



COLD CHRONICLE



Everything about COLD-CHAIN



STRENGTHENING SUPPLY CHAIN

**TECHNOLOGY
FROM THE
FUTURE**

**INDIA COLD CHAIN
CONCLAVE 4.0
REFCON 2025**

**NCCD-X-INDIAN
DEFENCE
FORCES**

**HEAT LOAD
SHEET
CALCULATOR**

**CLUSTER
DEVELOPMENT
PROGRAM**

**NCCD'S
CONTINUOUS
DEVELOPMENT**



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ENGINEER- NCCD

AS WE PRESENT THIS EDITION OF THE MAGAZINE, WE EXTEND OUR SINCERE GRATITUDE TO ALL THE CONTRIBUTORS WHO HAVE ENRICHED THESE PAGES WITH THEIR INSIGHTS, EXPERIENCES, AND PERSPECTIVES FROM ACROSS THE COLD CHAIN SECTOR. THE ARTICLES AND EVENT REPORTS FEATURED IN THIS ISSUE REFLECT THE COLLECTIVE KNOWLEDGE AND COMMITMENT OF POLICYMAKERS, PRACTITIONERS, INDUSTRY EXPERTS, AND INSTITUTIONS WORKING TOWARDS BUILDING A MORE EFFICIENT, RESILIENT, AND SUSTAINABLE COLD CHAIN ECOSYSTEM.

THEIR WILLINGNESS TO SHARE LEARNINGS AND BEST PRACTICES CONTINUES TO STRENGTHEN THE VALUE OF THIS PUBLICATION AS A KNOWLEDGE AND REFERENCE PLATFORM.

THIS EDITION ALSO CAPTURES THE LEADERSHIP VISION ARTICULATED BY THE JOINT SECRETARY (HORTICULTURE), WHO HAS UNDERScoreD THE POSITIVE RESPONSE RECEIVED BY NCCD'S GUIDELINES FROM STAKEHOLDERS ACROSS THE VALUE CHAIN. THE APPRECIATION AND CONSTRUCTIVE FEEDBACK RECEIVED REAFFIRM THE RELEVANCE AND PRACTICALITY OF THESE GUIDELINES. IMPORTANTLY, AS HIGHLIGHTED, NCCD HAS REMAINED ACTIVELY ENGAGED WITH STAKEHOLDERS AND HAS ADOPTED A DYNAMIC, CONSULTATIVE APPROACH—CONTINUOUSLY REFINING AND UPGRADING ITS GUIDELINES BASED ON REAL-WORLD FEEDBACK AND EVOLVING SECTORAL NEEDS.

FURTHER, THE ISSUE HIGHLIGHTS NCCD'S EXPANDING ROLE THROUGH ITS ACTIVE ENGAGEMENT WITH THE INDIAN NAVY, THIS COLLABORATION DEMONSTRATES HOW NCCD'S COLD CHAIN EXPERTISE CAN BE EFFECTIVELY APPLIED TO STRENGTHEN INSTITUTIONAL SUPPLY CHAINS OPERATING UNDER COMPLEX AND DEMANDING CONDITIONS. BY WORKING CLOSELY WITH THE INDIAN NAVY TO UNDERSTAND OPERATIONAL REALITIES AND CUSTOMISE SOLUTIONS, NCCD IS CONTRIBUTING TO IMPROVED EFFICIENCY, REDUCED LOSSES, AND RELIABLE ACCESS TO QUALITY FRESH PRODUCE ACROSS NAVAL ESTABLISHMENTS.

WE ONCE AGAIN EXPRESS OUR APPRECIATION TO ALL CONTRIBUTORS, PARTNERS, AND STAKEHOLDERS FOR THEIR CONTINUED SUPPORT AND COLLABORATION. WE HOPE THAT THE INSIGHTS SHARED IN THIS EDITION WILL INFORM, INSPIRE, AND ENCOURAGE FURTHER DIALOGUE AND INNOVATION IN THE COLD CHAIN SECTOR.

You can share your views and ideas.
Mail to: nccd.india@gmail.com

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SH. PRIYA RANJAN
JS- HORTICULTURE
MD- NHB
DIRECTOR- NCCD

THIS EDITION OF THE MAGAZINE BRINGS TOGETHER A RICH COLLECTION OF ARTICLES, INSIGHTS, AND EVENT REPORTS THAT COMPREHENSIVELY CAPTURE RECENT DEVELOPMENTS, EMERGING TRENDS, AND ON-GROUND EXPERIENCES FROM ACROSS THE COLD CHAIN SECTOR. BY DOCUMENTING KEY INITIATIVES, DELIBERATIONS, AND BEST PRACTICES, THE PUBLICATION SERVES AS A VALUABLE KNOWLEDGE PLATFORM FOR POLICYMAKERS, INDUSTRY STAKEHOLDERS, PRACTITIONERS, AND ALL THOSE ENGAGED IN STRENGTHENING INDIA'S COLD CHAIN ECOSYSTEM.

IT GIVES ME IMMENSE SATISFACTION TO NOTE THE ENCOURAGING RESPONSE RECEIVED BY THE GUIDELINES ISSUED BY THE NATIONAL CENTRE FOR COLD CHAIN DEVELOPMENT (NCCD). THE POSITIVE FEEDBACK AND APPRECIATION FROM A WIDE SPECTRUM OF STAKEHOLDERS—RANGING FROM INDUSTRY PARTICIPANTS AND PRACTITIONERS TO IMPLEMENTING AGENCIES AND POLICYMAKERS—REAFFIRM THE RELEVANCE, PRACTICALITY, AND TIMELINESS OF THESE GUIDELINES.

WHAT IS PARTICULARLY HEARTENING IS THAT NCCD HAS NOT VIEWED THE PUBLICATION OF GUIDELINES AS A ONE-TIME EXERCISE. THE CENTRE HAS REMAINED ACTIVELY ENGAGED WITH STAKEHOLDERS ON A CONTINUOUS BASIS, FOSTERING DIALOGUE AND INVITING CONSTRUCTIVE FEEDBACK FROM THE FIELD. THIS ONGOING INTERACTION HAS PROVIDED VALUABLE INSIGHTS INTO ON-GROUND CHALLENGES, EMERGING REQUIREMENTS, AND EVOLVING BEST PRACTICES ACROSS THE COLD CHAIN VALUE CHAIN.

MESSAGE FROM COO-NCCD



**SH. ASHEESH
FOTEDAR**
COO - NCCD

AT THE NATIONAL CENTRE FOR COLD CHAIN DEVELOPMENT (NCCD), WE STRONGLY BELIEVE THAT EFFECTIVE COLD CHAIN SYSTEMS ARE BUILT THROUGH CLOSE ENGAGEMENT WITH END USERS AND INSTITUTIONS THAT OPERATE IN DEMANDING AND DIVERSE ENVIRONMENTS. IN THIS CONTEXT, NCCD'S ACTIVE COLLABORATION WITH THE INDIAN NAVY MARKS AN IMPORTANT STEP TOWARDS STRENGTHENING INSTITUTIONAL SUPPLY CHAINS BY LEVERAGING DOMAIN EXPERTISE IN COLD CHAIN PLANNING, HANDLING, STORAGE, AND LOGISTICS.

THROUGH STRUCTURED INTERACTIONS, TECHNICAL CONSULTATIONS, AND ON-GROUND ENGAGEMENTS, NCCD HAS BEEN WORKING CLOSELY WITH THE INDIAN NAVY TO UNDERSTAND THEIR EXISTING SUPPLY SYSTEMS, OPERATIONAL CHALLENGES, AND MISSION-SPECIFIC REQUIREMENTS. BY APPLYING COLD CHAIN BEST PRACTICES AND CUSTOMISED TECHNICAL INPUTS, THIS ENGAGEMENT AIMS TO ENHANCE EFFICIENCY, REDUCE LOSSES, AND ENSURE CONSISTENT AVAILABILITY OF QUALITY FRESH PRODUCE ACROSS NAVAL ESTABLISHMENTS, INCLUDING REMOTE AND OPERATIONALLY SENSITIVE LOCATIONS.

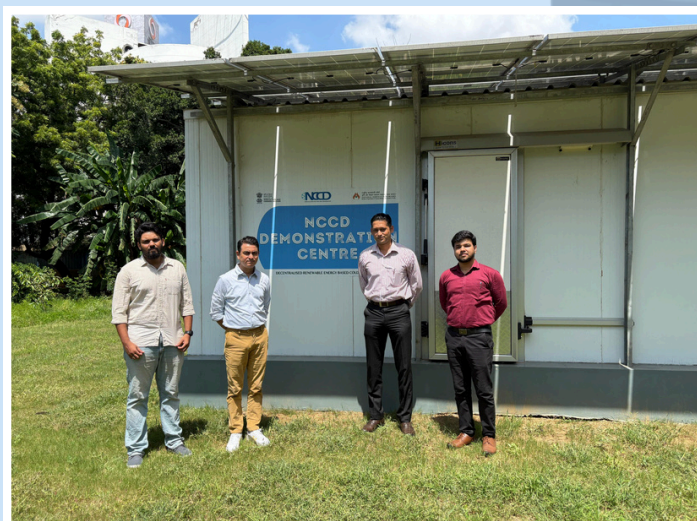
Strengthening Logistics, Ensuring Nutrition

and supporting our forces through a resilient cold chain ecosystem.

In a significant step toward reinforcing national food security and supporting India's defence forces, the National Centre for Cold Chain Development (NCCD) has entered into a collaborative partnership with the Indian Navy to further strengthen and modernise the Navy's already robust supply chain for fresh fruits and vegetables. The initiative reflects a shared commitment to ensuring that quality nutrition reaches personnel serving in demanding operational environments, both on land and at sea.

The Indian Navy operates across a wide spectrum of geographies—coastal bases, island territories, remote onshore establishments, and ships deployed far from the mainland. In such conditions, maintaining a steady supply of safe, fresh, and nutritious food presents unique logistical and technical challenges. Temperature fluctuations, extended transit times, and constrained storage spaces make the management of perishables particularly complex. Recognising the strategic importance of a scientifically designed cold chain in overcoming these challenges, the collaboration brings together NCCD's domain expertise in cold chain planning and standards with the Indian Navy's operational experience and logistical precision.

As part of the engagement, officials from the Indian Navy visited NCCD's Demonstration Centre, where they were exposed to modern cold chain technologies and best practices across the perishable supply chain. The visit covered critical aspects such as scientific storage systems, temperature-controlled transportation, improved handling protocols, and loss-reduction strategies across the farm-to-fork continuum. These interactions provided valuable insights into how technology-enabled cold chain interventions can significantly reduce post-harvest losses, enhance food safety, and preserve nutritional quality—factors that are vital for sustained operational readiness.



The collaboration was further strengthened through a reciprocal visit by the Chief Operating Officer (COO), NCCD, to the Indian Navy's facility situated at Karwar. This on-ground engagement provided valuable first-hand exposure to the Navy's existing supply chain architecture, operating protocols, and mission-specific logistical challenges. By closely observing real-world conditions and interacting directly with personnel involved in operations and end use, NCCD was able to gain nuanced insights into practical gaps, system inefficiencies, and areas where targeted interventions could add value. Such two-way engagement ensures that proposed solutions are not only technically sound but also operationally feasible, adaptable, and seamlessly integrable within the Navy's established logistics framework.

The joint initiative aims to enhance overall cold chain efficiency, strengthen handling and distribution practices, and enable seamless end-to-end logistics for fresh produce. With a focus on optimisation at every stage—from sourcing and aggregation to storage, transportation, and last-mile delivery—the collaboration seeks to minimise losses, maintain quality, and improve reliability. Ultimately, this effort is directed towards ensuring that naval personnel have consistent and timely access to high-quality fruits and vegetables, irrespective of their location, scale of operations, or deployment status.



Beyond its immediate operational benefits, the partnership represents a broader commitment to nation-building through institutional collaboration. It highlights how technical organisations under the Ministry of Agriculture & Farmers Welfare (MoAFW), such as NCCD, can extend their expertise beyond the civilian domain to support strategic national institutions. By applying sectoral knowledge to real-world challenges, NCCD continues to demonstrate the wider relevance of cold chain development in strengthening food security at multiple levels.

This meaningful collaboration between NCCD and the Indian Navy stands as a strong example of “Nation First” in action—where technology, logistics, and public service converge in support of those who safeguard the country. By strengthening the food supply chain for the armed forces, the initiative contributes not only to operational efficiency but also to the health, morale, and overall well-being of India’s naval personnel.



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Redefining the Mechanics of the Cold Chain

If the previous decade of cold chain development was defined by capacity expansion, 2025 has been defined by technological disruption.

For agrarian economies operating in high-ambient temperature zones, the challenge has moved beyond simply building more warehouses. The focus has shifted to how those warehouses operate. The past twelve months have witnessed a surge in indigenous R&D, moving away from expensive, imported legacy systems toward "frugal" high-tech solutions designed specifically for intermittent grids and extreme heat.

The headline innovation of 2025 is the transition from Electrical Dependence to Thermal Intelligence. We are no longer relying solely on the grid to keep compressors running; we are using advanced physics to store cold energy itself. Here are the four definitive innovations from the past year that are rewriting the industry rulebook.

Farm Gate Innovation: The "Battery-Less" Solar Cold Room



For years, the adoption of solar-powered cold storage was hindered by one expensive component: the chemical battery. Lead-acid and Lithium-ion batteries drive up capital costs and degrade rapidly in high temperatures.

2025 marked the commercial breakthrough of Hydronic Thermal Storage. Instead of storing electricity in a battery to run a compressor at night, these new units use the sun's energy during the day to freeze a large, insulated bank of water—effectively creating a "water battery."

Throughout the night, a low-energy pump circulates this chilled water through the heat exchangers, maintaining a steady 2°C to 4°C. This innovation has cut the operational cost of farm-gate storage by nearly 40% and eliminated hazardous battery waste, offering a sustainable, permanent solution for the first mile

Processing Innovation: The PCM "Rapid-Chill" Reactor

In the dairy and liquid processing sectors, the vulnerability has always been the reliance on diesel generators during power outages. 2025 saw the mass deployment of Phase Change Material (PCM) Thermal Banks.

These systems do not cool produce directly using the grid. Instead, they function as thermal accumulators. When grid power is available, the system "charges" a tank filled with specialized Phase Change Materials. When the produce arrives—regardless of whether the power is on or off—the system releases this stored cold energy to chill liquids from 35°C to 4°C in seconds.



The innovation lies in the material science: new domestic formulations of PCMs developed this year allow for rapid heat exchange cycles, effectively decoupling critical processing from the instability of the electrical supply.

Last Mile Innovation: Passive "Charge-and-Go" Logistics



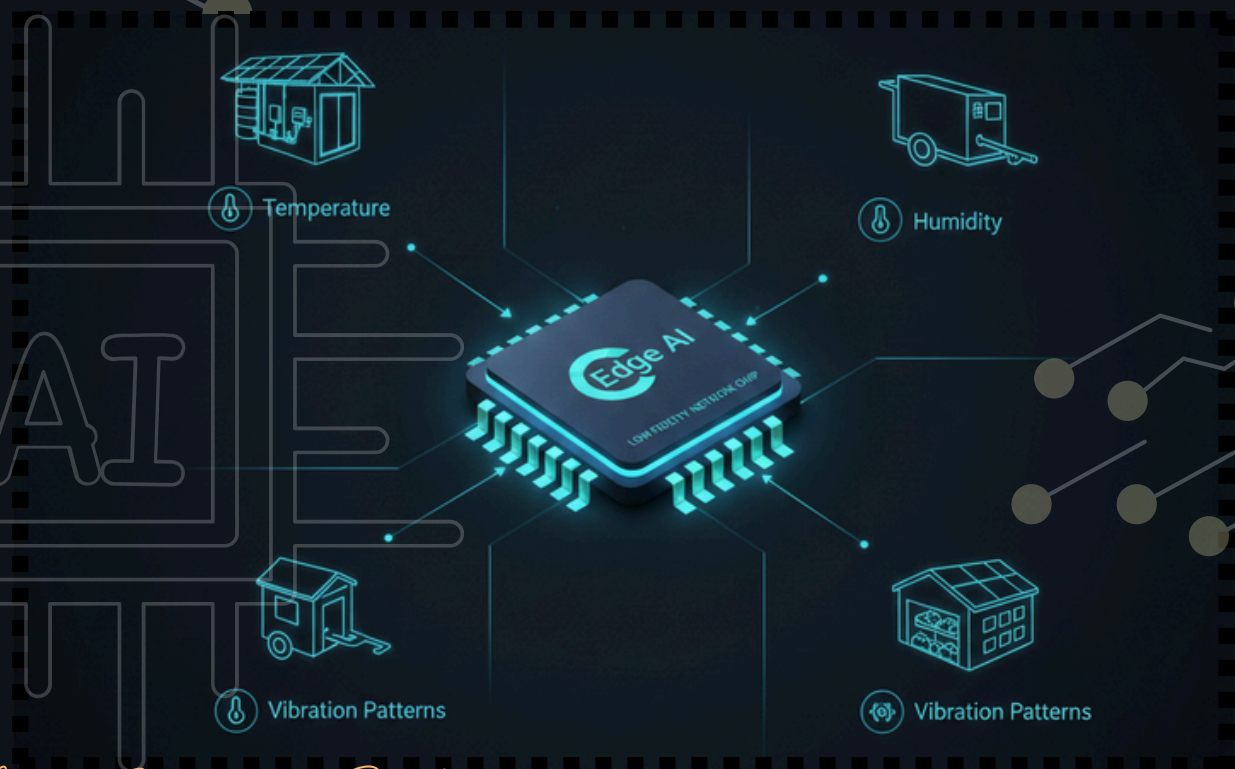
The "last mile" of distribution—often handled by smaller vehicles or pushcarts—has historically been the chain's weakest link. 2025 has introduced a solution that requires zero on-board power: Passive PCM Vending Units.

Unlike traditional reefer trucks that require diesel engines, these new modular units utilize high-density thermal plates frozen at a central hub. Once inserted into the transport unit, they maintain a sub-8°C environment for up to 16 hours in 40°C ambient heat. This is a triumph of "passive cooling" engineering. By removing motors and compressors from the transport vehicle, the industry has reduced the carbon footprint of the last mile to near zero, while ensuring high-value perishables reach the consumer without thermal shock.

Digital Innovation: "Low-Fidelity" IoT & Edge AI

Finally, the digital layer of the cold chain has evolved to match the reality of rural connectivity. While global standards often demand high-speed 5G data, domestic innovators have perfected "Low-Fidelity Network" IoT.

New control chips rolled out this year are designed to transmit critical health data—temperature spikes, compressor vibration patterns, and humidity levels—over patchy, low-bandwidth 2G networks found in remote rural areas. Furthermore, "Edge AI" embedded directly into these controllers can now predict motor failures days before they occur. This innovation shifts the sector from "reactive repairs" to "predictive maintenance," ensuring that a technical glitch in a remote village does not result in a harvest loss.



A New Standard of Resilience

The innovations of 2025 prove that the future of the cold chain is not just about bigger compressors; it is about smarter physics. By embracing thermal storage, passive cooling, and resilient electronics, the sector is building an infrastructure that is robust, affordable, and uniquely suited to our climatic needs. We are witnessing the emergence of a system that no longer fights the environment but intelligently manages it, ensuring food security through engineering excellence.

Energy Transition in India's Cold Chain:

Pathways to Efficiency and Sustainability

India's agricultural strength rests heavily on its ability to move perishable produce efficiently from farms to markets. As the world's second-largest producer of fruits and vegetables, the country has made significant gains in production over the past decade. However, these gains are partially offset by persistent post-harvest losses, particularly in fruits and vegetables, where 5–15% of output is lost annually due to gaps in storage, transportation, and handling. Strengthening cold chain infrastructure has therefore become central not only to food security and farmer incomes, but also to India's broader sustainability and climate commitments.

The report *Energy Transition in the Cold Chain Sector in India*, prepared by the National Centre for Cold Chain Development (NCCD), provides a comprehensive assessment of India's cold chain landscape and highlights the urgent need to modernize the sector through energy-efficient and low-carbon solutions. The study notes that while cold chain capacity has expanded steadily—driven by rising consumer demand, growth in organized retail, and government support—the infrastructure remains uneven, fragmented, and energy intensive. Standalone cold storages dominate the system, with nearly three-fourths of capacity dedicated to potato storage, much of it housed in facilities over 20 years old and operating on outdated technologies.

Energy use within the cold chain is heavily concentrated in older bulk cold storages and refrigerated transport. The report estimates that these two components together account for more than half of the sector's total energy consumption. Older cold storage facilities, in particular, consume significantly more electricity due to inefficient insulation, aging refrigeration systems, and limited automation. Refrigerated transport, though still underutilized in India, is another major energy consumer and continues to rely largely on diesel-powered systems. This combination of high energy use and fossil fuel dependence presents both a challenge and an opportunity for transition.

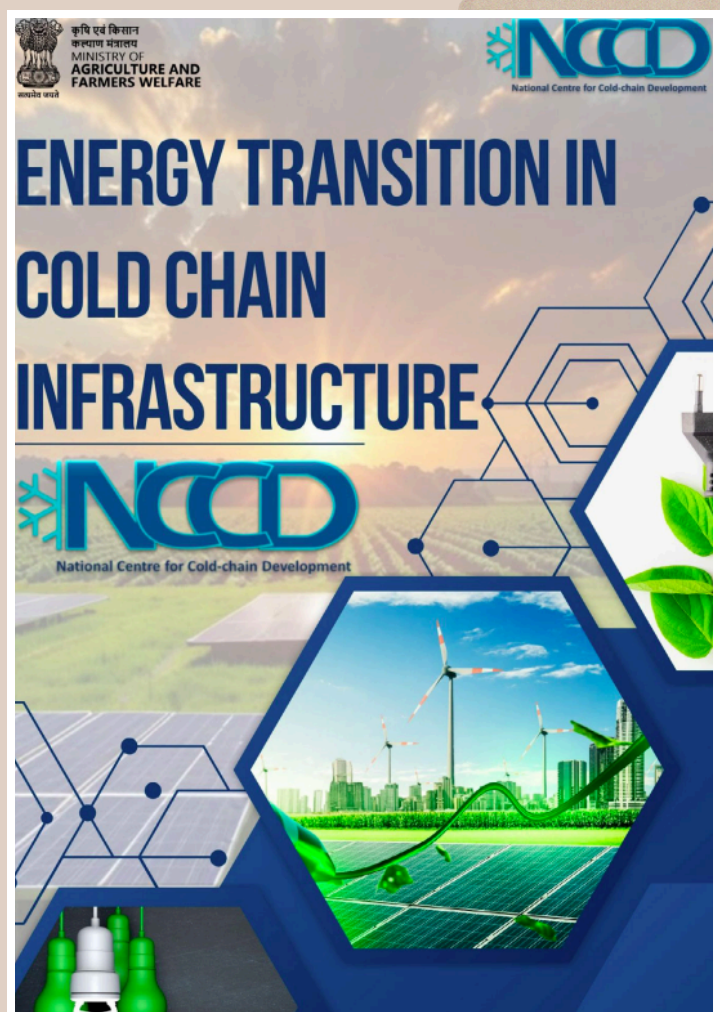
Drawing on field assessments across multiple states and value chains, the study evaluates the cold supply chains of three key perishables—potatoes, grapes, and-

chillies—to illustrate varied infrastructure maturity and transition potential. Potato cold chains, which dominate storage capacity, offer the greatest scope for energy savings through retrofitting and efficiency upgrades. Grape and chilli supply chains, by contrast, demonstrate the benefits of more integrated packhouses, diversified business models, and relatively modern technologies, particularly in export-oriented clusters.

The energy transition roadmap outlined in the report focuses on four interconnected levers: reducing energy demand through better facility design and insulation; improving efficiency by upgrading refrigeration equipment and motors; shifting to renewable energy, especially rooftop solar; and transitioning to refrigerants with lower global warming potential. Under the energy transition scenario, the report estimates that by 2031 the sector could achieve annual energy savings of nearly 900 GWh, increase renewable energy use, and reduce carbon emissions by approximately 785 kilotonnes of CO₂.

Equally important are the enabling measures identified in the study. Updated engineering guidelines, standardized performance benchmarks, digitization of cold chain assets, innovative financing mechanisms, and capacity building are seen as critical to accelerating adoption. With more than 90% of cold chain infrastructure privately owned, targeted incentives and accessible finance will play a key role in scaling energy-efficient technologies across the sector.

By aligning infrastructure development with energy transition goals, India's cold chain can evolve into a more resilient, efficient, and climate-aligned system—one that reduces food loss, strengthens farmer livelihoods, and supports sustainable agricultural growth across the country.



https://nccd.gov.in/uploads/ET_in_cold_chain_sector_in_India_v8_3bfe3b8148.pdf

INDIA COLD CHAIN CONCLAVE (ICCC) 4.0

India's cold chain sector is undergoing a decisive phase of transformation, driven by the dual imperatives of strengthening food security and advancing climate-resilient infrastructure. The India Cold Chain Conclave (ICCC) 4.0, held alongside REFCOLD India 2025 on 18 September 2025 at Bharat Mandapam, New Delhi, provided a focused platform to deliberate on the future direction of cold chain development in the country. Organised with the active collaboration of the National Centre for Cold Chain Development (NCCD), the Ministry of Agriculture and Farmers' Welfare, and ISHRAE, the conclave brought together policymakers, technical experts, industry stakeholders, and state representatives to deliberate on sustainable and energy-efficient cold chain systems.

REFCOLD 2025

18-20 SEPTEMBER

NEW DELHI

The central theme of ICCC 4.0—"Sustainable Cold Chain: Way Forward: Climate, Refrigerants, Energy Transition and Supply Chain"—reflected India's evolving priorities in aligning agricultural infrastructure with national climate goals. Discussions highlighted the growing need to modernise cold chain assets through efficient technologies, low global warming potential refrigerants, and renewable energy integration. With cold chain infrastructure playing a critical role in reducing post-harvest losses and ensuring quality preservation of perishables, the conclave underscored the importance of embedding sustainability at every stage of the value chain, from farmgate to consumer markets.

A key focus area of the conclave was impact analysis of primary and post-harvest management systems, with emphasis on government initiatives aimed at improving infrastructure coverage and performance. Sessions examined how policy interventions, updated engineering standards, and targeted financial mechanisms are enabling adoption of modern cold chain technologies across states. The role of structured guidelines and data-driven planning was discussed as essential for addressing regional disparities and aligning infrastructure capacity with production clusters.

The conclave also provided a platform for understanding stakeholder perspectives across the cold chain ecosystem. Industry representatives, technology providers, farmer producer organisations, and logistics operators shared insights on operational challenges, energy costs, technology adoption, and skill requirements. These interactions highlighted the importance of collaboration between the public and private sectors to ensure scalable and economically viable solutions. Digitisation, automation, and performance monitoring were identified as important tools for improving transparency, asset utilisation, and operational efficiency.



The India Cold Chain Conclave 4.0 was inaugurated by the Joint Secretary (Horticulture), Ministry of Agriculture & Farmers Welfare, marking a significant milestone for India's cold chain and post-harvest infrastructure sector. The conclave is being jointly organised alongside REFCOLD India 2025, providing a strong platform for convergence between policy, technology, and industry stakeholders.



During the inaugural session, the Joint Secretary (Horticulture) formally released the Energy Transition Report, a key knowledge document that highlights pathways for improving energy efficiency, reducing carbon intensity, and accelerating the adoption of sustainable technologies across cold chain infrastructure. The report underscores the importance of energy transition in achieving long-term resilience and sustainability in India's agri-logistics ecosystem.



On the occasion, the Joint Secretary also unveiled the newly developed website of the National Centre for Cold Chain Development (NCCD). The revamped platform is designed to enhance accessibility to technical resources, guidelines, project frameworks, and sectoral insights, while strengthening stakeholder engagement through a more user-centric and transparent digital interface.

Addressing the gathering, the Joint Secretary (Horticulture) emphasised the critical role of an efficient and integrated cold chain in reducing post-harvest losses, ensuring food quality and safety, and strengthening farmers' market linkages. The Chief Operating Officer (COO), NCCD highlighted NCCD's active role in policy support, technical standardisation, capacity building, and on-ground demonstration of best practices across the cold chain continuum. Together, they underscored the importance of coordinated efforts between government, industry, and other stakeholders to build a resilient, energy-efficient, and future-ready cold chain ecosystem for the country.



As part of its outreach and knowledge dissemination efforts, the National Centre for Cold Chain Development (NCCD), in collaboration with the National Horticulture Board (NHB), set up a dedicated stall at REFCOLD India 2025. The stall served as a platform for engaging with stakeholders, sharing technical insights, and discussing emerging trends and challenges in the cold chain sector with industry participants, entrepreneurs, and policymakers.

The Joint Secretary (Horticulture) also visited NCCD's stall at REFCOLD India 2025, where the Centre showcased its key initiatives, technical frameworks, and ongoing interventions aimed at strengthening India's cold chain ecosystem. The visit drew significant attention, following which the stall witnessed active engagement from a wide range of stakeholders, including policymakers, industry representatives, technology providers, entrepreneurs, and state officials. The strong footfall and interactions highlighted the growing interest in NCCD's role as a technical and knowledge partner, as well as the relevance of its work in advancing sustainable, efficient, and climate-resilient cold chain systems across the country.



Special attention was given to emerging cold chain states, particularly Himachal Pradesh and Andhra Pradesh, which are witnessing rapid expansion in horticulture and agri-processing activities. Discussions highlighted state-level initiatives, innovative models at the farmgate and aggregation levels, and the role of decentralised cold storage solutions in supporting smallholder farmers. These experiences were presented as replicable pathways for other regions seeking to strengthen cold chain connectivity while minimising energy and environmental footprints.

Innovation remained a recurring theme throughout ICCC 4.0, with emphasis on next-generation refrigeration technologies, sustainable refrigerants, and integrated supply chain solutions. The conclave reinforced the importance of transitioning from conventional, energy-intensive systems to future-ready infrastructure that is climate-responsive, resource-efficient, and aligned with India's long-term development objectives. By bringing together diverse stakeholders under a common platform, ICCC 4.0 at REFCOLD India 2025 reaffirmed the collective commitment towards building a resilient, sustainable, and inclusive cold chain ecosystem that supports farmers, consumers, and national priorities.

The event was followed by an award ceremony organised by Copeland to recognise special achievements and exemplary projects being implemented across the sector, with a particular focus on sustainability and energy efficiency. The awards highlighted innovative initiatives, best practices, and impactful interventions that are contributing to the transition towards more efficient, climate-resilient, and environmentally responsible cold chain and refrigeration systems.

REFCOLD INDIA COPELAND AWARDS 2025



Cluster Development Programme:

Building India's Horticulture Value Chains for Agricultural Future Resilient

India's agricultural growth story is one of remarkable scale and diversity. As the world's second-largest producer of fruits and vegetables, the country has made significant strides in production, productivity, and technological adoption. Yet, this success continues to coexist with persistent challenges post-harvest losses, fragmented supply chains, and uneven access to markets that limit farmer incomes and weaken food security. In this evolving landscape, the National Centre for Cold Chain Development (NCCD) has emerged as a key national institution redefining the way India builds its agri-infrastructure. By promoting integrated cold chain development, connecting farm-level handling, storage, transport, and market access-NCCD has shifted the narrative from isolated infrastructure creation to system-level integration. Through forward-looking frameworks such as the EG&MSS 2025 guidelines, digitalization initiatives, and national infrastructure mapping, NCCD is helping transform the cold chain into a strategic backbone of India's agri-economy, ensuring quality preservation, sustainability, and efficiency across the supply chain.



SH. PAWAN KUMAR

**DEPUTY DIRECTOR, CLUSTER DEVELOPMENT
PROGRAMME,
NATIONAL HORTICULTURE BOARD**



राष्ट्रीय बागवानी बोर्ड
कृषि और किसान कल्याण मंत्रालय, भारत सरकार
NATIONAL HORTICULTURE BOARD
Ministry of Agriculture & Farmers Welfare, Government of India



कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE
सत्यमेव जयते

This philosophy of integration reflects a deeper truth about Indian agriculture today the future does not lie in fragmented interventions, but in integrated value chain development. Agriculture can no longer function as a sequence of disconnected activities-production here, storage there, markets elsewhere. Real transformation lies in aligning pre-production planning, cultivation practices, post-harvest management, logistics, processing, branding, and market access into a single, seamless system. It is this vision of holistic, connected development that finds its most comprehensive institutional expression in the Cluster Development Programme (CDP) under the National Horticulture Board (NHB). Representing a fundamental shift in development thinking, CDP moves away from scattered, asset-based interventions to a cluster-based approach that brings farmers, private players, financial institutions, and government agencies into a single collaborative ecosystem. By building complete value chains and transforming geographic regions into integrated economic clusters, the programme creates economies of scale, improves competitiveness, strengthens market access, and ensures sustainable income growth for farmers-positioning Indian horticulture for both domestic resilience and global competitiveness.

Launched in May 2021 with pilot interventions in selected clusters, the programme demonstrated the transformative potential of cluster-based development in improving productivity, reducing wastage, and strengthening farmer-market linkages. Building on these learnings, the programme has evolved into a more structured and robust framework through the issuance of the Revised Cluster Development Programme Guidelines (CDP 2.0) in April 2025. This revision marks a significant policy and institutional strengthening of the programme. CDP 2.0 emphasizes integrated interventions across the entire horticulture value chain, mandates farmer-centric benefits with a minimum 40 percent farmer component, promotes convergence with national schemes, and introduces digital governance mechanisms to ensure transparency, accountability, and sustainability.

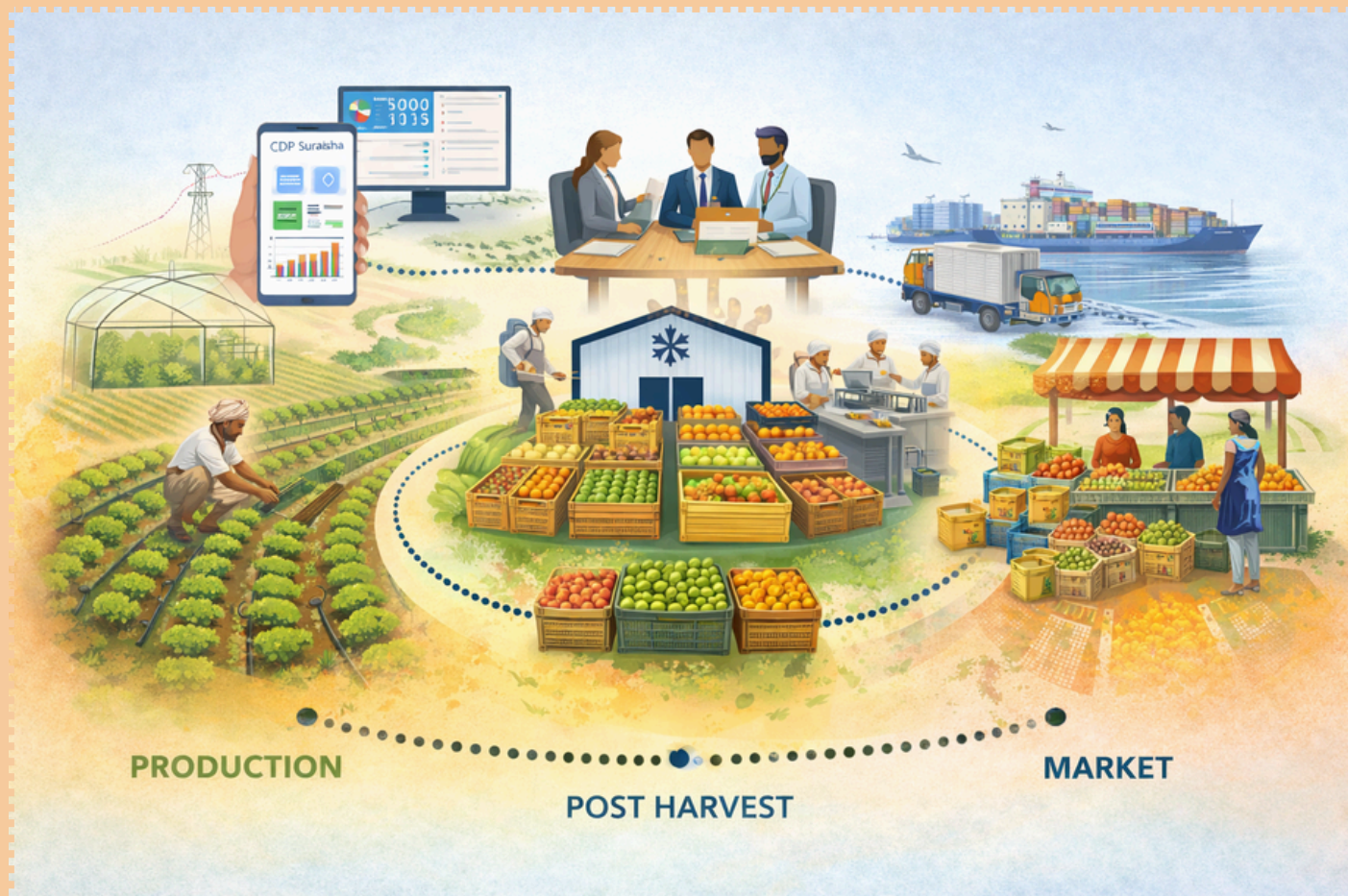
A defining feature of CDP 2.0 is its focus on creating economically viable and structurally strong clusters. Projects are selected through a challenge-mode process, ensuring that only well-conceived, financially sound, and scalable proposals are taken forward. Each cluster revolves around a primary focus crop with a minimum annual farm gate value of ₹100 crore, supported by allied crops to ensure diversification and risk mitigation. This structure ensures that clusters are not only development projects, but also economic enterprises capable of long-term sustainability and growth.

The programme now operates through two powerful cluster typologies that reflect India's diverse horticulture needs. Multi-Commodity High Value Clusters integrate fruits, vegetables, spices, and flowers around shared infrastructure such as packhouses, cold storages, processing units, and logistics hubs. By pooling multiple crops, these clusters optimize infrastructure utilization, reduce seasonality risks, and strengthen export competitiveness, while ensuring year-round economic activity. Peri-Urban Vegetable Clusters, on the other hand, are designed to serve rapidly growing urban markets through short supply chains, rapid logistics, and daily market linkages. These clusters enable fresh, reliable supply to cities while increasing farmers' share in the consumer rupee and strengthening urban food security.



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What makes the Cluster Development Programme truly transformative in its end-to-end value chain architecture. At the production stage, it supports quality planting material, micro-irrigation, mechanization, adoption of Good Agricultural Practices, Integrated Nutrient and Pest Management, and continuous capacity building of farmers across the crop life cycle. At the post-harvest stage, it enables interventions for sorting, grading, storage, processing, packaging, and value addition-reducing losses and enhancing product value. At the market stage, it strengthens logistics, branding, domestic outreach, and export integration, transforming farmers from isolated producers into active participants in organized markets and value chains.



Equally important is the programme's strong governance and institutional framework. The National Horticulture Board, as the nodal agency, has established a dedicated CDP Cell supported by a professional Programme Management Unit to ensure structured implementation, monitoring, and accountability. Transparent appraisal systems, standardized evaluation matrices, milestone-based disbursement mechanisms, and robust compliance structures ensure financial discipline and implementation integrity. The operationalization of the CDP Suraksha digital platform marks a major leap toward transparency and efficiency, enabling real-time monitoring, milestone tracking, subsidy disbursal, and direct benefit transfers to farmers.

The national response to the programme reflects its growing relevance and acceptance. Strong participation across geographies and commodities, increasing quality of proposals, and growing institutional engagement indicate that cluster-based development is being recognized as the future of horticulture development in India. The programme is now poised for significant scale-up, with multiple new clusters anticipated across states, supported by structured outreach, stakeholder engagement, and institutional handholding.

At its core, the Cluster Development Programme is not merely a horticulture scheme, it is a new development paradigm. It represents a shift from infrastructure creation to ecosystem building, from fragmented projects to integrated systems, and from short-term interventions to long-term economic transformation. By aligning production, infrastructure, markets, institutions, and governance into a single framework, CDP is laying the foundation for resilient value chains, empowered farmers, efficient markets, and sustainable growth.

In an era where food security, climate resilience, farmer prosperity, and economic competitiveness are deeply interconnected, the Cluster Development Programme stands as a blueprint for the future of Indian agriculture. It demonstrates that true transformation lies not in isolated assets, but in integrated systems, not in scattered schemes, but in coherent strategies, and not in short-term outputs, but in long-term impact. Through CDP, India is not just developing clusters it is building the architecture of a future-ready agri-economy.





Continuous

The cold chain sector in India stands at a decisive inflection point. While the past decade has rightly focused on expanding infrastructure capacity to address critical gaps in storage and logistics, the emphasis today has shifted toward improving quality, efficiency, reliability, and long-term sustainability of cold chain systems. This transition is essential if cold chain infrastructure is to effectively support India's agricultural growth, reduce post-harvest losses, enhance farmer incomes, and contribute meaningfully to national climate and energy goals.

In this context, the National Centre for Cold Chain Development (NCCD) undertook a comprehensive revision of its Engineering Guidelines and Minimum System Standards in 2025. I am pleased to note that this exercise has been widely appreciated and positively received by stakeholders across the cold chain ecosystem—including project developers, technology providers, state governments, financial institutions, and on-ground practitioners. The broad acceptance of the revised guidelines reflects both the technical robustness of the document and its strong alignment with sectoral needs.

The revised guidelines have emerged as a one-stop reference document for cold chain professionals and enthusiasts alike. By harmonising design principles, operational requirements, and performance benchmarks across various cold chain components, the document has introduced much-needed clarity, uniformity, and predictability in planning and execution. Importantly, it has helped bridge the longstanding gap between policy intent and on-ground implementation, ensuring that investments in cold chain infrastructure are not only technically sound but also economically viable and environmentally responsible. The emphasis on energy efficiency, system optimisation, and appropriate technology selection directly supports national priorities of reducing post-harvest losses, improving farmer realisations, and lowering the sector's energy footprint.

However, standard-setting in a sector as diverse and dynamic as India's cold chain cannot be viewed as a static or one-time exercise. The country's wide range of agro-climatic conditions, cropping patterns, scale of operations, and market linkages necessitates guidelines that are continuously informed by field realities.



SH. PRIYA RANJAN

**JOINT SECRETARY- HORTICULTURE
MD- NATIONAL HORTICULTURE BOARD
DIRECTOR- NCCD**



**कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE**

Recognising this, the Ministry directed NCCD to further strengthen and refine the guidelines through systematic field visits and direct engagement with farmers, operators, and end users. Such interactions are critical to capturing region-specific innovations, practical constraints, cost-effective solutions, and operational challenges that may not be fully evident through desk-based assessments alone.

In pursuance of these directions, NCCD undertook focused field studies in two important regions—Lasalgaon in Maharashtra and selected districts of Gujarat—each representing distinct yet equally significant storage models. Lasalgaon, as one of Asia's largest onion markets, offers valuable insights into large-scale, commodity-specific storage practices, operational economics, and farmer-driven innovations. Gujarat, on the other hand, presents a more diversified cold chain landscape, encompassing cooperative-led models, integrated value chains, and modern storage and logistics infrastructure catering to multiple commodities.



The learnings from Lasalgaon and Gujarat reaffirm the need for a balanced and context-sensitive approach to cold chain development—one that accommodates both low-cost, decentralised solutions suitable for small and marginal farmers, as well as advanced, large-scale infrastructure required for organised markets and export-oriented supply chains. These field-level insights will play a crucial role in fine-tuning engineering standards to ensure they remain practical, inclusive, and scalable.

I commend NCCD for proactively undertaking these field studies and for its continued commitment to evidence-based policymaking and continuous improvement of national guidelines. Going forward, sustained engagement with farmers, operators, technology providers, and state agencies will be essential to ensure that the engineering guidelines remain responsive to evolving needs and future-ready.

The Ministry will continue to extend its full support to such efforts, with the shared objective of building a resilient, efficient, and sustainable cold chain ecosystem that serves the interests of farmers and consumers alike, strengthens India's food systems, and contributes to the nation's broader economic and environmental goals.

Rethinking Low-Cost Onion Storage

Lasalgaon, being one of the largest onion trading hubs in the country, offers valuable insights into farmer-centric, low-cost storage solutions. The NCCD team visited the region to study the design and performance of traditional and improved onion storage structures that rely on natural ventilation, appropriate stacking heights, and locally available construction materials. These structures are designed to minimise sprouting, rotting, and moisture accumulation while keeping capital and operating costs low.

The field interactions highlighted how incremental design improvements—such as better airflow management, raised platforms, slatted side walls, and orientation aligned with prevailing wind directions—can significantly enhance storage life without dependence on energy-intensive refrigeration. The Lasalgaon experience underscores the importance of context-specific solutions, particularly for small and marginal farmers, and provides valuable lessons for integrating low-cost, energy-efficient storage concepts into national guideline



The Rise of Bulk Potato Storage

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The National Centre for Cold Chain Development (NCCD), in its continued efforts to modernize post-harvest infrastructure and promote efficient storage technologies, has recently developed comprehensive guidelines for bulk storage systems. These guidelines are aimed at facilitating the adoption of scientifically designed, energy-efficient, and crop-specific storage solutions that address the evolving needs of the horticulture and processing sectors. Bulk storage, particularly for potatoes, is increasingly being recognized as a viable alternative to conventional bag-based storage practices.

As part of this initiative, NCCD, in collaboration with state horticulture officials and technical experts, undertook detailed field visits to bulk potato storage facilities in Gujarat, primarily in the Sabarkantha and Mehsana regions. These facilities represent a technologically advanced storage model characterized by forced ventilation systems, ducted air circulation, precise humidity control, and bulk handling mechanisms. The study provided valuable insights into design practices and operational efficiencies associated with bulk storage.





The field observations highlighted the inherent strengths of bulk storage systems, particularly their ability to deliver uniform and reliable cooling. Through engineered airflow distribution and forced ventilation, cooling air is evenly circulated across the entire storage mass, preventing temperature variations and minimizing the risk of localized hot spots. Such uniformity is vital for potatoes, as inconsistent temperatures can accelerate deterioration, moisture loss, and quality defects. Compared to conventional bag storage, bulk systems therefore offer a more stable and controlled storage environment.



A further advantage lies in the elimination of repetitive bag handling, which significantly reduces mechanical damage and associated post-harvest losses. Bulk storage minimizes physical stress on the produce, lowering the incidence of bruising and pressure injuries while simultaneously improving labour efficiency. Reduced manual handling also contributes to better operational safety and faster material flow. These benefits make bulk storage particularly suitable for processing-grade and export-oriented potato varieties, where maintaining consistent quality and storage performance is critical.



A key focus of the study was the evaluation of technical and engineering parameters essential for effective bulk storage. Factors such as chamber dimensions, stacking height, airflow requirements, and relative humidity levels were assessed to understand their influence on system performance. The Gujarat facilities demonstrated that when these engineering considerations are properly addressed, bulk storage systems can successfully achieve both scale efficiency and consistent storage outcomes, reinforcing their potential as a technologically advanced alternative to traditional storage practices.



Processing Plant



The Gujarat model also underscores the importance of aligning storage design with crop physiology and end-use requirements. High relative humidity control, efficient ventilation, and controlled gas management contribute significantly to maintaining produce quality over extended storage durations. These learnings have directly informed NCCD's newly developed guidelines, ensuring that they are grounded in practical, field-tested experience.

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Beyond storage structures, the visits also emphasized the role of mechanization and system integration. The presence of grading lines and bulk handling mechanisms enables streamlined loading and unloading operations, reduces turnaround time, and enhances overall facility productivity. Such integration reflects the direction in which modern cold chain infrastructure must evolve.

At the conclusion of the technical tour, the NCCD team visited a potato processing plant, enabling a holistic understanding of the linkage between storage technologies and downstream value addition. This visit reinforced the critical role of bulk storage in supporting processing industries by ensuring consistent raw material supply and quality. The combined field learnings will contribute to strengthening NCCD's guidance framework for the benefit of stakeholders across the cold chain sector.



TRAINING AT DIRECTORATE OF HORTICULTURE, CHHATTISGARH

NEW RAIPUR, CHHATTISGARH

1ST SEPTEMBER 2025

As part of its ongoing state-wise capacity-building initiative, the National Centre for Cold Chain Development (NCCD) conducted a training programme on the revised NCCD Engineering Guidelines at New Raipur, Chhattisgarh, on 1st September 2025. The programme was organised in collaboration with the Department of Horticulture, Government of Chhattisgarh, and witnessed participation from state government officials, cold chain developers, technical consultants, and other key stakeholders.

Chhattisgarh, with its growing horticultural base and emerging agri-logistics infrastructure, offers significant potential for strengthening cold chain systems. In this context, the training aimed to build a clear and comprehensive understanding of the updated Engineering Guidelines and Minimum System Standards for the implementation of various cold chain components, in line with the evolving requirements of the sector.

The sessions provided detailed technical insights into recent revisions in the guidelines, including the incorporation of gas-tightening systems, specialized packaging and handling equipment, and enhanced provisions for energy-efficient insulation, monitoring, and control systems. Emphasis was placed on improving operational efficiency, sustainability, and region-specific adaptability of cold chain infrastructure. The programme saw active participation and constructive interactions, reflecting the relevance of such capacity-building efforts in enabling informed project planning, design, and implementation across the state.

In addition to the formal training sessions, the NCCD team engaged in interactive discussions with the Directorate of Horticulture and local stakeholders to understand on-ground challenges in cold chain development. One of the key suggestions emerging from these consultations was the inclusion of specific provisions for bulk potato storage in future revisions of the guidelines. Considering the importance of potato cultivation and storage requirements in the region, stakeholders highlighted the need for standardized and scalable solutions for bulk storage. The feedback received will be duly examined and considered during subsequent updates of the guidelines to ensure continued alignment with field-level requirements and commodity-specific needs.



Heat Load Calculation

Accurate heat load calculation is essential to maintaining interior comfort, energy efficiency, and system dependability in the changing field of building services and HVAC engineering. The National Centre for Cold Chain Development (NCCD) has created an online Heat Load Calculator as part of its larger knowledge and capacity-building platform after seeing the need for dependable and easily accessible digital tools. The calculator, which is hosted on the NCCD website, provides engineers, designers, students, and business people with an organised and easy-to-use interface for rapidly estimating thermal loads. The NCCD website and its Heat Load Calculator enable informed decision-making, encourage best practices in HVAC design, and help create more sustainable and efficient built environments by fusing digital convenience with good engineering principles.

Importance of Heat Load Calculation in HVAC design

Effective HVAC system design is built on accurate heat load calculations. It accounts for building attributes, occupancy, equipment loads, and outdoor climate to determine the precise heating and cooling capacity needed to maintain suitable indoor conditions. By preventing HVAC systems from being oversized or undersized, proper heat load evaluation increases energy efficiency, lowers operating costs, improves occupant comfort, and extends equipment life.

Limitations of Conventional Calculations Methods

Conventional heat load calculation techniques are laborious and prone to human error since they frequently rely on spreadsheet-based inputs, lengthy tables, and manual calculations. These techniques may not be flexible in the early stages of design or during quick adjustments, and they demand a high level of knowledge. The need for more streamlined and digital calculating solutions is highlighted by the fact that old methods can hinder productivity, consistency, and convenience of use as construction plans become more complicated and timeframes are compressed.

Digital Transformation in HVAC Engineering

By substituting intelligent, data-driven technologies for static design techniques and laborious computations, digital transformation is transforming HVAC engineering. Modern digital platforms assist sustainable and energy-efficient building practices while facilitating quicker analysis, increased accuracy, and simpler design iterations.

Overview of the Heat Load Calculator

The Heat Load Calculator is a technically structured, web-based application designed for estimating refrigeration and cooling loads of cold rooms operating above 0 °C. The tool incorporates location-specific ambient conditions, cold room design parameters, product characteristics, and operational factors to compute individual load components. It evaluates transmission heat gain through walls, ceiling, and floor based on insulation and dimensions; product and respiration loads considering loading rate, specific heat, and temperature pull-down; and auxiliary loads including fan motor heat, internal occupancy, and lighting. By integrating these parameters into a consolidated calculation framework with a summary of design conditions, the calculator enables systematic, repeatable, and engineering-consistent heat load estimation to support accurate refrigeration system sizing and cold-chain infrastructure planning.

Key features of the Calculator

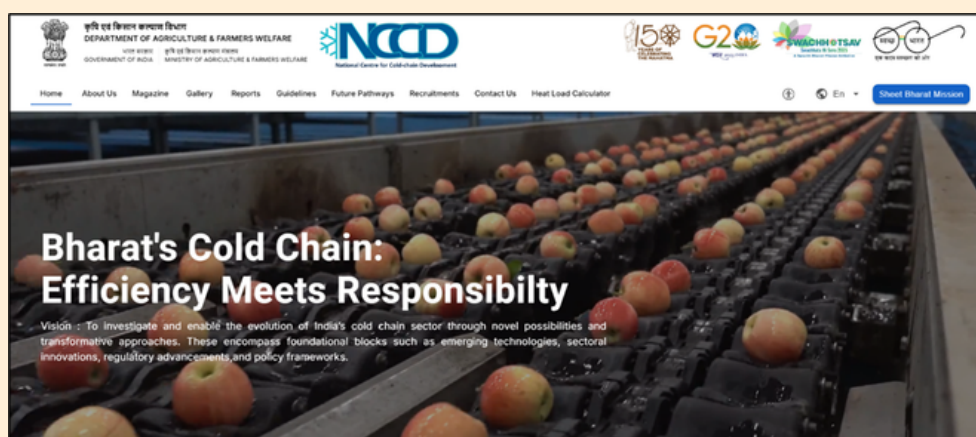
The Heat Load Calculator offers a structured, component-wise approach to refrigeration load estimation through a user-friendly web interface. It accounts for multiple heat gain sources including transmission, product respiration, internal occupancy, fan motor, and lighting loads. The tool supports location-specific ambient conditions, cold room operating parameters, and product characteristics, while providing a consolidated summary of design inputs and calculated loads. Its modular design ensures consistency, repeatability, and ease of use for both professional and academic applications.

How the Heat Load Calculator works

The calculator follows a sequential computational workflow that begins with the definition of site-specific ambient design conditions, including location, dry-bulb temperature, and relative humidity. Cold room operational parameters and product characteristics are then specified to establish internal and process-related loads. Transmission heat gains through the envelope are calculated using user-defined construction assemblies for walls, ceiling, and floor, accounting for insulation properties and exposed surface areas. Individual heat gain components—comprising product pull-down load, respiration heat, fan motor heat dissipation, internal occupancy load, and lighting load—are evaluated independently and subsequently summed to determine the total refrigeration load. The aggregated output forms a technically robust basis for accurate refrigeration system sizing and design verification.

About NCCD: Platform overview

The National Centre for Cold-chain Development (NCCD) is a multidisciplinary knowledge and capacity-building platform dedicated to advancing cold-chain infrastructure, technology adoption, and best practices across India. The NCCD website serves as a centralized resource offering guidelines, technical reports, and practical tools such as the newly introduced Heat Load Calculator and the Sheet Bharat portal for streamlined cold-chain assessments. Recent enhancements also include a dedicated Recruitments page to support institutional growth and engagement with professionals. By integrating digital tools, informational resources, and sector-specific updates, the NCCD platform empowers industry stakeholders, engineers, policymakers, and students with actionable insights and solutions for efficient and sustainable cold-chain development.



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Integration of the Heatload Calculator within NCCD website

The Heat Load Calculator, integrated within the NCCD digital ecosystem, provides a standardized and methodical framework for refrigeration and HVAC load estimation. By incorporating location-specific climatic data, construction parameters, product characteristics, and internal heat gain components, the tool enables accurate and repeatable thermal load calculations. Its deployment within the NCCD platform strengthens technical decision-making, supports appropriate equipment sizing, and contributes to the design of energy-efficient and performance-driven cold-chain and HVAC systems.



Author: Mr. Saurabh Kashyap

Mr. Kashyap is a Developer and Technical Associate at Krishitantra and a part of Sheet Bharat Mission as a software developer and developed a Heat Load Software for HVAC and Cold Chain applications.

Predictive Temperature Excursion Forecasting

Maintaining precise temperature conditions across the cold chain is essential for preserving the quality, safety, and shelf life of perishable commodities. Even brief deviations from prescribed temperature ranges can result in quality deterioration, economic losses, and reduced consumer confidence. Traditionally, temperature control in cold storage and refrigerated transport has relied on reactive monitoring systems that trigger alerts only after a deviation occurs. Recent advances in Artificial Intelligence (AI) are transforming this approach through predictive temperature excursion forecasting, enabling proactive intervention before losses take place.

Predictive temperature excursion forecasting uses AI-driven models that analyse large volumes of historical and real-time data to anticipate potential deviations in advance. These systems integrate inputs from temperature and humidity sensors, equipment performance data, weather conditions, power supply patterns, and handling activities across storage and transport operations. By identifying patterns and correlations that are not easily detectable through conventional monitoring, AI systems can forecast risk windows during which temperature excursions are likely to occur.

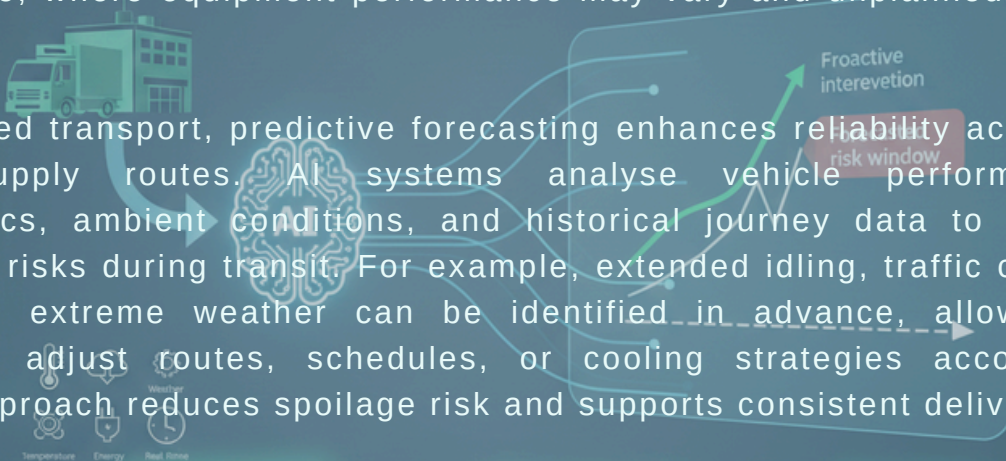
One of the key strengths of predictive forecasting lies in its ability to move beyond threshold-based alerts. Instead of responding only when temperatures cross set limits, AI models assess trends such as gradual temperature drift, rising compressor loads, door-opening frequency, or external heat exposure. When combined with weather forecasts, traffic conditions, or power reliability data, the system can -



anticipate stress points that may compromise temperature stability. This allows operators to take corrective measures—such as adjusting refrigeration settings, rescheduling loading operations, or deploying backup power—before deviations occur.

In cold storage facilities, predictive temperature forecasting supports improved operational planning and energy efficiency. By understanding how external temperature fluctuations and internal load variations affect cooling demand, AI systems help optimise pre-cooling cycles and compressor operation. Facilities can reduce unnecessary energy consumption while ensuring that products remain within safe temperature ranges. This predictive capability is particularly valuable for older infrastructure, where equipment performance may vary and unplanned failures pose higher risks.

In refrigerated transport, predictive forecasting enhances reliability across long and complex supply routes. AI systems analyse vehicle performance, route characteristics, ambient conditions, and historical journey data to flag potential temperature risks during transit. For example, extended idling, traffic congestion, or exposure to extreme weather can be identified in advance, allowing logistics planners to adjust routes, schedules, or cooling strategies accordingly. This proactive approach reduces spoilage risk and supports consistent delivery quality.



Predictive temperature excursion forecasting also contributes to improved decision-making and accountability across the cold chain. By providing early warnings and data-backed insights, these systems enable coordinated responses among operators, technicians, and managers. Clear visibility into risk factors supports better compliance with food safety standards and quality protocols, while reducing dependence on manual inspections and reactive troubleshooting.

As India continues to expand and modernise its cold chain infrastructure, predictive temperature forecasting offers a scalable and future-ready solution aligned with national priorities of efficiency, sustainability, and food security. By preventing losses before they occur, AI-enabled forecasting strengthens resilience across the supply chain, safeguards farmer incomes, and enhances consumer trust. The adoption of such intelligent systems represents an important step towards a more reliable, energy-efficient, and technology-driven cold chain ecosystem.



Author: Mr. Kushagra Jha

Mr. Jha is a Project Manager for the Sheet Bharat Mission at the National Centre for Cold Chain Development (NCCD), working through Krishitantra. He focuses on aligning policy intent with on-ground cold-chain workflows, coordinating with stakeholders to ensure the platform is practical, scalable, and easy to adopt, thereby supporting the long-term strengthening of India's cold-chain ecosystem.

From Storage to Smart Infrastructure:

The Next Leap for India's Cold Chain Sector

Every year, India handles perishable produce worth over ₹92,000 crore, a scale that reflects both the country's agricultural strength and the immense potential of its cold chain ecosystem. What was once a network of basic storage units has now evolved into a dynamic, technology-driven system that safeguards food quality, strengthens farmer incomes, and supports national food security. Over the past decade, the country's cold chain has moved beyond preservation to become a powerful enabler of strength, connectivity, and growth across the farm-to-fork journey.

What began as a fragmented network of cold storages serving select commodities has now become a vital part of India's agrifood and pharmaceutical supply chains. From large-scale distribution hubs to micro cold storage units in rural India, cold chain infrastructure is being reshaped through innovation, data, and digitization. Today, the focus has shifted from just adding capacity to ensuring greater accuracy, transparency, and energy savings.

Reefer vehicles are the backbone of temperature-controlled logistics, transforming how perishables move across India. These refrigerated trucks keep fruits, vegetables, seafood, and medicines at precise temperatures throughout long journeys.



India currently operates around 10,000 refrigerated vans to handle nearly 17 million tonnes of produce, highlighting the vast potential to expand capacity and efficiency. With IoT integration and GPS monitoring, modern reefers offer real-time visibility, reducing spoilage and strengthening trust between producers, logistics providers, and consumers.

The last mile remains one of the most challenging links in the cold chain. Here, mobility and reliability are everything. Advanced reefer fleets equipped with IoT sensors and AI-driven route optimization software are now enabling faster, more predictable deliveries, from urban fulfilment centres to remote rural markets. These solutions help maintain temperature integrity, cut fuel use, and reduce emissions. For temperature-sensitive goods like vaccines or fresh produce, such innovations mean the difference between safe delivery and costly waste.

India's next leap in cold chain growth will be powered by smart infrastructure. IoT sensors, AI analytics, and automation are redefining efficiency. Smart warehouses now employ digital twins to simulate storage conditions, while cloud platforms collect live data from reefer fleets to predict maintenance needs and optimize routes. Blockchain technology is enhancing transparency, providing a verifiable record of every transaction and temperature checkpoint. Meanwhile, renewable energy integration, such as solar-assisted cold storage, is helping the industry move toward sustainability without compromising performance.

The nation's cold chain transformation is entering its most thrilling phase. As demand surges across agriculture, pharma, and quick commerce, the focus must shift from isolated storage to connected, data-enabled logistics networks. By investing in technology, renewable energy, and skilled manpower, India can build a cold chain that is not only efficient but equitable, ensuring every farmer, retailer, and consumer benefits from its reach.

The journey from storage to smart infrastructure isn't just about cooling but about connecting. And as India scales this new frontier, precision, sustainability, and innovation will define the future of its cold chain logistics.

Author: Mr. Swarup Bose



Swarup Bose, Founder and CEO, Celcius, is a seasoned professional, with over 16 years of experience in Cold chain logistics. His efforts have been recognized by several leading media and industry platforms and finds mention among Business World's 'BW 40 under 40' list for 2021, 'ET aspiring Indian' for Innovation in Technology Logistics supply chain, and Economic Times Promising Entrepreneurs of India 2021, among others.

APICOL'S EVENT

The Cold Storage Conclave & Buyer–Seller Meet, jointly organized by the Agricultural Promotion and Investment Corporation of Odisha Limited (APICOL) in partnership with ASSOCHAM, was held on 13 December 2025 in Bhubaneswar, Odisha. The event marked an important step towards strengthening the state's cold chain ecosystem by fostering direct engagement between producers, entrepreneurs, policymakers, and national market players.

COLD STORAGE CONCLAVE & BUYER-SELLER MEET

13TH DECEMBER

BHUBANESHWAR, ORISSA

Platform for Market Integration and Investment

The primary objective of the conclave was to connect Farmer Producer Organizations (FPOs), Self-Help Groups (SHGs), and agri-entrepreneurs with buyers from the retail, e-commerce, and export sectors, thereby promoting market-linked agriculture and reducing post-harvest losses. The forum provided a structured platform for dialogue on investment opportunities, infrastructure gaps, and policy support required to build an efficient cold chain network in Odisha.

Government Support and Incentive Distribution

A key highlight of the event was the distribution of incentives and approvals aimed at accelerating cold chain infrastructure development. The Deputy Chief Minister of Odisha, Sh. Kanak Vardhan Singh Deo, presented:

- Go-Ahead Letters to six entrepreneurs under the Financial Assistance to Cold Storages (FACS) scheme, encouraging new cold storage projects in the state.
- Subsidy sanction letters to four entrepreneurs under the Mukhyamantri Krushi Udyog Yojana (MKUY) to support the development of commercial agri-enterprises.

These initiatives reaffirmed the state government's commitment to creating a robust post-harvest infrastructure that enhances farmer incomes and reduces wastage.



Role of NCCD and National Cold Chain Perspective

Sh. Pritam Sarkar, National Centre for Cold Chain Development (NCCD), participated in the conclave and highlighted the critical role of NCCD in supporting cold chain development across the country. He emphasized that strengthening cold chain infrastructure is not merely about capacity creation, but about ensuring quality, efficiency, energy optimization, and end-to-end integration from farm to market.

Sh. Sarkar also elaborated on the various Government of India schemes and policy interventions supporting cold chain infrastructure, including financial assistance, technical guidelines, and standardization efforts led by NCCD. He underlined the importance of scientifically designed cold storages, packhouses, and reefer transport, aligned with crop-specific requirements, to maximize returns for farmers and agri-entrepreneurs.



SH. PRITAM SARKAR
ENGINEER- COLD CHAIN, NCCD

Industry Insights and Knowledge Sharing

The conclave featured expert insights from representatives of APEDA, NABARD, Danfoss, and other leading institutions. Discussions focused on reducing food waste, improving energy efficiency, and promoting modern, market-linked logistics solutions to strengthen India's agri-supply chains. The sessions provided valuable guidance on technology adoption, financing mechanisms, and export-oriented infrastructure planning.

Showcasing Local Value Addition

A parallel exhibition showcased locally produced and value-added commodities, including GI-tagged cashews, honey, spices, mushrooms, and exotic vegetables. The exhibition facilitated direct interaction between producers and buyers, highlighting Odisha's potential for value addition and diversified agricultural exports.

Way Forward

The Cold Storage Conclave & Buyer–Seller Meet served as a convergence point for policy, investment, and technology, reinforcing the importance of coordinated efforts between state agencies, national institutions like NCCD, and the private sector. With continued focus on farmer-centric infrastructure and market connectivity, Odisha is well positioned to emerge as a strong hub for modern cold chain development.

For entrepreneurs and stakeholders, detailed information on investment opportunities and agriculture-related schemes is available through the APICOL government portal, along with Model DPRs for Cold Storage projects to support informed decision-making and project planning.

THE STRATEGIC PIVOT TOWARD NET-ZERO AND SMART COLD CHAIN INFRASTRUCTURE

The recently concluded REFCON 2025 series has emerged not merely as a convention of industry stakeholders, but as a definitive watershed moment for the cold chain sector. Bringing together policymakers, HVAC&R engineers, and agricultural stakeholders, the event moved beyond standard trade discussions to address a singular, urgent mandate: the integration of deep sustainability with digital intelligence.

For the National Centre for Cold-chain Development (NCCD) and its partners, the outputs of REFCON 2025 offer a clear roadmap. The discussions crystallized into three primary pillars of innovation: the operationalization of natural refrigerants, the structural evolution of cold storage infrastructure, and the deployment of "hybrid" thermal technologies.

REFCON 2025

**27TH JUNE
BANGALORE**

**22TH AUGUST
DELHI**

**29TH NOVEMBER
VADODARA**

The Shift to Natural Refrigerants

One of the most significant outputs of the event was the definitive shift in focus from simple compliance to the active adoption of natural refrigerants. The industry is no longer debating if we should move away from high-GWP (Global Warming Potential) synthetic refrigerants, but how to optimize the alternatives.

Technical sessions revealed comparative modeling between Transcritical CO₂ (R744) racks and Propane (R290) glycol chillers. The consensus emerging from the sessions suggests a nuanced approach: while CO₂ systems are demonstrating superior Coefficient of Performance (COP) in varying climates, R290 offers distinct advantages for specific medium-temperature retail applications. This distinction is vital for India's diverse climatic zones, indicating that the future of efficiency lies in "application-specific" refrigerant selection rather than a one-size-fits-all approach.

The "Hybrid" System: Innovation in Heat Recovery

Perhaps the most groundbreaking innovation discussed was the reimagining of the refrigeration cycle itself. Case studies presented at the event showcased the potential of turning refrigeration systems into thermal engines.

Innovators unveiled data on systems where evaporators are mounted on the condenser decks of CO₂ refrigeration units. This modification effectively transforms a standard cooling system into a hybrid machine capable of substantial heat recovery. For dairy and food processing industries—which require simultaneous cooling for preservation and heating for pasteurization or cleaning—this allows for the recovery of waste heat to be utilized for space heating or hot water generation. This closes the energy loop, drastically reducing operational costs and carbon footprints.

Structural Integrity: The Envelope Matters

REFCON 2025 also broadened the conversation from the machinery to the building envelope. Efficient compressors are rendered moot if the cold storage warehouse lacks thermal integrity. Prominent discussions centered on the utilization of advanced materials like Autoclaved Aerated Concrete (AAC) wall panels in modern warehousing. Moving beyond traditional construction, these materials offer superior fire resistance and thermal insulation. The output here is a new standard for "Smart Cold Warehousing," where the physical structure contributes actively to energy conservation, reducing the load on refrigeration plants by minimizing thermal bridging and heat ingress.

Post-Harvest Preservation: The Controlled Atmosphere

For the agricultural sector, the event provided critical insights into the future of post-harvest preservation. The spotlight was firmly on Controlled Atmosphere (CA) technology as a game-changer for long-term storage.

Experts detailed how modern CA systems are evolving from static storage to dynamic "breathing" environments that monitor and adjust oxygen and CO₂ levels in real-time. This technology is crucial for extending the shelf life of high-value crops, directly addressing the national objective of reducing food loss between the farm gate and the consumer. This aligns perfectly with the goal of strengthening the agrarian supply chain.

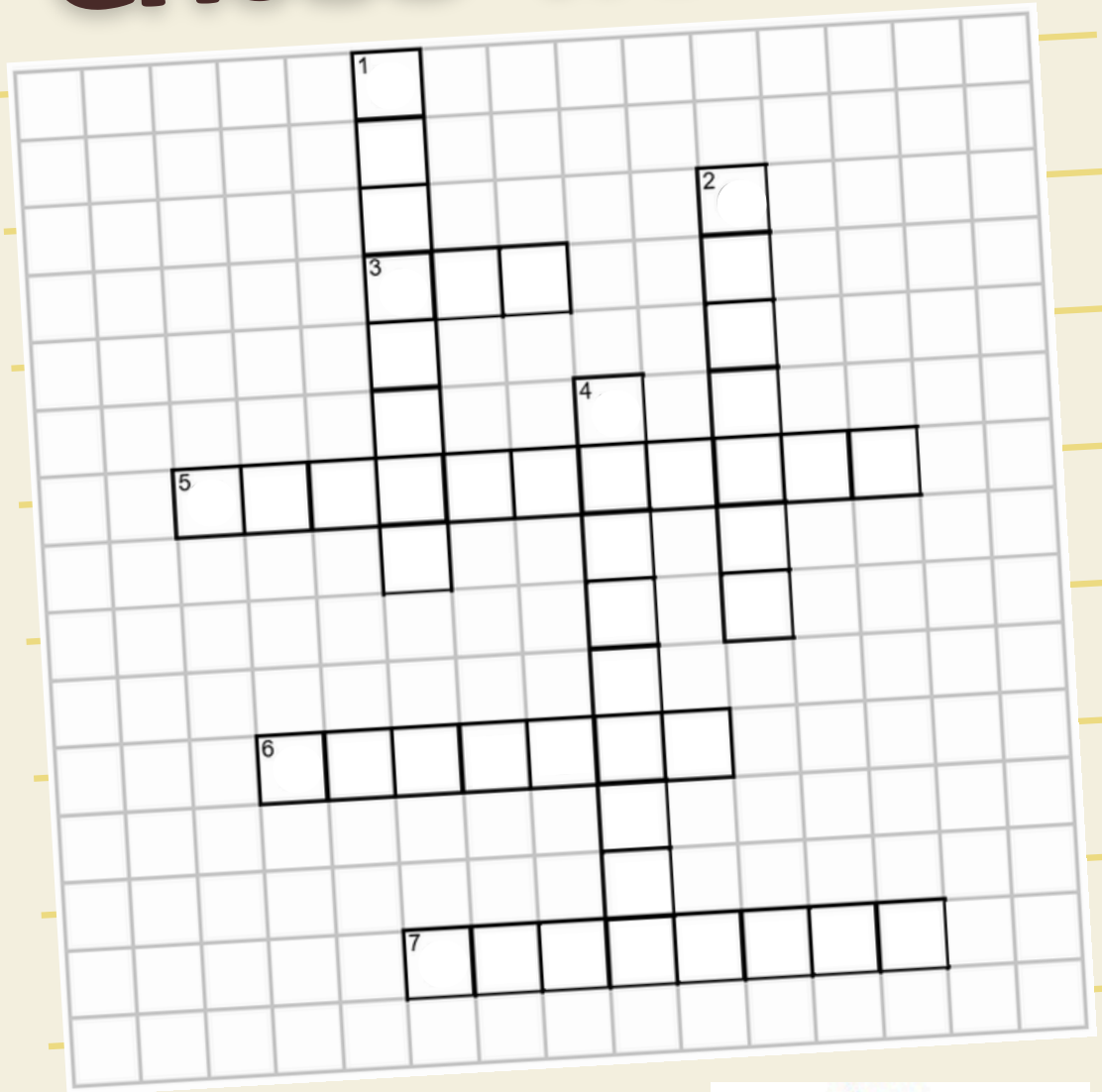
The Road Ahead

Ultimately, REFCON 2025 delivered a unified message: the cold chain of the future is not merely about temperature preservation; it is about net-zero thermal management. The event successfully demonstrated that the necessary technology—from hybrid heat recovery systems to advanced insulation and natural refrigerants—is already available. The focus must now shift to adoption and scaling.

For stakeholders across the sector, the event's output serves as a clear call to action. The integration of these sustainable technologies is essential to ensuring that the national cold chain infrastructure is not only robust but also resilient and environmentally responsible for the decades to come.



CROSS-WORD



CLUES:

Down

- 1 Key factor affecting shelf life besides temperature
- 2 Sorting produce by size or quality
- 4 Structure where produce is cleaned, sorted, and packed

Across

- 3 Freezing method used for individual quick preservation
- 5 Airflow requirement in storage structures
- 6 Initial rapid cooling after harvest
- 7 Physiological process leading to softening and sweetness

Coming
Soon...



Initiative By NCCD

**Sheet Bharat
Mission**

nccl.gov.in/sheetbharatmission

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Efficient Storage for Every Need

Monitor, manage, and optimize your storage with smart facility insights.

Storage Services Logistic Services

Location
Enter a location
Required

Commodity
Select a commodity

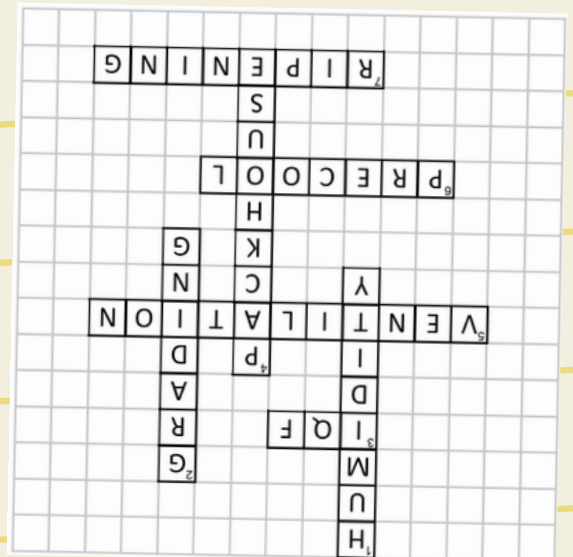
Commodity Volume
Eg: 100MT

Storage Duration
11-02-2026 → 26-02-2026

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