COMPLEXITY SCIENCE HUB VIENNA

ASCII Supply Chain Intelligence Institute Austria

POLICY BRIEF

NOV 27, 2023

India’s rice embargo as a threat to global food security

SUMMARY.

India’s proposed rice export restrictions, potentially affecting 40% of the global rice supply, may have severe consequences for several African and Middle Eastern countries. Projected losses of up to 304 kg per capita, as seen in the case of Djibouti, pose a threat to food security. Indirect effects through production and further trade can impact the availability of a range of secondary products such as meat, eggs, sweeteners, or alcohol. For instance, Liberia’s losses over secondary products, excluding rice itself, accumulate to 5.2 kg per capita. While a diverse portfolio of import sources and domestic production can help compensate for losses to a certain extent, it cannot eliminate them entirely.

Background

Since last year, India, the world’s largest rice exporter, has implemented several restrictions on rice exports. This included a complete ban on non-basmati and broken white rice in July 2023, encompassing over 40% of the total Indian rice exports [1]. Additionally, a minimum sale price for basmati rice and a tariff on parboiled rice were introduced. These measures are expected to remain in place until at least next year. Officially, the Indian government justifies the restrictions as necessary to protect domestic food security. Approximately 800 million people, out of India’s 1.4 billion population, are eligible for the free food grains program. Notably, India’s rice stocks at state warehouses were approximately double the target in November 2023 [2]. Therefore, the restrictions are often seen as an attempt to appease the domestic population, particularly with India heading into various state and national elections next year [3].

Food price inflation and food security has been a long-standing political issue in India, exerting significant pressure on the current Indian government. The situation is compounded by the global decrease in wheat availability with which rice is treated interchangeably as substitutes in India’s grain stockpiles caused by the war in Ukraine and the impending potential losses in rice production output due to weather-related factors such as El Niño which can lead to less rainfall, especially when the effects are combined with the ones of climate change [3,4].

Global and domestic rice prices have notably increased throughout the past year, and this upward trend is expected to persist. In India, the price has risen by 11.5% in the last year, and benchmark prices for rice in Thailand and Vietnam, the second and third-largest rice exporters globally, climbed by 14% and 22%, respectively, since India implemented its ban [3]. Given India's significant role in the global rice trade, accounting for about 40% of it and representing a trade volume of 9.7 billion USD [5], further price hikes are anticipated. Many Middle Eastern and African countries, as well as close neighbors, heavily depend on India for most of their rice imports.

Here, we introduce an adaptive shock propagation model on the global food trade and production network to illustrate how the availability of a commodity is affected, both directly and indirectly, after a complete production output loss of a certain commodity in a country. We expand upon a recently proposed model [6] by incorporating compensation strategies, such as switching trade partners and adjusting product allocation into and from processes, following a significant direct loss [7]. Within this model, we estimate the direct effects of an Indian rice export ban on rice supply in other countries, as well as the indirect effects on other types of food for which rice serves as a production input over the next few years.

Modelling the global impact to rice supply of an Indian rice export ban

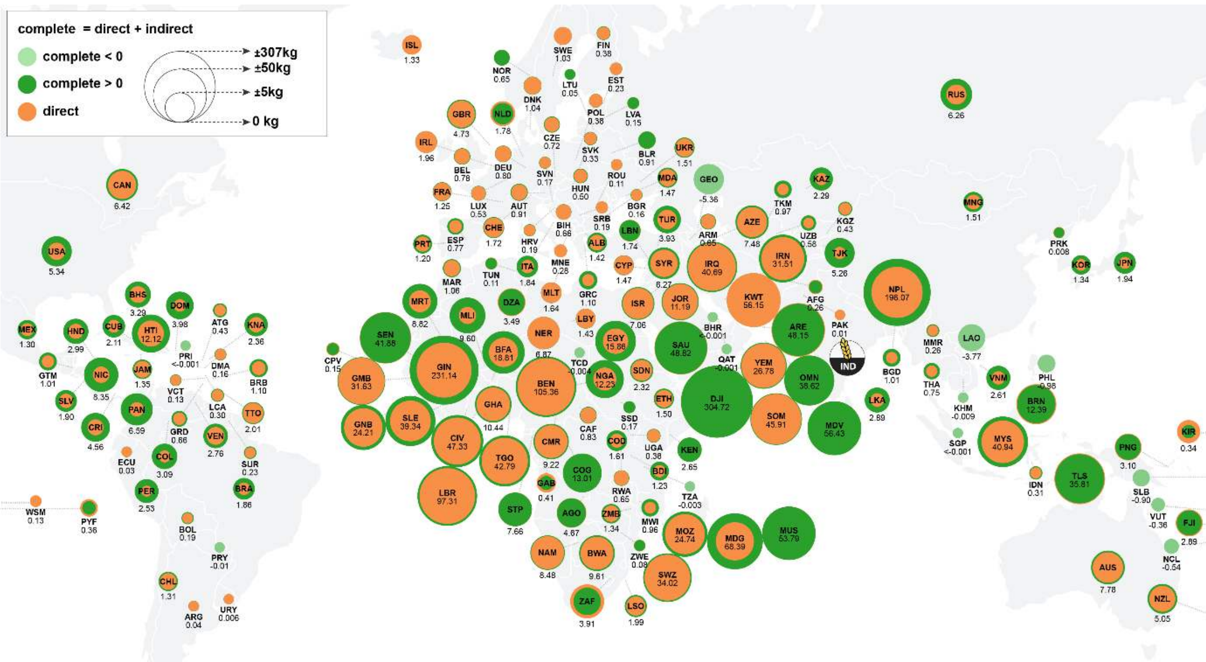

Figure 1: Losses and rice availability in different countries if India (in black) experiences a 100% loss in its rice production. Countries are ordered according to their approximate geolocation. Especially African and Middle Eastern countries, as well as India's close neighbor Nepal, experience significant losses. Indirect effects (depicted by green circles with a logarithmic scale) play a major role on top of the losses from direct trade (depicted by orange circles). In most countries, the total losses exceed the direct effects, but some countries, such as the United Arab Emirates, Timor-Leste, Georgia, South Africa, Laos, or Saudi Arabia, manage to compensate for some of their losses and reduce the overall loss compared to the initial direct losses by up to 7.1 kg per capita, as observed in the cases of the United Arab Emirates or Timor-Leste.

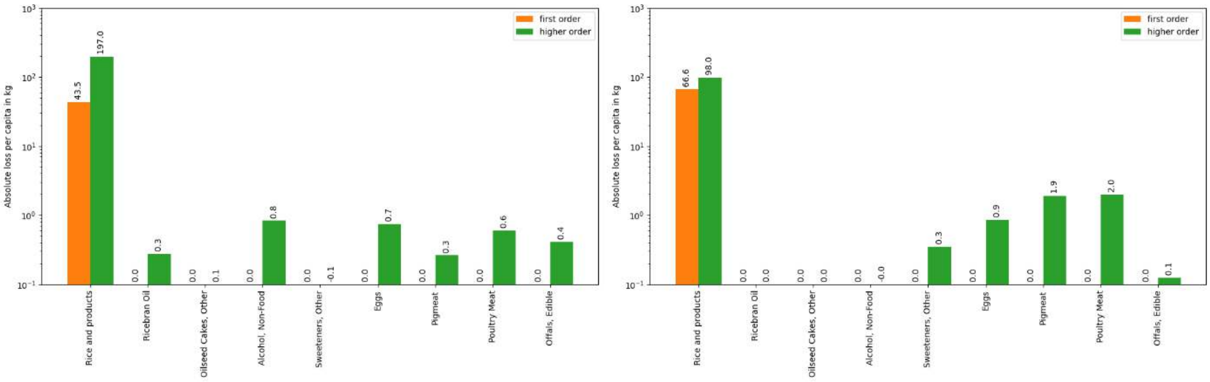

Figure 2: The failure of rice production in India propagates through supply chains and impacts downstream products. Here, we demonstrate how the loss of availability of Indian rice in **a)** Nepal and **b)** Liberia affects the production of ricebran oil, oilseed cakes, alcohol, sweeteners, eggs, pork meat, poultry meat, and offals, with Nepal's losses over the mentioned secondary products accumulating to 3.3 kg per capita and Liberia's accumulating to an even higher 5.2 kg per capita.

The impact of direct rice trade with India and the subsequent price hikes in numerous countries has been extensively discussed in various sources [3,8,9]. However, second-round effects are not always easily understood. Our model not only quantifies direct impacts on the global availability of the shocked commodity but also considers indirect effects on other products for which the shocked commodity serves as an input. When a shocked country loses all production output of a certain product, it can no longer be exported, resulting in a loss for direct trade partners. However, due to second- and third-tier trade relationships and the use of rice as a production input, the indirect effects can lead to a deterioration in the availability of rice in the already affected countries and initially unaffected countries or products (see Figure 1). In the case of a complete shock to Indian rice (100% of its rice exports), African and Middle Eastern countries will face severe losses, reaching up to 304 kg per person, as in the case of Djibouti. Djibouti, Guinea, Nepal, Benin, and Liberia are the countries experiencing the highest total absolute rice loss per capita (see Figure 3).

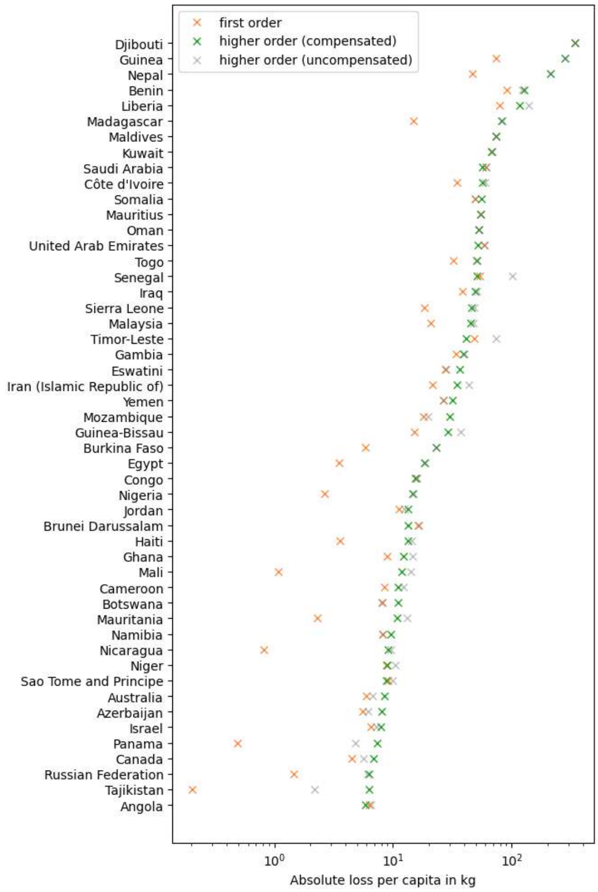

Figure 3: Top 50 countries ranked by highest total absolute losses of rice (kg per capita).

Although the share of domestic rice production varies significantly, ranging from 82% in Nepal to 0% in Djibouti, all these nations share a commonality — they rely on India for at least 75% of their rice imports. Generally, a high import share from India tends to correlate with higher overall losses, especially for countries geographically close to India. The Middle East (West Asia) records the highest average loss per capita at around 20.8 kg, followed by Sub-Saharan Africa with 14.9 kg (see Figure 4).

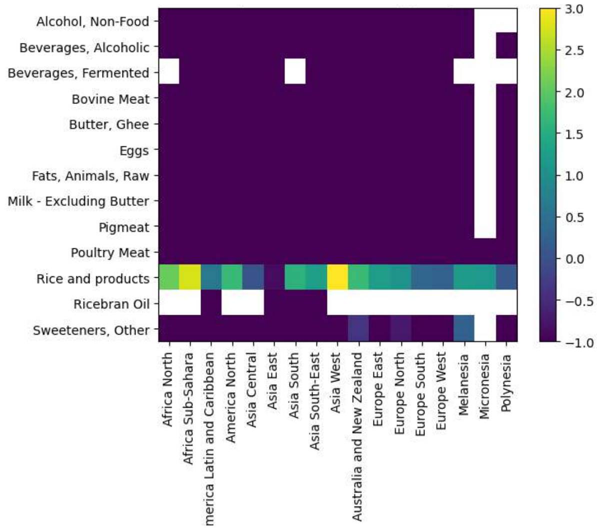

Figure 4: Absolute loss per capita in kg (in logarithmic scale) of products in different world regions after shock to rice in India: Especially rice, along with most of its secondary products, experiences losses worldwide. Rice bran oil is the only product where compensation manages to mitigate losses in many world regions and even shows slight gains (white areas).

Despite the option for these countries to engage in compensation strategies, such as intensifying trade relationships with alternative exporters or modifying the inputs and outputs of their established production processes, they cannot eliminate the effects of such a significant shock. On the contrary, while some countries may benefit from increased consumption in our model, others are at a disadvantage. However, the largest absolute losses are reduced at the expense of regions that were not so severely affected as countries that were particularly hard-hit seek to compensate for their losses, thereby redistributing the remnants of the available resources. A country's ability to compensate depends on its other import sources of rice and its capability for domestic production. Djibouti, lacking domestic rice production capacities, experiences immense direct losses, but at least, these do not intensify further due to the stability of its other rice trade partners. In contrast, countries like Nepal or Guinea, with substantial domestic rice production, undergo higher indirect losses as they allocate a significant share of their rice stock as seed to produce more rice. However, when experiencing the direct loss, they are forced to scale down their local rice production, leading to further losses.

While, on average, the compensating strategies reduce global losses, not every country will benefit. For instance, Liberia manages to maintain all its current trade relationships and increase the output efficiency of its rice production but still experiences an additional indirect loss that can only be partially compensated. On the other hand, Benin, with a lower domestic production share than Liberia, loses even more supply as it cannot substantially scale up its local production.

Compensating for the lost rice by importing from other established trade partners can be a relief when experiencing a shortage. The country that most successfully compensates is the United Arab Emirates. They manage to eliminate indirect losses, so that their total losses fall below the level of their direct losses by 7.1 kg per capita according to our model. Therein, the UAE significantly strengthens its already existing trade relations with Pakistan, Vietnam, and Thailand, which are the world's fourth, third, and second-largest rice exporters, while continuing to refrain from engaging in domestic production as they have done before. Saudi Arabia, which recovers 3.8 kg from the direct losses, displays similar behavior as it improves its trade relations with Pakistan and the United States of America, the fifth-largest rice exporter in the world.

Some countries can even domestically compensate adverse impacts. This applies to countries whose main rice importer is not India, and therefore, most of their imports are not impacted by direct losses. In such cases, it might suffice to increase the input in and output from rice production. Timor-Leste and Laos recover 7.1 kg and 4.3 kg per capita, respectively, without adapting their trade shares from other importers. In the case of Timor-Leste, India is the second most important importer, while for Laos, it is only the fifth.

Second-round effects on other products

Not only the global rice availability might be affected by a complete rice export stop by India, but also other products as the commodity is also utilized as an input in various production processes besides rice production itself. This includes husbandry, sweeteners, or beverage production. Consequently, although it might not be as crucial as other staple products like wheat, maize, or soy for husbandry, the availability of meat and dairy products in countries highly dependent on Indian rice could still be impacted. For instance, Nepal, India's northern neighbor, relies on India for over 99 % of its rice imports, constituting 18.5 % of its total rice volume. Most Nepalese rice allocated for production is used in animal farming and alcohol production. These products exhibit significant higher-order losses as the input quantity has decreased. Also, rice itself shows higher indirect losses as rice itself is needed as a seed for further rice production. Similarly, Liberia also experiences substantial higher-order losses. This West-African nation imports 57 % of its rice needs, of which 93 % are sourced from India. Most of the rice allocated to production in Liberia is used for husbandry, sweetener, and rice production itself (see figure 2).

Overall, the most affected region is the Middle East (see figure 4). Notably, not only rice but also sweeteners and alcoholic beverages are visibly affected globally. Surprisingly, the most significant rice shock is not detected in South Asia, as most other countries in the region can sustain rice production autonomously, limiting the shock's impact.

Policy implications

A complete halt in Indian rice exports would have a detrimental impact on food security worldwide. Especially Africa and the Middle East depend significantly on India for their rice supply and, consequently, their food security. These regions, on average, will lose 14.9 kg and 20.8 kg per capita, respectively, with some countries, such as Djibouti, experiencing a drastic increase up to 304 kg per capita. Relying on a single major import source carries the risk of massive losses that cannot be easily compensated. Djibouti, Guinea, Nepal, Benin, and Liberia, the countries that experience the highest total losses, all depend on India for at least 75% of their rice imports, resulting in high losses independent of their level of local rice production. Secondary products, especially meat, eggs, alcohol, and sweeteners, are globally affected as well, with Liberia being most harmed. Losses over relevant secondary products, excluding rice itself, reach 5.2 kg per capita in Liberia.

Compensation for direct losses after a shock is possible. Wealthier countries, such as the UAE or Saudi Arabia, which currently depend mostly on India for rice imports, manage to compensate some of their losses through trade. However, there are also alternative successful compensation strategies. In particular, the combination of having various strong import sources for rice beforehand combined with significant domestic production, like Timor-Leste or Laos, can help to mitigate shocks. Relying solely on domestic production can be problematic, especially with a high share of rice imports from India utilized as seeds, potentially resulting in insufficient rice to cover the population's needs and fuel further rice production simultaneously. Having a diversified portfolio of import sources before the occurrence of a shock is crucial. Setting up new major trade streams typically requires more time and effort from both political and logistical perspectives than is usually available when facing a sudden shock. Establishing a long-term, diversified set of import countries provides a stable and sustainable supply in case of disruptions in the global value chain. While building such additional trade flows is likely to involve additional costs, these costs should be seen as insurance against supply shocks in increasingly turbulent global value chains.

The Authors

Sophia Baum, Moritz Laber, Liuhuaying Yang, Stefan Thurner, Peter Klimek

About CSH

The mission of the Complexity Science Hub (CSH) is to host, educate, and inspire complex systems scientists dedicated to making sense of Big Data to boost science and society. Scientists at the Complexity Science Hub develop methods for the scientific, quantitative, and predictive understanding of complex systems.

The CSH is a joint initiative of AIT Austrian Institute of Technology, Central European University CEU, Graz University of Technology, Medical University of Vienna, TU Wien, University of Continuing Education Krems, VetMedUni Vienna, Vienna University of Economics and Business, and Austrian Chamber of Commerce (WKO). https://www.csh.ac.at

About ASCII

The Supply Chain Intelligence Institute Austria (ASCII) provides analyses to better address future challenges related to value networks, strategic interdependencies, and ensuring production and supply security. The aim is to provide decision-makers in politics, administration, and industry with a solid basis for achieving the Austrian and European goals of secure value creation and environmental neutrality.

This project is being implemented in close cooperation with the founding organizations: the Complexity Science Hub, WIFO, Logistikum of the Upper Austrian University of Applied Sciences and Verein Netzwerk Logistik.

Policy Briefs present socially relevant statements that can be derived from our research results.

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