

Learning Brief

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Potential impact of cooling technologies on the fish value chain

Insights from Keep IT Cool's experience in Kenya



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Executive Summary

The fish value chain is a source of livelihoods for many Kenyans, but its growth potential is limited by high post-harvest losses. A key reason for post-harvest fish loss is Kenya's lack of food cold chain infrastructure, which is constrained by a limited access to electricity. Based on the experience of Keep IT Cool (KIC), a social enterprise that facilitates trading of fish through shared cold chain transportation and solar back-up cooler boxes, this report looks at the potential impact that cold chain technology can have on small-scale fish retailers and fisherfolk in Kenya.

By qualitatively analysing key informant statements and quantitative analysis of KIC marketing data, the study finds the following benefits for a range of stakeholders:

- **Fish Retailers:** KIC's refrigerated trucks prevent fish from deteriorating during transportation. This enables retailers to access higher quality fish supplies, which allows them to charge a premium. This impact on price is amplified by their improved access to reliable cold storage provided by the cooler boxes, which further reduces post-harvest quality losses. What is more, the solar-power nature of KIC's cooler boxes has the potential to reduce energy expenses as compared to alternative sources of energy, further contributing to increasing profitability.
- **Fisherfolk:** As the fish is sold in the market at a higher price, fisherfolk are in turn able to sell their production at a higher price, KSH 10 (USD 0.09) superior to other off-takers. The competitiveness of the business model also allowed KIC to provide the cooperative with better trading terms such as upfront cash payments and guaranteed offtake, which improves fisherfolk's liquidity and stability of demand. As for retailers, solar technology has the potential to improve reliability of cold storage, which will further reduce post-harvest losses and empower fisherfolk. KIC thus intends to develop a first-mile cold storage aggregation facility.

The success of KIC's business model despite the tough economic climate suggests that with the recovery of economic activities, many more retailers, including hotels or restaurants, are likely to join the platform, and demand for cooling-as-a-service is likely to increase. KIC will thus have to adapt its business model to scale, not only to provide cold storage to first-mile customers, but also to cost effectively increase the supplier base, and expand geographically.

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1 Introduction

Post-harvest fish losses refer to the decline in quality and quantity of fish after harvest and can result from a multiplicity of factors. Indeed, fish is a delicate commodity, and its quality starts deteriorating immediately after harvest if it is not stored in specified conditions. This decreases the availability of nutritional food and leads to economic losses for actors involved in the value chain (Tesfay and Teferi, 2017). Collectively, the phenomenon of post-harvest losses poses an impediment to the achievement of Sustainable Development Goals (SDGs) 1, 2 and 12 to end poverty and hunger and ensure sustainable consumption and production patterns.

In Kenya, post-harvest losses occur at every level of the fish value chain and are known to decrease the quality of food available to consumers, while maintaining small-scale fisherfolk, who account for most of the inland fish landings in Kenya, in persistent poverty (Odoli et al, 2019). Key factors for these losses include poor handling practices, hygiene and sanitation, but also failure to reaching markets within the fish's shelf-life.

Cold chain technology thus has the potential to address this issue by extending the shelf-life of fish. Set up in early 2020 and operating under the trading name "Keep IT Cool" (KIC), Raino Tech4Impact is a social enterprise that aims to address post-harvest losses in Kenya through an inclusive business model powered by decentralised cold chain capable of working in off-grid, weak-grid and on-grid areas using solar power or solar powered batteries. With support from Shell Foundation, KIC has been testing a blended cooling-as-a-service model with fisherfolks to lower the cold chain access barriers for small scale fisherfolks. Based on KIC's experience, this report aims to draw insights on how access to off-grid cooling can increase financial outcomes for both fish retailers and small-scale fisherfolk.

1.1 Context

The fish value chain is a source of livelihoods for many Kenyans. Indeed, the country produced 149,700 metric tonnes of fish with an estimated value of USD 237,000 in the year 2020, with the fisheries sector contributing to 0.6% of the GDP (KNBS, 2021). Fish is obtained from fresh water and marine sources, with the former accounting for an estimated 80% of total landings (Obiero, Munguti, Ogello, Njiru & Hagiwara, 2021). The number of people directly employed remains modest: the Kenya Marine and Fisheries Research Institute (KMFRI) estimates that the fisheries sub-sector directly employs 500,000 people, and the Kenya Population and Housing Census of 2019 indicates that there is a total of 138,965 households (about 1% of households) engaged in aquaculture and fishing activities (KNBS, 2019). However, the fish value chain is a source of income for many more, since it is estimated to create indirect economic opportunities for two million people, including traders, retailers, processors, merchant of fishing accessories and providers of related services (KMFRI, 2017).

But the industry's growth potential is still unfulfilled and could unlock further economic opportunities. The fisheries sector contribution to the country's GDP, which amounted to 0.6% in 2020, has been stagnating over the past decade. (KNBS, 2021). Still, the annual fisheries potential in Kenya could be up to 300,000 metric tonnes (Obiero et al., 2021), implying that the sector is still operating below its capacity. Although fish is one of the major sources of protein diet in Kenya, the per capita fish consumption is still low (estimated at 4.5kg/year in 2020), compared to the 2010 estimated world average of 18.6 kg/year (Ochiewo et al, 2021). This means that the fish value chain has the potential to create further livelihood opportunities and jobs.

However, post-harvest losses are an obstacle to the growth of the Kenyan fish industry. KMFRI identified post-harvest losses as one of the key challenges faced by the sector (KMFRI, 2018). This includes both physical losses, which refer to a reduction in quantity of fish due to spoilage such as rotting, and deterioration in the quality of the fish, which both result in lower monetary value. However, a survey of Sub-Saharan economies including Kenya found that quality losses made up the majority (70%) of post-harvest losses (Akande & Diei-Ouadi, 2010). Both physical and quality post-harvest fish losses in Kenya vary with seasons due to biological and weather factors, making it hard to estimate the overall level of losses. For instance, sardine fish traders in Kenya recorded physical losses of up to 7.5% during the rainy season, while fresh tilapia traders and gillnet fisheries estimated quality losses to amount to 27-28%. Elsewhere, KMFRI estimated post-harvest losses (physical, quality and market forces) in Lake Turkana fisheries (Northern Kenya) at 35%.

A key reason for post-harvest fish loss is Kenya's lack of food cold chain infrastructure, which is constrained by a limited access to electricity. A food cold chain is an integrated set of activities that ensure perishable or temperature-sensitive food products are kept at optimum temperature from first-mile (harvesting) to last-mile (delivery to consumption) points. It includes the packing and cooling of fresh produce and the freezing of processed foods for long or short-term storage, and the transportation and distribution of produce under controlled temperatures. Kenya's general shortage of cold chain facilities and services is documented in the Fisheries and Blue Economy National Development Sector Plan (Republic of Kenya, 2018), and disproportionately impacts small scale fisherfolk, who are most likely to lack the standard fish handling infrastructure and information.

Indeed, access to cooling in fish landing sites, which provide small-scale fisherfolk with a first point of sale, is negligible. According to Odoli et al (2019), there are 557 documented fish landing sites in Kenya, the majority of which (61%) are located around Lake Victoria. Only 25 Kenyan landing sites (4%) have cold rooms installed, of which only two can be used for storage. Only 13% have got ice availability, and 20% access to electricity supply. The proportion of landing sites with any cold handling facilities is insufficient given the large number of small-scale fishing enterprises estimated at 14,000 by the Kenya Marine and Fisheries Research Institute (2018). In addition, even where cooling facilities are available, un-reliable grid power supply leads to disruption in cooling services due to lack of power back-ups. Indeed, the national electric grid in Kenya is overloaded, resulting in frequent and sometimes long interruptions in electricity. World Bank (2018) states that 83 percent of enterprises in Kenya experience power outages, quantifying the average frequency of the outage at 4 outages per week.

Similarly, there is a lack of cold chain transport serving domestic markets, with fish cold chain facilities only limited to produce destined to international markets due to strict phytosanitary standards (Odoli et al, 2019). With prevailing long distances between main fishing grounds or farms and consumption hubs, there is need for cold chain infrastructure to facilitate distribution and marketing of fish in Kenya. Absence of such infrastructure makes it difficult to distribute harvested fish to retailers and consumers while maintaining standard quality.

1.2 Keep It Cool's business model

The lack of cold chain infrastructure provides an entry point for private sector investment to supplement the limited public investment in the sector. KIC has taken up this challenge and has established an integrated cold chain solution, fit for small-scale fish retailers. To do so, KIC signed an off-take agreement with Osera Cooperative, a small-scale fisherfolk association located in Homa Bay County, alongside Lake Victoria, and developed an online trading platform, which enables retailers spread across four counties (Nairobi, Kiambu, Machakos and Kajiado) covering the Nairobi Metropolitan Area to purchase the fish. The company then delivers the products to the retailers using its fleet of refrigerated and chilled trucks.

In addition, retailers can use KIC's storage solutions (KIC's hybrid solar back-up cooler boxes) to maintain fish products under controlled temperature even in the event of power outage at premise. The boxes come in different volumes to meet the varying needs of retailers and rented at between 500 and KSH 1000 (or about USD 4.50-9.0) per week depending on capacity.

Osera cooperative aggregates fish harvest from about 20 small-scale fisherfolk, and handles produce ranging from 7 to 20 tons a week depending on the catch season. KIC started transporting fish cargo from the cooperative in early 2020, collecting about 1.5 tons a week. Unfortunately, the market was quickly disrupted as the country was hit by the COVID-19 pandemic, which lowered demand for fish. Nevertheless, KIC's off-take capacity has since doubled to about 2.5 tons per week, as an increasing number of retailers are seeking its services. This trend is expected to continue as the economy recovers.

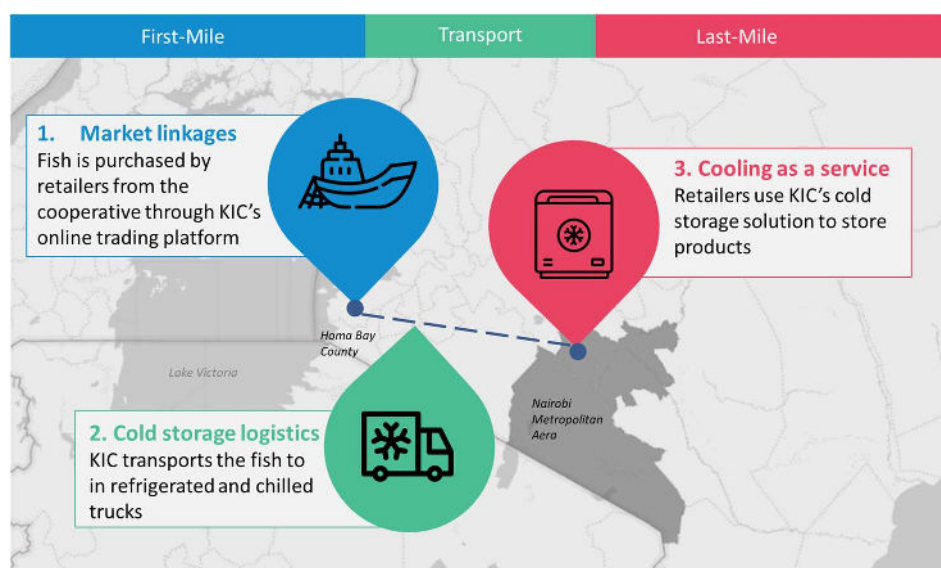


Figure 1: Keep It Cool's business model

2 Methodology

The objective of the study was to understand the potential impacts of investment in cold chain solutions serving small scale fisherfolk and fish retailers, using a case study of KIC. The key research question was:

To what extent does access to cooling solutions across the value chain result in (a) Increase in incomes for fisherfolk? (b) business growth of SMEs (fish retailers)?

Several data points have been collected:

- To assess the potential impact that KIC has on the fisherfolk through their cooperative, a key informant interview was conducted by the researcher with the manager of the cooperative. The answers were analysed to extract qualitative and quantitative information regarding the cooperative's status before and after entry of KIC.
- On the distribution point of the value chain, KIC had developed an initial marketing database of 148 retailers, from entry interviews they conducted in late 2019 on potential beneficiaries of cold chain services. A significant majority (60 percent) of these potential retailers that KIC approached were found to be retailing fish at time of entry, with the rest either having future prospects or completely disinterested in fish-retailing business. Based on this database, the researcher identified 43 retailers who consistently engaged with KIC and had shown interest in the KIC cool boxes. To assess the impact that use of cold chain has had on retailers of fish, marketing data was analysed. This provided a picture of the status of the fish retailers before they joined KIC.
- Further, to obtain a picture of the status of the 43 firms after engagement with KIC, a simple survey was conducted to collect 'after-entry' information that can be compared to what existed in the entry database. This mainly covers issues of inconveniences in procurement of fish, retail prices and stock maintained by retailers in the premises. The survey was administered by KIC sales representatives and supplemented with information on the 43 enterprises found on the KIC trading platform. To establish differences (naïve) regarding few attributes, a simple comparison of the before and after statuses was done using means and frequencies.

The project is only at an early stage, which is why the study does not attempt comprehensive impact assessment, but only to identify useful insights on the potential impact of KIC's business model. One limitation is that data on retailers' profitability was not collected in the initial market survey,

understandably due to the very nature of survey. There was no consideration of causal investigations in the initial data and a survey on the same could not be executed due to resource limitation. Lastly, the potential impact is masked by COVID-related economic disruptions, with enterprises slowly recovering from the lockdowns even at the time of this assessment.

3 Findings

The study enabled KIC to identify its model's potential to lead to business growth for retailers and improve economic opportunities for small-scale fisherfolk.

3.1 Cold chain logistics and access to solar-powered cold storage could lead to business growth among fish retailers

Cold storage services have the potential to lead to business growth among fish retailers by addressing a number of supply-chain related challenges. Among the active fish retailers surveyed, 67 percent reported facing a major supply-side challenge. As shown in [Figure 1](#), the most frequently cited issue was the unreliability of supply (36%), price fluctuation (25%), the long distance of fish supply points from retailers' premises (17%), and damaged stock loss (16%). These are impediments to earning potential and profitability of the fish-retailing enterprises, that KIC sought to turn around using innovative cold chain solutions.

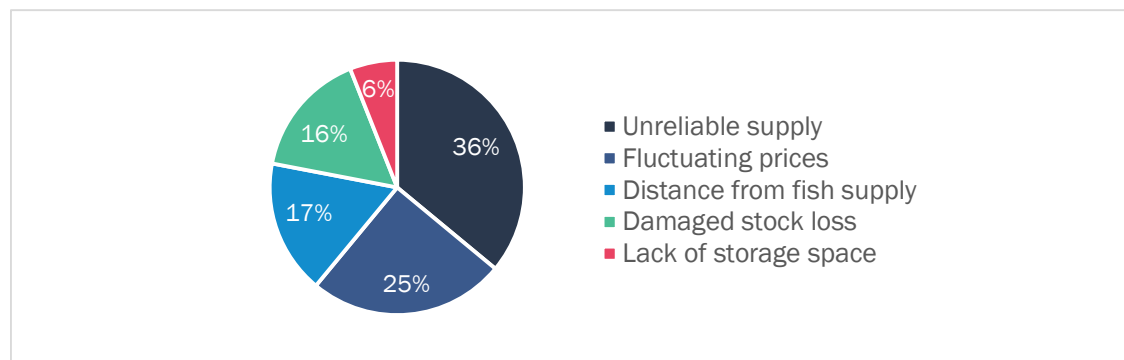


Figure 2: Supply-related challenges faced by fish retailers.

Indeed, cold chain services can enable retailers to sell fish at a higher price by preventing spoilage.

Deteriorated fish products fetch low prices in the market, occasioning post-harvest economic losses. Transportation and distribution in reliably powered cold facilities ensures that the produce reaches the seller in quality form, and the quality of the fresh produce supplied by KIC was cited by retailers as one of the reasons for becoming a customer. Further, the provision of KIC cool boxes ensures that the produce is maintained at ambient temperatures until the time of sale. While all retailers were connected to the national grid, about half (53%) expressed interest in having the KIC cooler box in their premises. This shows that solar-powered cold storage is perceived as a cost-effective solution to stock damage generated by power cuts. Indeed, KIC coolers come with a solar-powered back-up that activates upon grid power loss, which forestalls loss of stock quality due to deterioration of storage temperatures. The problem of damaged fish stock that was raised by fish retailers before joining KIC did not resurface in the after survey conducted to establish the status of enterprises. Enterprises that took up sourcing of fish on the KIC platform showed an increase in both the minimum and maximum sale price per kilogram of fish. The minimum price fetched increased from KSH 423 to 600 (USD 3.75-5.30) per kilogram, while the maximum price increased from KSH 430 to 800 (USD 3.80-7.0) per kilogram after joining KIC.

In addition, solar-powered solutions can reduce energy expenses. They constitute a more cost-effective alternative for retailers who used diesel-powered generators as back-up. The solar back-up cooler boxes are given free to the enterprises that sell more than 20kgs of fish per day, meaning that enterprises do not have to incur the initial capital cost of purchase. There are technically lower fuel costs associated with solar PV compared to diesel-generator back-ups once the initial investment capital has been

dispensed with (Babajide & Brito, 2021). Diesel and other petroleum products are expensive due to taxes and government interventions, with a litre retailing at KSH 110.6 (about USD 1) in October 2021 according to the Energy and Petroleum Authority. This is besides the attendant polluting cost of using diesel generators to the environment. Adoption of renewable-energy solutions like KIC solar-powered cooler boxes leased to retailers is thus not only essential in maintaining power supply for preservation of perishable stock, but also reduces attendant subsequent energy costs for business.

However, it is too early to assess the impact on business growth. Indeed, there is no clear trend in the size of fish orders by enterprises. While some factors are likely to be linked to individual farm characteristics, one known reason is that KIC has been operating within COVID-19 lockdown economic constraints. The constraints facing micro, small and medium enterprises (MSMEs) who form the base of KIC clientele range from decline in demand for their products and services, reduced turnover and cash flow problems (Feber & Buri, 2021). The demand for fish in the enterprises will only stabilize after an unknown lag because of reasonable micro-economic developments cited in the field. Fish is a premium¹ food product upcountry and has many competing proteins in the menu including beef, chicken, goat, pork, eggs (Obiero et al, 2019). As a result, the disruptions in incomes during COVID-19 lockdowns led to substitution of expensive fish with other cheaper food items in the eating habits of households as a coping mechanism (KNBS, 2021). The average size of the monthly orders placed on the KIC digital market platform ranged from 55-68kg, without a consistent pattern of increase or decrease. Return to work and business hours policies in Kenya was revised in late October, 2021² and there are prospects of increasing order sizes as the economy eventually goes back to full recovery.

3.2 Cold chain infrastructure could also improve economic opportunities for small-scale fisherfolk

KIC's cold storage services can also result in better economic opportunities for members of the cooperative by minimizing economic losses linked to post-harvest quality deterioration and instability of demand. Prior to their introduction, the fish was taken by traders, who would only pay fisherfolk after having sold the fish in their destination markets. However, the fish would usually be transported in unfavourable temperature and conditions, which would lead to deteriorations and yield lower prices for traders who would unilaterally renegotiate the price downwards. This would result in payment disputes between some fisherfolk cooperatives and off-takers amounting to millions of Kenya shillings. What is more, the cooperative's main buyers are small-scale retailers whose orders are often unpredictable. During the high catch season, off-takers without access to cold transport tend to maintain a given quantity of order and lower prices. Indeed, last-mile retailers are reluctant to hold large stocks, not only due to the lack of reliable cold storage, but also to the high risk of theft, which was cited by surveyed retailers as the main reason for not adopting KIC's cooler box. As a result, fisherfolk are forced to agree to throw-away prices.

By using refrigerated transportation, KIC enabled fisherfolk to unlock better payment terms. Indeed, KIC's refrigerated trucks have increased market linkages and stabilised offtake prices by decreasing post-harvest quality losses. They extend cold storage all the way to the retailer, ensuring that fish quality does not deteriorate during transport. As a result, the cooperative was able to obtain higher prices for their products, as compared to other off-takers. Indeed, the cooperative reported a difference of KSH 10 (USD 0.09) between the offtake price offered by KIC and that offered by other buyers. In addition, the competitiveness of this business model has enabled KIC to offer cash payments, when most local off-takers insist on credit terms, and to set up an offtake agreement. This guarantees the fisherfolk delivering produce to the cooperative prompt payment for their produce, thereby improving their liquidity, and ensures stability of the demand, therefore minimising economic losses occasioned by disposal of fish at throw-away prices during the high catch season.

¹ This does not include the Lake Victoria Sardine (Omena). Covers the main types of fish that KIC deals with: Tilapia and Nile Perch.

² <https://www.president.go.ke/2021/10/20/president-kenyatta-lifts-COVID-19-curfew-as-he-leads-nation-in-celebrating-mashujaa-day/>

In addition, solar-powered technology has the potential to increase fisherfolk's profits by improving their access to cold storage. Indeed, the cooperative currently has access to grid-powered cold storage, which enables it to delay the sale of fish when demand and prices are low. However, the small lake-side town where the cooperative is located suffers from frequent and long power cuts. According to the cooperative manager, electricity outage around Homa Bay occurs on average three days in a week during the rainy season and lasts for seven hours. This outage occasions quick deterioration of fish stock due to prevailing high temperatures, leading to massive sales at throw away price or complete rot of produce. Recently, the situation has worsened due to interruption of ice production by the nearby private ice-supplying enterprises. To exemplify the size of economic losses, the cooperative chairperson cites weekly incidences where fisherfolk dispose of hundreds of kilograms of deteriorated fish at a quarter of the prevailing price to prevent the ultimate rotting. Improved access to cold storage at first-mile thus can also contribute to eliminating post-harvest spoilage and their associated economic losses, and stabilise supply and prices across seasons. To this end, KIC and the cooperative are at an advanced stage of negotiations to construct a solar-powered cold-storage aggregation facility as part of the Keep IT Cool scaling and sourcing strategy. The facility, which will be owned and set up by KIC, will enable fisherfolk to store the fish at an appropriate temperature between KIC's biweekly collection runs, thus preventing spoilage.

4 Conclusion

KIC is occupying an identified business niche, aimed at reducing post-harvest physical and economic losses faced by small scale fisherfolk and fish retailers in Kenya. Albeit operating in a difficult period dominated by COVID-19 economic disruptions that affect demand for fish products in its primary market, there are noticeable benefits that the company is delivering at this stage. As of December 2021, Keep IT Cool had helped offtake over 150 metric tonnes of fish from fisherfolks and fish farms in Lake Victoria Basin through this cold chain powered distribution model.

Fish retailers up country have been able to improve the quality of their fish supply thanks to KIC's cold chain logistics and decrease post-harvest losses through access to reliable last-mile cold storage. This has enabled them to sell their fish at a higher price. What is more, solar-power nature of KIC's cooler boxes has the potential to reduce energy expenses as compared to alternative sources of energy, further contributing to increasing profitability.

For small-scale fisherfolk, KIC's services have enabled members to unlock better prices, but also to access cash payments, which increases their liquidity, and guaranteed offtake, which prevents fish spoilage and their associated economic losses. As for fish retailers, solar-powered technology has the potential to increase fisherfolk's profits by improving their access to cold storage.

The success of KIC's business model despite the tough economic climate thus suggests that with the recovery of economic activities, many more retailers, including hotels or restaurants, are likely to join the platform, and demand for cooling-as-a-service is likely to increase. KIC will thus have to adapt its business model to scale, not only to provide cold storage to first-mile customers, but also to cost effectively increase the supplier base, and expand geographically. Further research will thus be needed to understand in more details how KIC's services can be delivered at scale, and what are the needs of the first-mile customer segment.

Finally, KIC remains an early stage venture, and while the company's experience has provided useful insights on the potential of cooling technologies on the Kenyan fish value chain. In the longer term, an assessment should also be conducted to determine if the potential identified through these initial insights has indeed been translated into impact. Future studies could also investigate in more details how the positive impact of cold chain services on the fish value chain result in wider social and environmental impact. For instance, research could identify if benefits from access to cold chain technologies vary between demographics, including across gender. The link between access to quality fish supplies and improved nutrition should also be explored, along with the impact of KIC cool boxes on energy savings and greenhouse gases emissions. This would enable the Kenyan government, donors, companies and investors to better understand how to best support the development of cold chain infrastructure to support the inclusive growth of the fish industry.

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