstrates that soy farmers could stop using synthetic fertilisers, avoiding the higher costs and negative environmental impacts, without suffering any drop in yields.

Brazil's National Association of Producers and Importers of Inoculants (ANPII) has been promoting the practice since its formation in 1990 and estimates that biological inoculants covered 85% of the planted area of soy in 2022/23, with the use of 'co-inoculants' growing to cover 35%.

Biological nitrogen fixation techniques have been successfully applied to a wide variety of crops beyond soy and as substitutes for nitrogen, phosphorus and potassium fertilisers, demonstrating the clear potential to significantly reduce synthetic fertiliser use in Brazil and elsewhere.[33]

Chemical emissions inhibitors

As noted previously, the majority of GHG emissions occur once fertiliser has been applied in -the field. To reduce this, other chemicals - urease and nitrification inhibitors - can be applied. Urease Inhibitors block the activity of the enzyme urease found in soil and plant residues, reducing the conversion of ammonium into ammonia gas. Nitrification Inhibitors temporarily reduce populations of Nitrosomonas and Nitrobacter bacteria in soil. These are the bacteria responsible for converting ammonium to nitrite (Nitrosomonas) and nitrite to nitrate (Nitrobacter). Nitrification Inhibitors protect against both denitrification and leaching by keeping nitrogen fertiliser in the form of ammonium.

Chemical emissions inhibitors could have the potential to significantly reduce fertiliser-related GHG emissions globally. Gao & Serrenho (2023)[34] estimate a potential reduction of 29% in 2050 and; Systemiq's model suggests a reduction in GHG emissions in 2050 of 26%.[35] However, this solution comes at an added cost for farmers and does not necessarily increase yields.

Green ammonia

Ammonia produced using renewable energy and green hydrogen avoids the GHG emissions that normally result from the Haber-Bosch process. However, it is currently expensive to produce and global production capacity is extremely limited. Agora Industry's Global Green Fertiliser Tracker estimates global production capacity at 61kt, implying that the green fertiliser production capacity only covers 0.3% of current global fertiliser-related ammonia demand.[36]

Brazil has an opportunity to exploit its extensive renewable energy resources, including significant hydropower capacity,[e] to produce green ammonia to produce lower carbon nitrogen fertiliser. This potential is acknowledged in Brazil's PNF which includes a goal under Guideline 4 to add *'5% by mass of green ammonia equivalent per year from 2027, reaching 20% by 2030'*. However, nitrogen fertiliser produced from green ammonia will still cause significant GHG emissions and other pollution challenges when applied to crops, and these emissions are greater than those associated with production.

Manure and other organic fertilisers

Switching to organic fertilisers, such as manure and compost, avoids the GHG emissions associated with the Haber-Bosch process. However, organic fertilisers still produce negative environmental impacts, including potential methane emissions from the animals producing manure and from the manure itself unless it is managed properly.

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[e] In 2023 50% of the energy consumed in Brazil came from renewable sources including 29% from hydropower (Source: Statistical Review of World Energy 2024, Energy Institute, London. *https://www.energyinst.org/statistical-review/home)*

Compost, including vermicompost, and biochar also improved soil fertility. Biochar involves the pyrolysis (heating) of organic matter to convert it into charcoal, locking in the carbon captured by the plants which is stored in the soil when applied as fertiliser. A challenge in scaling organic fertilisers is that they can be more difficult to transport over long distances and can still lead to pollution problems (particularly eutrophication) if applied inappropriately. Organic fertilisers are most effective as part of farming systems that integrate crops and livestock, alongside regenerative practices.

Technological innovations

Technological innovations have significant potential to reduce synthetic fertiliser use but in many cases these solutions are at an early stage of development or are too expensive for the majority of food producers.

Technologies currently being trialled that could reduce synthetic fertiliser use include:

- Sensors that detect the nutrient levels in particular plants or the soil can help to avoid over or under application of fertiliser. Cameras on drones or satellites can provide similar information.
- GPS can enable machines to apply fertiliser on specified areas, avoiding areas where it is not required.
- AI can be used to analyse crop patterns and identify when fertiliser take-up is likely to be higher or lower.
- All the above technologies can be combined with robots that apply fertiliser in precise doses to the individual plants in line with the 4R approach (right fertiliser, right dose, right place, right time).
- Further developments of slow-release and controlled-release fertilisers will improve NUE.
- Gene-editing techniques could increase the effectiveness of bio-inoculants and increase the ability of a variety of crops to fix nitrogen and more effectively use nutrients in the soil.

Regenerative agricultural techniques

Reducing the need for synthetic fertiliser inputs by adopting regenerative agricultural practices that preserve and enhance soil health has proven effective in many countries and can reduce input costs and price fluctuations for farmers. The combined nature and climate benefits of regenerative approaches to agriculture are discussed in more detail and recommended as a priority area for support from financial institutions in Planet Tracker's *Financial Market Roadmap for Transforming the Global Food System*.

Regenerative agriculture aligns with the third pillar of Brazil's ABC+ plan: 'Foster adoption and maintenance of Sustainable Systems, Practices, Products and Production Processes.'[37] The ABC+ plan refers to 'Conservationist farming practices' and notes that they are 'pivotal for efficient management of agricultural systems as well as for strengthening their resilience and sustainability.' However, neither the ABC+ plan nor the PNF explicitly refer to strategies for reducing the use of synthetic fertilisers and this gap will need to be addressed if Brazil is to successfully transition to a sustainable agricultural system.

Fertiliser emissions reduction scenarios

Brazil's PNF sets out three fertiliser demand scenarios for 2050. In the low demand scenario, fertiliser demand increases by 33% and while the high demand scenario sees demand more than doubling by 2050, a 122% increase compared to 2021, with GHG emissions increasing by 89%. Planet Tracker undertook analysis to estimate the potential emissions reductions for these two scenarios from applying actions to reduce fertiliser demand and mitigate GHG emissions outlined in the previous section. The results for the high demand scenario are summarised in Figure 17 and the low demand scenario is summarised in Figure 18.

This report estimates that by undertaking certain emissions- and demand-reduction measures by 2050, Brazil's fertiliser-related GHG emissions would decrease by 53% in the high demand scenario and 68% in the low demand scenario compared to taking not action. Without any of these measures, in the high demand scenario, fertiliser-related GHG emissions would increase by 89% in 2050 compared to a 2021 baseline as illustrated in Figure 17. This would likely result in increased fertiliser-related pollution, negatively impacting human health and Brazil's economy.

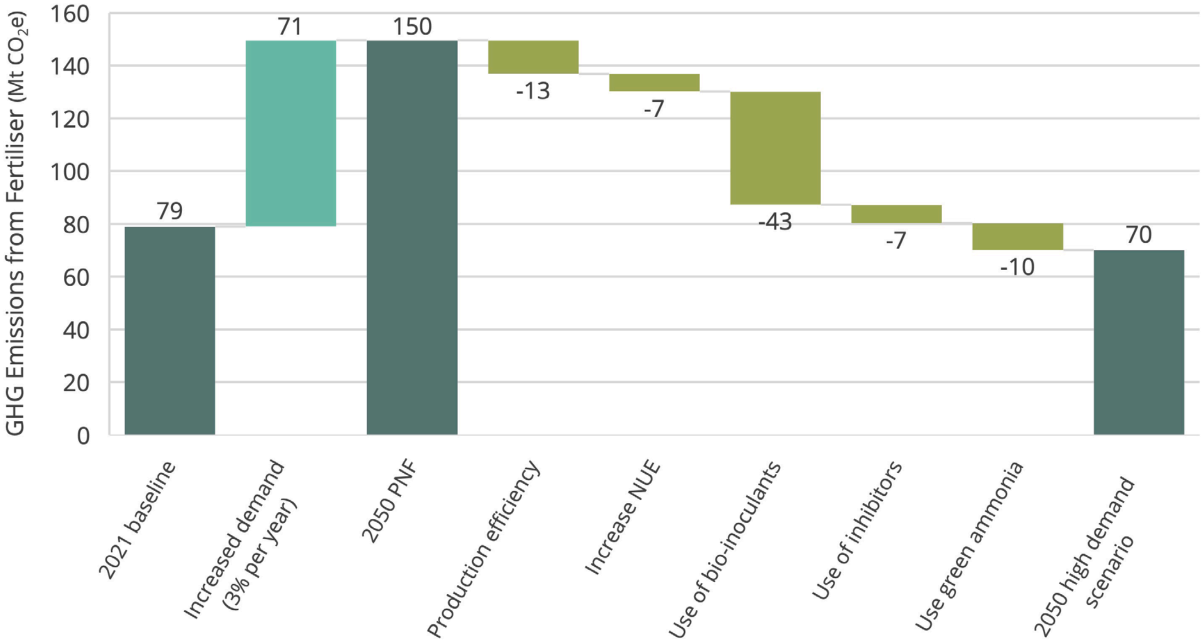

Figure 17: The impact of GHG emissions mitigation measures on fertiliser-related GHG emissions in Brazil in a high fertiliser demand scenario. Source: Planet Tracker.

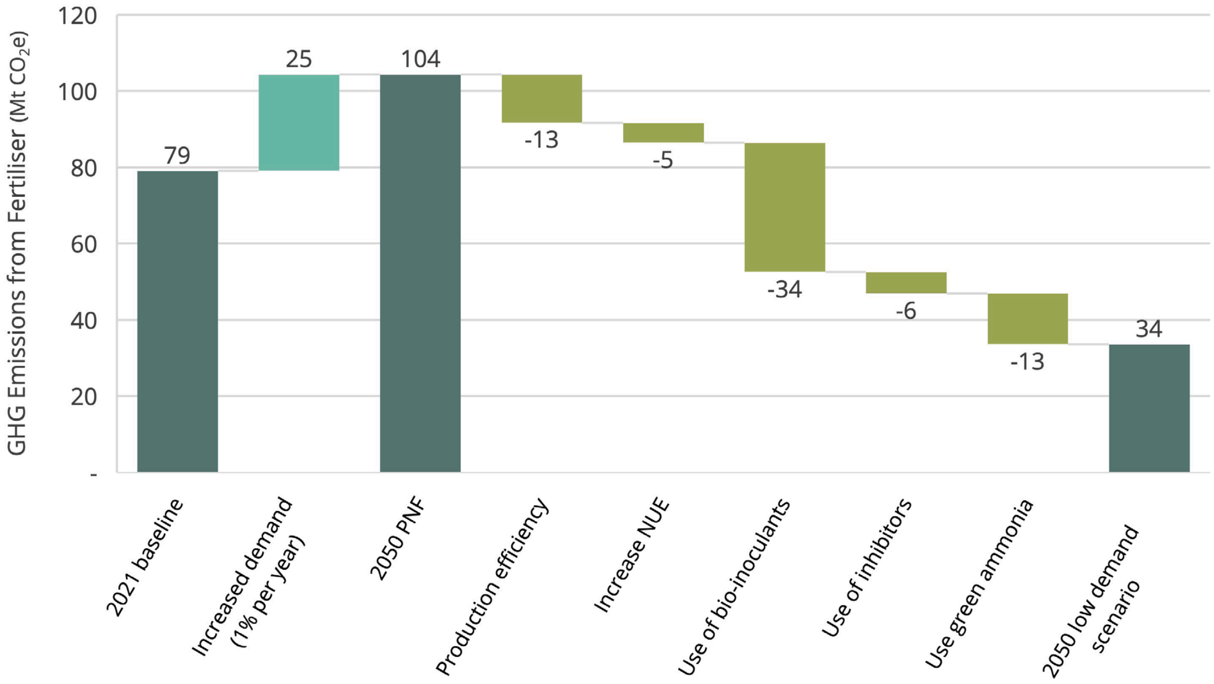

Figure 18: The impact of GHG emissions mitigation measures on fertiliser-related GHG emissions in Brazil in a low fertiliser demand scenario. Source: Planet Tracker.

However, even after taking these mitigating actions, including transition to low carbon fertiliser production, in the high demand scenario Brazil's fertiliser-related emissions would only be and estimated 11% lower in 2050 than in 2021 - see Figure 17. In comparison, in a scenario where fertiliser demand has been reduced, fertiliser-related emissions would be 58% lower in 2050 compared to a 2021 baseline – see Figure 18.

This highlights that reducing demand for synthetic fertiliser will be key to reducing Brazil's fertiliser-related GHG emissions over time. Planet Tracker estimates that fertiliser-related GHG emissions could be reduced by 86% by 2050 in a scenario where demand for fertiliser is reduced by 60% in 2050 compared to 2021 through measures such as increasing uptake of regenerative agriculture – see Figure 19.

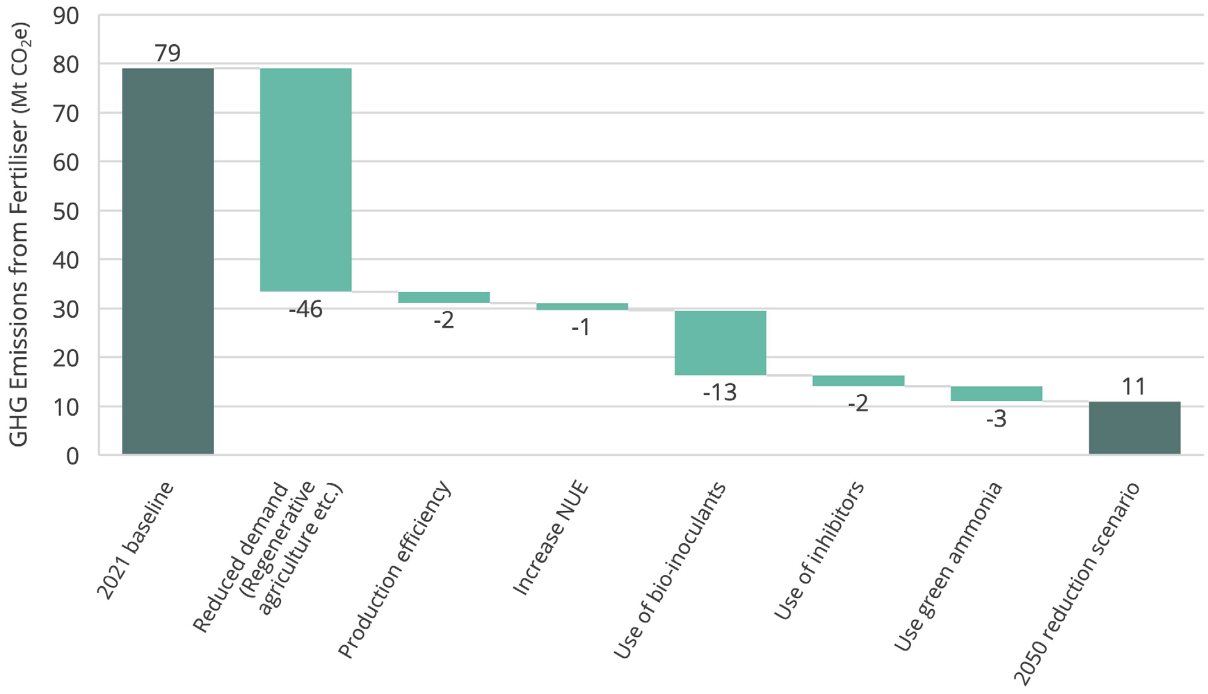

Figure 19: The impact of demand-reduction and GHG emissions mitigation measure to reduce fertiliser-related GHG emissions in Brazil. Source: Planet Tracker.

Significant benefits beyond emissions

In addition to reducing GHG emissions, reducing, or even eliminating, synthetic fertilisers from Brazil's agricultural system will have environmental and health benefits from reduced eutrophication and N_2O pollution.

A fertiliser reduction strategy would also successfully address Brazil's dependency on fertiliser imports and the associated financial risks. It could also achieve significant savings for farmers - Brazil spent US$ 26.8 billion on fertiliser imports in 2022 – a 70% reduction in this cost would be worth US$ 18.8 billion.

Using regenerative agriculture techniques to reduce synthetic fertiliser use could also help to restore on-farm biodiversity and enhance the resilience of the natural capital base, including soil health, on which Brazil's agricultural sector depends.

Conclusion

Brazil's current dependence on significant volumes of imported synthetic fertiliser exposes the country to environmental, health, financial and geopolitical risks. Brazil's National Fertiliser Plan addresses the financial risks associated with fertiliser imports by increasing domestic production, but this analysis find that the Plan fails to address the more serious climate, nature and health impacts from the overuse and misuse of synthetic fertiliser.

This report finds that Brazil's fertiliser-related GHG emissions could be reduced by up to 89% in 2050 compared to 2021 by investing in measures such as: increasing Nutrient Use Efficiency, using chemical emissions inhibitors, using green ammonia as a fertiliser feedstock, regenerative agriculture techniques (e.g. organic fertiliser) and the use of bio-inoculants. This would also reduce pollution from fertiliser use, improving the health of freshwater and marine ecosystems, and the health of the Brazilian population and could reduce input costs for farmers.

Brazil's environmental wealth depends on its environmental health which is threatened by the GHG emissions and pollution caused by the overuse of synthetic fertilisers. This in turn increases risks and reduces returns for Brazil's sovereign bond investors, and financial institutions more broadly funding companies across Brazil's economy.

Financial institutions therefore have a crucial role to play in encouraging Brazilian food system companies to address the negative impacts associated with the overuse of synthetic fertiliser. They can also help international food system companies with Brazilian suppliers to support the transition away from the overuse use of synthetic fertilisers, enhancing the resilience of their Brazilian supply chains. This will help to protect and enhance Brazil's natural capital base, increase the resilience of the economy, and could create significant investment opportunities as Brazil transitions to more sustainable agricultural practices.

How financial institutions can support a sustainable fertiliser transition

Outlined below are some key ways in which financial institutions can support the transition to more sustainable fertiliser use in Brazil:

Sovereign bond investors should:

- Engage with the Brazilian government, and the Ministries of Agriculture and of the Environment to submit an updated National Biodiversity Strategy and Action Plan[f] before the end of June 2025. This should include ambitious 2030 targets aligned with the Kunming-Montreal Global Biodiversity Framework to:
  - Reduce fertiliser-related pollution by 50%.
  - Ensure at least 20% of agricultural production is based on regenerative practices.
- Engage with the Ministry of the Economy – Industry, Foreign Trade and Services to update the National Fertiliser Plan to include specific target to reduce synthetic fertiliser use by 20% by 2030, and by at least 70% by 2050. This should include 2030 targets to increase Nutrient Use Efficiency, the use of bio-inoculants, chemical inhibitor use, invest in green ammonia capacity and encourage regenerative agriculture practices.

Financial institutions should:

- Engage with Brazilian food producers and their international customers to include Scope 1 and 3 fertiliser emissions in their GHG emissions disclosures and net zero plans and targets by 2026.
- Commit to channel 20% of direct and indirect funding for agricultural production to support regenerative agriculture practices by 2030.

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[f] National Biodiversity Strategy and Action Plan – a requirement for each country under Article Six of the Convention on Biological Diversity. *https://www.cbd.int/convention/articles/default.shtml?a=cbd-06*

Appendix 1

Fertiliser production process - summary

Nitrogen

The primary method for producing nitrogen fertilisers is the Haber-Bosch process. This process is highly energy-intensive, converting hydrogen—typically derived from methane in natural gas—and nitrogen from the air into ammonia. The ammonia produced is then used to synthesize nitrogen fertilisers, especially urea ($CO(NH_2)_2$) and ammonium nitrate (NH_4NO_3).[38] Due to the significant energy requirements for ammonia synthesis, the overall energy demand for crop systems using synthetic nitrogen is largely driven by the production of these fertilisers.

Phosphorus

The second major macronutrient, phosphorus (P) fertilisers are typically produced through the chemical treatment of mined phosphate rocks. These phosphate rocks are treated with sulfuric acid (H_2SO_4) to produce phosphoric acid (H_3PO_4), which serves as a precursor for many common phosphorus fertilisers, including monocalcium phosphate ($Ca(H_2PO_4)_2$), monoammonium phosphate ($(NH_4)(H_2PO_4)$), and diammonium phosphate ($(NH_4)_2(HPO_4)$).[39]

In terms of phosphorus fertiliser consumption, ammonium phosphates are the most widely used. The market for straight (single nutrient) phosphorus fertilisers predominantly comprises single superphosphate (45.6% of the straight market and 8.2% of the total market) and triple superphosphate (31.7% of the straight market and 5.7% of the total market). These fertilisers are produced through the wet process of transforming phosphate rock. In this process, phosphate rock reacts with sulfuric acid to produce single superphosphate or phosphoric acid. Triple superphosphate is then produced by reacting phosphate concentrate with phosphoric acid, while ammonium phosphates are obtained by reacting ammonia with phosphoric acid.[40]

Potassium

The final major macronutrient, potassium (K), is typically supplied to crops in the form of potash. Potash includes various potassium-bearing salts such as potassium chloride (KCl), potassium sulfate (K_2SO_4), and potassium nitrate (KNO_3). Similar to phosphorus fertilisers, the primary method for producing potash is through mining.[41]

Appendix 2

Emissions from fertiliser production

Fertiliser production and use account for approximately 5% of global greenhouse gas (GHG) emissions (1.3 billion tonnes CO_2e in 2019).[42]

Producing synthetic nitrogen (N) fertiliser using the Haber-Bosch process requires significant amounts of energy. Unless this is generated from renewable resources (which is currently rare) the energy requirements alone result in significant GHG emissions, but the process itself produces CO2 as a by-product,[g] adding to its GHG footprint.

Phosphorus (P) fertilisers are generally produced from the chemical treatment of phosphate rocks obtained through mining. These rocks are treated with sulfuric acid (H_2SO_4) to form phosphoric acid (H_3PO_4).

Potassium (K) fertilisers (often referred to as potash) are also produced by mining, usually in the form of potassium chloride. Since the mining process is much less energy-intensive, the GHG impact of producing phosphorus and potassium fertilisers is much lower (half or less) than the Haber-Bosch process for producing nitrogen – see Figure 20.

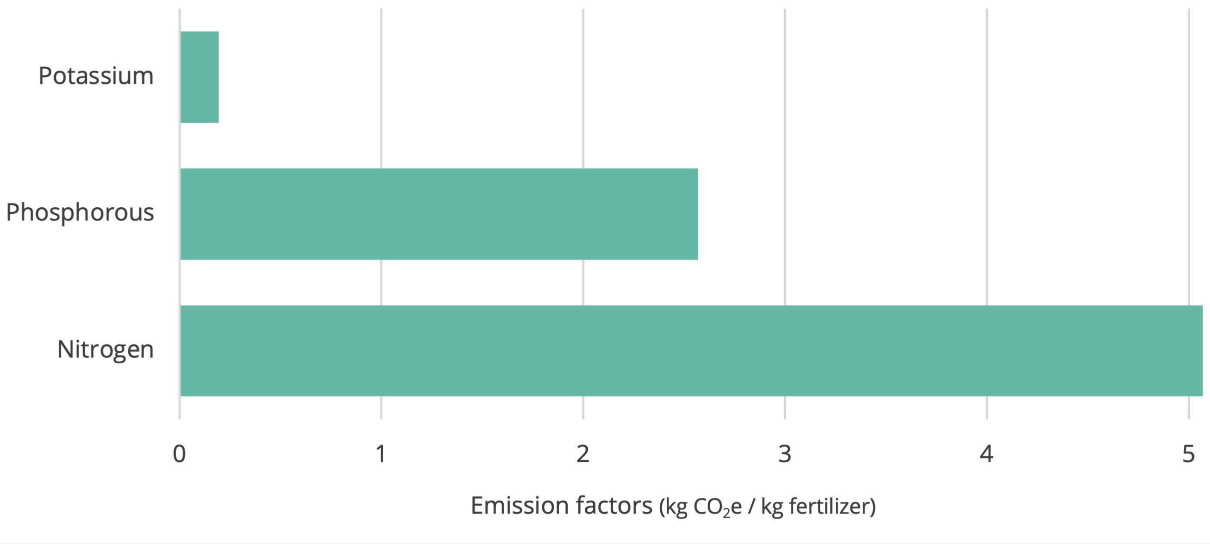

Figure 20: Average emissions factors for fertiliser production.
Source: Walling E, Vaneeckhaute C. 2020; Planet Tracker calculations.

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[g] Ammonia is formed by combining nitrogen from the air with hydrogen from fossil gas (CH4, methane) under pressure at around 4000C. The carbon molecules from the methane combine with oxygen to form carbon dioxide. Using renewable energy and hydrogen extracted from water using renewable energy could significantly reduce the GHG footprint of the Haber-Bosch process but this approach is currently rare

Transportation of fertiliser

Recent life cycle assessments have found that emissions from the transportation of NPK fertilisers are minimal when compared to production and application. Analysis by Hasler et al. (2015) determined that these emissions were only responsible for 1 to 3% of total fertiliser emissions,[43] while Zhang et al. (2013)[44] and Albaugh et al., (2012)[45] determined that transportation was responsible for <1% of emissions related to N-fertiliser and P-fertilisers respectively. Therefore, the literature consistently indicates that transportation is a low contributor to the GHG emissions of the global synthetic fertiliser chain.

Post-application fertiliser emissions and pollution

There are two main types of post-application emissions: direct emissions and indirect emissions. Nitrogen fertilisers are the principle cause of both.

Direct emissions occur as a result of the natural processes involved when the nitrogen fertilisers applied to soils are broken down by bacteria in the soil – a process referred to as denitrification. This results in the release of nitrous oxide (N_2O) – a GHG with a global warming potential 273 times higher than carbon dioxide.[46]

Denitrification also results in the release of nitric oxide and nitrogen dioxide (collectively, 'NO_x') and ammonia (NH_3) which collectively result in particulate pollution,[47] smog and acid rain, as well as the formation of ground-level (tropospheric) ozone, all of which are harmful to humans.

Finally, nitrogen fertiliser (and other fertiliser types) are often applied inefficiently so that they are not retained in the soil. This results in direct run-off or leaching from the soil into fresh water courses causing eutrophication, where excess of nutrients in the water leads to the growth of algae and other microorganisms that use up the available oxygen killing other aquatic life.

Appendix 3

Brazil's National Fertiliser Plan (PNF)

Brazil's National Fertiliser Plan (Plano Nacional de Fertilizantes 2050) was launched by government decree #10991 on 11 March 2022 and amended by decree 11518 on 4 May 2023.

Scenarios

The Plan includes six interacting scenarios for fertiliser production, importation and use in Brazil:

- Three demand scenarios (A: low-growth in demand, to C: high growth in demand), and
- Three Brazilian production scenarios (I: no PNF and no extra investment in Brazilian production, to III: PNF with technological innovation to enhance Brazilian production).

The PNF 2050 scenario used in this report combines high demand (Scenario C) with an assumption that the PNF has a significant impact on Brazilian production (Scenario III).

Guidelines

The Plan sets out five 'Guidelines', each with multiple goals for reforming the Brazilian fertiliser system by 2050.

1. **Modernization, reactivation, and expansion of existing fertiliser industrial plants and projects in the country.**

   This Guideline focuses on ways to increase Brazil's production capacity, including increasing the production and supply of organic and organomineral fertilisers by at least 500% by 2050.

2. **Improvement of the business environment in the country, aiming to attract investments for the production and distribution chain of fertilisers and plant nutrition inputs.**

3. **Promotion of competitive advantages for the country in the global fertiliser production chain.**

   This Guideline includes a goal to *'encourage and disseminate good practices in the production and use of fertilisers and plant nutrition inputs, both domestic and imported, that minimize greenhouse gas emissions by at least … 30% by 2050.'*

   However, the only GHG-related 'Action' set out in the plan focuses on reducing emissions through process improvements and recycling organic waste. It does not set out any steps relating to fertiliser use, and in particular, does not mention any actions to reduce fertiliser use.

   The Plan also envisages 60 new regional potassium and phosphorus mining projects by 2050 without proposing any actions to mitigate their environmental impact.

4. **Expansion of investments in research, development, and innovation activities, as well as in the improvement of the production and distribution chain of fertilisers and plant nutrition inputs in the country.**

   This Guideline includes goals relating to 'new products' with the aim of increasing supply by 200% by 2050. Much of the focus appears to be on organic fertilisers (which may not have such a heavy production GHG footprint but will still result in GHG emissions and pollution when used) rather than focusing on alternatives such as bio-inoculants and biological nitrogen fixation that have the potential to dramatically reduce GHG emissions and cut pollution to zero.

However, the Plan does include a goal to increase the adoption of 'bioinputs for plant nutrition' to cover 75% of Brazil's planted area by 2050, and to increase the contribution of 'biological fixation' by at least 100% by 2050.

The Plan sets out a vision for 2040 where *'biological inoculants for the management of biological nitrogen fixation in major crops … will reduce the need for mineral nitrogen sources by 50% compared to 2020'.*

5. **Infrastructure adaptation for the integration of logistics hubs and the viability of new ventures.**

National Bio-inputs Program (PNB)

Brazil's National Bio-inputs Program was developed by the Ministry of Agriculture, Livestock and Supply and aims to expand and strengthen the use of bio-inputs for sustainable development.

The program is led by a Strategic Council established in October 2020 with the objectives of supporting:

- investments in science, technology and innovation;
- the development of credit finance;
- training and promotion;
- implementation of bio-factories; and
- the development of state bio-inputs programs.

The program covers a wider range of topics than fertiliser (from pest control to animal feed and post-harvest technologies) and does not have specific targets.

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ABOUT PLANET TRACKER

Planet Tracker is an award-winning non-profit financial think tank aligning capital markets with planetary boundaries. Created with the vision of a financial system that is fully aligned with a net-zero, resilient, nature positive and just economy well before 2050, Planet Tracker generates break-through analytics that reveal both the role of capital markets in the degradation of our ecosystem and show the opportunities of transitioning to a zero-carbon, nature positive economy.

FOOD AND LAND USE PROGRAMME

Programme goal: to align capital markets with a sustainable global food system. Before 2050, Planet Tracker's Food and Land Use Programme will highlight the investment risks and opportunities associated with the just and equitable transformation of the global food system that eliminates negative externalities with respect to climate, nature, and health so that it is fit to feed the world's growing population within planetary boundaries. By highlighting these risks and opportunities, Planet Tracker's Food and Land Use programme will influence financial markets actors to actively support and fund this transformation.

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