Policy Paper 48

The Dilemma of Agricultural Price Policy Reforms

Balancing Food Security, Farmers' Interests, and Sustainability of Natural Resources

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Preface

Propelled by advancements in agricultural technology, irrigation expansion, infrastructure development, and incentives such as subsidies on inputs and guaranteed purchase of produce at government-determined prices, India's food system has evolved, transforming the country from a state of food deficit to food surplus. However, this transformation has come at a cost. The incentive structure that contributed to this transformation has now become unsupportive of agricultural sustainability, damaging natural resources, agrobiodiversity, and the environment. This paradoxical situation necessitates a critical examination of current policies and practices. In this study, we evaluated the impact of Minimum Support Prices (MSP), one of the key components of agricultural policy, on crop yields, market prices, farmers' income, and groundwater levels. The findings demonstrate that MSP-based procurement, by mitigating market uncertainties and price risks, and incentivizing production, serves as an income safety net for farming communities.

However, the disproportionate emphasis of the price policy on rice and wheat, which are water-intensive crops, has resulted in a decline in groundwater levels, particularly in intensively cultivated regions. These unintended consequences necessitate a more balanced approach to food system transformation. This study examines the potential of market-based instruments, including price deficiency payments, futures trading, and direct income support, as well as non-market-based instruments, such as targeted procurement, public-private partnerships, crop diversification, and agricultural research, as alternatives to MSP to balance food security, farmers' interests, and conservation of natural resources.

The authors have benefited immensely from the comments and suggestions of various individuals. We gratefully acknowledge their contribution. We sincerely thank Prof. R S Deshpande, retired Director, Institute for Social and Economic Change, Bengaluru, and Mr. Deepak Pareek, Member, Quinquennial Review Team of ICAR-NIAP, for their constructive suggestions, which helped us bringing the study in its present shape.

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Executive Summary

For a long time, the Government of India has intervened in agricultural markets through the Minimum Support Price (MSP) mechanism to protect farmers from market uncertainties and price risks and incentivize them to adopt modern technologies, including high-yielding crop varieties and agrochemicals. This strategy has led to a significant increase in crop yields and food supplies. The production of rice and wheat, the staple food crops, increased from an average of 51.5 million tons in 1966-68 to 77.6 million tons in 1975-77 and further to 239.2 million tons in 2020-22. This not only ensured food security, but also positioned India as a key player in the global food market. Concurrently, the government's procurement of rice and wheat increased from 10.5 million tons during 1975-1977 to 91.1 million tons in 2020-22. This demonstrates the government's commitment to ensuring consumers affordable access to food while ensuring fair prices to farmers for their produce.

However, price policy or, for that matter, agricultural policy has seldom been aligned with the evolving economic trends in domestic and international markets (Acharya et al. 2012) and environmental concerns stemming from the intensive cultivation of staple food crops. Critics have argued that the persistent disproportionate emphasis on rice and wheat has resulted in monocropping, particularly in states such as Punjab and Haryana, causing damage to land and water resources, biodiversity and the environment. This has also exacerbated interpersonal and interregional disparities; larger farmers in irrigated regions specializing in rice and wheat cultivation have benefited more. Furthermore, there are concerns about the rising fiscal burden due to the increasing procurement and distribution of foodgrains. Moreover, India's support for public stockholding has come under scrutiny of some member countries of the World Trade Organization (WTO) because of its being in excess of the permissible limit. [1]

Over the past two decades, the Government of India has undertaken several important steps to reform the markets. The marketing of agricultural produce is regulated by the Agricultural Produce Market Committee (APMC) Act. One of the earliest attempts to reform agricultural markets was the enactment of the Model APMC Act in 2003, which allowed the private sector to source

1 Since 2018, India's rice farmers have been supported beyond the *de minimis* threshold set by the WTO, invoking the Bali Peace Clause, a temporary solution to the issue of public stockholding agreed in the WTO's ministerial conference in Bali in December 2013 until a permanent solution is sought.

agri-commodities directly from farmers through institutional arrangements, such as contract farming.

In September 2020, the Government of India enacted three farm laws: (i) The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, (ii) The Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Service Act, and (iii) The Essential Commodities (Amendment) Act, with the aim of enhancing competition in agri-food markets and improving farmers' bargaining power in the marketplace. Fearing that these Acts might end the MSP regime, putting them at a disadvantage in the marketplace, farmers protested, and these were subsequently repealed in November 2021.

MSP is considered as a safeguard by farmers against market uncertainties and price risks; hence, farmer organizations have started demanding legal recognition. However, its legalization may (i) place a heavy fiscal burden on the exchequer if open market prices of commodities during crop procurement seasons remain below their MSP; (ii) encourage the overproduction of more profitable but water-guzzling crops, such as rice, causing further damage to natural resources, biodiversity, and the environment; (iii) require massive investment in infrastructure for procurement and storage of large volumes of grains; (iv) discourage private investment in agri-infrastructure and value chains; and (v) lead to disputes in the WTO for its trade with its probable trade-distortionary effects.

Reforming the agricultural marketing system and price policy is a significant challenge because of the involvement of multiple stakeholders from upstream to downstream of agri-food value chains with diverse and often conflicting interests. Consequently, policymakers face the complex task of balancing economic, social, and environmental considerations.

Using household-level data from the Situation Assessment Survey of Agricultural Households 2018-19 (hereafter, referred to as SASAH), conducted by the National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India, on production and disposal patterns of rice and wheat, the main crops procured by the government at the MSP, this study has examined the effectiveness and inclusiveness of the MSP-backed procurement system. The insights gained from this study provide feedback for reforming agricultural marketing systems and restructuring agricultural price policy. The key findings are as follows:

Agriculture is gradually becoming marker-oriented: Indian agriculture has undergone a significant transformation from subsistence to commercialization, as evidenced in the volume of marketable surplus of rice and wheat. More than half (55.0% paddy and 50.9% wheat) of the farmers sell approximately two-thirds of their produce (66.7% paddy and 63.1% wheat). The government procurement of these crops at the MSP substantiates this observation.

Market-orientation of agriculture is directly related to farm size: Agriculture is dominated by landholdings not exceeding one hectare in size. Overall, approximately 49.2% of farmers cultivating paddy and 41.6% of farmers cultivating wheat sell 62.7% and 56.5% of these crops, respectively. However, farmers with large landholdings (>4 ha) produce a substantial surplus of these crops. Approximately 90% of the large farmers sell 80% of their produce.

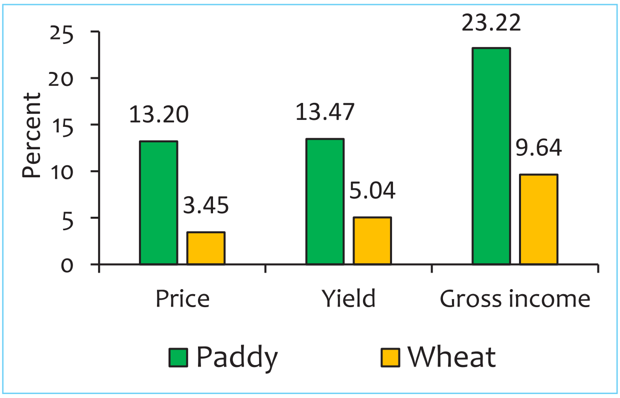
Outreach of MSP-backed procurement system is limited: Only a small proportion of farmers producing surplus grains participate in the MSP-backed procurement system. Specifically, only 15.0% of paddy farmers and an even smaller 9.6% of wheat farmers having their marketable surplus dispose of 23.7% and 20.8% of it at the MSP, respectively.

Participation in MSP-backed procurement system is directly proportional to farm size: Large farmers have a higher engagement with the MSP-backed procurement system - 31.3% of paddy farmers and 23.5% of wheat farmers who participate in the market dispose of 37.8% of their marketable surplus of paddy and 29.8% of wheat at the MSP. In contrast, small farmers have significantly lower participation rate. Only 10.5% and 4.5% of marginal farmers selling paddy and wheat, respectively, participate in the MSP-backed procurement system, disposing of 12.6% surplus paddy and 7.3% surplus wheat.

MSP safeguards farmers from price risks: Price realization from sales in open markets is lower than that of MSP. The estimated gap is 13.2% for paddy and 3.5% for wheat (Figure 1). An overtime comparison of their farm harvest prices and MSP also suggests the same.

MSP incentivizes farmers to produce more: MSP incentivizes farmers to adopt modern agricultural technologies, such as improved seeds and fertilizers, resulting in higher crop yields. This is evident from our findings. Farmers engaged in the MSP-backed procurement system could realize a 13.5% higher yield of paddy and a 5.0% higher yield of wheat (Figure 1).

Figure 1. Price, yield, and income effects of MSP



Source: Estimated by authors using data from GoI (2021)

Thus, by reducing market uncertainty and price risk and contributing to yield enhancement, the MSP-backed procurement system could result in a 23.2%

higher income from paddy cultivation and 9.6% from wheat cultivation.

Increasing procurement of rice and wheat results in a decline in groundwater level: While MSP-backed procurement provides substantial economic benefits to farmers, this, in conjunction with input subsidies, has resulted in unintended environmental consequences for groundwater. Our findings indicate that the procurement of rice and wheat has resulted in a decline in groundwater levels.

The political economy of agricultural incentives is complex, as their withdrawal, once provided, is challenging due to resistance from farmer lobbies and politicians. Nevertheless, given their crucial role in farmers' welfare, but negative externalities for natural resources, it is imperative to explore strategies that strike a balance among conflicting objectives. Considering this, we suggest the following market reforms.

Consider upscaling of price deficiency payment scheme: If the price in the open market falls below the MSP, the government may compensate farmers for this difference. By reducing the need for the government to procure crops, this approach has the potential to lead to a more efficient allocation of resources and lower storage costs. Farmers may also respond more effectively to market signals and diversify their crop portfolios.

However, there is the possibility of moral hazard in this scheme. Farmers may potentially sell substandard produce and buyers may engage in price manipulation. To make the scheme effective, it is crucial to improve transparency in transactions by creating infrastructure for quality assessment and setting limits on the difference between MSP and market prices.

Effectively incentivize private sector for procurement operations: Through the Pilot of Private Procurement & Stockist Scheme (PPPS), a component of the *Pradhan Mantri Annadata Aay SanraksHan Abhiyan* (PM-ASHAA), started in 2018, the Government of India authorized states to engage private sector for procurement of farm produce (mainly oilseeds) at the MSP from registered farmers in the notified areas during the notified period when open market prices rule below the MSP. Private procurement agencies bear all expenses (i.e., handling, storage, distribution, and transit losses), and in lieu of this, the government provides 15% of the MSP as a service charge. In addition, states are required to exempt such procurement from market fees.

The service charge offered under the PPPS is deemed low compared to incidental charges of 16.6% and 12.7% of the pooled costs of rice and wheat, respectively, in the existing procurement system. Further, the reluctance of states to exempt procurement from market fees complicates the implementation of the PPPS. These challenges underscore the need for a comprehensive review of the PPPS to address its shortcomings and enhance its effectiveness.

Effectively implement decentralized procurement: The scheme for the decentralized procurement of grains has been operational for long. However, only a few states, namely, Chhattisgarh, Odisha, and Madhya Pradesh, have successfully implemented it. Hence, it is suggested that the central government restricts the procurement of foodgrains to the requirements of strategic reserves and encourages states to procure grains to meet the requirements of the public distribution system (PDS) and other welfare schemes. Furthermore, states should be encouraged to engage in interstate trade of foodgrains.

Target smallholder farmers for procurement: The current procurement system is open-ended, wherein farmers can sell any quantity of grains to government agencies at the MSP. Expectedly, larger farmers benefit more because of their larger scale. The government may target grain procurement from smallholders who produce in excess of their consumption requirements, but have significantly less participation in the MSP-backed procurement system. Our findings show that small farmers (< 2 ha) produce 53.6% of the paddy and sell nearly half of it. The corresponding figures for wheat are 45.0% and 39.9%, respectively. It is worth noting that small farmers contribute more than one-third to the government's paddy procurement and one-fourth to wheat procurement. Prioritizing procurement from marginal and small farmers ensures equity in MSP policy.

Explore futures trading for price risk management: Futures contracts can serve as an instrument for mitigating market uncertainty and price risks. However, farmers' participation in futures markets is constrained by their scale. This limitation can be overcome if farmers collectively participate in the futures market through Farmer Producer Organizations (FPOs) and cooperatives. Futures trading enables the sale of produce at the exchange at a predetermined price by paying a fixed premium. They have the option to sell in the spot market if the open market price increases above the contracted price during the locked-in period by forfeiting the premium. However, farmers are risk averse and reluctant to pay premium. The government may consider subsidizing premiums given the significantly higher incidental charges associated with the current grain procurement system.

Moreover, a long-term policy for agricultural commodity derivatives is essential for efficient functioning of the futures market. A well-regulated futures market can also facilitate transparent price discovery. Of equal importance is the capacity building of farmers in futures trading and risk management, as the majority of them lack the requisite knowledge and skills to hedge price risks.

Provide direct income support: Subject to WTO's domestic support disciplines, India can provide unlimited support to farmers if it is not coupled with current levels of production or prices. Such payments fall in the Green Box and are considered minimal or non-distorting of the global markets. Payments coupled with production or prices are subject to production-limiting conditions and fall in the Blue Box, where unlimited support can be provided, similar to that in the Green Box. Coupled support without production-limiting conditions falls in the Amber Box; hence, India cannot exceed the *de minimis* limit of 10% of the value of the commodity. Therefore, it is essential for governments to appropriately design agricultural schemes that are compatible with the Green or Blue Box criteria.

Crop diversification: Crop diversification offers multiple benefits. This strategy enhances farmers' income, ensures food and nutritional security, reduces dependence on imports of certain commodities, such as pulses and oilseeds, and promotes ecological balance. The shift in dietary preferences towards a more diverse range of foods further underscores its significance as it aligns production with evolving consumer demand. Effective crop diversification requires the consideration of both ecological and economic factors. Development of area-specific crop plans based on natural resource endowments is essential. However, these plans may remain unimplemented if the suggested alternative crops are not as remunerative as the existing crops. This underscores the need to provide monetary support to farmers to mitigate potential income losses during the transition period.

Invest in maintenance of canal irrigation systems: A comprehensive irrigation water management strategy is imperative to mitigate the adverse effects of agricultural incentives on groundwater resources. This strategy should prioritize investment in the maintenance of canal irrigation systems and promote the conjunctive use of water. Additionally, micro-irrigation schemes should focus on precision irrigation components that have the potential to save water.

Revisiting the agricultural research agenda: India is self-sufficient in staple foods; therefore, it is imperative to reassess research priorities, emphasizing oilseeds, pulses, millets, and fiber crops to improve their yields, thereby enabling these crops to compete with rice and wheat. This reorientation is particularly crucial, given India's current dependence on edible oil and pulse imports. The country imports approximately 60% of its edible oil and 10% of its pulse requirements. However, this transition must be carefully managed to balance the need for increased domestic production with a strategic import policy that safeguards the interests of farmers.

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1 Introduction

Markets play a crucial role in shaping agri-food systems. By aggregating demand and supply, markets influence prices, which in turn alter the constraints and incentives for various stakeholders on the value chain, including farmers, traders, processors, distributors, and consumers (Barrett et al. 2022). However, agricultural marketing systems in most developing countries are imperfect because of inadequate infrastructure for transportation, storage, and processing; asymmetric information on trade flows and prices; and a lack of institutional and regulatory frameworks (de Janvry et al. 1991; Dorward et al. 2004; Meenakshi and Banerjee 2005; Chamberlin and Jayne 2013; Shiferaw et al. 2011; Negi et al. 2018). Market imperfections cause inefficiencies in the supply chain, resulting in higher trade costs and price margins that negatively impact producers and consumers.

The repercussions of market inefficiency are particularly pronounced for smallholders with small marketable surpluses, the sale of which is economically unfeasible in distant urban markets because of higher transportation costs (Joshi et al. 2006). Furthermore, the interconnectedness of products, inputs, and credit market transactions is common in smallholder agriculture. When institutional finance is limited or inaccessible, these farmers rely on informal sources, such as traders, commission agents, and input dealers, for their operational needs. Such arrangements provide immediate solutions but at a cost. These typically involve inflated input prices, high interest rates on credit, and below-market prices for produce (Babu et al. 2011; Negi et al. 2018). For instance, Negi et al. (2018) estimated 7-13% lower prices from sale of staple food crops in informal markets than in regulated markets. This difference is more significant in the case of interlinked transactions. Market imperfections also influence farmers' decisions regarding crop choices, production techniques, and farm investments.

Since the beginning of the Green Revolution in the mid-1960s, the Government of India has undertaken several initiatives to improve its agricultural marketing systems. In 1965, the Agricultural Prices Commission (APC) was established to determine the production costs of food and non-food crops and subsequently recommend their Minimum Support Prices (MSP) for procurement by the government for public distribution system and building buffer stocks to manage probable food insecurity risks arising from crop failures and supply chain disruptions due to pandemics and geopolitical tensions. The government assures the procurement of crops at the MSP if their prices in the open market fall below the MSP. Thus, MSP serves as a potential safeguard against market and price risks.

This price support mechanism, in tandem with technology and other initiatives, has led to significant increase in foodgrain production. By the late 1980s, the country had become almost self-sufficient in rice and wheat. Their production increased from an average of 51.5 million tons in 1966-68 to 106.3 million tons in 1985-87 and further to 239.2 million tons in 2020-22. Simultaneously, government purchases of these grains have increased substantially. During 2020-22, the government procured an average of 57.4 million tons of rice and 33.7 million tons of wheat, equivalent to 44.2% and 30.9% of their respective production levels.

Nevertheless, the pricing strategy remained unchanged, failing to adapt to evolving trends in domestic and international markets and the environmental challenges resulting from the intensification of agriculture. It is often argued that the price policy has fulfilled its intended purpose and has now become unsupportive of sustainable production patterns. It has predominantly focused on rice and wheat (Devneni et al. 2022; Chatterjee et al. 2024, Kishore et al. 2024). In Punjab and Haryana, the share of rice and wheat in the gross cropped area has increased to 72.3% in 2022-23 from 38.4% in 1970-71. Their cultivation, especially that of paddy, is highly water-intensive and has become increasingly reliant on groundwater. A stark example is the alarming 8.3 meter decline in groundwater level in Punjab and Haryana since 1996 (Kishore et al. 2024). This policy has also prompted the increased use of agrochemicals, causing the qualitative deterioration of natural resources, biodiversity, and the environment. Moreover, the procurement of grains has acted as a disincentive for crop diversification, even in favor of high-value crops such as fruits and vegetables (Negi et al. 2018). Morales et al. (2021) have also reported similar findings.

The cereal-centric price policy has also been reported as an important reason for regional imbalances in agricultural development. Irrigated regions specializing in rice and wheat have benefited more, leaving behind rainfed regions dominated by the cultivation of coarse cereals, pulses, and oilseeds. Furthermore, because crop sales are directly related to farm size, larger farmers benefit more from the price policy (Deininger et al. 2017). Chand and Singh (2023) showed that cereal-centric policies, including MSP and input subsidies, have ceased to contribute to agricultural growth.

Furthermore, concerns have emerged regarding the escalating fiscal burden due to the increasing foodgrain procurement and distribution. The economic cost associated with these mechanisms is 1.3 times the expenditure on price payments to farmers. Furthermore, the government has been distributing foodgrains at substantially subsidized prices — in 2022-23, the food subsidy amounted to Rs 34.92 per kilogram of rice and Rs 21.31 per kilogram of wheat. In 2022-23, expenditure on food subsidies amounted to Rs 2728 billion.

Government intervention in the agricultural and food markets is also claimed to have discouraged private sector investments in value chains and agro-processing (Ganesh-Kumar et al. 2007), which is essential for the diversification and commercialization of agriculture. Moreover, India's public stockholding has attracted scrutiny from the WTO. Since 2018-19, product-specific support for rice has exceeded the *de minimis* limit of 10% of its value, prompting India to invoke the Bali Peace Clause to continue supporting rice farmers (Sharma and Shajahan 2024).

India began to focus on economic reforms in the early 1990s. However, reforms in the agricultural sector followed a decade later. In 2003, the Government of India enacted The Model APMC Act (GoI 2003), allowing private agribusinesses to purchase farm produce directly from farmers through arrangements such as contract farming. As agriculture falls within the jurisdiction of states, the implementation of the Act was left for states, with some partially implementing it and others not. In 2018, the government enacted 'The Agricultural Produce and Livestock Contract Farming and Services (Promotion & Facilitation) Act'. This Act excluded contract farming from the scope of the APMC Act, guaranteed offtake of the contracted produce at a pre-agreed price, and provided insurance for the contracted produce (GoI 2018). Similar to the Model Act 2003, this Act was promotional and facilitative.

In September 2020, the Government of India enacted three legislations: (i) The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, (ii) The Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Service Act, and (iii) The Essential Commodities (Amendment) Act, with the objective of enhancing competition in agri-food markets, ensuring remunerative prices for farmers, and improving their bargaining power. However, farmers feared that their implementation may lead to the end of the MSP-backed procurement system and put them at a disadvantage in the marketplace. They protested against these Acts at the borders of the national capital city of Delhi for over a year. In November 2021, the government decided to repeal these Acts.

The MSP is considered as an income safety net by farmers. Hence, farmer organizations have now started demanding legal status for it. Legalizing MSP, however, can have several implications: (i) it could place a financial burden on the government if market prices are below MSP during the harvest seasons; (ii) it would require substantial investments in procurement and storage facilities; (iii) it might encourage excessive production of profitable but water-intensive crops, such as rice, further damaging water resources; (iv) it could discourage private sector participation in agricultural markets; and (v) it may result in non-compliance with the domestic support disciplines enshrined in the Agreement on Agriculture of the WTO.

While the challenges are significant, they underscore the necessity of a comprehensive approach to agricultural policy reform that navigates a delicate balance among the often-conflicting objectives of enhancing food security, improving farmers' income, and conserving natural resources.

There is a lack of empirical evidence regarding the effects of price policy or MSP on farmers' welfare and natural resources. Deshpande and Naika (2002), based on their research in Karnataka, reported that the MSP has altered the cropping pattern in favor of paddy at the expense of less-remunerative crops such as coarse cereals, pulses, and oilseeds. Furthermore, they noted a positive association between MSP and fertilizer use, but this did not translate into higher crop yield. Ali et al. (2012) observed that MSP is more effective in regions with surplus production. The effectiveness of MSP appears to vary not only by region but also by farm size. Larger farmers are more likely to participate in an MSP-backed procurement system (Joshi et al. 2006; Birthal et al. 2014; Deininger et al. 2017). The combination of price support and input subsidies (e.g., fertilizer and electricity) has resulted in unintended consequences for natural resources, particularly groundwater (Kishore et al. 2024), and the environment.

Recent studies have demonstrated that when agricultural markets are characterized by monopsony and limited spatial integration, MSP serves as an income safety net for farmers (Chatterjee et al. 2024). Misra and Basu (2022) evaluated the impact of market reforms that allowed private agribusinesses to purchase produce directly from farmers, and showed that market reforms help farmers obtain better prices outside regulated markets when supported by MSP-backed procurement system.

The outreach of MSP-based procurement system has also been a subject of debate. According to data from the Situation Assessment Survey of Agricultural Households, 2012-13, only 6% of farm households reportedly benefited from

MSP (GoI 2014). However, when calculated as the proportion of farmers who sold their produce, the participation rate was slightly higher.

This study utilizes comprehensive household-level data from the Situation Assessment Survey of Agricultural Households 2018-19 (GoI 2021) to evaluate the outreach, inclusiveness, and effectiveness of the price policy. This examines the following questions:

- To what extent do minimum support prices influence open market prices?
- Does the procurement of crops at the MSP incentivize farmers to produce more?
- What is the extent of the outreach of the MSP-backed procurement system?
- Does MSP-based procurement adversely affect the sustainability of natural resources?
- What kinds of reforms in markets and price policy can balance the interests of different stakeholders?

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2 An Overview of Agricultural Price Policy

India's agricultural development strategy is based on four main pillars: (i) technology, (ii) investment in irrigation and other infrastructure, (iii) incentives to farmers in the form of input subsidies, and (iv) procurement of foodgrains from farmers at government-determined MSP.

Agricultural policy started taking shape during the 1960s when the country struggled to increase foodgrain production to feed its growing population. In the early 1960s, the Government of India implemented several programs, such as the Intensive Agricultural Development Program and the Intensive Area Development Program, to increase foodgrain production. However, these efforts fell short of their intended goals because of a lack of adequate institutional and market support.

Rajkrishna (1963) demonstrated that prices can incentivize foodgrain production. Recognizing their importance, the Government of India constituted a committee under the chairmanship of Mr. L. K. Jha, Secretary, to the Prime Minister of India, to advise the Ministry of Food and Agriculture (now the Ministry of Agriculture and Farmers Welfare) to determine the fair prices of staple food crops (i.e., paddy and wheat) in a manner that can protect the interests of producers and consumers. Based on its recommendations, the government established the Agricultural Prices Commission (APC) in the Ministry of Food and Agriculture in 1965 with a mandate to evolve *"a balanced and integrated price structure from the perspective of the overall needs of the economy and with due regard to the interests of the producer and the consumer"* (GoI 1965).

The establishment of the APC recognized the critical role of prices in agricultural development. The Commission evolved a comprehensive agricultural price policy that aimed to protect farmers from price fluctuations and incentivize them to adopt modern technologies while ensuring consumers' affordable access to staple grains. The price policy comprised the following components: (i) fixing MSP of major foodgrains, (ii) purchasing surplus foodgrains from farmers at MSP or procurement price[2], (iii) distributing grains to poor consumers through

[2] In the initial phase of price policy, the MSP was declared prior to planting or sowing season, and announced the procurement price after the harvest. However, this approach is no longer followed.

public distribution system (PDS), (iv) building buffer stocks for exigencies due to crop failures and supply chain disruptions, and (v) restricting inter-zonal movements of foodgrains to manage supply and demand effectively.

The Commission used the cost of production approach to determine MSP but also considered other factors, such as demand and supply of commodities, their prevailing market prices in domestic and international markets, prices of inputs, production risks, cost-of-living index, and general price index.

In 1979, the Government of India constituted a Committee under the chairmanship of Mr. S. R. Sen to review the structure of the Agricultural Prices Commission and the methodology for determining MSP. On its recommendations, the APC was renamed as the 'Commission for Agricultural Costs and Prices' (CACP) with the renewed terms of reference. These included: (i) (a) the need to provide incentives to producers for adopting improved technology and for evolving a production pattern broadly in the light of national requirements, (b) the need to ensure rational utilization of land, water, and other production resources, and (c) the likely effect of the price policy on the rest of the economy, particularly on the cost of living, level of wages, industrial cost structure, etc.; (ii) to suggest non-price measures to facilitate the achievement of the objectives, (iii) to recommend from time to time in respect of different agricultural commodities, measures necessary to make the price policy effective, (iv) to consider the changes in terms of trade between agricultural and non-agricultural sectors, (v) to examine, where necessary, the prevailing methods and cost of marketing of agricultural commodities in different regions, suggest measures to reduce costs of marketing and recommend fair price margins for different stages of marketing, and (vi) to review the developing price situation to make appropriate recommendations, as and when necessary, within the framework of the overall price policy.

In 1986, a long-term perspective for agricultural price policy was presented in the Parliament, emphasizing the necessity to consider major factors that influence the prices of agricultural commodities and the farm sector's vibrancy, productivity, and cost-effectiveness (see GoI 1986; Acharya 1997; GoI 2002). Subsequently, a Committee was constituted in 1990 under the chairmanship of Prof. C. H. Hanumantha Rao to review the methodology of cost of production, especially regarding the valuation of labor, imputed cost of family labor, and managerial cost (GoI 1990). The Committee proposed that labor input should be valued at the actual wage rate and that family labor should be valued at the wage rate for casual labor. It also recommended that 10% of the total production cost should be incorporated as a managerial cost in arriving at the MSP. These recommendations provided a scientific basis for determining the cost of crop production and minimum support price.

In 2002-03, India faced a severe drought, which significantly affected the agricultural and rural economy and the livelihoods of farmers and consumers. Recognizing the severity of the situation, the Government of India constituted the National Commission on Farmers in 2004 under the chairmanship of Dr. M.S. Swaminathan to suggest: (i) a medium-term strategy for food and nutrition security to move towards the goal of universal food security, (ii) ways and means of enhancing productivity, profitability, and sustainability of the major farming systems, (iii) policy reforms to substantially increase the flow of rural credit, ensuring its inclusiveness, (iv) special programs for dryland farming in the arid, semi-arid regions, hilly and coastal regions, (v) enhancing the quality and cost competitiveness of farm commodities as to make them globally competitive, (vi) protecting farmers from imports when international prices fall sharply, and (vii) empowering elected bodies to conserve and improve the ecological foundations for sustainable agriculture effectively.

Among several of the recommendations of this Commission, those pertaining to agricultural prices include: (i) improving the implementation of the MSP, (ii) making arrangements for the procurement of crops other than paddy and wheat, and (iii) fixing the MSP of all crops at least 50% higher than their respective weighted average cost of production. In response to these recommendations, from 2018 onward, the government started fixing the MSP of all notified crops at least 50% higher than the cost of production (i.e., Cost A_2 + imputed cost of family labor).[3] Furthermore, it started diversifying the procurement portfolio to include millets, pulses, and oilseeds under the *Pradhan Mantri Annadata Aay SanraksHan Abhiyan* (PM-ASHAA).

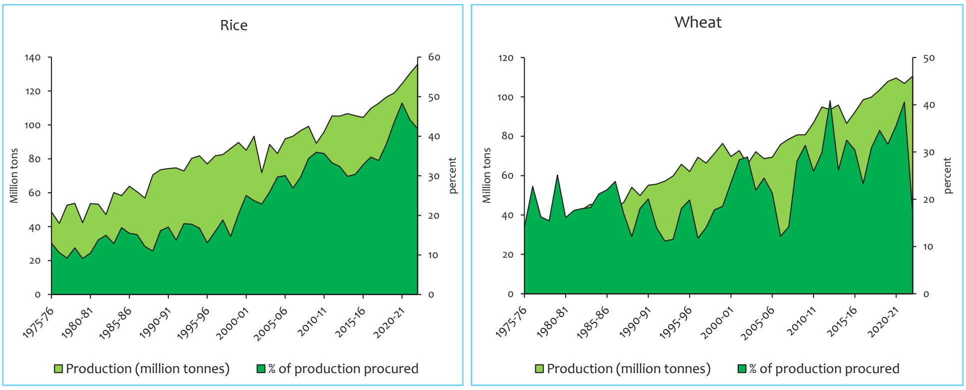
The CACP recommends MSP for 23 crops: seven cereals (i.e., paddy, wheat, maize, sorghum, pearl millet, barley, and ragi), five pulses (i.e., gram, pigeon pea, green gram, black gram, and lentil), seven oilseeds (i.e., groundnut, rapeseed-mustard, soybean, sesamum, sunflower, safflower, and niger-seed), and four commercial crops (i.e., copra, sugarcane, cotton, and raw jute). The price policy is implemented through government parastatals. Cereals are procured by the Food Corporation of India (FCI), pulses and oilseeds by the National Agricultural Marketing Federation Ltd. (NAFED), cotton by the Cotton Corporation of India Ltd. (CCI), jute by the Jute Corporation of India Ltd. (JCI), and copra by NAFED and the National Cooperative Consumers Federation (NCCF) at their pre-announced MSP. Sugarcane is procured by sugar mills at the government-determined Fair and Remunerative Price (FRP). Some major sugarcane-producing states also announce their own sugarcane

[3] Cost A_2 includes actual all expenses in cash and kind in production by the farmers such as cost of hired labour, machine, seed, fertilizer, manure, pesticides, irrigation, interest on working capital, depreciation on machines, land revenue, miscellaneous expenses and rent paid for leased-in land.

prices, termed as the State Advised Price (SAP), which is higher than the FRP. Sugarcane pricing has statutory backing under the Sugarcane (Control) Order of 1966 of the Essential Commodities Act of 1955.

The price support mechanism, together with technology and other initiatives, has turned India from a food deficit to a food surplus country. During 2020-22, the government procured 44% of the total output of rice and 31% of that of wheat (Figure 2).

Figure 2. Production and procurement of rice and wheat



Source: Production (GoI, various years, a), and procurement (GoI, various years, b)

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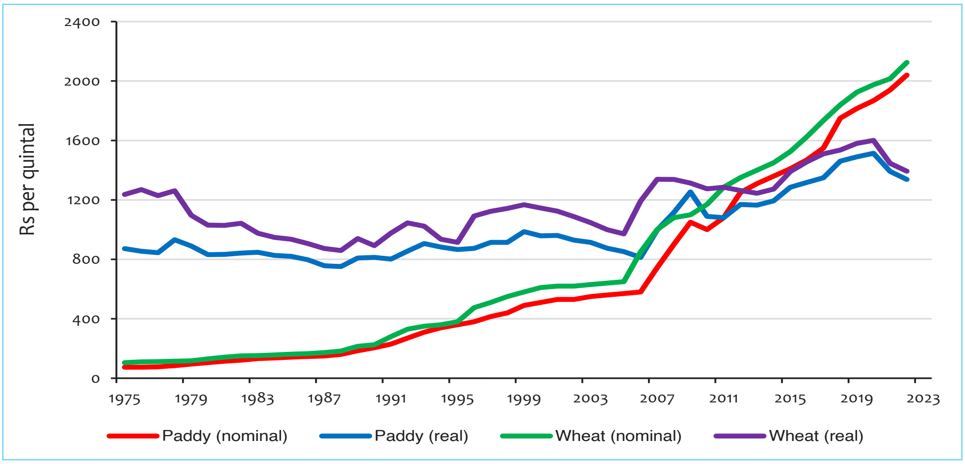
3 MSP, Production, and Procurement

This chapter examines (i) How has the MSP-backed procurement system has evolved over time and (ii) whether it has served as a price floor, preventing market prices from falling and protecting farmers from price risks. Understanding these patterns and their underlying causes is essential for policymakers to refine the price-support mechanism, improve its implementation, and develop complementary policies that can effectively support farmers, while promoting sustainable agricultural practices and balanced crop production.

3.1 Trends in minimum support prices

Figure 3 illustrates the trends in the nominal and inflation-adjusted (at 2011-12 prices)[4] MSP for paddy and wheat. In nominal terms, the MSP of both crops increased substantially. However, the inflation-adjusted MSP shows significant patterns. For both crops, it declined until 1988. This was followed by intermittent fluctuations over the next decade, coinciding with the initial phase of the economic reform process that commenced in 1991. Subsequently, it declined continuously until 2005-06. However, it experienced a significant increase in 2007-08, and subsequently remained relatively stable until 2013-2014. Thereafter, it has demonstrated a consistent upward trend until 2020-21.

Figure 3. Trends in minimum support prices



Source: GoI (various years, a).

[4] The nominal prices were deflated by wholesale price index.

3.2 Trends in production and procurement

Table 1 presents the trends in the production and procurement of rice and wheat. Rice production increased from an average of 47.78 million tons in 1975-77 to 129.87 million tons in 2020-22 at an annual growth of 2.06% (Table 1). During this period, wheat production increased annually by 2.69%, from 29.87 million tons to 108.10 million tons. Yield improvement was the primary factor in the growth of both crops. Rice yield increased 2.3 times, from 1211 kg/ha in 1975-77 to 2749 kg/ha in 2020-22, and wheat 2.4 times, from 1426kg/ha to 3489kg/ha. Nevertheless, yield growth has decelerated significantly over the past two decades, thereby dragging production growth.

As production increased, government purchases of rice and wheat at MSP also increased substantially. The proportion of rice output procured rose from 11% in 1975-77 to 44% in 2020-22, while that of wheat nearly doubled from 18% to 31%. Notably, growth in the procurement of both crops exceeded their respective growth in production. This indicates that MSP could stimulate growth in foodgrain production, particularly during the first three decades of the Green Revolution.

Table 1. Growth in production and procurement

	Rice				Wheat			
	Area (mha)	**Production (million tons)**	**Yield (kg/ha)**	**Procurement (million tons)**	**Area (mha)**	**Production (million tons)**	**Yield (kg/ha)**	**Procurement (million tons)**
				Quantity				
TE1975-77	39.42	47.78	1210.67	5.20	20.94	29.87	1425.67	5.27
TE1998-00	44.89	86.91	1936.00	17.37	26.91	72.45	2692.00	14.38
TE2020-22	45.27	129.87	2749.33	57.36	30.99	108.99	3489.33	33.71
				Growth (%)				
1975-2000	0.52	2.93	2.40	5.32	0.93	3.86	2.90	2.89
2001-2022	0.06	1.92	1.80	4.58	1.00	2.45	1.44	4.81
1975-2022	0.26	2.06	1.80	5.44	0.85	2.69	1.83	4.31

Source: Area, Production, yield (GoI, various years, a), and procurement (GoI, various years, b).

Over the past two decades, spatial patterns of procurement have changed significantly. Expectedly, Punjab maintained its position as the main contributor to the central grain pool, but its share in procurement declined (Table 2). In

1998-2000, Punjab contributed approximately 35% to the rice pool, which declined to 22% by 2020-22. Andhra Pradesh followed closely, but its share has declined from 34% to 21%. Note that the share of both states in total rice production remained almost unchanged. During this period, Chhattisgarh experienced an increase in its share of procurement from 4.9% to 9.8% and Odisha doubled from 4.4% to 8.9%.

Table 2. Spatial distribution of production and procurement

States	% share in production		% of production procured		% share in procurement	
	TE1998-2000	TE2020-22	TE1998-2000	TE2020-22	TE1998-2000	TE2000-22
			Rice			
Punjab	9.90	9.92	70.45	99.17	34.96	22.28
Haryana	2.95	3.54	35.93	83.17	5.32	6.67
Uttar Pradesh	13.92	12.05	9.54	28.25	6.66	7.71
Andhra Pradesh	13.41	15.86	50.87	58.27	34.21	20.93
Madhya Pradesh	4.76	4.17	13.76	53.35	3.29	5.04
Orissa	5.83	6.76	15.06	58.71	4.40	8.99
Tamil Nadu	8.84	5.74	14.53	32.35	6.44	4.20
West Bengal	15.15	12.51	2.34	13.28	1.78	3.76
Chhattisgarh	2.73	6.42	36.17	67.19	4.94	9.76
Others	24.33	23.03	1.07	20.46	1.30	10.67
All-India	100.00	100.00	19.95	44.17	100.00	100.00
			Wheat			
Punjab	21.13	14.89	50.96	72.87	52.49	35.18
Uttar Pradesh	34.33	31.43	6.63	9.27	11.10	9.45
Haryana	12.83	10.30	41.33	59.46	25.85	19.86
Madhya Pradesh	10.07	19.49	6.50	47.52	3.19	30.02
Rajasthan	8.82	9.69	9.62	14.40	4.13	4.52
Others	12.82	14.20	5.19	2.10	3.25	0.97
All-India	100.00	100.00	20.51	30.84	100.00	100.00

Source- Production (GoI, various years, a), and procurement (GoI, various years, b).

Wheat production is predominantly concentrated in the northwestern states of Punjab, Haryana, Rajasthan, Uttar Pradesh and Madhya Pradesh. The procurement pattern of wheat has changed drastically. Although Punjab and Haryana remained the primary contributors to the central wheat pool, their respective shares have gradually fallen. Punjab's share decreased to one-third in 2020-22 from over half in 1998-2000. Haryana's share also declined marginally, from 26% to 20%. Madhya Pradesh has emerged as a significant player. Its share in production increased to 19% in 2020-22 from 10% in 1998-2000 and in procurement to 30% from 3%.

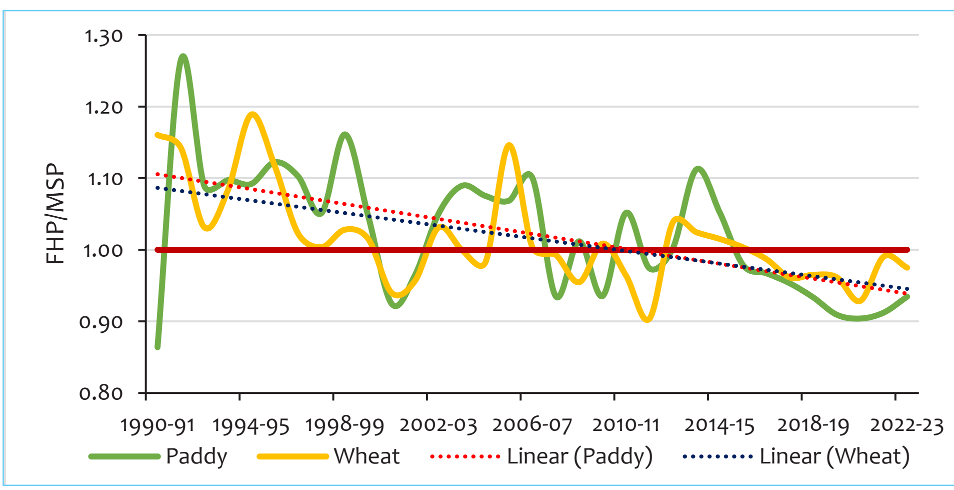
The increased contribution of Chhattisgarh and Odisha to the central grain pool can be attributed to the successful implementation of the decentralized procurement policy of the central government.

3.3 MSP and farm harvest prices (FHP)

MSP is intended to function as a floor for open market prices to foster competition. To understand the effectiveness of MSP in promoting market competition, we examined historical trends in the FHP/MSP ratio. A ratio of around one suggests (1 ± 0.05) a competitive market environment in which the actual market price tends to align with the government-set support price.

Historical trends reveal a distinct pattern in the FHP/MSP ratio for paddy and wheat (Figure 4). Prior to the early 2000s, FHP generally exceeded MSP, suggesting that market forces drove prices above the government-set floor. However, a significant shift occurred post-2007, indicating a change in the market dynamics. Over a 33-year period from 1990-91 onward, the ratio for paddy fluctuated within the competitive range (1 ± 0.05) for 21 years, whereas wheat experienced this for only eight years.

Figure 4. Ratio of FHP and MSP



Source- MSP (GoI, various years, a), and FHP (GoI, various years, c).

To further investigate the relationship between MSP and FHP, we regressed yearly changes in the logarithm of FHP on yearly changes in the logarithm of MSP, while controlling for the time trend for a period of 31 years. Our findings reveal a positive and statistically significant relationship between MSP and FHP for both paddy and wheat, albeit with slight variations. Interestingly, the impact of MSP appears to be more pronounced for paddy than for wheat; a one percent growth in MSP leads to a 0.55% growth in the FHP of paddy and a 0.49% growth in the FHP of wheat. The slightly stronger effect on paddy prices may be attributed to factors, such as differences in production costs, market demand, and supply chain characteristics.

Table 3. Estimated effect of MSP on FHP

Dependent variable: Ln FHP_t - Ln FHP_{t-1}	Paddy	Wheat
Predictor variables		
Ln MSP_t-Ln MSP_{t-1}	0.552*** (0.154)	0.485*** (0.128)
Trend	-0.001 (0.001)	0.000 (0.000)
Constant	1.928 (2.037)	-0.702 (1.811)
Number of observations	32	32
F (3, 28)	7.970	8.510
Prob > F	0.000	0.001
R^2	0.355	0.369

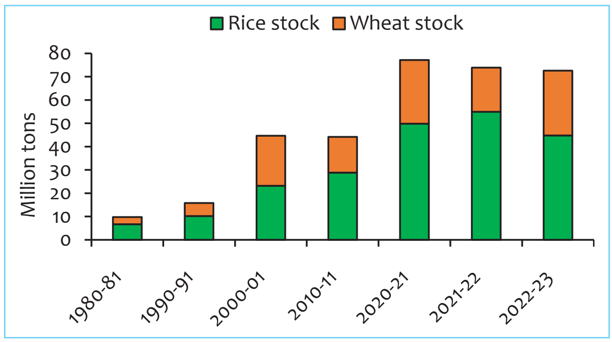
*Note: Figures in parentheses are standard errors; *** indicates significance at 1% level.*

Despite increased government procurement efforts, FHP has persistently remained below MSP in recent years. This discrepancy between policy objectives and actual market outcomes necessitates a deeper examination of the underlying factors contributing to this trend. Several potential factors may be at play, including inadequate market infrastructure, information asymmetry, and the influence of the local market dynamics.

3.4 Public stockholding of foodgrains

The Food Corporation of India (FCI) is responsible for storing the procured grains. To accomplish this task, the FCI utilizes its own storage facilities and rents storage space from various sources, including central and state warehousing corporations and agencies and the private sector.

Figure 5. Rice and wheat stocks



Source: GoI (various years, b).

As of April 1, 2024, the FCI had a total storage capacity of 80 million tons, including its own capacity of 37 million tons (GoI 2024).

Figure 5 illustrates the trends in stocks of rice and wheat. The combined inventory of rice and wheat has seen a dramatic increase, from 10 million tons in 1980-81 to 73 million tons in 2022-23. However, the rice stock consistently exceeded that of wheat.

The government determines stocking norms for operational purposes (i.e., distribution under PDS and other welfare schemes) and strategic reserves based on the inflow (procurement) and outflow (distribution) of grains from the central grain pool. Current stocking norms for rice and wheat have been in effect since January 1, 2015 (Table 4).

Table 4. Buffer stocking norms effective from January 1, 2015

(Million tons)

As on	Operational stock			Strategic reserve			Grand Total
	Rice	Wheat	Total	Rice	Wheat	Total	
1st April	11.6	4.5	16.0	2.0	3.0	5.0	21.0
1st July	11.5	24.6	36.1	2.0	3.0	5.0	41.1
1st October	8.3	17.5	25.8	2.0	3.0	5.0	30.8
1st January	5.6	10.8	16.4	2.0	3.0	5.0	21.4

Source: GoI (various years, b).

3.5 Economic cost of public stockholding

Table 5 presents the economic costs associated with the foodgrain management.[5] It works out Rs 3722 for rice and Rs 2550 for wheat. Breaking down these costs provides insight into the economic structure of grain procurement and distribution. The cost of pooling grains comprises approximately 77% of the economic cost for both rice and wheat, and the remainder is shared between the incidental charges and distribution costs. Incidental charges comprise 16.6% of the pooled cost for rice and 12.7% for wheat.

[5] Acquisition cost includes MSP and procurement incidentals (e.g., state taxes, commission to parathas or societies, labor charges, cost of bagging materials, and transportation). Distribution cost includes the cost of transferring grains from the first point of the godown to the targeted place.

Table 5. Cost of public stockholdings, 2022-23 (Rs/quintal)

Particulars	Rice	Wheat
Pooled cost	2854.85	1960.35
Incidental charges	475.32	248.13
Acquisition cost	3330.17	2208.48
Distribution cost	392.18	341.25
Economic cost	3722.35	2549.73

Source: GoI (2022)

Foodgrains procured by the FCI are distributed to economically disadvantaged consumers through PDS at highly subsidized prices called Central Issue Prices (CIP). The CIP for both rice and wheat is significantly lower than the prevailing market price. At present, the CIP for rice is Rs 3 per kg and for wheat, Rs 2 per kg. The difference between economic cost and CIP is the subsidy to consumers borne by the central government. Since 2021, the government has been distributing free grains to more than 800 million beneficiaries. In 2022-23, the expenditure on food subsidies was Rs 2728 billion.

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4 Outreach and Effectiveness of MSP-backed Procurement System

This chapter examines several issues pertaining to the MSP-backed procurement system to provide insights into its scope, effectiveness, and impact on farm income.

To ground our analysis into robust empirical evidence, we utilized household-level data from the Situation Assessment Survey of Agricultural Households (SASAH) conducted in 2018-19 by the National Sample Survey Office, Central Statistical Organization, Ministry of Statistics and Programme Implementation, Government of India (GoI 2021). This survey is nationally representative, encompassing 58,035 households from 5,940 villages across all Indian states and Union Territories.

The survey categorizes the sample households as agricultural or non-agricultural. To be classified as an agricultural household, the household must have earned a minimum of Rs 4000 per month from agricultural activities including cultivation of crops, animal husbandry, and fishing. Furthermore, at least one family member must have been self-employed in agriculture during the year preceding the survey. Agricultural households constituted 79% of the total surveyed households. This distinction between agricultural and non-agricultural households serves as the basis for our analysis. However, extending beyond the income-based categorization, we considered owned or cultivated land as a factor for retaining households in our analysis.

SASAH provides data on various aspects of farming and farm households. These include crop area, production and value, landholding size, land leasing practices, irrigation status, asset ownership, access to information and technical guidance, formal agricultural training, and affiliation with farm organizations. Information regarding the marketing of agricultural produce pertains to its distribution patterns (i.e., sales to various market agents, including local traders, commission agents, input dealers, cooperatives, farmer producer organizations, and government parastatals) and awareness of the MSP and agencies for the procurement of produce. The survey also provides information on social and demographic characteristics, such as age, sex, education of the household head, family size, and caste. Tables A1 and A2 in the Appendix present the summary statistics for these variables.

4.1 Outreach and inclusiveness of the MSP-backed procurement system[6]

Rice and wheat are the primary staples in the Indian diet, and as previously discussed the price policy has remained anchored to these crops. An analysis of the survey data indicates that 54% of the farm households are engaged in paddy cultivation and 41% in wheat cultivation. These patterns are not only significant for household food security, but also have commercial implications, as over half of the growers (55% for paddy and 51% for wheat) sell approximately two-thirds of their harvests (Table 6).

Given the significant proportion of farmers selling their harvests, it is crucial to examine their engagement with MSP-based procurement system. Towards this, we focused on two key aspects: awareness of the system and actual engagement. The findings reveal a significant gap between farmers' awareness of MSP and their active participation in the system. While a substantial proportion of farmers (44% of paddy sellers and 37% of wheat sellers) are aware of MSP, fewer are familiar with procurement agencies. Hence, only a small fraction of farmers (15% of paddy sellers and 10% of wheat sellers) are engaged in this system, selling approximately one-third of their surplus production (35% for paddy and 32% for wheat) at the MSP.

Table 6. Farmers' participation in MSP-backed procurement system, 2018-19

Particulars	Paddy	Wheat
% households growing	54.41	41.31
% growers having marketable surplus	55.00	50.86
% market participants aware of MSP	44.09	36.96
% marketed surplus output among market participant	67.70	63.05
% market participants aware of procurement agencies	30.30	27.20
% market participant selling to procurement agencies	15.03	9.61
% of total growers selling to procurement agencies	8.27	4.89
% output sold to procurement agencies	23.70	20.80
% marketed surplus sold to procurement agencies	35.13	31.73

Source: Estimated by authors using data from GoI (2021).

To better understand the dynamics of agricultural marketing, it is imperative to analyze the participation of different farmer categories in the market. There

6 The figures pertaining to the procurement of rice and wheat here are substantially lower than those reported by FCI, possibly measurement and reporting errors in the SASAH.

was a strong positive correlation between farm size and farmers' participation in the market (Table 7). Large farmers with greater resource availability are better positioned to produce surpluses and engage in marketing. This is evident in their high percentage of sales (85.9% for paddy and 78.9% for wheat). In contrast, despite their limited resources, marginal farmers still contribute significantly to production and marketed surplus. Nearly half of them produce surplus (49.2% paddy and 41.6% wheat) and sell 62.7% paddy and 56.5% wheat.

Smallholders' participation in the MSP-backed procurement system appears to be constrained by their scale of production. The data reveals an apparent disparity in participation rates across different farm categories. Marginal farmers have a notably low engagement with the MSP-backed procurement system. Only 10.5% of paddy sellers and 4.5% of wheat sellers from this farm class participate in the system and sell 12.6% surplus paddy and 7.3% wheat. In contrast, large farmers have a significantly higher engagement with this system; 31.3% of paddy sellers and 23.4% of wheat sellers participate by selling 37.8% of their surplus paddy and 29.8% of wheat.

Table 7 also shows the contributions of different farm classes to production, marketed surplus, and government procurement. Small farmers (less than or equal to 2 ha) contribute 53.6% to the production of paddy and 45.0% of wheat. The corresponding figures for their contributions to sales are 49.1% and 39.9%, respectively. However, their contribution to procurement is low: 34.4% for paddy and 24.7% for wheat. In contrast, large farmers dominate the procurement landscape despite their smaller share of overall production. They contribute 34.9% and 45.3% to the procurement of paddy and wheat, respectively[7], which is more than double the share of production.

The limited participation of small farmers in the MSP-backed procurement system can be attributed to several factors. The primary reason is smaller marketable surplus. Another crucial factor is their low awareness of the MSP and procurement agencies. A significant proportion of these farmers may lack information regarding MSP, its benefits, or procedures to avail it. For instance, only 40.2% of marginal farmers engaged in paddy sales are aware of MSP, compared to 66.3% of large farmers.

[7] The share of farmers possessing less than or equal to 2 hectares of land in the total procurement is in almost similar to that reported by CACP for some states in its reports (GoI 2020).

Table 7. Participation in MSP-backed procurement system by farm size, 2018-19

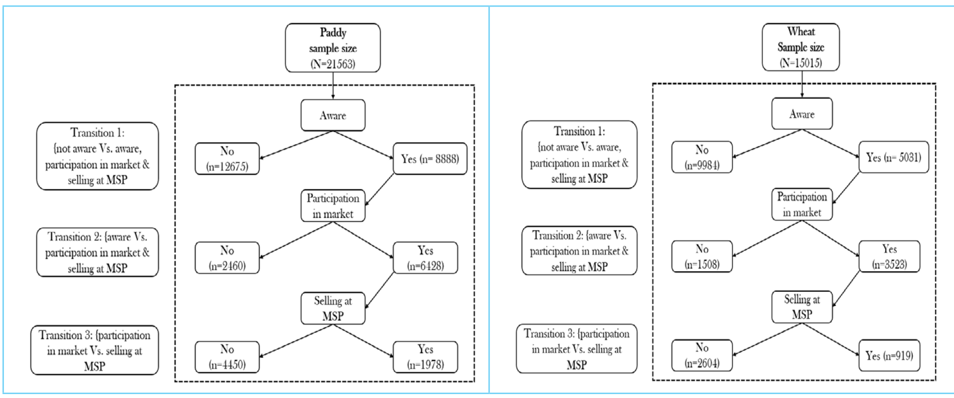
Particulars	Marginal (< 1 ha)	Small (1-2 ha)	Medium (2-4 ha)	Large (>4 ha)	Total
			Paddy		
No. of households	14341	7056	3371	718	25486
% households having marketable surplus	49.16	68.60	75.70	88.95	55.00
% market participant aware of MSP	40.15	47.78	56.45	66.30	44.09
% marketed surplus output among market participant	62.71	70.88	79.35	85.90	66.70
% market participant selling to government agencies	10.45	21.53	27.68	31.27	15.03
% of marketed surplus output sold to procurement agency	12.58	16.62	22.77	37.76	23.70
% share in production	21.63	31.95	27.79	18.62	100
% share in marketable surplus	18.83	30.28	28.98	21.91	100
% share in procurement	11.01	23.38	30.66	34.95	100
			Wheat		
No. of households	8042	4087	2305	677	15111
% households having marketable surplus	41.57	66.94	75.42	87.26	50.86
% market participant aware of MSP	27.41	42.67	54.23	65.31	36.96
% marketed surplus output among market participant	56.53	65.49	79.02	78.98	63.05
% market participant selling to government agencies	4.50	12.16	20.36	23.45	9.61
% of marketed surplus sold to procurement agency	7.28	15.60	21.01	29.83	20.80
% share in production	17.14	27.89	28.36	26.60	100.00
% share in marketable surplus	14.31	25.57	29.13	30.98	100.00
% share in procurement	5.11	19.56	30.01	45.32	100.00

Source: Estimated by authors using data from GoI (2021).

The current procurement system is open-ended, allowing farmers to sell any quantity of produce during the specified marketing period. The policy's non-discriminatory nature aims to support all farmers regardless of the size of their landholdings or production capacity. However, our findings suggest a need to develop mechanisms to improve the inclusiveness of the MSP-backed procurement system.

Several factors influence farmers' participation in the MSP-backed procurement system. The process begins with the farmers' awareness of the system. Farmers who are informed about MSP, its benefits, and sales procedures are more likely to participate. Once aware, farmers consider their production capacity and the surplus available for sale. After assessing the surplus, they evaluate their selling options. This sequential decision-making process determines the farmers' participation in the MSP-backed procurement system, as illustrated in Figure 6. Farmers' market participation constitutes a subset of producers and the choice of procurement agencies constitutes a subset of market participants.

Figure 6. Framework for sequential decisions



Econometrically, this process can be captured by using a sequential logit model.

$$\Pr\left(I_{k,i} = 1/X_i,\ I_{k-1,i} = 1\right) = \hat{p}_{ik} \qquad \dots (1)$$

Where $\hat{p}_{ik}$ is the standard logit model; that is, $\hat{p}_{ik} = \Phi(X_i, S_i, \beta)$. Φ is the cumulative distribution function and β is a vector of the parameters to be estimated. I_k is an indicator variable that takes the value of 1 for farm household i passing through the transition stage k, that is, awareness of the MSP, participation in the market, and choice of market channel, and 0 otherwise. X_i is a vector of farm and farm household characteristics.

Important predictors included in the sequential logit model are farm size, cropped area, household head's age, gender, education, caste, training in agriculture, affiliation to registered farmer organizations, and access to information or technical advice. The summary statistics for each transition stage are reported in Tables A1 and A2 in the appendix.

Table 8 shows the results of the sequential logit model. The results reveal several key demographic and socioeconomic factors playing a role in farmers' awareness of the MSP. Age, education, and information emerge as significant determinants, suggesting that older, more educated farmers with better information access are more aware of MSP. Notably, female-headed households demonstrate a lower level of awareness than their male counterparts, indicating a potential gender gap. Further, as expected, there is a positive association between awareness of MSP and farm size as well as cropped area.

The caste system exerts significant influence on diverse aspects of social and economic life. The four primary caste categories—Scheduled Tribes, Scheduled Castes, Other Backward Castes, and Upper Castes— represent a hierarchical structure that often determines a household's access to resources and opportunities. Lower-caste households, particularly those belonging to Scheduled Castes and Scheduled Tribes often encounter barriers in accessing credit, information, and government schemes (Birthal et al. 2015; Rao 2017). This phenomenon is also evident in the context of participation in the MSP-backed procurement system.

Table 8. Determinants of participation in MSP-backed procurement system

Variables	Paddy			Wheat		
	Transition I Aware of MSP = 1; otherwise = 0	Transition II Participation in market = 1; otherwise = 0	Transition III Selling to procurement agencies = 1; otherwise = 0	Transition I Aware of MSP = 1; otherwise = 0	Transition II Participation in market = 1; otherwise = 0	Transition III Selling to procurement agencies = 1; otherwise = 0
	Odds Ratio			Odds Ratio		
Age of the decision-maker(years)	1.015*** (0.001)	0.997 (0.002)	1.009*** (0.003)	1.008*** (0.002)	0.990*** (0.003)	1.005 (0.003)
Sex of the decision-maker (male = 1)	1.201*** (0.074)	0.903 (0.102)	0.894 (0.124)	1.370*** (0.112)	1.328* (0.209)	0.646** (0.127)
Household size (No.)	1.014** (0.007)	0.945*** (0.011)	0.989 (0.014	1.014** (0.007)	0.933*** (0.012)	1.011 (0.015)
Education status of the decision-maker (base = illiterate)						
Primary	1.343*** (0.057)	1.078 (0.081)	1.109 (0.106)	1.216** (0.067)	0.889 (0.095)	1.173 (0.159)
Secondary	1.893*** (0.079)	0.959 (0.071)	1.404*** (0.127)	1.611*** (0.082)	0.839* (0.081)	1.511*** (0.184)
Higher secondary	2.616*** (0.170)	0.947 (0.102)	1.574*** (0.201)	2.185*** (0.158)	0.736** (0.095)	1.531*** (0.250)

Variables	Paddy			Wheat		
	Transition I Aware of MSP = 1; otherwise = 0	Transition II Participation in market = 1; otherwise = 0	Transition III Selling to procurement agencies = 1; otherwise = 0	Transition I Aware of MSP = 1; otherwise = 0	Transition II Participation in market = 1; otherwise = 0	Transition III Selling to procurement agencies = 1; otherwise = 0
Diploma	2.743***	0.530***	1.457	2.678***	0.938	1.456
	(0.561)	(0.128)	(0.414)	(0.543)	(0.342)	(0.568)
Graduation and above	3.630***	1.012	1.629***	2.645***	0.863	1.692***
	(0.250)	(0.109)	(0.203)	(0.209)	(0.122)	(0.275)
Caste (base = scheduled tribe)						
Schedule caste	1.710***	0.989	2.164***	1.851***	2.240***	0.489***
	(0.103)	(0.099)	(0.312)	(0.185)	(0.446)	(0.128)
Other backward caste	1.740***	0.987	2.527***	2.143***	2.042***	0.783
	(0.092)	(0.086)	(0.327)	(0.195)	(0.370)	(0.176)
Upper caste	1.834***	1.059	1.996***	2.330***	2.311***	0.870
	(0.107)	(0.101)	(0.273)	(0.225)	(0.441)	(0.205)
Farm size (ha)	1.064***	1.306***	1.028	1.138***	0.958	1.034
	(0.021)	(0.054)	(0.028)	(0.029)	(0.045)	(0.037)
Paddy irrigated area (ha)	1.358***	3.084***	1.069**	1.193***	11.779***	1.038
	(0.041)	(0.243)	(0.032)	(0.052)	(1.708)	(0.048)
Agricultural training by any family member (yes = 1)	1.051	0.730*	1.121	1.196	0.678	1.654*
	(0.120)	(0.129)	(0.218)	(0.195)	(0.215)	(0.519)
Member of farmer organization (yes = 1)	1.463***	1.100	1.191	1.133	1.491*	1.788***
	(0.114)	(0.144)	(0.151)	(0.118)	(0.336)	(0.349)
Access to information (yes = 1)	1.727***	1.212***	1.265***	2.497***	1.110	0.659***
	(0.057)	(0.071)	(0.100)	(0.104)	(0.094)	(0.067)
Constant	0.004***	1.258	0.082***	0.011***	0.931	0.026***
	(0.001)	(0.735)	(0.058)	(0.002)	(0.324)	(0.021)

*Note: Figures in parentheses are standard errors; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.*

Source: Estimated by authors using data from SASAH, GoI (2021).

The results of the second stage of the sequential logit model show that farm size and cropped area are crucial determinants of farmers' participation in the market, suggesting that farmers with larger production capacities are more likely to participate in the market. Additionally, farmers' access to information and technical advice is a significant factor in their sales decisions.

Furthermore, an analysis of farmers' choices of market channels elucidates the role of farm size and cropped area. The probability of sales to government agencies increases proportionally to these factors. Education and caste are significant determinants of engagement in the MSP system, although their effects are not uniform.

4.2 Effectiveness of MSP-backed Procurement

Table 9 compares the means of the prices, crop yields, and farm incomes of non-participants and participants in the MSP-backed procurement system. Upon closer examination, the results reveal significant differences between the two groups. Farmers who did not participate in the system realized lower prices than the MSP. They also had significantly lower crop yield. These findings are particularly noteworthy, as they contradict earlier findings by Deshpande and Naika (2002), which indicated that while MSP could lead to increased fertilizer usage, it does not necessarily increase crop yields.

Table 9. Comparison of means of prices, yields, and farm incomes for participants and non-participants in the MSP-backed procurement system

Particulars		Price (Rs/kg)		Yield (Kg/ha)		Gross income (Rs/ha)	
		Mean	Std. error.	Mean	Std. error.	Mean	Std. error.
Paddy	Participants	18.51	0.09	4014	38	76308	717
	Non-participants	15.67	0.04	3667	17	61748	318
	Difference	2.84***		347***		14560***	
Wheat	Participants	18.04	0.05	3782	44	75118	918
	Non-participants	17.02	0.04	3330	16	62933	318
	Difference	1.02***		452***		12185***	

*Note: *** indicates significance at 1% level.*

Source: Estimated by authors using data from SASAH, GoI (2021)

The comparison of the mean prices, yields, and incomes of participants and non-participants may lead to erroneous conclusions owing to the differences in their observable and unobservable characteristics. To address these potential biases and ensure a more accurate assessment, we employ the inverse probability-weighted adjusted regression approach (IPWRA), which combines regression and propensity score methods (Wossen et al. 2017).

$$Y_i = \alpha_i + \theta_i x_i + \varepsilon_i \quad \text{for i = [0, 1]} \qquad \text{... (2)}$$

Where Y_i is the outcome variable of interest; x_i is a set of controls; α and θ are the parameters to be estimated; ε is the error term.

First, we estimate the propensity scores as $p(x;\hat{\vartheta})$, and then employ the inverse probability-weighted least squares method to estimate (α_0, θ_0) and (α_1, θ_1):

$$Min \sum_i^N (Y_i - \alpha_0 - \theta_0 x_i)/p((\text{x}; \hat{\vartheta}) \text{ if } I_i = 0 \qquad \text{... (3)}$$

$$Min \sum_i^N (Y_i - \alpha_1 - \theta_1 x_i)/p((\text{x}; \hat{\vartheta}) \text{ if } I_i = 1 \qquad \text{... (4)}$$

Equation (3) represents the outcomes for non-participants, and Equation (4) represents the outcomes for participants.

Where $\hat{\alpha}_1$ is the estimated inverse probability-weighted parameter for participants and $\hat{\alpha}_0$ is the estimated inverse probability-weighted parameter for non-participants in the MSP-backed procurement system. N_w is the number of participants. I_i is an indicator variable that takes the value 1 for participants and 0 otherwise?

IPWRA provides estimates of the average treatment effect for the treated (ATT), that is, the difference between Equation (3) and Equation (4). ATT is the expected outcome for participants in the MSP-backed procurement system against the counterfactual of their non-participation.

$$ATT = \frac{1}{N_w} \sum_i^{N_w} [(\hat{\alpha}_1 - \hat{\alpha}_0) - (\hat{\theta}_1 - \hat{\theta}_0) x_1] \qquad \text{... (5)}$$

The results of IPWRA are presented in Tables A3 and A4 in the Appendix.

The average treatment effects (ATT) obtained from the IPWRA (Table 10) substantiates the benefits of participation in the MSP-backed system. For paddy, the impact is particularly significant, with farmers receiving 13.2% higher prices and achieving 13.5% higher paddy yield, resulting in a 23% increase in income from paddy cultivation. Although less pronounced, the benefits of MSP for wheat farmers are notable. Farmers selling wheat to government agencies receive 3.5% higher prices and attain 5% higher yields, leading to a 10% increase in income. These findings suggest that MSP serves as an income safety net for farmers.

Table 10. Average treatment effect of MSP on outcome variables

Particulars		Price		Yield		Gross income	
		Rs/kg	Effect (%)	Kg/ha	Effect (%)	Rs/ha	Effect (%)
Paddy	ATT	2.15***	13.20	474***	13.47	14258***	23.22
	Potential outcome	16.29		3518		61401	
Wheat	ATT	0. 61***	3.45	180***	5.04	6544***	9.64
	Potential outcome	17.41		3570		67907	

*Note: Estimated from inverse probability weighting regression adjustment (IPWRA) model; *** indicates significance at 1% level.*

Source: Estimated by authors using data from GoI (2021)

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5 Impact of Procurement on Groundwater

The procurement of grains at the MSP undoubtedly benefits farmers and contributes to increased food production. However, this, along with other agricultural incentives, may result in unintended environmental consequences. The disproportionate increase in rice area backed by government purchases has resulted in groundwater depletion especially in water-stressed regions. One such case that exemplifies this issue is the state of Punjab, where the effects of grain procurement on groundwater levels are particularly pronounced. In this chapter, we examine the impact of rice and wheat procurement on groundwater levels in Punjab.

5.1 Evolution of rice-wheat system, and groundwater level in Punjab

The annual precipitation in Punjab is low (534 mm) and does not support the cultivation of water-guzzling crops, such as rice. Despite this climatic limitation, the share of paddy in the gross sown area has increased dramatically, from 23.12% in 1985-86 to 39.55% in 2021-22. The share of wheat also increased slightly from 41.63% to 44.06%. This change in cropping pattern has significant implications for natural resources (Figure 7a-b). Cultivation of both crops relies heavily on groundwater irrigation. In the 1960s, groundwater accounted for 41% of the net irrigated area in Punjab, which by 2021-22 increased to 72%.

This shift in irrigation system has put unprecedented pressure on groundwater resources leading to a critical situation of their overexploitation. In 2021-22, the rate of groundwater extraction was 66% higher than the natural recharge rate.

Figure 8 shows a visual representation of the groundwater depletion trend across the districts of Punjab. The groundwater level in most districts has fallen alarmingly over the past two decades. Furthermore, we observe similar patterns and clusters experiencing similar groundwater challenges. Such similarities allow for a more targeted approach for water resource management.

Figure 7a. Trends in area and groundwater level in Punjab

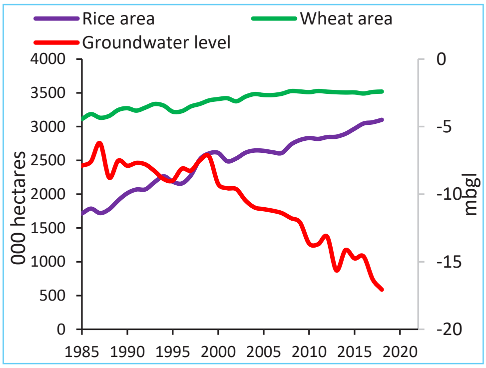
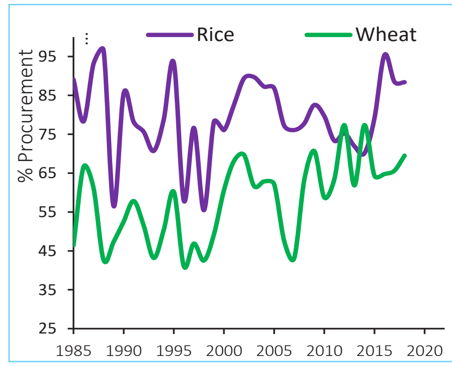


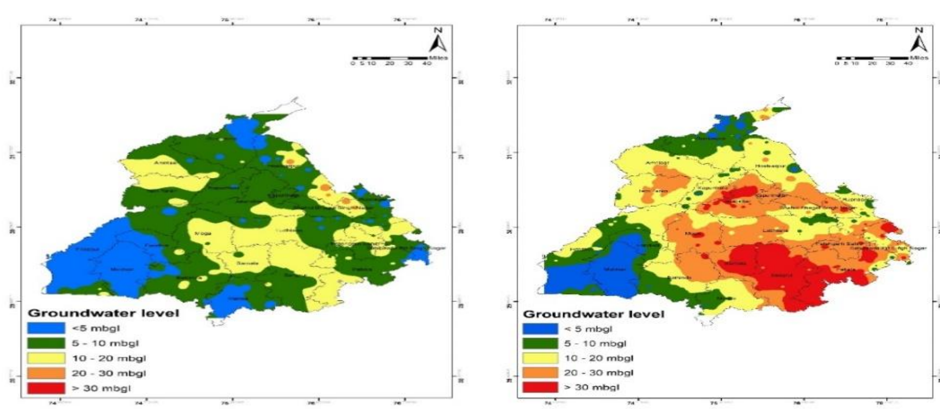
Figure 7b. Trends in procurement in Punjab



Source: Area, production, procurement (GoP, various years), and Groundwater level (GoI, various years, d)

Figure 8. Changes in groundwater level across districts in Punjab

2000 **2018**



Source: Created based on data from GoI (various years, d)

5.2 Effects of procurement on groundwater levels

To evaluate the impact of government procurement of paddy and wheat on groundwater extraction, we employed district-level data from Punjab spanning the period from 1997 to 2019 and conducted a panel fixed effects regression analysis. The fixed effects model accounts for time-invariant differences between districts, effectively controlling for unobserved heterogeneity that may influence groundwater levels and isolates the net effect of MSP on groundwater levels. The model is specified as follows.

$$Y_{it} = \alpha_{it} + \sum \beta_{it} X_{it} + u_{it} \qquad \dots (6)$$

Where i represents the district (1, 2, 3, ...N) and t the year (1, 2, 3...T). Y_{it} is groundwater level, and X_{it} is a vector of explanatory variables. a_{it} is the intercept for each district, β_{it} is a vector of coefficients associated with explanatory variables, and u_{it} is the disturbance term. u_{it} follows a two-way error component structure that accounts for both district and time fixed effects.

$$u_{it} = \mu_i + \tau_t + \varepsilon_{it} \quad \text{... (7)}$$

Where, μ_i is the unobserved individual heterogeneity (cross-section), τ_t is the unobserved time heterogeneity (time-series) and ε_{it} is the random error term. We assume that the μ_i and τ_t are fixed parameters to be estimated and the random error term, ε_{it},is identically and independently distributed with zero mean and constant variance, that is, $\varepsilon_{it} \sim$ IID$(0, \sigma_v^2)$.

The dependent variable, that is, the groundwater level at the end of harvest in a district, is a result of the balance between extraction and aquifer replenishment. On average, rainfall accounts for only 28% of aquifer recharge in the state, and most recharge occurs through canal irrigation. Groundwater is the primary source of irrigation in almost all districts. The groundwater level at the end of the Kharif (rainy) season, that is, in November, is the result of paddy cultivation and procurement. In contrast, its level at the end of the Rabi season (winter), that is, in May, is affected by wheat cultivation and procurement. Canal irrigation and rainfall were included in the model.

The results indicate a significant relationship between crop acreage and procurement and their impact on groundwater levels (Table 11). Farmers respond positively to government purchases of rice and wheat, leading to increased acreage allocation to these crops. Negi et al. (2020) reported similar results. The response is more pronounced for paddy, with a 1% increase in procurement resulting in a 0.38% increase in its acreage compared to a 0.08% increase in the case of wheat.

However, the results show a concerning relation between procurement and groundwater level. A positive and significant coefficient on procurement indicates a decline in the groundwater level. The impact is substantial and nearly identical for paddy and wheat, with a 1% increase in procurement of either crop, leading to a more than 0.6% decrease in groundwater level. These findings highlight the potential unintended environmental consequences of agricultural price policy and emphasize the need for a balanced approach to ensure food security and sustainable management of natural resources.

As expected, rainfall does not explain much of the variation in groundwater levels, whereas canal irrigation leads to an increase in the acreage of both crops while maintaining groundwater levels. Remarkably, canal irrigation contributes to 72% of aquifer recharge, serving the dual purpose of meeting irrigation needs and replenishing groundwater resources. These findings highlight that canal irrigation offers a potential solution to balance agricultural intensification with environmental conservation. Punjab has a well-developed network of canals, but for its efficient utilization, there is a need for its maintenance (Kishore et al. 2024).

This relationship between price policy, food production, and environmental sustainability highlights the potential unintended consequences of prolonged government intervention in the foodgrain market. The long-term effects of such policies on natural resources could be far-reaching and difficult to reverse, potentially compromising the long-term sustainability of agriculture- and agriculture-based livelihoods.

Table 11. Effects of procurement on groundwater level

Dependent variable	Ln (cropped area)	Ln (groundwater level)
	Paddy	
Ln (Paddy procured)	0.384***	0.617***
	(0.022)	(0.048)
Ln (% canal irrigation)	0.002***	-0.002*
	(0.0004)	(0.001)
Ln (Rain in Jun-Oct)	0.023	0.019
	(0.098)	(0.210)
Ln (Rain sq in Jun-Oct)	-0.003	0.004
	(0.009)	(0.019)
Constant	2.356***	-1.735***
	(0.294)	(0.628)
	Wheat	
Ln (Wheat procured)	0.080**	0.665***
	(0.007)	(0.039)
Ln (% canal irrigation)	0.0001	-0.001*
	(0.0001)	(0.000)
Ln (Rain in Nov-May)	0.028**	0.022
	(0.014)	(0.078)
Ln (Rain sq in Nov -May)	-0.004**	0.002
	(0.002)	(0.010)
Constant	4.659***	-1.810***
	(0.049)	(0.279)
No. of observations	391	
No. of groups	17	

*Note: Figures in parentheses are standard errors; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.*

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6 Reforming Markets and Price Policy

The price support mechanism, in conjunction with input subsidies, facilitated the technological transformation of Indian agriculture, transitioning the country from a food deficit to a food surplus state. However, the persistence of this incentive structure concentrating on a few staple crops, primarily rice and wheat, without significant alignment with emerging trends in domestic and international markets and challenges to natural resources, biodiversity, and the environment, has resulted in unsustainable patterns of agricultural development. Chand and Singh (2023) demonstrated that commodities receiving substantial support have ceased to drive agricultural growth.

The findings of this study indicate that the government's policy of procuring foodgrains at the MSP functions as an income safety net for farmers, mitigating market uncertainty and price risks and encouraging the adoption of improved technologies and inputs to increase production. However, this policy has inadvertently resulted in a decline in the groundwater levels. Considering these factors, this study examines the feasibility of implementing the following alternatives or strategies of price support mechanisms to strike a balance among farmers' interests, food security, and the sustainability of natural resources.

Price deficiency payment: If the price realized from sales in the open market is less than the MSP, the government may compensate farmers for this difference (Chand 2003). This mechanism is called the 'price deficiency payment.' This reduces the need for the government to physically procure crops, and leads to a more efficient allocation of resources and a reduction in procurement and storage costs. Furthermore, it may encourage farmers to respond more effectively to market signals and diversify their crop portfolios as they are less dependent on government purchases at fixed prices.

Madhya Pradesh implemented a price deficiency payment scheme called '*Bhavantar Bhugtan Yojana*' in 2017 for crops such as maize, soybean, groundnut, sesame, green gram, black gram, and pigeon peas. The following year, Haryana introduced a similar scheme, '*Bhavantar Bharpayee Yojana*,' specifically targeting vegetable crops that are prone to significant price fluctuations. It is important to note that the price deficiency scheme is an important constituent of PM-AASHA, a scheme designed to guarantee remunerative prices to farmers for their crops.

Sekhar (2022) explored the potential fiscal benefits of implementing a price deficiency payment scheme, focusing on 14 major crops, including cereals, pulses, and oilseeds. He considers a scenario in which the government procures 30% of the marketed surplus of these crops at the MSP and the remainder through the price deficiency scheme, assuming that the market price is 20% less than the MSP. The proposed model, which combines price deficiency payment scheme with limited government procurement, has significant potential to reduce the financial burden while providing remunerative prices to farmers.

Our analysis indicates that the probability of the open market price being 20% less than that of MSP is rare. Nonetheless, the financial impact of price deficiency payments is manageable. This approach can lead to more targeted and efficient price support mechanism, potentially benefiting both farmers and governments.

Despite these advantages, it is crucial to address the inherent limitations of this approach. As farmers are assured of compensation for price differences, they may become complacent in their market search efforts, potentially missing lucrative opportunities. Furthermore, there is moral hazard. Buyers may deliberately manipulate prices to gain an advantage. Similarly, farmers might be tempted to offload substandard produce in the market. To address these limitations, it is crucial to establish a robust quality assessment infrastructure in the markets and a band for compensable price differentials.

Encourage private sector participation for procurement: The Government of India, through the Private Procurement & Stockist Scheme (PPPS), a component of PM-AASHA, allows states to engage private agencies to procure crops, mainly oilseeds, at MSP from registered farmers in specific markets during designated periods when open market prices drop below MSP. In this scheme, private agencies bear all costs associated with handling, storage, distribution, and transit losses and receive a 15% service charge of the MSP from the central government. In addition, state governments are advised to exempt transactions from market fees.

However, several challenges remain. As observed, the likelihood of farm harvest prices falling significantly below the MSP is low, and in such instances, farmers have little incentive to sell their produce to private entities. The scheme imposes a restriction of 25% on procuring produce from designated areas, which further compounds this issue. A service charge of 15% of the MSP is deemed low compared to the incidental charges of 13-17% of the pooled cost of grains in the existing procurement system. In addition, the reluctance of states to exempt from market fees is a challenge. Hence, it is difficult for private agencies to establish viable business models. A more comprehensive consultation process involving state governments and private sector stakeholders is crucial to revamping PPPs.

Strengthen decentralized procurement scheme: The Government of India implemented a decentralized procurement scheme in the late 1990s to address the inefficiencies and high costs associated with the centralized procurement system. Under this system, states are tasked with procuring, storing, and distributing foodgrains within their jurisdictions, while the central government bears all the associated expenses. This reduces the financial burden on the central government and empowers states to manage their food requirements effectively. States, such as Odisha, Chhattisgarh, and Madhya Pradesh, have effectively implemented this scheme. These successes suggest reinforcing the scheme for states to procure surplus grains to meet their requirements and potentially engage in interstate trade. The central government's procurement may be limited to strategic reserve requirements.

Target smallholder farmers: The existing procurement system is open-ended, allowing farmers to sell unlimited quantities to government agencies; hence, the benefits of MSP are directly proportional to the scale of production. This is evident from this study: while small farmers (< 2 ha) account for 54% of the total production of rice and 45% of wheat, their share in total procurement is 34.4% and 24.7% respectively. This suggests the need for a more targeted approach that prioritizes procurement from small-scale farmers.

Futures trading in agri-food commodities: Futures contracts can serve as an important mechanism for managing market uncertainty and price risks. Despite their potential benefits, the scale requirements and complexities of futures markets often restrict individual participation. Recognizing this challenge, collectives such as Farmer Producer Organizations (FPOs) and cooperatives can act as intermediaries, enabling individuals to participate in futures trading. This approach is already in practice for some commercial crops at a limited scale. The National Commodity and Derivatives Exchange (NCDEX) partners with FPOs for futures trading (NCDX 2023). FPOs utilize put options; by paying a fixed premium, typically 5% of the strike price, they sell their produce at the exchange at a predetermined price. This approach allows for potential upside gains if market prices increase but forfeiting the premium. If implemented for other crops, their MSP can function as a reference for the strike price.

However, farmers' reluctance to pay premiums for futures trading is a challenge. In the existing government procurement system, incidental charges constitute 13-17% of the pooled price of grains. If farmers' organizations switch to futures trading, the government could potentially save this amount, which could be directed to subsidize premiums.

Several measures are necessary to make futures trading a viable alternative to the current procurement system. A consistent long-term policy for agricultural commodity derivatives is required to instil confidence in farmers and other market participants. Furthermore, educational initiatives are essential to inform farmers about the advantages and mechanisms of futures trading. Finally, the government may incentivize farmers to engage in futures markets by subsidizing premiums and making MSP as the strike price.

Direct income support: Governments can implement direct payment programs to support farmers. These payments are typically 'coupled' and' decoupled.' Coupled payments are directly linked to the current production or the price of a specific commodity. However, decoupled payments are not contingent on current output or prices. For example, the Government of India provides decoupled direct payments to farmers through the PM-KISAN scheme.

Subject to WTO's domestic support disciplines, India can provide unlimited support to farmers if such support is not coupled with current production or price levels. Such payments fall in the Green Box and are considered minimal or non-distorting of global markets. Payments coupled with production or prices, which are subject to production-limiting conditions, fall in the Blue Box, where unlimited support can be provided, similar to that in the Green Box. Coupled support without production-limiting conditions falls in the Amber Box; hence, India cannot exceed its *de minimis* limit of 10% of the value of the commodity.

The United States, China, and European Union provide subsidies to farmers as direct payments. The United States implements Amber Box payments, such as the price deficiency payments under the Price Loss Coverage (PLC) program. The European Union allocates substantial expenditure direct payments in the form of decoupled income support under the Green Box and through production-limiting payments under the Blue Box for commodities such as cotton, cereals, and rice. Similarly, China provides significant support under the Green and Blue Boxes. For India, adopting similar approaches could involve designing programs that fit within the Green (environmental protection initiatives or rural development programs), Blue (production-limiting subsidies), and Amber boxes (market price support or input subsidies). By carefully structuring its agricultural support policies, India can support its farmers while adhering to international trade commitments.

Crop diversification: Diversifying crop portfolios is an effective solution to circumvent the problem of overproduction of rice and wheat while addressing the environmental challenges. As disposable income increases, dietary preferences shift away from staple grains, indicating modest growth in demand and the need for diversification of crop portfolios. Crop diversification requires robust planning for the cultivation of crops suited to the natural resource endowments of the regions. However, farmers tend to grow crops that generate high profits. Hence, successful crop diversification depends on compensating farmers for the income they forgo in the transition to new crop plans. For example, in Punjab and Haryana, a few crops, excluding fruits and vegetables, generate as much revenue as rice or wheat.

The benefits of crop diversification extend beyond the income generation. It may improve the nutritional status, reduce imports, enhance exports, and generate a range of ecosystem services, including water conservation, enhanced soil health through biological nitrogen fixation, increased carbon sequestration, and improved climate regulation. Despite their significance, these ecosystem services remain economically unvalued. To fully realize the potential of crop diversification, it is imperative to develop mechanisms to quantify and monetize these ecosystem services. Implementing a crop-cluster-based approach could serve as an initial step toward demonstrating the advantages of diversification and ecosystem services to farmers, policymakers, and consumers.

Invest in canal irrigation: A comprehensive water management strategy is essential to minimize the adverse effects of incentives. This strategy should prioritize investment in the maintenance of canal networks. Furthermore, the strategy should include measures to improve water-use efficiency through the adoption of precision irrigation techniques and drought-resistant crop varieties. Additionally, the policy should incentivize farmers to adopt water conservation practices and penalize excessive groundwater extraction. Monitoring and regulating groundwater levels and implementing rainwater harvesting and artificial recharge projects can contribute to sustainable management of water resources.

Reorient research agenda: Agricultural research in India has historically prioritized rice and wheat. However, this has resulted in a notable disparity in productivity between the staples and alternative crops. As India has achieved self-sufficiency in foodgrains, there is a pressing need to reassess research priorities and reallocate resources towards crops such as oilseeds, pulses, millets, and fibers. This shift in focus is crucial to enhance the competitiveness of alternative crops.

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Appendix

Table A1. Descriptive statistics: paddy

	All households (21563)	MSP aware households (8888)	Mean difference from not aware	Participation in market (6428)	Mean diff from non-participant	Selling to procurement agencies (1978)	Mean diff from not selling to procurement agencies
Age (years)	51.310	52.573	-2.148***	52.811	-0.860***	53.347	-0.775**
Gender (male = 1; female = 0)	0.921	0.941	-0.034**	0.942	-0.003	0.932	0.013**
Household size (Nos.)	5.072	5.082	-0.017	5.051	0.109*	4.847	0.296***
Education status							
Illiterate	0.338	0.259	0.134***	0.254	0.019*	0.247	0.011
Primary	0.242	0.237	0.008	0.238	-0.003	0.231	0.011
Secondary	0.277	0.307	-0.051***	0.308	-0.003	0.325	-0.024**
Higher secondary	0.069	0.086	-0.030**	0.087	-0.002	0.085	0.002
Diploma	0.009	0.012	-0.006***	0.011	0.003	0.015	-0.005*
Graduation & higher	0.065	0.097	-0.055***	0.101	-0.014**	0.098	0.004
Social group							
Schedule tribes	0.160	0.121	0.066***	0.105	0.059***	0.092	0.018**
Schedule caste	0.152	0.146	0.010**	0.142	0.015*	0.130	0.017*
Other backward caste	0.415	0.409	0.009	0.407	0.008	0.477	-0.101***
Upper caste	0.273	0.323	-0.085***	0.346	-0.082***	0.300	0.065***
Operational land holdings (hectares)	1.155	1.422	-0.454***	1.601	-0.647***	1.962	-0.521***
Paddy irrigated area (hectares)	0.710	0.972	-0.446***	1.199	-0.819***	1.490	-0.419**
Agricultural training (yes = 1; no = 0)	0.020	0.028	-.013***	0.029	-0.005	0.038	-0.012***
Member of farmer organization (yes = 1; no = 0)	0.045	0.064	-0.034***	0.073	-0.029***	0.108	-0.051***
Access to any source of information (yes = 1; no = 0)	0.627	0.713	-0.145***	0.730	-0.063***	0.766	-0.051***

Table A2. Descriptive statistics: wheat

	All households (15015)	MSP aware house-holds (5031)	Mean difference from not aware	Participation in market (3523)	Mean diff from non-participant	Selling to procure-ment agen-cies (919)	Mean diff from not selling to procure-ment agen-cies
Age (years)	51.167	52.442	-1.917***	52.415	0.089	52.882	-0.632
Gender (male = 1; female = 0)	0.927	0.952	-0.037**	0.957	-0.017***	0.944	0.017**
Household size (Nos.)	5.583	5.796	-0.320***	5.765	0.105	5.694	0.096
Education status							
Illiterate	0.342	0.255	0.129***	0.247	0.028**	0.221	0.034**
Primary	0.205	0.186	0.028***	0.188	-0.007	0.190	-0.003
Secondary	0.292	0.326	-0.051***	0.328	-0.007	0.353	-0.034*
Higher secondary	0.084	0.114	-0.045**	0.113	0.004	0.113	0.001
Diploma	0.008	0.012	-0.006***	0.013	-0.003	0.011	0.002
Graduation & higher	0.070	0.107	-0.056***	0.112	-0.017*	0.112	0.112
Social group							
Schedule tribes	0.086	0.041	0.067***	0.031	0.031***	0.040	-0.012*
Schedule caste	0.153	0.126	0.041***	0.116	0.034***	0.076	0.053***
Other backward caste	0.477	0.478	-0.002	0.460	0.060***	0.399	0.082***
Upper caste	0.284	0.355	-0.106***	0.393	-0.126***	0.484	-0.124***
Operational land holdings (hectares)	1.294	1.748	-0.6823***	2.033	-0.952***	2.487	-0.614***
wheat irrigated area (hectares)	.737	1.061	-0.487***	1.328	-0.889***	1.749	-0.569***
Agricultural training (yes = 1; no = 0)	0.013	0.018	-0.006***	0.018	0.001	0.022	-0.005
Member of farmer organization (yes = 1; no = 0)	0.031	0.039	-0.013***	0.045	-0.017***	0.069	-0.032***
Access to any source of information (yes = 1; no = 0)	0.608	0.755	-0.219***	0.766	-0.037***	0.749	0.022

Table A3. Regression estimates for paddy

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
1. Coefficient of probit model to predict treatment (TME1)									
Age (years)	0.006	0.001	0.000	0.006	0.001	0.000	0.006	0.001	0.000
Gender (male = 1; female = 0)	-0.045	0.055	0.415	-0.045	0.055	0.415	-0.045	0.055	0.415
Household size (Nos.)	-0.036	0.006	0.000	-0.036	0.006	0.000	-0.036	0.006	0.000
Education status (base = illiterate)									
Primary	0.100	0.039	0.010	0.100	0.039	0.010	0.100	0.039	0.010
Secondary	0.194	0.037	0.000	0.194	0.037	0.000	0.194	0.037	0.000
Higher secondary	0.203	0.056	0.000	0.203	0.056	0.000	0.203	0.056	0.000
Diploma	0.283	0.132	0.032	0.283	0.132	0.032	0.283	0.132	0.032
Graduation & higher	0.250	0.055	0.000	0.250	0.055	0.000	0.250	0.055	0.000
Operational land holdings size (hectares)	0.105	0.010	0.000	0.105	0.010	0.000	0.105	0.010	0.000
Attended agricultural training (yes = 1; no = 0)	0.085	0.082	0.301	0.085	0.082	0.301	0.085	0.082	0.301
Member of any registered farmer organization (yes = 1; no = 0)	0.424	0.053	0.000	0.424	0.053	0.000	0.424	0.053	0.000
Access to any source of information (yes = 1; no = 0)	0.264	0.030	0.000	0.264	0.030	0.000	0.264	0.030	0.000
Constant	-1.625	0.083	0.000	-1.625	0.083	0.000	-1.625	0.083	0.000
2. Coefficient for untreated potential outcome (OME0)									
Age (years)	0.001	0.004	0.697	-8.544	1.882	0.000	-132.042	30.498	0.000
Gender (male = 1; female = 0)	0.034	0.182	0.850	53.742	75.931	0.479	1523.382	1214.669	0.210
Household size (Nos.)	0.023	0.026	0.377	-18.368	12.901	0.155	-161.351	168.091	0.337
Education status (base = illiterate)									
Primary	0.045	0.116	0.695	-12.637	54.961	0.818	416.545	944.197	0.659
Secondary	0.070	0.111	0.528	-118.721	60.407	0.049	-1473.321	985.551	0.135
Higher secondary	0.386	0.206	0.061	21.386	86.772	0.805	1389.062	1508.315	0.357
Diploma	-0.141	0.286	0.623	-292.921	400.299	0.464	-4207.530	7081.195	0.552
Graduation & higher	0.064	0.207	0.757	-64.903	103.380	0.530	-211.562	1626.058	0.896

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
Caste (base = scheduled tribe)									
Schedule caste	0.719	0.132	0.000	464.578	66.823	0.000	9528.905	1179.195	0.000
Other backward caste	0.720	0.122	0.000	478.572	61.311	0.000	9971.278	1052.503	0.000
Upper caste	0.695	0.130	0.000	702.212	73.488	0.000	12454.780	1162.726	0.000
Operational land holdings size (hectares)	0.052	0.038	0.178	-0.543	33.050	0.987	31.945	455.545	0.944
Paddy irrigated area (hectares)	-0.043	0.047	0.358	71.954	38.087	0.059	1233.448	515.827	0.017
Attended agricultural training (yes = 1; no = 0)	-0.001	0.374	0.999	-79.544	146.547	0.587	-2680.294	2725.880	0.325
Member of any registered farmer organization (yes = 1; no = 0)	0.174	0.191	0.362	-15.399	109.992	0.889	1948.587	1689.465	0.249
Access to any source of information (yes = 1; no = 0)	0.288	0.080	0.000	72.975	35.972	0.042	2224.888	625.695	0.000
Constant	20.184	0.803	0.000	3331.019	261.140	0.000	71180.000	4506.358	0.000
3. Coefficient for treated potential outcome (OME1)									
Age (years)	-0.004	0.005	0.457	0.757	2.372	0.750	-13.805	45.863	0.763
Gender (male = 1; female = 0)	-0.326	0.254	0.199	122.966	126.493	0.331	797.914	2655.782	0.764
Household size (Nos.)	-0.016	0.029	0.568	10.071	11.940	0.399	337.969	233.190	0.147
Education status (base = illiterate)									
Primary	-0.061	0.188	0.746	99.160	84.013	0.238	1963.793	1635.770	0.230
Secondary	0.096	0.192	0.615	78.319	83.871	0.350	2267.283	1619.580	0.162
Higher secondary	0.060	0.279	0.829	-107.536	122.032	0.378	-876.052	2319.391	0.706
Diploma	0.198	0.328	0.547	56.130	242.446	0.817	2175.404	4723.651	0.645
Graduation & higher	0.050	0.277	0.857	89.353	124.529	0.473	3146.910	2344.585	0.180
Caste (base = scheduled tribe)									
Schedule caste	0.278	0.271	0.305	331.268	125.351	0.008	6485.347	2501.954	0.010
Other backward caste	0.316	0.240	0.187	317.099	105.260	0.003	7122.907	2096.775	0.001
Upper caste	0.684	0.272	0.012	474.200	125.361	0.000	11067.880	2446.241	0.000
Operational land holdings size (hectares)	0.043	0.047	0.366	-108.420	25.687	0.000	-2035.641	450.862	0.000

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
Paddy irrigated area (hectares)	-0.106	0.044	0.016	147.449	26.927	0.000	2334.467	476.314	0.000
Attended agricultural training (yes = 1; no = 0)	0.316	0.311	0.308	-372.494	151.501	0.014	-5644.298	3183.252	0.076
Member of any registered farmer organization (yes = 1; no = 0)	-0.098	0.271	0.717	105.979	106.942	0.322	1917.611	2232.569	0.390
Access to any source of information (yes = 1; no = 0)	0.025	0.185	0.892	-40.806	73.931	0.581	-314.314	1447.641	0.828
Constant	17.860	0.578	0.000	3338.745	429.303	0.000	73079.160	8827.889	0.000

Table A4. Regression estimates for wheat

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
1. Coefficient of probit model to predict treatment (TME1)									
Age (years)	-0.005	0.003	0.049	1.060	1.898	0.577	4.777	36.011	0.894
Gender (male = 1; female = 0)	-0.202	0.127	0.111	159.151	77.034	0.039	2818.839	1418.187	0.047
Household size (Nos.)	-0.008	0.010	0.461	6.968	7.483	0.352	95.929	142.187	0.500
Education status (base = illiterate)									
Primary	0.112	0.093	0.227	-108.947	53.080	0.040	-2086.423	998.328	0.037
Secondary	-0.062	0.084	0.456	-33.099	59.226	0.576	-1146.524	1105.861	0.300
Higher secondary	-0.267	0.108	0.013	16.068	80.001	0.841	-36.569	1512.595	0.981
Diploma	0.603	0.293	0.040	12.276	178.892	0.945	1859.766	3762.215	0.621
Graduation & higher	-0.326	0.127	0.010	-1.560	79.928	0.984	-663.050	1532.271	0.665
Caste (base = scheduled tribe)									
Schedule caste	-0.232	0.179	0.196	523.697	71.482	0.000	10361.510	1428.780	0.000
Other backward caste	-0.202	0.168	0.229	657.131	66.834	0.000	12982.640	1341.600	0.000
Upper caste	-0.012	0.188	0.948	693.811	69.693	0.000	14042.500	1424.872	0.000
Operational land holdings size (hectares)	0.175	0.027	0.000	-50.859	18.557	0.006	-593.553	342.463	0.083
Wheat irrigated area (hectares)	-0.158	0.029	0.000	95.067	18.769	0.000	1440.949	345.902	0.000
Attended agricultural training (yes = 1; no = 0)	-0.648	0.379	0.087	229.041	201.367	0.255	3277.055	3681.803	0.373
Member of any registered farmer organization (yes = 1; no = 0)	0.386	0.204	0.059	101.313	89.455	0.257	3789.448	1879.307	0.044
Access to any source of information (yes = 1; no = 0)	0.118	0.053	0.027	-26.583	35.230	0.451	-512.534	692.792	0.459
Constant	17.444	0.224	0.000	2380.300	142.643	0.000	45453.860	2693.040	0.000
2. Coefficient for untreated potential outcome (OME0)									
Age (years)	0.000	0.003	0.996	-1.546	2.860	0.589	-15.843	59.556	0.790
Gender (male = 1; female = 0)	-0.060	0.159	0.704	96.889	189.152	0.608	2504.621	3674.160	0.495
Household size (Nos.)	0.000	0.013	0.997	24.940	13.955	0.074	528.629	277.369	0.057
Education status (base = illiterate)									

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
Primary	0.005	0.110	0.965	-155.971	127.022	0.219	-2128.018	2557.335	0.405
Secondary	-0.033	0.096	0.733	128.925	113.081	0.254	3017.708	2288.685	0.187
Higher secondary	-0.171	0.127	0.179	-14.604	143.684	0.919	-481.427	2974.866	0.871
Diploma	-0.691	0.599	0.249	-287.556	457.429	0.530	-3025.481	10354.230	0.770
Graduation & higher	-0.015	0.140	0.916	-24.894	153.453	0.871	-710.215	3074.499	0.817
Caste (base = scheduled tribe)									
Schedule caste	0.279	0.239	0.243	723.912	220.090	0.001	14635.700	4498.976	0.001
Other backward caste	0.291	0.226	0.199	970.563	182.958	0.000	20602.140	3662.478	0.000
Upper caste	0.214	0.223	0.338	1023.936	178.107	0.000	21222.650	3578.415	0.000
Operational land holdings size (hectares)	-0.031	0.032	0.339	-35.726	33.403	0.285	-858.038	677.057	0.205
Wheat irrigated area (hectares)	0.052	0.038	0.170	-8.186	37.777	0.828	-491.299	798.257	0.538
Attended agricultural training (yes = 1; no = 0)	-0.302	0.272	0.268	-111.072	267.859	0.678	-4483.190	5581.756	0.422
Member of any registered farmer organization (yes = 1; no = 0)	-0.052	0.150	0.728	260.632	145.583	0.073	7332.997	3115.116	0.019
Access to any source of information (yes = 1; no = 0)	0.354	0.090	0.000	35.271	83.522	0.673	4639.839	1703.600	0.006
Constant	17.504	0.295	0.000	2631.142	289.148	0.000	45665.600	5845.514	0.000
3. Coefficient for treated potential outcome (OME1)									
Age (years)	0.004	0.001	0.007	0.004	0.001	0.007	0.004	0.001	0.007
Gender (male = 1; female = 0)	-0.126	0.084	0.134	-0.126	0.084	0.134	-0.126	0.084	0.134
Household size (Nos.)	-0.004	0.007	0.579	-0.004	0.007	0.579	-0.004	0.007	0.579
Education status (base = illiterate)									
Primary	0.145	0.056	0.010	0.145	0.056	0.010	0.145	0.056	0.010
Secondary	0.258	0.050	0.000	0.258	0.050	0.000	0.258	0.050	0.000
Higher secondary	0.323	0.069	0.000	0.323	0.069	0.000	0.323	0.069	0.000
Diploma	0.305	0.187	0.102	0.305	0.187	0.102	0.305	0.187	0.102
Graduation & higher	0.329	0.072	0.000	0.329	0.072	0.000	0.329	0.072	0.000
Operational land holdings size (hectares)	0.094	0.011	0.000	0.094	0.011	0.000	0.094	0.011	0.000

	Price			Yield			Income		
	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|	Coefficient	Robust std. error	Sig. P>|z|
Attended agricultural training (yes = 1; no = 0)	0.077	0.143	0.591	0.077	0.143	0.591	0.077	0.143	0.591
Member of any registered farmer organization (yes = 1; no = 0)	0.382	0.086	0.000	0.382	0.086	0.000	0.382	0.086	0.000
Access to any source of information (yes = 1; no = 0)	0.276	0.041	0.000	0.276	0.041	0.000	0.276	0.041	0.000
Constant	-1.864	0.115	0.000	-1.864	0.115	0.000	-1.864	0.115	0.000

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