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CLEAN & SUSTAINABLE AGRICULTURAL COLD CHAIN POLICY BRIEF

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Developing a sustainable agricultural cold chain ecosystem in Kenya

Policy Brief
2024

This policy brief is based on the report, 'Diagnostic of the Current Situation of Cold Chain Infrastructure (CCI) and Needs in Kenya', developed by the World Bank Kenya Office through a collaboration with World Bank ASCENT (Accelerating Sustainable Clean Energy Access Transformation) Program and ESMAP's Efficient Clean Cooling Program, and proceedings of a stakeholders' workshop on 'Diagnostics, Opportunities, and Challenges in Sustainable Cold Chain Development in Kenya'. The workshop was organized by the Ministry of Agriculture & Livestock Development and the African Centre for Technology Studies (ACTS), in March 2024, where the report was presented. The brief summarizes important policy recommendations drawn after extensive literature review and interviews with stakeholders in the cold chain and cooling ecosystem; private sector actors, farmer organizations, national and county government representatives, research and academic institutions, and development partners. The brief, therefore, clearly delineates the current situation of the agricultural cold chain sector, the direction and expected positioning in the coming decade, and strategic resources and capacities needed to enable the country to achieve the expected milestones.

Problem setting: There are great potential impacts from effective cold chain investments, while uptake has remained low and impacts limited

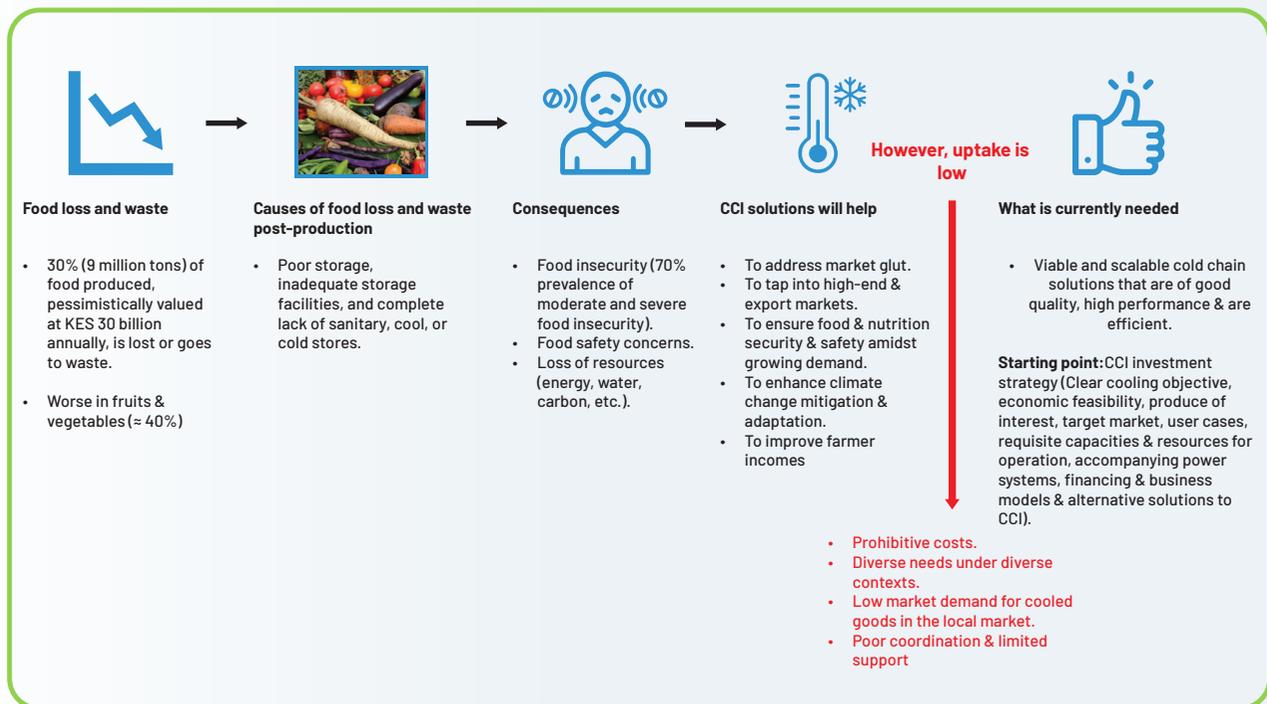


Figure 1: The need for cold chain solutions and enhancement of uptake

Exploitation of cold chain solutions is one such effort aimed at alleviating food loss and waste, mostly for highly perishable produce such as fish, dairy products and meat, and to some extent fruits and vegetable value chains. Besides, CCI generates other multiple benefits, including food safety and quality assurance, attracting premium prices and facilitating participation in export and high-end markets, addressing market gluts and, hence stabilizing market prices as well as contributing to climate change mitigation and adaptation.

The current CCI is mainly on-grid dependent, relying mainly on electricity. As a result, high power bills affect effective operations of CCI, which still typically requires a diesel generator (which is costly to run and provides ‘dirty’ energy) to provide continuous power as “back-up” due to the common occurrence of power shortages within the country. However, the emergence of off-grid renewable power solutions, especially solar-powered CCI, offers a promising avenue to reduce power costs, relative to grid-powered CCI, increase CCI adoption in far-flung areas, and promote environmentally-sustainable practices.

Key background facts

Increasingly, the need for investment in cold chain solutions is being acknowledged as one of the strategies to store nutritious food, extend shelf-life, alleviate food loss and waste, ensure food safety and quality, facilitate participation in export and high-end national markets, address market gluts, and stabilize market prices as well as contribute to climate change mitigation and adaptation. Market projections support this fact. There is substantial growth potential, with current CCI market values expected to double by 2030. For instance, the current CCI market value of fruits and vegetables (US\$ 511) is likely to reach US\$ 1 billion by 2030 (EforA, 2023; Mburu et al., 2024).

Demand for CCI in the country is mainly driven by increasing demand for fruits, vegetables, dairy and meat, attributed to population growth, urbanization, improved incomes and changing consumer behaviour (Figure 2).

However, cold chain infrastructure development in the country is nascent. Although the dairy sector has had significant investments in CCI by the national government and development partners with majority of dairy cooperatives equipped with coolers and chillers in many counties, not all smallholder farmers (SHFs) are served, especially in remote locations mainly due to lack of on-grid electricity connections. Besides, investments in CCI for the

fruits and vegetables industry are mainly concentrated on export produce and large retail chains targeting profitable markets. As such, only less than 5% of small-scale farmers, including those who cool fruits and vegetables for export, are served with CCI.

Notably, there is need for a clear demonstration of CCI entry point in cognizance of the other post-harvest strategies that address food loss and waste (fast delivery to packhouses and markets, drying, processing, greenhouse farming, etc.). Determining where and when to invest in CCI will strategically help actors address specific niche markets to realize positive returns on investments.

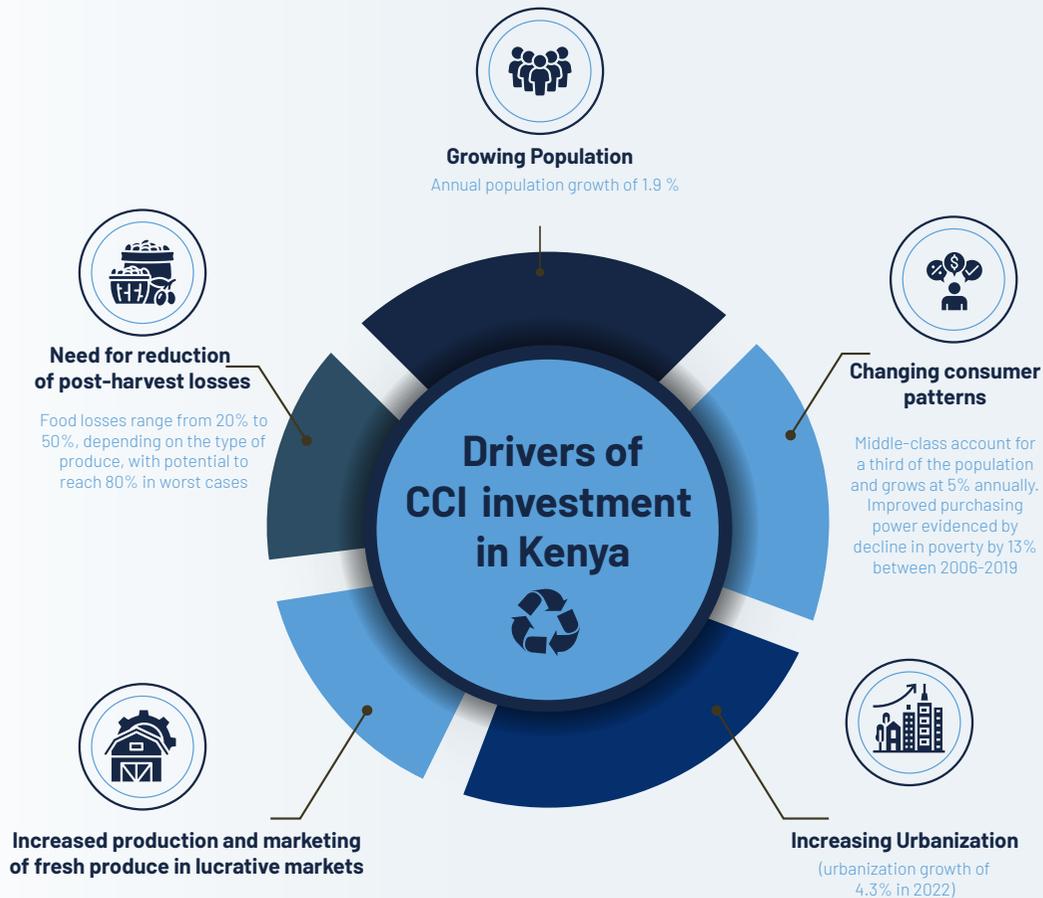


Figure 2: Drivers of cold chain investments and utilization in Kenya.

Therefore, rural area population, particularly smallholder farmers who produce most of the agricultural products, are underserved with CCI (only 5% are served). Further, the dominance of warm meat value chain curtails CCI development making this value chain the least developed in terms of CCI among the highly perishable commodities.

Although CCI investments in Kenya are at their early developmental stages, significant opportunities for growth exist. The future is promising and requires innovative business and

financing models, inclusion of all relevant value chain actors including women, enabling policy environment, innovative CCI solutions tailored to user contexts and need, investment in capacity building and continued interest among the diverse stakeholders to invest in CCI.

Why investments in CCI?

Both quantitative and qualitative food loss and waste (FLW) affect food safety and quality, leads to decreased market opportunities and incomes for smallholder farmers and, contributes to loss of production resources – energy, water and

land, hence resulting in increased greenhouse gases (GHG) emissions per unit of food produced. These challenges are prevalent in Kenya and other developing countries, due to, among other factors, poor storage, inadequate or non-existent storage facilities, and complete lack of cold stores. Therefore, in the recent past there has been increased interest in CCI investments (Figure 3) as one of the pathways to address these challenges.

Averting food loss and waste: Investments in CCI have the potential to reduce Kenya's 30 percent of food that is lost annually by up to 50 percent (World Bank, 2023). The critical loss points are during harvesting, storage, transportation (long distances between farms and distribution points), processing, packaging and marketing. Any successful CCI intervention would emphasize targeting these critical stages or points to have the highest positive impact. The worst hit sectors are fruits and vegetables where losses can rise as high as 40 percent. Investments in CCI could avert FLW and, therefore, reduce the number of households experiencing periodical food shortages in the country.

Food quality and safety: Food standards are essential to protect consumers from illness. CCI is essential for maintaining the quality and safety of perishable products, from farm to

fork (see the '*Cooling Atlas*'). This is important considering the changing consumption behaviour with consumers demanding fresh, safe and healthier food options. Growing urbanization is also fueling demand for well-functioning cold chains for their daily food supplies. Urban households tend to spend more money on food than rural households and their food preferences have been changing from grains to more animal-based proteins like meat and dairy products, fruits and processed foods that require cooling.

Price stabilization and income increase: Effective CCI can stabilize prices, reduce delivery delays and rejections, address market surplus and gluts, and ensure food security by mitigating seasonal shortages.

Climate change adaptation and mitigation: CCIs are avenues for ensuring efficient and sustainable energy utilization. Thus, sustainable CCI will support smallholder farmers' adaptation and mitigation measures to climate change. Adoption of passive cooling technologies, high energy efficient cooling appliances and phasing out of Global Warming Potential (GWP) refrigerants (set out in the Kigali Amendment to the Montreal Protocol) are some of the ways CCI could further contribute to climate change mitigation.



Figure 3: Some of the CCI adopted in Kenya

Snapshot of the cold chain ecosystem in Kenya



‘An ecosystem is needed to foster sustainable cold chains that deliver on food security, revenue generation & climate resilience goals (Figure 4).

Current state of CCI: The cold chain infrastructure in Kenya is vastly under-developed. The exceptions are the upmarket retail outlets and high-value horticulture and flower export-oriented businesses that have advanced cold chain systems. Advancement of CCI investments in this niche is attributed to the stringent ‘demand-pull’ requirements that local actors have to comply with to partake in this market. The country, particularly, has very strict food quality and safety standards in the export market. Although some smallholder farmers have invested in low-cost CCI such as ambient stores and charcoal coolers to avert losses, their participation in cold chains is very low; less than 5% even after considering those who cool vegetables for export at the first mile.



Figure 4: A holistic approach needed for the development of sustainable cold chains (adapted from ESMAP)

Besides the export business, the dairy sector has relatively advanced cold chain and cooling systems (milk coolers, chillers and cooling tanks), and milk producers and handlers are aware of the benefits. The sector is characterized by huge investments in CCI by the national and county governments and development partners.

As a result, the majority of dairy cooperatives, which play the role of aggregating and marketing milk for smallholder farmers (SHFs), are equipped with coolers and chillers in many counties. Nonetheless, not all SHFs are served with CCI. Those in remote locations are most affected due to lack of electricity connections.

The expansion of the dairy industry into the arid and semi-arid lands (ASALs), comprising both cattle and camel milk, has also seen expansion of CCI investments to these areas, though to a much lesser extent. Nevertheless, optimization of utilization of existing CCI in this sector is critical for enhancing milk cooling at the first mile.

Consumer awareness: The high-end consumers in urban areas are aware of the health benefits of fresh and safe produce. However, there is limited demand for cooled products among most rural and low-income urban dwellers. Consumers buy perishable produce at farm gate or from nearby markets (where prices are low),

or from the informal market in the case of milk. Therefore, there is limited demand for ‘fresh products’ in low-income urban areas and rural areas. Moreover, there is prevalence of a ‘warm’ meat chain in the country.

Funding by government and development partners: The current public funding of CCI is low and focused in fruits and vegetables, and meat value chains. In the counties, most County Integrated Development Plans (CIDPs) do not budget for cold storage of agricultural produce, except for milk. There is also uncoordinated funding. This has led to over funding of dairy in some first mile areas while others experience CCI shortages.

Development partners have demonstrated goodwill in supporting investments in CCI that make use of renewable and alternative energy, developing standards for CCI, building capacity of farmers to ensure efficient cooling, and providing cooling solutions using various financing models. However, funding has been limited to pilots and studies have shown a significant amount of these have resulted in under performance (in some cases ‘white elephants’) or lack of use in a large number of cases (Oosteweche, et al., 2022).

Policies and regulations: Policies and regulations, which could potentially facilitate development of CCI in the country, are found in several sectors – trade, food and agriculture, environment, infrastructure development, tax and finance, energy, and public engagement. However, these policies have not integrated or do not explicitly mention CCI in agricultural value chains. Worse still, most counties have not incorporated CCI into their CIDPs.

Business and financing models: Several business models are in use and : upfront purchase, pay-as-you-store, exporter-cooperative, donor/government-funded, cooperative-private company, third party logistic service provision, project-cooperative, and pay-as-you-go lease models. The performance of these models is hinged on their design elements. Where they have integrated market linkages, the models are working well, providing return on investment (ROI) to farmers and other actors. However, the government or donor funded model is transitive with sub-optimal performance of cooperatives after withdrawal of government support. Cooling as a Service is an emerging and affordable business model that allows users who are unable to self-finance and own CCI to access cooling services. The model is attractive at the first mile as farmers pay to cool produce according to their needs, e.g., based on the quantities and time they would like to store. The financing models include grant, government, climate and subsidy financing; upfront purchase through own financing; and credit financing (lease to own model, sale lease-back model, etc.).

Need for CCI investment analyses

A well-thought-out CCI investment strategy forms the basis for successful utilization of cold chain solutions. A clear cooling objective must be set out and economic viability assessed in view of the intended ‘use case’, including the produce of interest, target market and end-users. The CCI investment objectives are diverse – reducing post-harvest losses, attaining food security, addressing food safety concerns,

ensuring produce quality or meeting sustainability goals. In some cases, cooling may be an immediate need and in others it may be needed later in the value chain or it may not be necessary. Further, cooling needs may be influenced by local contexts from climate to energy sources, road infrastructure, consumer behaviour and production volumes. These dynamics imply the need to think critically beforehand when investing in CCI. Understanding these dynamics is integral for realization of successful and sustainable cold chain investments in the country.

The Case of community cooling hub model

The Africa Centre of Excellence for Sustainable Cooling and Cold Chain (ACES) is pioneering the use of cold chains with smallholder farmers through the Community cooling hub model. This initiative aims to provide sustainable cooling solutions to preserve both food and health, which simultaneously protects the quality and safety of food, 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 model aims to enable farmers and companies to deploy sustainable cold chain solutions at scale with fit-for-market technologies accompanied by robust business models. As ACES implementing partner, the African Centre for Technology Studies (ACTS) in Kenya is piloting the model in Lari Sub-County, in Kiambu County, working in collaboration with smallholder dairy and horticultural farmers. The collaboration will pilot and demonstrate a financeable business model for deploying sustainable cold chain technologies to enable aggregation of horticultural produce through a community cooling hub. The Sub-County is a key food basket for local and distant urban markets in Nairobi and Mombasa and has export opportunities that have not yet been realized.

Strategies, policies and actions to catalyze CCI development in Kenya

Develop inclusive policies and strategies: Already the country has the very useful National Cooling Action Plan (NCAP). However, coalescing the several policies spread in the different sectors – energy, agriculture, environment, into a single CCI legal and policy framework or entrenching CCI into

them would further improve the environment for the public and private sectors to develop and invest in CCI in the country. This could involve integrating cooling access with energy access, economic development and climate change policies and plans. Further, a CCI strategy or framework within the agriculture sector is needed to guide CCI investments in the country. The framework should provide a clear guide to determine the business case for CCI investments amidst other competing post-harvest handling strategies. It is also imperative for development of regulations, standards and quality assurance for cooling appliances. Moreover, strategic research is required to drive cooling in some agricultural

value chains. For instance, breeding efforts towards improvement of dormancy of existing Irish potato varieties, including the popular shangi variety, will be needed to help reap cold storage benefits in this value chain.

A systems thinking approach to cold chain development is critical: A holistic approach is needed that brings together academia and research bodies, different disciplines, development finance, research and development, development partners, the public and private sectors, policy makers, farmers, youth, women, the formal and informal sectors and local partnerships in the cooling ecosystem.

These should be engaged to create appropriate, efficient and cost-effective cold chain systems.

Developing a business case for smallholder farmers: This calls for concentrating on increasing production and growing sales including exports. This will give impetus for service providers to bring CCI investments to under-served smallholder farmers at the first mile. Furthermore, the presence of a footprint of past CCI investments at the first mile offers opportunities and incentives for adoption of cold chain technologies among potential CCI users that have not been reached.

A Walk Through

1. Current losses in different value chains



2. Current installed capacity and value added through cooling

Value chain	Estimated CCI installed capacity	Unit of measurement	CCI value added in billion KES
Avocado	298	MT	4.03
Banana	1,779	M3	8.49
Mango	501	MT	5.20
Tomatoes	2,973	M3	5.90
Iris Potato	420	MT	6.00
ALVs and garden pea	999	MT	2.07
Red meat	13,000	M3	45.0
Chicken	78	M3	9.62
Dairy	73,500	M3	0.10

3. Possible sustainable cooling solutions adopted at the first mile.



Refrigerated pre-chillers for milk collection

- Reduced milk losses since it is mobile.
- Low-cost innovation – using car batteries.
- Enhance coverage and reduce farmers' travel distances



Heat plate exchanger milk coolers

- Uses solar to make ice-for high-temperature areas with no electricity.
- The heat exchanger helps in temperature regulation with no quality effect on milk.



Zero-energy ambient stores

- Natural wind, no energy cost.
- Ambient stores increasing potato shelf life up to 2 months.
- e.g., for Irish potato in Nyandarua, Meru, and Nakuru counties.



Off-grid (solar-powered) evaporative coolers

- Uses solar – low maintenance costs.
- Application in mango and tomato value chains.
- Low-cost technology using locally available materials.



Solar-powered container (walk-in) cold rooms

- Uses solar – low maintenance costs.
- Application in French beans, mango, ALVs, and garden peas.
- Uses ice – improves sustainability and no need for power backup.

Scaling existing viable finance and business models: While there is always a role for innovation of new approaches, it is imperative to identify and build on existing viable finance and business models to ensure a swift roll-out and uptake of CCI investments. In particular, the cooperative-private company and farmer producer group/cooperative-exporter models are likely to have positive impacts in CCI investments in agricultural value chains in the first mile stage. The government should provide incentives for innovative models and upscale those tried and have worked. The models should also be restructured to integrate sustainability and mechanisms devised to align financing to specific CCI requirements based on demand across different user segments and needs. Measures such as 'green' credit, blended financing mechanisms, leveraging climate finance facilities, warehouse financing models, among others, form some of the opportunities that could be explored.

Incentivize sustainable solutions: This will entail promoting innovative, appropriate, cost-effective and sustainable technologies like solar-powered cooling systems. Green energy solutions such as solar-powered cooling systems are most likely to be suitable for smallholder farmer groups as they can provide cost-effective access to energy in remote off-grid areas. Besides, they can also provide on-grid farmers with affordable back-up solutions when grid power is unreliable. These off-grid walk-in cold rooms, chillers, refrigerators and freezers for smallholder farmers are market-ready but require scale up and cost reduction due to high initial cost (CAPEX) and lack of access to affordable finance for the target

groups. Innovations and investments in off-grid solutions such as solar-powered CCI would thus require public or donor-funded incentives to enhance uptake and meet local demand. The incentives would include import subsidies, tax regulations, and appropriate levels of subsidies to help bridge access.

Establish/strengthen stakeholders' coordination mechanism: This could be achieved through formation of a stakeholders' association or strengthening existing ones. Such an association should have capacities to gather data, facilitate actor interactions and track CCI investments by different actors. This would contribute to enhanced collaboration among national and county governments, the private sector, and non-state actors. The coordination mechanism would also leverage the various synergies that are required to achieve a holistic approach for cold solutions with greater impacts in the country.

Create awareness, improve knowledge and training, and enhance compliance with standards: Awareness campaigns targeted at CCI actors across all levels will stimulate demand while improving farmers' understanding of operation dynamics including matching supplied volumes with cooling capacity, and ensuring starting quality and compliance with food safety standards. This will ultimately enhance operational efficiency of installed CCI infrastructure. It is, therefore, imperative to provide training on CCI management - design, installation, operation and maintenance of CCI for effective and efficient operations, and sustainable CCI development. Additionally, to stimulate CCI investments in certain agricul-

tural value chains, it is important to enforce food safety regulations. This would include, for example, limiting live slaughter of livestock, particularly poultry in urban markets, which not only raises food safety concerns but also curtails development of CCI.

Adapt interventions to specific geographic and socio-economic conditions: There is no one-size-fits-all CCI. Therefore, there is need to conduct adaptive research on what works in different areas and implement locally tested innovations. This could create an understanding of appropriate business models for the different users as well as marketing arrangements that support sustenance of CCI investments. Local innovations could range from the establishment of simple aggregation centers and productive use of renewable energy ‘agro-industrial hubs’, particularly at the village level, to selecting climate-friendly refrigerants and integrating passive solutions based on indigenous knowledge. The country could also learn from other developing countries, such as India, and adopt existing tried-and-tested practices of improving storage and preservation of agricultural produce at the first mile.

Socially inclusive CCI investments: There is need to invest in pro-rural, pro-poor cold chain infrastructure. Importantly, addressing gender-based barriers can help promote gender equity in CCI development by leveraging women’s opportunities and unique skills in critical value chains such as African Leafy Vegetables, chicken and dairy among pastoral communities. In particular, women need to be allocated specific roles in CCI activities across

various nodes of the value chains where they are more productive. The activities include cleaning, sorting, grading, and packaging, which can motivate women engagement in CCI operations. It would also be important to target and foster women-friendly CCI investments, such as ambient stores.

Bottlenecks to be addressed to unlock development of CCI at the first mile

Several technical, economic, institutional and governance challenges hinder the development of sustainable CCI at the first mile (Figure 5). The major challenge is the high cost of acquiring and installing CCI, which has made affordability become a prominent barrier for uptake at the first mile. Other challenges include high costs of operating and maintaining CCI, inadequate technical capacity for installation, operation and maintenance of CCI (see Walk-In Cold Rooms, a Practitioner’s Technical Guide - Efficiency for Access), avoiding poor equipment quality, etc. (Figure 5). These impediments hinder upscaling of CCI to serve first mile smallholder farmers across value chains. It is, therefore, imperative to build technical, economic, institutional and governance capacities in the country to ensure optimal uptake and effective management of CCI at the first mile. It is particularly important to emphasize that availing CCI to smallholder farmers is not enough if the efforts are not accompanied with well-structured investments in building the other capacities. This would avoid failure that can lead to ‘white elephants’ and, therefore, loss of resources.

Figure 5: Barriers to uptake of CCI at the first mile.



Conclusions

A well-organized, collaborative approach is needed to develop and scale sustainable cold chain solutions in Kenya. The outlook for having sustainable cold chain solutions in the country is promising though currently CCI development is at a nascent stage and uptake at the first mile has been low. For successful implementation of cold chain solutions, a multi-year programmatic approach must be followed, based on careful consideration of a wide array of 'enabling ecosystem consideration' of factors, since every product-market combination requires a different approach. This has not been happening in the country to date.

Currently, there are insufficient, uncoordinated and often unviable efforts being undertaken in an effort to promote CCI uptake. Consequently, the fragmented interventions fail to lay the required foundations and leverage the various synergies that are required to achieve a holistic approach for cold solutions in order to serve smallholder farmers at the first mile. In particular, development partners and government projects (including National Agricultural Value Chains Development Project (NAVCDP) and Food Systems Resilience Program (FSRP)) that are investing significantly in CCI need to first define the principal goals of their interventions and rely on bankable investment analyses to avoid wastage that would arise if the country ended up with 'white elephants'.

Despite the presence of several impediments to growth, the cold chain ecosystem in the country is ripe for advancement. There is a rising interest in investments in CCI from both the demand and supply sides. Consequently, the future of CCI investments appears bright if it follows a path of successfully developing and leveraging viable innovative business and financing models that address CCI needs at both the downstream and upstream levels of the agro-supply chains. It is expected that such investments will play a substantial role in reducing food losses and waste, thereby enhancing food security, improving livelihoods, and contributing to climate change mitigation and adaptation.

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