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NAVCDP
NATIONAL AGRICULTURAL VALUE CHAIN DEVELOPMENT PROJECT

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ESMAP
Energy Sector Management Assistance Program

Diagnostics, Opportunities and Challenges in Sustainable Cold Chain Development in Kenya

STAKEHOLDERS' WORKSHOP REPORT

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Contents

1 Introduction

Cold chain infrastructure (CCI) is integral to mitigating food losses. A cold chain is an environmentally, temperature-controlled series of logistics activities that cools and preserves produce or products within stipulated parameters, such as temperature, humidity, atmosphere, and packaging, from farm to kitchen. A well-designed and developed cold chain can prevent food loss and reduce related greenhouse gas emissions. Cold chains can ensure food security by reducing food price inflation and overcoming seasonal shortfalls, potentially buffering vulnerable communities at risk of poverty and hunger, while supporting the growth of farmer incomes. Cold chains are, therefore, a critical infrastructure, vital for a well-functioning society and economy.

According to the World Bank (2023), Kenya loses and wastes about 30 percent of its food supply. This represents about 9 million tonnes of food with an economic value of KES 30 billion annually. These losses arise due to many factors, among them rejection at farm gate, delays in the distribution process, market glut, and lack of adequate storage facilities. Reducing food loss and waste could significantly increase food availability, stimulate agri-based businesses and trade, while contributing to climate change mitigation action in the country. An effective CCI can largely address part of the food losses.

However, conventional CCI is energy intensive, uses climate-polluting refrigerants, and relies intensively on fossil fuels for transportation. To avert these challenges, more sustainable cooling and cold chain systems should be deployed along the agrifood value chains. In Kenya, the launch of the National Cooling Action Plan provided a framework to guide accelerating market transition to high-efficiency cooling appliances and equipment, transitioning the cooling sector to natural refrigerants with low global warming potential, and to consider enhancing access to agricultural cold chain solutions. Reliable and sustainable cold chains can enhance food security and nutrition by reducing food losses and increasing incomes of smallholder women and men farmers, fisherfolk and pastoralists, thus enhancing the resilience of agrifood systems. Notably, there has been an increased momentum and growing investments in cooling and cold chain in the Kenyan market.

To effectively deliver on the expected transformational outcomes of sustainable cooling and cold chain, a systems multi-sectoral approach is needed. The approach requires collaborative efforts of the national and county governments, the private sector, farmers, non-state actors and other stakeholders to deploy innovative business models and the training and capacity building needed to make sustainable cold chains work.

To stimulate this collaborative effort, a one-day stakeholders' workshop was co-organized by the African Centre for Technology Studies (ACTS) in collaboration with the Africa Centre of Excellence for Sustainable Cooling and Cold-Chain (ACES), the World Bank Kenya office and the Ministry of Agriculture & Livestock Development. The workshop themed 'Diagnostics, Opportunities and Challenges in Sustainable Cold Chain Development in Kenya' brought together 123 stakeholders in the cold chain and cooling ecosystem who discussed an elaborate agenda. They included private sector actors, farmer organizations, national and county government representatives, research and academic institutions and development partners (see Annex 2 for Participant list).

The workshop provided a platform to learn from ongoing programs and investments, explore opportunities and gaps in current technologies and business models, and how see these could be leveraged to enhance deployment and uptake of effective and sustainable cold chain infrastructure in Kenya.

1.1 Objectives of the Workshop

The main objective of the workshop was to validate the country report on *'Diagnostic of the current situation of cold chain infrastructure needs in Kenya'* and engage stakeholders within the cooling and cold chain ecosystem in Kenya.

The specific objectives were to:

- Present findings from a scoping study conducted by the World Bank on cold chain and cooling infrastructure in Kenya
- Explore viable options for deployment and adoption of sustainable cold chain and cooling systems and the requisite business models and support ecosystems in Kenya.
- Consider opportunities for enhancing collaborative learning and knowledge exchange and partnerships to advance sustainable cold chain and cooling agenda in Kenya.

1.2 Structure of the workshop

The workshop was organized around presentations, plenary and panel discussions. The detailed agenda is in Annex 1. This report gives a summary of the proceedings.

2 Workshop Sessions

2.1 Welcome and introductory remarks

Dr. Dorcas Kalele of ACTS welcomed participants to Nairobi and to the workshop and gave them opportunity to introduce themselves.

Annastacia Kivuva of the National Agricultural Value Chain Development Project (NAVCDP) outlined the workshop objectives, highlighting their relevance in the cooling technologies in agrifood systems.

Dr Anne Kingiri, Director of Research and Innovation at ACTS on behalf of Prof Tom Ogada, Executive Director, explained the ACTS mandate, coverage and its programs. ACTS approach to delivering its mandate is informed by two principles: 1) applying Science Technology and Innovation Systems thinking to meet the agenda on the Sustainable Development Goals (SDGs). This systems approach emphasizes platforms (such as the present workshop) for individuals or organizations to interact, engage in information exchange/sharing, problem solving and mutual learning, and 2) an inclusive trans-disciplinary approach that is key to building strong systems (e.g. the multisectoral cooling and cold chain ecosystem). This approach works across academic and research disciplines, and with policymakers, non-state and private sector actors, but also deliberately find ways for other actors like farmers, youth, women, the informal sectors to be active and equal participants in knowledge generation and application pathways and processes. On behalf of ACTS, Dr Kingiri appreciated and welcomed the participants to the co-learning workshop to enhance systems change in the cold chain ecosystem.

Mr. Leo Blyth of the Energy Sector Management Assistance Program (ESMAP) at the World Bank, emphasized that the ESMAP fund supports research and provision of advisory services to reduce poverty and boost growth through sustainable energy solutions. He stressed on the importance of working together to transfer off-grid cooling technologies. The World Bank has pledged USD 15 million in the next 5 years to accelerate the energy transition and to ensure access to affordable reliable and sustainable and modern energy for all, and USD 320 million has been set aside for the solar cold chain. The World Bank has partnered with Wageningen University to support cold chain development across Africa.

Dr Kiplimo Lagat, the Chair of the CEC Caucus and the Agriculture and Cooperatives CEC of Nandi County said that smallholder farmers stand to benefit immensely from sustainable cooling and cold chain development. He explained that when a farmer cooperative in Nandi County invested in cold chain facilities it unlocked the milk value chain for smallholder farmers to benefit. Formerly processors would buy a kilogram of milk from farmers at 25–35 shillings, who suffered more economic losses as they shouldered the costs of feeds and transporting milk to the processors. With investment in coolers, the milk prices per kilogram rose to 60–70 shillings (US$ 0.50). Because coolers are expensive and there is no capacity locally to manufacture the technology, he stressed on the need to deploy solar-powered cooling and cold chain facilities to smallholder farming systems, as they are easy to maintain and have low operating costs. These must be taken to villages (closer to farmers) to obviate the need to transport produce over long distances. Dr Lagat asked participants to understand the dynamic context farmers work in, to leverage appropriate technologies to support them.

Mr. Douglas Kangi, the Director of Crop Resources in the State Department for Crops Development officially opened the workshop. He talked extensively on the importance of reducing postharvest losses, stressing that prioritizing the key value chains is essential in enhancing food security and Kenya's export market. He noted that Kenya losses vegetables and fruits worth KES 300 million yearly with losses of up to 40 percent experienced in the horticulture sector from the farm gate to table, resulting from insufficient cooling systems along the value chain. This is largely because most smallholder farmers can neither access nor afford cooling systems. He stressed that streamlining appropriate and affordable cooling systems along the agriculture value chains would save up to 50 percent of the food produced, making the country food secure and enhancing farmers' economic returns. He reiterated the government's role was to provide an enabling environment for all stakeholders to operate in. He asked participants to identify policies that were lacking or were inadequate and appreciated the importance of partnerships and collaboration to help streamline operations and delivery in the agriculture sector.

2.2 Report: Diagnostic of the Current Situation of Cold Chain Infrastructure and Needs in Kenya

by Prof. John Mburu

The presentation was drawn from a study on 'Diagnostic of the current situation of cold chain infrastructure and needs in Kenya'. It was funded by ESMAP through the World Bank Nairobi Office to support implementation of two key projects in the arid areas under the Ministry of Agriculture and Livestock Development—the National Agricultural Value Chain Development Project (NAVCDP) and the Food Systems Resilience Program (FSRP). It was carried out in three phases: i) Sector analysis: Diagnostic of the current situation of cold chain infrastructure and needs ii) Investment analysis: Identification of key investments, financial gap, and capacity-building opportunities in the cold chain sector, and iii) Sector strategy analysis: Development of capacity building plan.

The study was conducted in 11 counties and data were obtained from primary sources – focus group discussions and key informant interviews (key value chain actors: producers, aggregators, traders, processors, exporters, retailers, as well as suppliers of CCI who include manufacturers, county governments and NGOs). Secondary data was derived from desk reviews. Table 1 shows the value chains examined in the counties selected for the research.

Table 1. Value chains examined and counties selected for field visits

Value chain	County selected for field visit
Avocado	Murang'a, Meru, Nandi
Banana	Meru, Nyamira
Tomato	Kirinyaga, Kajiado,
Irish potato	Meru, Nakuru, Nyandarua

Mango	Makueni, Kitui, Murang'a
African leafy vegetables and garden pea	Nyamira, Nyandarua
Red meat	Isiolo, Kajiado
Chicken	Nandi, Kitui
Dairy	Murang'a, Kirinyaga, Meru, Nyamira, Nandi, Isiolo, Makueni, Kitui, Kajiado, Nakuru, Nyandarua

The study reviewed the existing cold chain technology, best practices globally and nationally, the financing and business models. It gave diagnostic picture of Kenya's high-value chains: of horticulture sector, dairy, beef and chicken value chains; the current state of CCI in production areas; the legal framework supporting CCI in Kenya. It identified investments appropriate to the national context and with the greatest potential in Kenya and recommends solutions to some of the challenges of institutionalizing CCI to maintain quality, nutritional value and safety of food products in the agrifood sector and in the process improve human well-being, boost economic growth and deliver socio-economic development.

Main findings

Demand for CCI is growing due to growth of the middle-class population where consumers in the are demanding safer and healthier food options and are willing to pay for it; of high-end and export food markets; and improved incomes of the population. However, uptake of cold chain infrastructure solutions is low because of prohibitive costs, diverse needs under varying contexts, low market demand for cooled goods in the local market, poor coordination of food supply chains and limited enabling environment support. Therefore, the country currently needs viable and scalable cold chain solutions that are of good quality, high performance and efficient, as well as business and financing models that are feasible.

Sector analysis: Diagnostic of the current situation of cold chain infrastructure and needs

The drivers of cold chain infrastructure investments in Kenya include:

- The need to reduce post-harvest losses which range from 20 to 50 percent depending on the type of produce with potential to reach 80 percent in worst cases.
- Growing population: Kenya has an annual population growth of about 1.9 percent, thus increasing food demand.
- Increased production and marketing of fresh produce.
- Changing consumer patterns demanding safer and healthier food options that consumers are willing to pay for. Kenya's middle-class accounts for a third of the population and grows at 5 percent annually and improved purchasing power evidenced by decline in poverty by 13 percent is spurring demand for safe and healthy food.
- Increasing urbanization growing at a rate of 4.3 percent increasing demand for food mostly supplied from rural regions.

The study identified the following challenges impeding development of CCI solutions:

- Market dynamics and price fluctuations
- Fragmented supply chains and market inefficiencies
- Limited capacity in installation, operation, and maintenance of CCI
- High operational and maintenance costs
- Competition from alternative post-harvest management practices
- Asset specificity of CCI and seasonal constraints
- Land ownership and security of tenure

- Governance issues within cooperatives
- Financial barriers to uptake of CCI
- Information gaps and lack of knowledge on benefits of CCI
- Fragmented marketing practices
- Accessibility and transportation
- Fragmented initiatives and missed synergies
- Transportation bottlenecks and supply chain disruptions
- Poor start quality

Table 2 lists the cooling technologies currently in use and Table 3 the CCI installed capacity for different value chains.

Table 2. Cooling technologies in use in Kenya

Milk chiller	Ice cube, flakes &blocks	Evaporative charcoal cooler
Milk cooling tank	Cold room	Reefer truck
Insulated milking cans	Ambient stores	Cooling box
Portable milk chiller		

Table 3. Estimated CCI installed capacity and value added in 2024

Value chain	Estimated installed capacity	CCI value added (KES billion)
Avocado	298 MT	4.03
Banana	1.779 MT	8.49
Mango	501 MT	5.20
Tomato	2,973 MT	5.90
Irish potato	420 MT	6.0
African leafy vegetables & garden pea	999 MT	2.07
Peas and French beans		1.51
Read meat	13,000 MT	45.00
Chicken	78 MT	9.62
Dairy	73,500 m^3	0.10

The discussion on the diagnostic picture of the horticulture sector and the dairy, beef and chicken value chains highlighted the following issues:

- Processors and stakeholders in the dairy, beef and chicken value chains have invested to some degree in CC systems.
- The dairy value chain is developed but is experiencing two key problems: the location of coolers is not fully optimized and cost of on-grid connection. There is need to optimize distribution of infrastructure and find mechanisms to reduce power bills. More investment is needed in milk ATMs, especially because of qualitative losses in the informal sector, where brokers still sell milk in the late evening hours.
- Though production volumes are increasing in the chicken sub-sector, handling and transportation are loss points as chicken needs refrigeration within an hour of slaughter as spoilage starts soon after.
- Optimizing CCI: Need for cold chain and cooling is highest among farmers. However, investment in CC should be guided by the shelf life of produce, for example, some potato varieties such as Shangi cannot be stored beyond 2 months even under CCI.

- Mapping of CCI: Most of the cold infrastructure constructed in some counties is incomplete or not being used. For example, dairy and chicken cold chains are lying idle for lack of power connection.

Investment analysis: Identifying key investments, financial gaps, and capacity-building opportunities in the cold chain sector

Most development partners associated with cold chain investment focus on:

- Providing physical infrastructure and technical capabilities for optimal utilization
- Forms of financing arrangements: subsidies, grants, or concessional loans
- Bridging the financial divide for CCI investments among the end users

A mapping of the current status of CCI in the 11 counties found that:

- Most CCI is incomplete or not being fully utilized
- Some CCI is not maintained after end of donor support
- A few CCI is being used daily

Table 4. Business models and financing mechanisms for CC in use

Business models	Financing mechanisms
Upfront purchase Pay as you store model/ rental model Exporter–cooperative model Government supported model Cooperative -private company model Third party logistic service provision Project-cooperative model Pay-as-you-go lease model	Grant financing Government financing Climate financing Subsidy financing Upfront purchase through private (own) financing Credit financing (lease to own model, sale lease back model)

Links to markets are important for the CCI ecosystem to work well. Where the CCI system is integrated to the market, the model is working well, for example, a cooperative and exporter working together. Exploitation is high where third partly logistics are in practice. The government-supported model is transitive, and the study found no successful case of a cooperative operating CCI by itself after getting government help.

Sector strategy analysis: Development of capacity building plan

Opportunities that create a conducive environment for development of CCI solutions exist in the country and include:

- Innovative CCI Solutions: Solar powered, use of AI for value chain transparency
- Existing and working business models and financing mechanisms
- National and county-level coordination mechanisms: JASSCM/CASSCM
- Growing interest in CCI and the need to address food loss and waste
- Pioneer in cooperative model
- Multiple use of CCI through production scheduling
- Human resource with basic requisite skills

Table 5 shows past projects that can be leveraged on to incorporate CCI solutions and Table 6 shows the main challenges and the proposed solutions.

Table 5. Opportunities for leveraging from past projects

Project name and duration	Opportunities for leveraging
SIVAP 2016–2021	Revive and implement off-grid powered sources in the CCI (mainly charcoal coolers) developed by the SIVAP project
KAPP/KAPAP 2004–2015	Introduce CCI in the value-addition cottage businesses created through the project
East Africa Dairy Development 2008–2018	Complement with energy-efficient systems to reduce maintenance costs and GHG emissions (e.g., using solar-powered pre-chillers and chillers in West Pokot)
SCDP 2005–2019	Complement with energy-efficient systems to reduce maintenance costs and GHG emissions (e.g., using solar powered portable chiller boxes in Kisii)
SHEP 2006–2020	Revive and implement off-grid powered sources in the CCI (mainly charcoal coolers) developed by the SHEP project
Agricultural Sector Development Support Program (ASDSP) 2012–2022	Implement off-grid powered sources in the CCI (ambient stores, chillers, etc.) to make them more efficient
KCSAP 2017–2022	Implement working and sustainable business models in all CCI being developed in different value chains (e.g., Isiolo PPP arrangements for the abattoir)
NARIGP 2016–2023	Implement working and sustainable business models in all CCI being developed in different value chains (e.g., Nandi's Private Company–Cooperative model)
NAVCDP 2023–2027	Project has just started. Implement energy-efficient and sustainable CCI
FSRP 2023–2027	Project has just started. It plans to have sustainable CCI in beef and other ASAL value chains

Table 6. A summary of the CCI diagnostics and treatments

Diagnostics	Treatment
Fragmented efforts in CCI investments	Coordination and concerted efforts from all the stakeholders
Affordability remains a prominent barrier	Align financing mechanisms to specific CCI requirements based on clear demand across different user segments and needs
Emerging innovations in CCI (off-grid, fabrication, portable) not scaled-up	Incentivize innovation and upscale tested innovations
Prevalent capacity gaps in installation, operation, and maintenance	Technical capacity development of aligned fields, after sales service and technical assistance
Limited utilization of already installed CCI (idle, less than full load)	Operationalize and optimize existing CCI as a starting point for CCI investments at the first mile
Nascent industry though it is promising	Create awareness, develop appropriate strategies and frameworks
Uncertain sustainability of business models in transition	Restructure existing models to integrate sustainability
Inadequate policy environment	Review existing policies to integrate aspects that would support sustainable CCI development
Existence of under-utilized infrastructure in past donor projects	Optimize utilization of installed infrastructure when installing CCI for the current projects
Poor starting quality	Train in starting quality

Some action points for upscaling

- Support and training are needed in installing and managing the CCI infrastructure
- Some value chains are exclusively a women's business, e.g. chicken in Nandi and goat in the arid and semi-arid areas. Avocado and potato value chains are mainly owned by men. Commodities should be looked at in relation to gender and how this affects or encourages use of CCI and how the different gender groups will benefit or not from CCI.

- Policies: the research highlighted several policies supporting CCI development. However, there are gaps as most policies have not integrated or do not explicitly mention CCI. The policies are in silos in the sectors of trade, food and agriculture, environment, infrastructure development, tax and finance, and public engagement. Most county integrated development plans have also not incorporated CCI.
- Past and ongoing projects (Table 5) provide opportunities for scaling up CCI. A lesson learnt in these projects is that where CCI investments are needed most, there is no sustainability due to non-viable business models. However, a few CCI are still in operation and their business models could be upscaled.

Conclusions

- Smallholder farmers in all the value chains except dairy are underserved with CCI, with most CCI investments mainly in the export market
- Investments in CCI are driven by the export market and increasing local demand resulting from increasing urbanization and growing middle class population.
- CCI investments are attracting diverse stakeholders: financiers, manufacturers and suppliers (CCI service providers to end users). There is a great need for coordination to reap benefits and synergies, and upscale what is working.
- Enabling environment, innovative CCI solutions, and incentivized business models that are supported by diverse financing mechanisms can propel growth of CCI investments.
- Need for pre-intervention needs analysis to determine commercial viability for sustainable CCI investments for each commodity.
- Though CCI development in Kenya is recent, the outlook is promising
- Promising innovations should be upscaled such as the those linking solar power to charcoal coolers.

2.3 Validating the report

Dr. Michael Njuguna of the World Bank facilitated this plenary session that allowed participants input into the research report on three main issues: accuracy of information and data presented, areas that required further clarification, gaps noted or important thematic areas that had been excluded. Participants made following observations:

Accuracy of information and data presented

- Tools used in the research followed a complete commodity system method, and the value chain can be analyzed to see where it is broken.

The following gaps in the report should be a priority for future research (Table 7 responds to some of the issues raised)

- Most CCI solutions highlighted have been applied in certain value chains, but their successes and impacts have not been documented. Documenting and disseminating good practices and lessons learned should be a feature of these innovations.
- The presence of a cold chain at farm level will not have any success if other nodes of the value chain have no cooling solutions. Cooling technologies on their own don't translate to efficient cold chain.
- The business case for CCI for smallholder farmers is tricky. Traders are not willing to pay farmers for the extra work involved and the cost of maintaining CCI. Reducing postharvest losses for agribusiness and smallholder farmers is therefore critical and ways should be identified on how to use off-grid cold chain solutions in rural areas closer to producers.

- The report does not exclusively articulate the causes of food loss along the value chains.
- Future research should integrate gender to identify the issues affecting women, youth and other marginalized groups and the benefits and opportunities CCI offers each group.
- The more advanced export market has invested in CCI because it must adhere to international food safety standards, though losses still occur. However, the business case for adopting CCI in domestic markets within the context of small businesses is not well articulated. The challenge lies in the pricing of business models and the fundamentals to consider are the unit cost, production cost and logistics.
- Innovations that do not use electricity from the main grid such as solar should also be considered. How will these be implemented?
- The national and county governments must make CCI a key policy and investment area in addressing food loss and waste. The State departments should consult each other considering each has areas touching on CCI and develop an integrated policy framework. Efforts should be made to ensure CCI issues are not captured by politicians because they decide which areas get CCI even when there is no potential in those areas for successful implementation.

Table 7. Summary questions from participants and responses

QUESTIONS	RESPONSES
How can we make cold chain investments cheaper?	Policies on food safety should be properly formulated Most of the agricultural products stored in cold rooms should be exported.
Is there a business case for adoption of cold chain infrastructure in counties?	The business case for domestic markets is being worked on because cold chain investments are driven by market prices.
Do you consider innovations that do not use electricity or solar and how do you implement them?	Yes. Though the main alternative of electricity in this case is solar energy.
Is there room for more gender perspectives?	Yes. There is a possibility of looking into gender in a broader perspective in subsequent studies linked to cold chain infrastructure.
Did you consider the right start time for agricultural products through a cold chain system?	Yes. For example, French beans and milk should be introduced into a cold chain system right after harvesting and milking consecutively. On the other hand, a product like avocado can stay up to six hours before the cold system and they will still maintain the right standards for exportation and that is why most cold systems for avocado value chain will start at the packhouses.

Workshop participants appreciated the report and validated it as an important document that will provide technical guidance and direction for creating and implementing holistic and sustainable CCI in Kenya.

3 Exploring options for deploying and adopting sustainable cold chains for smallholders

3.1 Background

Dr Catherine Kilelu, of ACTS presented the 'Africa Centre of Excellence for Sustainable Cooling and Cold-Chain (ACES) HUB and SPOKE Model - The Kenya Case.

ACES is a not-for-profit pan-African institution that is pioneering a model for deploying sustainable cooling and cold chain in rural Africa. ACES campus (hub) has its headquarters in Kigali, Rwanda, and aims to accelerate deployment of sustainable (environmentally, economically and socially) cold chain system to preserve both food and health, which simultaneously protects the quality and safety,

minimizes loss and provides value to all stakeholders. Reducing losses equates to improving food availability, affordability, stabilizing prices, efficient resource use (water, land and energy) and stable incomes for producers and value chain actors.

The ACES hub is linked to Specialized Outreach and Knowledge Establishments (SPOKES) at the country-level delivery arms throughout Africa. The hub and SPOKE model aim to enable farmers and companies to deploy sustainable cold chain solutions at scale with fit-for-market technologies accompanied by robust business models. The key areas where SPOKEs will provide support to in-country partners are:

- Research and Development on integrated end-to-end food and vaccine cold-chain solutions – to establish an understanding of the current and future cold-chain needs and demand, gaps, available resources.
- Demonstrating the best available cooling and cold-chain technologies and practices.
- Developing finance and business models that create and share value equitably and overcome perceived issues around affordability and viability.
- Skills and capacity building of the local community and awareness-raising.
- Standardization and certification.
- Providing a platform to build strong networks and collaboration among local and regional stakeholders: industry, academia, government, entrepreneurs, financiers, local communities, among others.
- Collating evidence and insights on the multiple benefits of access to sustainable cooling and cold chain in rural communities to underpin investments.

The first SPOKE is being implemented in Kenya with ACTS as the delivery partner, working in collaboration with smallholder dairy and horticulture farmers in Lari subcounty, Kiambu. The collaboration with these will pilot and demonstrate a financeable business model for deploying sustainable cold chain to enable aggregation of horticultural produce through a Community Cooling Hub (CCH). The subcounty is a key food basket for local and distant urban markets with export opportunities that have not been realized. The presentation showed farmers are more organized around the dairy value chain through Kiriita Dairy Cooperative to reduce post-harvest losses and engage with markets. However, their engagement in horticultural value chains is quite fragmented, resulting in huge postharvest losses and unfavourable marketing. This coupled with limited or fragmented cold chain has resulted in high food loss, poor quality and unsafe food, and income loss for farmers and other actors along the value chains.

Underpinning the SPOKE model at the community level through the CCH is a data-driven process of first undertaking rigorous needs assessment to understand cooling demand and opportunities and the potential business case for cold chain investment. A needs assessment methodology developed by ACES team has been conducted in two wards in Lari subcounty. This assessment is guiding the demonstration of cold chain integration for the farmers using a try-before-you-buy approach, where a 5-MT cold storage and refrigerated transportation are used over a period (minimum 6 months) to address post-harvest loss and enable structured market integration through aggregation by farmers. This will inform the requisite financable business model for the community and partners to co-invest in a CCH.

3.2 Panel discussions

Two panel discussions brought out perspectives from selected private and public stakeholders.

Panel 1. Current trends, barriers, and opportunities for market transformation

Panelists: Ecozen (James Ndwiga), Savannah Circuit (Mary Njuguna), InspiraFarm (Julian Mitchel), SokoFresh (Denis Karema), National Ozone Unit, Ministry of Environment (Marindany Kirui), Ministry of Energy, Department of Renewable Energy (David Mutisya), Horticulture Department of AFA (Collins Otieno)

The discussions featured factors and dynamics around ignition and adoption of CCI innovations and was guided by the following questions:

- What is the current trend of growth of CCI investments and adoption of technologies by users in Kenya?
- Do the findings of the diagnostic report provide a complete and accurate overview of factors fueling growth and adoption of CCI?
- Do you know of best practices in other countries that fuel growth and adoption of sustainable cold chain?
- What are the key barriers to growth and adoption of CCI and what needs to be done in the short and long term?

Key points

Systems thinking

- Cold chain development requires systems thinking approach to foster cooperation among the diverse actors, coupled with systems change approach which is essential to avoid doing any harm. This means looking at the roles of different partners–academia and development financing, research and development, local partnerships–and how they fit in the CC space.

Do no harm

- Ozone-depleting substances used in cold chain and refrigerants are driving cold chains globally. Caution is called for in the choices of technologies to be used to consider what will work locally to ensure cold chains and refrigerants are climate friendly so as not to reverse efforts to mitigate greenhouse gas emissions in the country. For some products, a small change in temperature has positive consequences, therefore innovations should consider the needs they are addressing.

Knowledge creation and sharing

- Encourage use of indigenous knowledge or passive solutions and learn how to incorporate this knowledge into the solutions and financing models in the CCI space.
- Part of the strategy should include the use and sharing of artificial intelligence and satellite technology to manage CCI.

Financing and business models

- Cold chain systems are driven by markets, prices, and product quality.
- Bringing down the cost of the CCI system will require bringing down the ultimate unit cost, making or implementing favorable policies, including in taxation, and giving impetus to producers to produce more for the market.
- Fundamental economics of CCI is to make it work, but consumers consider price of food over investing in CCI technology. Design innovative financing models or solutions with unit cost in mind to make CCI solutions more affordable for smallholder farmers and cooperatives.
- Design strategies to make CCI affordable such as making productive use of renewable energy, use of subsidies when selling cold rooms. Many stakeholders would like to use CCI, but it is too expensive.
- Providing CCI as a rental service might make adoption much easier. The growing urban middle class population needs food in large quantities and of high quality, which means the margins

allow for integration of CCI and shelf life that consumers now demand. Integrate these solutions but address the fundamentals to give value to the consumer who has to pay more for the cost of the added value.

- The question at the heart of the World Bank is whether Public Private Partnerships can have an impact on CCI adoption. ESMAP spent USD 15 m in building quality assurance frameworks that are used as the eligibility criteria to use their funds, and in developing industry consultations and working with governments and private sector in a consultative process.
- Business case for smallholder farmers and markets: Export-oriented value chains have a higher adoption of CCI. The horticulture and flower industries were key drivers of adoption of cold chain since the 70s and 80s, who were mainly producing for export. Many smallholder farmers started growing vegetables for the export market. Produce needs to reach their destinations when fresh and meet market quality and food safety requirements, providing the opportunity for adoption of CCI. Concentrate on growing exports to get CCI to smallholder farmers.

Research and development

- Most innovations shown in the report are expensive. Where is the space for testing the products and innovations?
- Harsh environments: Consider areas such as the arid and semi-arid areas (ASALs) with very high temperatures from planting to harvesting and storage. How and at what stage will ASAL communities benefit from CCI technologies? How can localized technologies that are portable be actualized?

Transport infrastructure

- Transportation along all nodes of the value chains plays a key role in CC and its role should not be overlooked.

Energy as an enabler or deterrent to CC uptake.

- Energy is an enabler and needs to be better understood. The SDGs mention renewable energy, and it is a key driver to CCI adoption.
- Emerging issues such as energy efficiency are struggling to get into the space, but cooling is missing as it is still in the nascent stage. A consortium is needed to address productive use of renewable energy and efficiency, and emission efficiency, to help contribute to the NDC.

Policy and an enabling environment

- Address policy gaps in renewable energy, implement polices already in place, and integrate policies found in the different departments into a single policy framework that will guide CC in Kenya.
- Provide incentives to manufacture cold solutions locally: the major challenge is that regulatory policies whether from the energy sector or other sectors are not specific on what is needed and appropriate.
- Poor law enforcement of food safety standards results in producers (farmers, fishermen) and middlemen taking produce directly from the farm to markets, which is not an incentive to integrate cold chain infrastructure.
- The government's perspective on renewable energy has not considered cold chain and cooling. The workshop is timely as it has now brought these seemingly parallel government agendas together. What must government do that the private sector can leverage on? What initiatives are directed at the private sector towards cold chain in this country?

Food safety and quality

- Meat-based foods (high value and export oriented) need more temperature control than plant-based foods. A large percentage of plant-based foods (horticulture sector) in Kenya is traded on informal markets. Where in that business space is the role for cold chain?

Table 8. Summary questions from participants and responses from panelists

QUESTIONS	RESPONSES
What is the current trend of growth of CCI investments and adoption of technologies by users in Kenya?	In terms of value chains, exports are highly adopting the cold chain infrastructure in Kenya. SokoFresh uses the rental model since it has no initial cost to cut costs associated with CCI.
In your opinion, did the findings of the diagnostic report provide a complete and accurate overview of factors are fuelling growth and adoption of CCI?	Yes. The issue of urbanization is very fundamental in fueling growth and adoption of CCI because most of the people in urban areas consume a lot of dairy products. Dairy products require a cold system to restore quality and safety standards. We need recommendations from the report that relate to the energy sector on efficiency. Other issues relate to addressing sustainable refrigeration in cooling systems linked the targets of the Kigali amendment of the Montreal protocol. Reference can be made to the = National Cooling Plan document.
Do you know of best practices in other countries that are fuelling growth and adoption of sustainable cold chain?	Yes. India has focused on government policy with strict enforcement laws that ensure horticultural crops are packed in crates and precooling is done immediately after harvest. The private agricultural sector in India was given financial incentive or rather a tax break.
What are the key barriers to growth and adoption of CCI and what needs to be done in the short and long term?	Policy gaps under the renewable energy. Energy is an enabler for CCI thus it should be fully understood keeping in mind that 92% of the Kenyan grid is smart/renewable. Cooling is missing the space of Energy access, Efficient energy, Renewable energy and Emission efficiency. This is an indication that cooling should be fixed in the space with a backup from data and knowledge.
What should the government do to address issues in CCI?	The government should push for affordability in setting up cold chain systems and it should also subsidize the energy costs associated with CCI.

Panel 2: Considerations for sustainable cold chain investments in smallholder systems—technical and business models

Panelists: Dan Church Aid (L), CLASP (Nyamolo Abagi), GIZ (Kilian Blumenthal), SE4All (Elizabeth Chege), FAO (Rouja Johnstone) and Tigoni Grown (Charles Orora)

This discussion considered the role of development partners as catalysts in sustainable cold chain systems delivery. Development partners present included civil society open in humanitarian and development space, and several private institutions in the CCI sector. They noted that the workshop provided a wide spectrum of representatives from the cold chain sector and with the right environment they could play a role in driving CCI solutions particularly with regards to food security, food loss reduction, and different ways to tackle food loss. These partners can also provide entry points for CCI investments in the domestic market where it was not the challenge was greater. For example, Tigoni Growers supplies fresh produce to supermarkets and other markets (local grocers) across the country and has partnered with farmers to build technology systems to trace food and look at value chains holistically.

Key points

Increased recognition of the value of CCI

- Beyond cold rooms, farmers are using domestic fridges and ice packs and are therefore taking risk to test early innovations. It was suggested that there was a need to identify key hotspots that produce high volumes to give a business case for deploying CC solutions.

Cost–benefit analyses

- Carry out cost-benefit analyses by analysing different actors' willingness and ability to pay for CC solutions, for example, of small-scale agrifood businesses with short supply chains that sell everything at the end of the day, though their supplies may need CCI (more informal markets).

Ensure availability and location of materials

- Materials location affects performance of CCI systems.

Training and education

- Provide training and education to users of CC technologies. Lack of skills and capabilities to operate, manage and maintain CC systems was noted as a key barrier to successful adoption of CC. There is need to close this gap, and many development partners are investing in this area and giving it more attention.

Leveraging underutilized CCI

- Previous efforts in deploying CCI especially in relation to smallholder farmers was led by government and was supply driven. These efforts failed, for both export and especially the domestic market, due to limited considerations for the demand side, of the market needs and the underlying business model for making the installed CCI work. This is the opportunity to now engage with the private sector to see how best to use this existing infrastructure. Private sector actors should be considered by development interventions when deploying interventions to ensure a more sustainable, market-led approach of the interventions to reduce the rates of failure or limited use of CCI.

Support the establishment of an innovation ecosystem

- The sustainable cooling agenda is now getting attention in other efforts that have been going on in parallel especially on energy efficiency, which has been led by the energy and environment sectors. The cold chain agenda in agrifood and health sectors has been on the periphery. This meeting provides a good opportunity to bring together the different sectoral efforts.

Aggregation systems as essential components of a functional cold chain system

- Government aggregation facilities are available, but these are not accessible to the users. The national and county governments should open or make available the facilities for use, especially with private sector.

Table 7. Questions from participants and responses from panelists (Panel II)

Questions	Responses
What is the risk of working with smallholder farmers?	The risk of working with smallholder farmers is high because most of them venture into agriculture after facing the crisis of unemployment. They operate on small farms and breaking even in terms of business is an uphill task due to low yields.
What has GIZ done in CCI to ensure success?	As an organization, GIZ gives support to most players within the agricultural space: Supporting organizations to improve business models and financial models, e.g. Kenya Bankers Association. Providing support in terms of policy formulation
What can be done in CCI to ensure it becomes successful?	Farmers need quality seed to produce more output. Once a farmer is effective in their agricultural practices, cold chain investment will be somehow affordable. Organize farmers into cooperatives Onboard everyone along the value chain. Piloting on-grid and off-grid units and select the one that is affordable for smallholder farmers. Build capacity of smallholder farmers to make data-driven decisions in their operations. Ensure that smallholder farmers are producing enough to invest in cold chain infrastructure.

What are the most sustainable ways for smallholder farmers in CCI?	The government should create an enabling environment that will promote collaborations between the food sector and the energy sector. Target hotspot markets or areas. This implies that regions that produce high volumes of perishable agricultural products should be identified and supported in terms of CCI installations in farms and marketplaces to control losses due to glut.
How is indigenous knowledge being considered in this discussion	The is role of indigenous knowledge in mitigating climate change impacts has already been recognized. This means attention should be paid to how to integrate both indigenous and local knowledges in the process of sustainable cooling and cold chain. SE4All is making these considerations in their work.
What is the role of AI technologies in CCI?	

4 Opportunities for enhancing collaborative learning, knowledge exchange and partnerships

4.1 Establishing best practices for developing sustainable cold storage/cold chain solutions in rural agriculture, fisheries, dairy and livestock value chains

By Leo Blyth, ESMAP World Bank, and Bas Hetterscheid, Wageningen University & Research

Leo Blyth and Bas Hetterscheid shared reflections on 'Looking ahead – Establishing best practices for developing sustainable cold storage/chain solutions in rural agriculture, fisheries, dairy and livestock value chains'.

Key messages

- Developing a successful cold store leave alone a cold chain is very challenging but is not enough – developing a whole cold chain system is needed and exponentially harder!
- A holistic 'market transformation approach' is needed to build an enabling ecosystem for sustainable cold chains to succeed
- Beware cut and paste! No one size fits all solution to cold storage and chain development due to multiplicity of stakeholders, circumstances and use cases
- Universal guiding principles need to be identified and used to determine best practices in deploying CCI through learning together, developing communities of practice, analysing and implementing together
- It is important to consider competing alternatives of cold chain, e.g. greenhouse farming
- For more information, it is important to consider the comprehensive Practitioners Technical Guide for Walk-In Cold Rooms that has been developed in partnership with ESMAP to assist in this process
- As CCI is an ecosystem, consider capacity building and training, ensure appropriate polices are in place, look at the financing models, and bring the government on board.

Best practices

- Need to integrate a principles approach to determine what should be done, where, when, why, how and by whom
- Perspective – Determines why we are here and what matters
- Position – How is success measured, who succeeds?
- Purpose - What do we seek to achieve & by when?

- Priorities - What are they & when do they apply?

Pathways to unlock the private sector

Effective demonstration project

- Before engaging the private sector, the commercial viability of the sold cold rooms in the country context must be assessed through a demonstration project to be tested.
- An effective demonstration project requires the simulation of a commercial case, that is, the investor has to pay-off the system e.g. payments to a separate own account.

Training of private sector on project development

- Local suppliers or distributors generally underestimate the complexity of project development for solar cold rooms especially if they usually do product business or projects with professional businesses.
- Training is needed on project development and business modelling.

Grant facility for financing project development costs

- The development of solar cold room projects does not only require competency, understanding for project business and patience but also capital for financing the required human resources and travel costs.

Subsidization scheme

- Systems costs of solar cold rooms are generally still high since the market is still at an infant stage. Subsidies are legitimate if there are no economies of scale.
- Effective demo projects need to provide evidence about extent of subsidy as basis for the discussion with governments.

Involvement of finance sector

- Local suppliers or rather distributors face high working capital needs in case of providing the solar cold rooms on basis of supplier credits or leasing schemes, and therefore they need loans.
- Banks can only be mobilized if the profitability of solar cold rooms is proven, and evidence is properly documented. They need to be trained/sensitized to ensure that risks can be properly analyzed. This is the concept of credit appraisal.

4.2 Next steps

The session was facilitated by Eng. Isaiah Omolo who stressed that the workshop was a springboard for collaborative discussions, knowledge exchange and stakeholders' learning hence the momentum and developments in the cold chain should not be kept abreast. Similar workshops and meetings will be organized soon on cold chain and cooling to continue the conversation. These include:

- A similar workshop in June 2024 that will include some participants of this workshop.
- An EIA energy conference to be held later in the year on opportunities in the cold chain ecosystem.
- The 8th Global Off-Grid Solar Forum and Expo 2024 will be held at the Kenyatta International Conference Centre in Nairobi, Kenya, from 8 to 10 October, co-hosted by GOGLA, the association for the off-grid solar industry, the Government of Kenya and the World Bank's Lighting Global Program.

Eng. Omolo also emphasized the need for more partnerships to carry out demonstrations on efficiency of cold chain systems. However, he stated that, there is a risk if too much focus goes to technology without considering integration of farmers as key actors in the value chains. There's thus a need to enhance farmer capacity on quality production that can meet standards for high-end markets, as well as enhance inclusive empowerment for all farmer groups (women, men, youth, marginalized and persons living with disabilities)

In the spirit of building stakeholders' capacity on cold chain systems, it was stated that ACTS in collaboration with ACES, academic and industry partners were planning to conduct a fully sponsored inaugural 'Foundation course in cold and sustainable cooling business models. The aim is to: i) provide participants with a solid and comprehensive understanding of fundamental concepts, skills, and knowledge within the food and pharma cold chains, and ii) serve as a building block, preparing individuals for more advanced and specialized studies or practical applications.

5 Closing remarks

Catherine Kinyanjui of the Ministry of Agriculture and Livestock Development facilitated this session. She stated that the Kenya government's development goals in the agricultural sector were to ensure food security, improved incomes, job creation and sustainable development. However the government has not been able to achieve these goals due to a myriad challenges including prevalence of pests and diseases, high cost of production as most farm inputs are not affordable to farmers, low adoption of modern technologies–appropriateness and cost, low productivity, effects of climate change (including unreliable rainfall), structure of production–small scale, seasonal fluctuation, disaggregated, poor infrastructure, energy/powering sources and food losses.

Thus, the World Bank's commissioned study on the 'Diagnostic of the current situation of cold chain infrastructure and needs in Kenya' was timely to spur achievement of the agriculture sector goals. The study showed that some value chains such as dairy, meats and chicken, and horticulture require cold chain systems. Factors to consider when advocating cold chain investments include addressing the concerns of producers and consumers, cost of production, postharvest losses, and pricing of produce.

She commended participants for engaging collaboratively on the various aspects that can catalyse CCI adoption as a potential solution to address food loss, and for the insights and key messages that will foster integration, utilization and adoption of sustainable cold chain solutions in Kenya.

Various approaches—holistic, ecosystem-based, collaborative (communities of practice) and the 4Ps (Purpose, Perspective, Position, Priority)— should be explored. The stakeholders in the CCI space should establish a common platform to continue with the discussions on CCI to strengthen partnerships and linkages. There is also needed to build capacity of consumers and farmers on best practices associated with cold chain technologies and innovations.

For more photos taken during the workshop visit

https://tinyurl.com/3w9xck2w

(credit Yvonne Gitu)

Annexes

Annex 1: Agenda

Time	Activity	Facilitator
Session Chair:	**Judy Amadiva**	
8.00–8.30 am	Arrival and registration	Margaret M – ACTS/ Young Professional–NAVCDP
8.30–8.40 am	Welcome & Introductions	Dorcas Kalele, ACTS
8.40– 8.45 am	Workshop objectives	Annastacia Kivuva, NAVCDP
8.45– 9.30 am	Welcome & Opening remarks	ACTS – Prof. Tom Ogada, CEO NAVCDP – Dr. Samuel Guto, NPC FSRP – Priscilla Muiruri, NPC Agriculture Caucus – Dr. Kiplimo Lagat World Bank – James Musinga, TTL State Department for Crop Development – Mr. Douglas K. Kangi, Director of Crop Resources
9.30–10.15 am	Kenyan Report: Diagnostic of the current situation of cold chain infrastructure and needs in Kenya	Dr John Mburu, World Bank
10.15–11.15 am	Feedback & Responses on the Kenyan Report	Michael Njuguna, World Bank
11.15–11.45 am	**Photo Session and Health Break**	
11.45–12.15 pm	ACES and Kenya SPOKE Model	Catherine Kilelu, ACTS
12.15–13.15 pm	Panel discussion (Industry players) Current trends, barriers, and opportunities for market transformation (Q & A)	Annastacia Kivuva, NAVCDP
13.15–14.00 pm	**Lunch Break**	
Session Chair: Isaiah Omolo		
14.00–15.00 pm	Panel discussion (Development partners): Considerations for investment in cooling and cold chain in smallholder systems Kenya–Technical and business models (Q & A)	Catherine Kilelu, ACTS
15.00–15.30 pm	Moving from Dialogue to Action–Best Practices	Leo Blyth, ESMAP
15.30–16.00 pm	Moving from Dialogue to Action–Next Steps	Isaiah Omolo, ACTS
16.00–16.30 pm	Closing remarks	Dr. Samuel Guto, NAVCDP Mr. Elmi Bishar, Director, Livestock Development
16.30 pm	**Health Break & Departure**	

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