

# OPTIMIZING COLD CHAIN TRANSPORT

Applying U.S. Lessons in Refrigerated Hauling  
in the Developing World





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## 1 INTRODUCTION

Managing the risks and disruptions encountered by refrigerated trucks in the cold chain are the top priority for all refrigerated trucking companies. Ensuring that cold chain products are transported under adequate temperature conditions is critical, but there is no single application to manage all the risks. Expert logisticians are needed to identify, assess, and address any problems that could cause disruptions in the cold chain.

Industry experts in the field of refrigerated trucking have mastered the elements of this delicate balance. Their expertise can be successfully applied to implementing and expanding cold chains, both domestically and globally. The developed world reaps the benefits from an efficient cold chain for the delivery of fresh food and pharmaceuticals, but in Sub-Saharan Africa, the lack of infrastructure for delivering fresh food and medical care has made feeding and vaccinating large segments of the population extremely difficult—with devastating consequences.

The most critical factor to keeping food fresh and maintaining the efficacy of vaccines is proper cold transportation and cold storage, but of the ten countries comprising East Africa, Kenya is emerging as the one with great economic potential. With a positive outlook for jobs and a significant increase in consumer confidence, Kenya is slowly addressing the many challenges it has yet to overcome due to a still-developing infrastructure. However, significant progress to that end is being made, and the stage is set for Kenya to restore investors' confidence in Kenya and keep the country on a strong path for continued growth.

Consistent refrigerated transportation instability is at the core of why cold chain logistics in Sub-Saharan Africa is nine times more expensive than anywhere else in the world. The lack of automation and logistics technology requires a much greater reliance on human supervision and regulation, often resulting in inadequate or deficient approaches to solving the problems. The most efficient economies of the world have achieved logistics costs of about 9 percent of GDP, while the most inefficient pay as much as 30 percent to make up for their logistics fails—with the average being between 11 and 16 percent.

The following is a look at the ways in which U.S. best practices in cold chain logistics can be applied to address the complex issues regarding the delivery of fresh food and potent pharmaceuticals to millions of people in the developing world whose lives depend on these products.

## 2 GOING GLOBAL—APPLYING U.S. BEST PRACTICES AND LOGISTICS EXPERTISE TO CLOSING THE GAPS IN THE COLD CHAIN IN SUB-SAHARAN AFRICA

In the United States, industry leaders have set the highest standards for implementing a complex refrigerated trucking system that operates at top efficiency. Highly skilled managers work to incentivize drivers with good salaries, benefits, and personal emotional investment, and use leading edge technology to maintain impeccable safety records and control over equipment and drivers.

In turn, American consumers enjoy an uninterrupted supply of fresh produce and frozen foods, and remain secure in the knowledge that their pharmaceuticals are safe and at full potency because they've been kept at the appropriate temperature.

Time and again, the developed world has watched in horror while reports of yet another famine or epidemic sweeping unchecked through Sub-Saharan Africa saturate the media. Aid is sent, but the truth is, Africa could distribute most of its own food and pharmaceuticals to its population if not for the serious gaps in its cold chain. It is fraught with challenges that experts in the U.S. refrigerated trucking industry have long resolved.

With the help of industry experts, the most acute issues plaguing the Sub-Saharan cold chain now could be mitigated if not nearly resolved, bringing desperately needed food and pharmaceuticals to the world's most impoverished population.

## 3 SOME COLD, HARD FACTS ABOUT COLD CHAIN LOGISTICS IN AFRICA

The Food and Agricultural Organization (FAO) at the United Nations estimates that the continent of Africa loses enough food annually to feed 300 million people (or nearly a third of all Sub-Saharan Africa) due to food spoilage.<sup>1</sup> This is the result of a number of serious lapses in the cold chain in that area, specifically the fact that insufficient infrastructure in low-resource regions results in an unreliable power supply plagued by frequent power outages.

Sub-Saharan Africa has the highest burden from disease per capita and the lowest average incomes in the world. This region represents about 10 percent of the world's population, but is home to about 70 percent of all people living with HIV/AIDS or under the threat of chronic malnutrition (or both).<sup>2</sup>

Food loss reduces income by at least 15 percent for small farmers in Sub-Saharan Africa. There are approximately 470 million smallholder farmers; most are among the 1.2 billion food insecure people.<sup>3</sup>

Numerous African countries are unable to reap the full economic benefits from exporting perishable food items that grow abundantly and could significantly improve their economies, simply because they are unable to reduce food spoilage. The need to address this problem grows more acute each year.

The world's population will reach over 9.6 billion by 2050, with over half that growth occurring in Sub-Saharan Africa. If food loss is not reduced, food production will need to increase in the developing world by about 70 percent and require an investment of over \$83 billion a year to keep pace with the demand.<sup>4</sup>

Unreliable transportation systems and poor refrigeration also make it difficult for African children to receive immunizations. Maintaining the cold chain is the number one threat to the success of the vaccination campaigns in remote areas of Africa, where refrigeration is rare. Aid workers must spend a disproportionate amount of time ensuring the temperature of the vaccines is cold enough, inhibiting their ability to keep moving toward the areas where they're needed.

Although the challenges to improving cold chain logistics in Africa are many, there is reason to be optimistic. With support, investment, and training from industrialized Western and Asian countries, certain aspects of the African cold chain are functioning very efficiently, particularly in Kenya.



## 4 KENYA: A BRIEF ECONOMIC OVERVIEW

Despite a history that includes its share of political unrest, recent elections in Kenya were peaceful.<sup>5</sup> Kenya is emerging as a relatively stable African country, although it's still plagued by political corruption issues, ranking 145 out of 175 in Transparency by International Transparency.<sup>6</sup>

Nevertheless, this country occupies a powerful position in the East African economy and continues to make slow but steady progress across multiple sectors. It is the region's financial center—Nairobi is the largest city between Cairo and Johannesburg, and the Port of Mombasa is the most important deep-water port in the region. Additionally, Kenya has a very strong private sector.<sup>5</sup> All of this is important infrastructure that will ultimately help support investing in refrigerated trucking in that region.

A significant bright spot in the Kenyan economy is that globally, it has risen to one of the top positions in the area of exporting horticulture. Kenya holds first place in the world in exporting many varieties of fresh-cut flowers and leading the world in exporting roses to Europe, mainly Holland.

With cooperation and investment from Dutch cold chain logisticians, a highly efficient cold chain has been operating for the last 20 years for the export of flowers.

Despite these positive indications, major challenges still exist. Kenya's population has tripled over the last 35 years, leaving the population continually vulnerable to food insecurity, compounded by inadequate rural infrastructure and an absence of technology diffusion. Kenya's marked success in maintaining a cohesive, effective cold chain for their horticultural exports is evidence that with further investment and cooperation from industrialized nations, their cold chain logistics can expand to include fresh meat, produce, dairy products, and pharmaceuticals.

<2

The **average Kenyan farm** is less than two hectares

74,000

In 2014, Kenya received **74,000 tons of food aid** from Food For Peace, but as well as multiple other organizations



Kenyans suffer a **20%-50% food loss** due to spoilage annually

**70% of the country's labor force is agricultural; most are subsistence farmers who must sell what they harvest immediately due to lack of refrigeration/shipping logistics/cold storage.**

**GDP: over \$44 billion, the largest in East Africa. The agricultural sector contributes 45% of the overall GDP.**

**10.8** 10.8 million Kenyans are undernourished due to frequent droughts – **1/4 of the total population**

## 5 SUCCESS IS ATTAINABLE - THE HORTICULTURAL COLD CHAIN IN KENYA

The Dutch-Kenyan floral trade is an integral part of Kenyan horticulture and European consumers continue to actively purchase Kenyan fresh cut flowers. As roses have become Kenya's biggest horticultural earner, the trade has created thousands of jobs and livable incomes for natives.<sup>7</sup>

However, Western Europe's cut flower market watchers have indicated that the rapid growth of this market is putting pressure on the supply chain, which casts a spotlight on myriad possibilities for investors to improve the logistics of the entire cold chain.

A study commissioned by the Dutch Ministry of Economic Affairs, Agriculture, and Innovation has revealed numerous serious trouble spots in the cold chain, underscoring the beneficial effects that foreign investment, education, and training would have on further maximizing this trade. The study focuses on problems in the current cold chain management, transport and logistics, and packaging that will soon need a complete overhaul in order to keep up with demand.

Many of these issues can be resolved by addressing the lack of consistent standards and protocols in the cold chain, establishing clear agreements about optimal temperatures of flowers, and creating standard procedures for ordering, storing, and erecting packages.<sup>7</sup>



**Horticultural exports represent 7% of the world market**

**As of 2011, the volume of horticultural exports have made Kenya's Jomo Kenyatta International Airport the largest hub of Africa, overtaking Cairo and Johannesburg**



**Kenya is among the leading suppliers of roses in Europe**



## 6 CAPITALIZING ON CONSUMER DEMAND BY INVESTING IN COLD CHAIN LOGISTICS

Under present circumstances, Kenya cannot take advantage of its own bumper cash crops because it lacks the capabilities to prevent a significant percentage of each harvest from spoiling.

Kenya is one of the world's largest producers of mangoes<sup>5</sup> but obstacles that farmers face from planting to harvest to market prevent them from reaping even half the financial benefits.

At the farm level, the lack of technology results in a production cycle that lasts too long. These problems, combined with inadequate handling facilities result in serious losses. In addition, poorly developed transport infrastructure, as well as often impassable roads that lead to production areas are a significant contributing factor to the spoilage of the fruit, and its low market value.<sup>8</sup> Exporting the fruit is also nearly impossible due to inadequate post-harvest practices, inadequate sea freight facilities, a lack of refrigerated trucking options, and high air freight costs.

A recent report highlighted that with the use of special reefer containers that are both temperature and atmosphere controlled, mangoes could last an additional nine weeks.<sup>5</sup> Studies show that currently, 30 percent of mangoes are not even harvested due to unfavorable market prices.

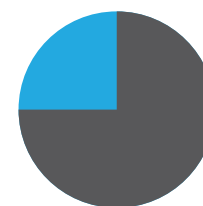
The value of exporting fresh produce using an uninterrupted cold chain has also been shown with avocados, with price premiums for avocados that had been packed and cooled as close to the farm as possible.<sup>5</sup> A longer shelf life due to the use of a cold chain means they can be exported to Europe, where they can fetch up to three times the price as what is possible at traditional markets.

A viable solution to this problem of waste and financial loss would be to invest in juicing plants. One small juicing plant could handle 1,000 tons of mangoes a year—this is already being done successfully in Tana River County in Kenya, where a recently opened plant has already grown to have a capacity of processing 30 metric tons of mangoes a day and is now able to process pineapple juice, tomato sauce, honey, and mineral water as well.<sup>9</sup>

Consumer demand is growing exponentially for imported goods as well. For example, Dutch onion exports grew by 19.1 percent<sup>10</sup> in 2012 in their exports to five main West African markets (Senegal, Guinea, Mauritania, Ivory Coast, and Sierra Leone), while their overall onion exports grew only 5 percent.

The importance of these markets to Dutch onion exporters is continually increasing, which spotlights the consumers' demand for more high-quality onions in Africa. If locally grown onions would be of better quality, with improved packaging, expanded onion production, and better cold storage to reduce spoilage and extend the growing season, a year-round local supply could be ensured and local farmers could capture a much larger market share.<sup>10</sup>

Currently, of the 1.1 million tons of onions produced in those markets, challenges surrounding high seasonality and post harvest losses of over 40 percent makes Africa unable to meet regional and domestic consumers' needs and keeps them dependent on the imported products, particularly in the off-season.<sup>11</sup>



**25% of farmers simply store the mangoes they have in their home** — lack of cold storage is among the most pressing challenges to farmers' ability to maximize profits on this cash crop

**63%**  
of farmers have no way to store their harvested mangoes

**40%** of farmers lost **30%-40%** of the mangoes after harvest, due to pests and diseases, lack of cold storage, immature harvesting practices

**30%**  
of mangoes not even harvested due to unfavorable market prices



**95%**  
of farmers could not store the mangoes for more than one week



Small juicing plants could handle **1,000 tons of mangoes a year** — this is already being done successfully in Tana River County in Kenya.

## 7 TARGETING THE SPECIFIC GAPS IN THE AFRICAN COLD CHAIN

Consistent refrigerated transportation instability is at the core of why cold chain logistics in Sub-Saharan Africa is nine times more expensive than anywhere else in the world. The lack of automation and logistics technology requires a much greater reliance on human supervision and regulation, often resulting in inadequate or deficient approaches to resolving the problems.

Kenya and other members of the East African community are making progress improving their regulatory environment and have great long-term potential. However, massive amounts of infrastructure investments are necessary to improve import and export cold chain logistics, as well as better, more uniform government standards in harvesting, processing, handling, and shipping food and perishable goods.<sup>12</sup>

Franchisers have found that production costs are prohibitively high in Kenya. Better cold chain logistics would help Kenya and East Africa realize their potential as major importing and exporting players in the global agricultural market.<sup>12</sup>

## 8 CRITICAL CHALLENGES FACING TRUCKING COMPANIES IN AFRICA

Each day that perishable goods are in transit can decrease its potential market value. A de minimis regime provides streamlined border clearance and exemptions that help keep perishable goods moving toward market, but at most African ports and other points of entry, the de minimis exemption is not broad enough. Everything over a very small amount must be accounted for—an unnecessary formality that adds to inefficiencies and delays.<sup>13</sup>

Serious transportation challenges occur on African roads. Road conditions can frequently be extremely dangerous, and fuel is only sporadically available in many countries. Finding necessary parts and skilled mechanics to maintain the trucks is a major obstacle, causing difficulty in keeping the equipment moving as well as equipment loss.

The trucks and their drivers are often subject to attacks and robberies. The rate of truck hijackings and robberies continue to be a serious concern in Sub-Saharan Africa and other neighboring countries. Recent crime statistics in South Africa report a 14.9 percent increase in truck robberies, causing serious problems not only for the trucking company, but also for the consumers and businesses awaiting the cargo.<sup>14</sup> In many cases, these robberies were heists committed by well-organized robbery syndicates. Incidents are often not reported to the police because frequently, local police are receiving bribes from the thieves to “look the other way.”



Almost all American trucking companies have security procedures and cameras in place to protect drivers, equipment, and cargo from loss. However, they are also educating drivers on how to prevent a robbery, or what to do if one occurs.<sup>15</sup> With stringent security measures in place, U.S. companies are maintaining control over cargo thefts at truck stops and in warehouses.

Best practices to combat this problem both on the road and in the warehouse include:<sup>16</sup>

- Installing GPS tracking, security, and vehicle immobilization devices on trucks. These devices have alarms that alert when a truck goes outside a prescribed route, disable the vehicle remotely, and are able to determine stolen trucks' location
- Training truckers to know their route and their cargo, and to inform the dispatcher of the route and not divert from it without communicating with the dispatcher
- Designating predetermined checkpoints along the route
- Training drivers never to leave their cab unlocked, including when they're stopped in traffic but still in the truck
- Stopping only in designated areas where there are other truckers parked
- Driver attention is diverted during the loading and unloading process. Installing surveillance cameras in loading and unloading areas as well as additional supervisors helps to more closely monitor this often chaotic process that involves numerous people--which is when theft is likely to occur
- Implementing manned security checkpoints at the entrances to the warehouse and requiring all drivers to stop for inspection prior to leaving
- At smaller warehouses, having security officers make announced checks of outbound vehicles on a random basis
- Restricting access to shipping and receiving areas, providing all unnecessary personnel a lounge or other separate area to wait
- Using an electronic access control system that monitors access into high-value rooms and provides an audit trail of who entered and when



**9 BEST PRACTICES FOR ELIMINATING “DEADHEAD” TRUCKS IN THE U.S.**

One of the most vexing challenges facing U.S. trucking companies are “deadhead” loads—a term describing a truck that takes a full load to its destination, unloads, and returns to its starting point with no cargo. Deadheading is a waste of fuel, money, and the driver’s time.

Too much deadheading can drive a company out of business very quickly. The ability to find a load to take back home or into a better freight lane is called a “backhaul.” Connecting an empty truck with that load of cargo presents a challenge for trucking companies.<sup>17</sup> New technologies are available to provide shippers, carriers, owner-operators, and brokers comprehensive, affordable online freight and truck matching services to overcome these and other challenges, which include credit, compliance issues, and routing.<sup>17</sup>

Several U.S. firms are active in the role of freight brokerage—essentially matching drivers with empty trucks with loads, and they post available loads on information boards at truck stops for drivers to peruse.<sup>18</sup> Private companies are developing partnerships with other shippers to handle their loads on what would otherwise be their own deadhead legs, and they are working to improve delivery schedules and plan more efficient routes to reduce deadhead time and distance.<sup>18</sup>

In East Africa, the key transport route is from Mombasa to Kampala (approximately 1170 km) and the average transit time is about 10 days. The road is reliable, but Africa’s inland freight networks is so troubled that it costs roughly seven times more to ship a container from Mombasa, Kenya to Burundi in central Africa (1,400km) than to ship a container from Mombasa to Shanghai, China (12,000km).<sup>19</sup>

“The lack of road and rail options for African importers is taking its toll on the continent’s trade growth, which is being driven by some of the fastest-growing economies in the world,” said Moussa Diop, Commercial Director for APM Terminal Inland Services West Africa in a speech at the TOC West Africa Market Briefing last year.<sup>19</sup>

“It is critical to establish inland capabilities and operations that serve adjacent and hinterland markets, including dry ports and cargo depots,” Diop said in his speech. “Effective intermodal transportation and inland services involves logistics, trucking, stevedoring, warehousing, storage, cargo handling, storage, container depots, and refrigerated container operations.”<sup>19</sup>

Because the refrigerated trucking industry in Africa is so underdeveloped and unstable, there are few statistics to show the impact of deadheading there.

**U.S. DEADHEAD STATISTICS<sup>18</sup>**

- Up to **10%** of driven truck miles are deadhead for leased freight carriers, wasting 1,500 gallons of fuel annually per truck
- Shipping **one ton** of freight on all current deadhead miles could generate \$6,500-\$8,500 in annual revenues per truck
- Private fleets have up to **28%** deadhead miles, wasting 5,600 gallons of fuel annually

**10 ACCESSIBILITY—THE FOUNDATION OF DEVELOPMENT**

Kenya is addressing one of its most acute infrastructure challenges with a newly developed annuity road-funding model that will upgrade over 10,000 km of road.<sup>20</sup> Kenya has long struggled with a backlog of road maintenance works requiring over \$4.3 billion, but the Kenyan government is moving ahead with this new annuity financing plan.

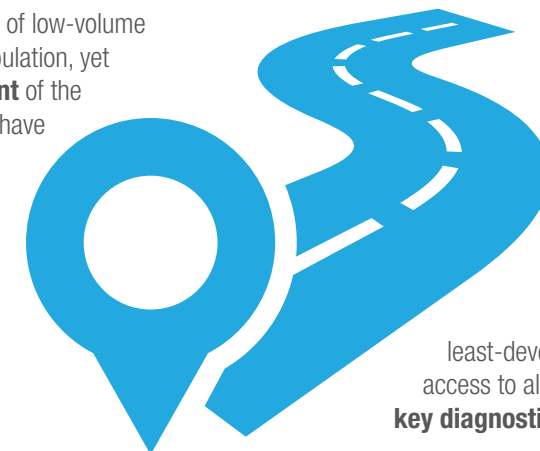
“Under this Annuity program, we will complete 2,000km of small roads within 2014/2015 financial year. This will be followed by 3,000km in 2015/2016, made up of 80 percent small roads, and 20 percent highways. In (the) 2016/2017 financial year, we will complete 5,000km, 80 percent of which will be small roads and 20 percent highways,” said President Uhuru Kenyatta when he launched the ambitious road project in the capital, Nairobi.<sup>20</sup>

The government believes the project will enable Kenya to transform itself into a low-cost investment and trading destination. This will also support the projected economic growth, which is expected to expand by 6.9 percent this year, up from an initial growth forecast of 6.5 percent according to a policy statement by the U.S. Treasury Department in January.<sup>20</sup>

Improving rural road connectivity in most of Africa continues to be a serious challenge. By most common statistical measures, Sub-Saharan Africa (except South Africa) remains the region with the least developed road network.<sup>21</sup> Steady progress is certainly being made, but the combined road network of the 49 Sub-Saharan African countries still lags far behind India and China.

In poor rural areas, isolation caused by inadequate transport is the main impediment to economic progress, limiting trade possibilities even within local markets. Production and distribution costs are increased, reducing surpluses and profit margins and keeping output below potential.<sup>21</sup>

Nearly **30 million km** of low-volume roads connect the world’s population, yet World Bank reports **31 percent** of the world’s population still do not have adequate access to transport.



**75 percent of 21** least-developed countries do not have access to all-weather roads, which are a **key diagnostic measure** of development.



## 11 ALTERNATIVE, RELIABLE ENERGY SUPPLY TO REFRIGERATE FOOD

Energy prices are prohibitively high in East Africa, and they are expected to continue to rise over the next few years.<sup>22</sup> Investing in its own energy supply is an attractive prospect that provides horticultural businesses and farmers considerable cost reductions and frees them from complete dependence on the electric supply, which is sporadic at best.<sup>22</sup>

Kenyan businesses are increasingly focusing on reducing energy costs by familiarizing themselves with energy efficient systems and applying sustainable energy, including solar power.<sup>22</sup> In Kenya, the cost of electricity per kWh is 17 cents, with prices doubling every few years.

Although it seems counterintuitive, solar energy can be harnessed to refrigerate foods—even make ice cubes. Without the use of electricity, solar icemakers use the sun's heat to drive a chemical reaction that separates a liquid refrigerant from a solid absorbent.<sup>23</sup> Organizations such as Save the Food have been helping Kenyan dairy farmers implement a system called ISAAC Solar Icemarkers to drastically extend the amount of time farmers have to get their dairy products to market.<sup>23</sup> The solid absorbent stays in the solar collector, while the liquid refrigerant is driven away and stored in a separate component called the evaporator.<sup>24</sup> This movement happens without valves or pumps or any mechanical components—simply natural convection.

Dairying is a common livelihood in Kenya, where there are over 650,000 small-scale farms.<sup>23</sup> Most do not have electricity and are a very long distance from markets. The solar icemakers can make 50 kg of ice on a sunny day, which allows up to 100 kg of milk to be chilled daily. One solar icemaker can supply the chilling needs of up to 30 farmers.<sup>24</sup> The icemaker has a zero carbon footprint and emits no greenhouse gases during its operation. The solar icemaker creates jobs for operating the icemaker itself, and also for distributing the milk. Each 100 liters of milk creates two jobs.<sup>23</sup>

This is a small amount of refrigeration by U.S. standards, but it has proven to be a very useful and effective refrigeration tool in rural communities. With operational solar icemarkers, small dairy co-operatives are able to chill milk and make yogurt and other dairy products for sale.<sup>24</sup> Further investment could expand this solar technology and significantly widen its reach to potentially power entire dairies in rural locations in Kenya and beyond.

**\$90 million** of milk is lost each year in East Africa due to lack of refrigeration

In Kenya, **95 million** liters of milk are lost annually due to spoilage

In Uganda, **27%** of all milk produced is lost, with **6%** wasted at the farm level, and over **10%** lost to spillage due to improper packaging or spoilage during transport or marketing.<sup>25</sup>





## 12 MINIMUM REQUIREMENTS FOR REFRIGERATION VEHICLES

Road transport refrigeration equipment must be properly equipped to operate reliably in harsh environments. Therefore, temperature controlled vehicles must be qualified before they become operational to ensure the viability of pharmaceuticals being transported and to maintain freshness of meats and produce.

According to the World Health Organization's qualification of temperature controlled road vehicles, minimum requirements should be established by implementing a process for reefer vehicles that should include:<sup>26</sup>

### Ability to check the accuracy of temperature control and monitoring devices

- Demonstrate that the temp distribution within the payload area of the temp controlled compartment is maintained within the range specified for the products being transported<sup>26</sup>
- Define zones within the vehicles payload area which should not be packed (like near cooling coils)<sup>26</sup>
- Demonstrate the time taken for temps to exceed the designated maximum or minimum in the event that the temp-control fails. Similar tests should be used to validate the anticipated door opening times that will occur during deliveries.<sup>26</sup>

### Refrigeration equipment maintenance

- Demonstrate by lab testing under controlled conditions that the equipment performs in accordance with requirements specifications<sup>26</sup>
- Demonstrate by documented testing that the components of the reefer truck have been assembled in a specific location in full accordance requirements and installation drawings.<sup>26</sup>
- Demonstrate ability to repair and maintain equipment, keep inventory of parts<sup>26</sup>

### Final check:

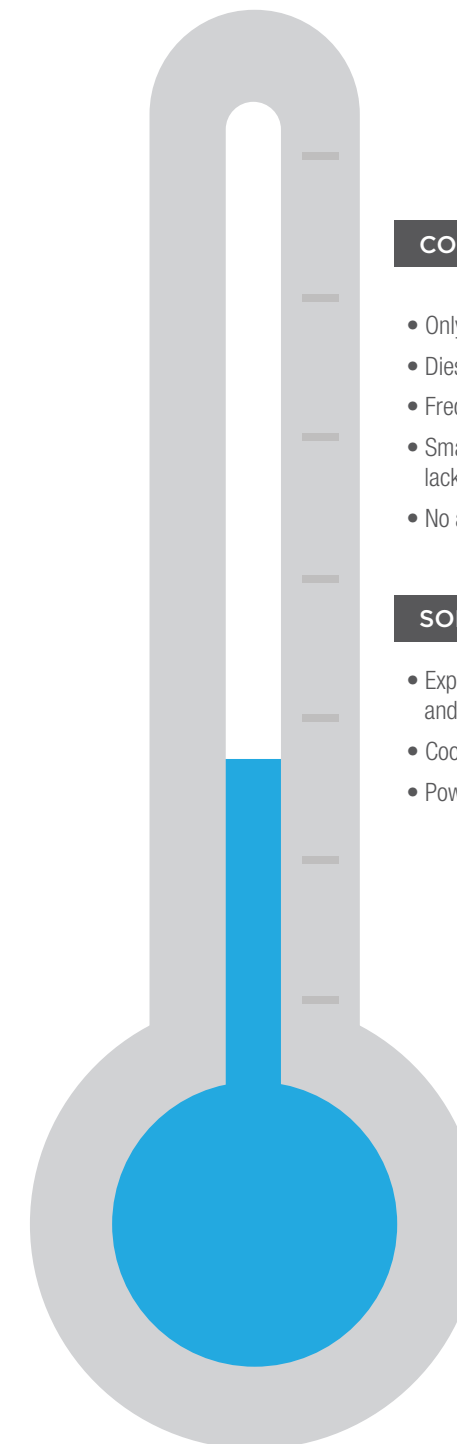
- Demonstrate with a high degree of assurance that the equipment, together with all the associated systems, does perform as intended during routine operations.<sup>26</sup>

### Other viable methods to keep produce cool:<sup>26</sup>

- Provide deep shade by adding overhangs or awnings to existing buildings
- Market umbrellas
- Light colored tarps to cover produce/reflect the heat
- Invest in evaporative coolers combined with a forced air cooler can work for small lots of produce

### Prime sector for investment: multinational quick service restaurants (QSRs) are expanding

KFC, Subway, Domino's Pizza scheduled to open multiple stores in Kenya, Egypt, Morocco, South Africa. This is a key driver for cold chain industry growth. Growth in this sector is highly appealing business opportunities that will create further growth.



### COLD STORAGE

- Only 18% of households connected to the grid
- Diesel gas cost is extremely high (generators)
- Frequent power outages and surges affect cold storage temps
- Small hotels and other retailers rely on cooler and cold rooms but lack proper processing and handling techniques for food preparation
- No available education at all in best practices in warehouse management

### SOME SOLUTIONS

- Exploring alternative energy sources that are working in Africa and other Third World nations<sup>26</sup>
- CoolBot controller
- Power generator can come from PV solar panels



### 13 TEMPERATURE RANGES FOR RAW MEAT AND POULTRY

Cold temperatures must be maintained throughout the butchering, processing, packaging, and distribution process of meats and poultry in order to ensure the safety of the consumers.

To reduce or prevent the process of meat deterioration, it is essential that raw meat and poultry products should be maintained at 40° F (4.4° C) or below. This cold temperature prevents the growth rate of any pathogenic bacteria that may be present on their surfaces. Chilling is required of all raw products unless it moves directly from the slaughter line to heat processing or cooking (made into hot dogs or luncheon meats, for example), which destroys pathogens.<sup>27</sup>

Temps at which raw poultry must be maintained: USDA's new rules for labeling raw poultry products as to their storage temperature will become effective in December 1997. The term "fresh" may ONLY be placed on raw poultry that has never been below 26° F (3.3° C). Poultry held at 0° F (-17.8° C) or below must be labeled "frozen" or "previously frozen." No specific labeling is required on poultry between 0° and 26° F.<sup>27</sup>

Temps at which raw meat products must be to be safe during transportation: To prevent rapid growth of pathogenic bacteria, perishable meat and poultry products should be kept cold (40° or below) or frozen (0° or below) during transport from the plant to a refrigerated warehouse or retail store. Microorganisms capable of causing foodborne illness either don't grow or grow very slowly at refrigerated temperatures of 40°F. Freezing keeps food safe by slowing the movement of molecules, causing any microbes present to enter a dormant stage. There's also no risk of dripping juices to contaminate nearby products and storage areas.<sup>27</sup>

### 14 TEMPERATURES FOR PRODUCE

The best cold storage environment for a fruit or vegetable depends on its unique requirements for temperature, ethylene concentrations, and relative humidity. It is very challenging to separate groups and requires separate temperature controlled rooms, but it's necessary to extend the life of the product. Ethylene levels in trucks or storage units that are kept consistently at the appropriate levels will remain very low and the food can remain fresh for at least a week.

- Milk, milk products: 33-42° F (.5-5.5° C)<sup>28</sup>
- The majority of produce in North American food handling operations, including most leafy vegetables, Cole crops, and fruits and berries: 32-36° F (0-2.2° C) at 90%-98% relative humidity.<sup>29</sup> This requires a higher humidity because leafy vegetables contain higher levels of water and will wilt quickly.
- Citrus, subtropical fruits, 45-50° F (7.2 – 10° C) , at 85%-95% relative humidity<sup>29</sup>
- Common root vegetables, winter vegetables, hard-rind fruits, tropical fruits: 55-65° F (12.8-18.3° C), 85%-95% relative humidity<sup>29</sup>

## 15 OPPORTUNITIES TO APPLY U.S. BEST PRACTICES AND LOGISTICS EXPERTISE TO ADDRESS CHALLENGES IN THE AFRICAN COLD CHAIN

Despite the complex challenges in feeding and immunizing Africa, there are significant signs of improvement, particularly in East Africa. Governments are beginning to keep promises to create free-trade zones and remove border restrictions and lowered tariffs. More roads are being built and the first ever double-lane highway with its own border terminal is being built across the Sahara. It will link to a new 1,000km long desert road going south to Sudan along the banks of the Nile. This is exactly the kind of infrastructure that will help support refrigerated trucks expanding their routes to help bring life saving food and pharmaceuticals to where they are desperately needed.<sup>30</sup>

Great gains have been achieved regarding transport time. Last year, it took 129 days to get from the port at Dar es Salaam to Rwanda. In 2015, it took 28 days.<sup>31</sup> These forward strides are a result of efforts to dismantle trade barriers and create much more liberal trade relations on the continent of Africa—another positive milestone that will create trade opportunities that in turn will create employment in the region. Trade gives governments a more solid tax base, which if used responsibly, drives investments in basic infrastructure such as improving and building more roads and hospitals. All these changes bode well for private sector investments in refrigerated trucking in Africa.<sup>32</sup>

These encouraging developments will continue with more expert American private sector intervention. Industry experts have said that maintaining implementing a telematics system to maintain constant communication with trucks and drivers is the key keeping the fleet moving and monitoring the equipment and carriers in real time. Investing in these systems would address several of the most pressing issues facing the African cold chain now: Tracking the drivers' locations in real time, providing communication regarding bad road or conditions, mechanical problems, protection of the equipment and its cargo, alerts to undesirable driver behavior, and ensuring drivers get the proper rest.



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Eberhart Capital, LLC is a U.S. and Singapore-based private equity firm with over a thousand employees who specialize in numerous business sectors, including cold chain and dry logistics. Under the leadership of founder Dan K. Eberhart, the veteran professionals at Twin Express, LLC and Poling Express, LLC have the knowledge and experience to expand operations both in the United States and globally, with an eye toward applying its cold packaging and shipping solutions to optimize the cold chain in chronically food insecure countries in Sub-Saharan Africa.

## Endnotes

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