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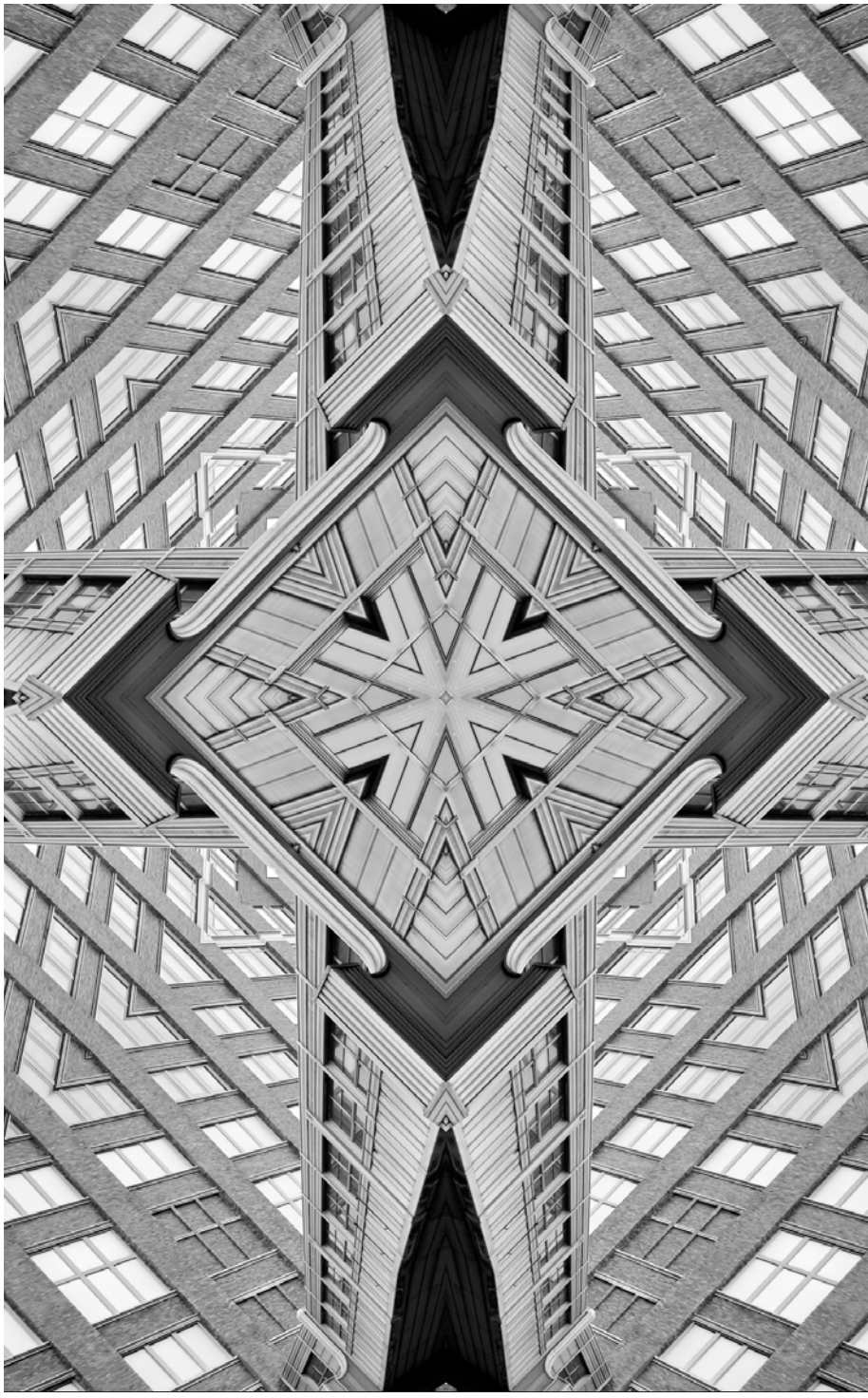

The New Green Revolution: A Just Transition to Climate-Smart Crops

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Abstract

The agriculture sector's contribution to India's GDP and employment makes it crucial to the country's growth. At the same time, the sector's massive greenhouse gas emissions pose a threat to India's green transition. The ongoing farmers' protests also highlight the need for a climate-smart agriculture strategy that will address fundamental issues like income support. This brief outlines a framework for India's "new green revolution" that will not only be feasible for small and marginal farmers, but will provide them stable incomes. The brief explores the necessary attributes of such a climate-smart transition.

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Introduction

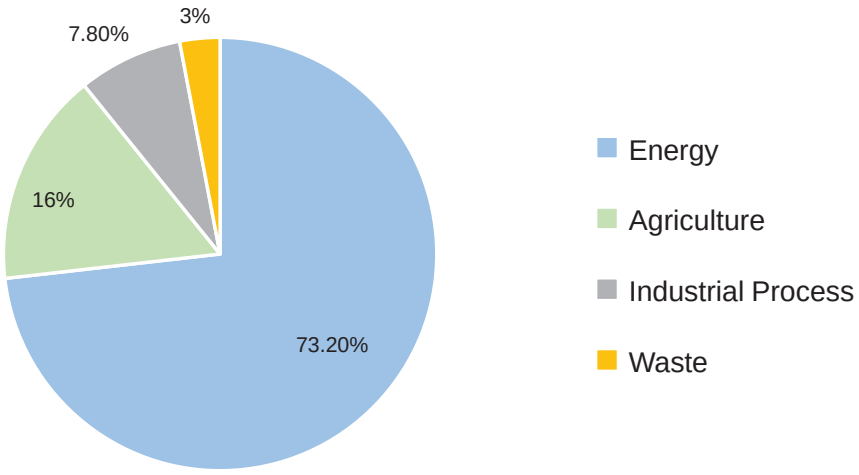
The agriculture sector is an integral part of India's growth story. It employs 58 percent of the population and contributes 18 percent of the country's GDP.[1] It is responsible for both food and nutritional security and is key to efforts towards alleviating poverty and reducing inequality. In the first quarter of 2020, agriculture was the only sector that showed some growth (3.4 percent) when the economy contracted overall by a massive 23.4 percent.[2] At the same time, agriculture contributes 16 percent of the total greenhouse gas emissions in the country, second only to the energy sector (See Figure 1).[3]

If India is aiming to transition to a green economy and achieve its Sustainable Development Goals (SDGs), it will have to pay greater attention to the agricultural sector. Agriculture can yet prove to be a catalyst for India to achieve a standard of inclusive, green growth.

> "In the first quarter of 2020, agriculture was the only sector that showed some growth when the economy contracted overall."

The ongoing farmers' protests in the capital region have made it clear that among the imperatives in the country's agriculture sector is addressing concerns about income support. Farmers are rejecting the three new farm bills primarily because of fears that their much-needed income support—in the form of Minimum Support Price (MSP)—would be rendered obsolete.[4]

Figure 1: Distribution of GHG Emissions (Gg CO_2e) by sector



Source: India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change[5]

It is important, therefore, to create a pathway towards climate-smart agriculture that is not just accessible and feasible to India's small and marginal farmers, but also creates a stable income stream. Consequently, a just transition to climate-smart agriculture requires combining the need for stabilised farmers' incomes with the shift towards greener and less climate-exhaustive practises.

This brief outlines the shortfalls of the present system of procurement that have led to environmentally unsustainable practises in agriculture. It argues that the procurement system could nevertheless be a powerful tool in achieving sustainability by switching to greener practises in the short term while ensuring income support. However, in the long run, switching to a more robust alternative for sustainable agriculture will require building an enabling environment with better income support for the farmers.

Rice is the staple food for more than 65 percent of the Indian population and contributes 40 percent of total food grain production in India.[6] It occupies a central role in Indian agriculture as it provides food and livelihood security to a large proportion of the rural population. In 2018-19, India produced 116.42 million tonnes of rice, second in the world only to China.[7]

However, rice cultivation is a considerable threat to sustainable agriculture as it is a significant source of GHG emissions (e.g., methane and nitrite oxide) and rice is a significant sequester of carbon dioxide from the atmosphere. Furthermore, emission of methane (or CH4)[a] from flooded paddy fields, combined with the burning of rice residues such as husks and straws, further add to GHG emissions.[b],[8] In 2017, India produced 112.78 million tonnes of rice,[9] which led to large emissions as summarised in Table 1. While rice formed only 9 percent of total consumption in Indian diets, it contributed 36.9 percent to the total GHG emissions in Indian diets (See Figures 2 and 3).

> "Rice cultivation is source of food and livelihood security for large rural populations of India, but also a threat to sustainable agriculture."

India being the world's second largest rice cultivator, it contributed 18 percent of the global CO2eq emissions from rice cultivation (See Figure 4). The creation of greener climate alternatives for rice cultivation in India is therefore not only important for achieving the country's SDGs, but will also have lasting benefits for the world. Indeed, rice cultivation is a disproportionately large threat to climate action in India, simply because a bulk of these activities take place in environments that are entirely unsuitable.

a CH4 is second in importance to CO_2 as a greenhouse gas

b 82% of rice residue is burned in the field which contributes to significant air pollution in North India.

Table 1: Emission Content of Rice Cultivation in India

Rice Cultivation	Value 2017	Unit
Implied emission factor for CH_4	10.556	g CH_4/m^2
Emissions (CH_4)	4622.3668	gigagrams
Emissions (CO_2eq)	97069.7036	gigagrams

Source: FAO Stat[10]

Figure 2: Proportion of food groups in Indian Diet

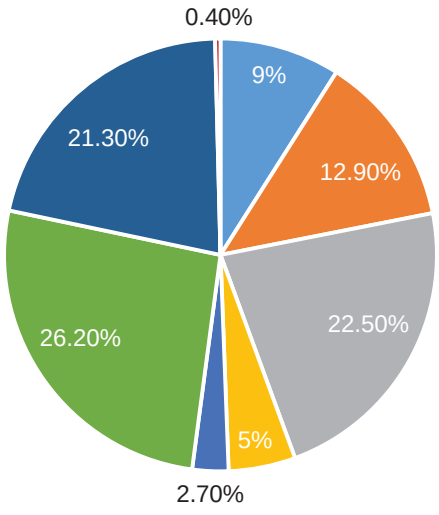
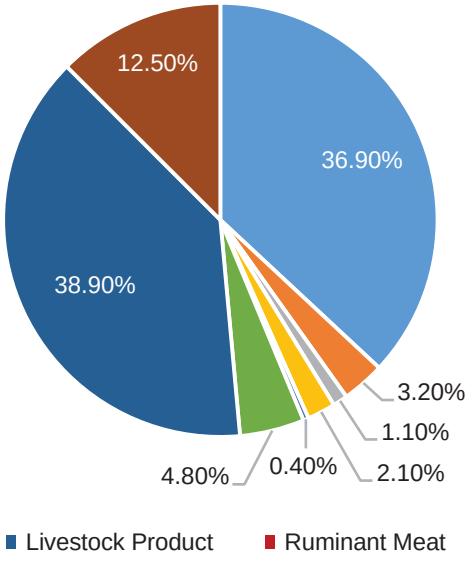
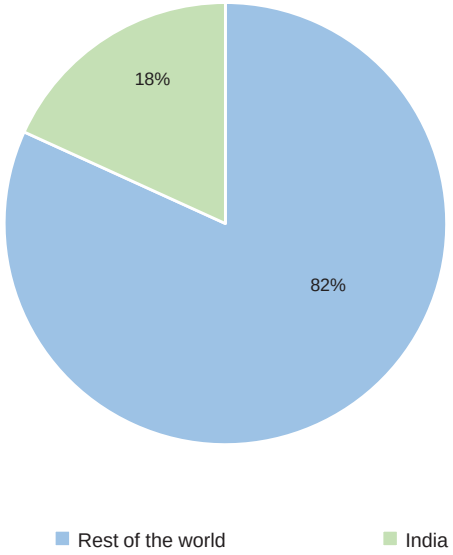


Figure 3: Distribution of GHG emissions of this diet



Source: S.H. Vetter et al., 'Greenhouse gas emissions from agricultural food production to supply Indian diets: Implications for climate change mitigation[11]

Figure 4:
Total CO_2eq emissions from rice cultivation



Source: FAO stat[12]

Much of agricultural GHG emissions in India arise in the primary production stage, through imprudent deployment of farming inputs, residue management, soil disturbance and misguided irrigation strategies employed to improve harvests.[13] In India, rice—a water-intensive crop[c] which ought to be grown in rain-fed areas, is largely cultivated in the semi-arid regions of Punjab, Haryana and Western Uttar Pradesh (See Table 2).[14] However, it was not a mere coincidence that the farmers in these regions that used to be desert-like, started producing a water-hefty crop like rice.

c Producing a kilogram of rice requires an average of 2,800 litres of water. WaterAid India's report, "Beneath the Surface: The State of the World's Water 2019" - https://www.wateraidindia.in/sites/g/files/jkxoof336/files/beneath-the-surface-the-state-of-the-worlds-water-2019_0.pdf.

Table 2:
Rice: Area and Production share to all India in major Rice-Producing States in 2018-19

State	Production % to all India	Area % to all India
West Bengal	13.79	12.61
Uttar Pradesh	13.34	13.12
Punjab	11.01	7.09
Andhra Pradesh	7.08	5.04
Odisha	6.28	8.47
Telangana	5.76	4.46
Chhattisgarh	5.61	8.23
Tamil Nadu	5.54	3.93
Bihar	5.19	7.26
Assam	4.41	5.62
Haryana	3.88	3.30
Madhya Pradesh	3.86	4.52
Others	14.24	16.34
All India	100.00	100.00

Source: Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare[15]

The present unsustainable patterns of rice cultivation in the country are a legacy of the government's procurement policy. The foundation of Green Revolution was laid in a food-scarce India of the early 1960s, which was experiencing an exponential rise in dependence on the US for wheat seeds. The government established the Food Corporation of India (FCI) to procure food grains at MSP from farmers and supply them through the Public Distribution System (PDS) to the consumers while also maintaining a buffer stock. This became India's way to gain self-sufficiency and food security. With a primary focus on rice and wheat, the states of Punjab and Haryana served as home to the green revolution.[16]

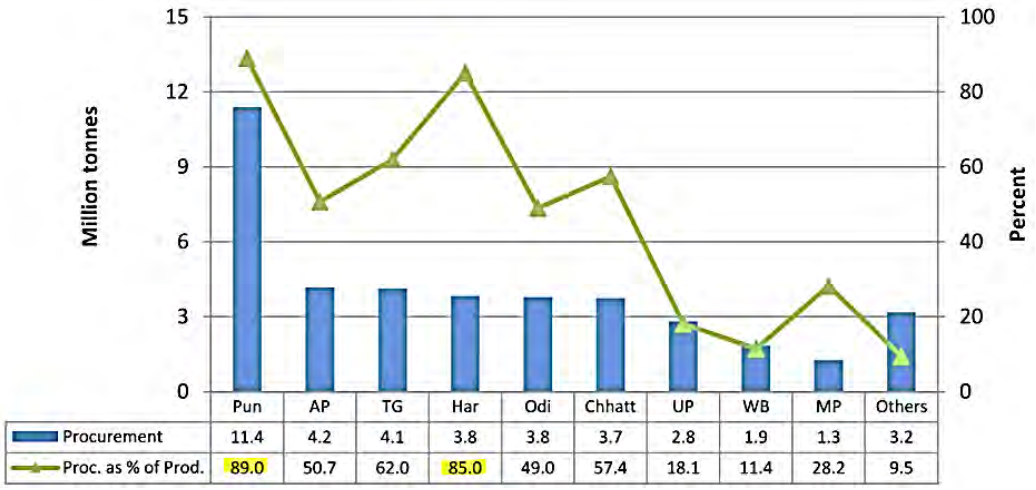
To make these dry regions conducive to rice cultivation, extensive investment in irrigation, assured government procurement, availability of subsidised inputs,[d] and well-functioning mandis, were installed in these states. These incentivised famers to cultivate rice, and eventually India increased its rice production manifold. [17]

> "The procurement system is highly unequal across India."

One could argue that since government procurement policies are applicable across India, the issue of unsustainable rice cultivation in Punjab-Haryana might not necessarily be a consequence of such a system. The truth, however, is that the procurement system is largely unequal across India. For instance, while the produce of 85 and 89 percent of paddy cultivators in Haryana and Punjab, respectively, are procured by the government, only a small proportion of rice farmers in other states benefit from this system (See Figure 5).

d Availability of subsidised fertilisers, free electricity, and seeds

Figure 5:
Procurement of rice in key Rice-Producing States (2018-19)



	Pun	AP	TG	Har	Odi	Chhatt	UP	WB	MP	Others
Procurement	11.4	4.2	4.1	3.8	3.8	3.7	2.8	1.9	1.3	3.2
Proc. as % of Prod.	89.0	50.7	62.0	85.0	49.0	57.4	18.1	11.4	28.2	9.5

Source: Department of Agriculture, Cooperation and Farmers Welfare[18]

The same system of procurement that allowed farmers to do away with price risk and provided income support to them, also facilitated the cultivation of rice in unsuitable areas because of the climate-blind incentives. In time, the production of rice increased many-fold and helped India gain self-sufficiency. However, the absence of checks on sustainability, coupled with the continuous adoption of intensive rice cultivation incentivised by the procurement system, simply added to India's climate woes. Since rice cultivation requires a hefty amount of water that is made available in these states without monitoring, along with free electricity to pump water, India's biggest rice producers—Punjab, Haryana, and western Uttar Pradesh—are experiencing extreme levels of groundwater depletion.[19] These areas are among the world's top water-risk zones for agricultural production.[20]

Furthermore, given the inherent unsuitability of the regions for the cultivation of rice, soil health is also depleting. In Punjab, Haryana, and Western UP, the organic matter content in soil is as low as 0.1 percent.[e] Likewise, the flooding of rice fields has led to waterlogging and salinity; and uncontrolled use of subsidised fertilisers and pesticides has polluted surface and ground waters.[21]

e Soil Organic Matter below 1% is usually found in deserts. Soil Organic Matter ranging between 12-18% is considered organic soil.

The unsustainability of rice production in India's dry regions is therefore actively contributing to the adverse effects of climate change in India in terms of water scarcity, soil depletion and GHG emissions. The direct impact of this climate crisis will seriously hinder rice production.

Rice farming in rain-fed areas faces risks of flooding; in semi-arid regions the production of rice is threatened by the depleting water table. Furthermore, degraded soil and uncertain climate also pose a risk to rice cultivation.[22] Increased temperature, according to research by the Food and Agriculture Organisation (FAO), is already negatively affecting rice yields in some parts of Asia.[23] Occurrence of a similar pattern in India could negatively impact farmers' incomes and push many of them to poverty. The consequential decline in food productivity—as crop production is hindered due to climate crisis—could threaten the nation's food and nutritional security.

> "The unsustainability of rice production in India's dry regions is contributing to the adverse impacts of climate change in the country."

A transition to climate-smart agriculture should encourage a movement away from reliance on rice and towards more feasible and climate-friendly crops. First of these are millets and pulses, which formed a larger proportion of agricultural production in India prior to the green revolution.

The share of pulses production to total food-grain production in India stood at 16.55 percent in 1950-1951 and continued to increase till 1960-61. This share, however, reversed following the green revolution and declined to a mere 6.50 percent by 2015-16.[24] Similarly, the share of millets in total food-grain production of India dropped from 22.17 percent in 1950-51 to 6.94 percent in 2011-12.[25]

> "India should farm more millets and pulses, and transition away from reliance on rice."

As the procurement system incentivised the cultivation of rice and wheat, low remuneration, lack of input subsidies, processing facilities, and price incentives led to declining proportion of pulses and millets. Indeed, even the area under production for millets and pulses dwindled significantly following the green revolution.[26] Today, for every 100-tonne production of food grain in India, rice and wheat account for 91 tonnes, nutri-cereals (millets and sorghum) for 5.5 tonnes, and pulses, 3.5 tonnes. [27]

Table 3:
Area Share of Crop Categories to Gross Cropped Area (In Percent)

Crops	Pre-Green Revolution Period (1960-61 to 1968-69)	Early Green Revolution Period (1968-69 to 1975-76)	Peak Green Revolution Period		Post Reform Period (1995-96 to 2004-05)	Post-Recession Period (2004-05 to 2014-15)
			(1975-76 to 1988-89)	(1988-89 to 1995-96)		
Paddy & Wheat	31.34	33.9	36.04	36.12	37.21	37.27
Nutri-Cereal (Millets)	25.52	21.24	19.79	15.28	14.00	12.67
Pulses	14.73	13.54	13.28	12.41	11.80	12.18

Source: Hindu BusinessLine[28]

While pulses eventually found their way in the procurement system, its market price has stayed below the MSP, and the procurement has also not met targets.[29] While India has started to increase its pulse production, it ends up importing a large proportion of its needs. Given the surplus of pulses in the market, its price falls below MSP; this hurts the producers, discouraging them from growing more pulses.[30] Millets, meanwhile, recently found their way in the procurement system after numerous calls by several agricultural economists and farmers' collectives.[31] However, as consumer preferences shifted to rice given the large PDS in India, demand for millets fell; production declined and so did prices.[32]

Both pulses and millets are climate-smart crops. Millets are extremely suitable for harsh, dry and hot environments, and require little water. They are drought-resistant, require low rainfall, and can grow in infertile soil.[33] Pulses also require significantly less water than rice, and can grow in any season and almost all types of climates. The diversity of pulses makes it adaptable to climate and temperature changes, which is further complemented by their ability to grow in infertile soil or under drought-like conditions.[34]

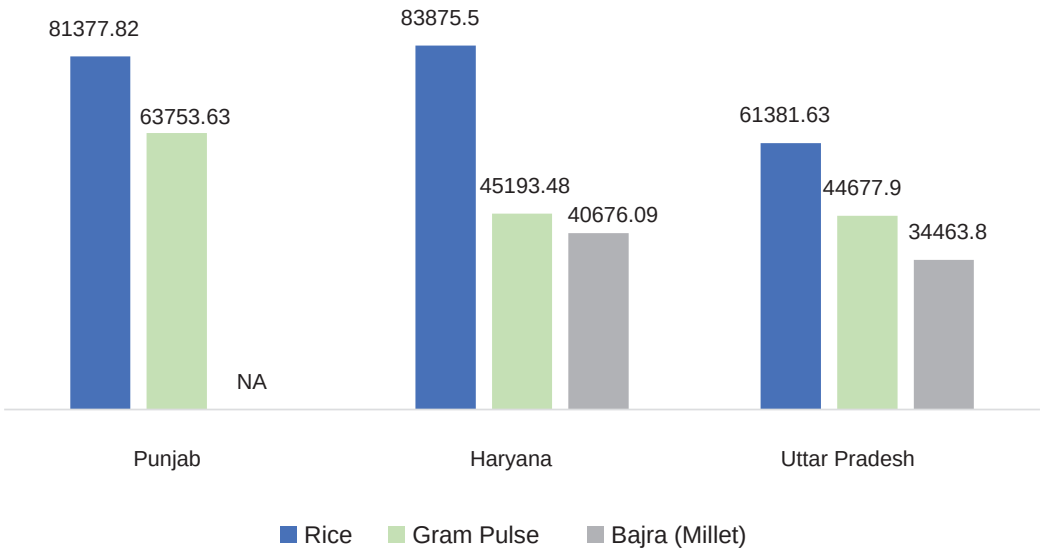
Furthermore, they contribute less GHG emissions as compared to rice. (See Figures 2 and 3)

Moreover, cultivating both millets and pulses helps retain soil health: pulses add the much needed nitrogen, while millets increase the content of organic matter in the soil.[35,36] Additionally, a study conducted in India reported that by replacing rice areas in each district with climate-smart crops like millets and pulses, it will be possible to reduce irrigation requirements by 33 percent and improve the production of protein (+1%), iron (+27%), and zinc (+13%).[37]

The cost of cultivation of pulses and millets is also significantly lower than rice, despite the availability of subsidised inputs for rice cultivation. (See Figure 6).

> “Replacing rice with climate-smart millets and pulses can help reduce irrigation requirements by 33%.”

Figure 6:
Cost of Cultivation of Rice, Gram Pulse and Bajra Millet in selected states in 2017-18. (Rs/hectare)



Source: Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare[38]

Pulses and millets not only require minimal inputs, but they also retain soil health, stabilise water depletion and restrict GHG emissions, making them extremely suitable to grow in the semi-arid, water-scarce regions of Punjab and Haryana. Furthermore, the yields of pulses and millets, if not equal, are greater than that of rice.[39] This would ensure that the country's food security is maintained as it faces the adverse consequences of climate change. Furthermore, switching to highly nutritious climate-smart crops will ensure a greater nutritional security the country[40] – which is presently under threat, as indicated by NFHS-5.[f, 41]

Aware of these potential benefits, the government has been focusing on promoting the production of millets and pulses. Initiatives have ranged from renaming millets to nutri-cereals, to increasing MSPs for these food-grains, and the inclusion of pulses and millets in the National Food Security Mission.[42,43] Prime Minister Narendra Modi has called for the promotion of production and consumption of millets; he has declared 2023 as the 'International Year of Millets'.[g,44] However, despite the increased attention towards the revival of the production of pulses and millets, there has only been a modest improvement owing to the absence of proper accommodating mechanisms.

f There are increased incidences of nutritional insecurity in the country.
g This has also been endorsed by FAO.

Indian farmers are incentivised to produce rice because of an assured demand at a remunerative price. On the other hand, the lack of such demand for millets and pulses has forced a decline in their production over the years. Thus, income support and demand are crucial facilitators for production of any desirable climate-smart crop.

In the absence of an income support system, farmers will be left to the mercy of seasonal changes—further worsened by climate change, which in turn would result in unstable incomes. Furthermore, so far, the assured demand for rice had been a motivator towards its production. But in its absence, farmers would be left without any market signals to indicate what should be produced. Consequently, over-production of one particular crop could result in its overflow in the market, leaving farmers who have little access to markets, with low prices[h] and extra inventory. This problem exists in other food crops (like vegetables) whose prices and stock fluctuate overwhelmingly at times, harming the smallest farmers most of all.[45]

> "Absent assured demand, farmers would be left without market signals to indicate what should be produced."

Moreover, the absence of feasible and accessible processing and storage facilities implies that in most situations, either the processing cost disincentivises growth of some food-grains and/or farmers end up destroying the produce that does not sell. Both these situations end up hurting farmers. It is also the availability of subsidised inputs for one set of food grains over the other that further promotes the production of the former.

There are four pillars that will enable a shift to climate-smart agriculture (See Table 4).

h It should be noted that even in the presence of MSP, farmers often get prices below MSP in the open market.

Table 4:
The Four Attributes of Sustainable Agriculture Planning

Attributes	Mechanisms	Impacts
Sustainable Practises	Shadow Prices of Inputs	Incentivises production of climate-suitable crops.
Income Stability	Income Support	Support against seasonal changes worsened by climate crisis. Balanced flow of revenue to farmers.
Market Signalling Infrastructure	Production as per demand	Restrains over-production of certain goods, ensures price and inventory maintained.
Accessible Enabling Environment	Feasible Storage & Processing Facilities	Cost of cultivation goes down.
	Better Market Access	Easier to sell food-grains.

Source: Author's Own

It begins with sustainable agriculture planning. As noted in the case of rice, the availability of free electricity to pump water in Punjab and Haryana incentivised farmers to cultivate paddy in these dry regions. If, however, the same region, given its suitability to grow millets, was provided easy and feasible access to processing facilities, subsidised inputs and enabling machinery for the transition to millet production, it would motivate farmers in the region to grow millets. Thus, an agriculture policy that integrates sustainable practises (by providing inputs at subsidised rates) that incentivise the production of the crop best suitable for the region will help in a more climate-friendly, just transition.

However, climate-appropriate agriculture planning needs to be supplemented with proper infrastructure to transmit market signals that allow farmers to produce according to market demand. As mentioned earlier, this will ensure that the market does not overflow with one particular food grain and prices do not fall drastically.

Furthermore, an enabling environment will need to be created and expanded to cover the smallest farmers: this includes better market access, and feasible storage and processing facilities. Some sort of income support will also need to be provided to farmers to ensure that they get stable incomes even amidst seasonal changes.

Box 1 presents a brief case study on Karnataka, showcasing how the implementation of these four attributes led to a successful "millet revolution" in the state.[46]

Box 1 – The Millet Revolution in Karnataka

The drought-prone state of Karnataka has made successful efforts in promoting millets through the use of the four attributes outlined in this brief. Having recognised the need for sustainable agriculture planning, the Government of Karnataka established a linkage between farmers growing millets, organised clusters, and consumers, thereby creating market signal infrastructure, and improving market access for farmers. The government has provided financial support and ensured processing of millets is accessible and close to farmlands. The successful implementation of these four attributes has enabled a just transition towards growing climate-smart millets in the region, leading to farmers earning higher incomes.

Recommendations

While it is clear that the unsustainable incentivisation towards production of rice was due to the procurement system and that the procurement system is largely unequal in its reach, it is nevertheless, a powerful tool to drive the transition towards climate-smart crops. A similar procurement system to the one that created an enabling environment which multiplied rice production, could increase the production of pulses and millets. Phasing out procurement of rice and in its stead, creating assured procurement (demand pull) for pulses and millets, at remunerative prices (income support) with subsidised inputs (shadow prices) will ensure a shift to the production of these climate-smart crops, which will aid in India's green transition.

The government could then supply the nutritious, climate-smart food-grains to its citizens utilising its PDS and mid-day meal scheme, thereby ensuring food and nutritional security. Furthermore, if the large population of the country dependent on the PDS and mid-day meal scheme are encouraged to switch their food intake, over time, consumer preferences for pulses and millets could increase, thereby ensuring a continued demand pull in the future as well.

> "India can switch to green agriculture practices using the already developed, if uneven, procurement infrastructure."

Therefore, at least in the short term, it would be better to switch to green agriculture practises with income support and assured demand with the already developed, if uneven, procurement infrastructure. This mechanism will further ensure that the transition would require minimal cost for the farmers. Moreover, in the short run, the government might be able to meet its procurement targets for pulses and millets which in turn, would cause a reduction in the storage cost for overflowing rice.

However, it is true that the procurement cost can only be retained for so long and there is a need to switch to a more robust alternative. Therefore, while sustaining the procurement policy in the short term, deeper networks—which create better market access, infrastructure, storage, and processing facilities—must be established. These in turn will form the fundamentals for a more efficient and inclusive contract-farming architecture that would help farmers in producing as per market demand given climate suitability.

In the long term, as deeper networks are built, the government could switch to contract farming proposals for their PDS and mid-day meals schemes. This will work in a way that will be similar to the procurement system but will essentially help in cultivating support for contract-farming. However, this still leaves the need for income support to farmers to help stabilise their incomes in the long run. As per Gulati et al., a Direct Income Support/per hectare (DIS) system currently in place in Telangana and Karnataka, will be best suitable for stabilising farming incomes in India at a relatively low cost, if tenancy laws were to undergo a reform.[47]

> "Deeper networks for market access, storage and processing should be established."

Conclusion

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Given the quantum of the agricultural sector's contribution to greenhouse gas emissions in India, any movement towards green growth must incorporate the principles of climate-smart agriculture. In turn, taking into account the contribution of rice cultivation to agriculture emissions, any such movement must also incorporate alternatives to improve rice cultivation. The alternatives suggested in this brief are nutrient rich, drought-resistant, and low GHG-emitting pulses and millets.

Despite the knowledge about the benefits of these climate-smart crops, government schemes aiming to promote their production have made little progress owing to the absence of accommodating policies. In the recent months, the massive farmers' protests are a wakeup call that any reforms that do not include substantial income support to farmers will only be met with resistance.

"The farmers' protests are a wakeup call that any reforms which do not include income support will only be met with resistance."

It is therefore important to initiate a new Green Revolution, wherein a just transition towards climate-smart agriculture will incorporate sustainable agriculture planning, provide market signalling and income support, and create an enabling environment through provisioning of processing and storage facilities and better market access. Even as the procurement system can be used for expanding on these networks for a green transition, there must be an effort to shift towards more market-based farming practises with proper income support to farmers through a Direct Income Support system.

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