IMPROVING FOOD SUSTAINABILITY IN THE FISH AND AGRI-FOOD VALUE CHAINS IN WESTERN KENYA THROUGH SOLAR COOLING SOLUTIONS

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WATER and ENERGY for FOOD

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Abbreviations

BMU - Beach Management Unit
FMCG - Fast Moving Consumer Goods
KES - Kenya Shilling
KG - Kilogram
PHL - Post Harvest Loss
WE4F - Water Energy For Food

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PROJECT OVERVIEW

About Water and Energy for Food (WE4F)

Water and Energy for Food (WE4F) is a joint international initiative of the German Federal Ministry for Economic Cooperation and Development (BMZ), the European Union (EU), the Ministry of Foreign Affairs of the Government of the Netherlands, the Norwegian Agency for Development Cooperation (Norad), Sweden through the Swedish International Development Cooperation Agency (Sida), and the U.S. Agency for International Development (USAID). The East Africa Hub, based in Nairobi, Kenya, represents WE4F in the region and provides a network function for the partners and other potential donors as well as government agencies in the region and works closely with private sector partners and other stakeholders in the fields of water, energy and food/ agriculture in East Africa.

WE4F aims to promote and to strengthen the use of climate-friendly, energy- and water-efficient innovations for more productive and ecologically sustainable food production across the world.

MIDEVA

About Mideva Venture Labs

Mideva Venture Labs (www.mideva.co) is a human-centered research, design, innovation, and co-creation firm based in Nairobi. The organization designs products, programs, and services that put users at the center, and it strives to design these interventions in collaboration with the users that they serve. The focus is to bring to life innovative, sustainable, and impactful interventions that address real needs faced by today's businesses, communities, and society at large. Mideva Ventures Labs was engaged as a consultant for this project.

Context Setting

Lake Victoria basin and the larger Western Kenya region have been documented as one of Kenya's rich food baskets. Fishing and horticulture production are the dominant activities providing nutrition and livelihood for millions in the surrounding environs for generations. From the lake, the fish species composition is mainly Tilapia, Nile Perch and Dagaa which supports a majority of the lake's economic exports. Horticulture farming is a supplementary activity in which local communities produce a variety of vegetables and fruits taking advantage of the tropical climatic conditions of the region. The farming is done at both small and large scale in various locations across the lake region. Other economic activities include livestock keeping and dairy farming, mining, manufacturing and micro-entrepreneurship and trading.

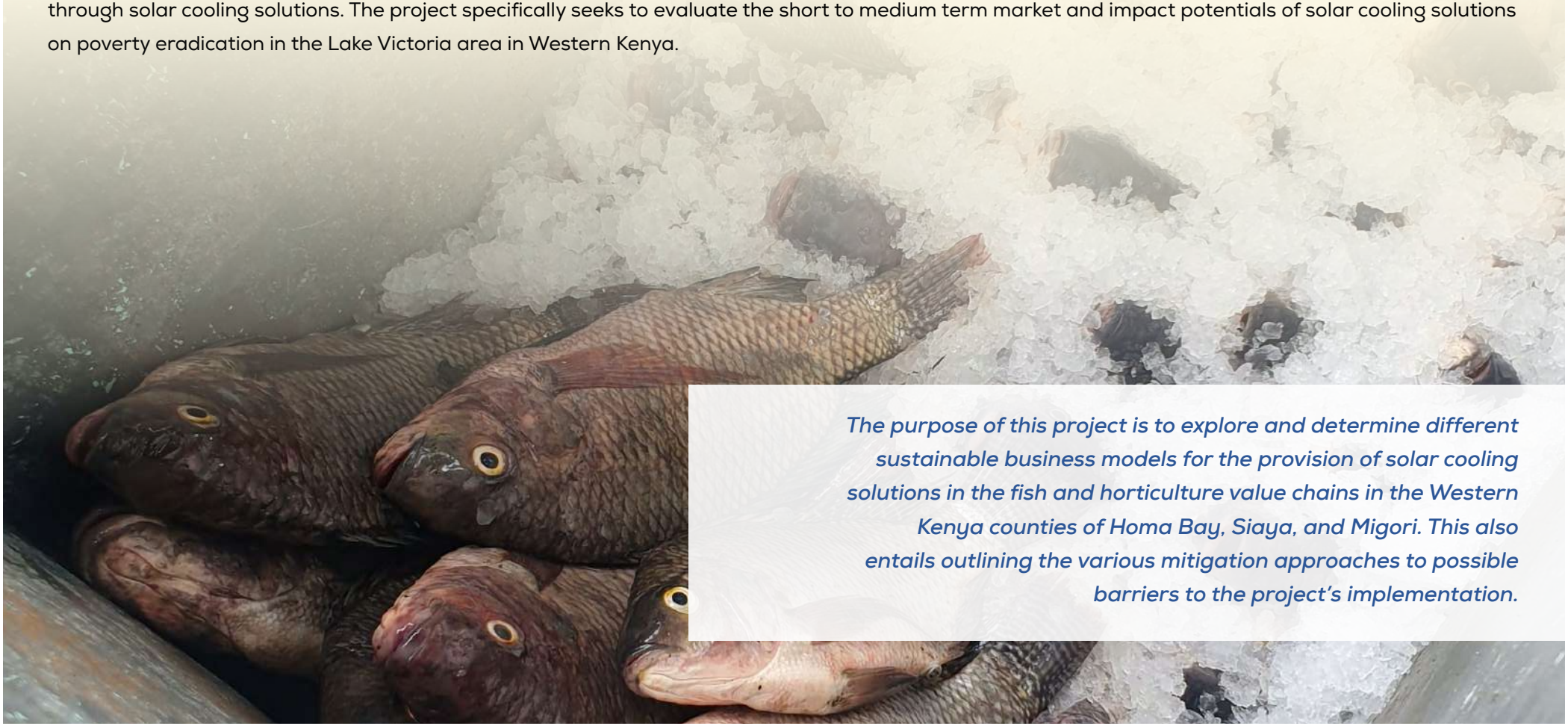
Despite the ideal farming environment, various socio-economic factors and poor policies in the ecosystem have contributed to the lack of food sustainability for the local communities and the country's population at large. Post-harvest loss (PHL) is a significant and perennial challenge plaguing the fish and agrifoods value chains in the region, and is increasingly

catalyzed by factors such as the highly perishable nature of fish and agrifoods produced, irregularities of market demand and over-supply dynamics, lack of critical long-term cold storage and value addition infrastructure, and local unfavorable environmental climate conditions. Research highlights that about 30-40% of food is lost to spoilage this increase food insecurity issues that affect approximately 36.5% of the population. Ultimately over time it has resulted in a decline in agricultural annual outputs, reduced economic viability for local communities and a shift to other economic activities in search of daily earnings sustenance.

The factors highlighted evidence of the clear need for interventions along the various value chain stages to mitigate the cyclical nature of Post Harvest Loss. This challenge has created an opportunity for solutions such as the introduction and application of cold chain cooling/storage.

The “Integrated Solar Cooling Solutions at Lake Victoria” Project

Through the integrated development partnership (iDPP), WE4F working with the private sector has launched several initiatives. One such initiative is the “Integrated Solar Cooling Solutions at Lake Victoria” project. This project aims to promote food sustainability, reduce poverty and combat unemployment through solar cooling solutions. The project specifically seeks to evaluate the short to medium term market and impact potentials of solar cooling solutions on poverty eradication in the Lake Victoria area in Western Kenya.



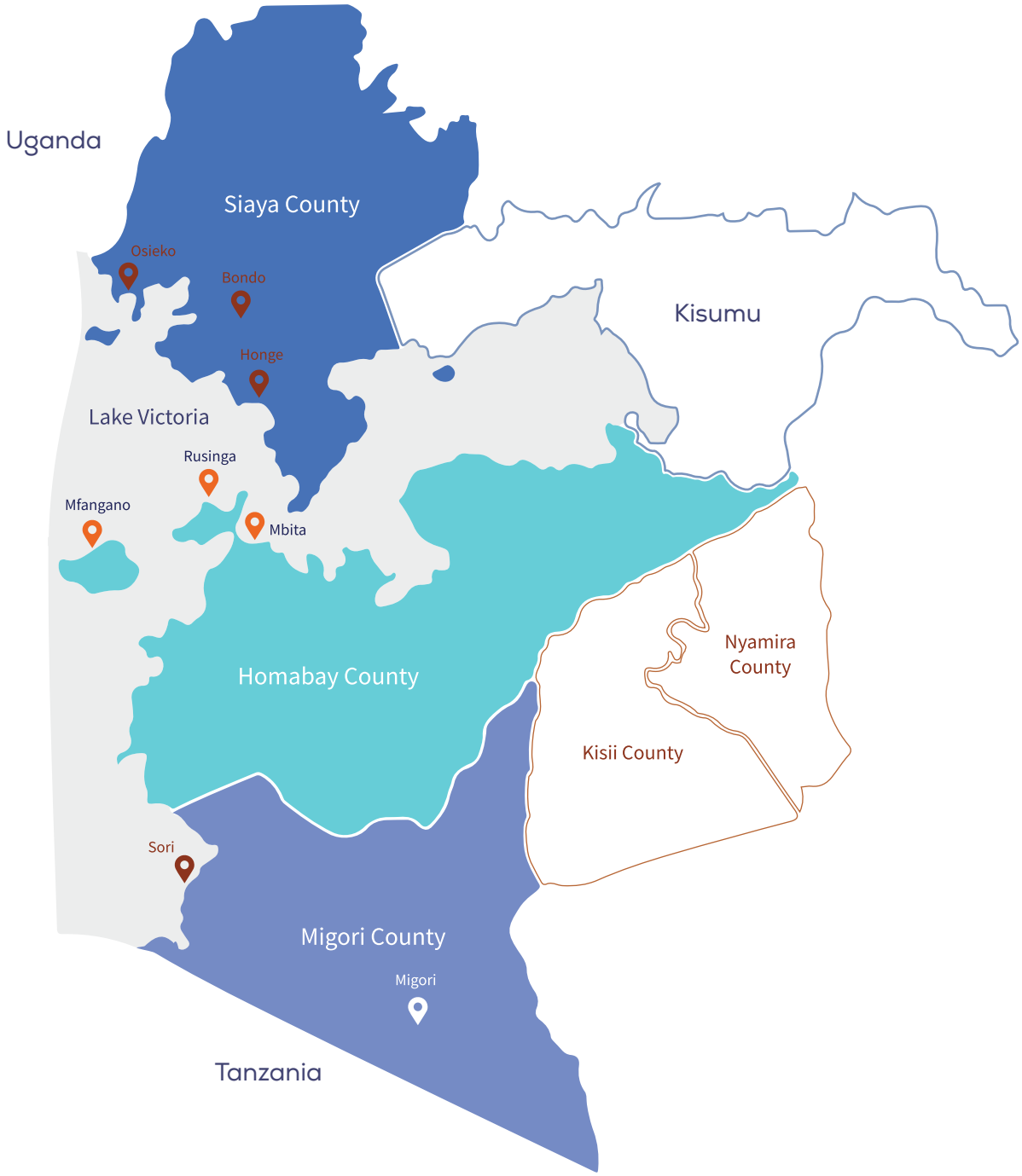
The purpose of this project is to explore and determine different sustainable business models for the provision of solar cooling solutions in the fish and horticulture value chains in the Western Kenya counties of Homa Bay, Siaya, and Migori. This also entails outlining the various mitigation approaches to possible barriers to the project’s implementation.

Publication Outcomes

This publication seeks to highlight the current settings, deployment methods, and costs of available cold/cooling chain options in Western Kenya and other region applications as a potential baseline for business model exploration. This will be achieved through primary field research and secondary research to generate baseline quantitative and qualitative data on cooling applications as applied in agrifood value chains in the region. The focus will be put on a thorough elaboration of existing technical options and commercial approaches currently being utilized for cold processing and storage of agrifood products. Insights from the research will inform the next phase of the project which is the development and elaboration of different business models for the provision of cooling services along different agri-food and/or other value chains. This publication further highlights the project approach, the findings from the field, insights, learnings, recommendations and further areas of exploration for the project.

Project Scope: Overview of the Counties

- Siaya
- Homabay
- Migori
- *Counties not visited*



Homa Bay County

Homa Bay County is one of the four key counties located on the Lake Victoria Basin covering an area of 3,183.3 sq km. The county has a population of approximately 1.3 million people residing in its 8 constituencies and 40 electoral wards including Homa Bay town, the capital of the county, and Mbita as the second largest town. Homa Bay county also includes the peripheral islands located in the lake, and hosts the two largest islands by land size, Mfangano and Rusinga Islands.

The county has tropical climatic conditions and experiences two main rainy seasons in a year, with temperatures averagely ranging between 26°C and 28°C. The main economic activities in the county are fishing (Nile Perch, Tilapia & Dagaa) and agriculture farming along the lake shoreline act as the main sources of household income. Subsistence and commercial farming focuses on cereals such as maize, beans, millet and horticulture products such as vegetables (tomatoes, kale, spinach, local greens) and fruits (watermelon) which are widely grown in the area. Livestock keeping is also common. There is potential to develop industries within the sectors of agribusiness, tourism, and mining.

Size of the location

3,183.3 km²

Population (as of 2019)

1.3 m

Siaya County

Siaya County is located on Lake Victoria Basin neighboring Kisumu County. It covers an area of 2,529.8 sq km and has a population of approximately 993,183 (people as of 2019). The county is composed of 6 constituencies and 30 electoral wards. The administrative capital of the county is Siaya town, however Bondo town is the largest urban town in the county.

The main economic activities include subsistence farming, dagaa fishing, and small-scale trading. Dagaa fishing is prevalent across the beach settlements such as Honge, Osieko, Usenge and Wich Lum.

Size of the location

2,529.8 km²

Population (as of 2019)

999,183

Migori County

Migori County is located on Lake Victoria Basin in southwest Kenya and borders Tanzania. This strategic location makes Migori an important transit hub for people, goods and services across the border. The county covers an area of 2,613 sq km and has a population of approximately 1.1 million people (as of 2019) inhabiting its 8 constituencies. Migori town is the administrative capital which is relatively centrally located. Sori, Nyadhiwa and Kisegi are small fishing towns along the lake shore within the county. Similar to its neighboring county Homa Bay, Migori has a tropical climate with temperatures range averagely between 24°C and 31°C and two major rainy seasons.

The main economic activities focus on agriculture, fishing, manufacturing and mining. The county also sees some limited commercial activity, mainly small and micro-enterprises in the Jua Kali (Informal) sector. Infrastructure in the county is underdeveloped with the majority of the roads being maram roads reducing efficient transport accessibility.

Size of the location

2,613 km²

Population (as of 2019)

1.1 m

PROJECT APPROACH

Project Objectives and Outcomes

The “Integrated Solar Cooling Solutions at Lake Victoria” project had the following objectives and outcomes:

1. Gain a deeper understanding of actors and stakeholders in the fish value chain and other agri-food value chains.
2. Collaborate with value chain stakeholders to co-design potential business models for solar cooling solutions.
3. Carry out small-scale testing of solar cooling solutions concepts and assess their desirability, feasibility and viability.
4. Explore further gaps that the suggested solutions do not still address as required and iterate on the concepts, if viable;
5. Design business models and recommendations for operationalization of solar cooling solutions in the region.

Our approach on the project

To carry out the objectives and achieve the outcomes set out by the project, we combined diverse approaches with the goal of further understanding the project, uncovering gaps and opportunities, co-designing solutions and concepts, and receiving feedback from stakeholders. The approaches include:

1. Secondary Research

We used secondary or desktop research as a means to review any existing data, publication and reports relating to the project. The goal was to obtain quantitative and qualitative data on existing cooling applications as applied in agrifood value chains in western Kenya and beyond. Through this, we were able to synthesize what data was available and also further highlight the missing data and information that guided further exploration in the field.

2. One-on-one Interviews

We carried out 1:1 field interviews with the different stakeholders; market traders, fish aggregators, fish resellers, fisherfolk, Beach Management Unit (BMU) teams, boat owners, fishing crew, community leaders, fisheries officials, consumers, market traders and other value chain actors. The goal for this approach was to obtain qualitative data regarding current use cases for cooling solutions, stakeholder challenges, concerns, opportunities for solar cooling solutions, as well as future considerations.

3. Observations

Apart from carrying out 1:1 interviews, we made observations of the environments that we visited; the agri-food markets, fish aggregation centers, fish landing sites, the ice-production facilities, current cooling solutions, as well as the different stakeholders that we spoke to. This allowed us to further understand the different stakeholders and their needs, challenges and opportunities, and complemented the responses from the 1:1 and group interviews. It also allowed us to further understand the context and to immerse fully in the community.

4. Immersion Activities

We actively took part in different activities that happen in the fish value chain - such as getting involved in the actual sourcing of ice from ice producers, transporting ice to the islands, taking part in meetings and forums organized by BMUs and community leaders, and visiting the agri-food markets. These immersion experiences and activities allowed us to further understand the stakeholders and their needs and to design interventions that are contextually relevant.

5. Co-creation research and Co-design workshops

As an added layer to the individual interviews, we carried out group interviews, focus group sessions and co-creation and co-design sessions with different groups of stakeholders. We designed the approach to include activities that encourage full participation and engagement of all participants. This allowed us to obtain a wide range of perspectives and information within short periods of time. We organized the forums where the participants could easily participate; including at the BMUs offices and at the market centers. We also carried out co-design workshops where participants actively took part in generating solutions and concepts, as well as provided feedback on the concepts and the business model experiments.

6. Key Expert Interviews

To validate some of the findings and obtain more reliable data, we spoke to key experts in the fish and other agri-food value chain actors. This included the ministry of fisheries officials, existing ice producers, market officials, county government officials and women associations leadership teams. With this approach, we were able to gather information such as the daily fish catch, existing policies that affect the value chain activities, future initiatives that would affect the project execution and data on population.

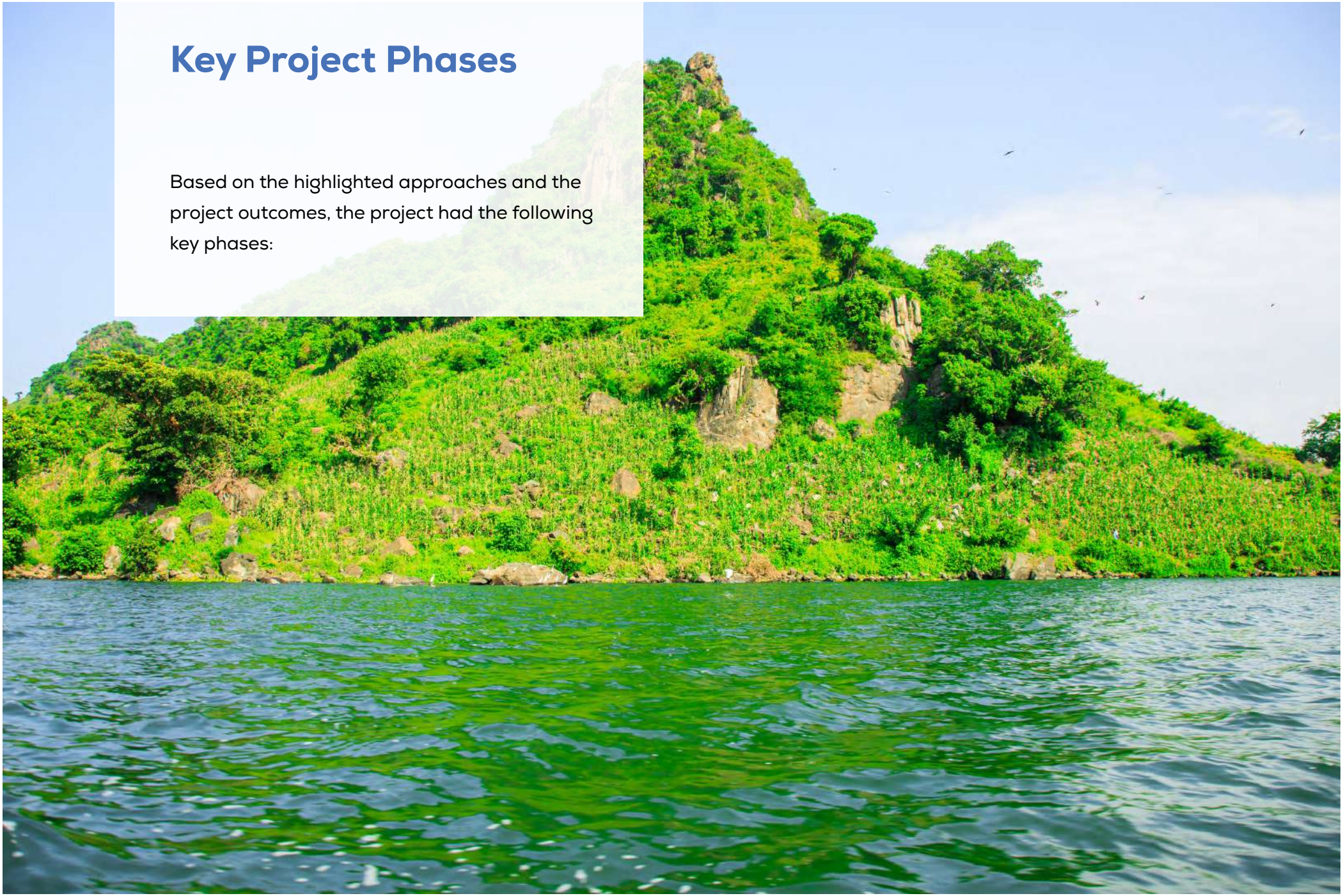
Integrating the "co-design" approach

It was important to integrate a co-design approach throughout the project activities and phases. This meant a participatory approach to designing solutions, in which community members were treated as equal collaborators in the design process. For this project engagement, the stakeholders and value chain actors were at the center of the activities. Part of the role that they played for the project included:

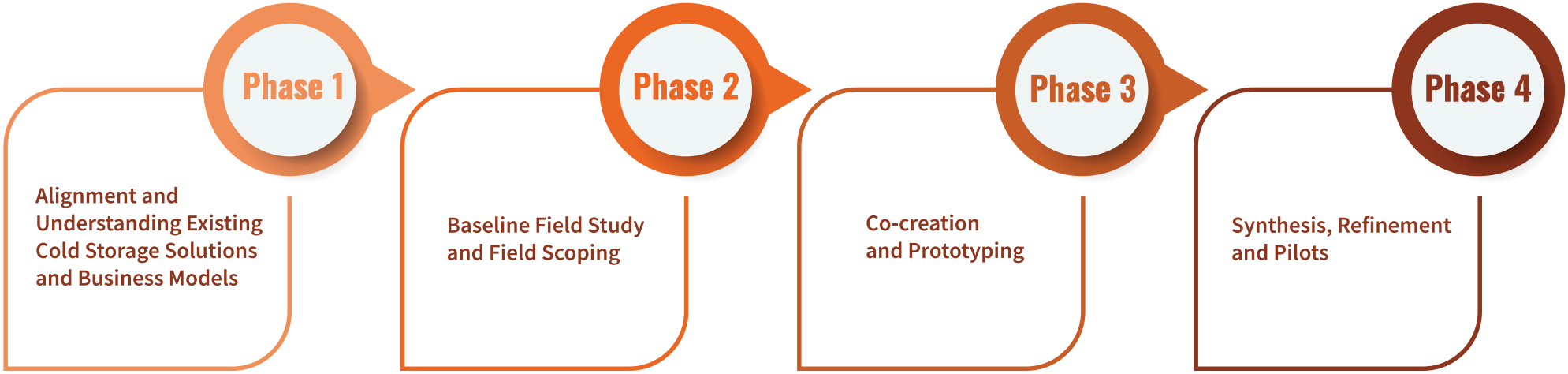
1. Providing a sounding board and appropriate for a for stakeholders to identify, analyze and develop business opportunities for solar cooling value chains.
2. Advising on wider co-design and stakeholder engagement processes to ensure effective participation.
3. Providing advice, guidance and leadership in the identification, analysis and development of business opportunities for solar cooling value chains in Western Kenya.
4. Providing updates and guidance on significant policy, implementation and sector changes, including jurisdictional reforms for cold storage and processing in Kenya.
5. Facilitating the identification of opportunities to influence decision-making on policy development and reform processes necessary for the effective deployment of clean cold value chain technologies.
6. Providing feedback on the identified business models and concepts.
7. Assisting in disseminating information to, and championing the identified opportunities and models within, their communities and networks.

Key Project Phases

Based on the highlighted approaches and the project outcomes, the project had the following key phases:



Key Project Phases



Phase 1: Alignment and Understanding Existing Cold Storage Solutions & Business Models

The first phase was focused on reviewing existing materials, publications and reports regarding the current state of cooling solutions in Western Kenya and beyond. Some of the activities that were carried out in this phase included:

1. Meetings and co-design sessions with key stakeholders
2. Secondary and desktop research to analyze existing data
3. Synthesis and opportunity identification workshops
4. Research planning

Phase 2: Baseline Field Study and Field Scoping

This was an opportunity to immerse into the project environment and learn more about the inner workings of the fish and agrifoods value chains engaging with the various actors within their environment. Therefore we sought to collect data on who the actors involved are, the roles they play and their interactions with other stakeholders within the chains.

Research goals

1. **Map the stakeholders present in the respective value chains**
    - Document their persona data, current experiences, challenges and goals
    - Understand the activities they carry out
    - How these activities are linked to the value chain

2. **Document & understand the key stages of each value chain**
    - Document the challenge/ pain points, bottlenecks and success of each stage
    - Document the current settings, solutions and alternatives being used
    - The shortcomings of these solutions - costs incurred, viability and availability

3. **Map the locations of key value chain activities in the region**
    - Link these locations to the stages of the value chain
    - Visit and observe value chain activities in key locations informed by secondary research

Research goals

4. **Understand the current cold/cooling products/ services available in the region**
    - To understand the nature of cooling solution product/ service offered
        - To understand the demand for cold/ cooling solutions
        - Map locations based on demand/ supply
        - Map current provider locations and accessibility
        - Document the cost of existing cooling solutions and deployment methods
    - Observe the strengths and weaknesses of the cooling solutions currently being provided

5. **Highlight opportunities and challenges of the existing cooling solutions in Western Kenya**

6. **Document the business models employed by the providers**
    - Outline the value proposition, target customer, pricing structure, deployment & distribution.

Phase 3: Co-creation and Prototyping

The co-creation approach made it possible to interact and engage the various stakeholders in the different value chains and understand deeper the existing challenges with regards to food preservation and post harvest losses. Therefore informed by the data collected from the scoping exercise and secondary sources, we set out to ideate and design solutions that can be tested with the identified stakeholders. This phase allowed the testing of various assumptions and hypotheses regarding the introduction of a solar cooling solution. Specifically, using the co-design approach, we set out to:

1. **Ideate potential business models for solar cooling innovations for the fish and other agri-food value chains**
2. **Build simple prototypes and experiments for the identified business model ideas**
3. **Set up and test the prototypes and concepts with the relevant actors**
    - Test the uptake of ice (cooling solutions) through the use of various business offerings
        - Distribution: Internal and external
        - Logistics Delivery
        - Shared cold storage facilities
    - Test various pricing models for the offering
4. **Document observations, findings and learnings from the experiments.**

In carrying out the experiments for the business models for, the following assumptions were held:

1. There is limited access/supply to cooling/cold solutions for stakeholders in need across the region
2. Various stakeholders are willing to incur the cost of cold/cooling solutions within relative parameters of affordability and convenience

Phase 4: Synthesis, Refinement and Pilots

The final phase was focussed on analyzing observations, findings, learnings and feedback from the experiments that had been ongoing for 2 months. The phase was also focussed on finalizing the stakeholder engagement in the target value chains through additional co-design sessions, as well as making refinements to the identified business models. In particular, the goals were to:

1. **Review the success and challenges of the prototyped business models for the solar cooling solutions**
    - Review data and findings from the business model experiments
    - Understand the factors that affected or influenced the outcomes of the models tested
    - Receive feedback from the stakeholders engaged in the models

2. **Conduct co-design workshops with value chain stakeholders in the selected counties**
    - Carry out final research on persona data,
    - Collaborate with stakeholders and gather insights on the prototype models
        - Collect suggestions and iterations for the cold chain business models
        - Collect data on gaps identified in the journey maps for agrifoods & fish value chains
        - Receive feedback on insights relating to policy changes and improvements.

3. **Review the operating environment and resources needed for the pilots for the business models to happen, and sharing and**
4. **Explore ideas for replication and scale for identified viable business models**

Locations Covered during the Field Activities

As part of undertaking the field activities, we covered and explored the following locations across the three counties; **Homa Bay, Siaya and Migori.**

HOMABAY

Mainland

Homa Bay
Mbita
Kisui
Nyachebe
Sindo
Koguna
Kendu Bay
Luanda

Islands

Mfangano Island
- Sena
- Kitawi

Rusinga Island
- Nyagina
- Luanda Rombo

Ngodhe Island
- Ngodhe

MIGORI

Mainland

Sori
Nyadhiwa
Kisegi

SIAYA

Mainland

Honge
Bondo
Usenge
Uhanya
Oseiko

FISH & AGRI-FOOD LANDSCAPE OVER-VIEW & FINDINGS

Fish Landscape in Western Kenya

The scope of this report focuses on the fish landscape in the three counties of Homa Bay, Siaya and Migori within Western Kenya. From secondary research it is critical to understand the landscape of the fish value chain exploring catch statistics, market prices and stakeholders relationships, which are fundamental factors in strategic design and operations of sustainable cold chain solutions in the region.

Catch Statistics

In **Western Kenya there are 334 beach landing sites** and the fish catch composition is made up of three major species of fish; Nile Perch, Tilapia and Dagaa (Omena) with other minority species present.

Catch statistics 2018:

Total Fish Landed:

19,310

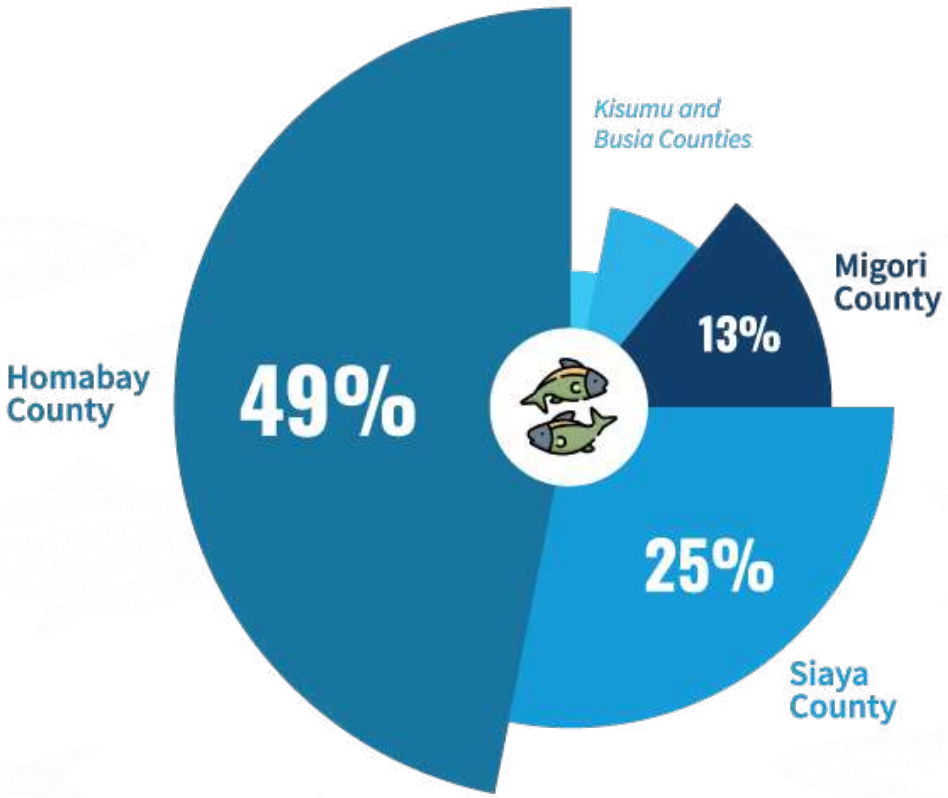
Metric Tonnes

82.8%
Dagaa

16%
Nile Perch

1.1%
Tilapia

Geographic Spread



The catch quantities are disproportionately spread across the riparian counties with **Homa Bay having the highest quantity at 49%, followed by Siaya at 25% and Migori at 13% with the remaining quantities sourced from Kisumu and Busia counties.** (2018, Ministry of Agriculture & Fisheries)

Economic Value

Interestingly it was noted the earnings derived is contrary to the tonnage of fish landed:

64% of fisherfolk earnings is derived from Nile Perch (450 KES/kg) and Tilapia (300 KES/kg)

as they yield more market value than Dagaa at:

35% which is sold at 36.6 KES/kg.

Preservation Needs

Research shows Dagaa does not require cold/cooling storage for its safe preservation instead utilizes drying options unlike Nile Perch and Tilapia that are highly perishable post harvest and hence ide al for a cold/cooling storage. Currently most fish actors use locally fabricated cooler boxes that have flake or block ice (if available) to carry out short term preservation. Those who do not have access to such facilities opt to sell the fish directly to consumers/ market traders whilst still fresh. Other traditional storage techniques include smoking and deep frying in a bid to store the fish. However these modes reduce the market price of the fish.

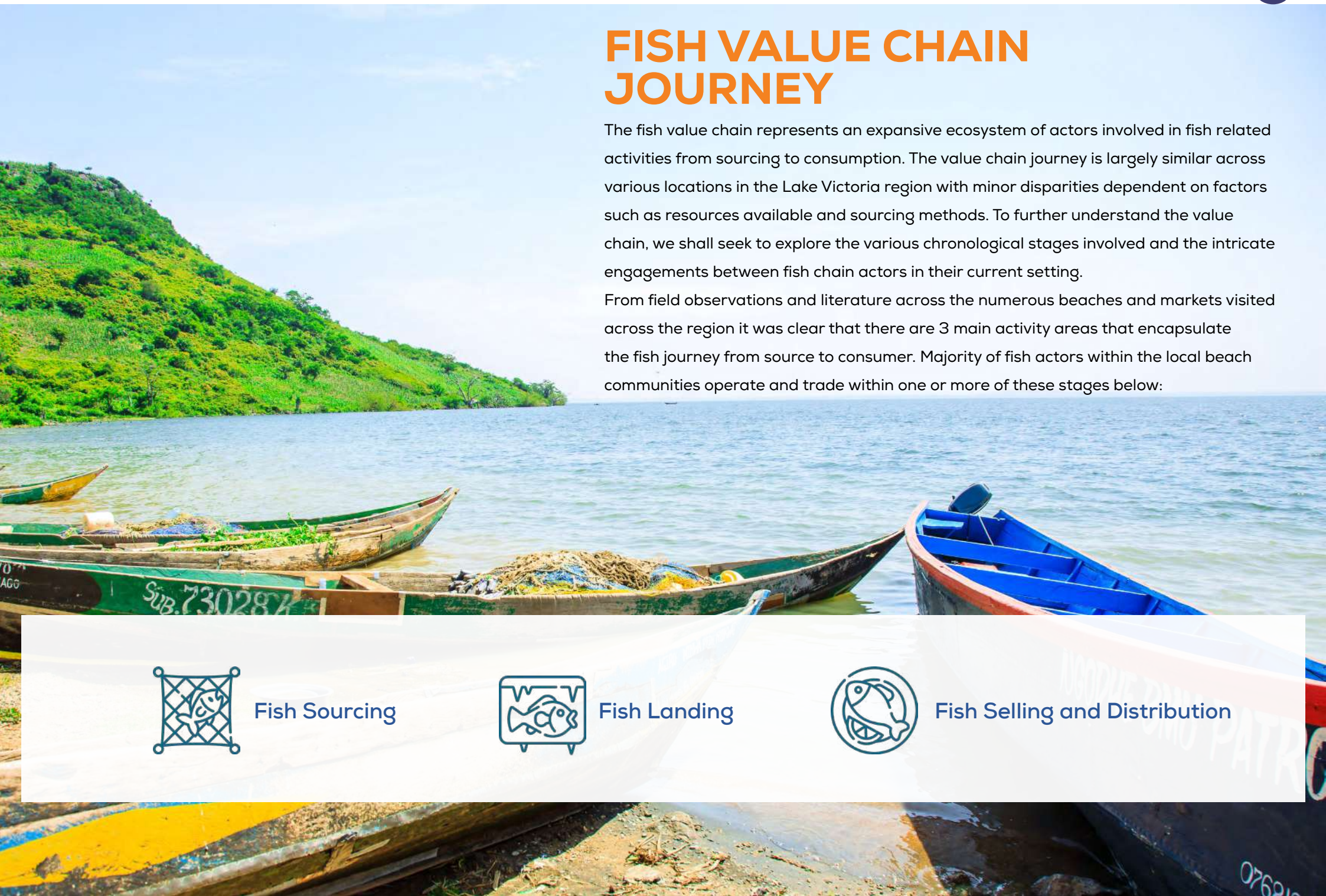
Learnings

Early deductions from the above data suggest that given the higher economic value of **Nile Perch & Tilapia** compared to Dagaa it is evident that there is opportunity for cold chain solutions within the region for sustainable economic gain for fish value chain actors particularly in Homa Bay County.

FISH VALUE CHAIN JOURNEY

The fish value chain represents an expansive ecosystem of actors involved in fish related activities from sourcing to consumption. The value chain journey is largely similar across various locations in the Lake Victoria region with minor disparities dependent on factors such as resources available and sourcing methods. To further understand the value chain, we shall seek to explore the various chronological stages involved and the intricate engagements between fish chain actors in their current setting.

From field observations and literature across the numerous beaches and markets visited across the region it was clear that there are 3 main activity areas that encapsulate the fish journey from source to consumer. Majority of fish actors within the local beach communities operate and trade within one or more of these stages below:



Fish Sourcing

Fish Landing

Fish Selling and Distribution

Fish Sourcing

This is the first primary activity in the value chain, whose outcome is center to the whole ecosystem. It was observed that across the Lake Victoria region there are two main types of fish sourcing; Free-range fishing and Cage fish farming. From this the majority of fisherfolk within the three counties typically engage in free range fishing (Nile Perch, Tilapia & Dagaa), on the other hand private investors at specific locations conduct commercial cage fish farming (Tilapia) ranging from small to large scale operations.

Free-Range

This typically describes the open-lake sourcing & capture of wild fish by the local fishfolk. In Free range fishing the catch quantity is subject to the seasonality of fish, **the high season usually occurs between February and April**. In this type of fish sourcing it was observed that the main actors involved are the fishing boat crew (Fishermen & Boat Captain/Coxswain) who generally set out on daily expeditions using motorengine/electric or sail/paddle boats to catch fish. In some occasions these **fishing excursions can range from over night to 2-3 days** before the crew lands back at their respective beach. The fish catch quantity per boat ranges upto 100 kg depending on the lake locations the crew sets course for. When conducting the excursion the fishing crew are required to use legal fishing gears such as nets which is regulated by the local authorities, to prevent the fishing of undersized young fish in a bid to prolong fish sustainability in the lake. There are numerous factors spanning from needs to challenges and risks that ultimately affect a successful catch outcome.

- **Excursion Resources**

Boat owners have a duty to facilitate the fishing crew's excursion by providing the resources required which ideally is food and fuel (petrol for motor engine). The fuel quantity provided dictates the distances that can be traveled into the lake and safely return. This then determines the potential catch quantity, as the majority of fishing sites around the lake shore have been depleted due to overfishing over the years, thus fishermen have to venture longer distances into the deeper parts of the lake to have a good opportunity for an adequate catch. Longer distance requires more fuel and food resources which incurs more cost to the boat owners, hence the reduced economic gain and earnings for the boat owner and crew from a successful catch.

- **Ice Availability & Logistics costs**

Typically fish crew attempt to preserve the freshness of their fish catch using ice (in the form of flakes & blocks). This is an additional required resource particularly for long fishing excursions lasting 2-3 days, that boat owners have to facilitate. Ice production in the region is only available in particular locations and hence boat owners from various beaches have to courier transporters to source ice for them. Courier transporters using motorcycles usually charge between **KES 50 - KES 250 per trip depending on the distance**. Due to challenges in ice availability in some locations, boat owners occasionally incur losses from transportation costs when ice is unavailable and a transport courier has been engaged. Furthermore the ice is usually packed in general sisal sacks and when transported on motorcycles over a long distance **under direct sunligh a significant quantity of the ice is lost due to melting,** which reduces the available ice for use during the fishing excursion leading to more losses for the boat owner.

- **On-board Fish storage**

The small scale boats used for fish sourcing are generally constructed with local materials such as hard wood, these boats are not equipped with cooling storage facilities/ compartments. In normal practice the fish crew store the caught fish within the boat hull, leaving fish exposed to the direct sunlight and ambient air. This exposure to the environmental elements poses a risk to the freshness and quality of the fish, particularly for fishing excursions that last more than 5 hours. The current practice is to purchase a sack of ice before departure and use it to preserve the fish catch. The limitation of this is that without an enclosed cold storage compartment to regulate the temperature, the ice melts relatively quickly thus only offering short preservation timelines. Herein lies an opportunity for a mobile cooler boxes that has sufficient capacity to store and cool fish using ice.

- **Fish Maw Value**

An interesting insight observed is that for Nile Perch the **fish maw (internal swim bladder organ) has more value (KES 3,000 per kg) relative to the entire fish carcass (KES 450 per kg).** This poses a challenge for boat owners who rely on the crew to bring back fish whole & intact, some crew members take advantage and harvest the fish maw then dispose of the fish carcass before returning to the beach with claims of no fish catch, therefore leaving the boat owner with nothing to sell to traders. It was also noted that the value of the fish reduces significantly once the fish maw has been removed.

Fish maw has a high demand due its various sought after uses, firstly in the healthcare sector it is used to manufacture surgical thread/ sutures and various other drug medications. Secondly it is a food delicacy for restaurants in countries such as China and is believed to have high nutritional value.

The value chain in Kenya is not formalised unlike in neighbouring countries such as Uganda whereby the Government facilitates access to export markets such as Asian countries and regulates the sourcing of fish maw and its market value. In Kenya through informal channels the local fisherfolk source and sell the fish maw to fish trader aggregators or any person interested directly, thereafter these actors move to sell to customers in urban areas such as Nairobi. There in no current official channel to track fish maw sourcing production and distribution data, however research and field observations showed that significant quantities of fish maw are produced and distributed across the lake region.
As mentioned its high market price makes it lucrative and prone to challenges such as insecurity & theft by boat crew and other stakeholders along the fish value chain.

Due to its high demand it has also propagated overfishing which then affects the sustainability of future fish populations in the lake.

- **Insecurity**

The insecurity in the lake affects the distances covered and quantity of fish caught by the fishing crew. In most cases, the fishing crew avoid doing deep-lake fishing and night fishing to stay away from other rogue fishing crews and robbers, who would ambush a boat returning back to shore and steal the catch, the boat's motor propeller and other fishing equipment therefore leaving the fisher crew stranded in the lake. This is insecurity is rampant in Siaya & Migori counties with the perpetrators fleeing to international waters within the lake.

Commercial Cage Farming

Given the reducing wild fish population in the lake as a result of overfishing, destruction of fish breeding ground locations and illegal fishing (fishing of undersized fish), private investors have sought to aquaculture commercial cage farming for fish production to meet the market demand. Cage farming involves the use of netted enclosures which are suspended in an aquatic environment – like the lake. The enclosures are fabricated out of locally available materials and are designed with a capacity that allows for a large quantity of fish to be reared. This type of fish sourcing is **prevalent in Homa Bay and Migori counties and is only done for Tilapia,** it is not suitable for Nile Perch. This mode of farming is mainly done by large scale corporations such as Victory Farms Kenya, & Lake View Fisheries.

- **Operations & Costs**

The cages are setup within relative proximity to the beach and the rearing operations are setup with a staggered timelines, allowing for fish to mature at different rates hence ensuring consistent harvest stock all year round. Each cage can host upto 10,000 fingerlings and the maturity process takes upto 8 months. The cages are managed and monitored daily by the owners or employees whereby they provide daily food and nutrition to the caged fish. The cost of operations varies depending on the scale but mainly incudes the personnel wages, animal feed cost and fuel for the operations boat. These are additional costs incurred in this type of fish sourcing compared to free range sourcing, therefore increasing the market price of fish that is produced from cages.

- **Market Dynamics**

Large scale market players such as Victory farms & Lake View Fisheries, are businesses that engage in cage farming and have the whole value chain internally; production-distribution-sales. Therefore they have the capacity to sell directly to customers can set fixed prices, **though high tilapia seasons affect their ability to sell,** leading to losses through spoilage despite the preservation of fish in their operational process. However for the small scale operators, in order to turn a profit and reduce potential of post harvest loss from their catch , they usually have to reach the market place as early as 4.00am to sell their harvest before the market is saturated by free range fish.

- **Lake Environment Conditions**

The lake conditions affect the cage farmers ability to harvest for example when the wave currents are too strong, cage farmers so not harvest hence have no fish to sell. Cooling storage solutions would enable them to harvest at earlier times when conditions are suitable and store fish for longer periods to meet market needs.

Lake Victoria, Kenya currently has

3,696 cages across the five riparian counties

with an estimated production capacity of

3,000 tonnes/year mainly focused on tilapia.

Fish Landing

This is the next step post-fishing where the boat crew land/ arrive at the beach usually in early morning hours. In this stage we encountered the introduction of new chain actors which are the Beach Management Unit Officials (BMU), fisher traders (wholesalers/ aggregators), who then engage in various activities with the fish catch that has arrived. Homa Bay County has the highest proportion of fishing activities and it was observed across nine locations that on an average weekly basis the total fish catch landing is approximately **7,150 Kilograms of Nile Perch and 2,240 Kilograms of Tilapia and 2,230 troughs of Omena.**

- **Catch Accounting**

On landing the boat owners (or their representatives) take tally of the fish caught and then pay the crew for their service. Thereafter engage the market traders and negotiate for the purchase prices based on weight, size, quality and quantity. At this stage the boat owners also inspect the fish (Nile Perch) to check if the fish maw has been extracted. Most often the market traders/ buyers have the bargaining power during the sales process as the boat owners do not have cold storage capacity and hence have to sell at sub market prices with no other options.

- **Revenue sharing**

The revenue made for fish sales is then proportionally split between the crew and the boat owner after excursion costs are deducted. The boat owners tend to take the bulk of the earnings portion, with the rest shared among the crew members. Boat owners incur losses if the catch revenue does not supersede the excursion expenses. Selling prices of the catch is a factor of the quantity, size and weight upon landing, and is also periodically affected by the overall seasonality of market demand.

- **Beach Taxation**

The BMU officials usually charge the boat owners and market traders an operating tax based on the quantity of fish caught or bought. These taxes go towards the development and management of the beach and BMU related activities.

- **Preservation**

It was as shared by market traders across the region that post fish landing, appropriate fish preservation techniques/ approaches are necessary to avoid spoilage and maintain quality. An example is at Mbita Beach (Homa Bay County), it was observed that traders separate different types of fish to enhance preservation, beyond cooling. For instance, Tilapia and Nile Perch were stored separately to avoid spoilage due to tilapia fat, such knowledge is key while designing cooling solutions, to avoid compromising their overall effectiveness.

Fish Selling & Distribution

This is the final activity in the chain involving the primary actors; fish traders, aggregators, reartilers, logistics providers and consumers. The fish that has been sourced from the various beaches by market traders/ agents is then transported to large markets or collection centers where it is stored in large cooler boxes using ice before being sold to retailers then to customers (both local & regional). This activity is primarily governed by two main elements market prices & logistics cost.

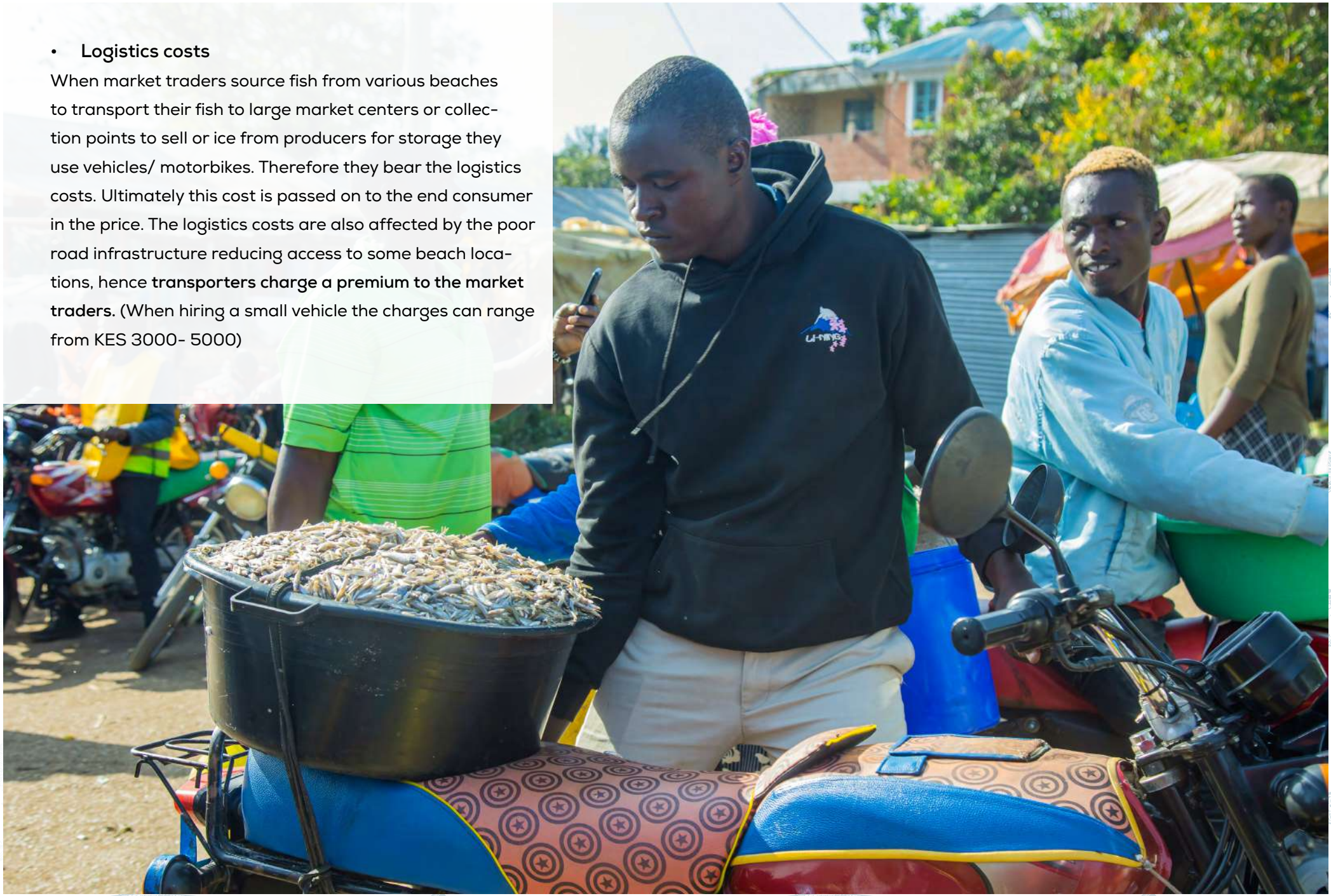
- **Market Pricing**

This is generally affected by general market dynamics of supply and demand. The seasonality of fish influences the market traders to manipulate prices to their benefit, particularly when the supply is low, the traders make larger margins taking advantage of fishermen.

Given availability of fish factors affecting pricing include the freshness of fish, distance to market location & presence of fish maw within the fish (Nile Perch). Challenges affecting fisherfolk at the sourcing and landing value chain stages is they do not have visibility over the final selling price of fish to consumers, thus that lack of knowledge affects their bargaining power. Finally the influence of large-scale cage farmers and processors brings about price fluctuations for small scale fisherfolk.

- **Logistics costs**

When market traders source fish from various beaches to transport their fish to large market centers or collection points to sell or ice from producers for storage they use vehicles/ motorbikes. Therefore they bear the logistics costs. Ultimately this cost is passed on to the end consumer in the price. The logistics costs are also affected by the poor road infrastructure reducing access to some beach locations, hence **transporters charge a premium to the market traders.** (When hiring a small vehicle the charges can range from KES 3000- 5000)



Fish Value Chain Map

Below is a visual representation of the fish value chain; covering fish sourcing, fish landing and distribution. The value chain map also highlights the different stakeholders involved, high level challenges they face, their current experience and the opportunities for cooling solutions at the different levels.

FISH SOURCING

Activity	 The fishing crew wakes up at 4am, heads to the beach and prepares for fishing by fueling the boat, preparing nets, etc.	 The fisherman is accompanied by 3 / 4 other crew members. They head out to the lake to fish.	 They travel for 4 hours or more based on the boat type and the ability to preserve fish.	 They travel back after the catch and meets up with the boat manager / owner.
Sentiment	*"I don't intend to stop fishing. This is the only work I can do."* **Ben** *Ngodhe Beach Fisherman* 	*"We cannot afford life jackets."* **Hezron** *Mfangano Beach Fisherman* 	*"When the fish is exposed to the sun for long hours, it goes bad. It's something we cannot control so the shortage of ice poses a huge disadvantage."* **Rollins** *Ngodhe Beach Boat Crew* 	*"We try to come back very fast to sell fish to the traders before the fish goes bad. We don't want to incur the loss."* **Collins** *Sindo Beach Fisherman* 
Challenge	If they pack the boat without ice, there is no other way for them to access it unless they come back to the beach.	They don't have appropriate fishing gear e.g proper fishing nets, life jackets, etc.	Lack of ice means less distance covered hence less fish captured.	The fishermen are sometimes forced to come back to the shore with very little or no catch.
Opportunity	Have a closer ice collection point where they could get the ice and put on the boats.	Encourage and raise awareness on the availability of ice by offering merchandise with every ice purchase. e.g. gloves, life jackets etc.	Have portable cooler boxes that can be used to preserve fish while on the boat, and for a longer duration of time. This will allow the crew to load lots of ice without worrying about it melting or being insufficient.	

FISH LANDING

Activity

Boat manager / owner takesa tally of the fish sourced and pays the crew for work done on arrival.

Fish is sorted according to type and size.

The fish trader purchases from the boat owner at the beach (per kg of the type of fish sourced).

The fish trader preserves the fish in coolers at the beach / market or transports it for preservation.

The fish trader sells the fish directly to customers / trucks heading to other markets.

Sentiment

"If the fish is spoilt, the cost of the fish goes down from KShs 350 per kg to KShs 150."

Ursela
Nyagina Beach Boat Owner

"Sometimes, we prepare to be fishing all day because we try to get a certain amount of fish by the time we get back."

Isaac
Mfangano Beach Fisherman

"The BMU charges KShs 5 for BMU management fees and KShs 15 per every kg caught. That's Kshs 20 for every kg caught."

Rollins
Ngodhe Beach Boat Crew

"Most of the fish arrives after the WeTu hub is closed; now because of that, we can't access the ice."

Tony
Mbita BMU Secretary and Fish Trader

"When I preserve fish with ice during the day, I know it will not go bad before it reaches Nairobi."

Aurelia
Fish Trader

Challenge

Catch may not be propotional to the expenses incurred.

The catch may be less or small in size hence a smaller profit margin.

Boat owners and traders have no visibility over market prices for fish. They also incur mandatory beach tax expenses despite it.

There are time inconsistencies between when the fish arrives at shore and when the ice is available.

Since fish is usually transported to Nairobi at night, the traders have to keep the fish fresh all day since the catch bought in the morning.

Opportunity

Ice coolers to be placed in the boats so that the boat managers are able to buy all of the fisherman's catch.

If cooler boxes are available with ice, they can store the fish long enough to get fair prices for their catch.

Preserve all their catch in ice so that they don't go on losses. This will allow them to pay the fees with ease.

Ice plants to open at fish landing times and in peak fishing trading hours.

More ice coolers loaded with ice stationed right at the beach to allow the fish to continually be preserved.

FISH SELLING AND DISTRIBUTION

Activity	 Trucks pack fish with ice for preservation during transport.	 Fish arrives at selling point and is preserved in coolers.	 Fish is sold to small scale traders at the markets to resell to consumers.	 Fish is sold directly to consumers by small scale fish traders.
Sentiment	*"I remove the fish from the ice onto the boat, take it to Luanda Rombo and from there, a truck takes the fish from Luanda to Homabay town."* ***Jane*** ***Ngodhe Beach Fish Trader*** 	*"We ensure the trucks are full of fish and hurrily get to the markets before the ice in the trucks melt."* ***Tony*** ***Mbita BMU Secretary and Fish Trader*** 	*"Fish gets to me every morning in time for me to sell to restaurants and other customers on the day."* ***Maryanne*** ***Homabay Fish Trader*** 	*"I always have fish for my customers to enjoy for lunch and dinner!"* ***Mike*** ***Restaurant Owner*** 
Challenge	Cost of transporting the fish to the trucks is high and it is incurred by the fish trader.	The trucks have to be full before leaving the beaches. This means that they need alot of ice to keep the fish fresh as they cummulate the amount.	Fish quality may be compromised because of inconsistent preservation methods leading to low resell prices and consequent losses to fish traders.	Fish dishes are costly because the customers have bought the fish at a higher price to cover the costs of transport, trading, fish quality and preservation etc.
Opportunity	Bring the ice coolers closer to the beaches so that traders can save money on ice preservation and transportation.	Set up ice distribution plants next to the truck stations so that they can source the ice with ease.	Encourage fish traders in market destinations to get ice coolers so that they can preserve the fish immediately they buy them.	

AGRIFOODS LANDSCAPE IN WESTERN KENYA

Overview

Horticulture supports approximately

25% of the country's GDP,

in 2021 the country exported

65,130 metric tonnes of vegetables and

110,500 metric tonnes of fruits

to the Middle East and Europe.

In Western Kenya across the 3 target counties, many local communities engage in horticulture as a major economic activity supplementing fishing activities and their income generation. They take advantage of the tropical environmental conditions to grow various agrifoods for local domestic consumption and commercial export. The value chain has four main segments, Production, Handling & Transportation, Sales & Distribution and Consumption in which various actors engaged.

- Agrifoods composition

Horticultural crops produced in Western Kenya are mainly vegetables (tomatoes, kales, cabbages, African leafy vegetables, onions) and fruits (mangoes, watermelon, guava, paw paw, oranges, pineapples and bananas) which are mainly farmed in Homa Bay, Migori, Kisii and Siaya counties. In Homa Bay County it was observed at the five main markets: Homa Bay, Mbita, Sindo, Mfangano and Luanda the following approximate quantities of horticulture produce is sourced from neighbouring farms on a weekly basis are **1680 crates of Green Leafy Vegables, 830 crates of Tomatoes, 630 crates of Cabbages and 470 crates of Assorted fruits. (One crate has a capacity of 50 kg)**

- **Food wastage**

Post harvest loss is the core problem experiences by all value chain actors, the severity of which varies along the value chain. The majority of agrifoods produced usually have a **short shelf life of 4-7 days** post harvest whilst exposed to ambient tropical conditions before the quality deteriorates and the food begins to decompose. Research shows that **40% of all agrifoods produced is lost due to spoilage** emanating from lack of proper cold preservation which incurs financial losses to farmers and traders.

The highest Post Harvest loss is experienced by the farmers

39% Is lost at the production stage

Is lost at the handling & storage phase **37%**

23% Is further lost during distribution & marketing

Ultimately, 5% makes it to the consumption stage **5%**

For agrifoods that are locally processed the wastage is relatively low at 7%, given the processors have the necessary equipment to appropriately preserve the inventory as required.

- **Farming Equipment & Irrigation Challenges**

The majority of small scale farmers along the lake basin do not have the financial resources to acquire modern farming equipment that would increase their production capacity and overal yield. Furthermore currently farmers struggle to consistently irrigate their farms due to lack of electric powered pumping equipment, access to stable electricity and terrain challenged when sourcing water from the lake to their farms.

Agri-food Value Chain

	PRODUCTION	HANDLING	DISTRIBUTION	SELLING	CONSUMPTION
Activity	 Farmers grow, harvest and audit the produce from the farm and put it in sacks for handlers / transporters.	 They collect the produce from various farms and transport it to wholesalers.	 They receive the produce from transporters, aggregate the quanitites and distribute to small scale traders in multiple locations.	 Small scale traders sell the produce to consumers in market areas.	 Customers go to the market to buy food.
Sentiment	*"For me to make a profit, I have to sell in large quantities."* *Morris* *Tomato Farmer* *Mbita Market,* *Homabay County*	*"The sacks are not the best to carry vegetables because the ones at the bottom get crushed."* *Omondi* *Truck Owner,* *Homabay County*	*"Every week, I buy 100kgs of tomatoes. Unfortunately, 20kgs will go bad."* *Lydia* *Vegetable Wholesaler* *Mfangano Vegetable Market,* *Homabay County*	*"I buy these vegetables so expensive so the price of them goes up."* *Florence* *Vegetable Vendor* *Mfangano Vegetable Market,* *Homabay County*	*"Some days I am lucky to get fresh vegetables to buy but other days, I just buy what is there. Even if they are not the best."* *Jacinta* *Lives in Homabay Town*
Challenge	There is an over supply of produce due to seasonality of the crops. Farmers are forced to sell their produce at low prices.	A portion of the produce is spoilt due to poor handling of the crates and sacks.	Due to ambient conditions in large scale storage areas, some of the produce is lost as a result of the rippening process and pest infestation.	The quality of the produce they receive from wholesalers has a short shelf life as its already ripe and ready to be consumed. They have to sell in a short period of time.	Consumers face inconsistency in quality and are subjected to flactuations in pricing.
Opporunity	Cold rooms allow farmers to store and sell their produce all year round at better prices.	Well designed and standardised crates allows transporters to pack larger volumes and preserves the quality of the produce.	A cold facility slows down the rippening process and prevents pest infestation.	Cold rooms extend the shelf life and ensures the produce is fresh for the consumer to buy.	

STAKEHOLDER MAPPING AND ANALYSIS OF VALUE CHAIN ACTORS

As part of the project undertaking, we identified and mapped out the following actors involved in the value chain. These are stakeholders who influence or directly get affected by the intervention that the project is seeking to create, and their involvement, opinion, feedback and interest is crucial to the project success.

Fish Value Chain Actors

Actor	Brief Description
 **Fish Crew**	• This is a team of fishermen who set out daily to the lake source for fish using a motor engine or sail boat and various fishing gears. • Each boat has a captain and roughly 2-3 supporting crew members who have various operational tasks during travel and fishing. • The crew is employed by a boat owner and are paid a daily wage based on the value of the fish caught upon return to shore.
 **Boat Owners**	• The boat owner is an entrepreneur who generates income from the fishing activities of their boat. • They financially facilitate daily fishing expeditions by providing the crew with resources such as fuel, fishing gears and food. • They audit the fish catch quantity upon the return of the crew to the beach and then sell the fish to Fish Traders.
 **Boat Managers**	• These are employees of boat owners who own multiple boats. They are tasked to maintain the daily resource facilitation for the fish crew.
 **Fish Traders - Aggregators/ Wholesalers**	• Theses are medium to large scale entrepreneurs who source fish from various beach locations then aggregate large quantities and then sell on to retailers in different markets.
 **Fish Traders - Retailers**	• These are small scale entrepreneurs in a marketplace who source fish from wholesalers and then sell directly to consumers.

Fish Value Chain Actors

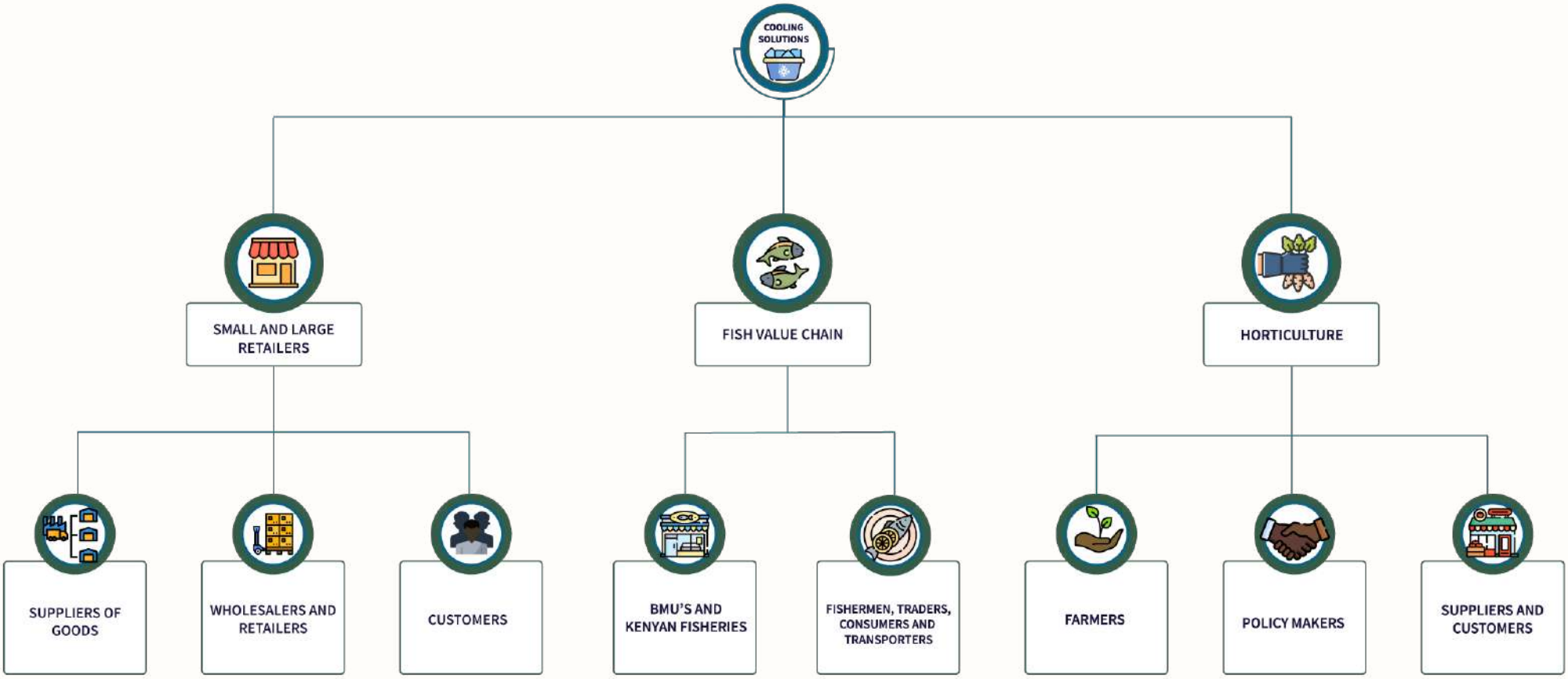
 **Beach Management Unit Officials**	• This is the local authority that governs a particular beach in a specific location. They manage activities, settle disputes and collect taxes from their membership (boat owners).
 **Transporters**	• Transporters serve as the link between various actors, they transport the fish along the value chain using various modes of transport - motorcycles, small boats, trucks.
 **Cold chain Providers - Ice Producers**	• They produce cold chain products such as flake ice and block ice then sell to various customers such as fish traders, transporters. • In some cases they provide cold storage as a service to fish traders.
 **Cage Farmers**	• These are fish folk engaging in fish cage rearing at particular locations within the lake. • They own or manage the whole production to distribution process. • During the rearing process they provide food and growth nutrients. • Upon fish maturity they sell the fish to fish traders.
 **Ministry of Fisheries - County Officials**	• The Ministry is the overall policy maker and governing authority of fisheries in the country. They implement and enforce regulations on fishing activities.

Other Agri-food Value Chain Actors

Actor	Brief
 **Farmer**	• The farmer plants various food crops and manages the growth, nurting and harvesting process • They sell the harvest to Wholsaler and repeat the process in the next season.
 **Agrifoods- Wholesale Aggregator**	• Agrifoods wholesalers are entrepreneurs who source and aggregate large quantities of various food products then distribute to other value chain actors such as small scale market traders and supermarkets across various locations.
 **Market Trader - Retailer**	• These are small scale traders who sell agrifoods produce directly to customers in the market.
 **Transporter**	• Transporters serve as the link between various actors, they transport the agrifoods produce along the value chain using various modes of transport - motorcycles, small boats, trucks.
 **Market Association Management**	• This is the local authority that governs the marketplace in town centers. They manage the allocation of space and regulations that market traders should abide to in their activities.

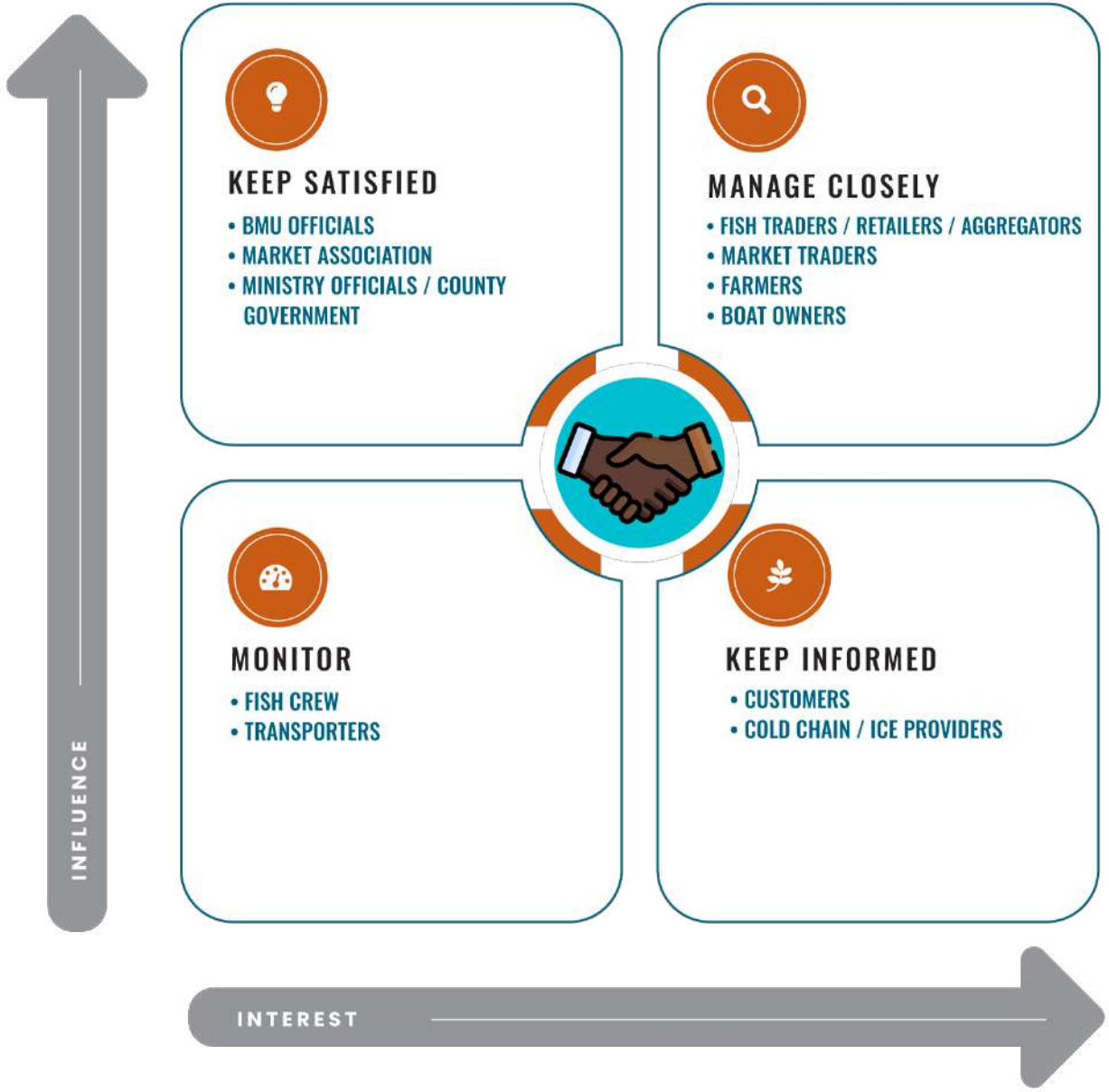
Stakeholder Map

Below is a visualized map for all the stakeholders involved in the fish and other agri-food value chain.



Stakeholder Analysis

We analyzed each of the stakeholders , their influence on the value chain and the adoption of the potential solar cooling solutions based on **interest vs influence**.



A REVIEW OF EXISTING COOLING SOLUTIONS AND THEIR BUSINESS MODELS

Insights from Secondary Research: Existing Models

The review of various case studies in documented literature gave an in-depth look into major cooling/cold chain providers in Kenya and other African countries within the agrifoods & fish value chains. The evaluation focused on their business models, mode of operation, and value propositions, which generally fall into two main classifications which are Business to Business (B2B) and Business to Consumer (B2C). An overall analysis and learnings from their successes and challenges will be important in the development of prototype solution design that caters to our targeted end user in each of the value chains.

BUSINESS TO BUSINESS (B2C)

The following case study examples showcase businesses directly offering cold/cooling storage services to mass market customers within the fish and agrifoods value chains based on a **Cooling as a Service (CaaS) or 'Pay As You Store'** business model.

- **Soko Fresh**

Overview: This is a Kenya-based company whose mission is to provide 'First Mile' cold storage as a service and a digital market linkage platform for farmers, traders, wholesalers, and exporters. Specifically, they offer mobile cold storage run 100% on solar energy, ensuring convenience and their solution charges **1 Ksh per 1 Kilogram** stored to reduce investment risk for farmers and traders. The storage units work with temperatures ranging from 4 to 12 degrees Celsius and have a capacity of holding up to five tons of produce each. **Flat rate pricing model lowers barriers to adoption** arising from variable pricing rates. For mass-market solutions, it is critical to have consumer-oriented pricing solutions.

- **Solar Freeze**

Overview: Solar Freeze offers portable solar-powered cold storage enabling farmers to store temperature-sensitive fresh agrifoods, similar to Soko Fresh and FreshBox. Their solution brings a new dimension focusing on user reliability and performance for temperature-controlled portable cold storage. In their pay-as-you-store model farmers pay 0.1 USD per crate per day for the cold storage service. Farmers and market vendors access produce inventory data through the Solar Freeze cold storage management system App and Internet of Things (IoT) platform. Their service incorporates effective and efficient logistics through refrigerated transportation allowing farmers and traders to move smaller quantities more frequently and cost-effectively through a 'Sharing Economy' model accessed through an 'ubering' USSD platform.

- **FreshBox**

Overview: FreshBox for-profit social enterprise offering cold storage system optimized to minimize food loss and maximize vendors' ability to sell more fresh produce utilizing a proprietary design for solar-powered large commercial refrigeration. Their solution has democratized high upfront cooling storage capital expenditures with a low-cost model which allows a retailer to preserve **30-40 Kilograms of produce as 0.50 USD per crate per day.** Each Fresh Box unit can accommodate more than **70 crates providing up to 25%** earning potential for marketing vendors.

- **Kuza Freezers**

Overview: Kuza is a business focused on offering solar powered freezers known as "Kuza Freezer". The Kuza Freezer solution enables the rural fishermen to effectively deal with the huge challenge of post-harvest losses by offering affordable and reliable cooling services. Unfortunately, most small-scale fishers are unbanked and lack access to credit in order to invest in cold storage equipment. Additionally, many of the fishing-dependent communities are either off-grid or do not have access to reliable and affordable electricity to run such equipment, as only 30 percent of the Kenyan population have access to reliable electricity. They offer their product on a pay-as-you-go payment model where the users are required to pay a **20% deposit followed by a daily installment of 2 USD for 12 months,** after which they fully own the freezer. The business targets women fish vendors who are in the secondary and tertiary levels of the fish value chain.

- **Cold Hubs: Nigeria**

Overview: ColdHubs, is a "plug and play" modular, solar-powered walk-in cold room, for 24/7 off-grid storage and preservation of perishable foods similar to Fresh Box & Soko Fresh. This solution extends the freshness of fruits, vegetables, and other perishable food from 2 days to about 21 days.

Deployment Model: Cold Hubs' solution is designed to operate in rural rugged terrains. They have strategically located their cold rooms in major food production and consumption centers i.e. large markets & farms in Nigeria within reach of farmers and retailers. Their business model is a 'Flexible Pay as you store' subscription in which customers pay **0.50 USD per crate per day.** Their solution focuses on job creation for women.

BUSINESS TO BUSINESS (B2B)

B2B businesses target wholesalers, aggregators, exporters, and other large businesses along the value chains offering medium to large scale cold/ cooling solutions.

- **Cold Solutions**

Overview: Cold Solution provides services which include temperature-controlled storage ranging from ambient to chilled to frozen (20° C to -40° C) temperatures, blast freezing, food processing, the latest technology in warehouse and logistics management systems. This allows their clients to keep track of their product in real-time and transportation across East Africa through temperature-controlled trucks either within inner-city or long-haul destinations. They focus on clients in the agrifoods, fish, meat, food manufacturing, supermarkets, pharmaceuticals, and Hospitality value chains. Their solutions are tailored to clients' needs and scale.

- **Inspira Farms**

Overview: Inspira's focus is to reduce shrinkage, provide extended shelf life and ensure maximum capture of the best harvest quality possible. Its cold room and pre-cooling solutions are designed by firstly considering the type of fruit and vegetables and their specific requirements on cold chain management. Each solution is delivered with a specific configuration on temperature, pressure, relative humidity, and airflow to maintain freshness as quickly as possible. They also provide agribusinesses, exporters, and food distributors with sustainable growth solutions for handling their fresh produce, that significantly cut energy costs, reduce food losses and come ready to meet the major international food safety certifications. Inspira also allows remote performance monitoring for their clients who have multiple facilities.

UPCOMING COLD/COOLING CHAIN PROJECTS

Projects in the pipeline yet to become established businesses including The Green Initiative - The Fish Cooling Store and The Eco-friendly storage project:

- **The Eco-Friendly storage Project**

The Eco-Friendly Cold Storage project offers affordable, off-grid cold storage technology to increase the availability of fresh fruits and vegetables. The technology uses Zero Energy Brick Cooler (ZEBC) and Evaporative Charcoal Coolers (ECC) made from 100% locally available eco-friendly materials such as river soil and invasive shrubs to minimize environmental impact. Eco-Friendly Cold Storage aims to promote a community-driven approach at marketplaces such as shared service to increase affordability, scalability, and pathway for other initiatives, including the creation of Village Savings and Loans Associations.

- **The Green Cooling Initiative - The Fish Cooling Store**

The Fish Cooling Store is a project established in the Lake Victoria region. It aims to reduce the negative environmental impact caused by typical storage facilities while providing cooling solutions to fishermen. It does this by optimizing its cold stores such that they are well insulated, decreasing energy consumption and other negative environmental effects.

Learnings: Summary from Secondary Research

'Pay-as-you-store' model

This was noted to be the predominant business model were adopted by Soko Fresh, FreshBox, ColdHubs, and Solar Freeze to enable affordability of cold-rooms by smallholder farmers and ensure the use of the cold rooms to maximum capacity and multiple farmers access and share the facility.

Strategic Operation Locations

The cold storage value offering should be strategically located or incorporate a mobility element to create convenience and easy reach for the end-users.

Price Sensitivity

The solutions in the above case studies if predominantly focused on the bottom of the pyramid mass market, therefore all providers offer a pricing strategy that is consumer sensitive.

Incentive-based Market Penetration Strategy

Early adoption of a cold storage solution service can be increased if the offering has added incentives such as other value chain services, for example, logistics and market linkages, furthermore communal benefits such as education training & local employment opportunities.

Cold Storage Focus

Most cooling solutions providers offer off-grid cold rooms rather than the production and selling of ice, specifically for agri-food preservation. Furthermore, an off-grid, solar-power setup is preferred due to the widespread challenge of constant power blackouts in African countries.

B2B Focus is not community-oriented

Main established large scale cold storage solutions providers such as Inspira Farms and Cold Solutions East Africa do not run 'shared models' and primarily engage larger businesses such as wholesalers and exporters. This reduces the impact to small scale value chain actors who are not able to access these cold chain solutions.

Insights from Field Research: Cold Chain Landscape

Cold Chain Solution	County	Location	Ownership / Manage-ment	Status	Energy Source	Product Pricing Structure	Challenges
Ice Flake Production	Homa Bay	Mbita	Plant 1 - Private	Active	Main Grid Electricity	KES 850 per 90Kg	• High cost of energy reduces production time • Affected by electricity blackouts
			Plant 2 - Private	Active	Solar	KES 1000 per 100kg	• Not in an ideal location, hence transportation cost incurred by consumers
			Plant 3 - Private	Active	Main Grid Electricity	KES 700 per 90Kg	• High cost of energy reduces production time • Affected by electricity blackouts
			Public - Government	Closed Down	-	-	-
		Sindo	Private	Active	Main Grid Electricity	KES 50 for 20liters filled jerrican	• High cost of energy reduces production time • Affected by electricity blackouts • Seasonality of fish affects demand
		Mfangano Island - Sena	Private	Closed Down	Main Grid Electricity	-	• High cost of energy and poor management lead to closure
		Mfangano Island - Mlundu	Private	Active	Main Grid Electricity	KES 600 per 50kg	• The plant is located far from the fish landing beaches and poor road infrastructure leads to the high cost of transportation

Cold Chain Solution	County	Location	Ownership / Manage-ment	Status	Energy Source	Product Pricing Structure	Challenges
Ice Flake Production	Siaya	Uhanya	Private	Active	Main Grid - Electricity	KES 50 for 10liters filled jerrican	• Affected by electricity blackouts
		Wich Lum	Public - Government	Closed Down	-	-	• Building facility submerged in the lake
	Migori	Sori	Public - Government	Not Active Under Construction	-	-	-
Ice Blocks	Homa Bay	Sindo	Private	Active	Solar	KES 50 per block	• Small Scale operation can only manufacture 10 blocks in 24 hrs
	Migori	Sori	Private	Active	Main Grid Electricity	KES 50 per block	• Affected by Electricity blackouts • Small Scale operation - can only manufacture 10 blocks in 24 hrs
	Siaya	Budalangi	Private	Active	Main Grid Electricity	KES 100 per block	• Affected by Electricity blackouts
Cold Room	Homa Bay	Homa Bay	Public	Active	Main Grid Electricity	KES 10 per fish	• Affected by Electricity blackouts • Poor sanitation standards affecting quality of produce stored

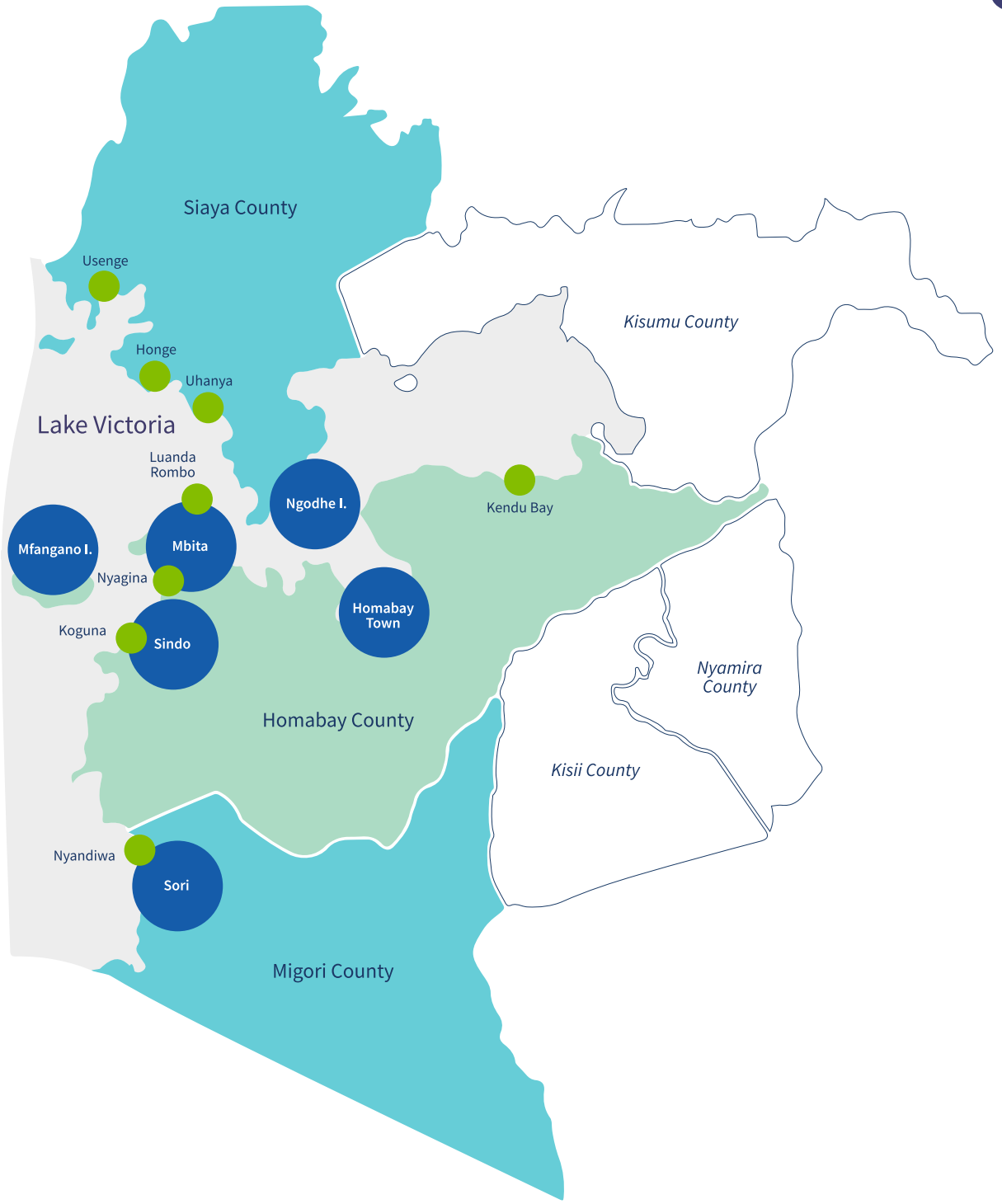
FISH VALUE CHAIN HEAT MAP

Major Fish Locations

- Homabay Town
- Mfangano Island
- Mbita Town
- Sindo Town
- Ndodhe Island
- Sori Town

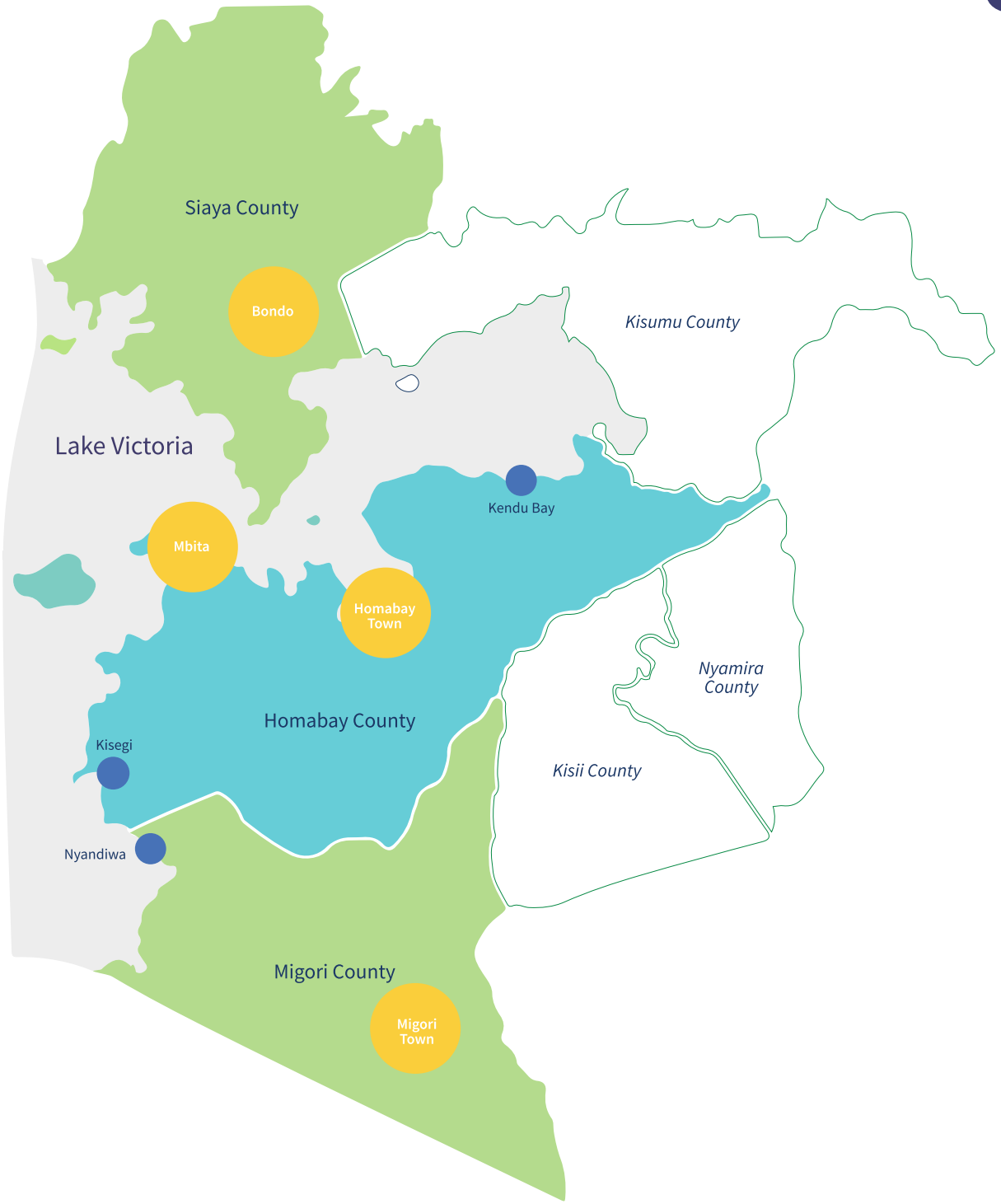
Minor Fish Locations

- Usenge
- Honge
- Uhanya
- Kendu Bay
- Koguna
- Nyagina
- Luanda Rombo
- Nyandiwa



AGRIFOODS VALUE CHAIN HEAT MAP

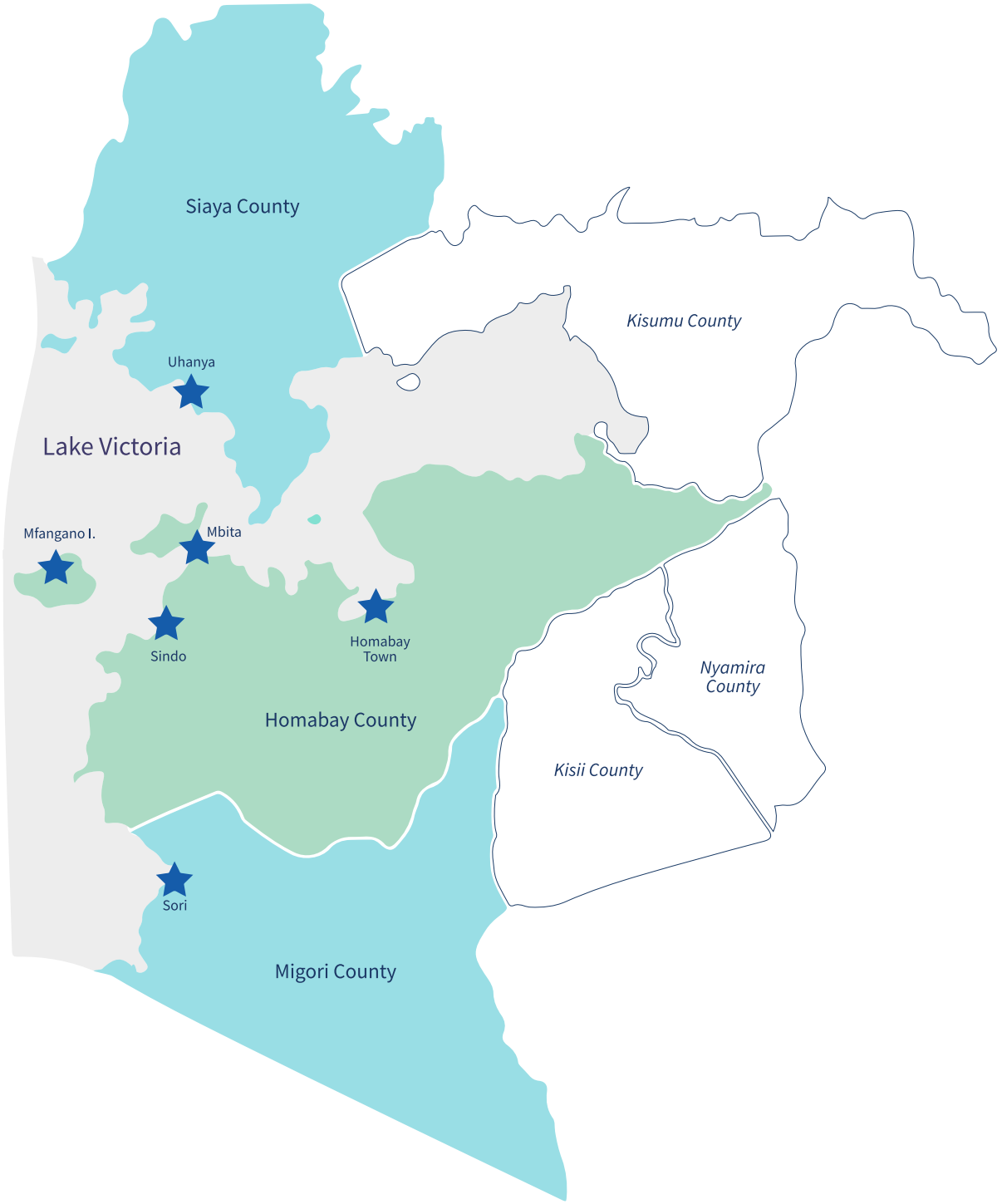
Major Agrifood Locations	Minor Agrifood Locations
• Bondo Town • Mbita Town • Homabay Town • Migori Town	• Kendu Bay • Kisegi • Nyandiwa



COLD CHAIN PROVIDERS MAP

Ice Production Locations

- Honge Town
- Mbita Town
- Sindo Town
- Homabay Town
- Mfangano Island
- Sori Town



STAKEHOLDER ENGAGEMENT: FINDINGS & INSIGHTS

Stakeholder Engagement: Across the region

we spoke to **185** stakeholders

FISH VALUE CHAIN

Stakeholder Type

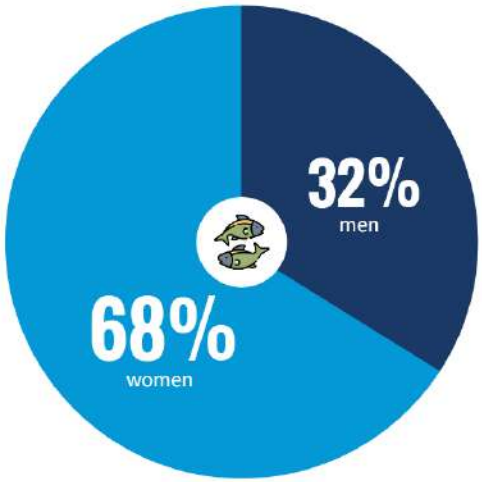
- Fish Crew
- Boat Owners
- Beach Management Officials
- Fish Traders - Wholesale/ Aggregators
- Transporters
- Cold Chain Service Providers - Ice Producers
- Customers
- Ministry of Fisheries County Officials

Engagement Type

73 Field Interactions e.g Brief Interviews.

25 Co-design Workshops / Focus Groups

Co-design Workshops / Focus Groups



AGRIFOODS VALUE CHAIN

Stakeholder Type

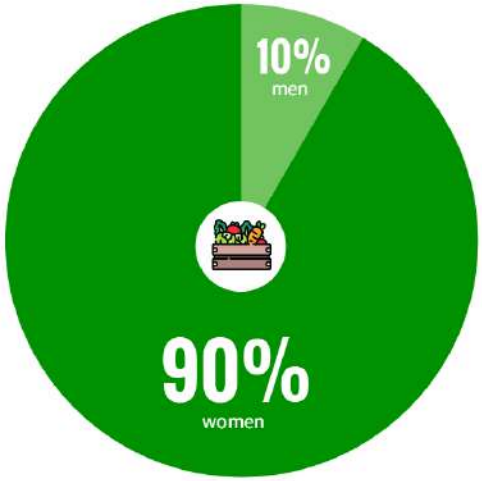
- Farmers
- Transporters
- Market Traders - Wholesalers
- Market Trader - Retailers
- Market Association Management Officials

Engagement Type

54 Field Interactions e.g Brief Interviews.

33 Co-design Workshops / Focus Groups

Co-design Workshops / Focus Groups



A look at the Personas in the Fish and other Agri-food Value Chain

Ben Rollins

Boat Crew / Fish Trader

Homa Bay: Ngodhe Island

Age

36

Bio Data

Married with 4 children

Gender

Male

Bio

- Ben has been a fisherman for 20 years
- He's originally from Mbita but works in Ngodghe

Challenges

- The lack of ice is being felt more by fish traders than fishermen.
- Flactuating prices of fish lead to inconsistent income.
- Transporting ice from Mbita to Luanda Rombo to Ngodhe island is a challenge.
- The cost of transporting ice only for it to not be enough / to melt on the way is posing a great challenge.
- Shortage of ice has really affected the quality of fish that Ngodhe island sells.

Concerns

- If the fish is spoiled, the price goes down from KES 350 per kg to KES 150.
- He is experiencing spoilage on the boat because of the sun. Despite their efforts to shield the fish under the fishing nets, it still affects their overall freshness.

When the fish is exposed to the sun for long hours, it makes the fish go bad. It's something we cannot control so the shortage of ice poses a huge disadvantage.

Goals

- To have a secondary source of income.

Needs

- Storage solutions that can fit on the boat to help in preservation during longer trips.
- An ice hub closer to them.

Suggestions

- If local ice plant could subsidize the cost of transporting ice, it would go a long way in helping them grow/expand their businesses.

Income

Earnings:

KES 10,000 - 15,000 monthly

Hezron Okoth

Boat Crew: Captain

Homa Bay: Nyangina Beach

Age

35

Bio Data

2 Wives and 9 children

Gender

Male

Sometimes we earn KES 100-150 or even nothing. Its the only work I do.

Bio

- Hezron is not only the bread winner in his family, he is also supporting his mother.

Challenges

- The overall quality of fish is dropping.
- Lack of preservation mechanism - fish caught starts to go bad as soon as it's out of the water.
- They don't have the means to buy life jackets and coast guard can arrest people for not having one.

Concerns

- Fishing locations are not consisitent. Sometimes fish move due to the brightness of the moon or because they changed diets.

Responsibilities

- Coordinated the fish sourcing process.
- Report fish landing quantities to BMU & Boat owner.
- Source for resources & fuel for the expedition.
- Responsible for the safety of the crew.

Goals

- To own a boat.
- To increase earnings

Needs

- Life jackets & Fishing gears.
- Working Capital for needs like fuel.

Suggestions

- If local ice distributors were to provide solutions, the beach would ensure to provide security and accept the rules the company has put in place.

Income

Earns:

KES 500 - 1,000 weekly

Ursula Akinyi

Boat Owner / BMU Treasurer

Homa Bay: Nyangina Beach

Bio

- Ursula used to be a fisher-woman but now owns 2 boats.

Challenges

- Crew going out and returning without a catch means she'll make a loss.
- Don't have bargaining power with clients and sometimes have to concede to selling at a loss.
- Competition for fish with neighbours on the border (Uganda).
- It's expensive to charge the lantern battery (costs KES 100 to charge one and the crew need around 8 lanterns a night).

Concerns

- Despite Solar powered lamps being more environmentally friendly than lead-acid battery powered lamps, the higher cost of using solar powered lamps versus using cheaper lead-acid battery powered lamps reduces their derived profits per catch of Omena as boat owners.
- That the youth aren't properly managing their money and can't reinvest into the community.
- The fishing lanterns they currently use go off quickly even if they're fully charged.

Age

47

Bio Data

Widowed with 4 children

Gender

Female

As a single mother, I want to see all my children educated.

Goals

- Wants to buy more boats.
- To have another source of income.

Needs

- Motors and gears for boats.
- Loans to continue paying for fish, storage and transport charges.

Income

Profit:
KES 10,000 - 15,000 monthly

Eric Isiah

Boat Owner / BMU Committee

Homa Bay: Mfangano Beach

Bio

- Isiah has owned a boat for 10 years.
- He was previously a fisherman.

Challenges

- Loss of equipment and bait to thieves.
- Boats don't leave at night because there is no ice.
- Fish move around because their diets change meaning they need to buy more fuel to cover the distance.

Concerns

- Fish changing their diet means that set out bait often goes bad.
- Safety at night because of pirates from neighbouring countries.
- The dwindling number of fish because of over-fishing.

Suggestions

- Having a cooler that fits on the boat would assist on their long-haul trips.
- That ice producers allow for individuals to purchase smaller cooler boxes for personal use.

Age

37

Bio Data

Married with 4 children

Gender

Male

Fishermen are like pastoralists.

Goals

- Wants to buy more boats.

Needs

- Motors and gears for boats.
- Battery-powered engines to help combat the price of fuel.

Income

Earns:
KES 8,500 - 15,000 monthly

Aurelia Omolo

Large Scale Aggregator

Homa Bay: Mbita Beach

Bio

- Aurelia has been selling fish in Mbita since was a teenager.

Challenges

- Consistency and timing (availability) of ice.
- No space available for additional cooler boxes in the market.
- Slim and unpredictable profits depending on the amount and quality of fish caught.

Concerns

- Her profit is dependent on external factors (e.g size of the fish, quality of the fish that arrives at the shore as fishermen need ice too etc.)
- Current homemade fabricated cooler boxes do not maintain the cooling capacity well and require more ice than a conventional cooler.

Age

26

Bio Data

Married with 2 children

Gender

Female

I don't want to risk buying ice early because it will melt before the fish arrives from the lake.

Goals

- To sell more fish because it will increase her income.
- To buy a second cooler so that she can have more storage space for fish.

Needs

- There was need for extra cold storage when she has large quantities of ice.

Income

Spend on fish:
KES 100,000 daily

Profit:
KES 20,000-25,000 monthly

Mary Oluoch

Fish trader

Homa Bay: Mainland

Bio

- Mary has been selling fish for 23 years.

Challenges

- The available storage unit sometimes goes off because of power failure and the food spoils.
- The current storage space is too small and sometimes doesn't have space.
- When the fishermen bring in the fish, it's already been sitting in the sun. By the time they put it in ice, it's already started going bad.
- Sanitation in the storage makes food spoil faster.

Concerns

- No access to ice means that the fish goes bad faster, costing them a lot of customers in the process.

Age

39

Bio Data

Married with 5 children

Gender

Female

I waste 30kg of fish per week (equivalent to KES 12,0000)

Goals

- Expand her business.
- To buy a car that will help her transport fish from Mbita to Homa Bay.

Needs

- There is no ice in Homa Bay, so they need to get it from Mbita.
- Loans to continue paying for fish, storage and transport charges.

Income

Profit:
KES 20,000 - 30,000 monthly

Jane Isaac

Fish Trader

Homa Bay: Ngodhe Island

Bio

- Jane has been a fish trader for the past 21 years.

Challenges

- Her fish goes bad as she's sourcing ice outside the island.
- She losses her catch because there in no sustainable method of preservation.

Concerns

- She used to get the ice from Mbita, but transport charges are now too expensive.
- She now has to wait for the only ice distributor on the island to stock up on the ice.

Daily Activities

- She buys fish from the fishermen, preserves it in ice and sells to the market in Homabay town, because the market in Mbita is too competitive.

Age

41

Bio Data

Mother of 4 children

Gender

Female

I can't invest in getting a cooler with ice because there may be no fish and I will end up running on losses

Goals

- She wants to sell more fish so she could expand her fish trading business.

Needs

- She needs more sustainable supply of ice to the island so that she can stock up on fish without the fear of it going bad.
- She wants a lot of ice to be sent to Ngodhe so that it addresses her main issue: Fish preservation.

Income

Earns:
KES 1,500 daily

Profit:
KES 200 daily

Edward Owuor

Fish Trader And Fisherman

Homa Bay: Mfangano Island

Bio

- Edward is the Ex-Chairman of the Mfangano BMU.
- He has been a fish trader for 20 years, but was previously a fisherman.

Challenges

- There are no ice plants on the island due to an unstable power supply.
- A bag of Ice can go for KES 100 and an additional Ksh 250 transport charge from Mbita.
- Ice from Mbita melts on the way to the island.
- They sometimes put out an order for fish when they leave at night, only to come back with their catch to find there isn't any ice.

Concerns

- They can't go fishing when getting ice isn't a certainty.

Age

36

Bio Data

Married with 4 children

Gender

Male

I don't have ice, what am I going to do with the fish? Where will I take them?

Goals

- Own a boat

Needs

- Are in need of funding/financial assistance to carry out their day to day activities.

Suggestions

- If the local ice producer has the capacity, they would appreciate a plant on the island as there currently isn't one.
- Implement a sustainable solar cooling solution because of their previous challenges with electricity.

Income

Earns:

KES 500 daily

Collins Odhiambo

Beach Management Unit /
Large Scale Fish Trader

Homa Bay: Sindo Beach

Age

34

Bio Data

Married with 8 children

Gender

Male

Bio

- Collins was born and raised in Sindo Village.

Challenges

- Fishermen can be in the waters for 3-5 days. By the time they return to shore, the fish may have already gone bad because they don't have any ice or means to preserve the fish immediately they catch them.
- The fishermen incurs great losses if the quality of omena is found to be bad. As a result, a tin of omena going for KES 200 ends up costing KES 50.
- Access to ice on a regular basis is a challenge becuase of the opening /closing times & distance of the ice plant.
- Ice obtained from local distributors melts too fast. Sometimes they resort to pouring salt on it in a bid to extend its lasting capacity.

Concerns

- The decline of the amount of fish in the lake.
- When it rains, traders can't dry the omena in the sun and as a result make a loss.
- He is guaranteed to lose 30%-40% of his earnings due to post harvest loss.

This is a very delicate business. Refrigeration should in fact start immediately when the fish is caught from the lake.

Goals

- He is keen on coming up with new and innovative ways of preserving omena.

Needs

- Local ice distributors should consider setting up a cooler station right on the beach or to add more cooler boxes in order to cut down on the cost incurred by the fish traders when buying and transporting the ice to the beach.
- Expressed a need for drying racks. Omena drying on the ground in unsanitary.
- There is a need to integrate any outside interventions with community Interest.
- The quantity and quality of omena has declined on an alarming rate.

Income

Earns:

KES 50,000 monthly

Margaret Mboya

Ice Distributor

Homa Bay: Ngodhe Island

Bio

- Margaret has been residing in Ngodhe for the last 25 years.
- In addition to selling ice, she is a fish trader.

Challenges

- Fuel prices have affected ice prices because of transportation costs.
- Sometimes the fish goes bad because of low ice availability, so it needs to be sold at a throw-away price.
- When she has to resort to drying for preservation, the price of a kg drops from KES 320 to KES 200.
- A lot of expenses are incurred in buying ice (Transportation, people that carry the fish from the cooler to the boat, to the car, to the market have to be paid by her)

Concerns

- The local ice distributor doesn't fill the sacks of ice. This results in low profits when she sells the sack.
- The ice affects her health because of the cold.

Goals

- To expand her business in order to make a bigger profit

Age

44

Bio Data

Married with 7 children

Gender

Female

At Ngodhe, we are all relatives. We help each other financially and in kind. There is a strong sense of community.

Needs

- She wants daily loans from the local ice plant in order to continue picking and selling ice for them. She believes that she can pay them back once people buy ice as she has been a trusted agent.
- She needs more coolers at the beach to ease her ice selling business and to cut expenses.
- She wants the local ice plant to provide her with equipment to handle the ice so that she doesn't fall sick (gloves and shovels).

Income

Earnings:
KES 8,750 weekly

Profit:
KES 1,200 weekly

Amollo Peter

Ice Plant Operator

Siaya County: Uhanya Beach

Bio

- Amollo started off as an ice handler. He has recently benn promoted to a plant operator.

Challenges

- Power outages are as frequent as daily.
- Regular operating cost are too high due to high cost of electricity.

Concerns

- They won't be able to meet their daily quotas due to circumstances out of their control.

Operation Statistics

- Capacity of machine output is 3 tonnes.
- Power requirement is 3 phase AC supply.
- Currently using a CBFI machine made in China, for their daily operations.
- They are charged by the electricity provider on a post-pay basis.
- Average cost of power supply ranges from KES 20,000 to KES 80,000 depending on the month's production.
- They have no AC units in the Ice storage container.

Age

30

Bio Data

Married with 3 children

Gender

Male

We have been looking into a backup solution due to the frequent power outages in the area.

Goals

- Ensuring ice production run with no interruptions and being able to open another ice plant.
- He is keen on getting more information on solar power as a backup solution for them.

Needs

- He requires an alternative source of energy to run the ice plant.
- A back up solution to run the ice production plant.

Income

Ice plant earnings:
KES 15,000 daily

Amollo's salary:
KES 25,000 monthly

Vincent Mito Otiyu

County Government Official

Siaya County: Uhanya Beach

Age

36

Bio Data

2 wives with 5 children

Gender

Male

We are working towards training the fishermen to be in groups like Cooperatives or Sacco's.

Bio

- Vincent was originally a member of the Uhanya Beach BMU committee.

Challenges

- Determining how they will relocate the Usenge Beach cold storage facility due to frequent flooding.
- Moving the cold storage room to higher ground.

Opportunities

- Grouping of the various stakeholders in the two value chains (direct and indirect beneficiaries of the ice value chain).

Goals

- Relocating the beach and its facilities to a place that won't be as susceptible to flooding.
- Assist fishermen to create unions that will help them dictate market prices as well as providing fishermen with fishing gear

Needs

- They need more collaboration with local organization to help uplift the community and aide their efforts.

Initiatives

- Ongoing & future Agri-food plans:
- Fund allocation to farming groups
- Training groups of farmers
- Consulting with groups of farmers
- Some of the initiatives taken to assist Fishing Stakeholders:
  - Construction of fishing stalls in some areas
  - Setting up cold room storage in Usenge Beach

Lucy Nyakech

Vegetable Trader

Homa Bay: Mbita Vegetable Market

Bio

- Lucy is originally from Rusinga Island and commutes to Mbita everyday to run her stall.

Challenges

- Loss of produce due to inadequate storage.
- She is only able to stock green vegetables as they have a longer shelf life unpreserved.
- She hardly breaks even and would need loans for continuous growth.
- No access to a shared cold storage unit.

Concerns

- Her current method of preserving vegetables, by dipping them in water, is not sustainable.
- The excessive amount of produce going to waste.

Suggestions

- The current cooler provided to the market is assumed to be under the ownership of one person. Lucy suggests providing more so it can benefit the larger market community.

Age

23

Bio Data

Married with 2 children

Gender

Female

“The customers are a few, so I end up throwing the vegetables and the loss is still counted

Goals

- To be able to expand her stock when cold storage is made available.

Needs

- Access to cold storage would help a lot of sellers expand the range of vegetables/fruits they stock.
- Loans or payment plans to help her afford storage.

Income

Stocking costs:

KES 30,000 per week

Profit:

KES 2,550 - 4,500 weekly

Jackeline Ogolla

Vegetable Trader

Homa Bay Town

Bio

- Jackeline started her business before she had children. Her eldest in now about to finish high school.

Challenges

- She sources some of her produce from Twiga and Riosir in Kisii as well as Homa Bay meaning she has to incur transport charges.
- Some of the produce she buys locally is already yellow/wilted because distributors don't use cold storage.
- Buys a crate of vegetables for roughly KES 3,000 to KES 5,000 a week and doesn't always break even.
- Since moving to the new market built by the government, they haven't had as many customers.
- Sometimes pests affect their produce.
- Some of her produce spoils faster than the rest and can't be stored together.

Concerns

- The economic inflation is making them increase their prices, but they are losing customers as a result.

Age

37

Bio Data

Married with 8 children

Gender

Female

"I'm paying taxes and sometimes the goods may stay longer and become affected by aphids

Goals

- To expand her existing business and open others.

Needs

- There is currently no cold storage solutions for people in the market.
- Financial assistance to expand her business and make more profit.

Income

Earns:
KES 7,000 per week

Profit:
KES 1,700 per week

Morris Oyugi

Vegetable WholeSaler / Market Vice Chairman

Homa Bay: Mbita Vegetable Market

Bio

- He has been in the market for 15 years selling onions, garlic, tomatoes, potatoes and chicken.
- He owns 3 acres of a tomato farm and has 7 employees.
- He usually pumps water from the lake to his farm.

Challenges

- There is not enough space in the market to install a cooler station despite the dire need.
- The cost of running his stall is high.
- Because the walk-ins are low, his customers are forced to carry their vegetables and walk to the the lake to try sell them. If they can't, they won't have the money to buy more produce.
- Shortage of rain forces him to irrigate using the lake water.
- Financial strain to buy equipment for irrigation.

Concerns

- The cooler box donated is hardly enough to cater for all the vendors.
- Due to lack of storage, the market vendors aren't functioning at full capacity and it has a domino effect on his business.

Age

47

Bio Data

Married with 3 children

Gender

Male

The vendors have created self help welfare unions to help them survive.

Goals

- His wife primarily runs the market business as he is majorly in the farm. He is hoping for capital to be able to grow both facets of their business.

Needs

- They are in need of drinking water as they usually drink salty water from a borehole constructed nearby.
- A storage solution to help his produce stay fresh for longer, but also to assist the businesses of the vendors in the market.

Income

Sells 17 -20 crates per season (2-3 months)

KES 2,000 - 3,000 per crate

Edward Ongoro

Market Association Chairperson

Homa Bay: Mbita

Age

78

Bio Data

Married with 8 children

Gender

Male

Bio

- Edward has been the M.A.C since 1986
- He earns a living by making traditional charcoal stoves.

Challenges

- Low rainfall due to climate change affects the quality of produce they recieve at the market.
- Lack of capital for general up-keep.
- Spoilage occurs when they don't have customers.
- No cooling interventions available.
- Farmers claim money from the traders, yet traders are making losses due to low sales as a result of inadequate preservation.
- They source alot of produce from Migori & Siaya so we bear alot of transportation costs.

Concerns

- The amount of food that goes to waste weekly because inadequate storage means they are no longer appealing to customers.
- Market traders suffer major losses due to this.

There is no solution for wastage

Goals

- Seeking access to export markets where local produce can be sold.
- Advocates for a cold room.
- To seek partnerships that help the market traders.

Needs

- Cooling storage for the market.
- To improve the amenities of the market.
- Provision for capital for market traders

Income

Earns:
KES 25,000 - 30,000 monthly

Zainab Catherine

Soda Trader

Homa Bay: Mfangano Island

Bio

- Zainab moved to Mfangano from Mombasa after marrying her husband.
- She has been selling soda for 30 years.

Challenges

- Sometimes the ferry doesn't bring gasoline for the generators, rendering her fridge useless.
- There is often a lull in business when it rains because nobody buys soda.
- Fish trading affects her business. If they don't catch fish, they don't make money and as a result, they don't buy soda.

Concerns

- If fishermen don't get proper means of preserving their fish, they'll loose money and won't be able to frequent her store.
- Lack of electricity means the soda doesn't stay cold and she won't attract her usual customers.

Age

40

Bio Data

Married with 10 children

Gender

Female

We only have ourselves, so it gets hard sometimes

Goals

- Her income has already helped her pay bills, build a house and start other businesses. She is hoping to continue on this trajectory.

Needs

- There is a need for cold storage solutions using solar energy.
- More affordable power source.

Income

Spends:
KES 900 per crate

Profit:
KES 150 per crate (weekly)

Value Chain Stakeholder Inputs: Observations, Challenges and Opportunities

A summary of the value chain stakeholder inputs; including their role in the value chain, their current experience, the challenges they face, the opportunities for solar cooling solution intervention, some ideas for the solar cooling models, and constraints and future considerations for the potential model to succeed.

FISH CHAIN STAKEHOLDERS

Stakeholder:

Fish Crew and Fish Crew Managers

Value Chain Stage and Role:

Fish Sourcing & Fish landing

> *Fish from a fridge is not fresh and tasty.*

Challenges

- Crews have no fishing gears & materials
- They have no saving facilities and end up depleting their working capital
- Shifting fish locations leads to lack of consistent catch
- Low catch due to overfishing & illegal fishing
- Harassment from local authorities
- Inconsistent fish catches
- High substance abuse by fish crew

For crew managers

1. Difficulty to account for catch value upon landing due to lack of visibility on market prices further along the chain. Hence sell catch at low prices.
2. Crews require fishing gear such as life jackets and the appropriate nets which in turn make the fish sourcing process dangerous.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Access to ice/cooling solution when going for fishing • Access to portable storage • Collaborations with fish aggregators and small scale fish traders **For crew managers** • Training on use of portable coolers for preservation of fish	• Make it possible to access portable boat cooler boxes. • Sourcing of ice or supply of ice from aggregators or small scale fish traders or from the beachers from ice distributors.	• Low earning potential from current fishing activities. • Unconcerned about use of preservation methods.

Stakeholder:

Beach Management Unit (BMU)

This is a very delicate business. Refrigeration should in fact start immediately when the fish is caught from the lake.

Value Chain Stage and Role:

Fish Landing

- They tax the fish crew landing on the beach: 10Ksh per kg.
- They keep a registry of daily fish catch at the beaches.
- First point of contact at the beaches.
- Incharge of the beach operations; relating to the fish (enforcing bylaws from the national BMU).

Current Challenges

- Nomadic nature of fishermen reduces ability to consolidate development funds from the membership
- Political ambition of individuals inhibits community development (in office for 4 years)
- There is discord among neighboring BMU's, resulting in misaligned goals in the region.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Mobilize members to acquire cooling solutions at the beaches (storage solutions). • Help ensure security for cooling solutions. • Use cases for the islands. • Help with ice transportation or fish transportation across islands.	• Partnership with organizations to provide microfinance to members. • Set up of cooling storage facilities at the beaches. • Set up of ice distribution centers at the beaches.	• BMU officials changes leadership after 4 years; so factor consideration on changing manifesto and priorities. • Political ambition/ individual interests of officials can be a barrier. • There is no collaboration between different BMUs that could potentially create a larger impact.

Stakeholder:

Small Scale Fish Trader

Value Chain Stage and Role:

Fish sourcing and Distribution
They buy fish from the fish landing - at the beaches/ fish bandas or fish aggregators or women fishmonger groups and sell directly to consumers.

> ***If you store 20 fish in the cold room that is available, about 4 fish go bad.*** *(Homabay Fish Market)*

Challenges

- Small scale fish traders have no access to cooling facilities.
- There is no visibility on pricing or quality of fish sourced.
- Traders experience post-harvest loss as a result of spoilage during fish sourcing & landing.
- The high cost of transportation when sourcing for ice.
- They experience the inconsistency of customers.

Contextual challenges

Island:
Fish traders in the islands experience the following unique challenges:
1. Islands are off-grid.
2. Access to ice/cooling solutions.
3. Transportation costs.
4. Irregular availability of ice.

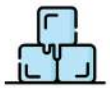
Mainland:
Fish traders at Homabay market (which has a shared storage facility) experience the following unique challenges:
1. Current facility is small, unregulated and not well maintained.
2. Sourcing of already spoilt fish.
3. Health and sanitation and cooling conditions not ideal.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Provision of ice at market centers. • Cooling solutions to support fish transportation (from fishermen/fish landing to the market). • Cooling solutions to support fish storage at the market (to allow traders to sell fish at the right prices, and also in good quality for human consumption). • Redesigning current shared cooling solutions available in the market.	• Design and production of small scale cooler boxes (for fish transportation and storage). • Research of new cooling solutions in the market (shared cooling solutions). • Due to the high cost of cooler boxes, there can be a pay to own installment model or leasing that allows access to the willing traders.	• The cost of cooler boxes. • Model of cooler supply (Leasing Vs Buy to Own) • Current consumer behavior around the price sensitivity for viability. • Political factors and influence when it comes to setting up models in the market. • Infrastructure and power. • Security for the cooling solutions . • Influence and role of women associations and saccos. • No guarantee of quality or status of fish supplied by fishermen to the traders • Branding of cooling solutions (cooler boxes) is important to create that identity for the provider and market awareness to potential consumers.

Stakeholder:		
Transporters (Ice & Fish)		*We depend on the fish catch, more catch guarantees demand for transportation.*

Value Chain Stage and Role:	Current Challenges
Fish & Ice Distribution	• High cost of fuel affects • demand for transport • Poor infrastructure limits reach to particular location

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• High cost of fuel affects • Demand for transport • Poor infrastructure limits reach to particular location	• Distribution (Collection & Drop off) locations for the portable cooler boxes to allow for passenger transport.	• Cost of portable ice boxes should be affordable.

Stakeholder:		
Ice Producers		*Power outages happen daily. We have been looking into a backup solution due to the frequent power outages in the area.*

Value Chain Stage and Role:	Current Challenges
Fish Sourcing and Distribution	• High cost of electricity, resulting in high operation costs. • Operational hours not guaranteed. • Ice producers are in need of methods of storing ice (after production).

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Partnerships and collaboration with other ice producers.	• Conversion of energy source from main grid to solar powered to lower costs. • Collaboration with other ice producers (leveraging solar).	• Interests and competition.

Stakeholder:

Ice Distributors

Value Chain Stage and Role:

Fish Sourcing and Distribution
They source ice from producers and sell them to consumers (fish traders, aggregators, boat owners, fish women groups).

> *I don't have enough money to purchase a sack of ice. Can we get discounts for the ice due to the transport costs incurred?*

Challenges

- Distributors are in need of working capital to purchase ice consistently
- High cost of transportation for ice from production plant
- As a result of low awareness, distributors experience inconsistent customer turnout.
- They experience lack of entrepreneurial spirit in some cases
- Unsafe handling of the ice (no existing ice-handling equipment

Contextual challenges for the islands include:

- Significant transportation cost to source for ice from mainland
- On the islands there is an apparent deficit of cooling storage facilities.
- Majority of ice plants have closed down due to high cost of operation - Case of Mfangano Island

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Provision of cold/ cooling storage • Ease of access to ice	• Value added support: ice handling equipment, packaging materials etc. • Redesigning around efficient ice transport/supply model.	• High transportation costs especially for ice distribution on the islands.

Stakeholder:		
Consumers/Customers		*Fish from a fridge is not fresh and tasty.*

Value Chain Stage and Role:	Current Challenges
Fish Consumption	• High prices for fish products • Inconsistent availability of fresh fish

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Preservation solutions at home	• Cold storage at market locations to preserve freshness of fish.	• Some consumers are skeptical of food stored in fridges or cold storage due to cultural preconceptions.

Stakeholder:		
Ministry of Fisheries / County Government Officials		*We are working towards training the fishermen to be in groups like Cooperatives or Sacco's.*

Value Chain Stage and Role:	Current Challenges
Entire Value Chain They regulate use of legal fishing gears. They dictate & regulate fishing locations to allow for sustainable fishing.	• Long decision making process • Resources to set up high quality storage/fish processing • Effectively collaborating with fisherfolk

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Can support with licensing for operations • Can support with resource allocation such as land	• Willing to work with fishermen in organized groups cooperatives. • Will provide legal fish gears to these cooperatives.	• Considering climate change, with rising water levels around the region, when planning and installing the various infrastructures on the beaches of the region.

Stakeholder:		
Fish Processors		*We make our own ice flakes but due to the high energy cost sometimes it is not enough for the fish we source.*

Value Chain Stage and Role:	Current Challenges
Fish Processing & Distributions These are companies that carry out fish value addition activities. They source fish using trucks from various aggregation locations in the region.	• High cost of operations - electricity • High cost of logistics to market • The fish they receive for processing is unable to meet international quality standards hence no access to export markets • Uptake consumption of processed fish locally is low • Increased competition from other fish locations in Kenya

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Potential partnership for sourcing bulk ice as part of the fish collection process.	• Designing sustainable energy solutions that can be incorporated into their existing operations, this will boost the provision of cooling solutions such as ice production.	• Fish processors run the risk of bargaining for lower priced cooling solutions due to their economies of scale factors. This can affect the business sustainability of a cooling service/ product provider.

Stakeholder:		
Cage Farmers		*We sometimes need to source ice from other producers due to high yield from cage farming, generally requiring more ice than we can produce.*

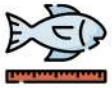
Value Chain Stage and Role:	Current Challenges
Fish Sourcing, Landing and Distribution	• Shifting market prices of free roam sourced fish affect revenues • Quality of fish is not the same as free roam fish • Security at the lake around the cages can be a challenge • Depending on the quantity harvested from the cages, the ice produced is not enough, therefore more ice is sometimes required to be sourced from other ice

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Partnership for sourcing of bulk ice.	• Setup of ice distribution at major fish landing centers where the cage farmers land their catch.	• Interests and competition

Stakeholder:		
Boat Owners		*We as boat owners we only depend on this lake. The crews are like nomads.*

Value Chain Stage and Role:	Current Challenges
Fish Sourcing & Landing They bear the initial cost of the expedition of fuel and resources. Their interest is to get a large catch and have the crew land with the fish still fresh.	• Risk of unsuccessful catch • High cost of expedition resources (fuel and food) • Risk of shrewd fish crew stealing catch or fish maws • Risk of boat being impounded by authorities • Ice purchased in sacks for long expeditions melts when in the boat due to exposure to direct sunlight and water.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Have the financial power to purchase portable cooler boxes to reduce spoilage from harvest • Have easy access to ice from producers, distributors or fish aggregators	• Portable cooler boxes that can store ice and fish and can be given to the fish crew. • Accessing ice from the beaches or ice distributors conveniently.	• Cost of the portable cooler boxer should be affordable • All time access to ice at distribution locations to facilitate the expeditions for their boats

Stakeholder:		
Fish Aggregators		*When I don't have ice, what am I going to do with the fish? Where will I take them?*

Value Chain Stage and Role:	Current Challenges
Fish Sourcing & Distribution They purchase fish from several suppliers and aggregate the fish in the markets before supplying them in larger quantities to other sellers, mostly across the country. Their average daily aggregation size is between 500kg to 1 tonne.	• Post-harvest losses are incurred due to spoilage resulting from lack of access to ice for preservation • Inconsistency of fish supply from the lake • Limited storage space in the market • Fluctuation of fish prices. • Current coolers can't preserve fish for long or in good quality over tie.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Ready and consistent supply of ice for preservation in the markets • Shared cold storage to allow for a larger quantity of ice to be stored • Potential redesign of current coolers used by the aggregators.	• Additionally ice facility powered by solar to supplement available ice producers (power outages). • Shared cold storage space for extra fish storage if they secure a larger catch. • Newly redesigned coolers that can preserve fish for longer and can fit into the available space in the market as well as can be secure.	• Space availability and security concerns in the market for the new cooling solutions. • Fluctuating fish catch quantity may render the bigger facility not viable.

AGRI-FOODS VALUE CHAIN STAKEHOLDERS

Stakeholder:		
Market Traders (Wholesalers/Aggregators)		*Cooling solutions are not for everyone in the market. For someone like me, I don't need it as my stock can be stored without putting it in the coolers. My stock is seasonal.*

Value Chain Stage and Role:	Current Challenges
Sourcing and Distribution	• High transportation cost to source for foods from various locations • Significant losses due to spoilage (30-40%) in the production and first mile handling • Vendors use the lake water to dip their vegetables, attempting to keep them fresh. This method is unsustainable and not effective • The cost of running the stall is high • There is not enough space to install a cooler station despite the dire need.

Opportunities for solar cooling solutions	Suggestions *(ideas of what cooling solutions might be)*	Considerations *(future constraints and risks)*
• Considering the large quantities of food produce they handle. The traders could use a mobile cold storage truck to transport the produce from the farm and a large cold chain facility (warehouse) to store aggregated produce as they seek market or meet export quotas.	• Shared cold storage facilities near or in the market location and mobile cold trucks.	• Cost or pricing for the cooling solutions and ease of access to major road infrastructure.

Stakeholder:		
Farmers 	*When I harvest my farm I have a full truck of tomatoes but little market to sell to so I just have to give the community and the rest I just throw.*	
Value Chain Stage and Role:	**Current Challenges**	
Food Production	• Post harvest losses are brought about by a shortage of storage facilities • Production of similar products by farmers in area leading to high supply and low prices • Climate change affecting overall yield • Poor road infrastructure reduces access to markets • Financial strain to buy farming equipment and inputs	
Opportunities for solar cooling solutions	**Suggestions** *(ideas of what cooling solutions might be)*	**Considerations** *(future constraints and risks)*
• Cold chain storage at first mile allows farmers to seek better prices • Farmers can supply markets for longer periods	• Cold storage mobility vehicles (trucks)	• Storage as a service model pricing should be affordable and accessible to the farmers.

Stakeholder:		
Market Association Management 	*The cost of running a stall is costly to the vendors as they pay approx KShs 500 a month (300 in stall rent and 50 a week in market fees). They don't make enough profit to comfortably take on that expense.*	
Value Chain Stage and Role:	**Current Challenges**	
Entire Agrifoods value chain	• Provision of clean drinking water to the market vendors. • Require more cooler boxes to cater to the large number of vendors.	
Opportunities for solar cooling solutions	**Suggestions** *(ideas of what cooling solutions might be)*	**Considerations** *(future constraints and risks)*
• Partner in the installation of cold storage facility.	• Cool rooms or facilities that are setup at the market center for use through a shared model.	• The management changes every few years hence, there is the risk of individuals officials potentially sabotaging the cold storage if it does not align to their interests.

Stakeholder:		
Market Traders (Retailers)		*The cost of transport affects my profit margins. The green vegetables take about two days before they are rotten.*

Value Chain Stage and Role:	Current Challenges
Sourcing and Distribution	• Traders are sometimes faced with a noticeable shortage of customers • Traders encounter an overt need of working capital • Perishability of agrifoods • Fuel increase resulting to higher transport costs • Sanitation concerns, as vegetables left out are often walked on by birds and cats • Unique challenge • Security concerns in the existing shared storage in Bondo Town Market

Opportunities for solar cooling solutions	**Suggestions** *(ideas of what cooling solutions might be)*	**Considerations** *(future constraints and risks)*
• The traders have small savings groups that can allow them to purchase cooling products if pricing is affordable.	• Cold storage facilities at the market centers	• The pricing structure should be flexible to accommodate those who do not make sales on a daily basis but require storage • Membership models could be an option for those whose working capital fluctuates.

Other Fish Value Chain Insights

Socio-political Factors

a.) Advocacy for engagement and inclusivity

Western Kenya region has very high potential for investors focused on areas that support both fish and agrifoods value chain activities (such as fish sourcing and food production), post harvest value addition and overall operational efficiency (use of green energy). **Local communities are very receptive to external companies/ entities** coming to the beaches and surrounding areas to provide these opportunities. However the caveat is community representatives (BMU's and Market Associations) advocate for engagement and inclusion when external parties want to conduct activities in their environment.

Engagement

It was generally observed that it is common practice to engage the community representatives (BMU or Market Association) at any location (beach or market) first before speaking to any other stakeholders in that community. The reason for this is these community representatives act as 'gatekeepers' and are able to influence and mobilize the community to support or oppose any external entity and its activities. This is important in the uptake of any solution offering being introduced such as cold/ cooling storage etc.

Inclusivity

Beyond engagement, the community advocates inclusivity in any external entities activities. This could be in the form of employment for local youth and other corporate social responsibility channels such as provision of community utility services such as clean water and provision of resources that aid in their daily activities - for instance a cooling ice producer can provide small scale branded cooler boxes, fishing gears and life jackets to be used in fish sourcing.

b.) Political Interest

The fish and agrifoods value chain operations are heavily influenced by political individuals who have varied interests. In some cases these interests are constructive and yield impact to the value chain while at times they act as barriers and are destructive.

The Beach Management Unit and the Market Association are politically elected officials who run the beach and marketplaces respectively, these officials have individual interests in the operations and have to be engaged in any introduction of products/ services that affect their value chain operations. The following cases illustrate field observations:

- In Homa Bay town, there is a small-scale cooling facility setup by a politician for the benefit of the community, offering the service with a pricing model of **KES 10 KES per fish stored, regardless of fish size and duration.** This model is not sustainable as it does not cover the cost of operations (Energy & Personnel), however it is used as a development beacon during political election cycles to sway influence. The pricing model makes it difficult for other cold chain providers to set up operations as the community is already used to that type of offering.
- Individual BMU officials in some locations impose barriers to the setup of businesses such as cold chain ice production or cage farming if they are not awarded a stake or other direct benefits. In Sindo a fish cage corporation had to set up cages for the BMU officials to own and operate in order to be granted access to operate their own cages in the area.
- The government operated Ice plants in a location such as Mbita (Homa Bay County) were **run down due to political interests**, whereby a political individual leveraged influence resulting in the public facility's mismanagement in a bid to shift its assets to a private ice plant that was then setup to provide the same service.

Cold Chain Locations

The cold chain providers in Western Kenya are sparsely located across the region, most of the providers are ice producers with few available cold storage facilities. It was noted that most of the ice producers are located close to the fish landing beaches for example in locations such as Mbita, Sindo & Mfangano Island (Homa Bay County), Sori (Migori County) and Uhanya (Siaya County). In order to remain competitive, part of their value proposition is offering convenience and on-demand ice directly to users such as fish traders and boat owners operating at the beach. The ice producers select locations that are also central aggregation centers (such as Mbita) as they are able to supply ice to value chain actors such as the large scale fish traders and transporters who then distribute ice to smaller beach locations.

Locally Fabricated Coolers

Fish value chain actors such as fish traders own cooler boxes that they use to store fish with ice flakes, however the quality of these coolers is relatively poor compared to a conventional cooler box in terms of cooling & storage capacity and sanitation due to the materials used. Fish traders opt for these locally fabricated cooler boxes (KES 8,000) as they cannot afford conventional manufactured cooler boxes (KES 70,000). These fabricated cooler boxes are usually stored in open air near to the beach by the fish banda and there are specific challenges when using them. First of which the cooler box depletes the ice due to faster melting from exposure to direct sunlight. The materials used in its construction are sometimes not suitable for food storage (in some cases rust and deteriorate) hence reducing the sanitation and can cause contamination of the fish. Finally the capacity of these cooler boxes is small relative to the fish catch needed to be stored particularly for aggregators, hence traders have to invest in multiple cooler boxes which incurs more cost to them.

High Cold/ Cooling Solutions Costs

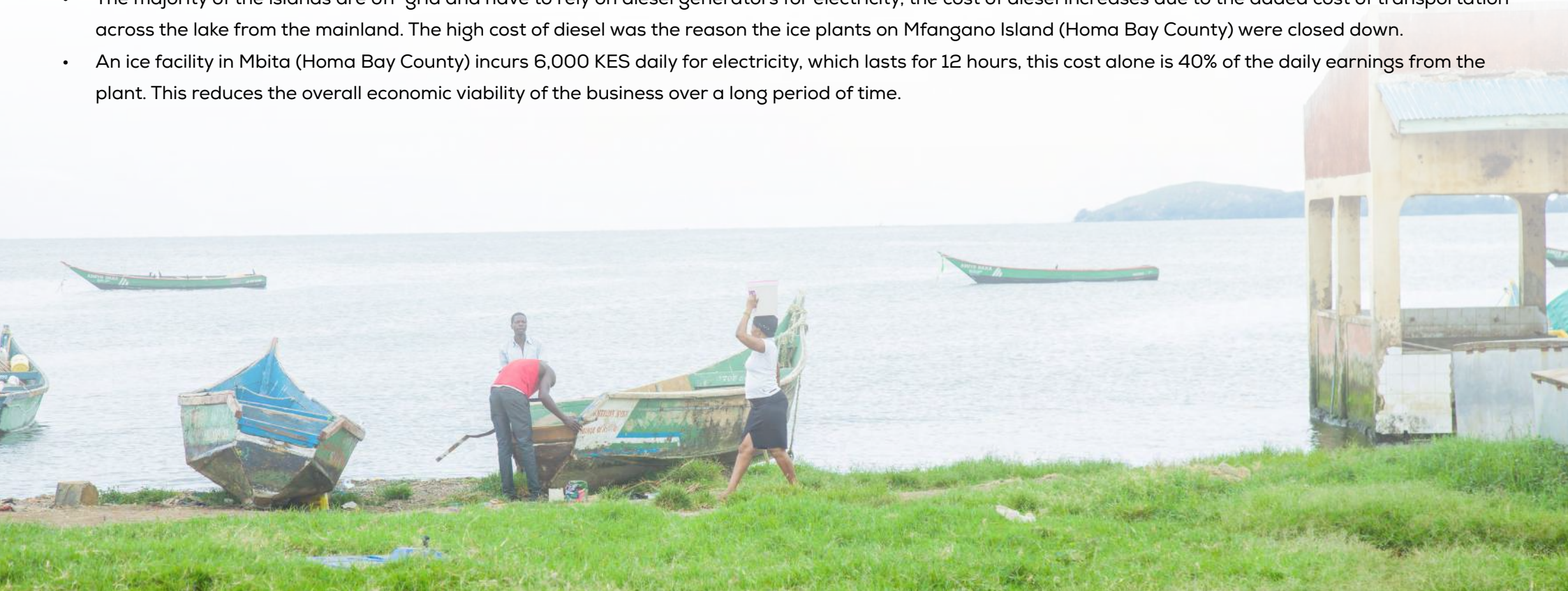
a.) Capital Costs:

It is evident that various value chain actors have expressed the need for cooling solutions and, specifically ice production along the beaches and cold room facilities in markets, however these stakeholders do not have the financial capacity or access to financial facilities to set up these plants/structures themselves due to the heavy capital investment required. Furthermore, fundraising through community members is difficult as they do not have any disposable income to spare to contribute, since most sustain themselves with their daily earnings.

b.) Energy costs

Across the three counties, the majority of the cooling solution providers use the main grid energy and diesel generators during blackouts hence electricity and fuel costs were the biggest pain points experienced by owners or employees of cold storage/ice-making businesses. Given the frequency of electricity blackouts and the cost of diesel is continuously increasing due to countrywide economic factors, this increases the final price of cold chain products such as ice.

- The majority of the islands are off-grid and have to rely on diesel generators for electricity, the cost of diesel increases due to the added cost of transportation across the lake from the mainland. The high cost of diesel was the reason the ice plants on Mfangano Island (Homa Bay County) were closed down.
- An ice facility in Mbita (Homa Bay County) incurs 6,000 KES daily for electricity, which lasts for 12 hours, this cost alone is 40% of the daily earnings from the plant. This reduces the overall economic viability of the business over a long period of time.



Fish Processors Landscape

The fish processing industry has undergone a substantial decline with the majority of fish processing plants having closed down leaving few that are currently operating. The high cost of operation due to energy costs. Secondly, overfishing over the years has reduced the amount of daily catch currently available, making it difficult for the fish processors to maintain their operations profitably. Finally the lack of sufficient cooling solutions available within the fish sourcing stage, increases the potential for spoilage thus a significant portion of fish that is received at the processing plants for value addition is not fit for consumption and therefore goes into wastage adding to the losses.

Government Support

Engagement with Ministry of Fisheries officials we learnt that the Government both at the county and National level is willing to support the fish value chain actors, particularly at the fish sourcing and landing stages through various initiatives. They have set and planned financial budgets to improve the infrastructure as roads for accessibility and Beach Fish Bandas where the catch accounting is done. However the government is keen to channel other resource support such as fishing gears and boats through a community cooperative which reduces the risk of individuals claiming ownership of the communal resources. The requirement is that the value chain actors congregate and form cooperatives in order to be supported by the government planned initiatives.

Other Fish Preservation Techniques

Small scale fish traders who are not able to sell their fresh fish to customers have turned to alternative preservation techniques to avoid losses due to spoilage. In some cases they fry the fish, smoke or salt the fish in an attempt to prevent it from getting spoiled, the effect of this is the fish then loses value and fetches a lower market price. The reasoning is they would rather not fully incur losses and selling fish preserved in such ways also offers an opportunity for customers who can not afford the fresh fish prices to purchase fish at KES 150-200 per kg.

Informal Ice Trade

The cold chain landscape is generally mapped with ice producers operating at fixed locations, however in some locations there is the frequent disruption in the normal operations of the value chain by **informal 'black market'** ice traders and fish processors. These informal ice traders are logistic transporters who are contracted by fish processors to aggregate fish, they are sent out with a truck full of flake ice from the factory so as to preserve the fish as they aggregate from different beaches. In this activity as they collect the fish they then sell the excess ice to fish traders at throw away prices. It was noted that these trucks are a significant number originating from other counties. The informal traders decrease the potential sales for ice producers in that area by undercutting their business. Some **fish processors incentivize fish traders to sell fish to them in exchange for benefits such as free ice**, provided that a minimum quota of fish is met. Similar to the informal ice traders reduces demand of ice from the local ice producers. Therefore consideration of such players is important to understand the full dynamics of the cold chain ice landscape and in the design of mitigation strategies to avoid losses.

Entrepreneurial Nature of Fisherfolk

Fisherfolk have adapted to the changing economic conditions and the resultant rising cost of living by supplementing their income through other activities such as small scale trading, sand harvesting, informal metal fabrication, construction and carpentry. This is to complement their income during low fishing seasons and due to their decreased ability to source large quantities of fish from the lake. However, despite these strides to increase their earning potential, the majority of the fishing communities live hand to mouth, below the poverty line and are not able to access financial resources to scale their secondary ventures.

Other Agri-food Value Chain Insights

Behavioral Change

Majority of local communities in the region are guided by their traditional beliefs and societal norms, this can have mixed effects on implementation of cooling solutions. To ensure uptake of cooling solutions, it is important to understand existing behavior around preservation and incorporate them during design and setup.

- Local consumers believe that food that is stored in a cold room (refrigerator) may not be fresh, hence they prefer sourcing fresh food from the market when it is available. This would demotivate stakeholders such as market traders from utilizing the cold room as their customers may not buy their goods in lieu of other traders not using cold storage. A greengrocer market trader in Bondo (Siaya County) expressed concerns over storing vegetables in fridges and their ability to stay fresh.
- Market traders in various locations who have experienced food spoilage have adapted by purchasing food varieties that have longer natural shelf lives and therefore purchase quantities every 2-3 days that they are guaranteed to sell.
- At Sori Market (Migori County), butchers and meat traders felt no need for a cooling solution as the slaughterhouse was close to their businesses hence able to source fresh meat when needed, and to avoid spoilage, butchers buy meat worth daily sales.

Similar Food Production

Throughout the region it was observed that small scale farmers planted relatively the same crops during the rain seasons, with hopes of a large yield during harvest. There are particular locations that over a time have predominantly become designated for farming particular foods like tomatoes, watermelons etc. From interactions with farmers we learnt that various factors influence the choice of crops planted with the most common being the ease of farming, some crops require minor attention which reduces the cost to the farmers. Additionally access to limited resources and farming equipment also dictated the crop selection. Unfortunately this leads to a saturation and oversupply of similar foods produced at the market during harvest which reduces the farmers earning potential. Large scale farmers have the capacity and resources to undertake crop rotation to reduce their risk of lowered market prices.

A LOOK AT POTENTIAL BUSINESS MODELS FOR SOLAR COOLING SOLUTIONS FOR THE FISH AND AGRI-FOOD VALUE CHAIN

Co-design approach

The outlined potential business models for solar cooling solutions for the fish and other agri-food value chain in Western Kenya is as a result of a co-designed and human-centered design approach. In coming up with the final business model concepts, we undertook the following steps:

1. We engaged with different stakeholders and value chain actors (fish traders, BMU officials, current cooling solution providers, transporters, market food traders, fisherfolk, fishery officials, and more) to understand current existing cooling solutions. This involved carrying out interviews, focus groups sessions, observations and key informant interviews.
2. We explored gaps and challenges for the existing cooling solutions. The next step was to analyze the shortcomings, frustrations and unfilled gaps with the current cooling solutions available in Western Kenya. With this information, it was possible to build a case for solar cooling solutions.
3. We engaged with stakeholders to ideate and conceptualize potential business models that would work in their context. Part of this included introducing potential models that have worked in other contexts and getting feedback on iterations. Three concepts were chosen to be further refined and tested through a 60-day experiment in different locations.
4. We piloted and tested three potential business model concepts with the different actors and stakeholders and the community in general. Some of the activities involved selecting pilot locations, identifying what aspects of the models and concepts to test during the experiments, recruiting and sourcing participants to take part in the experiments and setting up the actual solar cooling solution.
5. The final step was to refine these models based on learnings and feedback from the 60-day experiments. This step also involved highlighting constraints, and considerations for the refined models to work, including changes in the operating environment.

Business Model Insights

The in-depth research yielded various key observations, learnings and insights that informed the design of various business models addressing the clear demand for cooling solutions in the region and relevant considerations for successful outcomes. From the mapping of the cold chain landscape and synthesis of needs from primary value chain actors, it was clear the main cooling solution offerings were ice as a product and cold room storage as a service. The consultant, in collaboration with various stakeholders, carried out small scale prototypes of business models to ascertain the sustainable demand, impact and economic returns in various locations. The consultant envisions implementation of the business models will follow two generic options:

- **Ice Production**
- **Cooling as a Service (CaaS)**

Ice Production

1. Large Scale Ice Production & Distribution

The fish value chain is ever growing with the increasing population of fisherfolk in the region thus there is a proportional increase in demand and consumption for ice. The sustainability of large scale ice production is based on the ability to manage production costs, leveraging solar energy will cut down these costs significantly and increase the returns on investment better than the current existing solutions using main grid electricity. From research in Homa Bay County the **minimum quantity of flake ice purchased daily per location (town/beach) is 720kg (8 sacks of 90kg) and demand locations exceed 20 across the region.** The target customers for this model are large scale fish aggregators, retail traders, transporters and boat owners. To then match the demand investors/ entities can engage in production of ice flakes or blocks through a distribution model.

This model is generally inspired by similar production operations and deployment of Fast Moving Consumer Goods in the region, where goods are supplied from a central production/ storage location are then distributed to multiple retail locations to serve the needs for consumers in those areas. At a large scale i.e. with multiple distribution centers/ points, the provider can leverage economies of scale to reduce the operations costs and increase returns.

The main insights informing the design:

- **The ice is required at various first mile value chain stages; sourcing, landing and distribution for effective preservation**
- **The value chain actors are willing to pay the cost for cold chain solutions within relative limits of affordability as the majority of these actors are at the bottom of the pyramid**
- **The high cost of transportation/ logistics incurred in sourcing for cooling solutions (case of ice)**
- **The reduced ice supply and production capacity by current providers due to high production (energy) costs**
- **The financial losses incurred due to ice melting during transportation from source location to destination.**

The distributor model for potential large scale producers depending on the investment resources available can be deployed in two ways: **External Partnership Distribution** and **Internal Hub Distribution.**

i.) External Partnership

This is a **Business to Business (B2B) model** in which, the large scale ice producer will produce ice at a centralized location then transport and sell to onboarded distribution partners in various strategic locations who will then sell directly to the customers. The model has low margins but lower cost compared to **Internal Hub Distribution** and its sustainability depends on the ability of distributors to generate returns from their customer sales. The central production facility can be in centralized urban areas such as Mbita (Homa Bay County) and serve distributors located in peripheral beach settlements & towns (Kisui, Kendu Bay, Luanda, Nyachebe, Sindo, Koguna) and islands (Mfangano, Rusinga, Remba, Ngodhe, Ringiti, Takawiri). The current wholesale distribution rate for flake ice from the co-creation prototypes is **KES 700- 850 per 100 kg**.

Value Proposition

- **Increased Accessibility**: Through distributors the model increases availability of the cold chain solutions in the region to a larger population of value chain players simultaneously in various locations thus addressing the demand and reducing potential for PHL.
- **Financial Empowerment:** It creates new income opportunities for the distributors in the multiple locations which incentivises them to partner and drive the sustainability of the business.
- **Increased Affordability & Convenience:** Distributors strategically located at It reduces the cost of transportation of ice, it also reduces loss of ice due to melting during transport and time lost in sourcing for cold chain products creating convenience and customer loyalty.
- **Increased Awareness & Uptake:** Distributors will act as product ambassadors to increase the awareness of cold chain solutions to the community, thus increasing the potential for new users to uptake the offerings and returns for the distributors and producers.

Considerations/ Requirements

- **Distributor Recruitment:** The distributors will need to be vetted and due diligence carried out on their ability/capacity to carry out the distributorship. Moreover the distributor should have a pre-existing acumen on the fish value chain so as to understand its inner workings and consumers needs.
- **Facilitation of Assets & Resources:** The ice producer will need to facilitate the necessary assets that will support the distributorship, similar to the Coca Cola business model of facilitating a branded fridge for soda, the ice producer can supply distributors with large scale cooler boxes that will be used to store ice quantities. Additionally supply branded materials and ice handling resources that boost efficiency and also create a brand identity for market awareness.
- **Distributors Setup & Support Costs:** Initial high capital costs incurred in equipping distributors with required tools & equipment for operations for example storage cooler boxes and marketing costs in relating to creating awareness of the product/ service.
- **Distributors Spread:** The distributors onboarded should be strategically located to avoid serving the same market in the intersecting areas and therefore reducing their sales.
- **Distributor Risk:** Monitoring of distributors performance and maintenance of expected standards is necessary as the ice producers' whole business is dependent on onboarding performing distributors who are capable to consistently purchase required ice and hit their required sales targets. However the model offers the flexibility to change distributors through provisions in the partnership contract agreements.

ii.) Internal Hub Distribution

This model is Business to Consumer (B2C) based, in which the large scale ice producer sets up a central production facility at a particular location and hubs in various locations similar to the External Partnership Distribution. The only difference in this model is that the hubs are wholly owned and operated by the ice producer. The current approximate market retail pricing structure for **flake ice is KES 900-1000 per 100 kg** and for Block ice **KES 50-100 per 10 kg block.**

Value Proposition

The value proposition is similar to that of External Partnerships Distribution offering with some additions

- **Increased Margins:** The ice producer will enjoy increased margins from selling directly to customers in the various locations, as the ice will be sold at market retail prices unlike wholesale prices in the previous model
- **Employment Opportunities:** The internal hubs will need staff which the local communities can provide.

Considerations/ Risks

- **Hub Capital Cost:** Since all the hubs will be internally owned the ice producer will incur significant capital costs in the setup of these hubs particularly with relation to physical space (Buildings) costs
- **Hub Failure Risk:** In the event of poor performance from particular hub locations, the ice producers run the risk of losing the initial investment incurred for set up of the hub upon exit unlike in the External Partnership model where only supporting assets such as cooler boxes will be reclaimed and then given to a new distributor .
- **Provision of Community Utilities:** When setting up a hub in most locations, the surrounding community will demand support in one form or another such as provision of community utilities like clean water or employment of locals before allowing for the hub development. It is important to address their needs for a smooth symbiotic relationship.

2. Small/ Mini Scale Ice Production & Distribution

For small scale investors looking to penetrate the market, they can invest in small/ mini plants in strategic locations that will serve as both the production facility and distribution center in a **Business to Consumer model.** At this scale, given the operation cost gains from solar powered energy, the economic viability of this model is based on the strategic selection for the location of the plant. The plant given its location can have a price structure cheaper than mainland market rates of **KES 900-1000 per 100 kg for flake ice and KES 50-100 per 10 kg for block ice.**

The insights informing the design of this model:

- Majority of the peripheral islands in Homa Bay and Migori counties which are off-grid are underserved with cooling solution options yet they are the sources of significant quantities of fish catch due to their proximity to deep lake waters where fish is abundant. The fish is then transported to aggregation towns such as Homa Bay and Mbita.
- The high transportation cost of sourcing for cooling solutions such as ice, the fish actors on the islands have to incur high fuel costs to travel to the mainland to source for ice and in some cases, unavailability of ice increases the losses from the trip.
- Weather conditions occasionally affect the fish actors ability to source for ice, when the waves are unpassable fish actors are unable to travel to the mainland therefore the fish caught on the island goes to waste due to spoilage.

Value Proposition

- **On Demand Production:** Customers (Boat Owners) can place orders and the plant then produces on an on-demand basis which will promote customer loyalty due to the underserved nature of such locations, there is little to no competition. This will yield a faster return on investment compared to mainland urban fish centers with existing ice producers.
- **Increased Affordability & Convenience:** Small plants conveniently located at various beaches reduces the cost of transportation of ice incurred by the consumer sourcing from locations like the mainland. Additionally ice is not lost due to melting during transportation.

Considerations/ Risks

- **Capital cost:** The initial investment setup for the plant is relatively high.
- **Low Barrier of Entry for Competition:** Once the market demand is determined other investors with similar financial capacity can set up and reduce the market share and profits for the operator.
- **Seasonality of Fish:** The revenue generated and resulting profits can be affected by the seasonality of fish, given the ice producer's customers are limited to the fisherfolk on the island and neighboring islands.

Cooling as a Service (CaaS)

1. Large Scale Cooling Facility

The previous business model offering of ice production focuses on the fish value chain which is not suitable for the preservation of agrifoods. Learnings from the research highlights that the best solution for agrifoods preservation is the utilization of cold chain facilities. This creates an opportunity for investors to set up a cold facility offering Cooling as a Service (CaaS) to various value chain stakeholders. From a large scale perspective, the business model will involve the set up of a large capacity cold facility. From research the ideal target market is large scale farmers and market traders who aggregate produce then distribute to small scale retailers, supermarkets and the export market. The model will generate income from charging customers for the volume occupied of produce stored and duration of storage.

The insights informing this model

- The current status quo is majority of farmers in Homa Bay, Migori and Siaya do not have access to cold storage facilities, hence struggle with perennial post harvest loss which translates into financial losses
- Large scale aggregators have shared their willingness to pay for cold storage, as they incur significant losses from spoilage during the aggregation process to meet the required quotas for customers such as supermarkets.

Value Proposition

- **Access to Cold Storage:** Therefore introduction of a strategically located cold facility in urban aggregation centers or near large farms will incentivise the farmers and aggregators to use the services as mitigation to post harvest loss.
- **Ideal Storage & Sanitation Conditions:** The set up of a cold storage facility which meets international standards, will allow the farmers or aggregators to seek customers such as supermarkets and even open up opportunities in the export market which will increase their earning potential.
- **Appropriate Preservation:** A large capacity cold storage facility will enable the storage of multiple foods at different conditions that are required for the ideal preservation and therefore increase the overall shelf life of all the produce. The large capacity will allow multiple farmer or aggregators to simultaneously utilize the facility.

Considerations/ Risks

- **Location Choice:** Majority of the road infrastructure around large farm areas within this counties is still largely underdeveloped therefore it is key to consider a location with accessibility to and from the cold facility for farmers and aggregators.

Small Scale Market Cold Rooms

The small scale market cold room is an interesting initiative which can be deployed through a public private partnership with the county government. The reason for this is the county government allocates space within the market structures it has constructed in urban areas, therefore to reduce the capital cost of physical construction, investors/ providers can leverage existing facilities and then adapt the space to accommodate the cold room.

Insights informing this model:

- Small scale market traders also experience losses due to spoilage; this is a result of the rotting process beginning at earlier value chain stages and at the point they receive the produce for wholesalers the shelf life is severely reduced.
- These traders incur significant transportation costs every 3-4 days in a bid to always maintain fresh stock for their customers, from various locations the traders also highlighted they are willing to pay for CaaS within relative affordability parameters.
- Current practice is to store the food produced on racks, in sacks and crates and cover with polythene material or in a store on the ground. This exposed the produce to pests and unclean conditions which affect the quality.
- Occasionally there is insecurity in the market and traders lose their produce to theft, which causes losses.

Value Proposition

- **Increased Returns for Market Traders:** A cold room will allow them to buy in bulk and transport once or twice a week, then sell the produce over time to customers therefore boosting their earning potential and reducing losses for spoilage.
- **'Pay As You Store':** The market traders have relative working capital capacity hence are open to various Pay as You Store charging models such as storage per quantity per duration and storage per volume per duration. The pricing structure could
- **Security & Sanitary Conditions:** The cold room provides adequate security and sanitation conditions for food stored reducing any risks to the market traders. The cold room manager will maintain the cleanliness of the cold room and also the accounting of stock currently stored.

RECOMMENDATIONS

1. Need for Behavior Change Approaches

There is a need for behavior change interventions to allow for adoption of solar cooling solutions and its potential business model approaches. Findings from the field research and engagement showed that a majority of the value chain actors are used to a certain way of doing things or have an existing bias that hinder adoption of cooling solutions; e.g the perception that food that has been preserved is no longer fresh or perceptions that most of the interventions should be provided free of charge by the government or politicians. Understanding these existing biases, behaviors, attitudes and beliefs and designing and getting the stakeholders involved to adopt new behaviors and attitudes, by showcasing the value of the intervention, will go a long way in making these interventions sustainable.

2. Incorporating Entrepreneurship and Literacy Training to the value chain stakeholders and actors

Offering literacy and entrepreneurship training and support to ice distributors as well as fish traders, agrifood traders and other consumers on the solar cooling solutions and the value and margins that can be realized with its adoption is a vital step to realizing sustainable business models. Currently, most actors looking to benefit from the solar cooling solutions are not able to clearly see the value it brings such as extra earnings from the reduction of post-harvest losses for fish traders and agrifood traders, stable prices for fish traders as a result of good quality and fresh fish stock, commissions and margins for ice-distributors. This is largely because most of them are not currently skilled in entrepreneurship and literacy skills such as bookkeeping, sales, customer service, branding.

3. Long term sustained approaches and partnerships

There is a need for long-term sustained interventions as opposed to one time interventions. This is to allow for behavior change interventions to happen, but also for the community and beneficiaries to realize the benefits of solar cooling solutions, in relation to their standards of living and income levels. For this to happen, there has to be intentional and strategic partnership with local actors in the community, which are centered on aligned interests (such as improving the standard of living for the community, increasing income levels for the different stakeholders, creation of more employment opportunities for young people, guaranteeing food sustainability). Partnerships could include partnering with existing cooling solution providers, creating enabling policies and getting support from the National and local Beach Management Units and the Fisheries and Agriculture Ministry, partnerships with boda-boda associations, local finance institutions and other local stakeholders.

FURTHER EXPLORATION

FURTHER EXPLORATION

A look in the omena value chain (most beaches are both Omena and fish) could identify solutions for improved preservation

From the research, in the majority of the beaches in Homa Bay County and the other counties, omena (dagaa fish) account for the largest fish catch. This is largely because of the reduced fish catch in open lake fishing. Most fisherfolk engaged in omena fish did highlight omena preservation as their biggest challenge. Even though the focus was cooling solutions, there is a need to explore the use of solar solutions for omena drying and preservation.

Value Addition of Agrifoods & Fish Produce

Food sustainability was the core focus of this research, an interesting insight that emerged was most of the product output from both the fish and agrifoods value chains in Western Kenya are in the raw material with little done in terms of value addition beyond preservation to maintain the quality and freshness of the produce. There is opportunity for value addition exploration on the various ways these food products can be processed into products that yield more value in the local market and export market.

The reduction in the fish catch and how that influences relevancy of the solution

The lake over the years has undergone different changes that have affected the fish ecosystem ranging from overfishing, to destruction of fish breeding grounds to pollution. These are some factors that have affected the sustainability of the lake and the fish population significantly therefore it may be of interest to explore strategic methods to sustainable fishing, failure to which will make projects such as cooling solutions for fish redundant.

CONCLUSION

Through the "Integrated Solar Cooling Solutions at Lake Victoria" project by WE4F, the consultant was able to identify potential opportunities for Solar Cooling solutions within the Fish and Agri-foods value chains in Western Kenya. This publication has focused on highlighting the contextual setting, specifically the post harvest challenges currently faced by various value chain actors within their different counties. Thereafter an assessment of the existing solutions available for preservation and their shortcomings was explored. The consultant sought to identify the gaps and opportunities in which these existing solutions did not fully address.

The co-design approach informed an inclusive design, testing and review of viable & sustainable business models for solar cooling solutions. The business model options conceived address the collective needs and pain points of these value chain actors and can be implemented by interested investors/ entities at various levels of scale across the region to improve food sustainability, create employment opportunities as well as improve the living standards of the local communities in Western Kenya.

ANNEXES

Fish Value Chain Data

Field Quantitiavtive Research of Fish in Homa Bay County in 2022 between January and February.

Location			Mbita	Kisui	Sindo	Homa Bay	Nyagina	Luanda Rombo	Koguna	Nyachebe	Sena	Average Values	Total Values
Fish Catch Quantity	Nile Perch (Kg)		1800	50	1600	800	800	1000	400	400	300	794	7,150
	Tilapia (Kg)		600	100	300	600	300	400	120	120	-	318	2,540
	Omena (Troughs)		400	450	800	200	100	100	100	80	-	279	2,230
Fish wasted/ loss due to lack of storage	Nile Perch		40	20	50	10	10	10	20	20	30	23	210
	Tilapia		10	10	10	10	8	8	10	10	-	10	76
	Omena		10	5	10	3	5	5	10	10	-	7	58
How many BMU members?			300	400	600	200	300	500	800	700	1590	599	5,390
How many Fish traders operate in the market/ beach?	Male		100	50	200	50	100	300	60	250	6	124	1,116
	Female		200	150	400	150	200	200	270	450	32	228	2,052
Number of Fish Traders Talked to in Field			5	3	5	3	3	4	3	2	5	4	33
Average Profit for the Fish trader per fish	Nile Perch	Small - Medium (1-3kg)	KES 80	KES 50	KES 80	KES 100	KES 60	KES 80	KES 50	KES 50	KES 80	KES 70	-
		Medium - Large (4-6kg)	KES 80	KES 50	KES 80	KES 100	KES 60	KES 80	KES 70	KES 70	KES 100	KES 80	-
	Tilapia		KES 50	KES 50	KES 50	KES 80	KES 50	KES 50	KES 50	KES 50	KES 50	KES 50	-
How much do the fish traders pay in licenses to operate? (Annually)			KES 1000	KES 500	KES 1000	KES 800	KES 500	KES 500	KES 1000	KES 1000	KES 1000	KES 800	-
Price of transporting ice			KES 100	KES 150	KES 100	KES 100	KES 100	KES 150	KES 150	KES 150	KES 150	KES 130	-
Total Quantity of Ice Purchased - 100Kg Sacks Daily			15	3	10	15	3	8	5	5	10	8	74

Agrifoods Value Chain Data

Field Quantitiavtive Research of Agri-foods in Homa Bay County

Location		Mbita Market	Homa Bay Market	Lwanda Market	Sena Main Market	Sindo Market	Average Values	Totals
How many market traders (vegetables)	Male	2	10	-	-	10	8	22
	Female	148	300	40	20	150	132	658
How many market traders (fruits)	Male	5	8	-	-	10	8	23
	Female	150	240	20	10	150	114	570
Cost of transport (from source/farm) per trip		500	Delivered by Producer	300	200	Delivered by Producer	300	-
Quantity purchased from suppliers weekly	Greens/ vegetables: (Sacks)	300	750	30	300	300	336	1,680
	Tomatoes (Crates)	120	250	10	200	250	166	830
	Cabbages (Sacks)	120	250	10	100	150	126	630
	Fruits (Crates)	100	200	9	60	100	94	469
Quantity sold to customers weekly	Green vegetables: (Sacks)	260	700	25	280	260	305	1,525
	Tomatoes (Crates)	100	200	8	180	200	138	688
	Cabbages (Sacks)	100	200	8	80	100	98	488
	Fruits (Crates)	80	160	6	50	80	76	376
Quantity wasted/ spoilt weekly	Greens/ vegetables: (Sacks)	20	50	5	20	40	27	135
	Tomatoes (Crates)	20	30	2	20	20	19	92
	Cabbages (Sacks)	20	50	2	20	30	25	122
	Fruits (Crates)	20	30	3	10	10	15	73
Total lost income from spoilage (averagely)	Greens/ vegetables: (Sacks)	KES 4,000	KES 9,000	KES 400	KES 1,600	KES 4,000	KES 3,800	-
	Tomatoes (Crates)	KES 3,600	KES 3,000	KES 120	KES 1,200	KES 1,600	KES 1,904	-
	Cabbages (Sacks)	KES 6,000	KES 7,500	KES 200	KES 1,000	KES 1,800	KES 3,300	-
	Fruits (Crates)	KES 1,600	KES 3,000	KES 120	KES 300	KES 1,000	Ksh 1,204	-
Number of traders interviewed		7	5	4	5	3	5	24

WORK PLAN

Solar Cooling Value Chains In Western Kenya

Identification, Analysis and Development Of Business Opportunities for Solar Cooling Value Chains in Western Kenya

Phase	Task Title	Task Owner	Start Date	End Date	% Of Task Complete
1	**Project Scoping, Alignment and Understanding Existing Cold Storage Solutions & Business Models**				
	Kick Off Teams Call	Mideva Labs Team	4/10/2021	4/10/2021	100%
	Inception Work Plan	Mideva Labs Team	5/10/2021	13/10/2021	100%
	Team and Goal Setting	Mideva Labs Team	14/10/2021	15/10/2021	100%
	Inception Research	Mideva Labs Team	18/10/2021	29/11/21	100%
	Project Updates, Feedback & Guidelines	Mideva Labs Team	1/11/2021	2/11/2021	100%
2	**Baseline Field Study and Field Scoping**				
	Desktop Secondary Research	Mideva Labs Team	11/3/2021	13/11/2021	100%
	Field Scoping Visit Planning	Mideva Labs Team	11/8/2021	10/11/2021	100%
	Scoping Research & Initial Stakeholder mapping	Mideva Labs Team	16/11/21	23/11/2021	100%
	Field Stakeholder Interviews Part 1	Mideva Labs Team	16/11/21	23/11/2021	100%
	Client Updates & Feedback	Mideva Labs Team	22/11/2021	23/11/2021	100%
	Scoping Field Report & Concept of the Co-design workshop	Mideva Labs Team	23/11/2021	26/11/2021	100%
	Baseline Field Study and Field Scoping	Mideva Labs Team	2/12/2021	14/12/2021	100%
3	**Co-creation and Prototyping**				
	Planning Co-creation Workshops & Participant Recruitment	Mideva Labs Team	5/1/2022	22/1/2022	100%
	Co-Creation Workshop Location: Homabay , Migori & Siaya Part 1	Mideva Labs Team	17/1/2022	18/2/2022	100%
	Field Stakeholder Interviews Part 2	Mideva Labs Team	18/1/2022	17/2/2022	100%
	Research Prelimenary Findings, Synthesis, Documentation & Sampling	Mideva Labs Team	21/2/2022	4/3/2022	100%

Phase	Task Title	Task Owner	Start Date	End Date	% Of Task Complete
	Pilot/ Prototyping Business Modelling	Mideva Labs Team	1/3/2022	25/5/2022	100%
	Client - Interim Report from Co-design Workshops	Mideva Labs Team	7/3/2022	11/3/2022	100%
	Project Updates: Comprehensive report from co-design workshops	Mideva Labs Team	21/3/2022	15/4/2022	100%
	Prototype Model Refinement & Projections	Mideva Labs Team	21/3/2022	13/5/2022	100%
	Field Stakeholder Interviews Part 3	Mideva Labs Team	16/5/2022	23/5/2022	100%
	Co-Creation Workshop Location: Homabay , Migori & Siaya Part 2	Mideva Labs Team	16/5/2022	23/5/2022	100%
	Final Research Findings Documentations	Mideva Labs Team	28/5/2022	4/6/2022	100%
	Client Updates, Prototype Model, Comprehensive report from co-design workshops in Homabay, Siaya & Migori	Mideva Labs Team	3/6/2022	4/6/2022	100%
4	**Synthesis, Refinement and Pilots**				
	Final Research Synthesis	Mideva Labs Team	28/5/2022	4/6/2022	100%
	Monitoring & Benchmarking of Pilot Models	Mideva Labs Team	1/3/2022	25/5/2022	100%
	KPIs Mapping for Final Model	Mideva Labs Team	28/3/2022	22/4/2022	100%
	Documentation of Final Publication Report	Mideva Labs Team	24/5/2022	8/6/2022	100%
	Final Publication Report Handover	Mideva Labs Team	13/6/2022	17/6/2022	100%

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More about the global initiative "Water and Energy for Food (WE4F) Grand Challenge": https://we4f.org/

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