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AGRICULTURAL SITUATION IN INDIA

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AGRICULTURAL SITUATION IN INDIA

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Editorial Desk

The current issue of "Agricultural Situation in India" covers farm sector news and statistical data on production and procurement of foodgrains, price indices, inflation rates, state-wise average daily wages along with two research articles, one on "Present Status and Challenges of Foodgrain Storage System" and second on "Effect of Sources and Levels of Silicon on Growth and Yield of Garlic Cv. Phule Nilima". In addition to this, an Agro-Economic Research study titled "Requirement and Availability of Cold-Chain for Fruits and Vegetables in the Country" conducted by the Agro-Economic Research Unit, Institute of Economic Growth (IEG), Delhi under the Agro-Economic Research scheme of Economics, Statistics and Evaluation Division, DA&FW is part of this edition.

The major farm sector news, inter-alia, cover events of G20 Meeting of Agricultural Chief Scientists (MACS); launch of Seed Traceability portal and mobile app; launch of Millets Experience Centre (MEC); news on linking of Atal Tinkering Labs (ATLs) with Krishi Vigyan Kendra (KVKs) and Agricultural Technology Management Agency (ATMAs).

The annual rate of inflation based on all-India WPI has decreased from 15.38 percent in April, 2022 to (-) 0.92 percent (provisional) in the month of April, 2023. The annual food inflation rate increased by 0.17 percent in the month April, 2023 (provisional) over April, 2022, whereas on month-on-month basis, the food inflation rate increased by 0.87 percent in April, 2023 over March, 2023, provisionally. The cumulative pre-monsoon season rainfall in the country during the period 1st March, 2023 to 26th April, 2023 has been 8 percent higher than the long period average (LPA). Current live storage in 146 major water reservoirs in the country is 64.13 BCM, as against the average storage of last 10 years, 53.39 BCM.

The research article on "Present Status and Challenges of Foodgrain Storage System" attempts to study the current scenario of grain storage, damages incurred, public-private initiatives undertaken and the farmers' perspective to this arrangement. The study finds that though India has become self-reliant in foodgrains, but it still lacks storage & warehousing facilities and also has low percentage of capacity utilization of warehouses. Although over the years, the quantity of foodgrains damaged in godowns has declined, but still a large quantity is lost dues to many reasons, majorly in transit. Government over the years is encouraging involvement of private companies to provide infrastructural as well as supply chain support but farmers still prefer the traditional way of selling the produce through mandi commission agents. The study recommends setting up of government owned silos on market yards as it will help reduce the financial burden on the government procuring agencies and is also the favored way of sale by the farmers.

The article on "Effect of Sources and Levels of Silicon on Growth and Yield of Garlic Cv. Phule Nilima" tries to ascertain the effects which the application of different silicon sources *viz.*, diatomaceous earth, calcium silicate and bagasse ash at multiple levels (0 to 200 kg Si ha^{-1}) has on the growth, yield and quality parameters of garlic. The study concludes that in addition to significant increase in growth and quality parameters of garlic, application of silicon helped in increased uptake of N, P, K and Si by the crop. However, there are variations among different silicon sources as well as levels of application. Application of silicon through bagasse ash @ 200 kg ha^{-1} was found beneficial for increase in polar diameter, total yield and marketable yield of garlic. Considering the availability and cost of material, bagasse ash can act as a good source of silicon for garlic.

The Agro - Economic Research study "Requirement and Availability of Cold-Chain for Fruits and Vegetables in the Country" focuses on the status of cold-chain industry in India, link between food security in the country and cold-chain and its growth prospects. The study observes that over the years, the number and capacity of cold storages have increased across the country. However, the cold-chain industry in India is highly fragmented with unorganized sector accounting for majority share of the total capacity. Cold-chain helps in reducing wastage of fruits and vegetables which in turn helps in providing regular access to safe, nutritious and sufficient food to the additional people. The study finds that much of the potential of cold-chain industry remains untapped as there is focus on storage of a single commodity. The study recommends development of other infrastructures like pack-houses, integrated cold-chains, etc. in addition to cold storages as it will ensure round-the-year delivery of fresh produce to vast majority of consumers and economic gains to all the stakeholders in the chain. Also impetus needs to be given to innovative approaches like real time monitoring of storage and quality parameters, data recording applications, leveraging ICT tools, etc. to improve the cold-chain sector in India.

Promodita Sathish

Farm Sector News

Meetings and Events

G20 Meeting of Agricultural Chief Scientists (MACS)

General (Dr.) VK Singh (Retd.), Union Minister of State for Civil Aviation, and Road Transport and Highways inaugurated the G20 Meeting of Agricultural Chief Scientists (MACS) in Varanasi on 17th April, 2023. The MACS is the 100th G20 meeting during India's G20 Presidency. About 80 foreign delegates from G20 member states, *i.e.* Australia, Argentina, Brazil, Canada, China, France, Germany, Indonesia, Italy, Japan, Mexico, Republic of Korea, Russia, Saudi Arabia, South Africa, Turkey, United Kingdom, USA and European Union; invited guest countries, *viz.* Bangladesh, Egypt, Mauritius, Netherlands, Nigeria, Oman, Singapore, Spain, UAE, Vietnam and International Organizations such as United Nations, International Monetary Fund, World Bank, World Health Organization, World Trade Organization, International Labour Organization, FSB, OECD, Chairs of Regional Organizations AU, AUDA-NEPAD, ASEAN and Special Invitees by India, *i.e.* International Solar Alliance, CDR and Asian Development Bank participated in the three day meeting.

General (Dr.) Singh said that India's G20 Presidency theme "One Earth, One Family, One Future" signifies collective efforts for achieving SDGs and the theme of MACS, "Sustainable Agriculture & Food System for Healthy People and Plant" resonates the emphasis put forth in the theme.

The Minister exhorted that bio-fortified crop varieties are the quicker solution to improve health and address nutrition issues of women and children. Over 5 m ha area in India is under bio-fortified varieties of different crops, he added. He emphasized that the pan-India presence of ICAR institutes and KVKs with domain expertise for crops, horticulture, livestock, fisheries, soil and water expertise/farm machineries, and farmers outreach is being utilized to provide ICT interface with plants, animals, man and machine.

General (Dr.) Singh urged the G20 countries to look into diverse areas of sustainable practices that promote diversification of crop production systems, efficient utilization of water resources and fertilizers, assimilation of horticulture practices, soil, health management, and post-harvest management of crops, among others. He said the emerging digital technologies should be utilized to usher in ease of farming across the G20 countries and the world.

Subsequently the discussions were held on Innovations and Technological Interventions for Agri-Food Systems Transformation, Frontiers in Science and Technology for Achieving Food Security & Nutrition, Biofortification in Food Crops for Enhancing Nutritional Value, Tropical Seaweed Farming for nutrition and blue growth, Millets And otHer Ancient Grains International Research Initiative (MAHARISHI), One Health as an Integrated and Unifying Approach: Partnerships and strategies for coordinated action, Transboundary Pests and Diseases: R&D Priorities for resilient agri-food systems, Climate Resilient Technologies and Innovations for sustainable agri-food systems, Nature-Positive Agriculture: Science and Innovations for building resilient agri-food system, Biological Nitrification Inhibition (BNI): Reducing GHS emissions and Increasing crop yields.

On the second day of the G20 Meeting of Agricultural Chief Scientists (MACS), deliberations were held on Digital Agriculture and Sustainable Agri Value Chain & Public - Private Partnership in Agricultural R&D. MACS Communique was also discussed. Secretary (DARE) & Director General (ICAR), Dr. Himanshu Pathak, who is also the MACS Chair, led the discussions.

Morning session deliberations focused on Digital Agriculture and Traceability; Digital Technological Solutions for Reducing Food Loss and Waste; Agri-tech Startup Ecosystem; Pluralistic Agricultural Extension and Advisory Services (EAS): partnerships for improving lab to land and outreach, Smallholder and Family Farming: G20- Global South Cooperation for Agri-R&D, Public-private Agri-R&D for Public Goods: Experience in Generating and Accelerating Innovations.

Earlier, a bilateral meeting was conducted with FAO. Dr. Pathak emphasized that the extension service through KVK to farmers would be a very important area of cooperation. FAO representatives also expressed keen interest in extending cooperation in extension service. Dr. Ishmahane Elouafi, Chief Scientist, FAO, and Dr. Selvaraju Ramasamy, Senior Agriculture Officer, FAO participated in the meeting. They recognized India's strength in the seed sector, which will be very useful to other countries.

The meeting adopted chair summary cum outcome document focussing on major area of cooperation in agricultural research and development for food security and nutrition, digital agriculture, resilient agri food systems and public private partnership in agricultural R&D. MACS 2023 also supported launching of MAHARISHI which inter-alia will include:

- Establish mechanisms to connect researchers and institutions working on identified grain crops to enhance the dissemination of research findings, and identify research gaps and needs.
- Establish web platforms to connect researchers, exchange data, share communication products and thematic briefs to encourage research and information sharing.
- Organize capacity - building activities and international workshops and conferences.
- Performance identification and recognition to scientists

MAHARISHI secretariat shall be housed at Indian Institute of Millets Research (IIMR), Hyderabad with technical support from ICRISAT, One CGIAR Centres and other International organizations. On the sidelines of G20 MACS, bilateral meetings were held with France, United Kingdom, Argentina and Germany for future collaboration in agriculture research. A bilateral meeting was also held with Food and Agriculture Organization, Rome, Italy. In the meeting, Dr. Pathak emphasized that the FAO and ICAR may develop collaborations for strengthening extension service through KVKs. Dr. Ishmahane Elouafi, Chief Scientist, FAO also expressed keen interest in extending cooperation in extension service. Dr. Selvaraju Ramasamy, Senior Agriculture Officer, FAO also joined the meeting.

Indo-German bilateral meeting discussed to address the challenges of Food Loss and Waste Prevention targeting SAARC Region.

General Agricultural Sector News

ATLs linked with KVKs & ATMAs

Atal Innovation Mission (AIM), NITI Aayog, and the Ministry of Agriculture and Farmers Welfare (MoA&FW) have come together to promote innovation in the agricultural sector among school students across India. The two government bodies have agreed to connect Atal Tinkering Labs (ATLs) with Krishi Vigyan Kendra (KVKs) and Agricultural Technology Management Agency (ATMAs) under the initiative. KVKs function as a "Single Window Agricultural Knowledge Resource and Capacity Development Centre," and this collaboration will provide numerous stakeholders with necessary information, training, and inputs. KVKs, in partnership with ATMA, will collaborate with nearby ATLs to support agricultural related innovation.

During the first phase of the implementation, one KVK under each of the 11 Agricultural Technology Application Research Institutes (ATARIs) will be involved, providing technology backstopping and facilitating knowledge sharing and skill building exercises. KVK experts will also undertake need based visits to nearby ATLs, while KVKs will provide literature, seeds, planting materials and other inputs as required. The pilot project will be extended after assessing the positive outcomes after two years.

Addressing the gathering, Secretary, DA&FW, Shri Manoj Ahuja spoke about the potential of this collaboration to address the various challenges of agriculture. He further added that under this framework, MoA&FW and ATL can develop a problem finding platform and organize hackathons. He stressed the need for adopting an "integrated learning approach" to find solutions to the problems of farm sector.

Seed Traceability portal and mobile app

Hon'ble Union Agriculture and Farmers Welfare Minister, Shri Narendra Singh Tomar on 19th April, 2023 launched the SATHI (Seed Traceability, Authentication and Holistic Inventory) portal and mobile app, a centralized online system for seed traceability, authentication and inventory designed to deal with the challenges of seed production, quality seed identification and seed certification. It has been developed by the NIC in collaboration with the Union Ministry of Agriculture and Farmers Welfare on the theme of 'Uttam Beej – Samriddh Kisan'.

Shri Tomar said that the first phase of SATHI portal has just been launched. He directed the officials to ensure that the second phase does not take long. Efforts should be made to increase awareness so that the farmers get full benefit from it. There will be a QR code under this system through which the seeds can be traced. Training should be imparted through Indian Council of Agricultural Research (ICAR), Krishi Vigyan Kendras and State Governments. He urged all the states to join the Seed Traceability System.

SATHI portal will ensure quality assurance system and identify the source of seed in the seed production chain. The system will consist of integrated 7 verticals of the seed chain - Research Organization, Seed Certification, Seed Licensing, Seed Catalogue, Dealer to Farmer Sales, Farmer Registration and Seed DBT. Seeds with valid certification can only be sold by valid licensed dealers to centrally registered farmers who will receive subsidy through DBT directly into their pre-validated bank accounts.

Millets Experience Centre (MEC)

Hon'ble Union Minister of Agriculture & Farmers Welfare, Shri Narendra Singh Tomar, along with Shri Rajbir Singh, Managing Director, NAFED commemorated the launch of the first of its kind 'Millets Experience Centre (MEC)' at Dilli Haat, INA, New Delhi on 28th April, 2023. NAFED in collaboration with the Ministry of Agriculture and Farmers Welfare (MoA&FW) established the Millets Experience Centre with an aim to raise awareness on millets and encourage its adoption among general public. The Ministry led initiative of establishing a consumer oriented 'Millets Experience Centre' would not only promote the dietary benefits of the ancient grain, but also popularize millets or Shree Anna as a nutritional powerhouse fit for cooking a variety of dishes like millets dosa, millets pasta, etc. In addition to a unique dining experience, customers can also purchase a variety of ready to eat and ready to cook products from local millet startups at the MEC.

General Survey of Agriculture

Trend in food prices

The rate of inflation, based on all-India WPI, stood at -0.92% (Provisional) for the month of April, 2023 as compared to 15.38% during the corresponding period of last year.

WPI food index (Weight 24.38%): The food index consisting of 'Food Articles' from Primary Articles group and 'Food Product' from Manufactured Products group has increased from 172.1 in March, 2023, to 173.6 in April, 2023. The rate of inflation based on WPI food index decreased from 2.32% in March, 2023 to 0.17% in April, 2023.

Based on Wholesale Price Index (WPI) (2011-12=100), the WPI of pulses and cereals increased by 5.55 percent and 7.69 percent, respectively, and for fruits and vegetables it decreased by 4.55% and 1.50%, respectively, in April, 2023 over corresponding period of last year. On month-on-month basis, the WPI for vegetables, pulses and fruits increased by 4.49 percent, 2.22 percent and 8.04 percent, respectively, and for cereals, it decreased by 0.05 percent in April, 2023 over March, 2023.

Among cereals, the WPI based rate of inflation for wheat and paddy increased by 7.27 percent and 7.12 percent, respectively, in April, 2023 over April, 2022 while on month-on-month basis, the WPI for paddy increased by 0.40 percent and for wheat it decreased by 0.64 percent in April, 2023 over March, 2023.

Rainfall and Reservoir Situation, Water Storage in major Reservoirs

Cumulative pre-monsoon season (March-May), 2023 rainfall for the country as a whole during the period 1st March, 2023 to 26th April, 2023 has been 8% higher than the Long Period Average (LPA). Rainfall in the four broad geographical divisions of the country during the above period has been higher than LPA by 167% in Central India, by 32% in South Peninsula but lower than LPA by 24% in East & North East India and by 2% in North-West India.

Out of 36 meteorological sub - divisions, 23 meteorological sub-divisions received large excess/ excess rainfall, 05 meteorological sub-divisions received normal rainfall and 08 meteorological sub-divisions received deficient/large deficient rainfall.

Current live storage in 146 reservoirs (as on 27th April, 2023) monitored by Central Water Commission having Total Live Capacity of 178.19 BCM was 64.13 BCM as against 66.63 BCM on 27.04.2022 (last year) and 53.39 BCM of normal storage (average storage of last 10 years). Current year's storage is 96% of last year's storage and 120% of the normal storage.

Articles

Present Status and Challenges of Foodgrain Storage System

H.K. MAVI[1] AND SANGEET RANGUWAL[2]

Abstract

Foodgrains are an integral part of day to day needs of all human beings. Specifically in case of our country, there is no dearth of foodgrains, but there is lack of proper storage and warehousing facilities. Furthermore, India also faces a low percentage of capacity utilization (86.15%) of total installed capacity of the warehouses. The utilisation of the owned storage capacity has declined from 87.64 percent to 84.4 percent while that of the hired has risen from 78.41 to 89.13 percent during the period 2000-01 to 2020-21. Further, the quantum of damaged/wasted foodgrains was about 1806 tonnes in 2020-21 with major reason being losses during transport. Though the Government is trying to provide appropriate and adequate storage facilities, it needs some inputs from the private players in the related field with a vision to fill the infrastructural gaps. But the situation is not that good even after the inputs from private players as the silos set up them are proving to be a costly affair for FCI. It is recommended that the Government should set up highly developed silos on the APMC market yards in order to cut the financial costs that are a burden on the farmers as well as FCI's pockets.

Keywords: *Foodgrains, wastage, warehouse, FCI.*

1. Introduction

India being an agrarian economy has about 70 percent of its rural households still reliant mainly on agriculture for their living, in which 82 percent of agriculturalists belong to small and marginal category. India is the second largest grower of rice, wheat, sugarcane, cotton, groundnuts, vegetable and fruits (FAO, 2021). India's foodgrain production is projected at 315.72 million tonnes (mt) in the crop year 2021-22 which is supposed to be higher by 23.8 mt compared to that produced during 2020-21 (MOA, 2021). Further, for the 2022-23 crop year, foodgrain production target of 328 mt has been framed which is 4% more than foodgrain output in the previous year (Das, 2022). However, only producing a large quantity of foodgrains is not sufficient to eradicate the hunger of a country with population of 141 crore but it is equally important to distribute it efficiently and for this purpose, proper storage of the foodgrains is a must. Lack of adequate infrastructure and effective supply chain management are the foremost problems of food security in Indian agriculture which results in foodgrain wastage (Parwez, 2014). As per the United Nations Development programme, it was stated that up to 40 percent of the food produced is wasted in India resulting in weakening of country's economy (Akila and Shalini, 2018). In India, Food Corporation of India (FCI) is the lone agency that delivers foodgrains with the help of its network of storage setups like warehouses, etc. from the producing as well as procuring states to the consuming states. Further, foodgrains are distributed by the State Governments through the Targeted Public Distribution System (TPDS) and other welfare schemes. To ensure that the

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farmers get appropriate prices for their produce as well as to control any inflation, foodgrains are now and then sold within the open market under the Open Market Sales Scheme. For storing of procured produce, FCI depends upon Central Warehousing Corporation (CWC), State Warehousing Corporations (SWCs) and private players. India currently lacks required storage facilities at the farm level; moreover, the traditional storage systems don't guarantee protection against major storage pests, leading to higher grain losses, particularly due to post-harvest insect pests and grain pathogens (Tefra *et al.*, 2011; Ahmad *et al.*, 2021).

1.1 Objectives of the study

The present study was carried out to study the existing storage capacity for foodgrains and its utilization along with storage losses and suggestions for effective foodgrain storage.

2. Data sources and methodology

The study was based on both primary and secondary information. To understand farmers' perspectives towards the public-private initiatives/silos situated near them, primary data was collected from 72 farmers of the Moga district in Punjab on well-structured schedules. For secondary information, different published sources and websites were followed like CAG reports of the Ministry of Consumer Affairs; Food and Public Distribution, FAO report; Indiastat website, etc. For private silos information, Adani Agri Logistics Limited website and Lok Sabha question (2017) were consulted.

3. Results and discussion

3.1 Present scenario of storage of foodgrains

The owned/covered storage capacity under Central Warehousing Corporation (CWC) was 55.36 lakh metric tonnes (MT) during the year 2000-01 with the utilization of 48.52 lakh MT, *i.e.* about 88 percent while the hired/covered CWC capacity was 23.62 lakh MT with utilization of 18.52 lakh MT, *i.e.* 78 percent only (Table 1). With time, the total capacity of CWC increased from about 79 lakh MT in 2000-01 to 102.11 lakh MT in 2005-06 and further to about 115.51 lakh MT in 2015-16 and 123.51 lakh MT in 2020-21 with utilisation of about 86 percent of the capacity. Similarly, the owned/covered and hired/covered storage capacity for foodgrain storage showed a rising trend during 2000-01 to 2020-21 though the utilisation of the former declined from 87.64 to 84.4 percent while that of the latter rose from 78.41 to 89.13 percent during the time period.

TABLE 1: Capacity and Utilisation of Warehouses (owned/hired/covered) Under Central Warehousing Corporation in India

(in lakh metric tonnes)

Year	Owned/Covered		U as % of C	Hired/Covered[1]		U as % of C	Total		U as % of C
	C	U		C	U		C[2]	U	
2000 -2001	55.36	48.52	87.64	23.62	18.52	78.41	78.98	67.04	84.88
2005 -2006	66.83	44.83	67.08	35.28	26.76	75.85	102.11	71.59	70.11
2010 -2011	68.74	60.64	88.22	34.77	30.13	86.66	103.51	90.77	87.69
2015 -2016	76.64	56.35	73.53	38.47	35.47	92.20	115.11	91.82	79.77
2020 -2021*	77.62	65.51	84.40	45.89	40.9	89.13	123.51	106.41	86.15

Source: www.indiastat.com
Note: 1: Includes management warehouses and open storage capacity.
2: Indicates Operational Storage Capacity.
C - capacity and U - utilization
* up to January, 2021

3.2 Damage/wastage of foodgrains

The main reason behind the losses/damages and wastage of foodgrains in the central pools is that the warehouses or godowns lack required conditions like proper temperature and moisture which seriously harms the standard of grains, resulting in damage and wastage of the stocks. Dearth of suitable, safe and scientific storage practices has led to unnecessary damage to foodgrains within the central pools maintained by the Government agencies in the state of Punjab. The foodgrains have to be stored in the open spaces where no preventive measures are available to preserve the excessive foodgrain because of lack of appropriate cover and plinth storage services during the procurement seasons. As a result of open space storage and lack of proper plinth, water seeps from the ground during rains and floods causing damage to the foodgrain stock. The foodgrain damaged in FCI godowns in India was 24695.5 metric tonnes in the year 2013-14 (Table 2).

TABLE 2: QUANTITY OF FOODGRAINS DAMAGED IN FCI GODOWNS IN INDIA

Year	Quantity of damaged foodgrains (in metric tonnes)
2013-2014	24695.5
2014-2015	18847.2
2015-2016	3115.7
2016-2017	8775.6
2017-2018	2663.49
2018-2019	5213.36
2019-2020	1930.36

Source: www.indiastat.com

Though with time, the quantity of damaged/non-issuable foodgrains has declined, still about 1930 metric tonnes of foodgrain loss persists. For a country which is fighting with hunger, this foodgrain damage at storage level is quite immense which is a major concern. It is stated that approximately one percent of the GDP is worn-out in the form of food wastage. According to the Ministry of Agriculture & Farmers Welfare (Govt. of India), every year around Rs. 50,000 crore of food produced gets wasted due to one reason or another.

Analysis of data for the damaged foodgrains indicates that Punjab is one of the states/UTs contributing to national foodgrain damage (Table 3). In the state, about 25 metric tonnes of foodgrains were lost during the year 2020-21. With time, the quantum of foodgrain losses has risen from 8 metric tonnes in the year 2016-17 to 318 metric tonnes in the year 2018-19 but declined thereafter to 25 metric tonnes in the year 2020-21.

TABLE 3: FOOD GRAINS STOCK ACCUMULATED AS NON-ISSUABLE/DAMAGED IN FCI

(in metric tonnes)

States/UTs	2016 -2017	2017 -2018	2018 -2019	2019 -2020	2020 -2021
Andhra Pradesh	6	0	0	640	0
Arunachal Pradesh	0	0	0	0	0
Assam	205	328	868	2	6
Bihar	0	1617	3568	0	5
Chhattisgarh	12	0	7	5	6
Delhi	12	14	2	44	34
Gujarat	119	6	19	694	32
Haryana	0	0	0	286	0
Himachal Pradesh	0	0	0	0	0

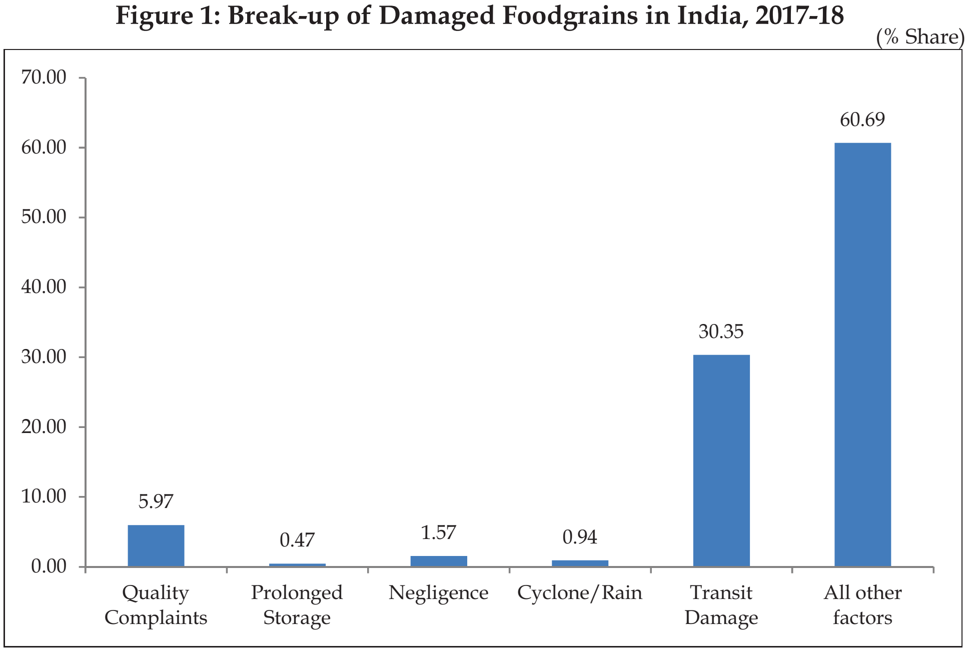
States/UTs	2016 -2017	2017 -2018	2018 -2019	2019 -2020	2020 -2021
Jammu & Kashmir	0	0	0	0	8
Jharkhand	0	45	31	0	12
Karnataka	13	75	53	10	6
Kerala	88	2	113	32	14
Madhya Pradesh	0	0	5	0	0
Maharashtra	7963	15	35	18	0
Manipur	0	0	0	0	0
Nagaland	3	0	0	0	0
Odisha	1	0	2	87	1445
Punjab	8	211	318	56	25
Rajasthan	125	1	0	2	78
Tamil Nadu	66	16	6	1	0
Uttar Pradesh	48	243	116	26	57
Uttarakhand	0	0	0	0	0
West Bengal	0	0	12	0	79
North Eastern Frontier*	105	92	58	27	0
India	**8776**	**2663**	**5213**	**1930**	**1806**

Source: www.indiastat.com

Note:* includes Meghalaya, Tripura and Mizoram

Though India is now self-sufficient in foodgrain production, still there is a need to investigate the stated matter urgently. Appropriate measures need to be planned and implemented to feed its ever-increasing population.

Figure 1: Break-up of Damaged Foodgrains in India, 2017-18



Source: Ministry of Consumers Affairs, Food and Public Distribution and www.indiastat.com

A study conducted by the Ministry of Consumers Affairs, Food and Public Distribution during the year 2017-18 discussed the share of foodgrain losses due to various reasons. It was stated that about 30 percent of foodgrains were lost during transit while about 6 percent faced quality complaints, another 2 percent were lost due to negligence, about 1 percent due to natural calamities like cyclones/rains and about 0.47 percent was stored for a prolonged period. All other factors like storage losses due to storage facilities, insect pest attack, etc. constituted the 60 percent of foodgrain damage/losses (Figure 1).

3.3 Public-Private initiatives for foodgrain storage

For taking care of the special needs while storage, Government launched two schemes. One was Gramin Bhandaran Yojna in year 2001-02 in which subsidy was provided for the construction or overhauling of rural godowns. The purpose of this scheme is to help any individuals, farmers, groups of farmers, firms, NGOs, SHGs, companies, corporations, cooperatives, federations, etc. for the development of godowns.

The second scheme was the Private Entrepreneurs Guarantee (PEG) Scheme launched by the Central Government in the year 2008 in which the private players, Central Warehousing Corporations or State Government Agencies created storage capacity with assured hiring by the Food Corporation of India. Though the whole responsibility of the foodgrain storage should be of the Government, the real picture is totally different. In this scheme, the Government is not involved in funding or land for the development of godowns. Private parties or CWC or state agencies are responsible for full investment. Once the godown is developed and hired by the FCI, storage charges are paid to the investor for a guaranteed period of 9 to 10 years, irrespective of the quantity of foodgrains stored. On the way forward, Government allowed private players to set up their own procurement centres across the country where they can directly procure foodgrains from farmers and store it in high storage capacity silos. Adani Agri Logistics Limited is involved in bulk handling, storage and transportation (distribution) of foodgrains and is offering an end-to-end bulk supply chain solution to Food Corporation of India and various State Governments. India's first advanced grain storage infrastructure was made by Adani Agri Logistics Limited for Food Corporation of India in the year 2007. For procurement and storage of foodgrains, grain silos in Moga (Punjab) and Kaithal (Haryana) were established and receiving silos were set up in Mumbai, Chennai, Bengaluru, Kolkata and Coimbatore, cities linked via Adani Agri Logistics Limited's railway rakes. In Punjab, two Adani Agri Logistics Limited (AALL) silos were established under an agreement with FCI. In Moga district, near village Dagru, AALL were set up in year 2007 and another one in Kotkapura district. The contract for procurement between FCI and AALL is for 20 years. The silo capacity at Moga district is 2 lakh metric tonnes with 16 main storage bins. Each silo has a capacity of 2.25 lakh tonnes to store the grain. The two silos became operational in the year 2008 and were subsequently recognized as market yards by the Punjab and Haryana Governments. With this, FCI can possess wheat directly at the silo storages, rather than first procuring in grain markets and then transporting it to those storages.

TABLE 4: PRIVATE INITIATIVES IN STORAGE OF AGRICULTURAL PRODUCE HIRED BY FCI

Place	Year of setup	Capacity (metric tonnes)
Moga (Punjab*)	2007	2,00,000
Chennai (Tamil Nadu**)		25,000
Coimbatore (Tamil Nadu**)		25,000
Bangalore (Karnataka**)		25,000

Place	Year of setup	Capacity (metric tonnes)
Kaithal (Haryana*)	2013	200,000
Navi Mumbai (Maharashtra**)		50,000
Hooghly (West Bengal**)		25,000
Total		**5,50,000**

Source: www.adaniagrilogistics.com and Lok Sabha question (2018)
*Base Depot/Grain silos
**Field Depot/Receiving silos

But such structures set up by AALL are a costly affair for Food Corporation of India (FCI) which has rented it for Rs. 3.3 crore on an average for every month (Rs. 2,000 per tonne per year). Though the silo management affirms strongly that farmers are getting benefits in many ways by transporting their produce directly to Adani Agri Logistics Limited, however, while talking to the farmers of Moga district (72 surveyed farmers), they claimed that they choose conventional mandis/grain markets and prefer to pay commission agent/arhtiyas for cleaning and packing the produce in gunny bags. For promotion, the Adani Agri Logistics Limited management gave incentives, gift coupons and procured the produce at price above the MSP to farmers for first 2 years, even then the farmers were reluctant to sell their produce to AALL. The FCI asked arhtiyas/commission agents of the Moga region in Punjab and Kaithal region of Haryana to encourage farmers to sell their produce at AALL and agreed to pay commission to arhtiyas/commission agents as is done in mandis. AALL silos are hired by FCI for storage of foodgrains but these have failed to become effective market yards as farmers are not ready to bring their produce directly to them by bypassing the commission agents in mandis.

3.4 Farmer's perspective

Based on data collected from farmers by personal interview from the Moga region of Punjab state, the major problems faced by the farmers in following the new initiative includes long distance, long waiting hours, no parking place, non-availability of transport facility due to occupancy of tractors, lack of basic amenities, refreshment, safety issues, weather issues, etc. On their way, they have maximum 7 to 8 mandis, so farmers have to bear more transportation cost. Also in this kind of procurement, during loading, unloading and cleaning of the produce, less labour is required which creates a huge amount of unemployment among labour.

TABLE 5: Farmers' Perspective Towards Private Players for Procurement

(Multiple responses)

S. No.	Problems faced	No. of farmers	Percentage of farmers
1	High transportation cost	63	87.50
2	Long distance from village	55	76.39
3	No parking space	69	95.83
4	Long waiting hours	58	80.56
5	Tractor remained busy	72	100.00
6	Basic amenities	50	69.44
7	Refreshment	52	72.22
8	Safety issues	57	79.17
9	Weather issues	72	100.00

In grain markets, commission agent has the responsibility of all the produce and also takes care of farmers' food and water requirement, basic amenities, etc. On the contrary, in these private procurement centres, these issues remain a problem. If rain occurs while waiting for their turn, it remains farmers' responsibility to look after their produce while in grain market, commission agent is there to do the arrangements.

4. Conclusion and policy implications

India being a foodgrain abundant country is a fertile ground for agro-economic sector; more precisely saying that it works as a major economic input for the private sector. Moreover, the Government itself is promoting the entry of large private players into the agricultural sector. Government is also shedding up its hands from setting up the storage structures for farmers and the issue of subsidy for setting up of the storage structures by the farmers is on a standstill. For development of storage structure, no funds or land is provided by the Government and major share of investment comes from private parties or CWC or state agencies. FCI pays hiring charges to the investor/developer of storage structure for a guaranteed period of 9 to 10 years irrespective of the quantity of foodgrains stored. Though a highly developed silo was set up by AALL in Moga, Punjab but it became a financial liability on FCI as it is paying a rent of Rs. 3.3 crore on an average for every month (Rs. 2,000 per tonne per year), which is a very large amount and in economic terms we can say that the plant is facing an opportunity cost of Rs. 3.3 crore which might have been used for storage setup in the nearby marketing yard of Moga, which would be economical to both farmers and FCI. It is recommended that the silos which are being rented by the Government agencies from private players can be set up by the Government in the nearby marketing yards in each district, and if the inputs are taken by the private players, then there should be regularisation of such structures.

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Effect of Sources and Levels of Silicon on Growth and Yield of Garlic Cv. Phule Nilima

GAWADE M.H.[1]

Abstract

Field experiment was conducted during Rabi season with a view to study the effect of different silicon sources viz., diatomaceous earth, calcium silicate and bagasse ash, and levels of silicon (0, 50, 100, 150 and 200 kg Si ha^{-1}) on growth and yield of garlic. Plant height, number of leaves per plant, number of cloves per bulb, weight of 10 cloves, polar diameter, equatorial diameter, neck thickness, average weight of bulb, total soluble solid, total yield of bulbs and marketable yield of garlic were significantly influenced due to application of different silicon sources and their different levels. Source A_1 (DE) recorded highest TSS; source A_2 (CS) recorded highest number of leaves per plant, weight of 10 cloves, equatorial diameter and average weight of bulb, while source A_3 (BA) recorded superior plant height, polar diameter, neck thickness, total yield of garlic and marketable yield. Application of Si @ 200 kg ha^{-1} recorded superior plant height, number of leaves per plant, number of cloves per bulb, weight of 10 cloves, polar diameter, equatorial diameter, neck thickness and average weight of bulb. The total uptake of N, P, K and Si was also found to have increased significantly with application of different silicon sources.

Keywords: *Silicon, garlic, polar diameter, neck thickness.*

1. Introduction

Silicon (Si) is a second most abundant element, on the basis of weight and the number of atoms, in the earth's crust. Because of strong affinity of Si with oxygen, it always exists as silica (SiO_2 - silicon dioxide) or silicates which occur in nature in combined form with various materials. Silicon dioxide comprises about 60 percent of the earth's crust. In soil, silicon dioxide accounts for more than 50 percent of silicon concentration.

Although Si is abundant in the earth crust, but because of low solubility (Lindsay and Norvell, 1978) many soils contain inadequate supply or are naturally low in plant available silicon. Depletion of silicon may occur in traditional soils with continuous monoculture, intensive cultivation of high yielding cultivars of crops and can be a limiting factor for sustainable crop production (Miyake, 1993).

Silicon does not form a constituent of any cellular components but is primarily deposited on the walls of epidermis and vascular tissues conferring strength, rigidity and resistance to pests and diseases. Silicon nutrition also manages many abiotic stresses including physical stresses like lodging, drought, radiation, high temperature, freezing and chemical stresses like salt, metal toxicity and nutrient imbalance (Epstein, 1994). It plays a role in phosphorus nutrition and there is an inter-relationship with phosphorus (Silva, 1971). Silicon has non-significant role in the nutritional process of crops. A number of studies have been carried out to study the effect of silicon on plant growth. However, until now, silicon has not been put in the list of essential elements for higher plants. According to the criteria processed by Arnon and Stout (1939) for essential element, a given plant must be unable to complete its life cycle in the absence of an element. However, no evidence has shown that a plant is unable to complete its life cycle in the absence of silicon. One argument about this is that silicon may function as a micro-nutrient and that is not possible to completely remove silicon from the growth medium by currently available techniques because of various contaminants.

Silicon plays a significant role in imparting both biotic and abiotic stress resistance and in enhancing the productivity. For this reason, silicon has been recognized as agronomically essential element and

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silicate fertilizers have been applied to soils (Ma and Takahashi, 1990). Epstein and Bloom (2005) suggested that silicon enhances disease resistance in plants, imparts turgidity to the cell walls and has putative role in mitigating the metal toxicities. It is also suggested that silicon plays a crucial role in preventing or minimizing lodging in crop which is a matter of great importance in terms of agriculture productivity.

An adequate supply of silica is essential if grasses and cereals are to give a good yield. Some crops are larger silicon accumulator. Silicon plays a very important role in increasing yield, disease and pest resistance of rice. Much of the work of silicon nutrition has been done in respect of rice, sugarcane, wheat, maize and other cereals, but little work has been reported on vegetables. In view of this, the present investigation was conducted to evaluate various indigenous sources of silicon (diatomaceous earth, calcium silicate, bagasse ash) and levels of silicon which influence the garlic crop yield, quality of garlic bulbs, disease and pest resistance, uptake of nutrients and soil properties.

1.1 Objectives of the study

(i) To study the effect of sources and levels of silicon on NPK and silicon uptake by garlic.

(ii) To study the effect of sources and levels of silicon on yield and quality of garlic.

2. Data sources and methodology

An investigation was carried out by conducting a field experiment at Department of Horticulture, All India Co-ordinated Research Project on Vegetable Crop, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during Rabi season. The details of material used in experimental techniques and analytical methods adopted during the investigation are presented.

2.1 Location: Geographically, the Central campus of M.P.K.V., Rahuri lies between 19°47' N to 19°57' N latitude and 74°19' E to 74°42' E longitudes with elevation of 525 m above mean sea level. The tract lies on the eastern side of Western Ghats and falls under scarcity of rainfall zone.

2.2 Soil: The topography of experimental site was a uniform field, with leveled and flat beds for garlic planting, soil was well drained and having good water holding capacity. The soil of experimental plot is grouped under the order vertisol. The texture of soil was medium deep black having (pH 8.02) alkaline nature. The electrical conductivity of soil was 0.45 dS m^{-1}. The soil was low in available nitrogen (195.47 kg ha^{-1}), medium in available phosphorus (24.12 kg ha^{-1}) and high in available potassium (288 kg ha^{-1}). The available silicon was 68.88 mg kg^{-1}. No deficiency of micronutrient was observed except iron (3.94 ppm).

TABLE 1: INITIAL SOIL PROPERTIES OF EXPERIMENTAL PLOT

Sr. No.	Particulars	Value
A.	**Physical properties**	
1.	Texture	
i.	Sand (%)	12.65
ii.	Silt (%)	29.11
iii.	Clay (%)	58.54
	Textural class	Clay
2.	Bulk density	1.21

Source: Field data

2.3 Selection of crop: Garlic (Phule Nilima) was selected as a test crop during Rabi season.

2.4 Treatment details:

A .	Experimental details for field trial	
1.	Name of crop	Garlic
2.	Crop variety	Phule Nilima
3.	Soil type	Medium deep black soil
4.	Experimental location	AICRP on vegetable crop farm
5.	Design of experiment	Factorial Randomized Block Design (FRBD)
6.	Number of treatment	15
7.	Replication	3
8.	Recommend Dose of Fertilizer (RDF)	100:50:50 kg ha^{-1} N, P_2O_5 and K_2O, respectively, + 20 t ha^{-1} FYM (Farm Yield Manure)
9.	Date of sowing	21.10.2021
10.	Planting distance	15 x 10 cm
11.	Plot size	Gross plot= 4 m x 2 m Net plot= 3.70 m x 1.80 m
B.	**Treatment detail**	
a.	**Factor A**	**Source of silicon**
1.	A_1	Diatomaceous earth (36%)
2.	A_2	Calcium silicate (36%)
3.	A_3	Bagasse ash (27.9%)
b.	**Factor B**	**Level of Si (kgha^{-1})**
1.	B_1	0
2.	B_2	50
3.	B_3	100
4.	B_4	150
5.	B_5	200

Source: Field data

Note: The soil application of nutrients to garlic was be applied to all treatments plots as per GRDF (i.e. 100:50:50 kg ha^{-1} N:P_2O_5:K_2O + 20 t ha^{-1}FYM) as per schedule.

TABLE 2: TREATMENT COMBINATION

Treatment	Combination	Treatment	Combination
T_1	A_1 B_1	T_9	A_2 B_4
T_2	A_1 B_2	T_{10}	A_2 B_5
T_3	A_1 B_3	T_{11}	A_3 B_1
T_4	A_1 B_4	T_{12}	A_3 B_2
T_5	A_1 B_5	T_{13}	A_3 B_3
T_6	A_2 B_1	T_{14}	A_3 B_4
T_7	A_2 B_2	T_{15}	A_3 B_5
T_8	A_2 B_3		

Source: Designed by author

The present investigation was carried out in Factorial Randomized Block Design (FRBD). Treatments comprised of five levels of silicon (0, 50, 100, 150, 200 kg Si ha^{-1}) applied through three sources of silicon *viz.*, diatomaceous earth, calcium silicate, bagasse ash and were replicated thrice. The general recommended dose comprised of FYM and NPK fertilizers were applied as per schedule.

2.5 Preparatory Tillage: The experimental site was ploughed and harrowing was done with the help of tractor drawn implements. Clod crushing was done by rotavator. The field was leveled with the help of wooden plank and was made ready for layout.

2.6 Sampling techniques: Five hills were selected randomly in each net plot. The selected hills were marked by fixing pegs. All the plant growth observations were recorded on these hills.

2.7 Application of silicon sources and fertilizers: Different silicon sources such as diatomaceous earth, calcium silicate and bagasse ash were applied as basal dose before planting. The recommended fertilizer dose of 100:50:50; $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM was applied. A basal dose of 50:50:50; $N:P_2O_5:K_2O$ kg ha^{-1} was applied at the time of planting through urea, single super phosphate and muriate of potash for all treatments. The second split dose of nitrogen, *i.e.* 50 kg N ha^{-1} was applied at 50 days after planting.

2.8 Irrigation: Optimum soil moisture was maintained in each treatment by periodically irrigating the plot during the crop period as per requirements considering rainfall and crop growth stages.

2.9 Methods: The methods adopted for recording the observations of soil and plant are explained here under different subheads.

2.9.1 Characterization of silicon sources: Total silicon was determined by HCl (12.1N) + HF (48%) method by Korndorfer *et al.* (2004). In this method of 0.1 g sample, 1 ml of HCl and 4 ml of hydrogen fluoride is taken in a 250 ml silicon free plastic conical flask. After 12 hrs, 50 ml of boric acid (70 g l^{-1}) and 40 ml of distilled water were added. Silicon in the extract was determined colorimetrically by using spectrophotometer at 630 ηm wavelength.

2.9.2 Soil analysis: Before sowing and after harvest of garlic crop, the representative soil samples were collected from each experimental plot. The collected soil samples were air dried under shade, pounded in wooden pestle and mortar, sieved through 2 mm sieve and utilized for analysis of physical and chemical properties of soils. Soil samples for available silicon estimation were collected at 50 days after planting. These soil samples were analyzed by adopting standard methods given in Table 3.

2.9.3 Soil physical properties: Soil texture was determined by international pipette method given by Black (1965) and bulk density was determined by Core method by Blake and Hartage (1986).

TABLE 3: STANDARD ANALYTICAL METHODS

Sr. No.	Parameter	Method	Reference
I.	**Total silicon from various sources**	HCl (12.1N) +HF (48%)	Korndorfer *et al.* (2004)
II.	**Physical properties of soil**		
1.	Texture	International pipette method	Black (1965)
2.	Bulk density	Core method	Blake and Hartage (1986)
III.	**Plant analysis**		
1.	Total N	Micro-kjeldahl method (H_2O_2+H_2SO_4)	Parkinson and Allen (1975)
2.	Total P	Vandomolybdate Yellow colour in Nitric Acid System. (Diacid digestion method)	Jackson (1973)

Sr. No.	Parameter	Method	Reference
3.	Total K	Flame photometry (Diacid digestion method)	Chapman and Pratt (1961)
4.	Total Si	Triacid digestion method	Nayar *et al.* (1975)
IV	**Bulb Analysis**		
1.	TSS	Hand Refractometer	A.O.A.C. (1990)

Source: Designed by author

2.9.4 Methods used for plant analysis

1. **Uptake of nutrients by garlic:** The uptake of nitrogen, phosphorus, potassium and silicon was worked out by multiplying the percentage of these nutrients in bulb and straw with the corresponding dry matter yields of the respective constituent.

2. **Total nitrogen:** The silicon sources and plant samples (0.2 g each) were digested using concentrated H_2SO_4 (5 ml) and H_2O_2 (5 ml). The volume was made by distilled water to 100 ml after digestion of sample. A suitable aliquot was taken for nitrogen distillation and nitrogen was determined by Micro kjeldahl method (Parkinson and Allen, 1975).

3. **Phosphorus:** The plant samples (0.2 g each) were wet digested with nitric acid, sulphuric acid and perchloric acid. The volume was made to 100 ml with distilled water after digestion and was used for determination of phosphorus. The total phosphorus was determined by using triacid extract and the yellow colour was developed with combined nitric acid vandate-molybdate reagent. Phosphorus was determined colorimetrically by using spectrophotometer at 420 nm wavelength as described by Jackson (1973).

4. **Potassium:** The plant samples (0.2 g each) were wet digested with sulphuric acid, nitric acid and perchloric acid. The volume was made to 100 ml with distilled water after digestion and was used for determination of potassium by flame photometer given by Chapman and Pratt (1961).

5. **Silicon:** The following method was adopted to determine Si content in plant samples.

a) **Plant samples preparation**

Plant samples were collected from experimental plots at the time of harvesting. Straw samples were initially washed in tap water followed by double glass distilled water, tapped with clean filter paper and then air dried. The garlic bulb samples were collected separately and air dried. Then straw and bulb samples were dried in oven at 65°C to get constant weight. The dried samples were powdered in a stainless steel grinder and used for determining concentration of silicon by adopting standard methods of analysis.

b) **Plant samples digestion for estimation of silicon**

One gram oven dried plant sample was digested on a hot plate with 5 ml concentrated nitric acid, 1 ml perchloric acid (70%) and 0.5 ml concentrated sulphuric acid in a 50 ml corning glass conical flask which was thoroughly cleaned with hot alkali followed by acids and distilled water. The digestion was continued till the brown fumes ceased and the volume of the acid was reduced to about 2 ml which took about 30 minutes. The resultant solution from digestion was then carefully transferred with repeated washings of solution 1 to 1.5 g of anhydrous AR sodium carbonate in suspension so that there was sufficient alkali in excess after neutralization of the acid. The resultant solution, after cooling, was made up to 250 ml and stored in polythene bottles (Nayar *et al.*, 1975).

c) **Estimation of silicon from plant**

A suitable aliquot (2 ml) was treated with 2 ml of 1:1 HCI followed by the addition of 2 ml of 10%

ammonium molybdate and allowed to stand for 5 minutes. With addition of 0.5 ml of hydroxylamine hydrochloride (5%) and 1 ml of oxalic acid (10 %) plus 2 ml of ascorbic acid (0.5 %), the volume was made up to 50 ml in corning flask. The blue colour developed after waiting for 15 to 20 minutes was measured at 660 nm using spectrophotometer (Nayar *et al*., 1975).

2.10 Observations recorded at harvest

The observations recorded while conducting this investigation were as under.

2.10.1 Growth characters

a) **Plant height (cm):** Ten plants from each treatment were selected randomly and labelled. The observations for plant height were recorded in centimeters at harvest. The height was measured from ground level to the tip of leaves.

b) **Number of leaves per plant:** Number of leaves per plant was counted and average was taken for same plants selected. The observations were recorded at harvest.

2.10.2 Yield and quality attributes

a) **Number of cloves per bulb:** The cloves were separated from the bulbs which were selected for measuring diameter. The cloves were counted and average was worked out.

b) **Average weight of 10 cloves (g):** Ten cloves were taken from each of the ten randomly selected bulbs. The cloves were weighed and average was worked out.

c) **Polar diameter (cm):** Ten bulbs of garlic were selected randomly from each net plot at harvesting to measure the polar diameter with the help of vernier caliper. The mean value was calculated and expressed in centimeters.

d) **Equatorial diameter (cm):** Ten bulbs of garlic were selected randomly from each net plot at harvesting to measure equatorial diameter with the help of vernier caliper. The mean value was calculated and expressed in centimeters.

e) **Neck thickness (cm):** Neck thickness was measured by vernier caliper from ten randomly selected bulbs.

f) **Average weight of bulb (g):** Ten bulbs of garlic were selected randomly from each net plot at harvesting and weighed with the help of digital weighing balance. The mean weight was calculated and expressed in grams.

g) **Yield of bulbs (t ha^{-1}):** The bulbs from each net plot were separated from leaves so as to weigh with the help of weighing balance and expressed in kilogram.

h) **Marketable yield (t ha^{-1}):** The harvested bulbs were sorted in two grades, *i.e.* grade-I and grade-II. Grade-I garlic had good size (4-6 cm) and quality while grade-II bulbs had size less than 3 cm.

i) **Total Soluble Solid (^{0}B):** The selected bulbs were sliced and pressed to remove juice for placing on hand refractometer for recording TSS.

2.10.3 Statistical analysis: The data generated after observations of soil, plant, pest and disease incidence from present experiment were statistically analyzed by methods suggested by Panse and Sukhatme (1985).

3. Results

3.1 Plant height (cm)

The data regarding mean plant height is influenced by different treatments at harvest and is presented in Table 4. The plant height was found significantly influenced by the sources and levels of silicon. The source (A_3) BA recorded highest plant height (55.50 cm) over all other sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest plant height (55.54 cm) over all the levels of silicon. The interaction effect of sources and levels of silicon was non-significant.

TABLE 4: EFFECT OF SOURCES AND LEVELS OF SILICON ON YIELD ATTRIBUTING CHARACTERS

Treatments	Plant height (cm)	No. of leaves $plant^{-1}$	No. of cloves $bulb^{-1}$	Weight of 10 cloves (g)
A. Sources (A)				
A_1 : DE	54.97	12.00	17.92	8.75
A_2 : CS	54.39	12.74	19.46	9.38
A_3 : BA	55.50	12.20	17.43	8.68
S.E.±	0.13	0.02	0.08	0.02
CD at 5%	0.39	0.06	0.23	0.06
B. Levels (B)				
B_1 : 0	54.32	11.23	17.79	8.64
B_2 : 50	54.84	11.95	18.01	8.65
B_3 : 100	54.67	12.35	18.25	8.82
B_4 : 150	55.43	12.81	18.41	9.20
B_5 : 200	55.54	13.22	18.89	9.37
S.E.±	0.17	0.03	0.10	0.02
CD at 5%	0.51	0.08	0.30	0.08
C. Interaction (A×B)				
S.E.±	0.30	0.05	0.17	0.04
CD at 5%	NS	0.15	NS	0.13
Initial	3.94	8.90	0.69	1.72

Treatments	Polar diameter (cm)	Equatorial diameter (cm)	Neck thickness	Weight of bulb (g)
A. Sources (A)				
A_1 : DE	3.26	3.36	1.10	18.87
A_2 : CS	3.26	3.54	1.13	19.23
A_3 : BA	3.39 a	3.42	1.3	18.27
S.E. +	0.02	0.01	0.002	0.04
CD at 5%	0.07	0.04	0.007	0.12
B. Levels (B)				
B_1 : 0	3.12	3.36	1.11	18.18
B_2 : 50	3.25	3.39	1.14	18.35
B_3 : 100	3.30	3.44	1.16	18.85
B_4 : 150	3.39	3.48	1.16	19.25
B_5 : 200	3.45	3.52	1.19	19.33
S.E. +	0.03	0.01	0.003	0.09
CD at 5%	0.09	0.05	0.009	0.27
C. Interaction (A×B)				
S.E. +	0.05	0.03	0.005	0.09
CD at 5%	NS	NS	0.01	0.27
Initial	3.94	8.90	0.69	1.72

Source: Computation by author from field level data

3.2 Number of leaves per plant

The number of leaves per plant was found to be significantly influenced by the sources and levels of silicon. The source (A_2) CS recorded highest number of leaves per plant (12.74) over all other sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest number of leaves per plant (13.22) over all other the levels of silicon. The interaction effect of sources and levels of silicon was significant.

3.3 Number of cloves per bulb

The number of cloves per bulb was found to be significantly influenced by the sources and levels of silicon. The source (A2) CS recorded highest number of cloves per bulb (19.46) over all the other sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest number of leaves per plant (18.89) over all the other levels of silicon. The interaction effect of sources and levels of silicon was non-significant.

3.4 Weight of 10 cloves (g)

The weight of 10 cloves of garlic bulb was found to be significantly influenced by the sources and levels of silicon. The source (A_2) CS recorded highest weight of 10 cloves (9.38 g) over all the other silicon sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest weight of 10 cloves (9.37g) over all other the levels of silicon. The interaction effect of sources and levels of silicon was significant.

3.5 Polar diameter (cm)

The polar diameter of garlic bulb was found to be significantly influenced by the sources and levels of silicon. The source (A_3) BA recorded highest polar diameter (3.39 cm) over all the other silicon sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest polar diameter (3.45 cm) over all other the levels of silicon. The interaction effect of sources and levels of silicon was non-significant. Increase in polar diameter may be due to supply of nutrients from soil and beneficial effect of added silicon. The role of silicon in increase in cell division, elongation, expansion and deposition of silicon at cellular level helps increase the size. Similar finding were also reported by Durgude *et al.* (2014).

3.6 Equatorial diameter (cm)

The equatorial diameter of bulb was significantly influenced due to sources and levels of silicon. The source (A_2) CS recorded highest equatorial diameter (3.54 cm) while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest equatorial diameter (3.52 cm). However, it was at par with B_4 and B_3 (3.48 cm and 3.44 cm, respectively). The interaction effect of sources and levels of silicon was not significant in respect of equatorial diameter. Significant increase in equatorial diameter by the application of silicon might be due to the supply of nutrients from soil and beneficial effect of added silicon. The role of silicon in increase in cell division, elongation, expansion and deposition of silicon at cellular level helped increase the size. Similar results were also reported by Durgude *et al.* (2014).

3.7 Neck thickness (cm)

The neck thickness of bulb was significantly influenced due to application of different sources and levels of silicon. The source (A_3) BA recorded highest neck thickness (1.3 cm) over all other silicon sources while the application Si @ 200 kg ha^{-1} (B_5) resulted in highest neck thickness (1.19 cm). However, it was at par with B_4 (1.16 cm) and B_3 and B_4 (1.16 cm). The interaction effect of sources and levels of silicon was significant. The availability of nutrient to the crops at growth stages through silicon source might have increased neck thickness. Similar results for effect of sources and levels of silicon on neck thickness of garlic bulb were reported by Durgude *et al.* (2014).

3.8 Average weight of bulb (g)

The average weight of garlic bulb was significantly influenced by different sources and levels of silicon. The source (A_2) CS recorded highest bulb weight (19.23 g) over all sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest bulb weight (19.33 g). However, it was at par with B_4 (19.25 g). The interaction effect of sources and levels of silicon was significant. The increase in the bulb weight with increased levels of silicon might be attributed to the better crop stand and enhanced photosynthesis which resulted into the availability and translocation of nutrients as well as photosynthates from source to sink. These findings are in accordance with Durgude *et al.* (2014).

3.9 Yield

The data in respect of effect of different sources and levels of silicon on yield of garlic bulbs is presented in Table 5. The yield of garlic was found to be significantly influenced by the sources, levels and their interactions.

TABLE 5: EFFECT OF SOURCES AND LEVELS OF SILICON ON YIELD OF GARLIC (t ha^{-1})

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	14.21	15.43	16.52	16.59	16.88	15.93
A_2 : CS	13.89	15.51	16.62	16.82	17.65	16.10
A_3 : BA	14.61	15.37	16.52	17.54	17.77	16.36
Mean	14.24	15.44	16.55	16.99	17.43	16.13
	A		B		(A×B)	
S.E. +	0.01		0.01		0.02	
CD at 5%	0.03		0.04		0.08	

Source: Computation by author from field level data

The source (A_3) BA recorded highest bulb yield (16.36 t ha^{-1}) over all other silicon sources while the application of Si @ 200 kg ha^{-1} (B_5) resulted in highest garlic bulb yield (17.43 t ha^{-1}) over all the levels of silicon. The interaction effect of sources and levels of silicon on yield of garlic was significant and was recorded highest for A_3B_5 (17.77 t ha^{-1}) over all other interactions.

Improved crop stand by making leaves more erect due to silicon might have enhanced the photosynthetic activity and enabled the plant to accumulate sufficient photosynthates. The accumulation of silicon in plant reduced its lodging as well as pest and disease incidence. These together coupled with efficient translocation of photosynthates towards sink ultimately resulted in more bulb yield. These results resembled to the findings reported by Korndorfer *et al.* (2001), Singh *et al.* (2005a) and Durgude *et al.* (2014).

3.10 Marketable yield

The marketable yield of garlic bulb is significantly influenced by the application of different sources and levels of silicon. The source (A_3) BA recorded highest marketable yield (14.90 t ha^{-1}) while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest marketable yield (15.98 t ha^{-1}) over all the levels of silicon. The interaction effect of sources and levels of silicon was non-significant.

TABLE 6: EFFECT OF SOURCES AND LEVELS OF SILICON ON MARKETABLE YIELD (t ha-1)

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	13.19	14.48	14.52	15.93	15.63	14.64
A_2 : CS	12.44	13.42	14.24	15.47	16.21	14.36
A_3 : BA	12.83	14.34	15.54	15.69	16.09	14.90
Mean	12.82	14.08	14.77	15.52	15.98	14.63

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
	A		B		(A×B)	
S.E. +	0.06		0.08		0.14	
CD at 5%	0.18		0.23		0.40	

Source: Computation by author from field level data

There was significant increase in the marketable yield of garlic grown on vertisols. The adequate silicon supply might have attributed to higher yield. Similar findings were reported by Singh *et al.* (2006), Prakash *et al.* (2011) and Durgude *et al.* (2014)

3.11 Total soluble solid (TSS ^{0}B)

The TSS (^{0}B) of garlic is found to be significantly influenced by the application of silicon through different sources, levels and their interactions. The source (A_1) DE recorded highest TSS (38.71^{0}B).

TABLE 7: EFFECT OF SOURCES AND LEVELS OF SILICON ON TOTAL SOLUBLE SOLID (^{0}B)

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	37.28	38.24	38.52	39.72	39.82	38.71
A_2 : CS	37.05	38.12	38.41	39.52	39.64	38.55
A_3 : BA	37.21	38.24	38.47	39.48	39.53	38.59
Mean	37.18	38.20	38.47	39.57	39.66	38.62
	A		B		(A×B)	
S.E. +	0.01		0.02		0.03	
CD at 5%	0.04		0.05		0.10	

Source: Computation by author from field level data

The application of Si @ 200 kg ha^{-1} (B_5) recorded highest TSS (39.66 ^{0}B) over B_4 and B_3 (39.57 and 38.47 ^{0}B, respectively). The interaction effect of silicon sources and levels significantly influenced TSS of garlic. Similar findings were also reported by Pharande *et al.* (2014).

3.12 Effect of sources and levels of silicon and their interaction on uptake of nutrients by garlic

The effect of sources and levels of silicon and their interactions on uptake of N, P, K and Si by garlic is presented below.

3.12.1 Nitrogen

The nitrogen uptake was significantly influenced by the sources and levels of application of silicon. Source A_2 recorded highest total nitrogen uptake (113.51 kg ha^{-1}) and was at par with A_3 (112.53 kg ha^{-1}). Application of Si @ 200 kg ha^{-1} (B_5) recorded highest uptake of nitrogen (130. 49 kg ha^{-1}) over all other levels of silicon. The interaction effect of sources and levels of silicon on nitrogen uptake was found to be significant and was recorded highest for A_3B_5 (134.51 kg ha^{-1}) over all other interactions.

TABLE 8: EFFECT OF SOURCES AND LEVELS OF SILICON ON NITROGEN UPTAKE (kg ha^{-1})

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	89.36	106.18	111.30	121.86	126.77	111.09
A_2 : CS	88.50	109.40	114.57	124.90	130.20	113.51
A_3 : BA	87.93	107.25	111.52	121.42	134.51	112.53
Mean	88.60	107.61	112.46	122.73	130.49	112.38
	A		B		(A×B)	
S.E. +	0.46		0.60		1.045	
CD at 5%	1.35		1.74		3.02	

Source: Computation by author from field level data

This might be due to the proper crop stand, probable root growth, supply of nutrient and conducive physical environment created on account of addition of silicon. Such favourable situation might have facilitated better absorption of nitrogen by crop. Silicon fertilized plant gained maximum benefits of ample nitrogen availability. This result agrees with reports of Talashikar *et al.* (2000), Egrinya *et al.* (2008) and Savant *et al.* (1997).

3.12.2 Phosphorus

The total phosphorus uptake was significantly influenced due to the sources of silicon. The effect of source (A_2) CS was highest for phosphorus uptake (28.33 kg ha^{-1}) and it was at par with A_3 (26.96 kg ha^{-1}).

TABLE 9: EFFECT OF SOURCES AND LEVELS OF SILICON ON PHOSPHORUS UPTAKE (kg ha^{-1})

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	19.16	23.63	24.08	27.46	28.76	24.62
A_2 : CS	20.30	24.50	28.58	36.97	31.28	28.33
A_3 : BA	20.55	24.23	27.33	29.37	33.33	26.96
Mean	20.00	24.12	26.66	31.27	31.32	26.64
	A		B		(A×B)	
S.E. +	0.69		0.89		1.53	
CD at 5%	1.99		1.99		NS	

Source: Computation by author from field level data

The levels of silicon also showed significant influence on phosphorous uptake. Application of Si @ 200 kg ha^{-1} (B_5) recorded highest phosphorus uptake (31.32 kg ha^{-1}) and it was at par with (B_4) (31.27 kg ha^{-1}). The interaction effect of sources and levels of silicon was not significant.

The increase in total uptake of phosphorus due to application of silicon might be attributed to role of silicon in increasing the availability of soil phosphorus which might have increased the biomass and root activity. Similar findings on increase in uptake of nutrients due to application of silicon were reported by Gerroh and Gascho (2005), Yang *et al.* (2008), Rani and Narayan (1994) and Mongia *et al.* (2003).

3.12.3 Potassium

Potassium uptake was significantly influenced due to sources and levels of application of silicon. The source (A_2) CS recorded highest potassium uptake (99.63 kg ha^{-1}) and was at par with A_3 (98.52 kg ha^{-1}). The application of Si @ 200 kg ha^{-1} (B_5) recorded highest potassium uptake (113.02 kg ha^{-1}) over all other levels of silicon.

TABLE 10: EFFECT OF SOURCES AND LEVELS OF SILICON ON POTASSIUM UPTAKE (kg ha^{-1})

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	88.47	91.93	96.20	101.00	111.00	97.72
A_2 : CS	88.57	93.93	97.47	105.43	112.77	99.63
A_3 : BA	88.10	93.33	95.46	100.40	115.30	98.52
Mean	88.38	93.07	96.38	102.28	113.02	98.62
	A		B		(A×B)	
S.E. +	0.46		0.60		1.03	
CD at 5 %	1.34		1.73		2.98	

Source: Computation by author from field level data

The interaction effect of sources and levels of silicon significantly influenced the potassium uptake by plant. The application of Si through BA @ 200 kg ha^{-1} (A_3B_5) recorded highest potassium uptake (115.30 kg ha^{-1}) followed by A_2B_5 (112.77 kg ha^{-1}).

The positive response of higher silicon application towards uptake of potassium can be linked to silicification process of cell walls. Increase in the potassium uptake possibly might be due to stimulating effect of silicon on activation of H+-ATPase in the membrane. Similar results were also noticed by Kaya *et al.* (2006), Egrinya *et al.* (2008) and Schelhass and Muller (1977).

3.12.4 Silicon

The silicon uptake was significantly influenced due to sources and levels of application of silicon. The source (A_3) BA recorded highest total silicon uptake (6.66 kg ha^{-1}) over all other sources while the application of Si @ 200 kg ha^{-1} (B_5) recorded highest silicon uptake (8.56 kg ha^{-1}) over all the levels of silicon.

TABLE 11: EFFECT OF DIFFERENT SOURCES AND LEVELS OF SILICON ON SILICON UPTAKE (kg ha^{-1})

Silicon sources (A)	Levels of silicon (B) kg ha^{-1}					
	B_1 : 0	B_2 : 50	B_3 : 100	B_4 : 150	B_5 : 200	Mean
A_1 : DE	0.92	2.95	4.03	4.82	5.20	3.58
A_2 : CS	0.94	3.63	5.51	6.73	8.50	5.06
A_3 : BA	1.21	4.28	6.39	9.43	11.97	6.66
Mean	1.02	3.62	5.31	7.00	8.56	5.10
	A		B		(A×B)	
S.E. +	0.128		0.165		0.286	
CD at 5%	0.370		0.479		0.829	

Source: Computation by author from field level data

The interaction effect of silicon source and level on silicon uptake was found significant and was recorded highest for A_3B_5 (11.97 kg ha^{-1}) over all the interactions.

Higher silicon uptake associated with increased levels of silicon might be due to increase in root growth and available form of silicon in soil. The addition of silicate material to soil increased the silicon availability which might be the reason for higher silicon uptake. The applications of silicon lead to improvement in crop stand, enhanced photosynthesis and resistance against biotic stress. These results are in conformity with the findings of Nayar *et al.* (1982), Liang *et al.* (2006) and Prakash *et al.* (2011).

4. Discussion

4.1 Effect of sources and levels of silicon on yield and quality of garlic

The yield attributing characteristics of garlic *viz.,* plant height, number of leaves per plant, number of cloves per bulb, weight of 10 cloves, polar diameter, equatorial diameter, neck thickness, total yield as well as marketable yield of garlic bulbs, total soluble solid (TSS) and average weight of bulb was significantly influenced due to the application of different sources. Source A_2 (CS) recorded highest number of leaves per plant, number of cloves per bulb, weight of 10 cloves, equatorial diameter, average weight of bulb while source A_3 (BA) recorded highest plant height, polar diameter, neck thickness, total yield as well as marketable yield of garlic bulbs. The source A_1 (DE) recorded significantly highest total soluble solid.

The plant height, number of leaves per plant, number of cloves per bulb, weight of 10 cloves, polar diameter, equatorial diameter, neck thickness, total yield as well as marketable yield of garlic bulbs of garlic was significantly influenced due to application of different levels of silicon. The level (B_5) Si @ 200 kg ha^{-1} was significantly highest in these respects.

The total yield and TSS of garlic bulbs was significantly influenced due to interaction effect of sources and levels of silicon. The interaction (A_3B_5) recorded significantly highest yield of garlic and interaction (A_1B_5) recorded significantly highest TSS.

4.2 Effect of sources and levels of silicon on total uptake of N, P, K and Si by garlic

The nutrient uptake *viz.,* N, P, K and Si was significantly influenced due to application of different sources of silicon. Source A_2 (CS) resulted in highest N, P and K uptake while application of source A_3 (BA) recorded highest Si uptake by garlic crop. The nutrient uptake of N, P, K and Si was significantly influenced due to application of Si @ 200 kg ha^{-1}.

The total nutrient uptake by garlic was significantly influenced due to interaction effect of sources and levels of silicon. The interaction A_3B_5 recorded significantly highest N, K and silicon uptake.

5. Conclusions

1. There was significant increase in plant height, number of leaves per plant, number of cloves per plant, weight of 10 cloves, polar diameter, equatorial diameter, neck thickness, weight of bulb, total soluble solid, total yield and marketable yield due to silicon application. However, there was significant difference between levels of silicon and sources of silicon.
2. Application of silicon through bagasse ash @ 200 kg ha^{-1} along with recommended dose of fertilizer (100:50:50 kg ha^{-1} and FYM) was found beneficial for increase in polar diameter, total yield, marketable yield of garlic in medium deep black soil. Considering the availability and cost of material, bagasse ash proved as good source of silicon for garlic.
3. The uptake of N, P, K and Si was significantly increased by the application of different silicon sources, silicon levels and their interaction.

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Agro-Economic Research

Requirement and Availability of Cold-Chain for Fruits and Vegetables in the Country*

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1. Introduction

The issue of food loss and waste has emerged as a major policy issue in recent times in the world in general and developing countries like India in particular. Though horticulture production outpaced foodgrains production since 2012-13 and made India the second largest producer of fruits and vegetables worldwide, its distribution suffers significant post-harvest losses in the supply chain, primarily due to the perishable nature of fresh produce and its sensitivity to handling damages.

Improving cold-chain has a crucial bearing in driving down food loss and waste in developing countries, where supply-side factors are important in reducing the consumable food. There are direct and indirect causes of food loss and waste. Direct causes are associated with actions (or lack thereof) of individual actors in the food supply chain that directly cause food loss and waste; whereas indirect causes refer to the economic, cultural and political environment of the food system under which actors operate. Reductions in food losses or waste may improve the food security and nutrition status of food-insecure groups, depending on where these groups are located and where the reductions are made. The food loss is a supply side problem and most often happens in developing countries like India where the post-harvest technology and cold chains are primitive.

Review of literature establishes clearly the relationship between cold-chain network development and benefits to all stakeholders in the chain including farmers, middlemen, processors, wholesalers and retailers. While protecting the margins and improving the volume of trade is the main benefit for most of the stakeholders, farmers in the country stand to gain by means of higher prices and profits. However, development of cold-chain is only a necessary condition, and subject to the fulfilment of the sufficient condition which is participation by the farming community in harnessing the facilities with awareness.

India produced 282 million tonnes of fruits and vegetables from 16.77 million hectares at a trend growth rate per annum of 1.2% during the last decade. The losses of fruits and vegetables using the proportion of losses by ICAR-CIPHET constitute 3.5% of gross value added in agriculture (GVA) as a whole and 1.52% for fruits and vegetables. However, several scholars including Government agencies have questioned these estimates. A realistic estimate using FAO figures reveal losses to the tune of 3.5% of GVA from fruits and vegetables alone. Also, food loss and waste is a dynamic concept and the estimates may go up as households may prefer to eat food with higher sanitary and safety standards as their income increases. A large numbers of additional people can be fed reducing losses by half in the case of mango, papaya, guava, green peas, citrus, grapes, tomato, cabbage, onion, cauliflower and potato.

1.1 Objectives of the study

The study has been conducted with the following specific objectives:

1) To develop a conceptual framework for understanding the links between food security in the country and cold-chain.

2) To ascertain the economic losses due to food losses and wastage and the additional welfare gains by reducing these losses.

3) To analyze the status of cold-chain in terms of its requirement and availability of infrastructure in the country.

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4) To examine the growth prospects of cold-chain industry and the policy framework.

2. Data sources

The study is based on both field surveys and case studies data.

3. Major findings of the study

1) Positive rate of growth (2010-11 to 2017-18) has been registered in the production of fruits (1.4%), vegetables (1.1%) and their total (1.2%) for all-India. Majority of the states followed similar pattern of growth.

2) Estimates of economic value of losses among fruits and vegetables using the ICAR-CIPHET (2015) projected loss percentages indicate that there was a loss of Rs. 1.14 lakh crore in 2017-18 at 2018 prices in all crops including food crops. They constitute 3.5% of the gross value added in agriculture in that year for all crops and 1.52% from fruit and vegetables.

3) Across the crop groups, large quantities are wasted in vegetables followed by fruits and then food crops. Potato, onion, tomato, cabbage, green peas and cauliflower from Uttar Pradesh, Madhya Pradesh, West Bengal, Maharashtra, Bihar and Andhra Pradesh need particular attention in view of the seriousness of the problem. Among fruits, the major losses are in mango, grapes, apples, guava, and papaya from Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra and J&K.

4) The analysis in terms of percentage changes in the number and storage capacity of Food Corporation of India (FCI), Central Warehousing Corporation (CWC), State Warehousing Corporations (SWCs) and godowns has shown improvement for India and in most of the states during 2015-2019. Zone-wise and state-wise analysis suggests that barring North-East Zone and South Zone, other zones have shown increase in storage capacity with FCI, CWC, and SWCs. However, within zones, states have shown mixed pattern of change in storage capacity.

5) With respect to number of godowns, reverse pattern is observed in Haryana (-8.23%) and Kerala (-2.37%), whereas for storage capacity, Haryana (-2.85%) and Uttarakhand (-2.24%) have shown negative change. Cold storages have also shown improvement (both in its number and capacity) across all the states of India, barring Andhra Pradesh for storage capacity (-0.64%). At present (up to 23-09-2020), there were 8186 number of cold storages with capacity of 374.25 lakh tonnes in the country for storing fruits and vegetables (an excess capacity of 6.62%) against the required capacity of 351.00 lakh tonnes (as assessed by NCCD-NABCONS study on All India Cold-Chain Infrastructure Capacity, 2015).

6) The top five states in terms of total installed cold storage capacity are Uttar Pradesh (14.71 million tonnes), West Bengal (5.95 million tonnes), Gujarat (3.82 million tonnes), Punjab (2.32 million tonnes) and Andhra Pradesh and Telangana (1.57 million tonnes). These 5 states together contribute to an overall 76.73 percent of the total storage capacity.

7) To narrow down the existing gap in infrastructure, the Government's emphasis on mega food parks and integrated cold-chain development has increased in the recent past, by providing financial assistance in the form of subsidies. A total of 1,248 cold-chain projects with respect to various components (such as cold storages, pre-cooling units, reefer vehicles and ripening chambers) have been supported by National Horticultural Mission (NHM) during 2006-07 to 2015-16 (having a capacity of 4.57 million tonnes); 2,347 projects by National Horticultural Board (NHB) during 1999-00 to 2019-20 (having a capacity of 8.44 million tonnes) and 789 projects by Ministry of Food Processing Industries (MoFPI) during 2013-14 to 2018-19 in India. Most of these projects were related to cold storages as compared to other components of

cold-chain infrastructure: 72% (under NHM) and 71% (under NHB) and 30% (MoFPI), respectively. Note that, out of total capacity generated under NHM and NHB, about 95.9 percent and 97.3 percent belongs to cold storage, respectively.

8) Under MoFPI, 30 percent of the projects supported were related to cold storages followed by 28 percent projects pertaining to reefer transport. Further (out of 81 projects), 68 percent of projects supported by APEDA were related to pack-houses. For fruits and vegetables, MoFPI had sanctioned 162 cold-chain projects (out of 328 projects) up to 30.11.2020. It is evident that the total cost of these projects is Rs. 3,909.41 crore with private investment of Rs. 2,598.94 crore and grant-in-aid of Rs. 1,310.47 crore.

9) In terms of physical progress, analysis suggests that commercial production has started in maximum number of the projects related with fruits and vegetables (about 61%). However, only 11% of them are completed (out of 162 projects). It indicates that market is gradually getting better organized and focus has shifted towards multi-purpose cold storage.

10) The cold-chain industry in India is still at a nascent stage and despite large production of perishable produce, the cold-chain potential remains untapped due to high share of single commodity cold storage. For instance, about 60% of the cold storage capacity is concentrated in the states of West Bengal, Uttar Pradesh and Bihar, wherein storage of potatoes accounts for 85-90% of the capacity.

11) Cold-chain is a highly fragmented industry and the unorganized sector accounts for an estimated 80-85% share of the total capacity. Wholesalers and organized retailers are the key user segments of cold-chain services with a share of 70-75% and 10-15%, respectively. The cold chain sector in India has not progressed at par with the global developments in the monitoring and control technologies. Even though new entrants in the sector are employing some of these modern technologies, most of the earlier generation cold storages are still dependent on the manual modes of monitoring assisted with conventional measuring systems.

12) Lack of proper and adequate refrigerated food storage, processing and cold-chain logistics remains a serious challenge. Moreover, maintaining cold-chain services during fruits and vegetables distribution has its own set of challenges. Most workers are not properly trained in handling the perishable products resulting in deterioration of product quality before reaching the consumers.

13) The cold-chain industry has been emerging as a sunrise industry because of several positive and promotional policies of the Central Government and active support of some of the fast-growing State Governments. The industry needs huge investments and calculations show that there is a need of 18.51 billion USD worth of investment in the short-run to make integrated cold chain operational for the fruits and vegetables along with others. While this will make available more fruits and vegetables to additional people and enable welfare gains through food security, this can also create an employment of 2.5-3.0 million in the coming years, provided the right impetus is given.

14) Several innovative startups have been coming up with novel solutions for improving the cold chain and several others have been building cold-chain on their own or creating market for third party logistic services (3 PLS). Solar-powered cold storages at field level by Ecozen, storage-cum-transporter named Sabjikothi by Saptakrishi, cold storage build up by Godaamwale, cold storage aggregator model of Arya Collateral and Oregon are some of the exciting innovations worth policy support to scale up.

15) Several of the ongoing schemes require course corrections to make them more helpful in

upgrading the existing cold-chain and build up large capacities. The Pradhan Mantri Kisan Sampada Yojana grants were found to be skewed in favour of the fast-growing western and southern states. Schemes like Operation Greens, one-lakh crore Agricultural Infrastructure Fund (AIF) have to be made more concrete with detailed guidelines for operationalization. Though it is a good initiative to provide support to farmers, FPOs, PACS and MCS through AIF with interest subvention, the actual operationalization is fraught with procedural difficulties in view of their lack of financial muscle.

4. Policy suggestions

1) Infrastructure created under cold-chain projects by various agencies is biased towards the cold storage facilities in India as well as in states. Developing of cold storages alone cannot mitigate the losses incurred by domestic perishable produce, unless other infrastructure like pack-houses, modified cold storages, integrated cold-chain, ripening chambers and transport are also associated to avail connectivity with consumption areas. It may ensure round-the-year delivery of fresh produce to vast majority of consumers and economic gains to all the stakeholders in the chain.

2) Indian Government is one of the driving forces in developing the cold-chain industry and supports private participation through various subsidy schemes. Eventually, this support makes cold-chain more efficient and provides a huge opportunity for multi-commodity & multi-value chain based interventions, especially for the development of post-harvest logistics, storage, handling and marketing infrastructure. As findings indicate that market is gradually shifting towards organised players, which serves well for not just storage but overall inventory management, and it is expected to gain momentum in the cold-chain industry in India in the near future.

3) The cold-chain sector in India has not progressed at par with the global developments in the monitoring and control technologies. Focus needs to be given in supporting development and implementation of upcoming technologies and improvement of cold-chain from farm to fork in order to cater the rising demand for quality and quantity, predominantly from urban markets. Innovative approaches across the cold-chain focusing on new age storage systems, real time monitoring of storage and quality parameters, data recording applications, leveraging ICT tools as well as use of renewable sources of energy are some of the innovations shaping up this space.

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Commodity Review

Foodgrains

Procurement of Rice

The total procurement of rice during kharif marketing season 2022-23 up to 22.05.2023 is 51988 thousand metric tonnes as against 57588 thousand metric tonnes during the corresponding period of last year. The details are given in Table 1. A comparative analysis of procurement of rice for the period of marketing season 2022-23 (up to 22.05.2023) and the corresponding period of last year is given in figure 1. The percentage share of different states in procurement of rice has been given in figure 2.

TABLE 1: Procurement of Rice in Major States

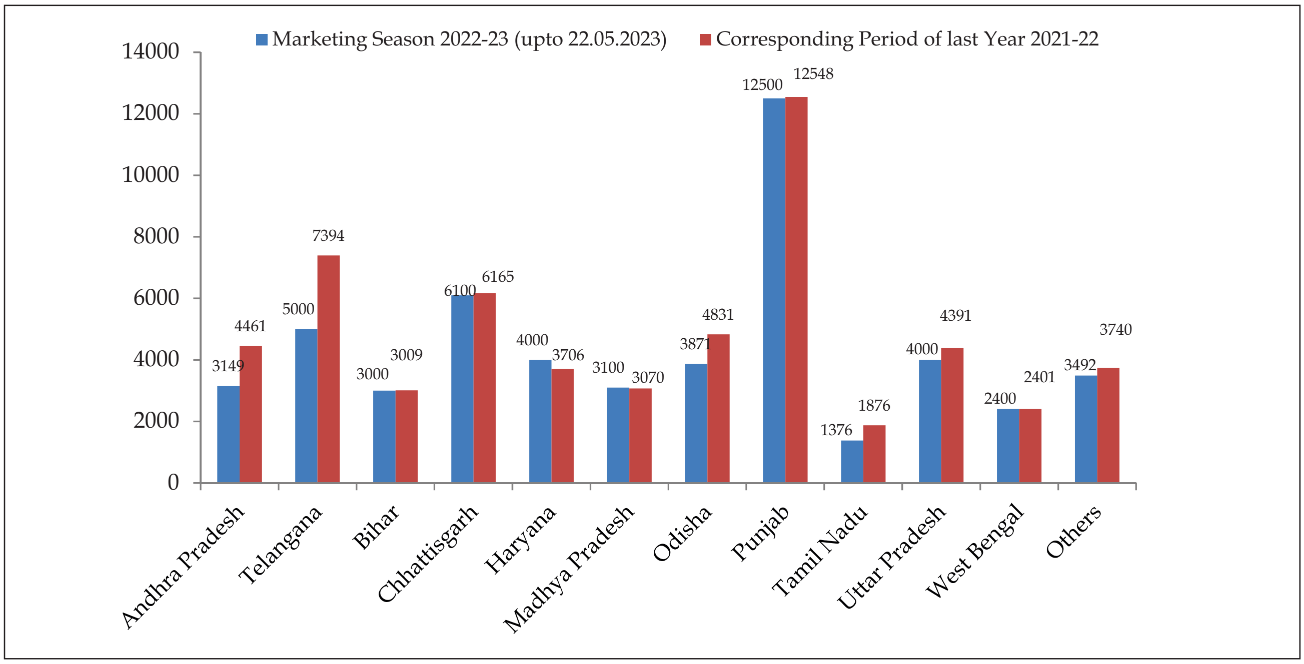
(In thousand metric tonnes)

State	Marketing season 2022-23 (up to 22.05.2023)		Corresponding period of last year 2021-22	
	Procurement	Percentage to total	Procurement	Percentage to total
1	2	3	4	5
Andhra Pradesh	3149	6.1	4461	7.7
Telangana	5000	9.7	7394	12.8
Bihar	3000	5.8	3009	5.2
Chhattisgarh	6100	11.9	6165	10.7
Haryana	4000	7.8	3706	6.4
Madhya Pradesh	3100	6.0	3070	5.3
Odisha	3871	7.5	4831	8.4
Punjab	12500	24.3	12548	21.8
Tamil Nadu	1376	2.5	1876	3.3
Uttar Pradesh	4000	7.8	4391	7.6
West Bengal	2400	3.8	2401	4.2
Others	3492	6.8	3740	6.5
All India Total	**51988**	**100.0**	**57588**	**100.0**

Source: Department of Food & Public Distribution, Govt. of India.

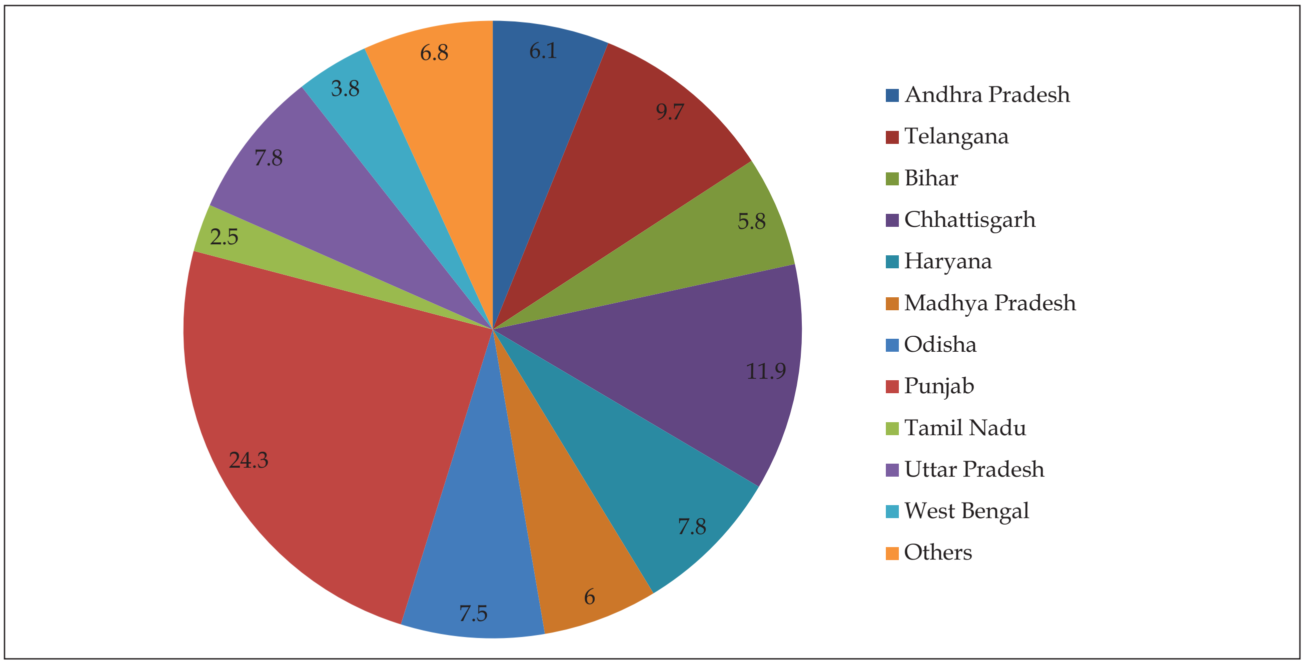
Figure 1: Procurement of Rice in major States

(In thousand metric tonnes)



Source: Department of Food &Public Distribution, Govt. of India.

Figure 2: Percentage Share of Different States in Procurement of Rice during Marketing Season 2022-23(up to 22.05.2023)



Source: Department of Food & Public Distribution, Govt. of India.

Procurement of Wheat

The total procurement of wheat during rabi marketing season 2023-24 up to 22.05.2023 is 34150 thousand metric tonnes as against 18792 thousand metric tonnes during the corresponding period of last year. The details are given in Table 2. Figure 3 depicts the comparison of procurement of wheat during the marketing season 2023-24 (up to 22.05.2023) with the corresponding period of last year. The percentage share of different states in procurement of wheat has been given in figure 4.

TABLE 2: PROCUREMENT OF WHEAT IN MAJOR STATES

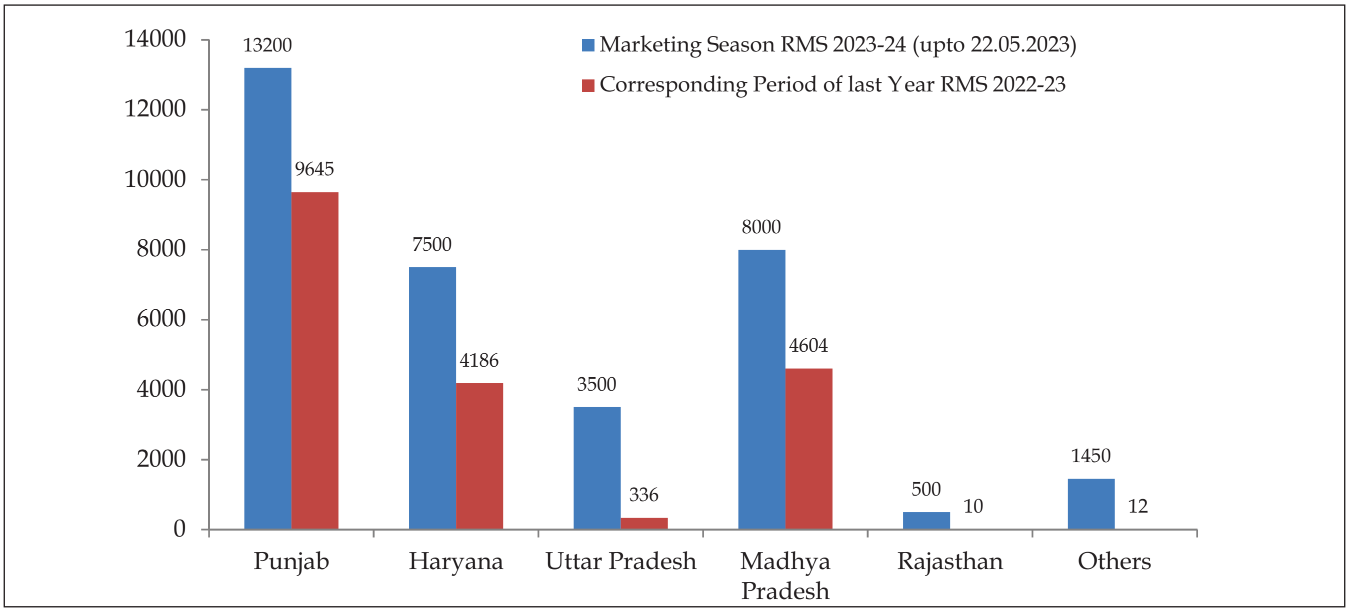
(In thousand metric tonnes)

State	Marketing Season RMS 2023-24 (upto 22.05.2023)		Corresponding period of last year RMS2022-23	
	Procurement	Percentage to total	Procurement	Percentage to total
1	2	3	4	5
Punjab	13200	38.7	9645	51.3
Haryana	7500	22.0	4186	22.3
UttarPradesh	3500	10.2	336	1.8
Madhya Pradesh	8000	23.4	4604	24.5
Rajasthan	500	1.5	10	0.1
Others	1450	4.2	12	6.4
All India Total	**34150**	**100.0**	**18792**	**100.0**

Source: Department of Food & Public Distribution, Govt. of India.

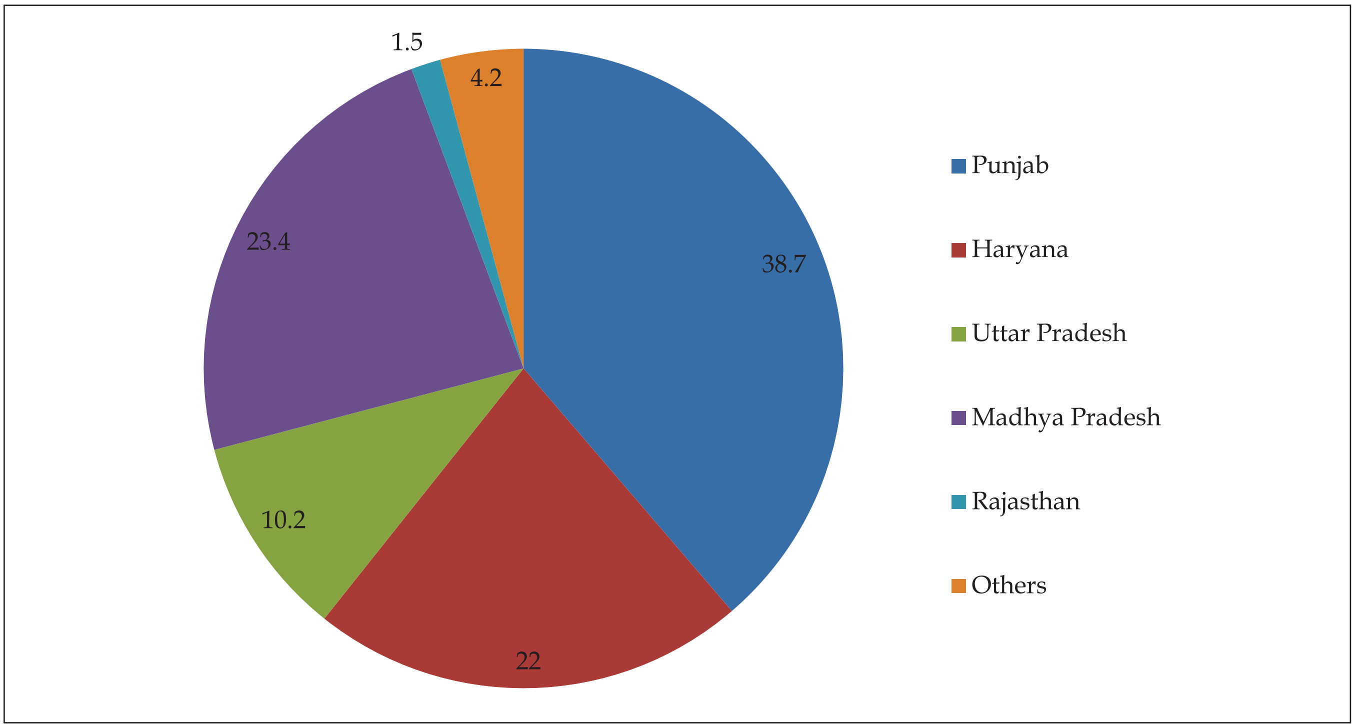
Figure 3: Procurement of Wheat in major States

(In thousand metric tonnes)



Source: Department of Food & Public Distribution, Govt. of India.

Figure 4: Percentage Share of Different States in Procurement of Wheat during Marketing Season 2023-24 (up to 22.05.2023)



Source: Department of Food &Public Distribution, Govt. of India.

Commercial Crops

Oilseeds

The Wholesale Price Index (WPI) of nine major oilseeds as a group stood at 191.9 in April, 2023 showing a decrease of 0.31 percent over the previous month and a decrease by 15.54 percent over the corresponding month of previous year.

The Wholesale Price Index (WPI) of all individual oilseeds showed a mixed trend. The WPI of niger seed (3.19 percent), gingelly seed (sesamum) (1.82 percent), soybean (1.06 percent), cotton seed (1.93 percent) and groundnut seed (0.20 percent) increased over the previous month. However, the WPI of rape & mustard seed (2.55 percent), copra (coconut) (1.31 percent), safflower (7.01 percent) and sunflower (1.83 percent) decreased over the previous month

Manufacture of vegetable and animal oils and fats

The WPI of vegetable and animal oils and fats as a group stood at 156.1 in April, 2023 which shows a decrease of 2.01 percent over the previous month. Moreover, it decreased by 25.91 percent over the corresponding month of previous year. The WPI of groundnut oil (1.96 percent), mustard oil (3.01 percent), soybean oil (4.14 percent), sunflower oil (4.48 percent), rapeseed oil (5.55 percent), copra oil (2.29 percent) and cotton seed oil (5.33 percent) decreased over the previous month.

Fruits & Vegetable

The WPI of fruits & vegetable as a group stood at 192.0 in April, 2023 showing an increase of 6.14 percent over previous month and decrease of 3.03 percent over the corresponding month of previous year.

Potato

The WPI of potato stood at 158.2 in April, 2023 showing an increase of 14.06 percent over the previous month. However, it decreased by 18.66 percent over the corresponding month of previous year.

Onion

The WPI of onion stood at 128.5 in April, 2023 showing a decrease of 6.95 percent over the previous month and a decrease of 18.41 percent over the corresponding month of previous year.

Condiments & Spices

The WPI of condiments & spices (group) stood at 197.7 in April, 2023 showing an increase of 2.49 percent over the previous month and an increase of 13.75 percent over the corresponding month of previous year. The WPI of chillies (dry) increased by 2.04 percent and turmeric decreased by 1.91 percent over the previous month. However, the WPI of black pepper decreased by 2.35 percent over the previous month.

Tea

The WPI of tea stood at 180.5 in April, 2023 showing an increase of 13.45 percent over the previous month and an increase of 6.74 percent over the corresponding month of previous year.

Coffee

The WPI of coffee stood at 145.7 in April, 2023 showing no change over the previous month. However, there is a decrease of 2.08 percent over the corresponding month of previous year.

Sugarcane

The WPI of sugarcane stood at 210.1 in April, 2023 showing no change over the previous month. However, there is an increase of 5.16 percent over the corresponding month of the previous year.

Raw cotton

The WPI of raw cotton stood at 172.2 in April, 2023 showing an increase of 1.71 percent over the previous month and a decrease of 17.92 percent over the corresponding month of previous year.

Raw jute

The WPI of raw jute stood at 257.1 in April, 2023 showing an increase of 0.59 percent over the previous month and a decrease of 11.77 percent over the corresponding month of previous year.

Wholesale Price Index of commercial crops is given in Table 3. A graphical comparison of WPI for the period of April, 2023 and March, 2023 is given in figure 5 and the comparison of WPI during the April, 2023 with the corresponding month of last year has been given in figure 6.

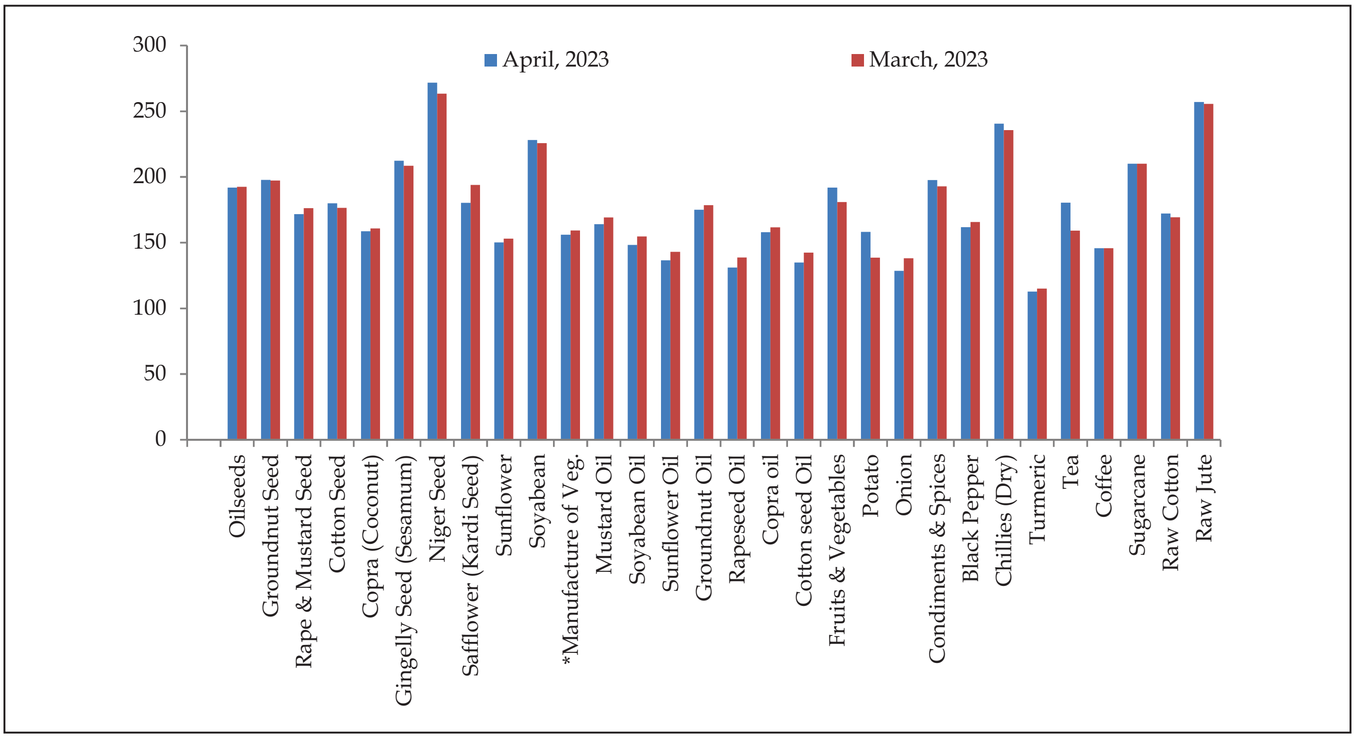
TABLE 3: INDEX OF WHOLESALE PRICE COMMERCIAL CROPS

(Base Year: 2011-12)

Commodity	April, 2023	March, 2023	April, 2022	Percentage variation over the	
				Month	Year
Oilseeds	191.9	192.5	227.2	-0.31	-15.54
Groundnut seed	197.8	197.4	171.2	0.20	15.54
Rape & Mustard seed	171.7	176.2	208.3	-2.55	-17.57
Cotton seed	180.0	176.6	194.0	1.93	-7.22
Copra (Coconut)	158.7	160.8	200.0	-1.31	-20.65
Gingelly seed (Sesamum)	212.4	208.6	187.2	1.82	13.46
Niger seed	271.8	263.4	239.8	3.19	13.34
Safflower (Kardi seed)	180.4	194.0	229.6	-7.01	-21.43
Sunflower	150.2	153.0	198.9	-1.83	-24.48
Soyabean	228.2	225.8	311.3	1.06	-26.69
Manufacture of vegetable and animal oils and fats	156.1	159.3	210.7	-2.01	-25.91
Mustard oil	164.1	169.2	218.1	-3.01	-24.76
Soyabean oil	148.3	154.7	201.6	-4.14	-26.44
Sunflower oil	136.6	143.0	181.8	-4.48	-24.86
Groundnut oil	175.1	178.6	177.3	-1.96	-1.24
Rapeseed oil	131.1	138.8	188.4	-5.55	-30.41
Copra oil	158.0	161.7	186.7	-2.29	-15.37
Cotton seed oil	134.9	142.5	192.6	-5.33	-29.96
Fruits & Vegetables	192.0	180.9	198.0	6.14	-3.03
Potato	158.2	138.7	194.5	14.06	-18.66
Onion	128.5	138.1	157.5	-6.95	-18.41
Condiments & Spices	197.7	192.9	173.8	2.49	13.75
Black Pepper	161.8	165.7	168.7	-2.35	-4.09
Chillies (Dry)	240.5	235.7	197.4	2.04	21.83

Source: Department of Food & Public Distribution, Govt. of India.

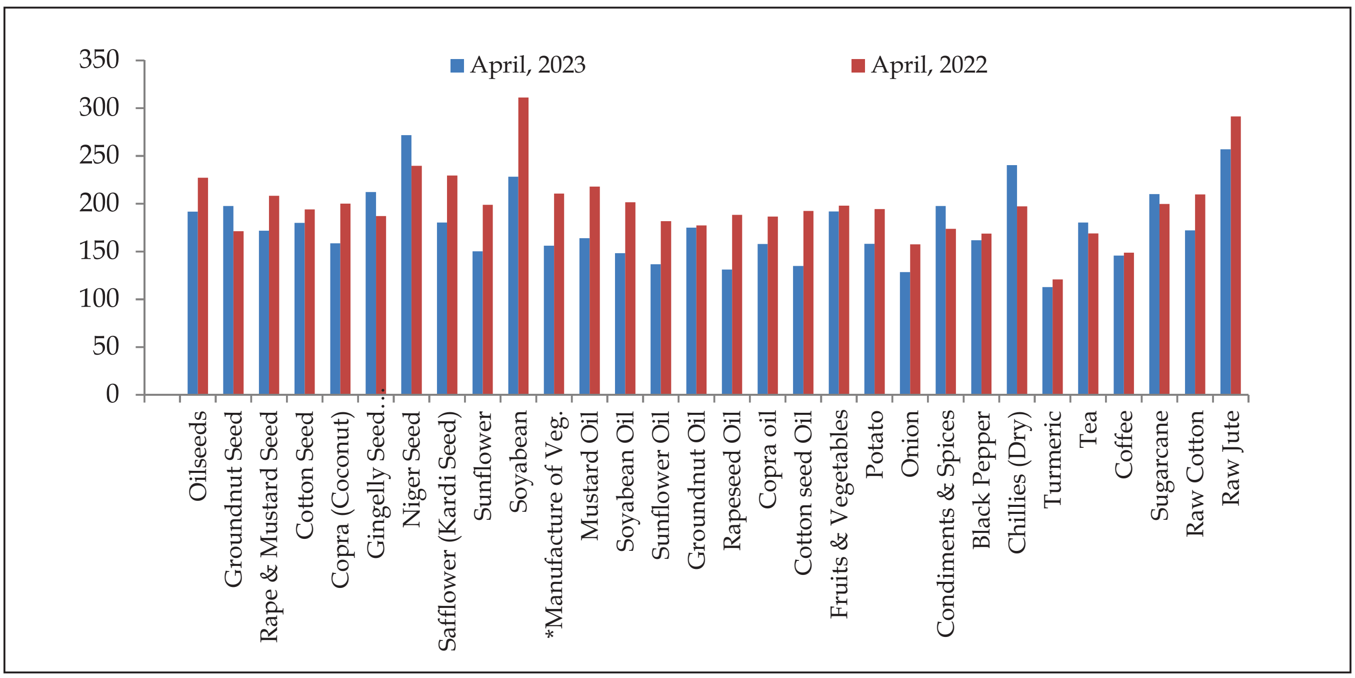
Figure 5: WPI of Commercial Crops during April, 2023 and March, 2023



*Manufacture of vegetable, animal oils and fats.

Source: Office of the Economic Advisor, DPIIT, Ministry of Commerce, Govt. of India.

Figure 6: WPI of Commercial Crops during April, 2023 and April, 2022



*Manufacture of Vegetable, Animal Oils and Fats.

Source: Office of the Economic Advisor, DPIIT, Ministry of Commerce, Govt. of India.

Statistical Tables

1. Wages

STATE-WISE PREVAILING AVERAGE DAILY WAGES

(Value in Rs)

Sr. No.	State	Month & Year	Normal Working Hours	Field Labour								Other Agri. Labour		Tractor Driver		* Field Labour		Non-Agri. Occupation		
				Ploughing		Sowing		Weeding		Reaping & Harvesting								Carpenter	Blacksmith	Mason
				M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	M	M
1	Andhra Pradesh	Nov, 22	8				Not Required					624	343	NR		522	372	602	495	NR
2	Assam	Dec, 22	8	390	358	377	333	363	356	399	331	381	339	484	-			531	438	496
3	Bihar	Feb, 23	8	390	345	358	320	357	315	374	-	378	336	464	-			552	525	530
4	Chhattisgarh	Jan, 23	8	428	-	221	190	205	175	195	164	232	187	436	-			420	313	355
5	Goa	Dec, 22	8	725	650	591	457	725	525	584	375	670	439	1212	-			1046	800	934
6	Gujarat	Nov, 22	8	309	NR	262	254	249	247	257	253	203	203	382	-			504	501	501
7	Haryana	Nov, 22	8	609	500	539	463	507	453	527	480	493	455	603	-			705	665	771
8	Himachal Pradesh	Sep, 22	8	491	491	343	343	339	339	339	339	339	339	535	-			529	533	533
9	Jharkhand	June,22	8	290	265	270	249	278	242	274	NR	256	238	NR		Not Required		408	434	NR
10	Karnataka	March, 23	8	662	391	446	327	374	293	432	321	455	332	623	-			552	510	695
11	Kerala	May, 22	8	947	NR	NR	609	NR	592	744	609	731	632	NR				986	973	986
12	Madhya Pradesh	March, 23	8	368	276	326	266	291	262	331	291	348	297	444	-			492	474	506
13	Maharashtra (P*)	June, 22	8	406	283	381	256	356	244	490	NR	378	244	607	-			500	450	472
14	Odisha	June, 22	8	412	373	366	324	353	307	363	NR	379	313	513	-			577	529	590
15	Punjab	Dec, 22	8	509	443	489	429	453	405	489	NR	468	407	501	-			600	591	598
16	Rajasthan	Oct, 22	8	439	314	442	314	351	316	378	328	384	274	488	-			522	471	583
17	Tamil Nadu	Feb, 23	8	685	-	634	327	677	335	706	331	658	354	850	-			798	716	852
18	Telangana	Sep, 22	8				Not Required					470	NR		NR	452	239		NR	
19	Tripura	Dec, 22	8	407	NR	354	302	348	303	345	281	303	251	472	NR			448	371	351
20	Uttar Pradesh	March, 23	8	345	-	334	317	323	310	339	317	330	313			Not Required		555	-	584
21	Uttarakhand	Nov, 22	8	691	NR	462	412	425	390	441	403	485	428	NR				694	NR	718
22	West Bengal	Dec, 22	8	453	316	346	309	337	297	361	311	381	269					508	477	517

Source: State Governments

Note: 1 Other agricultural labour include field waterping,carrying load, well diggers, cleaning silt from waterways and embankment, etc.

2. *States of Andhra Pradesh and Telangana do not give operation–wise details as they furnish data for the group

3. P* - Provisional as the State has not furnished data for its all districts.

4. NR: Not Reported

2. Prices

WHOLESALE PRICES OF CERTAIN AGRICULTURAL COMMODITIES AND ANIMAL HUSBANDRY PRODUCTS AT SELECTED CENTRES IN INDIA

(All Prices in Rupees)

Commodity	Variety	Unit	State	Centre	Apr-23	Mar-23	Apr-22
Wheat	PBW 343	Quintal	Punjab	Amritsar	2125	NA	2015
Wheat	Dara	Quintal	Uttar Pradesh	Chandausi	2130	2200	2100
Wheat	Lokvan	Quintal	Madhya Pradesh	Bhopal	2231	2270	2098
Jowar	-	Quintal	Maharashtra	Mumbai	4200	4200	3500
Gram	No III	Quintal	Madhya Pradesh	Sehore	4730	4890	4351
Maize	Yellow	Quintal	Uttar Pradesh	Kanpur	2330	2250	2125
Gram Split	-	Quintal	Bihar	Patna	6800	6940	6350
Gram Split	-	Quintal	Maharashtra	Mumbai	6000	6000	5900
Arhar Split	-	Quintal	Bihar	Patna	11250	11300	9450
Arhar Split	-	Quintal	Maharashtra	Mumbai	10500	10500	8900
Arhar Split	-	Quintal	NCT of Delhi	Delhi	10400	10400	9600
Arhar Split	Sort II	Quintal	Tamil Nadu	Chennai	10400	9800	8500
Gur	-	Quintal	Maharashtra	Mumbai	4650	4650	4600
Gur	Sort II	Quintal	Tamil Nadu	Coimbatore	4900	4800	4800
Gur	Balti	Quintal	Uttar Pradesh	Hapur	3150	2900	2950
Mustard Seed	Black (S)	Quintal	Uttar Pradesh	Kanpur	5180	5350	6500
Mustard Seed	Black	Quintal	West Bengal	Raniganj	6500	6500	6500
Mustard Seed	-	Quintal	West Bengal	Kolkata	5725	6000	7500
Linseed	Bada Dana	Quintal	Uttar Pradesh	Kanpur	5200	5600	7800
Linseed	Small	Quintal	Uttar Pradesh	Varanasi	5200	5300	7850
Cotton Seed	Mixed	Quintal	Tamil Nadu	Virudhunagar	3500	3500	3200
Cotton Seed	MCU 5	Quintal	Tamil Nadu	Coimbatore	4000	4125	4100
Castor Seed	-	Quintal	Telangana	Hyderabad	NT	NT	NT
Sesamum Seed	White	Quintal	Uttar Pradesh	Varanasi	12750	13500	9400
Copra	FAQ	Quintal	Kerala	Alleppey	8550	8550	9150
Groundnut	Pods	Quintal	Tamil Nadu	Coimbatore	6850	6500	5500
Groundnut	-	Quintal	Maharashtra	Mumbai	11000	11000	9900
Mustard Oil	-	15 Kg.	Uttar Pradesh	Kanpur	2200	2260	2460
Mustard Oil	Ordinary	15 Kg.	West Bengal	Kolkata	1750	1898	2430

Wholesale Prices of Certain Agricultural Commodities and Animal Husbandry Products at Selected Centres in India - *Contd.*

Commodity	Variety	Unit	State	Centre	Apr-23	Mar-23	Apr-22
Groundnut Oil	-	15 Kg.	Maharashtra	Mumbai	2500	2530	2550
Groundnut Oil	Ordinary	15 Kg.	Tamil Nadu	Chennai	2950	2950	2800
Linseed Oil	-	15 Kg.	Uttar Pradesh	Kanpur	2260	2315	2400
Castor Oil	-	15 Kg.	Telangana	Hyderabad	2400	2250	2625
Sesamum Oil	-	15 Kg.	NCT of Delhi	Delhi	2400	2400	2700
Sesamum Oil	Ordinary	15 Kg.	Tamil Nadu	Chennai	4000	4000	3350
Coconut Oil	-	15 Kg.	Kerala	Cochin	1950	1950	2220
Mustard Cake	-	Quintal	Uttar Pradesh	Kanpur	2750	2750	2850
Groundnut Cake	-	Quintal	Telangana	Hyderabad	NT	NT	NT
Cotton/Kapas	NH 44	Quintal	Andhra Pradesh	Nandyal	7000	7000	11250
Cotton/Kapas	LRA	Quintal	Tamil Nadu	Virudhunagar	6200	6200	9200
Jute Raw	TD 5	Quintal	West Bengal	Kolkata	5825	5750	6500
Jute Raw	W 5	Quintal	West Bengal	Kolkata	5825	5750	6650
Oranges	Big	100 No	Tamil Nadu	Chennai	2000	1800	2000
Oranges	Nagpuri	100 No	West Bengal	Kolkata	NT	1300	900
Banana	-	100 No.	NCT of Delhi	Delhi	583	666	417
Banana	Medium	100 No.	Tamil Nadu	Kodaikkanal	600	590	560
Cashewnuts	Raw	Quintal	Maharashtra	Mumbai	60000	60000	85000
Almonds	-	Quintal	Maharashtra	Mumbai	75000	75000	84500
Walnuts	-	Quintal	Maharashtra	Mumbai	95000	80000	95000
Kishmish	-	Quintal	Maharashtra	Mumbai	20000	24000	16200
Peas Green	-	Quintal	Maharashtra	Mumbai	7000	7200	8500
Tomato	Ripe	Quintal	Uttar Pradesh	Kanpur	1050	1000	1600
Ladyfinger	-	Quintal	Tamil Nadu	Chennai	2400	2500	3000
Cauliflower	-	100 No.	Tamil Nadu	Chennai	2000	1500	2000
Potato	Red	Quintal	Bihar	Patna	1130	870	1140
Potato	Desi	Quintal	West Bengal	Kolkata	1500	1000	1900
Potato	Sort I	Quintal	Tamil Nadu	Mettuppalayam	2593	2308	2722
Onion	Pole	Quintal	Maharashtra	Nashik	700	750	750
Turmeric	Nadan	Quintal	Kerala	Cochin	11000	11000	11500

WHOLESALE PRICES OF CERTAIN AGRICULTURAL COMMODITIES AND ANIMAL HUSBANDRY PRODUCTS AT SELECTED CENTRES IN INDIA- *Concld.*

Commodity	Variety	Unit	State	Centre	Apr-23	Mar-23	Apr-22
Turmeric	Salam	Quintal	Tamil Nadu	Chennai	11000	10800	11800
Chillies	-	Quintal	Bihar	Patna	21700	21400	16500
Black Pepper	Nadan	Quintal	Kerala	Kozhikode	47300	48100	49000
Ginger	Dry	Quintal	Kerala	Cochin	24000	21500	17000
Cardamom	Major	Quintal	NCT of Delhi	Delhi	57500	57500	57300
Cardamom	Small	Quintal	West Bengal	Kolkata	170000	190000	122500
Milk	Buffalo	100 Liters	West Bengal	Kolkata	7500	7500	6500
Ghee Deshi	Deshi No 1	Quintal	NCT of Delhi	Delhi	62031	61698	59363
Ghee Deshi	-	Quintal	Maharashtra	Mumbai	75000	80000	40000
Ghee Deshi	Desi	Quintal	Uttar Pradesh	Kanpur	45000	47000	44000
Fish	Rohu	Quintal	NCT of Delhi	Delhi	12000	12000	12000
Fish	Pomphrets	Quintal	Tamil Nadu	Chennai	73000	65000	80000
Eggs	Madras	1000 No.	West Bengal	Kolkata	5335	4730	4025
Tea	-	Quintal	Bihar	Patna	25800	25600	27800
Tea	Atti Kunna	Quintal	Tamil Nadu	Coimbatore	12144	11911	10235
Coffee	Plant-A	Quintal	Tamil Nadu	Coimbatore	44000	44000	41000
Coffee	Rubusta	Quintal	Tamil Nadu	Coimbatore	26000	25000	22500
Tobacco	Kampila	Quintal	Uttar Pradesh	Farukhabad	9800	9600	8600
Tobacco	Raisa	Quintal	Uttar Pradesh	Farukhabad	4800	4600	4100
Tobacco	Bidi Tobacco	Quintal	West Bengal	Kolkata	13300	13300	13300
Rubber	-	Quintal	Kerala	Kottayam	13500	13400	15600
Arecanut	Pheton	Quintal	Tamil Nadu	Chennai	93000	92000	90000

Source: DPIIT, Ministry of Commerce and Industry, Govt. of India.

Crop Production

SOWING AND HARVESTING OPERATIONS NORMALLY IN PROGRESS DURING MAY, 2023

State	Sowing	Harvesting
(1)	(2)	(3)
Andhra Pradesh	Autumn Rice, Sugarcane, Groundnut.	Summer Rice, Onion.
Assam	Winter Rice, Maize, Tur (R), Cotton.	Summer Potato (Hills).
Bihar	Autumn Rice, Jute, Mesta.	Summer Rice, Wheat, Barley, Gram, Castor seed, Linseed.
Gujarat	Sugarcane, Ginger, Turmeric.	Onion.
Himachal Pradesh	Maize, Ragi, Small Millets (K), Summer Potato (Hills), Sugarcane, Ginger, Chillies (Dry), Tobacco, Sesamum, Cotton, Turmeric.	Wheat, Barley, Gram, Other Rabi Pulses, Linseed, Onion.
Jammu & Kashmir	Autumn Rice, Jowar (K), Maize, Ragi, Small Millets (K), Mung (K), Tur (K), Other Kharif Pulses, Summer Potato, Chillies (Dry), Tobacco.	Wheat, Barley, Small Millets (R), Tur (K), Sesamum, Rapeseed and Mustard, Linseed, Onion.
Karnataka	Autumn Rice, Jowar (K), Maize, Ragi, Urad (K), Mung (K), Summer Potato (Hills), Tobacco, Castorseed, Sesamum, Cotton, Sweet Potato, Turmeric, Sunn Hemp, Onion, Tapioca.	Summer Rice, Ragi (R), Winter Potato, Tapioca.
Kerala	Autumn Rice, Ragi, Small Millets (K), Tur(K), Urad (K), Mung (K), Other Kharif Pulses, Ginger, Turmeric, Tapioca (Early). Sugarcane, Ginger, Chillies (Dry),	Summer Rice, Other Rabi Pulses, Tapioca (Late).
Madhya Pradesh	Turmeric.	Winter Potato (Plains), Onion.
Maharashtra	Turmeric.	-
Manipur	Autumn Rice, Groundnut, Castor seed, Cotton.	-
Orissa	Autumn Rice, Sugarcane, Chillies (Dry), Jute, Turmeric.	Summer Rice, Cotton, Chillies (Dry).
Punjab and Haryana	Autumn rice, Summer Rice, ragi, Small Millets (K), Tur (K), Summer Potato (Hills), Chillies (Dry), Cotton, Sweet Potato.	Wheat, Barley, Winter Potato (Plains), Summer Potato, Tobacco, Onion.
Rajasthan	Sugarcane.	Wheat, Small Millets (R), Tobacco.

SOWING AND HARVESTING OPERATIONS NORMALLY IN PROGRESS DURING MAY, 2023

State	Sowing	Harvesting
(1)	**(2)**	**(3)**
Tamil Nadu	Autumn Rice, Bajra, Summer Potato, Sugarcane, Chillies (Dry), Groundnut, turmeric, Sunn Hemp, Tapioca.	Summer Rice, Jowar (R), Winter Potato (Hills), Sugarcane, Chillies (Dry),. Sesamum, Onion
Tripura	Autumn Rice, Maize, Sugarcane, Ginger, Chillies (Dry), Sesamum, Cotton, Jute, Mesta.	-
Uttar Pradesh	Autumn Rice, Tur (K), Chillies (Dry), Groundnut, Cotton, Jute, Mesta.	Summer Rice, Wheat, Barley, Sugarcane, Tobacco, Rapeseed & Mustard, Sunn Hemp, Linseed, Onion.
West Bengal	Autumn Rice, Winter Rice, Maize, Tur (K), Ginger, Chillies (Dry), Jute, Mesta.	Summer Rice, Chillies (Dry), Sesamum.
Delhi	Jowar (K), Onion.	-

(K)- Kharif (R)- Rabi

Note to Contributors

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