Dynamics of Agriculture Supply Chain: Insights from Pan India Survey during Rabi Marketing Season

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This study examines the dynamics of retail food price formation for major rabi crops based on a pan-India survey covering farmers, traders, and retailers. Farmers' share in consumer prices is estimated in the range of 40 to 67 per cent across the select crops, with the highest share realised by wheat producers. The retailers' markups are generally observed to be higher than those of the traders. While cash transactions dominate payments in the agriculture supply chain, electronic payments registered a significant increase compared to previous similar surveys. Empirical analysis suggests that policy interventions, such as enhanced market infrastructure, and expanded cold storage capacity, to reduce supply chain inefficiencies and post-harvest losses, may benefit farmers and consumers.

Introduction

Food prices remain an important driver of overall inflation in several economies, especially emerging and developing economies. At the same time, the paucity of adequate data across various segments of the supply chain limits the understanding of dynamics of price formation - a crucial input in developing appropriate policy interventions. Access to granular information about the supply chain

could enhance market efficiency by improving trust among stakeholders (EU, 2024; GoI, 2025). The agriculture supply chain involves several actors, *viz.*, farmers, aggregators, traders, commission agents, processors, wholesalers and retailers that play their due role in delivering the final agri-commodity to the consumer. An efficient agriculture supply chain maintains transparency in the price formation mechanism with information available regarding cost structures, margins, and value additions across the supply chain. Various countries have taken steps to improve the efficiency of agricultural supply chain, such as the European Union's (EU's) initiative on the EU Agri-food Chain Observatory (AFCO) to strengthen farmers' position in the food supply chain and build trust among all stakeholders. A number of schemes such as the National Agriculture Market (eNAM), the formation of Farmer Producer Organizations (FPOs), Agriculture Infrastructure Funds, Agricultural Marketing Infrastructure scheme, Integrated Cold Chain, Food Processing, and Preservation Infrastructure scheme, Comprehensive Programme for Vegetables & Fruits have been introduced by the government of India in the recent years to improve the agriculture supply chain (details at Annex 1).

In this context, the Reserve Bank of India had conducted pan-India surveys to explore agriculture supply chain dynamics in 2018 and 2022 for major *kharif* crops. These surveys were aimed at assessing the price formation process at the retail level in major *kharif* crops by estimating the farmers' share in consumer prices and capturing the perception of the participants across the supply chain regarding various challenges and efficacy of the policy measures. This study expands the coverage to major *rabi* crops, *viz.* wheat, gram, lentil, and mustard. These crops, exclusively grown in *rabi* season, account for around 5 per cent of the CPI basket and 11 per cent of CPI

food basket. To the extent possible, a comparison of findings with the previous surveys of 2018 (Bhoi *et al.*, 2022) and (Suganthi *et al.*, 2024) has also been made[1,2].

The rest of the article is organised into four sections. Section II provides stylised facts on the significance of *rabi* crops and changing margins. Section III describes the survey methodology and coverage. Section IV presents the key survey findings and empirical analysis, and Section V provides concluding observations.

II. Stylised Facts

Rabi Season

India's agriculture year (July-June) comprises two major seasons: *kharif* and *rabi*.[3] The sowing of *kharif* crops, which require a hot and humid climate, starts with the onset of the southwest monsoon around the first week of June and finishes by around the end of September. The *rabi* (winter) season sowing starts in October and continues till the first week of February and generally requires a cold and dry climate. The *rabi* season accounts for around 48 per cent of the annual foodgrains production.

Crop-wise, wheat, gram and lentils within pulses, as well as rapeseed and mustard within oilseeds, are the major *rabi* crops grown exclusively during the *rabi* season. Over the years, the area and yield for *rabi* crops have increased (Chart 1).

Rabi crops have faced various challenges in terms of climate change and geopolitical tensions[4] in the last two years. With significant implications for food inflation and volatility, these challenges have also attracted a series of domestic and trade-related policy interventions. Analysing the behaviour of market intermediaries in fixing their markups can help to strengthen assessment and outlook of inflation dynamics.

In line with the previous *Kharif* surveys of 2022 and 2018, the trends in price dispersion between retail and *mandi* prices[5] have been examined by calculating margins using secondary data. Margin, as per cent of retail prices, has varied over time with some increase in wheat, and a drop in other crops (Chart 2). The margins could vary across crops for several reasons, such as transaction costs, wastage during transit, length of the holding cycle, *mandi*-level competition and infrastructure facilities.

Since margins at the aggregate level do not generally capture mark-ups[6] at various stages of the supply chain (*i.e.*, traders and retailers) and between production and consumption centres, an in-depth analysis of price build-up from farm to retail level assumes importance. While the previous surveys of 2022 and 2018 focused on *Kharif* crops, the present survey covers *Rabi* crops, thereby filling an important data gap.

III. Objectives, Coverage and Methodology of Survey

Survey Objectives

The current study uses a market structure that considers traders and retailers as intermediaries

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[1] The crops overlapping with the previous two *kharif* surveys include - tomato, onion, potato (TOP) and rice.

[2] The findings can be highly sensitive to the sample coverage and timing of the survey.

[3] The third cropping season is *Zaid* (summer) season. However, it has a minimal share, and separate data reporting for this season has started very recently. This study follows the earlier practice of clubbing it with *rabi* to have a longer time series of data.

[4] With Russia and Ukraine as major global players in wheat and edible oil markets, the geopolitical tensions between the two countries led to significant increase in international prices of these commodities that affected the domestic prices in India also.

[5] With retail prices being paid by the end-consumer and *mandi* prices assumed to reflect the price received by the farmer, margin is calculated as the difference between the two. Margins are presented as per cent of retail prices.
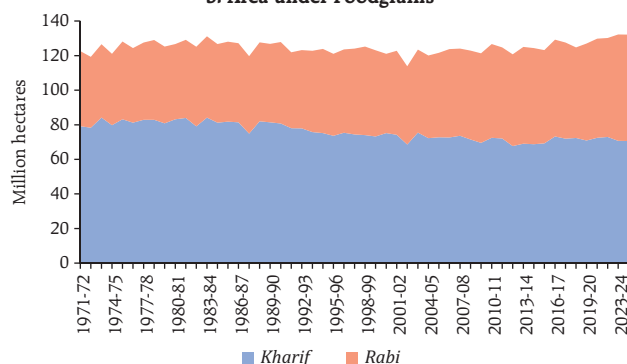
[6] Mark-up is the difference between revenue and total cost (including transaction cost) as per cent to total cost.
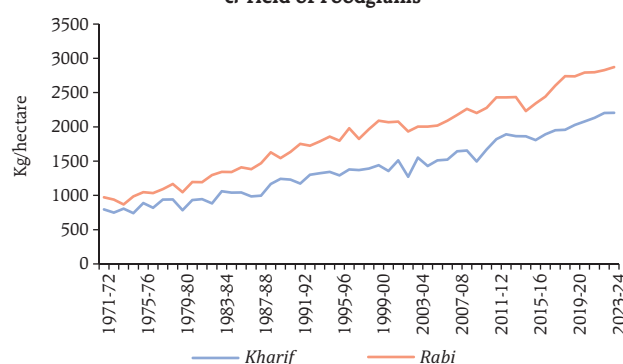
Chart 1: *Rabi* Crops

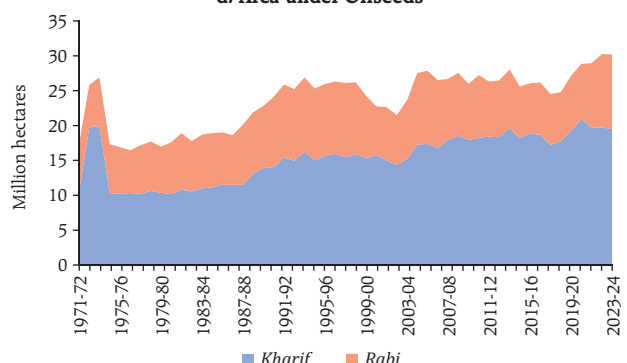**a. Major *Rabi* Crops (Share in area sown during *rabi* season 2023-24, in per cent)**
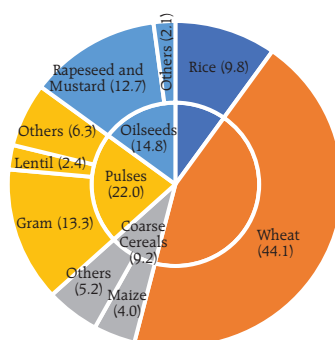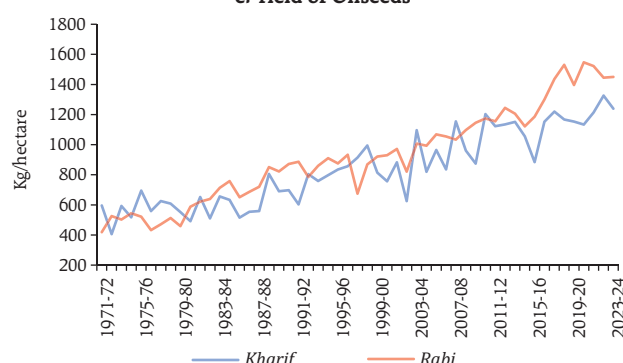

b. Area under Foodgrains

c. Yield of Foodgrains

d. Area under Oilseeds

e. Yield of Oilseeds

Sources: Agricultural Statistics at a Glance, 2023, Unified Portal for Agricultural Statistics; and Economic and Political Weekly Research Foundation.

between farmers and consumers, like the practice adopted in the past RBI surveys conducted in 2018 and 2022.[7] The primary objectives of the study are to assess the share of various market participants

in consumer prices[8], estimate the usage of different payment instruments in agricultural sales/trading, understand the perceptions of various stakeholders towards existing challenges in the agri-supply chain and assess the efficacy of the policy measures.

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[7] Given the inherent complexity of agriculture supply chains, with variations in number and roles of intermediaries across crops and regions, this study categorises the supply chain participants into three broad groups (farmers, traders, and retailers). While the existence of other intermediaries is acknowledged, this categorisation was done to ensure consistency and facilitate a comparative analysis.

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[8] For studying the value chain of a commodity, the average prices across the intermediaries and centres are used here rather than tracing the prices of the same item across intermediaries in the same location.

Chart 2: *Mandi* Prices *vis-à-vis* Retail Prices for Key Food Items

a. Cereals: Wheat

b. Pulses: Gram/Chana

c. Vegetables: Potato

d. Vegetables: Tomato

e. Vegetables: Onion
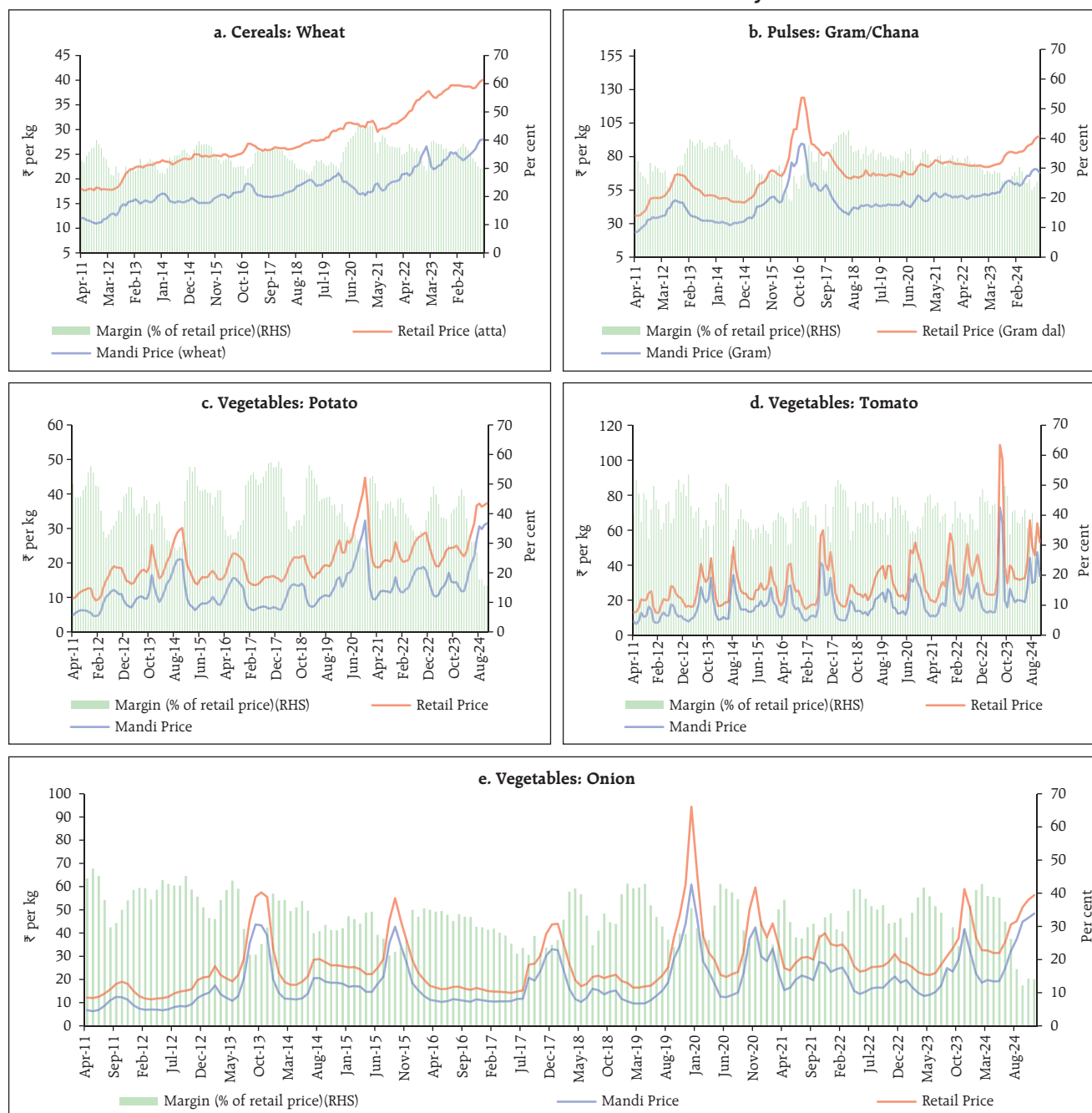
Sources: Agmarknet (mandi prices) and Department of Consumer Affairs (retail prices).

Survey Methodology

The survey covered *mandis/*villages in 86 centres across 18 states for 12 *rabi* crops using three separate questionnaires for farmers, traders, and retailers. It included 10,699 respondents across various consumption and production centres (Table 1). The survey was conducted during May-July 2024 in select production and consumption centres separately, considering the difference in supply chain dynamics of production centres, confined majorly in rural areas and consumption centres lying mostly in urban settlements.

Table 1: Coverage of Surveys

Survey Round	Segment	*Mandi*/Centre (Number of respondents)			Commodities
		Consumption Centres	Production Centres	Total	
2024 (*Rabi*)	Farmers	-	3800	3800	Cereals: Rice, Wheat, and Maize
	Retailers	2447	570	3017	Pulses: Gram (*Chana*) and Lentil
	Traders	2953	929	3882	Oilseeds: Rapeseed and Mustard
	Total	**5400**	**5299**	**10699**	Fruits and Vegetables: Mango, Onion, Potato, Tomato and Cauliflower
					Spices: Garlic
2022 (*Kharif*)	Farmers	-	2134	2134	Cereals: Paddy/Rice
	Retailers	3640	648	4288	Pulses: Tur, Moong, Urad
	Traders	3787	960	4747	Oilseeds: Groundnut, Soyabean
	Total	**7427**	**3742**	**11169**	Fruits and Vegetables: Apple, Banana, Coconut, Onion, Potato, Tomato, Green chillies and Brinjal
					Spices: Turmeric
2018 (*Kharif*)	Farmers	1147	1664	2811	Cereals: Paddy/Rice
	Retailers	2356	1052	3408	Pulses: Tur, Moong, Urad, Bengal gram
	Traders	2176	1008	3184	Oilseeds: Groundnut, Soyabean
	Total	**5679**	**3724**	**9403**	Fruits and Vegetables: Apple, Banana, Coconut, Onion, Potato, Tomato, Green chillies and Brinjal
					Spices: Turmeric, red chillies

Source: Primary surveys.

Two-stage sampling was used to select the respondents. Production centres were chosen based on their production share of the select *rabi* crops. In the production centres, *mandis* were identified as the first-stage units, and traders and retailers (within *mandi* and 5 km of *mandi*) were second-stage units. For participating farmers[9], the villages near the identified *mandis* were selected first, followed by the selection of the farmer households. The second stage selection process was random. The dataset was trimmed by eliminating the outliers pertaining to the estimated cost and profit margin per kilogram for traders and retailers.[10]

IV. Survey Findings and Empirical Analysis

Survey Findings

The average share of farmers in consumer prices varies between 40 per cent and 67 per cent for the crops covered under the Survey and the shares are generally higher for non-perishable crops (Chart 3). The farmers' share is the highest at 67 per cent in the case of wheat which is a notified commodity[11] for which a significant share of produce is sold by the farmers through the public procurement system. Around one-fourth of the respondent wheat farmers in the 2024 survey reported to have sold their output to the government under a procurement system. Procurement at minimum support price (MSP) gives farmers an assured market option. The estimate of 67 per cent in this study is consistent with the available literature which suggests that wheat farmers' share in the consumer price ranges between 53 per cent and 74 per cent (RACP, 2016 and Kumar *et al.*, 2023).
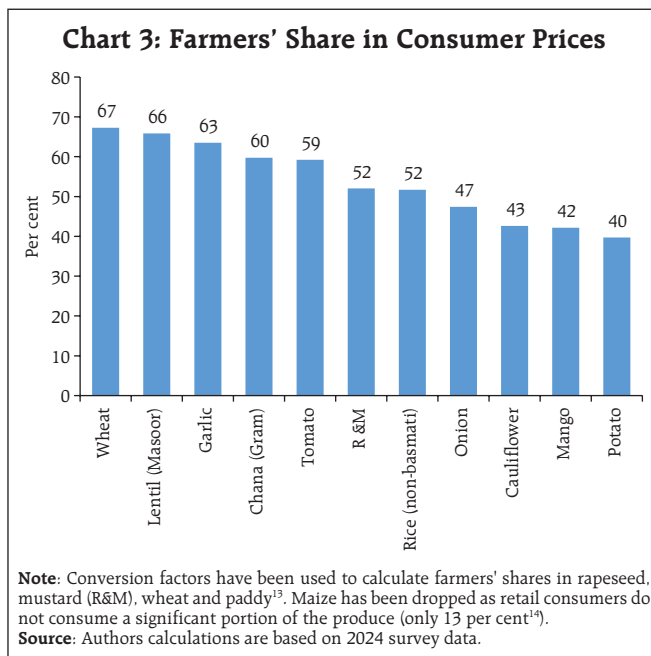
Within pulses, lentil producers receive around 66 per cent and gram (*chana*) around 60 per cent[12] of the rupee spent by the consumers. A higher share

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[9] Following the survey done in 2022, farmers were covered in the production centres alone.

[10] While every effort has been made to ensure the quality of responses through rigorous questionnaire design, robust sampling and telephonic verification of respondents, inherent limitations of primary surveys such as social desirability bias may still exist. The data used in the study is self-reported data and hence, is subject to potential recall error. Further, there could be loss of some information due to data trimming.

[11] The Agricultural Produce Market Committee (APMC) Act notifies agriculture commodities produced in the region and provides that first sale in these commodities can be conducted only under the aegis of the APMC through the commission agents licensed by the APMCs set up under the Act (GoI, 2015).

[12] The farmers' share for gram was estimated at 75 per cent in Jose *et al.* (2024).

Chart 3: Farmers' Share in Consumer Prices

Note: Conversion factors have been used to calculate farmers' shares in rapeseed, mustard (R&M), wheat and paddy[13]. Maize has been dropped as retail consumers do not consume a significant portion of the produce (only 13 per cent[14]).
Source: Authors calculations are based on 2024 survey data.

of farmers is desirable for lentils to incentivise production, as it is mainly grown by small-holder farmers and there is significant import dependency (Malik *et al.*, 2021). Within oilseeds, the survey results put farmers' share for rapeseed and mustard (R&M) at 52 per cent, comparable with the 55 per cent estimate reported by Layek *et al.* (2021). R&M are the second highest in terms of area and production after soybean and they contribute the most to the total edible oil basket of India (GoI, 2022). The government is also active in procuring it through the public procurement system to provide an assured market for the farmers.

The farmers' share in the prices of perishable commodities (fruits and vegetables) is estimated around 40-63 per cent. The share in consumer prices in case of perishable items can fluctuate widely

depending upon the prevailing demand-supply conditions. The existing literature suggests farmers' share to be in the range of 30-50 per cent of the final price in the case of fruits and vegetables (Gandhi and Namboodiri, 2002; Bhoi *et al.*, 2019; Das *et al.*, 2024). The perishable products are characterised by short shelf-life cycles, seasonal production, diverse quality and quantity, special logistical requirements, quality standards, demand and cost uncertainties, dependency on climatic conditions and supply chain lead time that create more uncertainties about their timely and sufficient availability in the markets (Duarte, 2024). In India, the fruit and vegetable supply chain comprises of many unorganised intermediaries, which creates difficulties in identifying the flow of products, funds and information across the supply chain, and, can compress farmers' share in consumer prices (Patidar *et al.*, 2018). A lower share of farmers' can also act as a constraint for farmers in diversifying from traditional cereal crops. As per the current survey, the combined share of traders and retailers is estimated to be more than half for all surveyed fruits and vegetables except tomatoes.

Amongst the set of crops which were surveyed in previous *kharif* rounds and this *rabi* round survey, the farmers' share in retail prices of rice is estimated at around 52 per cent in this survey.[15] The shares were 45 and 49 per cent during the *Kharif* surveys of 2022 and 2018, respectively. The TOP (Tomato, Onion, Potato) are primarily *rabi* crops. The farmers' share in consumer prices in the *rabi* survey is also broadly comparable to the estimates of the previous two *kharif* surveys (Chart 4).
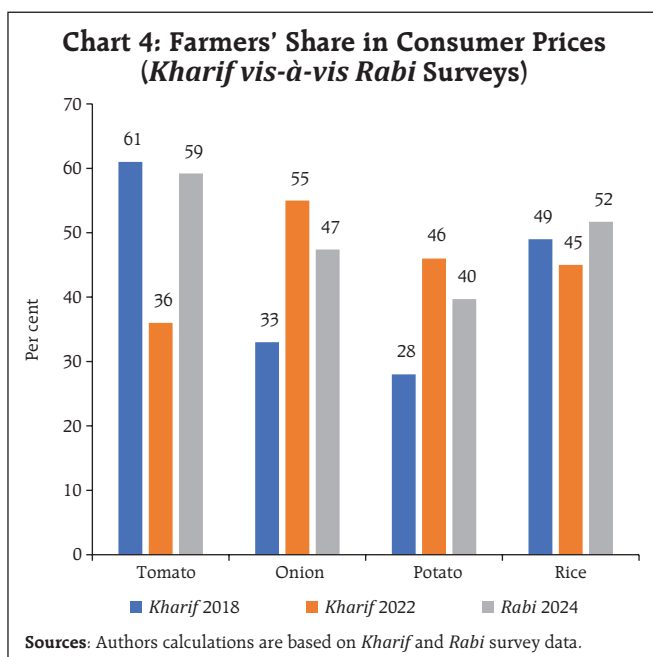
Traders' and Retailers' Mark-ups

Regarding the price build-up across the agriculture value chain, *i.e.*, between farmers' price realisation and the price charged by retailers, it was observed that farmers, traders, and retailers incur various charges

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[13] The oilseeds (here R&M) are sold by farmers as seeds but purchased by the final consumers in the form of oil. Moreover, the oilcake (leftover after extracting oil) is used as feed for cattle, poultry or fisheries. Accordingly, while computing the farmer's share, the retail price of oil has been converted to that of seed equivalent (at conversion rate of 0.4). Similarly, paddy gets converted into rice after milling which is then sold as final product at retail level. Wheat is also not generally sold as whole grain, rather purchased as atta at retail level. Accordingly, a conversion rate of 0.67 in the case of rice and a price differential for wheat (of around ₹4/kg) has been applied while computing the farmers' share.

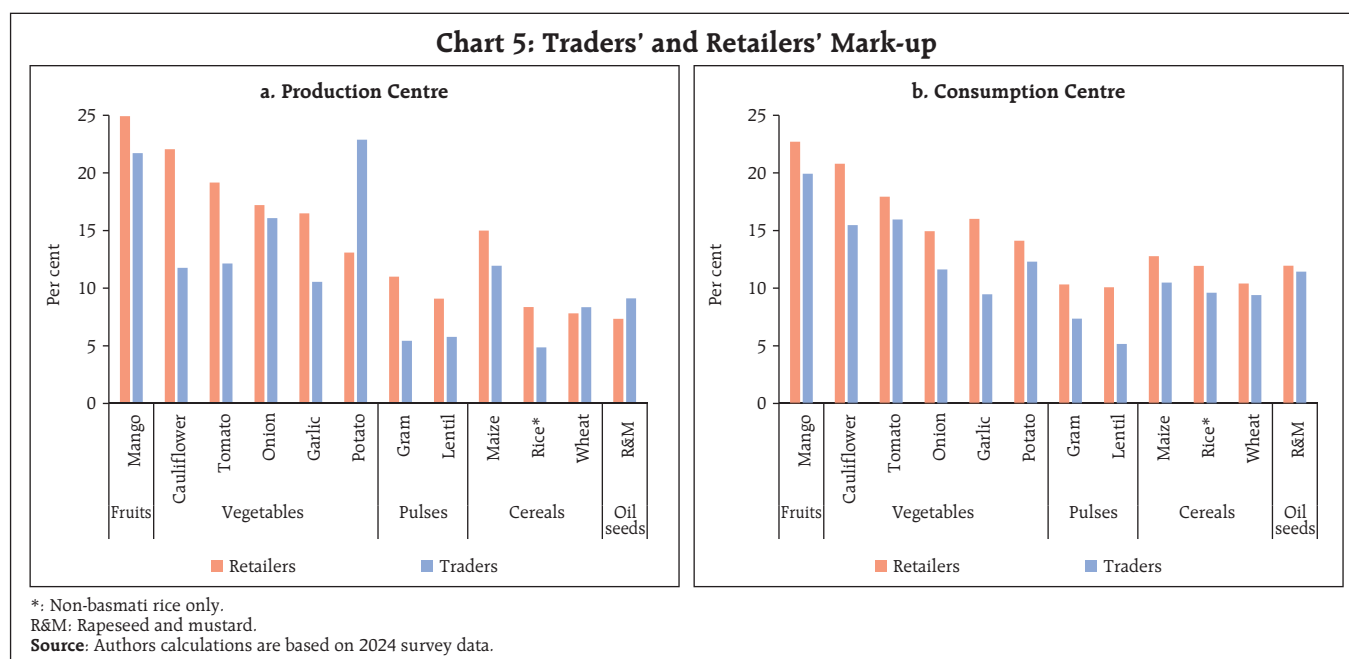[14] Indian Institute of Maize Research (https://iimr.icar.gov.in/?page_id=51).

[15] Rice is mainly a *kharif* crop. *Kharif* rice and *rabi* (including *zaid*) rice have shares of around 80 per cent and 20 per cent, respectively, in total rice production.

**Chart 4: Farmers' Share in Consumer Prices
(*Kharif vis-à-vis Rabi* Surveys)**

Sources: Authors calculations are based on *Kharif* and *Rabi* survey data.

during transactions. For farmers, post-harvest costs primarily include commission and *mandi* charges, loading/unloading charges, packing, weighing and grading charges. For traders and retailers, the factors influencing their mark-ups include membership fees, transport costs, shop rentals, local taxes, and storage costs.

The mark-ups of traders and retailers, defined as revenue less total cost (cost of products and transaction costs) as a percentage of the total cost, may vary amongst crops due to factors such as variation in storage cost depending on the length of holding cycle, quality including crop loss during transit and the shelf-life of the produce. The retailers' mark-ups across the surveyed commodities were estimated around 7-25 per cent, generally higher than those of the traders (5-23 per cent) in both production and consumption centres. Further, the traders' and retailers' mark-ups for perishables were observed to be higher than those for non-perishables (Chart 5). These survey findings are in consonance with other recent studies (Gulati *et al.*, 2022). Higher traders' markup for potatoes[16] in production centres in this survey could be a reflection of the surge in wholesale prices during the survey period, outpacing the increase in retail prices.

Amongst the common crops in the previous surveys and this survey, the mark-ups of traders and retailers appear to have generally moderated over

Chart 5: Traders' and Retailers' Mark-up

*: Non-basmati rice only.
R&M: Rapeseed and mustard.
Source: Authors calculations are based on 2024 survey data.

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[16] *Rabi* season accounts for 90 per cent of the overall potato production.

the previous survey results (Chart 6)[17]. At the same time, it may be noted that TOP are predominantly *rabi* crops; the lower mark-ups of traders and retailers in these items might be a reflection of the ample availability of perishable produce during this season (Jose *et al.*, 2021). Further, the government's recent policy measures, such as maintenance of buffer stock and external trade regulation of onion, supply through retail outlets such as Mother Dairy, *Safal*, and *Kendriya Bhandar* and setting up of the Price Stabilisation Fund (PSF) for TOP vegetables might have contained the intermediaries' mark-ups.

Usage of Payment Instruments

The survey also collected data on the usage of payment instruments by farmers, traders, and retailers for transactions and these data reveal that cash payments hold the highest share in their respective total payments - around 72 per cent for farmers, 45 per cent for traders and 61 per cent for retailers; the shares have, however, declined by 7-13 percentage points relative to the 2022 survey, although it may be noted that the crop coverage in the two surveys is different. Concomitantly, the usage of electronic payments, though highest for traders, has increased for all supply chain agents in line with the growing digitalisation of payments in the country[18]; as per the survey, 18-31 per cent of the responses were for electronic modes of payments (Chart 7). Cash-based value chains and market barriers can lead to lower returns for farmers (APEC, 2017). Digitalising agricultural payments can help make it easier for

Chart 6: Traders' and Retailers' Mark-up in 2024 *vis-à-vis* Past Surveys
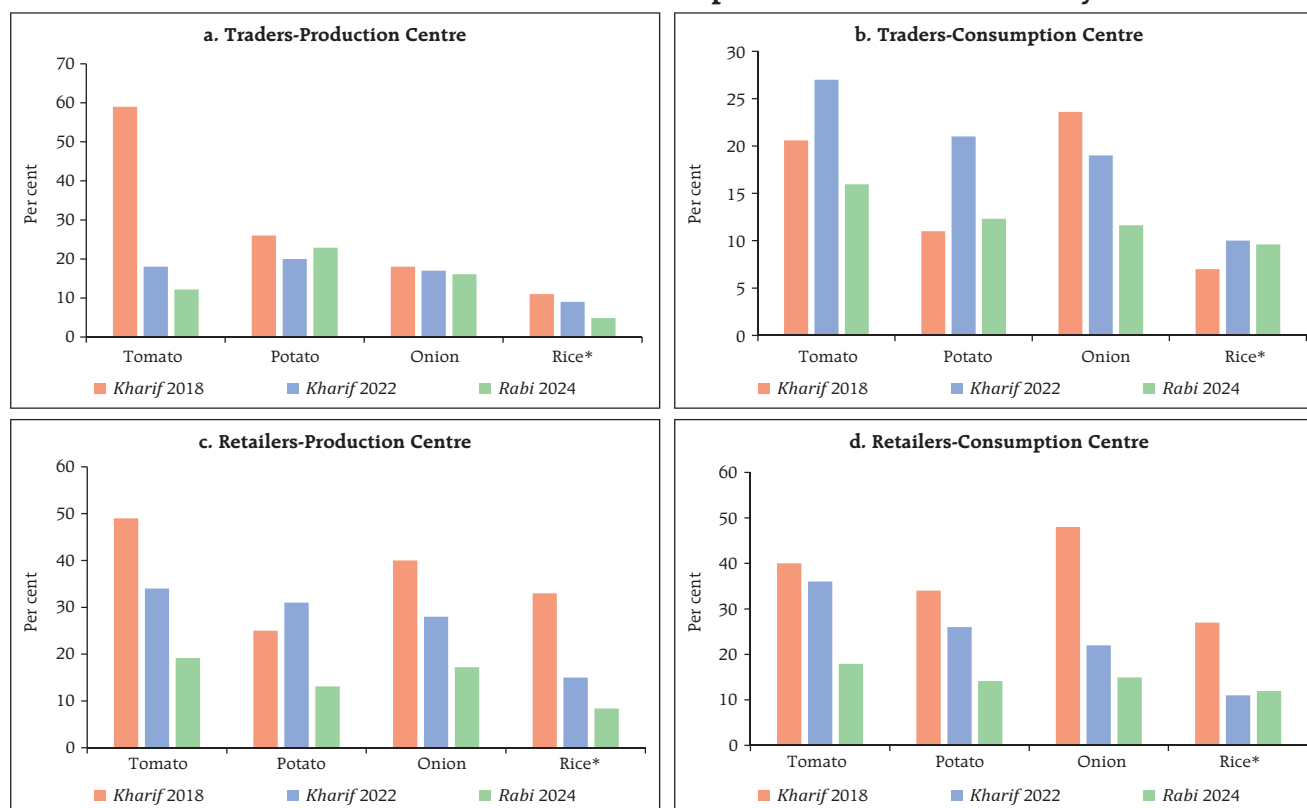
*: Non-basmati rice only.
Sources: Authors calculations are based on 2018, 2022 and 2024 survey data.

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[17] The study's comparison to previous surveys is subject to the change of agriculture marketing season as previous surveys were conducted during *kharif* marketing season.

[18] The usage of electronic payments, reported during 2022 survey, reflected an increase of more than 3-fold for traders and 5-fold for retailers relative to 2018 survey (Suganthi et al., 2024).

Chart 7: Modes of Payment

a. *Kharif* 2022

b. *Rabi* 2024

Note: 'Others' in Chart 7a includes redeemable receipts, on credit and vouchers; and 'Others' in Chart 7b includes redeemable receipts, cheques and credit transactions.
Source: Authors calculations are based on Kharif 2022 and Rabi 2024 survey data.
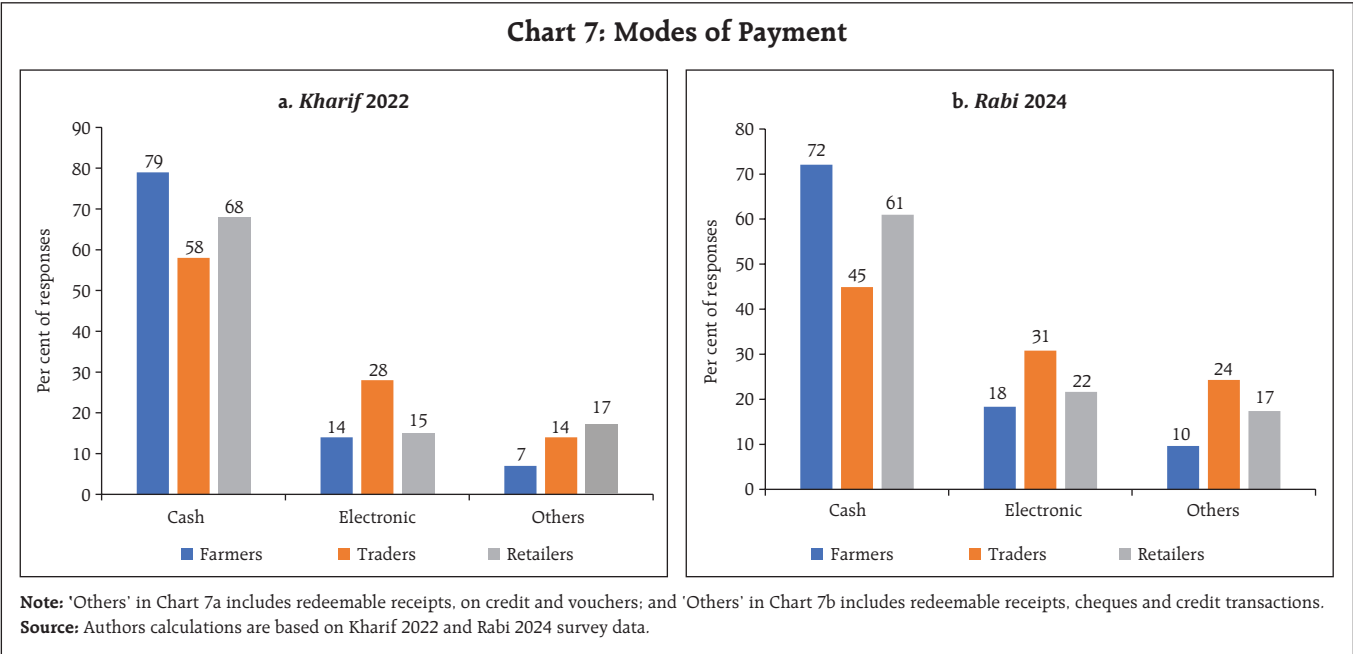
farmers to buy directly from input providers and sell directly to consumers, developing greater resilience of farmers to income shocks, especially in the light of their increasing vulnerability to adverse weather events and climate change (World Bank, 2024).
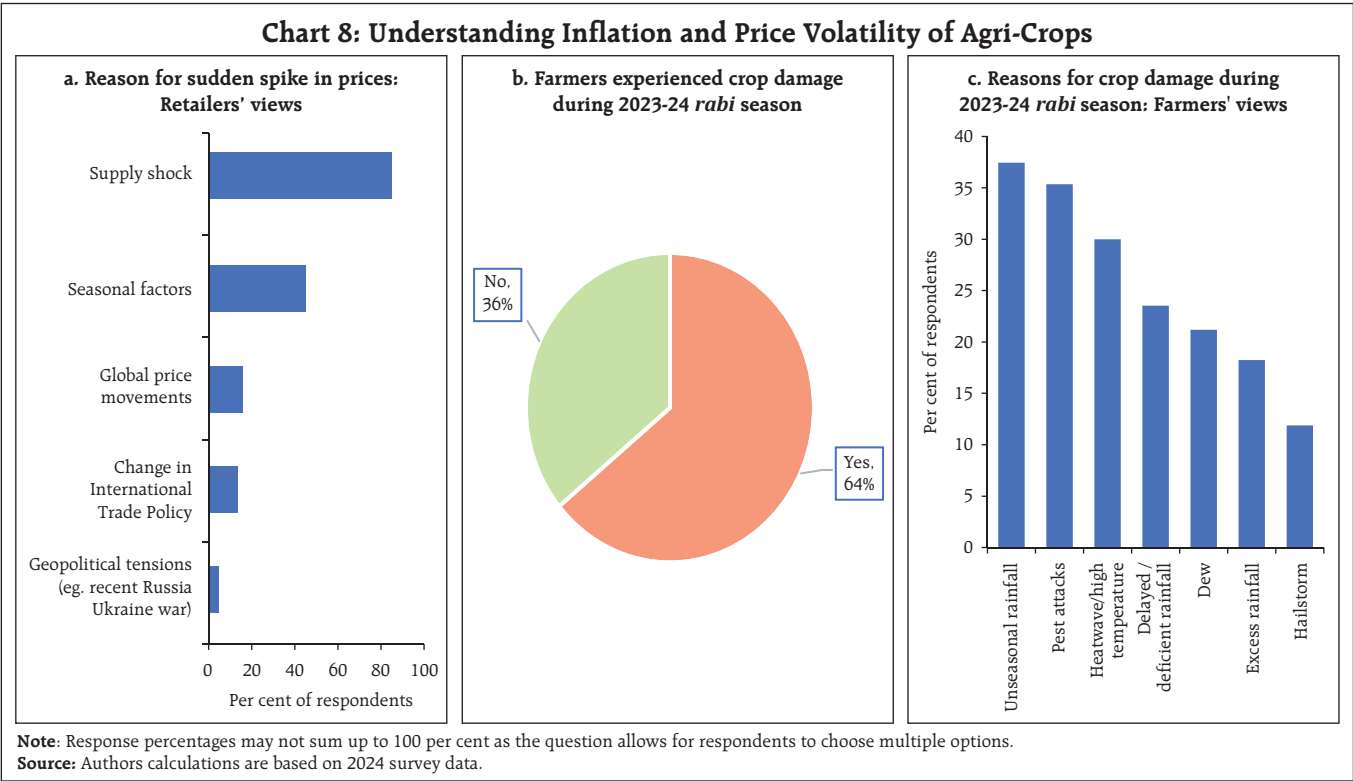
Price Volatility

As per *Rabi Survey* 2024, 85 per cent of surveyed retailers believed that supply shocks are the main reason behind the sudden rise in prices, followed by seasonal factors (Chart 8a). This is endorsed by

Chart 8: Understanding Inflation and Price Volatility of Agri-Crops

a. Reason for sudden spike in prices: Retailers' views

b. Farmers experienced crop damage during 2023-24 *rabi* season

c. Reasons for crop damage during 2023-24 *rabi* season: Farmers' views

Note: Response percentages may not sum up to 100 per cent as the question allows for respondents to choose multiple options.
Source: Authors calculations are based on 2024 survey data.

the farmer respondents, with 64 per cent of them experiencing some form of crop damage during the 2023-24 *rabi* season. Almost 37 per cent of the farmers held unseasonal rainfall as the primary reason for damages, followed by pest attacks and heatwaves (Chart 8b and 8c). Weather forecasts and the availability of irrigation are observed to be the primary factors that determine crop-sowing patterns for farmers (Chart 9).
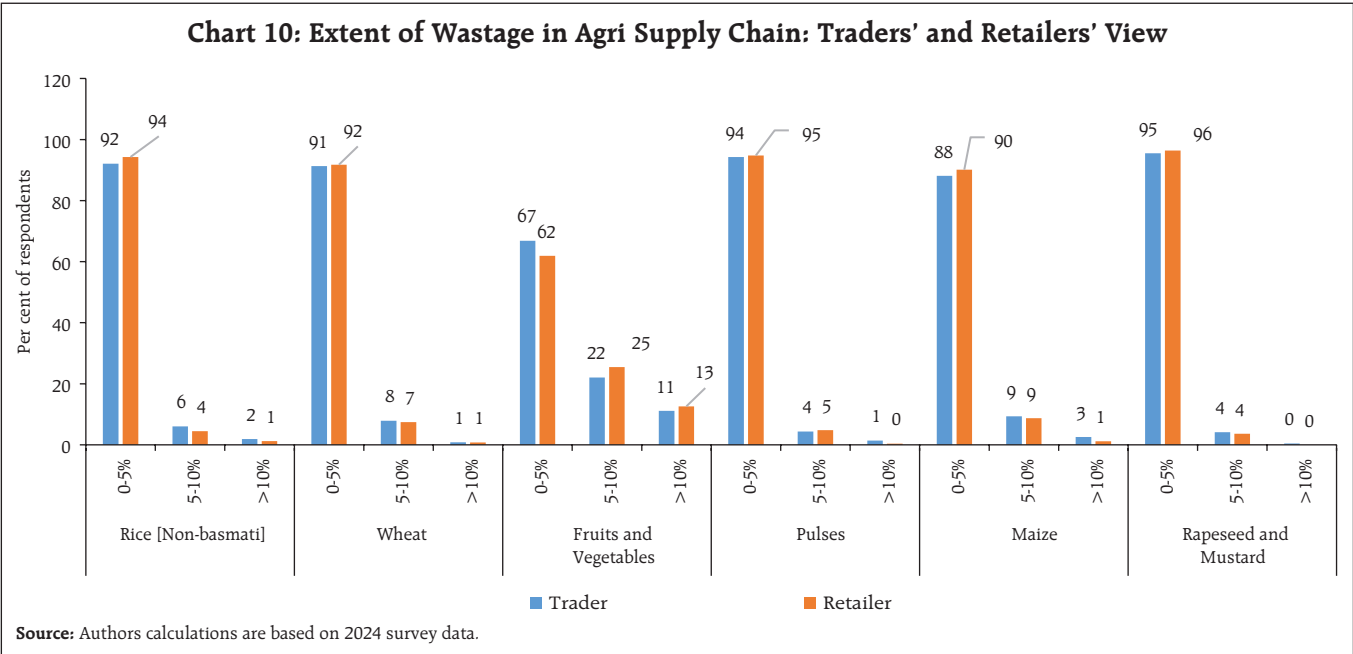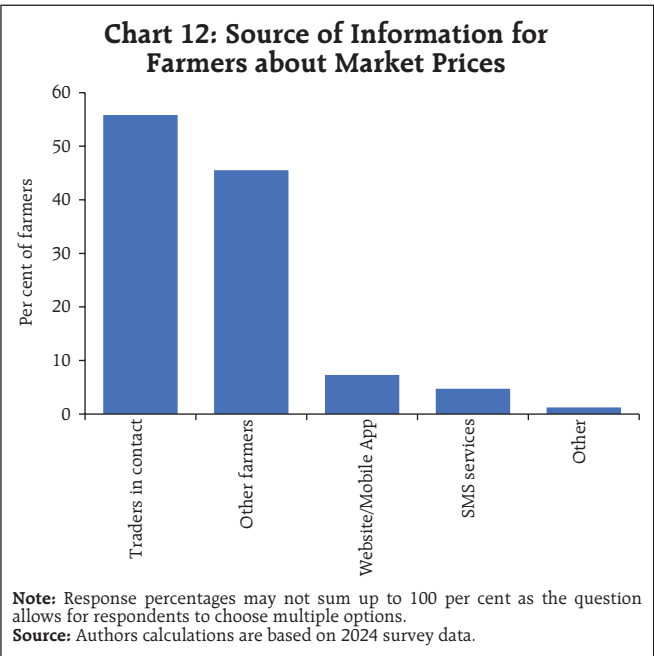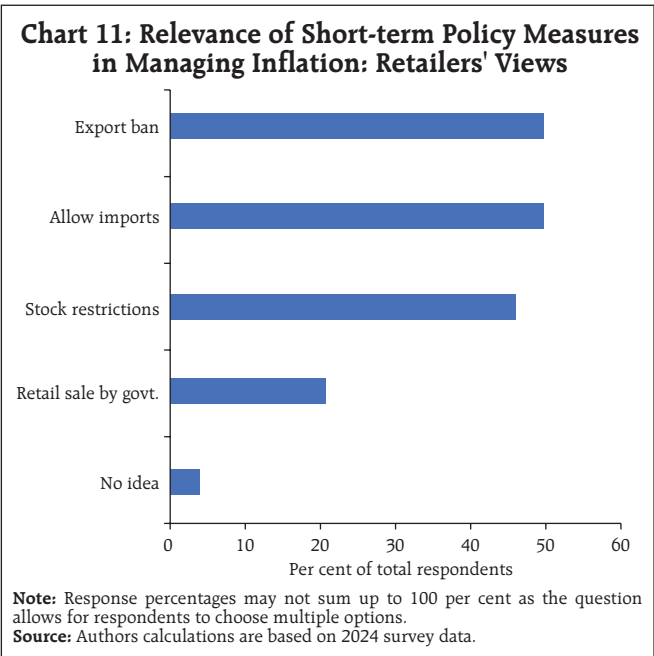
According to the survey, the traders and retailers reported higher wastages in fruits and vegetables relative to other crops (Chart 10). More than 10 per cent of the output wastage was reported to be prominent in the case of fruits and vegetables. Inadequate storage facilities, power outages, poor infrastructure connectivity to agricultural areas, and insufficient road and highway networks in India contribute to high post-harvest losses and the wastage is estimated to be in the range of 20-44 per cent (Kumar *et al.,* 2020; Kumar and Agrawal, 2023; Rais and Sheoran, 2023; NHB 2021 and Duarte, 2024).

To control price pressures, the government has in the recent years undertaken several crop-specific policy interventions such as imposition of stock

Chart 9: Factors Affecting Farmer's Crop Sowing Decision

Note: Response percentages may not sum up to 100 per cent as the question allows for respondents to choose multiple options.
Source: Authors calculations are based on 2024 survey data.
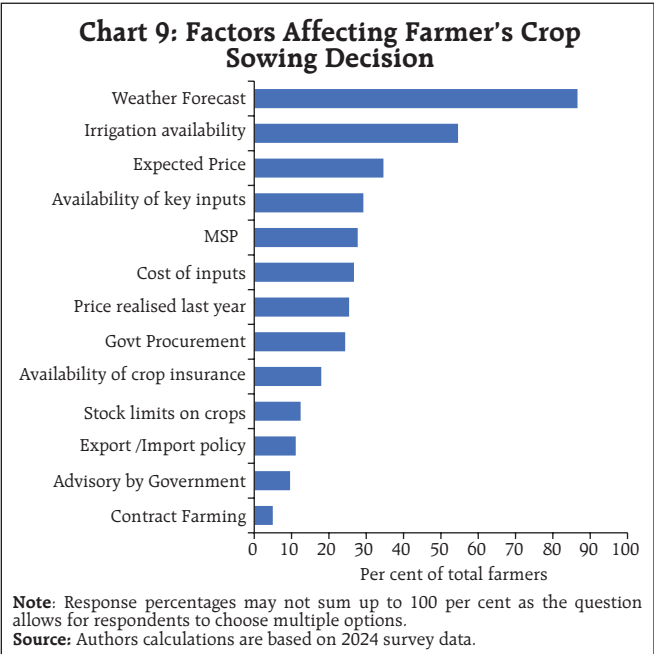
limits, restricting certain exports and liberalising certain imports and open market sales to ensure ample supplies in the domestic market. As per 59 per cent of the surveyed retailers, such intervention measures could be effective in curbing price pressures in the short run. Further, external trade and stock measures are suggested to be effective by almost half of the total respondents (Chart 11).
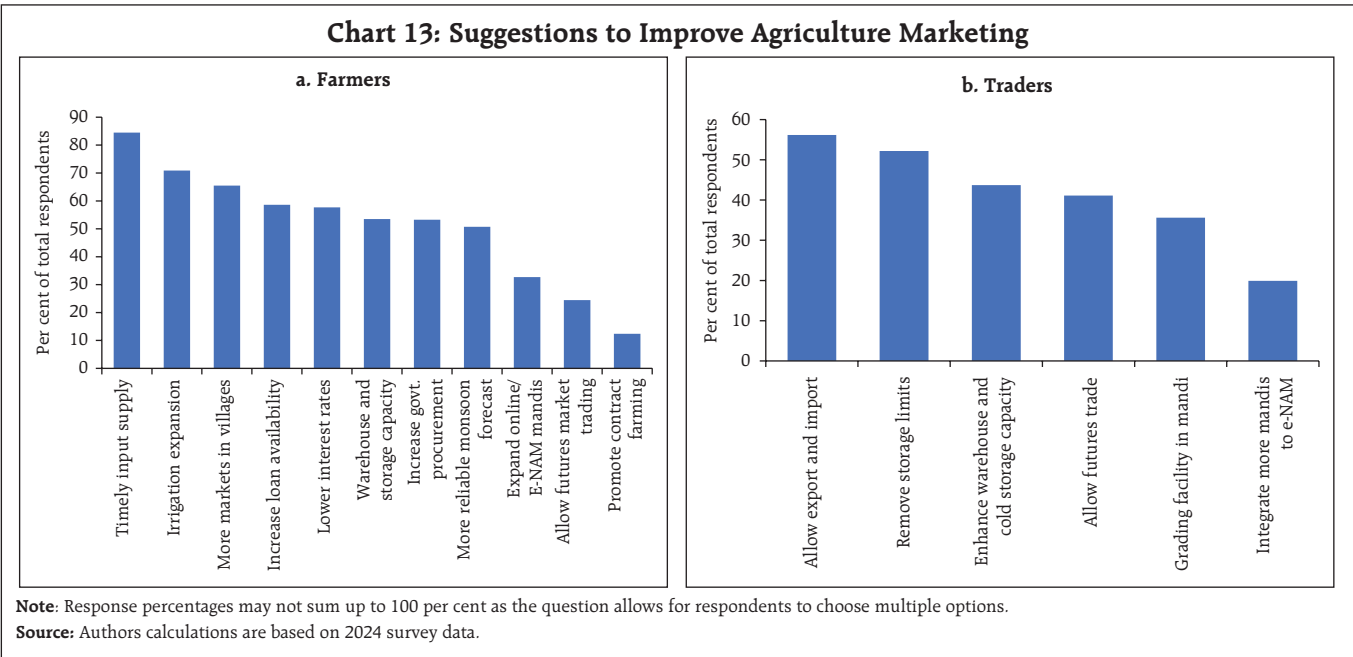
Chart 10: Extent of Wastage in Agri Supply Chain: Traders' and Retailers' View

Source: Authors calculations are based on 2024 survey data.

Chart 11: Relevance of Short-term Policy Measures in Managing Inflation: Retailers' Views

Note: Response percentages may not sum up to 100 per cent as the question allows for respondents to choose multiple options.
Source: Authors calculations are based on 2024 survey data.

Chart 12: Source of Information for Farmers about Market Prices

Note: Response percentages may not sum up to 100 per cent as the question allows for respondents to choose multiple options.
Source: Authors calculations are based on 2024 survey data.

Agricultural Marketing

Timely and reliable information on market prices can help farmers in the marketing of their produce. As per the survey, about 76 per cent of the farmers had information about prevailing market prices and they sourced it primarily from traders in their contact (Chart 12). The traders, being the main interlink between farmers and other supply chain participants, appear to serve as the dominant source of market information.

On improving marketing of agri-produce, the respondent farmers' main policy recommendation included 'creation of more markets in the villages', while traders reported liberalisation of the trade policy as the most essential tool (Chart 13). Although agriculture marketing has been one of the main areas

Chart 13: Suggestions to Improve Agriculture Marketing

a. Farmers

b. Traders

Note: Response percentages may not sum up to 100 per cent as the question allows for respondents to choose multiple options.
Source: Authors calculations are based on 2024 survey data.

of policy focus[19], agriculture being a state subject, implementing such policies is often hindered due to varying levels of regulation, willingness and consensus among the states (GoI, 2024). In terms of budgetary allocation, a significant share of government expenditure for agriculture has been observed to be apportioned more towards input subsidies like fertiliser and power, rather than supply chain development (Zafar *et al.*, 2023).

Empirical Findings

Mark-ups in the agriculture supply chain are the crucial indicators of added value at each stage. While excessive mark-ups could lead to higher food prices, lower mark-ups could impact the stakeholders' profitability (Bhattacharya, 2016). In the article based on the previous round of this survey, an empirical exercise was carried out to understand the factors impacting the traders' mark-ups (Suganthi *et al.*, 2024). In this study, an attempt has been made to identify the determinants of the mark-ups at the retailers' level based on the data collected from the survey. Ordinary Least Square regression has been run using following equation:

$$M_{idc} = \alpha + \beta_1 R_i + \beta_2 S_i + \beta_3 TC_i + \beta_4 D_i + \beta_5 W_i + \beta_6 (W_i \times P_c) + \beta_7 (E_d \times P_c) + \beta_8 N_i + \beta_9 CT_i + \beta_{10} C_c + \beta_{11} P_c + \varepsilon_{idc}$$

where, *i*, *d* and *c* represent 'retailer', 'district' and 'commodity', respectively.

Here, M_{idc} is the mark-up, defined as the selling price less total cost (including transaction cost) as a percentage of total cost for retailers. R_i represents retailers' demographic profile such as age, education and gender; S_i represents the retailer's perception

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[19] As part of strengthening agriculture markets, government initiated e-NAM to create a unified national market, thereby improving transparency and price discovery of agriculture commodities. Besides, government has taken steps to upgrade the existing rural *haats* into well-equipped Gramin Agricultural Markets to connect farmers directly with buyers. Further, to provide farmers with direct market access, FPOs have been onboarded on to Open Network for Digital Commerce (ONDC) portal for selling their produce online to consumers across the country.

about change in commodity supply over last year; TC_i is the transaction cost incurred per kg; and D_i denotes the distance of the retailer outlet from the point of procurement. W_i denotes the retailer's perception regarding the extent of wastage experienced; N_i represents the number of commodities sold by the retailer; E_d is the dummy variable capturing the extreme weather events in terms of large excess, excess and large deficient rainfall (cumulative) in the district. CT_i represents the fixed effect for retailer's outlet location (production/consumption centre). C_c and P_c denote the fixed effect for specific commodities and nature of commodity (perishable/non-perishable), respectively and ε_{idc} is the residual. Three model specifications have been presented here. While Model 1 (M1) serves as basic equation, the Model 2 (M2) utilises the interaction $(W_i \times P_c)$ of wastage with the nature of commodity (perishable/non-perishable) at multiple levels of wastage. Further, Model 3 (M3) replaces the wastage with extreme weather events and attempts to understand the impact of the latter on mark ups of perishable commodities using the interaction variable $(E_d \times P_c)$.

The regression analysis suggests that retailers are able to pass on the cost of wastage losses to consumers through higher retail prices in the case of perishable commodities (fruits and vegetables), while not being able to do so in the case of non-perishables. Accordingly, while the mark-ups are negatively impacted by product losses at the aggregate level (Model 1), for perishable commodities, the impact is positive (Model 2) [Table 2]. This suggests that retailers can draw higher mark-ups for perishable commodities, wherein the post-harvest loss incidence and product differentiation are relatively higher (Gulati *et al.*, 2022). Additionally, the transmission appears to increase with the extent of wastage, as indicated by model 2. The same is also revealed in model 3 where

the wastage dummy is replaced by extreme weather conditions dummy.[20] Weather disruptions are often one of the major contributors to post-harvest losses and supply chain wastage in the absence of adequate availability of temperature-controlled storage and transportation facilities (Tchonkouang *et al.*, 2024). The higher transaction cost (transportation, labour, rent) is found to shrink the mark-ups. Among the demographic variables, male retailers realise higher mark-ups across the various model specifications.

Table 2: Determinants of Retailers' Mark-ups: Regression Results

Dependent variable: Markup (log)	Model 1 (M1)	Model 2 (M2)	Model 3 (M3)
Demographic variables			
Log(Age, Years)	0.11 (0.04)**	-0.05 (0.06)	-0.03 (0.05)
Education (Dummy, SSC and above=1)	0.20 (0.03)***	-0.01 (0.04)	0.01 (0.04)
Gender (Dummy, Male =1)	0.19 (0.06)***	0.15 (0.08)*	0.11 (0.06)*
Higher supply compared to previous year (Dummy, Higher=1)	-0.06 (0.05)	-	-
Log (Transaction cost, Rs./kg)	-0.06 (0.02)***	-0.10 (0.02)***	-0.04 (0.02)**
Distance from place of procurement (1 if >10 km) [21]	-0.07 (0.05)	-0.09 (0.06)	-0.04 (0.05)
Wastage (1 if >2%)	-0.43 (0.06)***	-	-
Wastage (Dummy, Base: 0-2%)***Perishable** (Dummy)			
Wastage (2-5%)*Perishable	-	1.15 (0.11)***	-
Wastage (5-10%)*Perishable	-	1.25 (0.13)***	-
Wastage (>10%)*Perishable	-	1.46 (0.11)***	-
Extreme Weather (Dummy#)***Perishable** (Dummy)	-	-	2.20 (0.11)***
Number of commodities sold by the retailer (Log)	0.03 (0.01)***	0.01 (0.01)	0.02 (0.01)***
Intercept	1.23 (0.22)***	2.62 (0.27)***	2.42 (0.20)***
Centre fixed effect (Production/Consumption)	Yes	Yes	Yes
Commodity fixed effect	Yes	-	-
Perishable commodity fixed effect	-	Yes	Yes
Adj. R Square	0.57	0.23	0.56
No. of obs.	2287	2287	2287

***,**&*: significance levels at 1%, 5%and 10% respectively.
#: excess/large excess/large deficit rainfall.
Note: Figures in parentheses are robust standard errors, clustered at district level .
Source: Authors estimates are based on 2024 survey data.

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[20] a. https://seller.globallinker.com/bizforum/article/the-supply-chain-and-its-impact-on-agricultural-food-waste-in-india/8925#/overlay/signup/articleview/8925

b. https://www.wri.org/insights/climate-adaptation-agricultural-supply-chains

[21] Although statistically insignificant, the distance of the retail outlets from the procurement points appears negatively associated with the markups.

V. Conclusion

This article provides insights into India's agriculture supply chain across farmers, traders, and retailers based on a pan-India survey of major *rabi* crops conducted during May-July 2024. The survey results indicate that the farmers' share in consumer prices ranges from 40 per cent to 67 per cent across the crops surveyed, with the wheat producers realising the highest share. The perishable crops (fruits and vegetables) have lower farmers' share and higher trader/retailer markups than the non-perishables. The combined share of traders and retailers in consumer prices is more than half in perishables (except for tomatoes). The mark-ups of traders and retailers are observed to be lower for TOP crops during the *rabi* season compared to the *kharif* season, partially reflecting the impact of the ample availability of perishable produce during the *rabi* production season. While cash transactions dominate the payments in the agriculture supply chain, electronic payments registered a significant increase in 2024 survey over the previous surveys of 2018 and 2022 for all the participants. The weather forecast and irrigation availability appear to be the most critical factors in the farmers' decision function regarding *rabi* sowing.

An empirical analysis of mark-ups, using the survey data, indicates that higher transaction costs (transportation, labour, rent) reduce the retailers' markups, while higher post-harvest losses in perishables seems to permit the retailers to pass losses onto the consumers.

Overall, the survey findings and analysis indicate that further strengthening of market infrastructure through increased investment in cold storages and transportation systems can make agriculture supply chain more efficient and lower the post-harvest losses. Technology and enhanced collaboration among stakeholders can play an important role in improving such infrastructure, ultimately benefiting producers as well as consumers.

References

Bhattacharya, R. (2016). How does Supply Chain Distortion affect Food Inflation in India?. National Institute of Public Finance and Policy.

Bhoi, B., Kundu, S. Kishore, V and Suganthi, D. (2019). Supply Chain Dynamics and Food Inflation in India. RBI Bulletin, October.

Das, R., Roy, R., Gupta, S., Bordoloi, S., Kumar, R., Mohan, R. and Gulati, A. Price Dynamics and Value Chain of Fruits in India: A Study of Grapes, Bananas and Mangoes. RBI WPS (DEPR), 06/2024.

Duarte, A.L.C.M., Rodrigues, V.P., & Costa, L.B.M. (2024). The Sustainability Challenges of Fresh Food Supply Chains: An Integrative Framework. Environment, Development and Sustainability. April. (doi: 10.1007/s10668-024-04850-9).

EU (2024). https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/market-transparency_en (European Commission).

Gandhi, V.P. and Namboodiri, N.V. (2002). Fruit and Vegetable Marketing and its Efficiency in India: A Study of Wholesale Markets in the Ahmedabad Area. Indian Institute of Management. Ahmedabad.

Government of India (GoI) (2015). *Chapter 08: A National Market for Agricultural Commodities- Some Issues and the Way Forward.* Economic Survey (2014-15), Ministry of Finance.

Government of India (GoI) (2025). *Chapter 04: Price and inflation:- understanding the dynamics.* Economic Survey (2024-25), Ministry of Finance.

Government of India (GoI) (2024). *National Policy Framework on Agricultural Marketing (Draft).* Ministry of Agriculture and Farmers' Welfare. (https://www.dmi.gov.in/Documents/DraftNationalPolicyFrameworkOnAgriculturalMarketingPublicComments.pdf)

Government of India (GoI) (2022). PM Formalisation of Micro Food Processing Enterprises Scheme. E-Newsletter, Mustard Special, November. (https://pmfme.mofpi.gov.in/pmfme/newsletters/enewsmustardspecial1.html)

Gulati, A., Wardhan, H. and Sharma, P. (2022). Tomato, Onion and Potato (TOP) Value Chains. Agricultural Value Chains in India, 33.

Jose, J., Kishore, V. and Bhoi, B.B. (2021). COVID-19 Impact on Food Price Mark-ups in India. RBI Bulletin.

Jose, S., Gupta, S., Prasad, M.K., Das, S., George, A.T., Sonna, T., Suganthi, D. and Gulati, A. (2024) Pulses Inflation in India: A Study of Gram, Tur and Moong. RBI WPS (DEPR), 07/2024.

Kumar, A. and Agrawal, S. (2023). Challenges and Opportunities for Agri-Fresh Food Supply Chain Management in India. Computers and Electronics in Agriculture. Volume 212. (doi: 10.1016/j.compag.2023.108161).

Kumar, A., Mangla, S., Kumar, P. and Karamperidis, S. (2020). Challenges in Perishable Food Supply Chains for Sustainability Management: A Developing Economy Perspective, Business Strategy and the Environment, 29(5), pp. 1809-1831. (doi: 10.1002/bse.2470).

Kumar, S., Bhargava, H., Singh, P., Singh, J. and Verma, S.K. (2023). Economic Analysis of Marketing Channel of Wheat Production in Hardoi District of Western Uttar Pradesh, India. Asian Journal of Agricultural Extension, Economics &Sociology, Volume 41. Issue 10. pp140-148.

Malik, D.P., Devi, M. and Reddy, A.A. (2022). Global Status of Lentil Production with Special Reference to India. Indian Journal of Agricultural Sciences 92 (4). April.

National Horticulture Board (2021). National International Year of Fruits and Vegetables. October. (https://www.nhb.gov.in/KnowledgeCenter/IFVY-Presentation-Nov.pdf)

Patidar, R., Agrawal, S. and Pratap, S. (2018). Development of Novel Strategies for Designing Sustainable Indian Agri-Fresh Food Supply Chain. Indian Academy of Sciences. Sadhana 43:167. (doi: 10.1007/s12046-018-0927-6).

Rais M. and Sheoran, A. (2015). Scope of Supply Chain Management in Fruits and Vegetables in India. Journal of Food Processing & Technology. 6: 427. (doi: 10.4172/2157-7110.1000427).

Rajasthan Agricultural Competitiveness Project (RACP) (2016). Value Chain Analysis- Wheat. Prepared by Grant Thornton. Delhi.

Roy, R., Gupta, S., Wardhan, H., Sarkar, S., Tewari, S., Bansal, R., Bhatia S. and Gulati, A (2024). Vegetables Inflation in India: A Study of Tomato, Onion and Potato (TOP). RBI WPS (DEPR), 08/2024.

Saini, S., Khatri, P. and Hussain, S. (2024). Change in Farmers Stocking and Marketing Decisions: Findings from Survey of Gram and Mustard Farmers in Madhya Pradesh and Rajasthan. Arcus Research Report 4. New Delhi. March.

Singh, R.K., Patil, T., Pandey, D. and Sawarkar, A.N. (2021). Pyrolysis of Mustard Oil Residue: A Kinetic and Thermodynamic Study. Bioresource Technology. Volume 339, November.

Suganthi, D., Kumar, R. and Sethi, M. (2024). Agriculture Supply Chain Dynamics: Evidence from Pan-India Survey. RBI Bulletin, January.

Tchonkouang, R. D., Onyeaka, H. and Nkoutchou, H. (2024). Assessing the Vulne*rabi*lity of Food Supply Chains to Climate Change-Induced Disruptions. *Science of the Total Environment*, 171047.

Villacis, A.H., Kopp, T and Mishra, A.K. (2024). Agricultural Marketing Channels and Market Prices: Evidence from High-Value Crop Producers in India. Economic Analysis and Policy. Volume 81. pp 1308-1321. (https://doi.org/10.1016/j.eap.2024.02.004).

World Bank (2024). Data from the Global Findex 2021: Digitalizing Agricultural Payments in Sub-Saharan Africa. Regional Note. November. (https://www.worldbank.org/en/publication/globalfindex/brief/data-from-the-global-findex-2021-digitalizing-agricultural-payments-in-sub-Saharan-africa).

Zafar, S., Aarif, M. and Tarique, M. (2023). Input Subsidies, Public Investments and Agricultural Productivity in India. *Futur Bus J* **9**, 54 (2023).

Annex 1:

Government Schemes for Improving Supply Chain in Agriculture

To improve the agriculture supply chain, the government has implemented various schemes in recent years. Some of the important schemes include:

1. eNAM

eNational Agriculture Market (eNAM), a pan-India electronic trading portal, was launched in 2016. It networks the existing Agriculture Produce Market Committee (APMC) *mandis* to create a unified national market for agricultural commodities. Presently, 1410 *mandis* in 23 states and 4 UTs are integrated on eNAM.

2. The Agricultural Marketing Infrastructure (AMI) scheme

The AMI scheme aids with the construction or renovation of godowns and warehouses in rural areas to boost agricultural storage capacity. Since the scheme's inception on April 1, 2001, through June 30, 2024, a total of 48,512 storage infrastructure projects, with a combined capacity of 940 lakh tonnes, have been sanctioned across 27 states with subsidy disbursement of Rs. 4,735 crore.

3. The Agriculture Infrastructure Fund (AIF) scheme

The AIF scheme aims to attract investments for agricultural infrastructure development, with a total allocation of Rs 1 lakh crore until 2025-26. Under the scheme, loans with subsidised interest rates are provided for investments in farm-gate infrastructure like cold storage, warehouses, grading and sorting units and e-marketing platforms. As of January 2025, Rs. 53,687 crore has been sanctioned for 89,028 projects under the scheme.

4. Integrated Cold Chain, Food Processing, and Preservation Infrastructure scheme

The Integrated Cold Chain, Food Processing, and Preservation Infrastructure scheme aims to facilitate the establishment of a strong cold chain facility for agricultural, horticultural, dairy, fish & marine, poultry & meat products by establishing linkage from the farm gate to the consumer, to reduce losses through efficient storage, transportation, and minimal processing. As of August 2024, there are 8,698 cold storages in the country with a capacity of 396 lakh MT. Besides, the government of India has launched *Kisan Rail* to cater exclusively to the movement of perishable agri-horti commodities.

5. Prime Minister Dhan-Dhaanya Krishi Yojana

The budget 2025-26 has announced the launch of 'Prime Minister Dhan-Dhaanya Krishi Yojana' in 100 low productivity districts wherein measures to augment post-harvest storage at the panchayat and block level would be taken.

6. Comprehensive Programme for Vegetables & Fruits

The budget 2025-26 also announced a comprehensive programme for vegetables and fruits to promote production, efficient supplies, processing, and remunerative prices for farmers in partnership with states. Appropriate institutional mechanisms for implementation and participation of farmer producer organizations and cooperatives will also be set up. The government also announced to upgrade infrastructure and warehousing for air cargo including high value perishable horticulture produce.