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Can Rice Policy Reform Help Improve Food Security and Diets in India?

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ABSTRACT

India's rice policies have played a crucial role in shaping the country's agricultural sector and ensuring food security for its vast and diverse population. Since rice is a staple food for millions, policies governing its production, pricing, and distribution are vital to maintaining sufficient supplies, stabilizing prices, and making rice affordable and accessible to everyone. However, as dietary patterns change and there is increasing concern about nutrition and environmental sustainability, it is important to consider whether shifting existing rice support toward more targeted or diversified strategies could better promote food security and healthier diets in India. This paper explores this question by evaluating, in advance, the effects of different ways of allocating current support using model-based scenario analysis. The study shows that eliminating all current support would do little to improve the affordability of rice and other foods or to make production more sustainable in India. In contrast, redirecting just a portion of input subsidies—the main type of domestic agricultural support—toward increased investment in research and development for productivity-boosting and climate-resilient technologies could drive meaningful change. This shift could promote more sustainable agricultural practices, lower food prices and the cost of a healthy diet and, ultimately, enhance food security and nutrition across the country.

Keywords: India, healthy diets, sustainable rice production, price stability, repurposing of agricultural support.

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1. Introduction

India's rice policies have long played a pivotal role in shaping the country's agricultural landscape and ensuring food security for its large and diverse population. As rice remains a staple for millions, the policies surrounding its production, pricing, and distribution are central to the nation's efforts to maintain adequate supplies, stabilize prices, and make this essential food affordable and accessible to all. However, with evolving dietary needs and growing concerns over nutrition and environmental sustainability, an important question emerges: could redirecting the existing support for rice toward more targeted or diversified approaches offer greater benefits for food security and healthier diets in India? Exploring the effectiveness of current rice support programs and the potential for policy reform is thus crucial for achieving broader goals of nutrition and sustainability.

To address these questions, we will first assess how effective India's current rice support programs are in meeting food security goals. This includes examining the adequacy and stability of rice supplies, the affordability and accessibility of rice for all populations, and the broader dietary implications. We will also evaluate the impact of current support policies on the environmental sustainability of food production. After reviewing existing policies and past reform efforts, the research will explore options for reforming rice policies to improve food security and dietary outcomes. The research will take an integrated approach to ensure that gains in food security and nutrition are balanced with environmental sustainability and political feasibility. By systematically analyzing these dimensions, our findings will provide valuable new evidence and nuanced insights that can inform policy makers as they seek to align objectives of agricultural development, food security, healthy diets and environmental sustainability. The results will help bridge knowledge gaps about the trade-offs and synergies between efforts to achieve those objectives, thereby equipping decision makers with clearer guidance for designing more effective and equitable rice policies that respond to India's evolving needs.

The paper is structured as follows: Section 2 reviews India's current agricultural support policies and political barriers to reform; Section 3 presents policy reform options and their production and distribution impacts; Section 4 analyzes the economy-wide effects of repurposing support using model scenarios; Section 5 discusses trade-offs and potential political challenges to these reforms.

2. India's policy goals

Before beginning an analysis of India's rice support policies, it is important to consider the goals of policy; the instruments currently used, the impacts of these policies and some potential questions for which answers are needed as a basis for reform. Policy makers in India appear to have been pursuing several dietary and food security goals of rice policy: (i) reaching something close to self-sufficiency in key staple foods; (ii) facilitating adequate and affordable access to major staples (particularly rice and wheat) for low-income households; (iii) influencing the domestic price of rice relative to the world price in a way that balances political-economy pressures; and (iv) stabilizing domestic prices.

Since the late 1960s, support for rice and wheat has been central to India's agricultural policy. These policies were initially created to address the urgent needs arising from past famines and political pressures, leading to the prioritization of self-sufficiency in these two staple crops. While this focus made sense in the historical context and given India's large population, it is important to recognize that self-sufficiency is not the same as food security. True food security means that all people have access to the food they need for a healthy life, regardless of the source, at all times.

Political factors will always play a role in shaping protection and support measures. However, it is generally advisable to choose policy instruments that achieve these goals at the lowest possible cost to society. Addressing these issues remains particularly important for India, as the country continues to grapple with persistent hunger, malnutrition, and the need to make its food system more resilient and equitable (see NITI Aayog, 2022).

At present, support to rice in India takes five main forms: (1) public investment in R&D and provision of other public goods in support of agriculture; (2) trade policy; (3) input subsidies; (4) public purchases of rice to guarantee a minimum support price for producers; and (5) public distribution of rice at below-market prices. We briefly review the evidence regarding these policies and raise questions for policy research for each.

The first instrument, *public investment in agricultural R&D* is a relatively small but important part of the government's provision of public goods in support of agriculture in India. OECD estimates (OECD 2025, p383) put India's public-good support, primarily for infrastructure development, at 4.1 percent of the value of agricultural output in 2024. Of this support, agricultural knowledge and extension funding of $1.5 billion in 2024 accounted for 7.5 percent, or about 0.3 percent of output value. Despite its modest size relative to output, this support has been critical in driving India's Green Revolution in agriculture from the 1970s, resulting in strong productivity growth in rice and wheat. Going forward, it will remain important given the market failures that limit private investments in R&D for self-pollinating crops like rice. A detailed study of past investments in R&D for rice and wheat in India concludes that this has created a well-developed national agricultural research system that was able to secure enough funding for crop improvements helping sustain steady increases in yields (Pal 2017). This study further finds that yield increases have been much higher in the poorer states of Bihar and Uttar Pradesh than in the "breadbasket" states of Punjab and Haryana, with annual yield growth averaging a whopping 3.7 percent in Bihar between 1980 and 2014. This study estimated the internal rate of return on investments in research on rice and wheat at 39 percent. Such investments tend to be strongly poverty-reducing because so many poor people work in agriculture and because poor people spend large shares of their income on staple foods (Ivanic and Martin 2018).

This evidence of extremely high returns is indicative of the success of past public investments in R&D and extension services (Pal, 2017; Kandpal, Birthal and Mishra, 2024). However, there are two concerns about the current situation. The first is that current public spending on agricultural R&D is likely insufficient to ensure sustaining yield growth while improving resilience of rice and wheat production (Reddy and Lingareddy, 2024). The second concern is that the allocation of R&D investments across commodities appears to be sub-optimal, when considering how those investments could contribute to poverty reduction, making healthy diets more affordable, and making production environmentally sustainable. In particular, studies have also expressed concerns about the cereals-bias in India's R&D investments, which likely has contributed to lagging productivity growth in other crops, increasing concentration of area under rice and wheat and adverse ecological impacts (Singh et al., 2024).

Second, *trade policies* include an applied tariff of 70 percent on rice imports and a range of discretionary export restrictions, such export bans, export duties and minimum export prices (Glauber and Mamun 2024). Since India has become the world's largest rice exporter supplying over 40 percent of global rice trade in 2024-25 and with exports accounting for around 10 percent of production, India's export policies matter to both global market stability and the affordability of rice for Indian consumers. In this regard, it is remarkable that India's current border policies generally appear to tax, rather than subsidize, rice production in India, as shown in Table 1.

Table 1. Rates of border protection for domestic rice production by country, and input subsidies in India, %

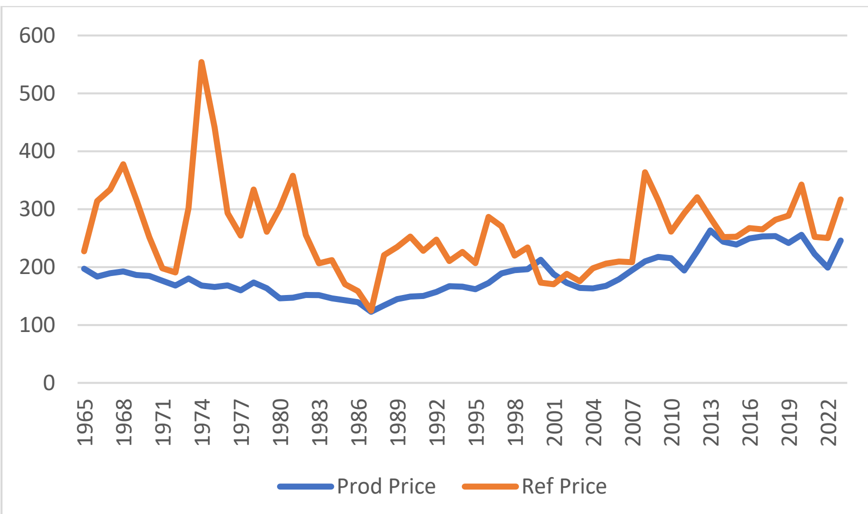
	Bangladesh	India		Indonesia	Japan	Korea	Pakistan	Philippines
	Border	Border	Input Subsidy	Border	Border	Border	Border	Border
2005		-18.7	4.9	-5.8	426.3	225.7	-0.8	33.7
2006		-14.5	5.4	28.2	303.3	206.0	10.2	47.4
2007		-6.6	6.8	33.8	237.8	209.8	-6.6	41.9
2008		-42.3	11.0	-28.6	213.8	77.8	-27.2	19.2
2009		-31.1	7.7	-11.9	168.0	112.4	-18.7	46.7
2010		-17.6	6.6	44.7	229.0	74.0	2.5	63.6
2011		-33.7	6.0	53.4	231.6	109.3	10.9	40.6
2012		-29.1	5.4	47.5	311.9	138.3	6.5	80.5
2013		-7.7	4.8	66.9	258.5	149.9	-18.4	127.2
2014	18.0	-3.2	5.3	93.4	203.7	129.1		142.7
2015	6.1	-5.3	5.4	93.5	111.1	94.2		186.1
2016	-31.9	-6.7	4.9	72.8	206.2	87.9		145.5
2017	95.1	-4.5	4.7	59.3	296.3	87.0		99.8
2018	37.6	-10.1	4.8	53.0	210.2	136.5		96.0
2019	16.9	-16.3	5.6	54.6	220.0	152.4		127.7
2020	16.7	-25.3	7.1	23.5	211.7	142.6		57.1
2021	59.4	-11.7	7.0	24.4	145.4	131.9		48.1
2022	63.9	-20.4	9.8	64.5	47.9	68.8		53.1
2023		-22.4	7.8	52.1	37.9	83.3		21.7
Avg.	31.3	-7.2	6.4	43.1	214.2	127.2	-4.6	77.8

Source: AgIncentives.org

India's rate of protection contrasts with the estimates for other Asian rice producing countries such as Bangladesh, Indonesia, Japan, Korea and the Philippines, where border protection—measured in the same way—is positive. Only Pakistan shows a broadly similar pattern, with negative support in many years. But the average rate of negative border protection in India appears to be much lower than in Pakistan. While there is some controversy about the apparent negative protection in India, this apparent pattern has been evident in studies going back to the mid-1960s. The rate of border protection has clearly been highly volatile, which generates substantial economic costs. Protection also appears to have been inversely related to world prices, with strongly negative protection in 2008, not just in India but also in Indonesia and Pakistan.

Because of the uncertainty about the actual stance of rice trade policy in India, it is worth examining a longer series of the producer prices and reference prices used to calculate the Nominal Rate of Protection for rice in India. These are presented in real rupee terms, deflated by the India wholesale price index, in Figure 1 for the period 1965 to 2023.

Figure 1. Real prices for India rice, (2015 Rupees)



Source: Data in Figure 1 are based on the producer and reference prices prepared by for the World Bank Distortions to Agricultural Incentives project by Pursell, Gulati and Gupta (2009) for the period 1965 to 1999. For the period 2000 to 2023, they are obtained from the OECD which documents these data in their India Cookbook (Sorescu and Bossard 2024, p.70). For non-Basmati rice, their estimates of producer prices are sourced from the Directorate of Economics and Statistics, Ministry of Agriculture for the harvest months (October to January) for West Bengal, Uttar Pradesh, Andhra Pradesh and Punjab. The reference prices for non-Basmati rice are based on fob export prices of Thai 25% broken rice plus transport costs to Mundra/Kakinda (2.1%); less 6 percent for charges from farm to port. For the period 1965 to 1999, producer prices were represented using prices paid by millers from the Bulletin on Food and Fertilizer Statistics at www.indiastat.org which appear to have been national averages (Pursell, Gulati and Gupta 2007a, p. A1). Border prices during this period were for Thai 15% broken rice fob Bangkok adjusted for transport and marketing costs to three states—Andhra Pradesh, Punjab and Uttar during import periods and Punjab and Andhra Pradesh during exporting periods (Pursell, Gulati and Gupta 2007b, lines 359-61).

A key feature of Figure 1 is the sharp divergence between the volatility of the external reference price and the domestic producer price, particularly in the first part of the analyzed time period.

This suggests that India's trade policy for rice has contributed to reducing the degree of volatility of the domestic price of rice relative to its world price. This differs from findings in Martin, Mamun and Minot (2026) using earlier data in Pursell, Gulati and Gupta (2007b, line 179). Whether the finding of lower volatility in domestic prices continues to hold once the destabilizing impact of India's price insulating policies and those of other countries adopting similar policies are taken into account is an important question for future research.

Third, India's *input subsidies* apply to crops more generally and, thus, are not specific to rice. According to OECD estimates, these accounted for about 8 percent of the value of agricultural output at world prices in 2023 and about 6.5 percent on average over the period since 2005. Of these fertilizer subsidies accounted for roughly half of the total and subsidies for irrigation for another third in 2023. While these subsidies are not targeted to specific crops, subsidies on electricity (especially to power groundwater pumps) and water supplies (for surface irrigation schemes) disproportionately favor rice producers, given that rice production (and specifically flooded rice which is the most widely grown in India) is particularly water intensive. India also has targeted subsidies through specific schemes ("Missions") that promote production and marketing of specific commodities, but these account for only 1.2 percent of total budget support.

Broadly, the input subsidies are meant to stimulate agricultural production and provide income support to farmers by reducing input costs and, as such, they are politically attractive. They have clear appeal to policy makers concerned about self-sufficiency, particularly given the apparent political appeal of negative border protection seen in Figure 1. Parish and Maclaren (1982) argue that a subsidy on an input with elastic supply is more cost-effective in increasing output than a subsidy on output. In India's case, this may hold for the fertilizer subsidy but is less likely to hold for inputs less elastic in supply, like groundwater coming from aquifers with fixed recharge rates pumped using subsidized electricity. While a power subsidy can increase use of ground water during periods in which the water table is lowered (Gupta 2023), the higher costs associated with deeper wells ultimately lead to a new equilibrium in which water use is determined by the recharge rate.

Given the lower costs of stimulating output using input subsidies relative to output subsidies, India's policymakers may have chosen an efficient set of policies if combining output taxation through trade policies designed to lower the cost of food to consumers with output subsidies designed to increase output, avoid import dependence, and raise farmers' incomes. However, a key question in this situation is whether the current level of output subsidies overcomes the effects of lower output prices on output levels. Another question is how much and how efficiently the combination of policies achieves its objectives of lowering the cost of food to consumers and raising incomes of farmers.

Fourth, India's large-scale program of *public purchases of rice* serves two distinct objectives: (i) to create a floor price for rice farmers (the Minimum Support Price, MPS) and (ii) to ensure sufficient supplies of cereals for the Public Distribution System (PDS). As pointed out by Tinbergen (1952), it is generally not possible to hit two goals with a single economic policy instrument. However, India's policy makers currently use a single policy instrument, the

Minimum Support Price (MSP), in attempting to achieve these two objectives, so it's important to understand how the Tinbergen rule plays out in this situation.

The MSP is set prior to planting, so the government is uncertain at that point in time as to how its level will compare with market prices during the harvest. If the government focused entirely on the stabilization goal, it would set the MSP at a level that it judged would provide support to the market while avoiding excessive risk of stock accumulation and allowing stocks to build in periods of surplus and to be liquidated in years with unexpectedly small harvests (see Box 1 for further explanation). Studies like Gouel, Gautam and Martin (2016) provide guidance on approaches for achieving such a stabilization goal. A key problem with the use of rigid mechanisms like the Minimum Support Price is the need for strongly fluctuating and unpredictable purchases when the market price falls near the support price. If governments continue to purchase in this situation, stock levels can become unmanageable, resulting in the collapse of the stockholding scheme (Jayne 2012). If governments respond to excessive stock accumulation by ceasing to buy at the MSP, then they fail in their objective of providing market stability.

Box 1. Limitations of Stockholding Policies

Stockholding policies are frequently implemented to pursue a wide range of objectives, including (i) ensuring availability of food; (ii) stabilizing prices; and (iii) increasing output prices for farmers.

While holding stocks is important for ensuring food availability, managing stocks for this purpose is very challenging. If stocks are being managed to help stabilize prices, there is no guarantee that stocks will be sufficient to ensure availability when production falls short of expectations. If stabilization stocks have been run down because of a poor harvest, they will not be available to meet demand in the next period. For this reason, Gouel and Jean (2015) generally recommend that trade policy is more effective in meeting production shortfalls, while endorsing stockpiling to deal with positive production shocks.

Turning to the third goal, it is important to recall that prices cannot consistently be supported using stockholding, and that stockholding is only likely to be effective in influencing domestic prices when domestic policies are not linked to world prices. If the domestic price is linked to world prices—as seems likely to be the case when India is an importer—then stockholding can influence prices only by changing world prices. By contrast, when quantitative trade restrictions like export bans are in effect, purchasing for stock holding will raise prices, while selling out of stocks will lower prices. On average, however, stockholding cannot raise prices.

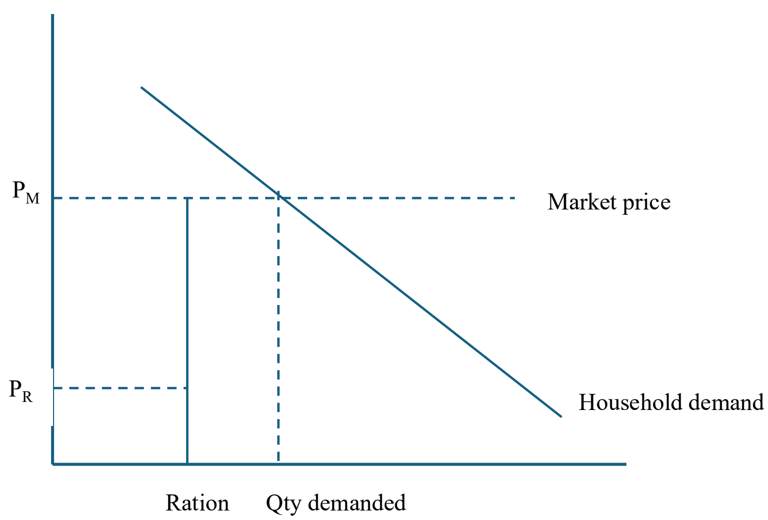
By contrast with the stabilization goal, purchasing food for the PDS requires very stable purchases for delivery in locations dispersed around the country. Purchasing at the MSP creates uncertainty about whether the MSP has been set high enough to secure the quantities needed for the PDS and generates volatility in the volume of food being purchased and consequent uncertainty about the funding required. Purchasing at the MSP when this is enforced in only part of the country introduces distortions between where food is produced and where it is needed for the PDS, with consequent increases in transport costs.

The uncertainty associated with current arrangements could be removed by separating the two functions of purchasing for the PDS and purchasing (and sales) for price stabilization. The quantities needed for the PDS are known well in advance and government purchases for the PDS could therefore be a stable feature of the market. While the prices to be paid would be uncertain, the current volatility in the quantity to be purchased would be removed. Policies for price stability could then be designed using trade and storage policies along the lines recommended by Gouel, Gautam and Martin (2016) without being compromised by a need to set a minimum price at a level needed to acquire rice for the PDS. Moreover, this would also remove the apparent conflicts between the WTO's rules on domestic support—which are completely permissive of mechanisms like the PDS that distribute domestic food aid—and India's current policies.

Fifth, the *Public Distribution System* (PDS), managed by the Food Corporation of India, procures food in the market, which is then distributed in fixed rations (35 kg per household per month) to low-income households. While the rations were previously released at low prices (between US$ 0.010 and US$0.035 per kg, or US$10 and US$35 per tonne), they are now released for free to eligible households.

Purchases for the PDS are frequently seen as a way of raising domestic food prices. However, as long as purchases and releases match, there is no reason to expect them to influence domestic prices at all. A study by Sicular (1988) shows distribution of food rations is, in principle, a pure income transfer, rather than a way of influencing market prices. This is explained in Figure 2, which shows the household's compensated demand curve for rice, the ration of rice, R, the market price of rice, P_M, and the central issue price at which the household's ration can be bought, P_R. In the absence of the ration scheme, the household demands the quantity given by the intersection of the demand curve and P_M.

Figure 2. The household welfare impacts of PDS rations



Source*:* Sicular (1988).

With the ration scheme in place, the household continues to consume the same quantity of rice, with purchases from the market reduced one for one by distributions from the PDS. The household obtains the ration quantity at the price P_R (which is currently zero) and the remainder at the market price. The only impact of the PDS is to reduce the household's cost of living by (P_M – P_R) times the ration quantity. As Sicular (1988) emphasizes, this result is not conditional on the household's ration quantity being below its demand for the food. If the ration quantity exceeds the household's demand, it has the option of accepting the full ration quantity and selling what it does not wish to consume on a secondary market. Note that there is no welfare triangle of losses. In this simple illustration, a stylized system like the PDS allows a costless transfer to eligible households. Not only that, but the system provides insurance against the adverse impacts of higher food prices on the real incomes of the poor.

In reality, of course, there are costs associated with providing these transfers using in-kind transfers. A question is whether the approach of using physical deliveries of food through the Food Corporation of India is more or less efficient in improving food security of the targeted households than, for instance, by supporting them through cash transfers. A key policy question therefore is whether it would be more cost-effective to provide both transfers and insurance against price risk via a cash transfer system.

3. Options for policy reform

In summary, India's current rice support policies pursue achieving food security, rice price stability and affordability for low-income populations. The main policy tools include public investment in R&D, trade policies, input subsidies, public procurement with minimum support prices, and the Public Distribution System (PDS). These policies appear to have had mixed results, including high historical returns from R&D, trade policies that implicitly tax rice production, uneven impact of input subsidies, difficulties in simultaneously maintaining the price floor for rice farmers and purchasing enough cereal for the PDS, and effective income transfers to low-income households through the PDS. These challenges raise questions regarding how to achieve an optimal policy mix:

- Is current public spending on agricultural R&D sufficient to sustain yield growth and resilience, and how can allocation better support nutrition and environmental sustainability?
- What are the net effects of India's contradictory trade and input subsidy policies on rice output, income distribution, and efficiency?
- How can the dual objectives of public procurement (price support for farmers and cereal supply for PDS) be better separated or managed?
- Would cash transfers be a more cost-effective and efficient alternative to the current in-kind transfers through the PDS system?
- How effective are existing policies in stabilizing domestic rice prices relative to global price volatility?

When assessing these scenarios, it is important to consider past policy reform attempts that have tried to resolve some of the indicated contradictions and inefficiencies. As noted by Ramaswami (2022), expansion of existing farm support has enormous political support. This traction exists despite the fact that agriculture does not present a viable livelihood to most farmers, with 86 percent of farms working less than two hectares and mostly growing staple foods (Government of India, 2020), and that support prices backed by storage are unable to raise prices on a sustainable basis.

As discussed in the previous section, input subsidies may have perpetuated the staple crop bias and thereby stunted structural transformation and growth. They have also contributed to the near depletion of valuable water resources by electricity subsidies that promote excessive groundwater withdrawal. However, environmental damage stemming from agriculture has primarily entered the policy debate through air pollution, as crop-residue burning is a major (but not the only) cause of poor air quality in Northern India. Crop-residue burning appears to be primarily a consequence of the paddy-wheat crop rotation sustained by support prices (Kumar, et. al., 2015). The problems posed by GHG emissions have yet to receive similar prominence. Methane emissions from rice cultivation are sustained by provision of free electricity, which makes water cheaper in the short term and reduces the incentive to adopt alternative wetting and drying practices. But, as water tables fall due to the excessive pumping encouraged by free electricity, the user cost of water rises, as water wells must be drilled deeper and deeper, raising the user cost of water and, hence, encouraging its conservation.

Resolving conflicts between supporting livelihoods, food security, and environmental sustainability remains a conundrum for India's agricultural policy. Current agricultural subsidies amount to around 2 percent of GDP, but account for about 20 percent of farm income (Sengupta 2024). Hence, repurposing (some of) this support towards more R&D could potentially be transformational, generating massive productivity gains that would allow many farmers and agricultural workers to leave agriculture for (potentially) better paid jobs in other sectors, while there would be big gains for low-income consumers through lower food prices.

In the last decade, successive governments have experimented with agricultural policy reform. Traditionally, open-ended procurement has been most direct mechanism to provide price support to rice and wheat farmers. The system is logistically demanding, dumps unwanted stocks on the government and cannot increase average prices because of the need to keep stocks at sustainable levels. When extending support to other crops, policy makers have favored price deficiency payments, which are easier to administer though expensive, as their history in rich countries demonstrates, they are expensive and reproduce some of the distortions of the procurement system. Policy makers also increasingly see direct (decoupled) transfers as an alternative to distorting price subsidies. Progress has been made in financial systems to facilitate such payments, but gaps remain in reaching all farmers in part because land records are imperfect.

Stockholding is perhaps better thought of as contributing to price stabilization, rather than to the price support that it cannot achieve on a sustained basis. It works in conjunction with trade policies, which—as in the case of rice—generally appear to lower average prices. Trade policy reforms could potentially help to avoid destabilizing domestic prices by moving away from measures such as export bans that make domestic prices more sensitive to supply shocks.

Agricultural policy reform frequently lacks political ownership in India. The country's federal structure where state governments legitimately exercise considerable influence on agriculture forms an additional obstacle. Ignoring these constitutional constraints have proved costly. In 2020, the central government pushed through reforms to liberalize agricultural markets. Although these reforms represented a desirable direction of reform, they encroached on the powers of State governments and enraged some farmer constituencies. As a result, the central government was forced to reverse course. To gain greater political support, any policy reform may have to be incremental. The political constraints would be less pressing in an economy that offers plentiful jobs in the non-farm sector.

4. Model-based simulation analysis of India rice subsidy policy reform for better diets

We conduct a model-based scenario analysis to simulate both efficiency and equity effects of each of the existing policy instruments and the instruments taken together, as well as simulate options for repurposing such measures to test the feasibility of achieving greater impact on improving food security, affordability of healthy diets, poverty reduction and environmental sustainability.

Using IFPRI's MIRAGRODEP global computable general equilibrium (CGE) model, policy impacts will be assessed for implications for household incomes, food prices and consumption, poverty, food security, GHG emissions, and dietary patterns (see Appendix A.1 for details). The model has been extensively used previously to assess impacts of reforms of agricultural and food policies, including scenarios for repurposing of existing agricultural support (see e.g., Gautam et al. 2022 and Glauber & Laborde 2023). Given the dynamic nature of the model, these outcomes will be assessed for the short-, medium and long-run (2025-2030). The simulated outcomes are assessed against the new updated baseline of the MIRAGRODEP model (see Appendix A.1.3).

While MIRAGRODEP is a global model it includes a fully-fledged model for India's economy. Using this model has the advantage of also being able to assess the global repercussions of India's rice policies for global rice market stability, as well as to assess effects of shocks in global markets for India's support programs.

Outcomes for poverty and food insecurity are estimated through the POVANA household model in top-down fashion (Appendix A.1.2), that is, it simulates outcomes for productivity, incomes, and prices from the CGE model simulations to estimate impacts on the distribution of (farm and other) incomes, poverty, and food insecurity. Once a poverty line has been chosen, this allows the full impact of agricultural policy changes on poverty to be estimated. Changes in the cost of a healthy diet are determined by the baseline cost of a basket of nutritious foods and changes in the prices of these foods. The prevalence of undernutrition is determined using a baseline level of income needed to afford a satisfactory diet. Then, at the household level, changes in affordability are determined using changes in real income and in the cost of the standard diet, in a manner similar to that used to measure changes in poverty.

As detailed in the Appendix, lacking availability of a recent full-fledged household income and expenditure survey, for purposes of this study, the original 2012-13 household survey data for India were updated to the MIRAGRODEP model's base year (2017) using adjusted income and consumption distributions to reflect recent demographic shifts, employment changes, and national average income data across different earner groups. This updated database was then validated against expenditure data from the 2022-23 Household Consumption Expenditure Survey (Government of India, 2023) and the World Bank's trend analysis of poverty and consumption estimates for 2012-2023 (World Bank 2025). The updated POVANA household data set for India, includes imputed values for PDS benefits. These benefits, along with other in-kind transfers, were imputed using model-estimated market prices for PDS commodities. Base year (2017) estimates for extreme and moderate poverty are consistent with 2017 poverty estimates and trends using international poverty lines (Edochie et al. 2022; World Bank 2025). However, given that the base-year household-level income and expenditure data are approximates, we report the policy simulation results for poverty and food insecurity indicators by "order of magnitude", as specified below each results table.

Based on the review of policies in sections 2 and 3, we assess two sets of policy scenarios: (i) scenarios that assess the effectiveness of existing policies and (ii) scenarios of the policy reform options outlined in section 3.

4.1 Impacts of existing policies

To create a counterfactual to assess the present influence of all six types of existing policy support for rice, we sequentially remove the main forms of existing support:

(i) Removal of import tariffs and export restrictions on rice
(ii) Removal of fertilizer and other input price subsidies – for rice and more generally.
(iii) Repurposing support

Please note that none of these simulations should be seen as a reform option (removal of all support), but rather to assess the influence of each type of existing support on food security and diets.

(i) Removing border measures

Table 2 provides results for the first scenario of removing import tariffs and export restrictions. Since base-year (2017) border restrictions in the model were very low, removal of export taxes and import tariffs on rice show almost negligible effects on key outcome variables, as shown in the first column of Table 2. To further test the sensitivity of rice production, prices and other outcome variables to border measures (as implemented in years after 2017, as discussed in section 3), we also simulated two alternative scenarios in which (i) the export tax rate is lowered by 25 percentage points and (ii) an increase in the export tax rate of 25 percentage points. While the first scenario may seem unrealistic, many countries have seen dramatic turnarounds in protection to agriculture, with protection moving from strongly negative to strongly positive in periods of 20-30 years (Anderson 2009). Table 1 above showed several situations in which domestic prices were held below world prices by more than 33 percent.

Table 2. Implications for India of removal of border measures and changes in export taxes on rice (percentage changes from baseline, unless indicated otherwise)

	Removing border measures	25% pts lower export tax	25% pts higher export tax
Terms of Trade	-0.001	-0.43	0.17
National Real Income	0.001	-0.22	0.05
National Real Income (M$)	13	-3,840	868
Production Volume – Rice	-0.03	9.07	-4.22
Production Volume – Wheat	-0.01	0.91	-0.45
Production Volume – Veg & Fruits	0.00	-0.59	0.27
Private Consumption Price – Rice	-0.05	6.68	-3.04
Private Consumption Price – Wheat	-0.01	2.03	-0.91
Private Consumption Price – Veg & Fruits	0.00	1.17	-0.50
Production Price - Rice	-0.03	6.47	-3.00
Production Price - Wheat	-0.01	1.93	-0.92
Production Price - Veg & Fruit	0.00	1.04	-0.49
World Rice Prices	0.00	-0.58	0.30
Real Farm Income	-0.01	1.94	-0.88
Real Farm Income (M$)	-31	7,564	-3,430
Real Farm Income per Worker	0.00	0.92	-0.43
Total Exports - Rice	0.14	82.1	-52.0
Sugar Consumption Per Capita	0.00	-0.17	0.06
Fats Consumption Per Capita	0.00	0.15	-0.11
Dairy Consumption Per Capita	0.00	-0.48	0.19
Veg & Fruit Consumption Per Capita	0.00	-0.28	0.12
Cereals Consumption Per Capita	0.01	-1.49	0.74
Actual Food Prices	0.00	0.71	-0.34
Healthy Diets Unaffordability (pp)	0.00	0.02	0.00
Healthy Diets Food Prices	0.00	0.22	-0.10
Farm Employment	0.00	1.01	-0.45
Extreme Poverty $2.15 (pp)	*0*	*~0.0*	*~0.0*
Moderate Poverty $3.65 (pp)	*0*	*~0.0*	*~0.0*
Extreme Poverty $2.15 among Farmers (pp)	*0*	*~0.0*	*~0.0*
Moderate Poverty $3.65 among Farmers (pp)	*0*	*~0.0*	*~0.0*
Prevalence of Undernourishment (pp)	*0*	*~0.0*	*~0.0*
Agricultural Land	-0.00	-0.01	-0.02
Emissions – Production	-0.00	0.32	-0.18

Source: Authors based on simulations with MIRAGRODEP model.

Notes: M$ refers to change in millions of 2017 US. Poverty and food insecurity outcomes are expressed in percentage points (pp) changes from the baseline in the specified ranges, with *0* indicating no change at all and *~0* indicating change of between *-0.2pp* and *+0.2pp*, and otherwise the specified range.

Starting with the macroeconomic outcomes, we see that converting the export tax on rice into an export subsidy would cause a deterioration in India's terms of trade because of India's large share in global exports, and the low elasticities of supply and demand for rice. National real income would fall because of the decline in the terms of trade and the inefficiencies associated with having an export subsidy. Production of rice would rise by an estimated 9 percent, with a small decline in production of vegetables and fruit as resources were pulled into production of rice. This estimate suggests that the average export tax rate of around 17 percent is likely to increase rice production by around 6 percent. This is slightly larger than the 4 percent increase in rice output associated with subsidies to rice alone.

Consumer prices of rice would rise substantially, with prices of wheat and vegetables rising by much less. Real farm incomes would rise because of the higher price of rice. Consumption of fruits and vegetables would fall in response to the higher prices, despite the increase in national income. Poverty would rise overall because of the higher price of food, although this estimate does not take into account the fact that poor consumers are insulated from this income effect through provision of free food through the Public Distribution System. Rice exports, in turn, would increase sharply by 82 percent.

Not surprisingly, the effects of increasing the export tax rate are broadly mirror images of those resulting from an export subsidy. National income rises because of improvements in the terms of trade. Production and exports of rice fall, while production of vegetables and fruit increases, albeit marginally, as land is shifted away from rice. The price of vegetables and fruits falls, albeit by much less than the fall in the price of rice. Real farm income falls by close to one percent. Consumption of vegetables and fruits increases slightly because of lower consumer prices. Real farm income declines. Impacts on poverty and food insecurity are negligible, owing – as explained above – to the buffering effect of PDS rations on the food costs of the poor. Overall impacts on land use change and agricultural emissions are also small to negligible.

(ii–iv) Removing domestic support

Table 3 provides results for the other scenarios of removal of existing support. As indicated, we do not see these scenarios as a form of repurposing, rather as counterfactuals to assess the influence of existing policies. The results for removing, respectively, all domestic support, input subsidies and all (domestic and border) support are by and large the same. This is because domestic support essentially consists of input subsidies and the rice sector is the main beneficiary of this type of support. Output subsidies and factor payments are non-existent, while – as shown above – both import tariffs and export taxes were relatively low in the base year. Further, as discussed in section 2, removal of the PDS should not have much of an effect on rice output and producer prices and incomes derived from it, though such removal would have an impact on the cost of living for recipient households. Hence, we focus the discussion of the results in Table 3 only for the impact of the input subsidies, while we analyze separately the impact of the PDS program on household poverty, food security and diets.

Table 3. Implications for India of removal of domestic subsidies and all support (percentage changes from baseline, unless indicated otherwise)

	Removing all domestic support	Removing all input subsidies	Removing input subsidies for rice
Terms of Trade	0.00	0.00	0.04
National Real Income	-0.00	-0.00	-0.02
National Real Income (M$)	-27	-27	-381
Production Volume – Rice	-2.21	-2.21	-3.98
Production Volume – Wheat	-5.34	-5.34	1.51
Production Volume – Veg & Fruits	-1.35	-1.35	0.13
Private Consumption Price – Rice	2.75	2.75	4.30
Private Consumption Price – Wheat	3.77	3.77	0.41
Private Consumption Price – Veg & Fruits	0.98	0.98	-0.47
Production Price – Rice	3.90	3.90	4.52
Production Price – Wheat	5.22	5.22	0.65
Production Price - Veg & Fruit	2.27	2.27	-0.28
World Rice Prices	0.18	0.18	0.09
Real Farm Income	-4.21	-4.21	-0.59
Real Farm Income (M$)	-16,392	-16,392	-2,282
Real Farm Income per Worker	-2.29	-2.29	-0.38
Total Exports – Rice	-11.85	-11.85	-13.80
Sugar Consumption Per Capita	-0.17	-0.17	0.17
Fats Consumption Per Capita	0.00	0.00	-0.13
Dairy Consumption Per Capita	0.09	0.09	0.09
Veg & Fruit Consumption Per Capita	-0.51	-0.51	0.04
Cereals Consumption Per Capita	-1.21	-1.21	-1.01
Actual Food Prices	1.04	1.04	0.35
Healthy Diets Unaffordability (pp)	0.27	0.27	-0.08
Healthy Diets Food Prices	0.73	0.73	-0.28
Farm Employment	-1.96	-1.96	-0.21
Extreme Poverty $2.15 (pp)	*0.2-0.6*	*0.2-0.6*	*~0.0*
Moderate Poverty $3.65 (pp)	*0.6-1.0*	*0.6-1.0*	*~0.0*
Extreme Poverty $2.15 among Farmers (pp)	*0.2-0.6*	*0.2-0.6*	*~0.0*
Moderate Poverty $3.65 among Farmers (pp)	*0.6-1.0*	*0.6-1.0*	*~0.0*
Prevalence of Undernourishment (pp)	*0.2-0.6*	*0.2-0.6*	*~0.0*
Agricultural Land	-0.22	-0.22	0.12
Emissions – Production	-3.18	-3.18	-0.35

Source: Authors based on simulations with MIRAGRODEP model.

Note: M$ refers to change in millions of 2017 US$. Poverty and food insecurity outcomes are expressed in percentage points (pp) changes from the baseline in the specified ranges, with *0* indicating no change at all and *~0* indicating change of between *-0.2pp* and *+0.2pp*, and otherwise the specified range.

As indicated, the input subsidy program benefits all agriculture, not just rice production. Elimination of the input subsidies does not affect India's terms of trade, just input costs to farmers. The impact of eliminating all input subsidies on national income is negligible (-$26 million or -0.0 percent). The volume of production for rice and wheat would fall between 2.0 percent and 5.5 percent, while rising input costs would also induce a decline, albeit smaller, in the production of fruits and vegetables. Also rice exports would decline by more than 10 percent, owing to the increase in the cost of Indian rice vis-à-vis world prices.

Consumer prices for all main crops would rise commensurately to the drop in supply. Real farm incomes would fall because of higher input costs and despite the increase in producer prices. the higher price of rice. Together these outcomes for incomes and prices would cause a drop in the consumption of rice and other cereals, sugar, and fruits and vegetables. As prices of fats and dairy products would not be affected directly, consumption of those food items would show a very slight increase. Overall, though, the cost of healthy diets would increase, while also all poverty and food insecurity indicators would go up, despite the cushion provided by the PDS. Put differently, especially by supporting farm incomes, the existing input subsidies have a slight poverty-reducing effect and equally slightly contribute to improved food security.

There would be some minimal gains for the environment from removing all support, as production would fall and with it land use and emissions from agricultural production. Put inversely, the result can also be seen as existing domestic support have these negative environmental impacts, even if small at the margin.

Estimated effects on household welfare of *removal of the PDS* are shown in Table 4. These impacts were assessed through microsimulation with the POVANA model. As explained above and in Appendix A.1.2, lacking availability of a more recent full-fledged household income and expenditure survey, the original 2012-13 household survey data for India were updated the MIRAGRODEP model's base year (2017) using expenditure data (including imputed values for the benefits of the PDS) of the 2022-23 Household Consumption Expenditure Survey (Government of India, 2023), demographic and employment changes in the population, and national average income data for different groups of income earners.

Table 4 Implications for India of removal of the PDS, 2017 (percentage changes from baseline, unless indicated otherwise)

	Prevalence (%) with PDS	***Prevalence (%) without PDS***	***Difference (with minus without) in pp***
Extreme Poverty $2.15	11.4	14.1	*-2.8*
Moderate Poverty $3.65	48.4	50.4	*-2.0*
Extreme Poverty $2.15 among Farmers	14.1	17.6	*-3.6*
Moderate Poverty $3.65 among Farmers	53.6	55.5	*-2.0*
Prevalence of Undernourishment	14.4	20.7	*-6.3*
Healthy Diets Unaffordability	77.9	79.8	*-1.9*

Source: Authors based on simulation with POVANA model. See Appendix A.1.2 for explanation of updated household income and expenditure distribution data for India.
Note: Pp refers to change in percentage points.

We find that the PDS has a tangible impact on extreme poverty and food insecurity (as measured by the prevalence of undernourishment), which are, respectively, 2.8 and 6.3 percentage points lower than would have been in the absence of the program. Extreme poverty among farmers is even 3.6 percentage points lower, reflecting the program's targeting of rural poor. Removing the PDS would increase the share of the population unable to afford healthy diets by almost 2 percent. This impact is smaller than the impact on undernourishment because the PDS focusses on staple foods, which are central to the undernourishment measure, but not to the healthy diet measure.

4.2 Impacts of repurposing the support of rice and other crops

Based on the assessment of role of current policies for productivity and prices in the rice sector, spillovers to other food commodities, and impacts on poverty, food security, diets, and environmental variables, as well as a review of present and past policy reform proposals in India, a set of scenarios for ways of repurposing of rice subsidies were identified:

(v) Shift part of rice (input) subsidies towards more nutritious foods, especially fruits and vegetables
(vi) Shifting rice producer support (input subsidies) to consumer support (subsidies on rice consumption and/or social protection)
(vii) Repurpose existing support towards R&D for improved agricultural productivity and efficiency targeting, respectively, all crops and healthier foods (fruits and vegetables and dairy).

Table 5 summarizes the key findings of these scenarios.

(v) Shifting part of rice (input) subsidies towards input subsidies for healthier foods

Repurposing support away from input subsidies for rice cultivation towards more nutrient-dense foods, like fruits, vegetables and dairy products, would shift resources towards the targeted foods, lower their consumer prices relative to rice and make healthy diets more accessible. As Table 5 shows, the simulated impacts of repurposing 50 percent of input subsidies on rice to healthier foods would raise the consumer price for rice by 2.4 percent and lower that for fruits and vegetables by 0.3 percent. The muted drop in prices of healthier might reflect a higher degree of substitutability of these products in people's diets than is the case for staple foods, like rice and wheat. The limited impact on relative prices of this scenario also implies a very modest impact on key outcome variables. The effect on national income would be near zero, there would be a marginal increase in the per capita consumption of fruits and vegetables (+0.05 percent) and a small decrease in cereals consumption (-0.55 percent). On average the cost of a healthy diet would decrease slightly. Poverty and food insecurity indicators would barely move, though worsen very slightly owing principally to the increase in the price of rice.

(vi) Shifting part of rice (input) subsidies towards consumer subsidies on healthier foods

In this scenario, producer support is repurposed aiming to improve the affordability of healthy diets through consumer subsidies on fruits and vegetables and dairy products. As in the previous scenario, lower input subsidies increase the cost of rice, but the consumer subsidy more strongly reduces prices of fruits and vegetables (-2.6 percent) and dairy products (-2.1 percent). Consequently, also, the drop in the cost of a healthy diet is more substantial (-1.0 percent). The stimulus to the production of fruits, vegetables and dairy products would lift overall farm income and employment and this, together with lower food prices, would help reduce poverty, albeit slightly. However, the increased cost of rice would lead to less cereal consumption and food energy intake, explaining the slight simulated increase in the prevalence of undernourishment in this scenario. Further trade-offs emerging from this scenario are the expansion of land use and higher emissions from greater agricultural output in response to increased demand for healthier foods.

Table 5. Impacts of repurposing 50% of input subsidies towards (a) input subsidies for fruits, vegetables and dairy production; (b) consumer subsidies on healthier foods; and (c) R&D for improving productivity of, resp., healthier foods and all crops (percentage changes from baseline, unless indicated otherwise)

	Reducing input subsidies on **rice** by 50% towards input subsidies for healthier foods	Reducing input subsidies on **rice** by 50% towards consumer subsidies on healthier foods	Reducing input subsidies on **rice** by 50% to increase R&D for healthier foods	Reducing input subsidies on **all crops** by 50% to increase R&D for **all crops**
Terms of Trade	0.03	0.03	-0.05	-0.58
National Real Income	0.00	0.06	1.21	2.60
National Real Income (M$)	-22	1,099	21,053	45,179
Production Volume – Rice	-2.05	-2.08	-1.43	12.21
Production Volume – Wheat	0.67	0.62	1.77	16.55
Production Volume – Veg & Fruits	0.19	0.20	7.72	13.39
Production Volume – Dairy	0.63	0.79	7.43	2.25
Private Consumption Price – Rice	2.36	2.48	1.60	-15.15
Private Consumption Price – Wheat	0.46	0.58	-0.41	-18.41
Private Consumption Price – Veg & Fruits	-0.27	-2.55	-11.95	-19.29
Private Consumption Price – Dairy	-1.11	-2.13	-10.34	-0.90
Production Price – Rice	2.35	2.35	1.63	-14.78
Production Price – Wheat	0.47	0.47	-0.39	-18.58
Production Price - Veg & Fruit	-0.29	0.23	-12.59	-19.88
Production Price – Dairy	-1.11	0.62	-10.32	-0.47
World Price of Rice	0.05	0.06	-0.23	-1.52
Real Farm Income	0.09	0.23	-2.34	-5.55
Real Farm Income (M$)	350	900	-9,093	-21,599
Real Farm Income per Worker	0.03	0.11	-0.55	-1.43
Sugar Consumption Per Capita	0.01	0.04	-0.20	3.39
Fats Consumption Per Capita	-0.10	-0.05	-1.23	-0.77
Dairy Consumption Per Capita	0.59	0.84	6.89	2.21

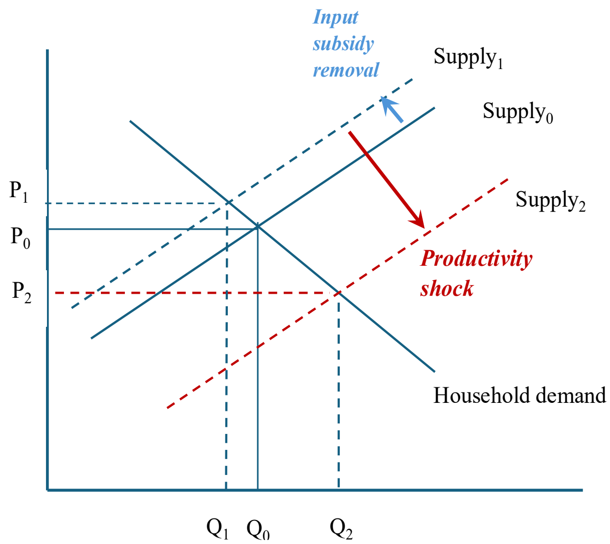
	Reducing input subsidies on **rice** by 50% towards input subsidies for healthier foods	Reducing input subsidies on **rice** by 50% towards consumer subsidies on healthier foods	Reducing input subsidies on **rice** by 50% to increase R&D for healthier foods	Reducing input subsidies on **all crops** by 50% to increase R&D for **all crops**
Veg & Fruit Consumption Per Capita	0.05	0.28	3.44	6.37
Cereals Consumption Per Capita	-0.55	-0.56	-0.09	6.25
Actual Food Prices	0.26	-0.06	-1.49	-6.76
Healthy Diets Food Prices	-0.07	-0.95	-4.13	-8.99
Healthy Diets Unaffordability (pp)	-0.08	-0.40	-1.99	-3.24
Farm Employment	0.06	0.12	-1.79	-4.18
Skilled Workers Real Wage	-0.03	-0.01	2.09	4.84
Unskilled Workers Real Wage	0.03	0.12	0.73	1.43
Extreme Poverty $2.15 (pp)	*~0.0*	*~0.0*	*~0.0*	*-1.5 to -1.0*
Moderate Poverty $3.65 (pp)	*~0.0*	*~0.0*	*~0.0*	*-2.0 to -1.5*
Extreme Poverty $2.15 among Farmers (pp)	*~0.0*	*~0.0*	*~0.0*	*-2.0 to -1.5*
Moderate Poverty $3.65 among Farmers (pp)	*~0.0*	*~0.0*	*~0.0*	*-2.0 to -1.5*
Prevalence of Undernourishment (pp)	*~0.0*	*~0.0*	*~0.0*	*-1.5 to -1.0*
Cropland	0.02	0.02	0.29	-0.61
Pasture	0.15	0.15	-0.39	1.04
Agricultural Land	0.03	0.03	0.25	-0.52
Energy Use in Agriculture	-0.46	-0.39	2.32	10.24
Emissions – Production	0.20	0.26	4.71	1.52

Source: Authors based on simulations with MIRAGRODEP model.
Note: M$ refers to change in millions of 2017 US$. Poverty and food insecurity outcomes are expressed in percentage points (pp) changes from the baseline in the specified ranges, with *0* indicating no change at all and *~0* indicating change of between *-0.2pp* and *+0.2pp*, and otherwise the specified range.

(vii) Shifting part of rice (input) subsidies towards R&D for improved agricultural productivity

Shifting support towards R&D for improved technologies that enhance productivity and climate resilience of rice cultivation would involve both an upward shift in the supply curve for rice due to removal of the input subsidies, and a downward shift due to the reductions in cost that follow from successful research and development, as illustrated in Figure 3. On balance, we expect the R&D effect to outweigh rising input costs, such that supply increases to Q_2 in the graph and the price of rice falls to P_2. The evidence on the impact of R&D on production costs suggests that the downward movement would indeed be much larger. While many studies point to even larger impacts, the survey by Alston, Pardey and Rao (2021) suggests that the benefit-cost ratio for agricultural R&D is at least 10:1. This implies that repurposing subsidies amounting to 1 percent of the value of output would lower the supply curve by 9 percent.

Figure 3 Impact on rice supply of reduction in input subsidy and increase in R&D spending



Source: Authors' depiction.

Using half of the input subsidy for rice (amounting to between 2.5 and 3 percent of the rice output value around 2017, the base year of the model) for increased R&D spending would be commensurate with a TFP increase of about 25 percent, assuming the same benefit-cost ratio. Typically, there are substantial time lags (ten years or more) for new technologies to become available and to be adopted. However, one could also consider an initial focus of R&D on the adaptation of many available improved technologies and practices (see e.g., Herrero et al. 2022; Vos and Martin 2026) to India's agroecological context, which could substantially shorten the time lag involved. Understanding the time lags involved is crucial for further political-economy analysis of options for rice policy reform. However, since we use a comparative static approach to all model simulations, we ignore the time lags and assess the expected long-term impacts only.

By contrast with the removal of domestic support experiments presented in Table 3, the impacts of repurposing support to R&D shown in Table 5 are dramatically larger. This is because of the very high returns (over time) to R&D investments. In practical terms, we reallocate half of the input support from each crop sector to R&D and assume that the repurposed resources will generate productivity gains equivalent to ten times the share of the newly assigned R&D budget relative to the sector's value. For example, the removed support accounts for 5 percent of the rice sector's value, the resulting R&D investment (2.5 percent) yields a 25 percent increase in total factor productivity (TFP) for rice, and similarly, 27 percent for wheat, 24 percent for maize, 21 percent for vegetables and fruits, 15 percent for oilseeds, 9 percent for sugar, 22 percent for fibers, and 22 percent for other crops. Resources going into input or output subsidies, in contrast, tend to have benefit-cost ratios of less than one because of the combination of the economic distortions and likely deterioration in the terms of trade they cause.

As shown in the final two columns of Table 5, shifting only half of the input subsidy for rice towards R&D for technology improvements in healthy foods would increase national income by 1.2 percent. Shifting half of the input subsidies for all crops to R&D would raise national income by 2.6 percent.

Looking at the results for these two scenarios separately, we find, first, that repurposing support to ***R&D for innovations in all crops*** (including rice) would raise rice output by over 12 percent, while reducing consumer rice prices by 15 percent. Outputs of wheat, fruits and vegetables and dairy also increase, and prices of those products fall and consumption per capita increases. Even though agricultural productivity improves substantially in this scenario, the drop in producer prices causes farm incomes and farm employment to fall, posing a trade-off. However, increased real wages for both skilled and unskilled workers and lower cost of living would help reduce poverty and food insecurity by between 1 and 2 percentage points. The sector-wide repurposing of support has transformational consequences for overall food affordability and particularly for the cost of healthy diets, which would fall by 9 percent, while the share of people unable to afford a healthy diet would decline by 3 percentage points. The outcomes for 'nature' and 'climate' would be mixed, as the sector-wide yield improvements would lower use of agricultural land (though pasture areas would expand) and use of energy and emissions from agricultural production would increase. To achieve wins for healthy diets, poverty reduction and environmental sustainability, R&D investments would need to target farming practices that are not only productivity-enhancing but also improve land and energy efficiency and reduce emissions.

Repurposing input subsidies towards spending on ***R&D for healthier foods only*** would induce a shift away from rice production and rice prices would increase as a result of both lower input subsidies and less supply. As in the previous scenario, outputs of other crops would increase, but especially those of the targeted fruits, vegetables and dairy products and lower the prices of those products. However, those impacts would be weaker overall, as the overall welfare improvements are larger in the sector-wide R&D approach. Also, the gains in reducing the cost of a healthy diet would be lower (-4 percent), while the income losses for rice farmers would offset all gains towards poverty reduction. Trade-offs in the form of greater land use and higher agricultural emissions are also more concerning in this scenario.

5. Conclusions, policy recommendations and questions for further policy research

Policy for the rice sector in India is complex, with border support that appears to have been negative but highly volatile in recent years, at a reported average rate of -17 percent. By contrast, support through subsidies appears to have been relatively consistent at an average rate of 6.4 percent.

Trade policy for rice involves tariffs of around 70 percent that have played little role in recent years, with the emergence of India as the world's largest exporter of rice. Export policy for rice has used a wide range of discretionary interventions such as export bans, licensing and minimum export prices. Stockholding policies have attracted much attention for their ability to influence prices, but it is important to remember that stockholding policies cannot consistently increase prices because of the need to keep stocks at sustainable levels. India has been able to sustain its stockholding and stabilization policies by using combinations of stockholding and trade policies, although Gouel, Gautam and Martin (2016) concluded that it might have been possible to achieve the same result, at least for wheat, by using simpler, rule-based approaches.

A major concern with stockholding policies is the use of a single policy instrument—the Minimum Support Price (MSP)—to achieve multiple goals. This instrument is set with an eye both to allowing the government to purchase very stable, predictable quantities of rice needed for the Public Distribution System, and to purchasing the extremely unpredictable quantities of grain needed to support the MSP to achieve the government's price stabilization goals. Separating the two functions of purchasing for the PDS and providing price support could help better achieve both of these goals.

Re-examining and potentially repurposing both border measures and domestic support deserves serious consideration. Key insights into the impacts of both border measures and domestic support are provided by analyses of the impacts of their removal. It appears that border taxation in the order of 17 percent reduces rice production by around 6 percent, slightly outweighing the increase in rice output due to subsidy support. Repurposing support by redirecting part of it to R&D has the potential for transformational outcomes both for households' food security and access to healthy diets and for India's overall economic performance. Improving diets in India thus seems better served when taking a sector-wide approach towards investing in agricultural innovations, rather than merely targeting R&D for healthier foods. Additionally, to address trade-offs with higher pressures on the use of natural resources and more agricultural emissions, the repurposing of rice input subsidies for enhanced R&D investments should consider prioritizing climate-smart productivity enhancing innovations. This could then create win-win-wins for diets, welfare, and sustainability.

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Appendix 1 The MIRAGRODEP and POVANA global modeling framework

The model-based scenario analysis uses estimates of the productivity impacts of large scale and geographically widespread weather or disease related disasters that significantly affect crop production in major agricultural regions to generate productivity shocks for the MIRAGRODEP global equilibrium model. This, in turn, generates estimates of changes in the commodity prices and wages that—along with changes in productivity—affect the incomes of households. These changes are then applied as shocks to the POVANA household model, with detailed information on roughly 300,000 households, that is used to assess the impacts on global poverty.

In the discussion below, we first describe the methodology underlying the global general equilibrium modeling framework. After that, we consider the productivity shocks to be used in the analysis. Finally, we return to the POVANA model used to assess poverty impacts.

A.1.1 The MIRAGRODEP Model

MIRAGRODEP is a global Computable General Equilibrium (CGE) model based on MIRAGE (Decreux & Valin, 2007). The model was developed and improved with the support of the African Growth and Development Policy Modeling Consortium (AGRODEP). It is a multi-region, multi-sector, recursively dynamic CGE model. The model allows for a detailed and consistent representation of the economic and trade relations between countries (Laborde, Robichaud & Tokgoz, 2013). In each country, a representative consumer maximizes a CES-LES (Constant Elasticity of Substitution-Linear Expenditure System) utility function subject to an endogenous budget constraint to generate the allocation of expenditures across goods. Once total consumption of each good has been determined, the origin of the goods consumed is determined by another CES nested structure, following the Armington assumption of imperfect substitutability between imported and domestic products.

On the production side, demands for intermediate goods are determined through a Leontief production function that specifies intermediate input demands in fixed proportions to output. Total value added is determined through a CES function of unskilled labor and a composite factor of skilled labor and capital. This specification assumes a lower degree of substitutability between the last two production factors. In agriculture and mining, production also depends on land and natural resources. In the present application of the model, we assume that new capital investment is perfectly mobile across sectors, while installed capital is immobile. Furthermore, skilled labor is assumed to be fully mobile across sectors, while unskilled labor is only partially mobile between agricultural and non-agricultural sectors.

We use the GTAP 11 database as MIRAGRODEP's main source of data and parameters. In addition, the database is enhanced by datasets on land use, agricultural production, food balance sheets, agricultural domestic support measures and trade policies, as well as updated Social Accounting Matrices for all individually specified countries. For this specific study, we condensed the model to 22 sectors, of which 15 are related to agri-food activities (primary production and downstream activities) and 34 regions/countries.

A.1.2 Modeling Poverty and Food Security Impacts

The POVANA model uses a top-down modeling approach to estimate the impacts of changes in productivity on household incomes. The changes in productivity in farm production for each country are imposed directly on each farming household, and changes in commodity prices and wages derived in the model analysis are used to estimate the impact of changes in agricultural productivity on the real incomes of the households covered by the surveys. Once a poverty line has been chosen, this allows the full impact of productivity shocks on poverty to be estimated.

Changes in the cost of a healthy diet are determined by the baseline cost of a basket of nutritious foods and changes in the prices of these foods. The prevalence of undernutrition is determined using a baseline level of income needed to afford a satisfactory diet. Then, at the household level, changes in affordability are determined using changes in real income and in the cost of the standard diet, in a manner similar to that used to measure changes in poverty. The specific procedures used for this analysis are presented in *Appendix A.1.2* of Laborde, Martin and Vos (2021).

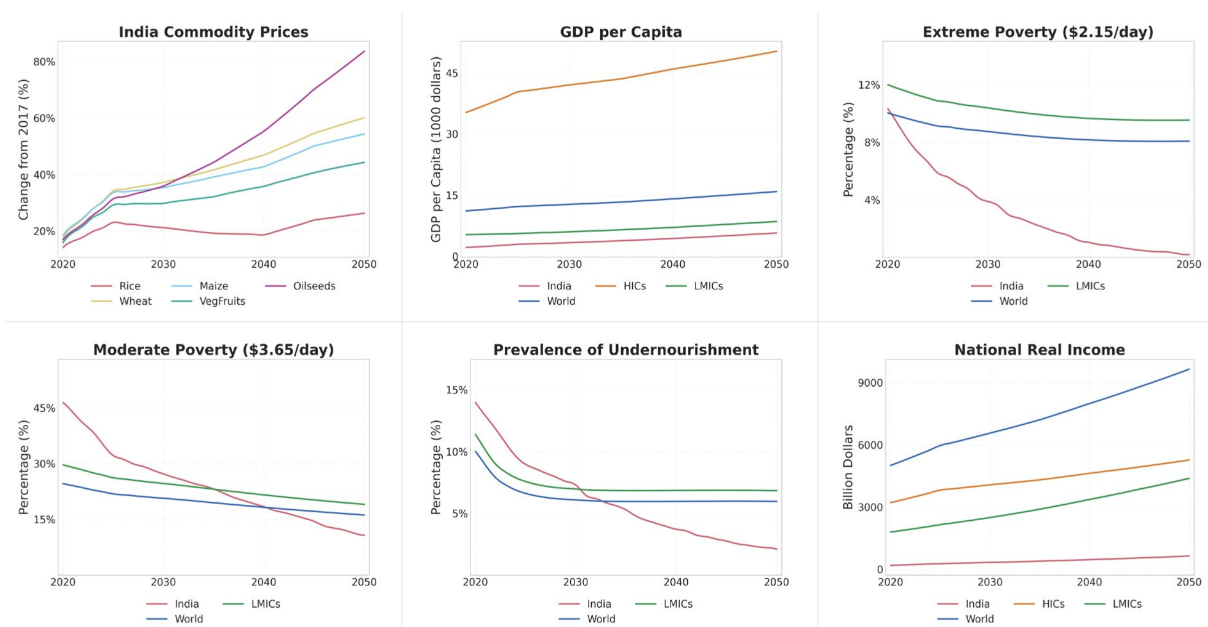
Lacking availability of a recent full-fledged household income and expenditure survey, for purposes of this study, the original 2012-13 household survey data for India were updated the MIRAGRODEP model's base year (2017) using expenditure data (including imputed values for the benefits of the PDS) of the 2022-23 Household Consumption Expenditure Survey (Government of India, 2023), demographic and employment changes in the population, and national average income data for different groups of income earners. The new income and consumption distribution was fitted to align with 2017 poverty estimates and trends using international poverty lines (Edochie et al. 2022; World Bank 2025). The benefits of PDS and other in-kind transfer programs were imputed using market prices and included in both household income and consumption, following procedures also applied by the Government of India (2023) and a methodological note of the World Bank (2025).

A.1.3 MIRAGRODEP Baseline Scenario

Key baseline assumptions: The MIRAGRODEP baseline scenario builds on the new Shared Socioeconomic Pathways (SSP) database of July 2024 as provided by the International Institute for Applied Systems Analysis (IIASA). We use their middle-of-the-road (SSP2) scenario for population and GDP growth. The scenario assumes a global temperature rise of 3.6 degrees Celsius above pre-industrial levels by the end of the century, as projected under IPCC's Representative Concentration Pathway (RCP) 7.0, i.e. scenario SSP2-7.0 as defined in the latest IPCC report (IPCC 2023). This climate scenario is paired with IFPRI's most recent projections for crop yields by country and crop (irrigated and non-irrigated) under the business-as-usual scenario of IFPRI's foresight multimarket global crop model IMPACT and further informed by FAO-OECD's outlook for crop yields and livestock production.

Key characteristics of the baseline trends: This baseline scenario places India's economy, consistent with global trends, on a path of moderate but steady growth through 2050, with agricultural productivity growth gradually slowing over time. As shown in Figure A.1, India's staple food prices rise over the projection period as projected grows of supply growth lags demand, a pattern also consistent the model's baseline price trends in global markets. India's oilseed prices are projected to show the largest increase, which would be up by about 80 percent in 2050 relative to the base year. Prices for wheat, maize, vegetables, and fruits also show substantial increases in the 40–60 percent range. Rice prices are projected to rise at a more moderate pace, though still up by 25 percent in 2050. The projected rise in food prices would moderate the pace of reducing poverty and hunger in the baseline. In India, however, the projected income growth is strong enough to outpace global improvements in poverty reduction and improving food security. Additionally, the Public Distribution System (PDS) is assumed to continue to shield India's poorest from the impacts of much of the rise food prices throughout the baseline period. The PDS has a lesser effect on moderate poverty, as low-income households that are not in extreme poverty line receive only a relatively small share of grain needs through the PDS.

Figure A.1 Key Features of World Economic Trends in the Baseline, 2020-2050



Source: Authors' Simulation Results.

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