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COLD STORAGE BUSINESS MODELS FROM DEVELOPING COUNTRIES

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SUMMARY

In developing countries, various approaches and technologies are used to reduce food loss in horticultural crops during harvest, handling, and distribution stages. In the market, where fresh produce is usually displayed all day long and deteriorates rapidly due to inadequate temperature management, the food loss is high. Placing low-cost cold storage units at wholesale and retail markets can often have a large impact on reducing this food loss. CoolBot™, a low-cost technology that helps establish a cold room anywhere and with low investment, is ideal for this purpose. A successful agronomist turned entrepreneur in Rwanda has used this technology to start a collection center and then turned it into an improved market place. Local farmers from 7 cooperatives sell their produce at the market and store it in the CoolBot™ equipped cold room. A similar business model is also being used in Sultanpur, India that has resulted in reduced food loss and increased profits for farmers. These cold storage units, both in Rwanda and India have proved to be self-sustaining models and are helping farmers to avoid distress sale that results in lower margins. Another technology called Controlled Atmosphere (CA) storage has become popular in India in the last decade and is used for long term storage of apples. It works by slowing down the physiological activities of the produce by controlling the levels of carbon dioxide, oxygen, RH, and temperature around the produce. Many cultivars of apples can be preserved for 9-12 months period in CA storage as compared to 3-4 months in refrigerated storage. Heavy investment by various actors in CA infrastructure has led to year-round access to apples, reduced postharvest losses, and improved profit margins for growers. Installing the CA unit is a high-cost project, therefore to promote the CA infrastructure, the government is providing subsidies.

BACKGROUND

Dr. Michael Reid, a leading global expert on Postharvest Extension from the University of California, Davis often says, “The three most important aspects in postharvest handling are - Temperature, Temperature, Temperature.” While a bit tongue in cheek, temperature management is indeed one of the major factors in reducing Food Loss and Waste (FLW) and this is especially true for the horticultural sector. In the developing world, 30% - 50% of fruits and vegetables are never eaten as they are lost to damage or spoilage after harvest. Without the ability to manage temperature and with long waiting times, farmers are forced to sell their fresh produce during peak season and are not able to wait for a better price.

The quality of produce is best at the time of harvest. Cold storage allows for produce to stay fresh for longer periods by delaying physiological changes like respiration, water loss, ethylene production, etc. that lead to quality deterioration.

Developing cold storage solutions that work at different scales and are cost-effective has been a challenge in the developing world. This case study will explore two different business models for cold storage and controlled atmosphere (CA) storage in the developing world, which are inclusive of smallholder farmers.

COOLBOT™ POWERED LOW-COST COLD STORAGE

Ron Khosla, a farmer in upstate New York, invented the CoolBot™ (www.storeitcold.com) when he was looking for a low-cost walk-in cooler for his farm. The CoolBot™ is a small electrical device that tricks an air conditioner below 5° Celsius by overriding its temperature gauge and causing it to work harder which converts a well-insulated room into a cold room. The main items needed to build a CoolBot™ powered cold room are CoolBot™ (\$299), an air conditioner (\$700), and insulation (\$1500-\$2000). Hence cold rooms can be built for around \$3,000, depending on the size of the cold room. This assumes that a basic room has already been built. The main maintenance cost is the monthly electricity bills. The CoolBot™ can run on solar panels, however, the high cost of solar panels and batteries often make it too expensive for the informal sector.

COOLBOT™ POWERED COLD STORAGE AT MARKET LOCATIONS IN RWANDA AND INDIA

Uninterrupted cold chains are expensive and often not needed in developing countries for the fresh produce market when the temperature can be managed by transporting during the night or early morning and where good road infrastructure is present to reduce travel time. While fruits and vegetables are lost at all stages of the value chain, timely harvest and swift transportation can reduce losses during the harvest, handling, and distribution stages. At the market, however, fresh produce is usually displayed all day and it rapidly deteriorates. Hence, placing cold storage units at wholesale and retail markets, where the produce is waiting to be sold can often have a large impact on reducing FLW.

Serge Ganza, a Rwandan Agronomist and Entrepreneur, started the Kamonyi Collection Center in 2017. This Center is an Improved Market Place where local farmers from 7 Cooperatives sell their produce as well as store it in a cold room. Ganza trains the farmers on good production and postharvest handling practices and trains on the adoption of low-cost technologies like zero-energy cool chambers.

The CoolBot™ powered cold room costed him approx. \$3,500 and has increased his profits and reduced food losses. The market sells directly to clients as well as to wholesalers. The market also caters to local schools. Ganza procures vegetables locally using trucks and plastic crates. He sells the vegetables at his Collection Center, where other farmers can also directly sell their produce to



Figure 1: Improved Market with Cold Room in Rwanda

customers. In his own words, “By using improved seeds and production practices, postharvest best practices, crates, ZECCs, and the cold room I have nearly reduced by losses to zero. My market center is a success and I’m on my way to opening a second market.”

Another example of a CoolBot™ powered cold room benefiting smallholder farmers is from Sultanpur, Uttar Pradesh in India. The cold room is operating near a farmer retail market and helping farmers to earn a profit of about \$500 - \$650 per month.

The main benefit of having cold storage near or at the retail market, both in Rwanda and India, is that the cold storage unit proved to be a self-sustainable business model. Farmers can extend shelf life by quickly lowering produce temperature, thus avoiding distress sale and resulting in lower profit margins.

CONTROLLED ATMOSPHERE STORAGE IN INDIA

The apple industry in India faces high losses of 10 to 25 percent. The primary cause of these losses is that the apple growers don’t have access to appropriate temperature-controlled storage space. The growers store harvested apples in their orchards, which results in a high spoilage rate because of dampness, high temperatures, and humidity. Without the availability of cold storage or controlled atmosphere storage, it is hard to extend the shelf life of apples. During harvest season, there is a slump in the market price of the produce, as the majority of the harvest reaches the market in a short time. Since the growers do not have access to solutions to store their produce and maintain high quality for better off-season prices, they either have to sell at lower prices or discard their produce that has gone bad and cannot be sold.

However, in the last decade, a new type of cold storage technology is being adopted in India called Controlled Atmosphere (CA) storage. CA storage is an entirely natural process that reduces the produce’s respiration to a minimum by controlling the environmental conditions surrounding the stored fruit. CA units are special-purpose cold stores that are mainly used for certain fruits or vegetables like apples, pears, cherries, etc. CA works on the concept of controlling the percentage of oxygen and carbon dioxide during the storage and maintaining the desired temperature and relative humidity to slow down the fruits’ physiological activities. A CA unit has several small chambers that can be opened individually depending on the demand from the market. However, installing CA units are high-cost projects as these employ special technology for gas-tight construction and provision of continuous monitoring of oxygen and CO₂ levels along with temperature and relative humidity control.

CA storage makes it possible for consumers to buy crisp, juicy apples year-round. Many cultivars of apples can be preserved for a remarkable 9–12 months in CA storage, as opposed to only 3-6 months if using refrigerated storage. Currently, industry insiders estimate that the apple CA capacity in India is 225,000 tons (60,000 tons in Himachal Pradesh, 130,000 tons in Jammu and Kashmir). The annual production estimate for India is 2,254,000 tons, hence the controlled atmosphere storage capacity is 10% of the total production.

Fresh apples are typically available in the market between August – December. Considering a large number of cultivars from different altitudes, the season is extended. Fresh apples had an

average wholesale price of Rs. 90/kg in 2010. During the harvest season, some apples are put into cold storage and controlled atmosphere storage. The cold storage apples have a shelf life of 4-6 months and hence are released slowly into the market from January to March. In 2019, the wholesale price of these apples was at Rs. 105/kg. As the cold storage apples come to an end, April onwards the controlled atmosphere stored apples are released into the market at a wholesale price of Rs. 130/kg.

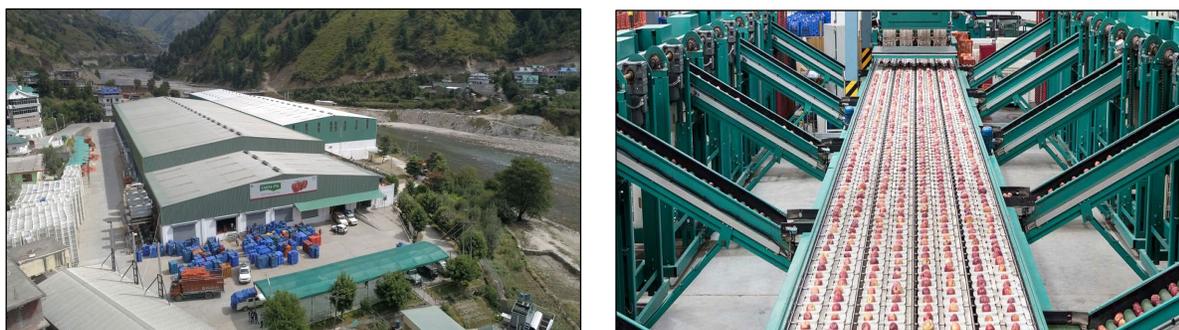


Figure 2. Controlled atmosphere storage unit and apple grading line in Himachal Pradesh, India

The wholesale prices from 2005-2008, indicate a low seasonal price of Rs. 40/kg and a high off-season price of Rs. 100/kg. Whereas in 2019, the seasonal price was Rs. 90/kg and the off-season price was Rs. 130/kg. It may be premature to say, but extended storage may be allowing for a price smoothening effect year-round and benefiting farmers who are selling during the harvest season as well.

TABLE I. APPLE STORAGE IN INDIA			
TIMELINE	AUGUST - DECEMBER	JANUARY - MARCH	APRIL - JULY
Fresh/Stored Apples	Fresh Apples	Cold Storage Apples	Controlled Atmosphere Apples
Shelf Life	1 – 2 WEEKS	4 – 6 MONTHS	11 – 12 MONTHS
Wholesale Price in 2005 – 2008	Rs. 40/kg	Rs. 70/kg	Rs. 100/kg
Wholesale Price in 2019	Rs. 90/kg	Rs. 105/kg	Rs. 130/kg

Apples sold in CAs can be owned by different players along the value chain however, they are more often owned by commission agents, wholesale buyers, CA owners, and organized retail. These are the players, who most profit from the stored apples in the off-season. Table 2 shows the breakdown of costs for storing a kg of apple for 5 months in CA storage. Growers are rarely able to store their apple stock in the cold room because of cashflow issues. The government is planning to invest in CA at the block level so that it is more accessible to a small farm or orchard owners.

The cost of a 5000 ton fully automated modern CA with color/size grading and packing line is \$4.7 million. The major manufacturers or installers of CA storage rooms in India are Blue Star, Infracool, Lloyd Insulations India, Unicool Technologies, etc. To promote the CA/CS

infrastructure, Central & State Governments provides financial assistance as a subsidy which ranges from \$680,000 - \$2 million (depending on the State). Breakeven is typically reached in 4-6 years (the Break-even depends upon the capacity utilization of the cold storage (90%) which is achieved in 4th year). CAs are owned by large traders, wholesalers, agribusiness investors, and big corporations (e.g. Concor, Adani, Devbhumi, etc.).

TABLE 2. CONTROLLED ATMOSPHERE – COST OF STORAGE

CONTROLLED ATMOSPHERE COSTING	PER KG PRICE IN INR
Farm Gate Price of Apple at Time of Storage	80.00
5 Months Lock-in Period (Rs. 1.8/month * 5 months)	9.00
Loading/Unloading	0.75
Value Loss (2%)	1.60
After 5 Months, Holding Cost	91.35
Market Price in April	130.00
Profit	38.65

CONCLUSION

Investing in cold storage infrastructure at critical loss points, where losses are very high and the wait times are high, can have outsized returns in reducing loss in a value chain. For fresh produce, this may often mean at the wholesale or retail market, where there are high levels of stock and long wait times for the produce to sell. For produce like apples, as well as onion and potatoes and other which can be kept in cold storage for several months, cold storage allows for steady availability of produce for a long period of time, with small price fluctuation.