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# ASSESSMENT OF THE COLD CHAIN MARKET IN NIGERIA

**MARCH 2023**

EFFICIENCY FOR ACCESS COALITION

## ACKNOWLEDGEMENTS

Efficiency for Access (EforA) is a global coalition working to promote high-performing appliances that contribute to clean energy access for the world's poorest people; its members have programmes and initiatives spanning 62 countries and 34 key technologies. This report seeks to provide EforA stakeholders with an understanding of the role and potential of cold chain in enhancing food security, unlocking sustainability, and tackling climate change. It aims to generate awareness and provide information on the cold chain technologies applicable in Nigeria across four key value chains (fresh fruits & vegetables, dairy, meat, and fish). It also maps the existing ecosystem of cold chain solutions and provides recommendations on how to support the market development of this sector over the next ten years.

This study was carried out by pManifold (authors: Rahul Bagdia, Akshay Gattu, Yamini Keche, Ankit Agrawal, and Apurva Parakh) and Intellecap, and was supported by CLASP.

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# ABBREVIATIONS

| | |
|---|---|
| **3PL** | Third Party Logistics |
| **BMC** | Bulk Milk Chiller |
| **CAGR** | Compound Annual Growth Rate |
| **CBN** | Central Bank of Nigeria |
| **CCI** | Cold Chain Infrastructure |
| **ECOWAS** | Economic Community of West African States |
| **EDF** | Export Development Fund |
| **EEFP** | Export Expansion Facility Programme |
| **FAO** | Food and Agriculture Organization |
| **FMARD** | Federal Ministry of Agriculture and Rural Development |
| **GAIN** | Global Alliance for Improved Nutrition |
| **GDP** | Gross Domestic Product |
| **IARW** | International Association of Refrigerated Warehouses |
| **NADP** | National Aquaculture Development Plan |
| **NAHCO** | Nigerian Aviation Handling Company |
| **NEPC** | Nigerian Export Promotion Council |
| **PLAN** | Post-Harvest Loss Alliance |
| **TPO** | Trade Promotion Organization |
| **USAID** | United States Agency for International Development |
| **VCR** | Vapor Compression Refrigeration |

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## GLOSSARY

| | |
|---|---|
| **Capital Expenditure** | Asset acquisition or asset investment |
| **Cooling as a Service (CaaS)** | Payment for cold chain services on a per-use basis depending on the quantity of produce and the number of days stored in a cold chain facility |
| **Total Market (TM)** | The total market demand for CCI solutions across different value chains, calculated either from a CAPEX perspective or from a CaaS perspective |
| **Total Addressable Market (TAM)** | The segment of the TM that could be realistically serviceable by CCI solutions |
| **CCI projected 2030** | Projected market size for CCI by 2030 |
| **'As is' market size** | Cold chain infrastructure market size from 2019, which is the latest historical data available based on FAO's data sets |
| **First mile** | Stage between production at farmgate and the point of aggregation or collection of produce |
| **Third Party Logistics (3PL)** | An organisation (a third party) provides logistics services, such as warehousing & storage or transportation, to farmers' collectives or companies in need of cold chain inventory management and distribution |
| **Phase Change Material (PCM) / thermal ice batteries** | PCM can absorb or release sufficient energy at phase transition (solid to liquid) to provide cooling. Thermal ice batteries then store this energy, enabling them to operate at normal range for a long time without the need for external power |
| **Hydrofluorocarbons (HFCs)** | HFCs are powerful greenhouse gases that contain fluorine and hydrogen atoms. They are specifically manufactured, unlike other greenhouse gases which are mostly waste or by-products |

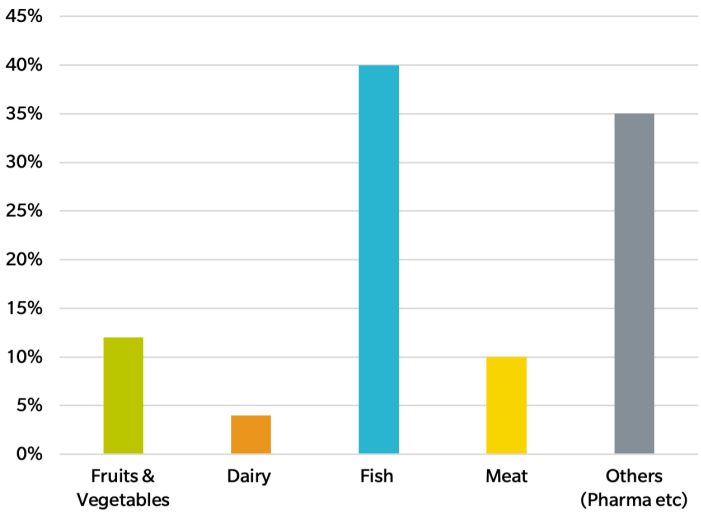
**Nigeria is an agricultural state and home to over 213 million people – the largest population of all African countries. Agriculture accounts for nearly 24% of Nigeria's GDP[ii] and employs more than 36% of the labour force**, making it the largest employer in the country. More than 80% of farmers in Nigeria are considered smallholders; they own less than 5 hectares of land. 99% of Nigeria's agricultural outputs can be attributed to smallholder farmers.[iii] 86% of the outputs consist of crop production, followed by livestock (8.1%), fishing (3.2%), and forestry (1.1%).[iv] Despite the predominance of agriculture, Nigeria still depends heavily on food imports to meet domestic demand. Major agricultural imports for consumption include wheat, sugar, fish, and milk;[v] a dependency that threatens food and nutritional security. Food imports have been growing over time, resulting in an agricultural trade deficit, of about N689.7 billion in 2019, up from N549.3 billion in 2018.[vi] In addition, the focus on food production relative to developing supply chain linkages, such as farm-to-table, means 40-50% of fresh fruits and vegetables (FFV) and about 30% of fish are lost during and after harvesting.[vii] Functional cold chain infrastructure (CCI) development has the potential to mitigate the negative impacts of food loss on the environment/climate, livelihoods, health and social well-being by improving supply chain efficiency through better post-harvest management of food.

**A cold chain is an environmentally controlled chain of logistics activities that cools and preserves produce or products within stipulated parameters, including temperature, humidity, atmosphere, and packaging.** A well-designed and developed cold chain can prevent food losses and reduce carbon emissions related to food waste. Cold chains also ensure food security by reducing food price inflation, buffering the food supply, and overcoming seasonal shortfalls. This buffering mechanism dampens the price fluctuations that typically put vulnerable communities at risk of poverty and hunger and better supports the growth of farmers' incomes.

This report uses secondary research, modelling, and stakeholder consultations to study the FFV, dairy, fish and meat value chains in Nigeria and the Cold Chain Infrastructure (CCI) required. It establishes and assesses the gap between the CCI deployed and what is necessary to meet these value chains' CCI needs by 2030. In modelling the market size, the capital expenditure (CAPEX) business method was considered, whereby CCI technology users purchase the asset upfront.

**CCI in Nigeria is nascent but growing, primarily driven by fish imports**. Common CCI components are cold rooms at farmgate, food processing, and distribution centres; ice plants for fish at landing centres; refrigerated logistics networks (such as reefer vehicles); and deep freezers or refrigerators at retail counters. Global Alliance on Improved Nutrition mapped around 200,000 cubic metres of CCI in the state of Lagos alone in 2018 compared to the estimated total installed capacity of 10,000 cubic metres in 2014 in the entire country.[viii] According to experts, this tremendous growth rate is primarily driven by fish imports. It is estimated that close to 39% of total CCI in the country is used for fish imports, with only a small percentage used at the retail level. 12% of CCI is currently used for FFV, 10% for meat and 4% for dairy. The remaining 35% is used for storing and transporting vaccines and other pharmaceutical products. Most FFV is grown far from consumption centres and requires long-range transportation. The absence of proper infrastructure for storing and transporting these commodities results in huge losses.

**Figure 1: Utilisation of CCI in Nigeria**




**Solar-powered CCI solutions are expected to grow, given the current adoption rate.** On-grid CCI technologies, often powered by fuel-based generators, are used at processing, import and export facilities. This is especially true for the fish and meat value chains. Due to frequent electricity cuts, the generators are intended as a backup; however, they contribute to the country's GHG emissions. In the FFV value chain, some solar-powered CCI solutions are being developed, many paired with innovative business models that address farmers' affordability challenges. Achieving the projected adoption requires cultivating an enabling environment through policy interventions that promote solar-powered CCI solutions across the different value chains.

Current government policies in Nigeria focus on improving production practices rather than value addition. Policies and regulations that affect CCI mainly relate to agricultural exports, intending to promote non-oil exports through commodity diversification. Restrictions on milk imports and efforts to boost local production are expected to drive CCI development indirectly. However, the focus should be on addressing supply-side challenges to increase cold chain adoption rates.

**The total market opportunity for CCI deployment is estimated at US$5.9 billion by 2030 under a CAPEX market sizing model.** The breakout by value chain is US$1.77 billion in FFV, US$234 million in dairy, US$2.67 billion in fish and US$1.31 billion in meat.

Nigeria faces several challenges in growing CCI:

- A lack of confidence in the viability of the technology and business models
- A lack of awareness among stakeholders of CCI benefits
- The unavailability and/or unreliability of electricity
- The disconnect between the first mile and the endpoint in the value chain
- A lack of skilled labour
- Small and medium-sized farmers, aggregators and traders are hesitant to invest in cold chain solutions because they cannot access financing for them. Local banks are unwilling to lend to firms with limited collateral and uncertain prospects
- Lack of investment in cold chain infrastructure
- The regulatory environment surrounding cold chains, including food safety standards, is unclear and complex

**A collaborative effort is required from all industry stakeholders to enable the development of CCI that will impact farmers' income, add value to foods, and create millions of jobs.** CCI has immense potential to help reduce food losses. The government is advised to adopt policies aimed at scaling it. Nigeria can learn from and adopt India's strategy, having faced similar challenges with the affordability and viability of CCI. India's approach involved implementing focused policy interventions, including; attracting direct foreign investment, providing capital subsidies, developing farmer-producer organisations (FPOs), and supporting the domestic food processing industry. Table 1 includes other key recommendations of this report.

**Table 1: Recommendations for Various Stakeholder Groups in Nigeria's CCI Sector**

| Stakeholder Group | Recommendations |
|---|---|
| OEMs<br>CCI Owners<br>Operators | • Focus on developing first-mile (near farm-gate) cold chain infrastructure (CCI)<br>• Provide access to financing through a variety of channels like:<br>  • First-loss capital<br>  • Results-based or performance-based financing<br>  • Public/Private Partnerships (PPIs)<br>• Capacity-building and educating CCI technicians and operators to drive the adoption of CCI<br>• Capacity building and providing technical assistance to OEMs<br>• Support local manufacturing<br>• Policy support through incentives and subsidies |
| Government<br>Donors | • Strengthen product development, making them low-cost sustainable and farmer-centric<br>• Develop financing and servicing model as value-added services |

*OEMs - original equipment manufacturers

# Report Overview

## 1.1. Background and Overview

**CLASP engaged pManifold and Intellecap to evaluate and segment the market for cold chain technologies across four value chains (fish, dairy, meat, and fresh fruits & vegetables) in Nigeria, India and Kenya.** This research aimed to identify current trends, barriers, opportunities for market transformation, and strategies to accelerate the adoption of cold chain technologies at scale. The goal was to identify existing cold chain technologies, business models and technical challenges, and to quantify the existing cold chain infrastructure and opportunities for improvement. The research consisted of the following:

- Undertaking a value chain analysis of the cold chain ecosystem, with a focus on dairy, meat, fish and fruits & vegetables
- Conducting a feasibility and technology assessment of cold chain solutions, taking into account costs, improvement opportunities, etc.
- Evaluating the existing business models of cold chain innovations and approaches by conducting primary research with off-grid solar refrigeration enterprises
- Examining cold chain policy and regulatory assessment at national and county government levels
- Estimating the market size of off-grid solar refrigeration technologies across the four CCI value chains
- Developing case studies on innovative business and financial models deployed by off-grid solar refrigeration enterprises in Nigeria

## 1.2. Methodology Used to Estimate Cold Chain Infrastructure (CCI) Market Size in Nigeria

Data were collected from primary and secondary sources to assess Nigeria's cold chain market. The key components of this research were as follows:

- **Secondary research**: An extensive literature review was conducted to understand the state of the CCI market in Nigeria. This included studying industry research reports, official government websites, media articles and blogs. Some significant reports on CCI include the Nigeria Cold Chain Capacity Mapping Report by GAIN, the IARW Global Cold Store Capacity Report (2014), and the Vegetable and Potato Sector in Nigeria (2019) by Wageningen Economic Research. Based on these sources, a comprehensive framework was developed to estimate current and future CCI deployment.
- **Stakeholder consultations**: Interviews were conducted with industry experts, and the resulting data and insights were collated to conduct qualitative and quantitative analysis of the challenges, opportunities, and market size of CCI across value chains. Stakeholder consultations also helped fill data gaps and validate the secondary research findings. The stakeholder groups consulted were CCI technology providers, consultants, and service providers.
- **Calculate the market size of CCI in Nigeria**: Based on quantitative and qualitative data analysis, we triangulated the current and 2030 potential market sizes and identified CCI growth drivers and challenges for each value chain.

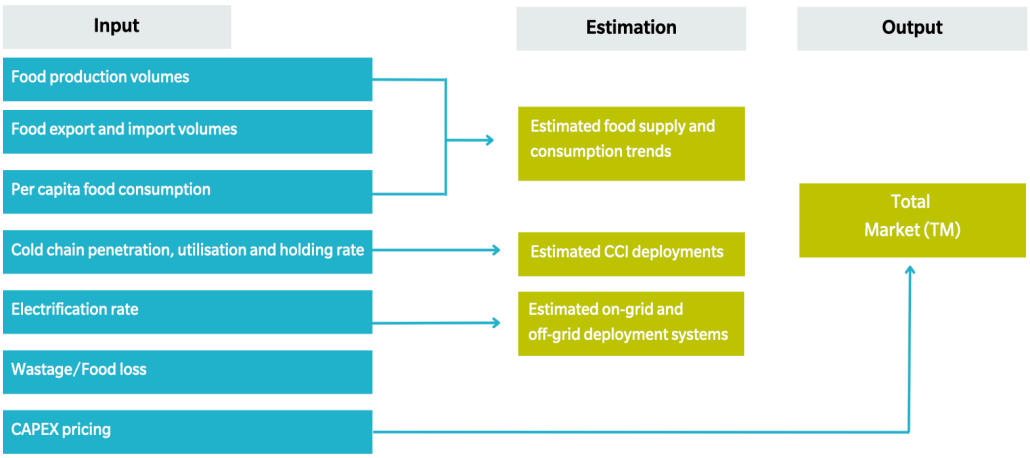
Various market models were analysed to estimate the current CCI market size and the projected CCI market size by 2030. The framework sought to estimate the dollar value of the market from a capital expenditure (CAPEX) perspective, whereby users of CCI technologies purchase the asset upfront.

## 1.3. Limitations of the Study

The following were some of the limitations identified during project delivery:

- **Limited number of CCI stakeholders in the region**: There are very few CCI stakeholders, and those that exist are primarily in the early stage of operations. This problem required a bottom-up approach, with secondary research and stakeholder consultations triangulated to create a framework for assessment.
- **The absence of a central database for government and private sector agencies**: Nigeria does not have a central repository of data on losses, which can be attributed to a lack of CCI across various levels of the value chain. A central database would have helped calculate the CCI market size. To overcome this challenge, data gaps were filled through stakeholder consultations.

**Figure 2: Framework for Market Analysis**



# Market Assessment for Cold Chain Infrastructure in Nigeria

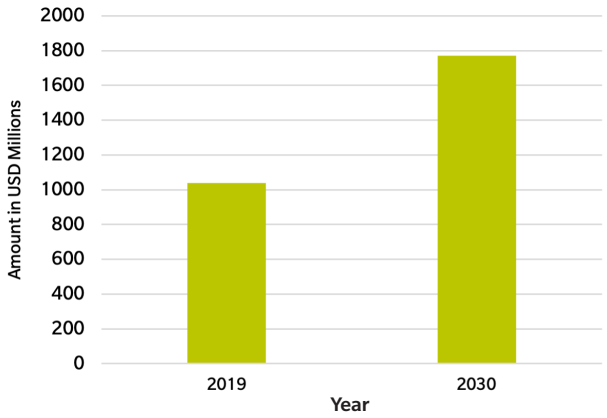
## 2.1. Cold Chain Infrastructure Market Summary

This report focuses on four value chains for cold chain solutions: fresh fruits & vegetables (FFV), dairy, meat, and fish.

For each value chain, the Total Market (TM) is estimated for 2019, 2025 and 2030 based on CAPEX market sizing. Assumptions on the addressable geographic reach and affordability were not considered in this model. This analysis found that the total opportunity for CCI deployment will be valued at US$5.9 billion in 2030. The breakout by value chain is US$1.77 billion in FFV, US$234 million in dairy, US$2.67 billion in fish and US$1.31 billion in meat.

### Fresh Fruits and Vegetables

**Figure 3: Estimated Total Market Size for Fresh Fruit and Vegetables Value Chain**




The current overall market for CCI for FFV is estimated at US$1.04 billion and is projected to grow to US$1.77 billion by 2030. The most common CCI component used in Nigeria's FFV value chain is cold rooms, mainly found at production and aggregation centres and tend to be a mix of both on-and off-grid technologies. Cold rooms are not currently used at the processing[1] or export levels. The market for solar-powered cold rooms grew at a CAGR of 95% between 2015-2020, primarily driven by the FFV sector. This is equivalent to about 200MT of additional capacity and US$2.13 million investment over that period. Of the 300,000 cubic metres of CCI deployed in Nigeria in 2018, 10% was used for FFV.

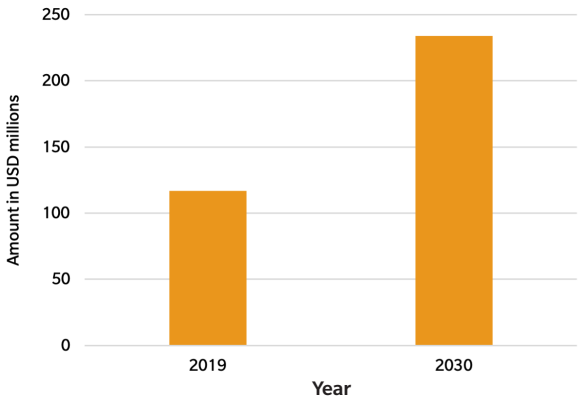
Packhouses are primarily used at the processing level, where FFV is sorted and packed manually. But as awareness and adoption of cold rooms rise at the production level, cold storage operators are also looking to set up such facilities at the processing and export levels of the value chain.[ix]

**Solar-powered walk-in cold rooms with thermal storage (water/PCM based) provide a viable solution to the problem of an unreliable grid and high fuel costs.** CCI demands a constant supply of electricity, and Nigeria's weak electrical grid poses a challenge for CCI businesses in the country. To keep their cold stores in operation, such companies are forced to use fossil fuel-based generators that increase operational costs.[x]

**Solar off-grid CCI solutions appear to be viable for the FFV value chain,** although few companies currently offer them.They have grown at an annual rate of 95% since 2015.[xi] Payback periods are three to four years, assuming annual revenue to be 25-35% of the initial investment. In the future, solar off-grid solutions are expected to be driven by the FFV value chain. Such technologies are also being deployed in the fish value chain, although their growth is less dramatic.

### Dairy

**Figure 4: Estimated Total Market Size for Dairy Value Chain**




The high import rate of dairy in Nigeria limits cold chain development for this value chain. The current overall CCI market for dairy is estimated at US$117 million and is expected to reach US$234 million by 2030. The most common forms of CCI used in the dairy value chain are bulk milk chillers and reefer vehicles. Only a small number of farmers supply liquid milk to the formal market. Bulk milk chillers are used at the production/ aggregation level at milk collection centres, where farmers in the formal market store milk before transferring it further along the value chain. From there, milk is transported in insulated or refrigerated vehicles to centralised plants for further processing and packaging. With the increased focus on reducing imports and improving local milk production, bulk milk chillers' usage is expected to grow.

Through its Backwards Integration Policy, the Central Bank of Nigeria (CBN) has added milk and dairy products to the growing list of items that cannot be imported with foreign exchange,[xii] thus allowing imports only through companies investing in local dairy production. This policy should boost local production, which had an estimated growth of CAGR of 5% between 2019-2021. [xiii]

The CBN's move is already attracting investment. Most of this investment is being used to develop pastoralist systems. In these value chains, milk from pastoral communities is aggregated at local collection centres and transported to centralised processing and packaging units. Packaged milk and milk products are then distributed to retailers and wholesalers nationwide. Since the most pressing challenge for commercial processors looking to source locally produced milk is the lack of a cold chain between the herds and the processing units,[xiv] installing bulk milk chillers at collection centres and using refrigerated or insulated tanks for transport could improve this value chain significantly.

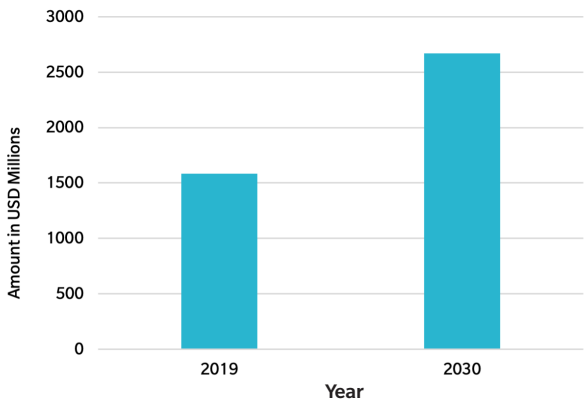
1. "Processing" here includes the grading and packing of fresh fruits and vegetables, but not other forms of processing like the preparation of tomato ketchup, potato chips, fruit juices, etc.

Community bulk milk chillers at the farmgate, of 200-2,000 litre capacity, could also help to reduce milk wastage and transport costs. A continuous power supply is required to operate a bulk milk chiller, which could be supported by a diesel generator or solar-integrated backup using phase change materials or batteries.

Several development activities are included in the Backward Integration Policy, including educating farmers and establishing dairy collection centres. These efforts can help grow local milk production, thus driving the growth of CCI.

## Fish

**Figure 5: Estimated Total Market Size for Fish Value Chain**




CCI in Nigeria is concentrated in the fish value chain—amounting to 39% of the country's total CCI capacity. Almost all these deployments are used for imported fish. The current CCI market for fish is estimated to be US$1.5 billion. Based on the current growth rate of CCI in the fish value chain, the market is expected to reach US$2.67 billion by 2030.

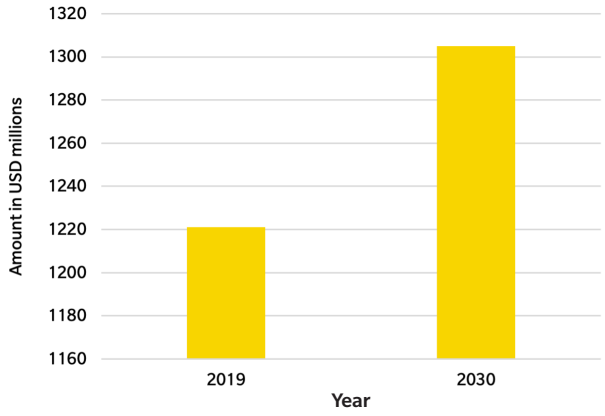
As of 2020, major players in the fish import industry had deployed nearly 80,000 tonnes of cold storage capacity, accounting for 70% of the CCI market share in fish imports.[xv] It is estimated that more than 39% of Nigeria's total cold chain capacity (300,000 cubic metres) is used for fish, with most CCI facilities, especially cold rooms located at import aggregation centres where fish is stored before being distributed to retail outlets, hotels and restaurants. Another CCI component used at the aggregation level is icemaking plants, with ice used primarily to store and transport domestic capture and aquaculture fish.

CCI is still underdeveloped for domestically captured fish, restricting the market near the production site. The only CCI component used in fish production is icemaking plants, with fishermen using iceboxes to store their catch before it arrives at the shore. Ideally, all freshly caught fish should be stored in ice boxes. Since most domestic fishing sites are in remote locations with little access to electricity, solar-powered icemaking plants and cold stores could be a sustainable solution to service the entire CCI market for domestically produced fish. They would add value to the domestic fish value chain and improve the market outlook for domestically produced fish.

The uptake of solar-powered walk-in cold rooms has been very low in the fish value chain. This is because frozen fish require temperatures of between -25 to -15°C, and achieving such low temperatures utilises considerable energy. This energy requirement increases operational costs and upfront investment, including technology development and solar integration costs. A solar cold room for fish and meat is estimated to cost almost twice as much as one for FFV. Therefore, the adoption of solar-based off-grid CCI solutions is expected to be driven primarily by FFV rather than fish.

## Meat

**Figure 6: Estimated Total Market Size for Meat Value Chain**




CCI is required in the meat value chain only after the animal is butchered and processed in abattoirs. Common CCI components are cold rooms at abattoirs, deep freezers at retail centres, and reefer vehicles transporting meat from abattoirs to retail markets. The estimated CCI market for meat is currently valued at US$1.2 billion and is expected to reach US$1.3 billion by 2030. Currently, CCI application is minimal in the meat value chain; most meat is sold in open markets soon after butchering without passing through a cold chain. A considerable portion of this meat is transported in open trucks and taxis.

The states of Lagos and Abuja have banned the transport of meat in "air cool vans" and motorcycles, mandating the use of refrigerated vehicles to transport meat. This move is expected to drive the growth of cold chain solutions for meat, especially reefer transport.

Currently, no solar cold rooms are deployed exclusively for the meat value chain. But cold rooms for fish are often used to store meat because their temperature requirements are similar. Frozen meat generally requires temperatures between -25°C and -15°C (ideally -18°C), and such low temperatures take considerable amounts of energy to maintain. As with fish, solar walk-in cold rooms for meat are relatively expensive, costing almost twice as much as similar units for storing FFV. As a result, the uptake for solar walk-in cold rooms in the meat value chain is relatively low.

## 2.2. CCI Technology Assessment

While both off- and on-grid cold storage technologies are used in Nigeria, the technology differs at different levels of the value chain. CCI used at processing, import and export facilities is mostly on-grid refrigeration technology supported by fossil fuel-based generators. However, CCI also includes solar-powered off-grid technologies in the domestic value chain. The choice of CCI solution also depends on the temperature requirements for different perishable commodities; ideal temperatures for storing FFV range from 0-12°C, milk requires 0-4°C, and fish and meat require much lower temperatures of between -25 and -15°C.

The following are some of the CCI technologies currently in use:

**1. Evaporative cooling**: Evaporative cooling technologies convert liquid water to gas and store heat. When dry air moves across a saturated surface, such as a container full of water, the water molecules absorb heat and change from liquid to gas, cooling the surrounding air and providing a stable storage environment with low temperatures. Depending on the temperature and humidity of the air, evaporative cooling can achieve temperature reductions of 5-10°C compared to outside temperatures while maintaining appropriate humidity levels for storing fruits and vegetables. Small cooling chambers use a combination of passive and active evaporative cooling at the farm level. Solar power can run suction fans and water pumps in active evaporative cooling systems.

**Figure 7: CCI Using Evaporating Cooling**

Evaporative cooling-based refrigeration systems are typically simple and locally made; when operating as expected, they can be a suitable and cost-effective off-grid CCI solution. Their major drawback is that it is impossible to actively control temperature and humidity, making them unsuitable for all climates. The performance of such systems typically varies during different seasons and climate conditions, even in the same location.

**2. Vapour compression refrigeration (VCR)**: Vapor compression technology is Nigeria's most widely used cooling technology, using phase change material to provide cooling. It works by circulating the refrigerant through the system, which is alternately compressed and expanded, enabling the state to change from a liquid to a vapour. As the refrigerant changes state, heat is absorbed and expelled by the system, lowering the temperature of the conditioned space. Almost all large-scale cold rooms, refrigerated vehicles and home refrigeration units are based on this technology. External energy is required as the refrigerant is compressed, which can be supplied by grid electricity, diesel generators or renewable energy-based power sources.

**Figure 8: CCI Using VCR Technology**

**3. Icemaking**: Ice can be made by any cooling technology suitable for freezing. Most common are vapour compression systems or absorption cooling, with ammonia-water or lithium bromide-water working pairs.[2]

**Figure 9: Icemaking Machines**

**4. Sorption cooling**: In this process, refrigeration is thermally driven and based on the physical/chemical attraction between a refrigerant and an ad/absorbent. When subjected to a low-pressure environment, the refrigerant will evaporate at ambient temperatures. This evaporation absorbs heat from the environment, creating a cooling effect. Once evaporated, the gaseous refrigerant is attached to or absorbed by the ad/absorbent (adsorption or absorption, respectively). Pressure is thereby reduced in the evaporator, allowing for more refrigerant to evaporate. Thermal energy is then used to evaporate the refrigerant out of the ad/absorbent and restore original conditions.

**5. Thermal storage**: Thermal storage technologies use phase change materials, water, and ice. These technologies provide cooling inside insulated vehicles and off-grid freezers and are used as backup solutions for off-grid solar-powered VCR systems.

The applicability of these technologies to different value chains has been summarised below:

**Table 2: Applicability of Cooling Technologies Across Value Chains**

| Cooling Technology | Fruits & Vegetables | Dairy | Fish | Meat |
|---|---|---|---|---|
| Vapour Compression Cycle (VCC) | | | | |
| Evaporative Cooling | | | | |
| Sorption Cooling | | | | |
| Ice Making | | | | |

| High | Medium | Low |
|---|---|---|

2. The working pair in absorption cooling is an absorbent–refrigerant pair: a refrigerant creates a cooling effect while it expands in an expansion valve, and an absorbent absorbs the heat in the condenser of the refrigeration cycle. Ammonia (refrigerant)-water (absorbent) and Lithium bromide (refrigerant)-water (absorbent) working pairs are very popular absorbent–refrigerant pairs.

## 2.3. Business Models and CCI Ownership

Public and private players in the value chains own CCI infrastructure. Their business models vary based on the value chain, use case, and asset ownership structure. Because CCI is a capital-intensive business and access to finance is challenging for farmers, suppliers, aggregators and retailers, innovative business models are essential to scaling up CCI.

The following are some of the business models in use:

**1. Direct sales/upfront purchase**: Most of the CCI in Nigeria's fish import value chain is purchased upfront by prominent private sector players like Stallion Group, usually with financial assistance from banks and other financial institutions. In the dairy value chain, bulk milk chillers and cold rooms are mostly purchased upfront by big dairy players like FrieslandCampina WAMCO.

**2. Lease-to-own models**: This model targets cooperatives, aggregators, large-scale farmers, and processors who need cold chain solutions but cannot pay upfront for CCI assets. In lease-to-own, customers are not required to pay the total upfront cost for equipment and installation; instead, payments are staggered and spread across a fixed term, with ownership transferred after all payments are complete. InspiraFarms uses this model.

**3. Third-Party Logistics (3PL)**: Most CCI businesses are not linked to transportation services. In the 3PL model, customers (usually importers, exporters, and intercity distributors) can outsource reefer transport services to third-party companies, typically charging per kg or trip. Kennie-O Cold Chain Logistics is an example of a 3PL company.

**4. Pay-as-you-store or Cooling-as-a-Service (CaaS)**: In this model, users pay a fixed cost for using the CCI facility for a particular period or quantity of produce rather than purchasing the asset upfront. This allows smallholder farmers and aggregators to store their commodities in cold rooms without incurring huge upfront costs and is popular in the FFV value chain. ColdHubs uses this model.

**Table 3: Comparison of Business Models**

| Parameters | Direct sales/upfront purchase | Lease-to-own | Third Party Logistics (3PL) | Cooling-as-a-Service (CaaS) |
|---|---|---|---|---|
| **Ownership** | • Farmer<br>• Processor<br>• Trader | • Technology provider until transfer<br>• Farmer<br>• Processor<br>• Trader | • Service provider | • Service provider |
| **Finance** | • Banks<br>• Institutions<br>• Donor funds | • Technology provider<br>• Banks<br>• Private equity<br>• Donor funds | • Service provider<br>• Banks<br>• Private equity<br>• Donor funds | • Service provider<br>• Banks<br>• Private equity<br>• Donor funds |
| **Revenue Model** | • Dependent on self-use | • Dependent on self-use | • Dependent on number of users<br>• User charges can be either fixed or variable | • Dependent on number of users<br>• User charges can be either fixed or variable |
| **Risks** | • Higher technology & operational risk<br>• Effect on cashflows | • Higher technology & operational risk<br>• Effect on cashflows | • Payment default by users<br>• Low-capacity utilisation<br>• Low technology & operational risk | • Payment default by users<br>• Low-capacity utilisation<br>• Low technology & operational risk |
| **Benefits** | • Limited risks of non-payment | • Limited risks of non-payment if re-sale market for asset class exists and re-possession is viable | • Cheaper for the user<br>• Access to better tech-nologies at a cheaper price for the user | • Cheaper for the user<br>• Access to better tech-nologies at a cheaper price for the use |

## CASE STUDY

### CaaS for FFV: ColdHubs

CCI Element: Cold Room

Walk-in cold rooms are solar-powered modular plug-and-play units. Energy from solar panels mounted on the roof of the cold room is stored in high-capacity batteries; these feed an inverter, which in turn feeds the refrigerating unit. Thermal storage using phase change materials is used as backup.

**Product specification**

- Temp range: 0 to 12°C
- Humidity control range: 65%-95%
- Size: 20 cubic metres, capable of storing 150 20kg crates.
- Solar size: 1.5 kWp
- 120 mm thick insulated panel walls

Note: These specs can be customised to meet lower temperature requirements (-25°C to -18°C).

**Description**

Walk-in cold rooms are deployed at both the market and the farm level. Users include retailers (50%), wholesalers (30%) and farmers (20%). The cold rooms can extend the shelf life of FFV from 2 to 20 days.

**Business Model**

The company uses a flexible pay-as-you-store subscription model.

| Asset Owner | Financing Model | End-User | Pricing Model |
|---|---|---|---|
| ColdHubs | Self + support from financial institutions | Farmers, traders, wholesalers | US$0.26 per crate (20kg) per day |

**Impact**

- Reduces FFV losses (about 20,400 tons of food saved from spoilage in 2019[xvi]).
- Increases shelf life (2 to 20 days) of produce, translating into monetary benefits (about 50% more income) for farmers and traders.
- Creates jobs for women (about 100 jobs created so far).
- Makes more nutritious food available, especially for children.

**Challenges**

- Low adoption rates among farmers due to the lack of cold transport linkages down the value chain
- Year-round capacity utilization is low
- Questionable commercial viability
- Access to low-cost financing is a big challenge for large deployments

**Market**

- 54 solar-powered cold rooms (3 MT each) have been deployed since 2015, at an annual growth rate of 95%.[xvii] Of these, 40 (74%) are used by retailers and wholesalers and 14 (26%) are used by farmers
- 52 (96%) of these cold rooms are used for FFV while 2 (4%) are used for fish

## CASE STUDY

### Lease-to-Own: Eja-iCe

CCI Element: Solar Refrigerators

Eja-iCe offers solar-powered refrigerators to women in the fisheries value chain through direct sales, or through individual or communal Asset Credit Sales. This allows women fish retail traders to be more profitable, while providing them a cheaper, tailor-made repayment plan over an agreed term.

**Product specification**

- Solar-powered freezer for fish
- Natural-refrigerant-based cooling system

**Business Model**

The company sells their freezers to fish retailers on credit, with a flexible repayment plan.

| Asset Owner | Financing Model | End-User | Pricing Model |
|---|---|---|---|
| Individual/group of fish retailers | Self/retail groups | Asset owner | Lease-to-own |

**Impact**

In 2020:

- 137,760 kg of fish saved from spoilage
- US$17,173 saved on fuel costs
- 99,965 kg of $CO^2$ averted

## CASE STUDY

### Third Party Logistics: KCCL

CCI Element: Refrigerated Vehicles

KCCL offers refrigerated or climate-controlled transportation services for fruits and vegetables, meat and other perishables to farmers and aggregators. The company presently works with ten major markets in Lagos, as well as six retail outlets (Shoprite, Spar, Hub Marts, Karma, Domino and Leventis Foods).

**Product specification**

- Refrigerated trucks
- Temperature control and monitoring

**Business Model**

KCCL charges for cooling services through a truck hire system, on a per-kg basis.

| Asset Owner | Financing Model | End-User | Pricing Model |
|---|---|---|---|
| KCCL | Self + support from financial institutions | Farmers, traders, wholesalers | Truck hire |

**Impact**

- 15,000 tonnes of FFV moved
- 6,750 tonnes of FFV losses averted
- 2,040 direct beneficiaries
- 15,000 indirect beneficiaries

## 2.4. Policies and Regulations Affecting CCI

Globally, policy and regulatory instruments used to develop CCI include general incentives, taxes and duties on technology imports, food regulations, and refrigerant regulations. **In Nigeria, policy support is minimal; policies and regulations only affect CCI as it relates to the import and export of agricultural commodities.** In export, such policies are tied to promoting non-oil exports and diversifying export commodities. Certain imported goods are regulated to reduce import dependency and encourage local production.

### Import Regulations Affecting CCI:

**Import restrictions on dairy products**: In 2019, the CBN added dairy products to the list of forex-restricted commodities[3] as part of its Backward Integration Policy. As a result, only companies investing in local milk production are permitted to trade in forex; so far, the CBN has allowed only six companies to do so. By restricting dairy imports, the CBN hopes to improve milk production in the country. The Bank is also working closely with the Federal Ministry of Agriculture and Rural Development (FMARD) and relevant state governments to set up dairy cooperatives and push for increased local milk production.

FrieslandCampina WAMCO, one of the participating companies, has invested N21 billion (US$51 million) in its dairy development program, supporting over 10,000 smallholder dairy farmers and pastoralists. They have set up 23 organised cooperatives with collection centres, integrating them into the company's fresh milk supply chain.[xviii] As local production increases and more cooperatives and collection centres are established, the CCI requirement for dairy is expected to grow.

### Export Policies and Regulations Affecting CCI:

Most of Nigeria's policies and regulations around CCI are focused on meeting the requirements of importing markets. Produce grown for export is carefully regulated at all value chain stages. The Nigeria Agricultural Quarantine Service (NAQS) is charged with inspecting and issuing Phyto-Sanitary Certificates for fresh export produce to guarantee its safety and imposing regulations to ensure that the quality standards of importing countries are met. The Nigerian Export Promotion Council (NEPC) is the government institution responsible for promoting, developing, and diversifying exports. FMARD's Zero Reject Initiative[xix] aims to boost agricultural exports by setting global quality standards and standardising products, thus enhancing the international acceptability of Nigerian products.

Because CCI plays an essential role in maintaining produce quality, there are also policies enabling exporters to access CCI assets. These policies include:

**1. Export Development Fund (EDF)**: The Federal Government set up the EDF scheme under the Export Act CAP E19 Laws of the Federation, 2004.[xx] Its main objective is to provide financial assistance to exporting companies, including helping them acquire CCI.

**2. Export Expansion Facility Programme (EEFP)**: The EEFP is an N50 billion scheme that aims to boost Nigeria's non-oil exports by building on ECOWAS' Trade Promotion Organizations (TPOs) network. Through this program, the government has partnered with the Nigerian Aviation Handling Company (NAHCO) and FOB Logistics to develop CCI by providing Nigerian exporters with improved logistics and export services.[xxi]

**3. Domestic Export Warehouse (DEW) program**: Under this NEPC-backed program, aggregation centres were established as a one-stop facility for storage, packaging, labelling, pre-shipment inspection and fumigation for export goods in preparation for transport to ports.[xxii] The program has supported companies in building capacity and acquiring infrastructure, including cold warehouses.

### Other Policies and Regulations Affecting CCI:

• The Federal Government has collaborated with GAIN-USAID to develop PLAN Nigeria, a scheme that seeks to address the shortage of cold chain facilities and address post-harvest losses. Under the PLAN program, several projects have been implemented to 1) assess post-harvest losses and their link to cold chain, 2) map existing cold chain infrastructure in the country, and 3) identify and strengthen business links in Nigeria's cold chain.[xxiii]

• States like Lagos and Abuja have set guidelines to ban the transport of meat using motorcycles and "air cool vans,"[xxiv] instead requiring authorised refrigerated meat vans. Steps like these are expected to boost the growth of CCI.

## 2.5. Drivers of CCI Uptake

CCI in Nigeria is still nascent, especially in the domestic value chain. However, the following factors are expected to drive growth in the sector:

**1. Improve farmer income sustainability**: In Nigeria, a significant portion of FFV wastage is due to poor handling and a lack of CCI for post-harvest transport and storage.[xxv] Food waste could be reduced by using cold rooms at the farmgate and distribution centres and reefer vehicles to connect the different stages of the cold chain. Reducing food waste would enable better utilisation of limited resources like water and soil, improving farmers' income sustainability.

**2. Growth in local production**: Nigeria largely depends on imports to meet the domestic demand for fish and milk; around 70% of dairy products and 60% of fish consumed in the country are imported. To reduce this dependence, the government has taken steps to promote the local production of these commodities. The CBN has included dairy in the growing list of products restricted from foreign exchange trading, while FMARD is promoting the growth of aquaculture through its National Aquaculture Development Plan (NADP). These measures are expected to boost local production, which should drive the growth of CCI.

3. Commodities include meat and processed meat products, poultry, vegetables, and processed vegetable products.

**3. Growth of formal-sector fresh food retail chains**: The formal fresh food and meat retail market has tripled in Nigeria over the last decade,[xxvi] the result of growing urbanisation and increasing acceptance of processed foods.[xxvii] As these retail markets expand, operators are likely to develop CCI to maintain the quality of their products.

**4. Emergence of business models such as Cooling as a Service (CaaS)**: Due to financing challenges and a lack of credit facilities, users of CCI solutions often cannot afford the assets. Innovative payment models such as CaaS significantly reduce the burden of acquiring CCI assets. The availability of these more affordable options should drive the uptake and utilisation of CCI.

## 2.6. Challenges that Inhibit the Uptake of CCI Solutions

Despite the need for CCI in Nigeria, usage rates for cold chain technologies are meagre due to challenges faced by various stakeholders in the value chain. These can be categorised as follows:

### Enabling Environment:

**1. Lack of subsidy support from the government:** CCI is a capital-intensive business that requires a high upfront investment. Financial support is needed to scale up, which could take the form of subsidies or reduction of import duties to create market demand and support local manufacturing. This sort of support is not currently available in Nigeria.

**2. Limited financing**: Accessing financing is a major challenge for CCI uptake. At the farm gate, CCI is only financially viable if financing is available at low-interest rates (1-2% monthly), which only a few development banks and financial institutions provide. Farmers are perceived to be high risk because they rarely keep detailed farm/business records, and their income is seasonal. Rainfed agriculture is also affected by adverse changes in the weather, which ultimately impacts income and a farmer's subsequent ability to repay loans.

**3. Unavailable or unreliable electricity grid**: Nigeria's electricity grid is poor and unreliable, forcing cold rooms to use fossil fuel-based generators as backup. This increases the upfront investment and operational cost of CCI, which poses a major challenge for uptake.

**4. Affordability of CCI**: Storing fish and meat generally requires temperatures of -15°C to -20°C. Achieving these low temperatures consumes considerable energy, significantly increasing CCI's upfront investment and operational costs.

**5. Lack of skilled labour**: CCI technologies must be properly operated and maintained to reliably provide optimum temperature and humidity levels, which requires skilled personnel. There are few workers in Nigeria trained in operating CCI, which is a barrier to the uptake of these technologies.

**6. Lack of awareness among stakeholders**: Awareness and knowledge of cold chain's benefits are minimal among farmers and other stakeholders. Agricultural activities focus primarily on production, with post-harvest activities and value addition largely neglected. Despite significant FFV losses during transportation, for example, people still use traditional baskets and open trucks for long-distance transport. This lack of awareness contributes to post-harvest losses.

### Demand Side:

**7. Fragmented and informal unorganised market**: Agricultural produce in Nigeria travels through a highly fragmented, unorganised supply chain, leading to significant losses. Thousands of small businesses are engaged in crating, transportation, storage, and distribution. In the tomato sector, for example, most smallholder farmers supply a vast network of small aggregators and traders who sell directly to either informal market sellers or wholesalers. Most locally produced milk is sold in highly scattered, unorganised markets. Very few large companies are involved in agri-food transportation and storage, and there needs to be more public funding. Such an unorganised supply chain makes planning difficult and poses a challenge to the development of CCI.

**8. Consumer preferences**: In Nigeria, consumers generally prefer fresh produce over frozen. When it comes to fish, for example, people prefer it to be fresh or smoke-dried.

**9. Limited need for CCI in the first mile of some value chains**: The meat industry functions very differently than the FFV, dairy and fish value chains. Livestock can be stored and transported alive, eliminating the cold chain requirement in the first mile. CCI is needed only after slaughtering; if this is deferred to the end mile (retail level), there is even less need for CCI.

**10. Dependence on imports**: Most of the dairy consumed in the country consists of imported powdered milk, which does not require any CCI. Local producers are facing stiff price competition, and many cannot compete with multinational companies selling imported milk powder.

**11. Absence of reefer vehicles connecting farmgate to retail centres**: Cold storage is primarily used by retailers and wholesalers. The use of CCI among farmers is limited due to the absence of reefer transport to connect farmgate cold storage to retail centres.

### Supply Side:

**12. Absence of indigenous technology and manufacturing**: Imported technology poses a major challenge in CCI deployment. Key elements such as compressors and condensers are generally imported since locally made alternatives are unavailable, raising the price of CCI and reducing uptake.

## 2.7. Potential Interventions to Increase the Uptake of CCI

**For Government:**

**1. Focus on developing first mile CCI**: Since most losses occur due to poor post-harvest management at the first mile (near the farmgate), this is where CCI is in most need of development. First-mile CCI should include reefer transport that can integrate it with the processing and retail levels, thus reducing losses further down the supply chain. Locating CCI near the farmgate would also make it more accessible to smallholder farmers, allowing them to improve their incomes.

**2. Provide access to financing through diverse channels**: Farmers and enterprises developing CCI need low-interest financing to make these assets commercially viable. This could be provided through equity capital from commercial investors considering the energy-agriculture nexus or through grants. It should target either companies that manufacture or distribute CCI, or MFIs and cooperatives that can provide consumer financing for farmers.

There are several possible structures for such financing:

- *First loss capital:* a donor deploys grant capital in an investment and agrees to bear first losses if the ROI is negative, thus catalysing the participation of commercial co-investors.
- *Results-based or performance-based financing*: an impact investor or financier provides capital as long as measurable impact metrics are met, such as the amount of food "saved" by using CCI solutions.
- *Public-Private Partnerships (PPPs)*: a private investor invests but relies on equity sponsors or the public sector for any cashflow shortfalls. This model would need to be well structured and adequately coordinated to succeed.

Another possible structure could involve the government providing financing for an asset while a private partner or donor is responsible for its repair and maintenance, as well as providing technical expertise to the user to ensure sustainability.

**3. Build capacity of CCI technicians and operators**: CCI technologies require skilled personnel. The capacity gap in Nigeria represents a risk for enterprises deploying these assets, so considerable education and capacity building is needed to help expand CCI. In partnership with the government, donors could help sponsor educational programs for local experts in the sector, as well as exchange and benchmarking programs that would further build technical and manufacturing skills.

**4. Capacity building and technical assistance for OEMs**: Local CCI companies require technical assistance to ensure that they become sustainable. This could be sponsored by donors andinclude subjects such as pricing models, market entry points, relevant value chains and optimal technologies. Donor programs could also include education campaigns for farmers and consumers, increasing the uptake of CCI through enhanced awareness of its benefits.

**5. Support local manufacturing**: Imported technology remains a significant challenge in CCI deployment, raising the price of cold chain technologies and reducing uptake. Focusing on locally manufactured components would reduce costs, bypass tedious import processes and improve the viability of CCI solutions. Using locally manufactured technology would also reduce the overall cost of CCI assets for consumers.

**6. Incentives and subsidies**: For the market to grow, more comprehensive policies are needed to provide incentives and subsidies for CCI development.

**For OEMs:**

**7. Strengthen product development**: OEMs should focus on developing low-cost sustainable, farmer-centric products using clean, climate-friendly technology (including refrigerants with low GWP), thus creating the best product-market fit.

**8. Develop financing and service models**: OEMs and system integrators should play a more active role in financing, providing end-to-end solutions to customers. The pay-as-you-store or CaaS models should be further explored, allowing more smallholder farmers to access CCI. OEMs should also focus on value-add features like warehouse financing products, after-sales support by trained personnel, and reefer transport integration to improve market linkages.

# Conclusion

## CONCLUSION

**CCI in Nigeria is still nascent, and the value chains that require it are underdeveloped and largely informal.** Existing CCI is concentrated in the fish value chain and used almost exclusively for imports. However, there is immense potential for CCI market growth in the FFV and dairy value chains and locally produced fish.

**The CCI used at processing, import and export facilities mainly consists of on-grid technologies supported by fossil fuel-based generators that supplement the country's weak electricity grid.** This impacts Nigeria's GHG emissions. However, in the FFV value chain, a few CCI solutions are emerging powered by renewable energy (primarily solar). These technologies are often paired with innovative business models like CaaS, thus addressing the affordability challenges for farmers. Similar solutions for fish and meat are not yet economically viable; policy interventions could help create an enabling environment in these value chains, furthering the development of off-grid CCI.

**No single government policy focuses on CCI deployment or offers incentives for its adoption.** Existing policies and regulations around CCI mainly relate to the agricultural export market, which is small. However, regulations like milk import restrictions and efforts to develop local production are expected to indirectly drive CCI uptake, especially for components like bulk milk chillers.

**Several measures could help develop and expand CCI use in Nigeria.** Appropriate policies could be implemented to reduce upfront costs through incentives, promote sustainable technologies, and provide financing access. Capacity building and support for local manufacturing could also help grow the CCI market, thus reducing food waste and improving livelihoods along the agricultural value chain.

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**Annexure-1: In-Depth Analysis of the Value Chains**

## Fresh Fruits and Vegetables

### Market Overview of the Fresh Fruits and Vegetables Value Chain in Nigeria

**The agriculture sector contributes 24% of Nigeria's GDP,[xxviii] with fruits and vegetables accounting for about 34% of the sector's total gross production value.[xxix]** The diverse agro-climatic conditions in the country are favourable for growing fruits and vegetables, particularly in the northern and southern regions.

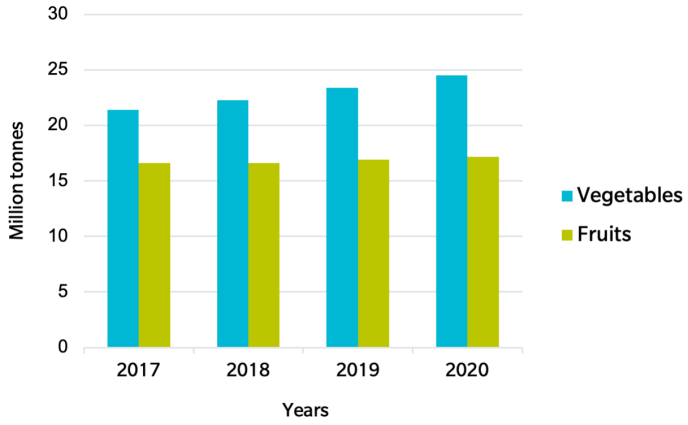
In northern and central Nigeria, Kaduna, Kano, and Jos Plateau are leading vegetable producers, growing more than 50% of the country's onions, potatoes (Irish and sweet), peppers and okra. Delta, Cross River, and Oyo lead southern Nigeria's fruit production, growing mangoes, pineapples, plantains/bananas, citrus fruits, guavas, and papayas.

**In 2020 the annual supply of fruits and vegetables stood at 17.2 and 24.5 million tonnes, respectively, with domestic production at 16.9 and 24.3 million tonnes.** Based on historical data (2011-17), production is expected to grow at a CAGR of around 4% for fruits and 5% for vegetables until 2030. A small portion (< 2%) of Nigeria's demand for FFV is met by imports; in 2020, the country imported 0.37 tonnes of fruits and 0.22 million tonnes of vegetables.

**In 2020, Nigeria consumed 11.2 million tonnes of fruits and 16.9 million tonnes of vegetables, an annual per capita consumption of 54.2 kgs of fruits and 82.1 kgs of** vegetables. The country also exported around 2,000 tonnes of FFV that same year.

Around 50% of fruits and 40% of vegetables are wasted during harvest and post-harvest activities at different levels of the value chain. This is primarily due to poor harvesting, poor handling, inappropriate packaging, lack of cold chain, and climate change-related temperature increases.

**Figure 10: Fresh Fruits and Vegetable Supply (million tonnes) in Nigeria (2017-2020)**




Due to the seasonality of the harvest, production sometimes exceeds demand (market glut), and farmers are forced to dump their produce or sell it at a low price. This pattern results in significant losses for farmers, leading to financial distress and loan defaults. It also means wasting precious resources like water and soil.

With FFV production concentrated in northern and southern Nigeria, fresh produce must often be transported 800-1,000 kilometres to the market, which takes about three days. The traditional baskets used to stack produce during transport, poor road conditions and the absence of reefer trucks all result in rotting and wastage.[xxx]

Most markets also lack cold storage facilities. Even Mile 12, the biggest market in southwestern Nigeria, has no temperature-controlled storage facility.[xxxi] This results in tremendous losses. About 30-40% of all FFV waste can be attributed to a lack of cold chain: 50% to a lack of reefer vehicles and 50% to a lack of cold storage.[xxxii] Cold chain interventions at several stages of the FFV value chain are crucial to reducing wastage, improving food security, and making supply chains more efficient.

**Figure 11: FFV Value Chain in Nigeria**

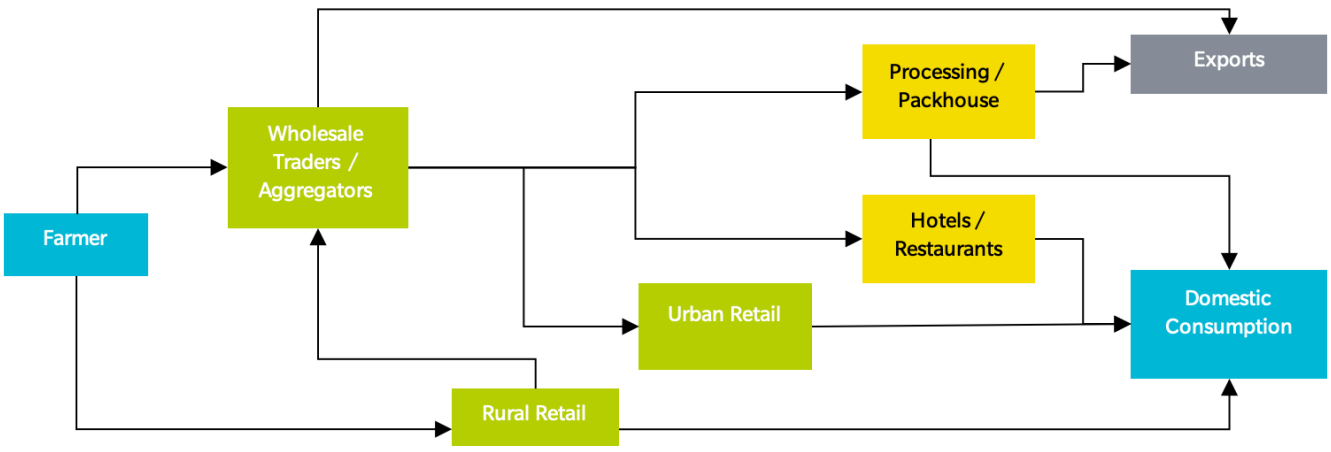
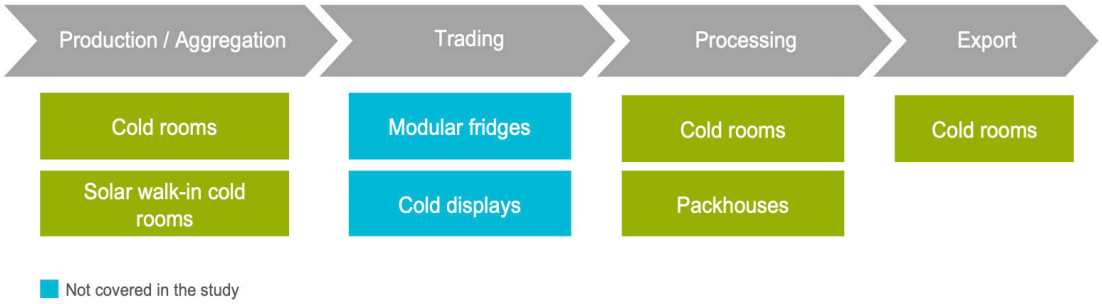


**Figure 12: Current Use of CCI Components at Different Levels of the FFV Value Chain**




## Dairy

### Market Overview of the Dairy Value Chain in Nigeria

**Nigeria's livestock sector contributes 1.7% to the national GDP, with around 20.5 million cattle producing half a million tonnes of milk.**[xxxiii] National milk production grew at a CAGR of 0.5% between 2015 and 2019. 82% of livestock are raised in pastoral systems, 17% in agri-pastoral systems, and 1% in commercial systems. In pastoral systems, the average herd size is 300, while in agri-pastoral systems, it ranges from 20 to 100. The milk yield from pastoral and agri-pastoral cattle is 0.5-2 litres per day per animal; these two systems account for 95% of the milk produced in the country. The remaining 5% is supplied by commercial systems, where the milk yield is 30 litres per day per animal.

Most of the milk produced in pastoral and agri-pastoral systems is consumed domestically or sold in informal markets. Multinational processors collect about 5% of this milk, then blend it with reconstituted imported milk for further processing. 100% of commercially produced milk is processed and sold in formal markets.

**In 2019,[4] annual milk consumption in the country was 1.7 million tonnes, equivalent to 8.6 litres (8.9 kgs) per capita.**[5] According to FAO estimates, annual per capita milk consumption should reach 16 litres (16.5 kgs) by 2050,[xxxv] which translates to an annual growth rate of 2% from 2019-2050. Milk is consumed in the form of powdered milk (70%) and liquid milk (20%), as well as other value-added products (10%) such as nono (sour milk), kindirmo (sour yoghurt), manshanu (local butter), cuku (Fulani cheese) and wara (Yoruba cheese).

**Because domestic demand exceeds local production, Nigeria spent about US$1.5 billion on dairy imports in 2019.**[xxxvi] In terms of volume, around 70% of demand was met through imports mostly in the form of milk powder. This milk powder is either sold as reconstituted milk or processed into other value-added milk products such as yoghurt, butter, and cheese. According to FAO estimates, less than 40% of domestic milk demand will be met by imports by 2050, thanks to government efforts to ramp up local production.

**Table 4: Dairy Farming Systems and Their Market Characteristics**

| | Pastoral | Agri-pastoral | Commercial |
|---|---|---|---|
| **Cattle Head Count** | 15,111,309 (82%) | 3,089,804 (17%) | 203,548 (1%) |
| **Milk Yield** | 0.5-2 litres/day | 0.5-2 litres/day | 30 litres/day |
| **% of Total Production** | 80% | 15% | 5% |
| **Target Market** | Primarily informal (~95%) | Primarily informal (~95%) | Formal (~100%) |

4. Import restrictions were in place in 2020 due to the CBN's Backward Integration Policy. The numbers here are from 2019.
5. Density of milk = 1.03 kgs/ltr

**Figure 13: Milk Consumption in Nigeria**

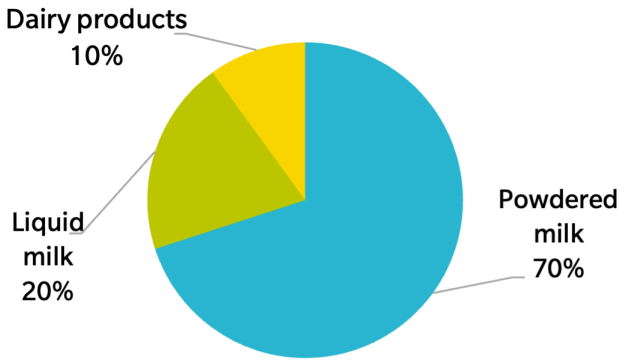



**Figure 14: Domestic Production and Consumption of Milk in Nigeria (million tonnes) (2017-2019)**

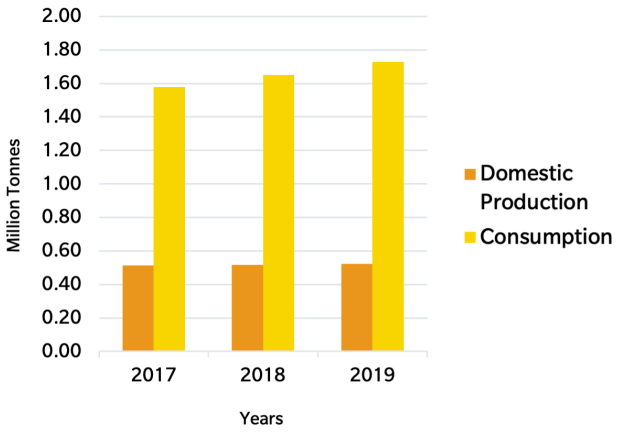



**Figure 15: Dairy Value Chain in Nigeria**

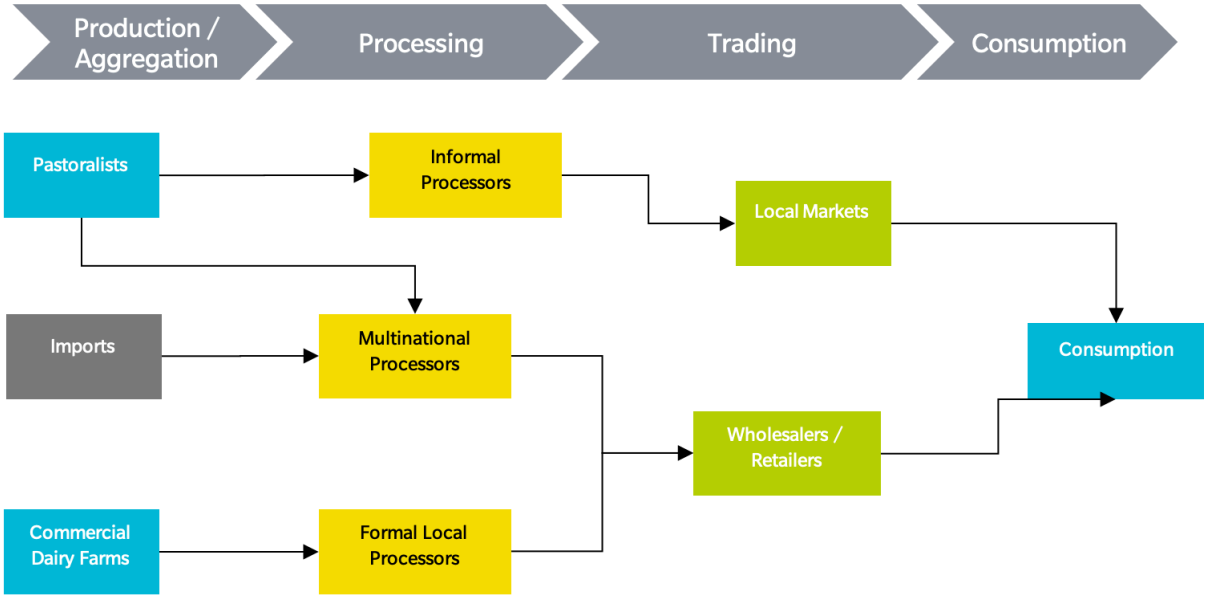



**Figure 16: Current Use of CCI Components at Different Levels of the Dairy Value Chain**

## Fish

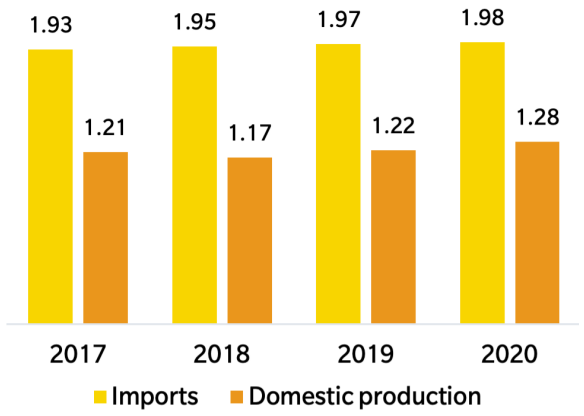
### Market Overview of the Fish Value Chain in Nigeria

**Fisheries contribute about 0.5% of Nigeria's GDP. These consist of artisanal fishing on the coast and inland (60%), aquaculture (38%) and industrial fishing (2%).**[xxxviii] The main types of fish produced in Nigeria are torpedo-shaped catfish, tilapia, African carp, elephant snout, Nile/Niger perch, bonga shad and bony tongue fish. **In 2020, the country produced about 1.17 million tonnes of fish.** Based on historical data (2010-2019), fish production has grown at an estimated CAGR of 3.5%.

**Fish is an important part of Nigeria's household diet, accounting for around 40% of the country's protein intake.**[xl] Nigerians consume fresh and processed fish, including frozen fish, smoke-dried fish, and dried fish. Total annual consumption is 2.6 million tonnes or 13 kg per capita; according to a study by Worldfish, socio-economic conditions in the country are expected to push per capita fish consumption down to 10 kg by 2030.[xli] After adjusting for population growth, total fish consumption is expected to grow at a CAGR of 0.6% between 2020 and 2030, indicating flat demand.

**Because local demand exceeds domestic production, Nigeria imported around 1.9 million tonnes of fish in 2020, accounting for more than 60% of the country's total fish supply.** Based on historical data (2015-2020), imports have grown at a CAGR of 0.9%. Almost all frozen fish is imported, while domestically produced fish is consumed either fresh, dried, or smoke-dried.

**Figure 17: Supply of Fish in Nigeria (million metric tonnes) (2017-2020)**




**Nigeria is a net importer of fish.** To reduce this dependency, improve food security and ease the drain on foreign exchange, the government has adopted several measures to reduce the gap between demand and supply, including policies intended to boost coastal fishing and aquaculture.

**As a result, local fish production is growing four times faster than fish imports. 40% of this local production is aquaculture, and 60% is capture fishing. Between 2010 and 2019, aquaculture and capture fishing grew at 4.2% and 3.3%, respectively.**

Aquaculture operations produce mostly catfish (80%) and tilapia (20%). Aquaculture-raised fish are transported live in water-filled containers and are typically transferred from farmer to consumer or processor within two hours of harvesting.[xlii] But significant quantities of these fish often die in transport due to high temperatures, vehicle breakdowns and the absence of suitable storage facilities at markets.

These dead fish are smoke-dried and sold, but they lose up to 50% of their value.[xliii] For example, feedback from stakeholder consultation revealed that smoke-dried catfish is sold for N1,500 per kg if smoked fresh but only N750 per kg if smoked after two days. This loss in value is due to a mismatch between supply and demand at the retail level, which could be avoided if fish were frozen at the farm gate. Freezing would also allow produce to be transported longer distances.

The post-harvest value chain is short and simple for marine and river capture fishing. The harvest is transported to customers or processors in boxes filled with ice and sold fresh or smoke-dried to preserve it along the value chain. Although smoking improves the shelf life of fish, about 25-28% is still lost due to a lack of CCI facilities.[xliv] **One of the biggest challenges faced by the capture fishing community is a lack of value addition for their produce,[xlv] which hinders the development of the fish value chain.** Today, smoking is the only form of value addition available.

According to a study conducted by the Federal University of Agriculture in Ogun State, 79.2% of fishermen, 62.4% of fish processors and 82.2% of fish marketers report that poor transportation networks and storage facilities in coastal communities are a very severe constraint to the development of the fish value chain.[xlvi] This suggests that adding CCI to the post-harvest value chain can potentially improve the market outlook of domestically produced fish.

**Figure 18: Fish Value Chain in Nigeria**

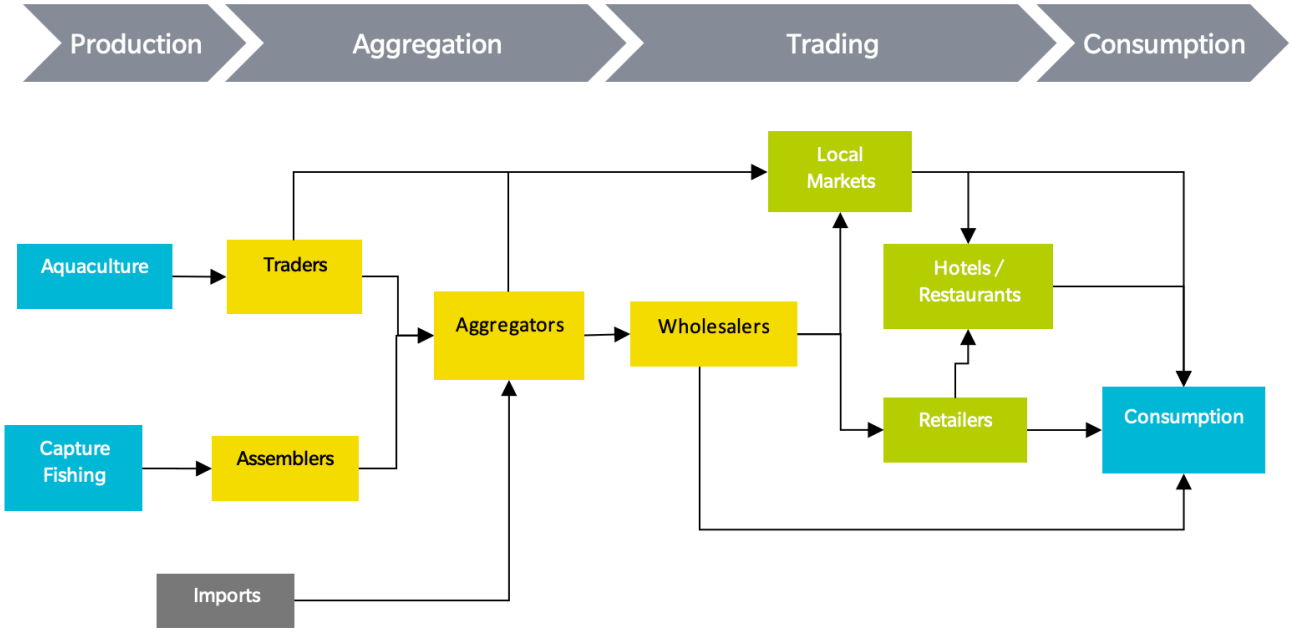
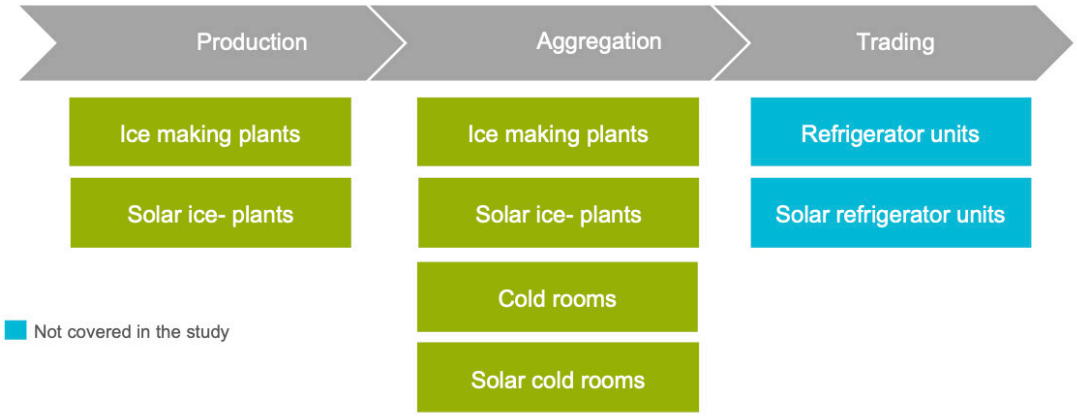



**Figure 19: Current Use of CCI Components at Different Levels of the Fish Value Chain**




## Meat

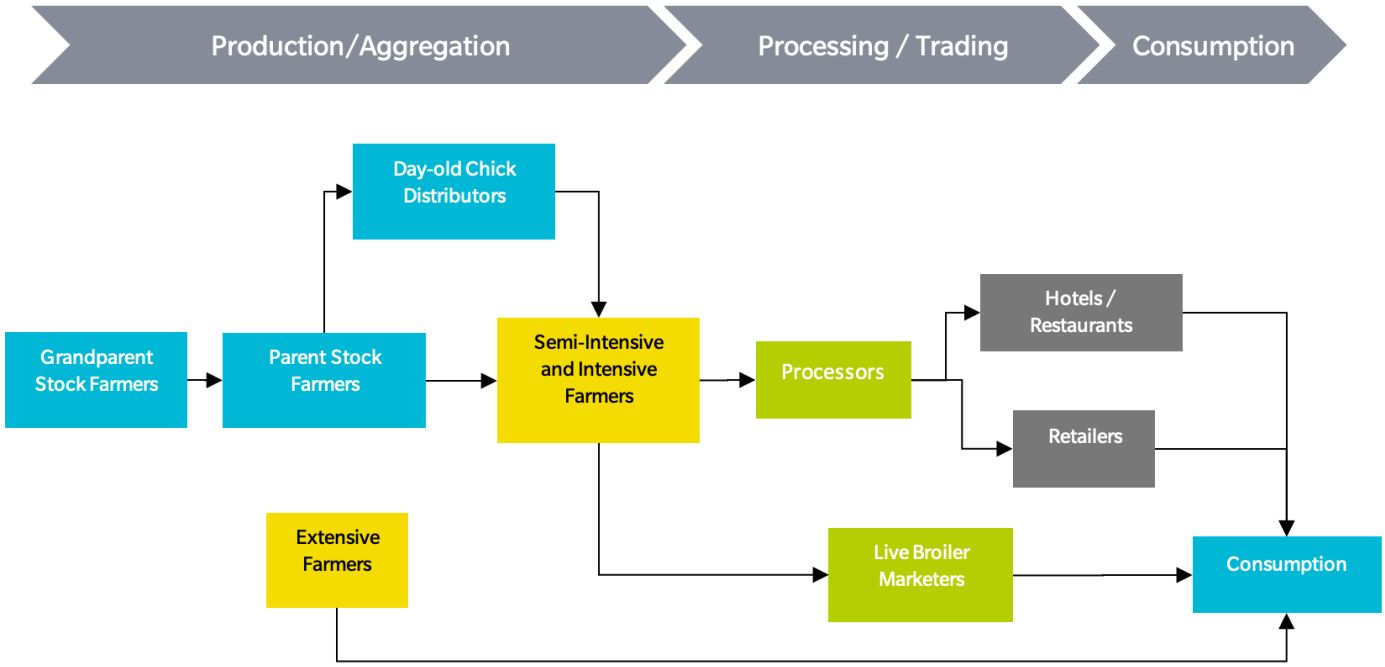
### Market Overview of the Dairy Value Chain in Nigeria

**Nigeria's livestock sector contributes around 1.7% of the national GDP, with an estimated 20.5 million cattle, 43.4 million sheep, 76 million goats and 180 million poultry producing 1.73 million tonnes of meat yearly.**[xlvii] Based on historical data (2000-2019), this production is expected to grow 2% from 2019-2030. The meat industry consists primarily of beef (25.5%), goats (20.6%), sheep (11.2%), pork (23.4%) and chicken (18.6%). In 2020, less than 0.1% (880 MT) of the total meat supply was imported.

**The total demand for meat in Nigeria was about 1.3 million tonnes in 2020**, equivalent to an annual per capita consumption of 6.7 kgs.[xlviii] Historical data (2007-2017)[xlix] suggests that the per capita demand for meat will decrease at 2.2% per year, resulting in a 0.7% annual decrease in total meat consumption.

**There are about 180 million birds in the Nigerian poultry industry, and three systems of production: extensive or free-range (46%), semi-intensive (33%) and intensive (21%).**[l] In the extensive production system, birds are left to roam freely and scavenge for food and water. These flocks contain birds of different species and ages, raised primarily for family consumption. In semi-intensive and intensive systems, farmers keep flocks of only one species, which produces meat or eggs for the market. In these systems, day-old chicks are purchased from parent stock farmers and then raised for 6-10 weeks before being sold to local customers, live broiler marketers and processors. Live broiler marketers sell these mature birds (broilers) to household consumers. Processors process, package and weigh the broilers, then sell them as whole chickens, cut chicken, gizzards, heads, and legs. Processed chicken is sold to household consumers (12%), fast food outlets (50%), hotels (8%), restaurants (10%) and supermarkets (20%).

**Figure 20: Poultry Meat Value Chain in Nigeria**

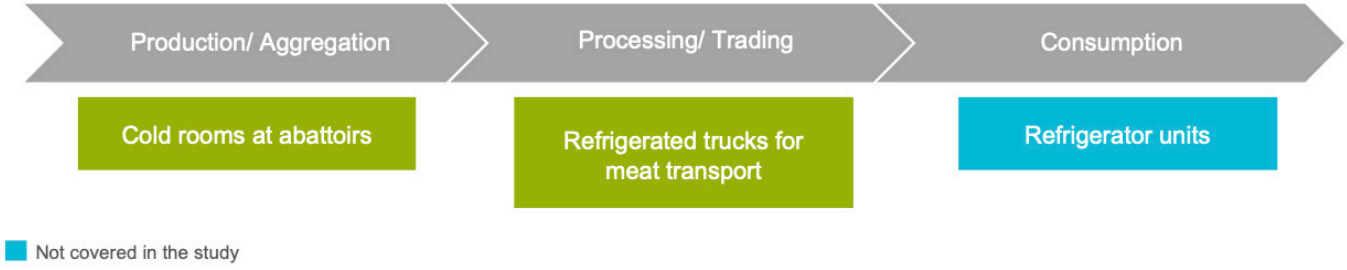



There are three systems of production in the Nigerian beef industry: extensive pastoral, home fattening and concentrate fattening systems. **The cattle reared by pastoralists in extensive systems account for 75% of the total beef produced.**[li] In the home fattening system, farmers buy adult cattle (bulls and cows) capable of gaining weight within three to four months of grazing. This production system is typically practised by smallholder farmers combining animal husbandry with other businesses to improve their standard of living; it accounts for 15% of the total beef produced. The remaining 10% is produced in concentrate fattening or intensive systems practised by large-scale cattle marketers and producers.

In all these production systems, mature cattle are transported live to markets. They are butchered in abattoirs and meat shops and sold through meat shops or in open markets. **Currently, most beef is transported in open trucks and taxis from abattoirs to meat shops, where it is sold fresh.** Traditional open-air market stalls account for about 85% of the beef trade. Other small but growing end-market segments are retail stores (3%), retail supermarkets (1%), institutions (3%), fast food restaurants (5%), and hotels and restaurants (3%).[lii]

### CCI Utilization and Gaps Within the Value Chain

**Figure 21: Current Use of CCI Components at Different Levels of the Meat Value Chain**



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