INCLUSIVE INNOVATIONS

Storage Solutions

Reducing post-harvest losses by providing on- and off-farm affordable storage

HIGHLIGHTS

- Annual post-harvest food losses are as high as 30 percent of the total produce in Sub-Saharan Africa.
- Enterprises provide affordable post-harvest storage solutions, both on-farm and near transportation hubs.
- Innovations include centralized management information systems to help track real-time information on the multi-location holdings of customers and solar power in cold-storage solutions to save electricity and diesel costs.

Salahaldeen Nadir / World Bank

Summary

The United Nations estimates that by 2050, total world population will increase to 10.5 billion. In developing countries, increased demand for food and competition among the different uses of land, such as industries and residential areas, has made efficiency an imperative for food security. Post-harvest losses are especially significant in developing countries where rural areas lack basic infrastructure to store agricultural produce.

Post-harvest losses are in the range of 35-50 percent in Latin America and Caribbean countries.

Annual post-harvest food losses are as high as 30 percent of the total produce in Sub-Saharan Africa.[1] Latin America and the Caribbean are responsible for 6 percent of global food losses; the region loses nearly 15 percent of the total agricultural produce. Of this loss, 28 percent occurs at producer level and 22 percent during the post-harvest handling and storage.[2] In developing countries, nearly 90 percent of the food wastage occurs within the value chain. It directly impacts smallholder farmers whose incomes are reduced by at least 15 percent because of the post-harvest food losses. Globally, a quarter of smallholder farmers also constitute the population that is food insecure. If the current rate of food loss continues, by 2050, food production would need to be increased by 70 percent, which would require an annual investment of USD 83 billion.[3]

Solutions to address post-harvest losses, therefore, are critical to reduce the potential demand-supply gap in agriculture. A number of social enterprises (SEs) across the globe have addressed this challenge with post-harvest logistics and storage solutions that allow them to simultaneously create positive environmental and social impact. SEs provide stationary and mobile post-harvest storage solutions, such as warehouses with cold storage facilities, solar-powered on-farm cold storage units, and air-conditioned vegetable carts. In addition, some of the enterprises also offer collateral management and market linkage services.

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This series on Inclusive Innovations explores business models that improve the lives of those living in extreme poverty. Editors are Elaine Tinsley and Natalia Agapitova. Researched and developed by Intellecap.

Development Challenge

Globally, food wastage amounts to a monetary loss of USD 1 trillion. In developing countries, this loss is estimated to be high at around USD 310 billion; and 40 percent of the losses occur at post-harvest and processing levels. In Sub-Saharan Africa, approximately 150 kilograms of food produced is lost per person per year. FAO estimates that saving one-quarter of the food lost annually would be enough to feed the world's hungry.[4] Amongst the Latin America and Caribbean countries such as Ecuador, Paraguay and Haiti, post-harvest losses range between 35 percent-50 percent of the total produce. Lack of adequate information, inappropriate use of technology, transportation barriers and climate change are some of the factors that result in such huge losses in the region. The environmental footprint of food wastage is also very high. According to FAO, water used for irrigation to grow crop that is eventually wasted is enough to meet the domestic water needs of 9 billion people.

Food wastage accounts for a monetary loss of USD 310 billion in developing countries.

In developing countries, significant post-harvest losses from farm to depot are caused due to financial and structural limitations in harvesting, storage, packing, and transportation. Further, challenges in institutional and regulatory frameworks, market mechanisms, and climatic conditions also contribute to food spoilage. It is difficult to penetrate the vast and fragmented smallholder farmer population, and small and upcoming companies find it cost-prohibitive to reach thousands of dissimilar farms, while big companies encounter a number of logistics issues.[5] A major drawback in agriculture supply chains in developing nations is limited access to a formalized cold-storage network, especially for smallholder farmers. Inadequate infrastructure including roads, electricity supply, and inadequate handling of post-harvest agricultural produce adds to the challenges.[6] For instance, in India, there is a need to double the cold storage capacity to prevent further food wastage.[7]

Post-harvest losses have dire economic implications on farmers. When a kilogram of produce is wasted, losses accrue through the production process, including the cost of inputs such as land, seeds, water, fertilizers and pesticides as well as the effort that the farmer and his family puts into production. Lack of storage and warehousing facilities also impacts farmers' incomes as they are often compelled to sell their produce at very low prices to avoid losses due to spoilage. For example, in East Africa, during the very short banana harvest season, supply outstrips demand, and market prices fall. Within a month after harvest, there is very limited produce for sale. Given the short shelf life of bananas, farmers are forced to accept the prevailing low market prices during harvest season. Most of the produce is purchased by bigger enterprises at extremely low prices. These enterprises process and market the produce and earn higher margins, while farmers find it difficult to even cover their cost of production.

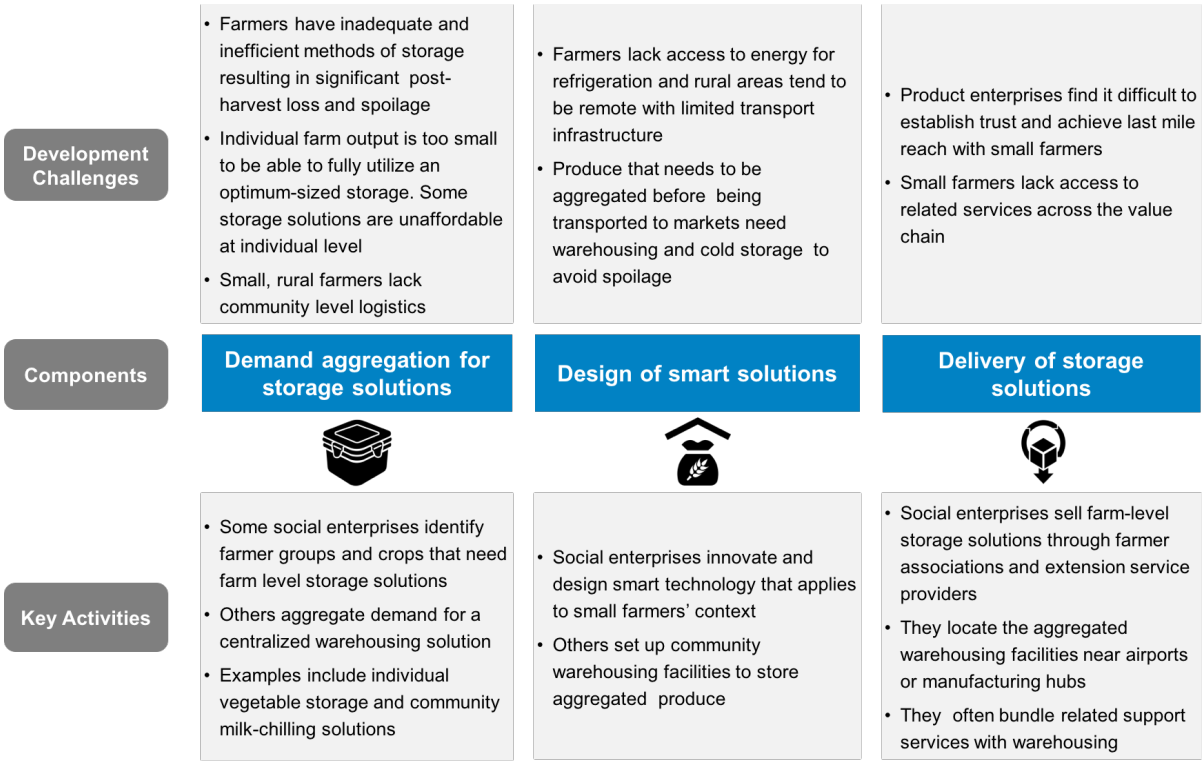
In India, the public sector accounts for around 72 percent of agriculture warehousing capacity. Overall, there is a gap of 35 million tons of warehousing capacity.

Business Model

Components of the Model

SEs that reduce post-harvest losses offer storage solutions that are general as well as sector-specific. General storage solutions can be used for different types of agricultural produce, and comprise large facilities that farmers can lease as well as local storage that farmers can purchase and own. Specific solutions cater largely to the dairy sector for milk chilling. Enterprises providing storage solutions often cut through several levels of middlemen by procuring agricultural products directly from farmers on behalf of processors, traders and government bodies, thereby ensuring better prices to smallholder farmers. Some of them also provide extension services in the pre-harvest phase and/or market linkage and collateral management services in the post-harvest phase. A number of these storage and warehousing solutions are powered by clean energy to cater to farmers in areas with limited or no grid connectivity.

Figure 1. Components of the model



Demand aggregation for storage solutions

Insufficient awareness regarding efficient handling of post-harvest agricultural produce, inadequate post-harvest storage facilities in rural and remote locations, smaller outputs of individual smallholder farmers, and inadequate transport facilities result in significant food spoilage globally. Enterprises address this issue by providing innovative strategies and solutions that include large warehouse units that can be leased to farmers, and small on-farm solutions that can be bought or rented by either individual farmers or groups of smallholder farmers. Commercial and large-scale warehousing facilities either have a logistics wing that functions as a procurement agent, and collects fresh farm produce from agriculturists or have an aggregation center within the village cluster where farmers bring their produce. Some enterprises provide warehousing as a component of their larger pool of extension and consultancy services. Baridi Stores and Kilimo Markets are examples of such solutions.

On-farm storage solutions scale down the concept of large scale refrigeration to protect perishables against spoilage before they reach the market. They are sold through retail distribution models as stand-alone products directly to farmers, and involve inventive use of technology to ensure the product is easy to use. Greenpath for instance, uses Coolbot, a cold storage product that enables small farmers to build their own cold storage using an air conditioner, as opposed to purchasing a refrigeration system.

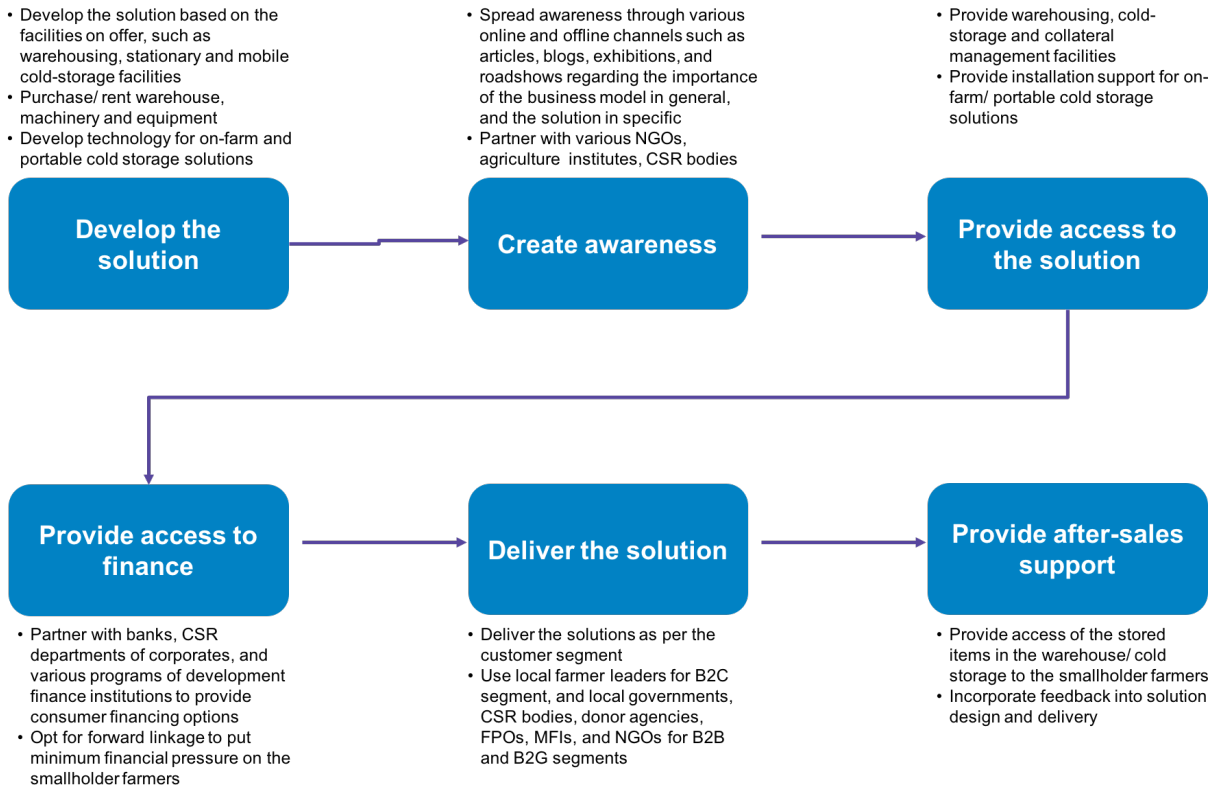
Design of smart solutions

Access to electricity is a major concern across all developing countries, and smallholder farmers use expensive fossil fuels to power their few farming tools and implements. Therefore, and particularly for perishable produce, even if farmers can access warehouse and cold storage facilities, they cannot effectively use them due to poor grid connectivity. To prevent such instances, enterprises innovate and develop renewable energy operated storage solutions. For instance, Wakati's storage solution can protect up to 200 kg of fresh produce without cooling, using a small solar panel. The solution can serve the storage needs of a group of smallholder farmers simultaneously.

Delivery of storage solutions

Post-harvest value addition companies, such as processors, packagers, and exporters, hesitate to deal directly with smallholder farmers. Instead, they establish contracts with the warehouse companies, who provide them the required agricultural output in the desired quality. The warehouses are often centrally located from a cluster of areas that lack local storage facilities, often close to transportation hubs such as airports. Many of these enterprises also connect farmers with potential buyers of their stored commodities. On-farm storage solution providers reach the customers mainly through village leaders or farmer co-operatives. Once they sell the product, enterprises such as Ecozen provide robust after-sales support, wherein the technical representatives from the company visit the customers, and check and guide them to how to use the solution in the most optimum manner. The enterprise also provides technical support to the users through its mobile application.

Figure 2. Process of the model



Cost Factors

The major cost components for the enterprises include cost of goods produced, warehouse rent, manpower, logistics, and business development expenses. Currently, a number of post-harvest storage solution providers offer either cold storage warehousing or cold storage units. These enterprises incur very high costs on refrigeration, its control mechanisms and electricity. Therefore, they need to invest in energy efficiency, automation systems, and roofing while designing a cold storage.[8] Enterprises such as India based Ecozen and UK based Inspira Farms incur expenses for in-house research and development, prototype development, field testing, and certifications, apart from vendor development, and client scouting/servicing.

Longer payback periods pose a major challenge while establishing a larger cold storage facility.

The initial capital expenditure in establishing a warehouse, especially a cold storage, is very high. For instance, in India, the cost of establishing a cold storage facility of 6000 metric tons is USD 750,000. High costs make it difficult to undertake the investment, particularly as it is perceived to have a long

payback period. Therefore, a number of enterprises are exploring opportunities to establish smaller cold storage facilities, or on-farm cold storage units that incur relatively less capital expenditure.[9] Table 1 illustrates typical investment and working capital incurred by an apple cold storage facility.[10]

Table 1. Typical investment and working capital for a cold storage facility

Particulars	Expenses (USD)
Land	57,101
Construction	1,690,494
Equipment	1,322,574
Trucks	19,461
Working capital	47,376
TOTAL	3,137,006

Revenue Streams

The primary sources of revenue for post-harvest storage solution providers include rental fees from warehousing services, and sale of cold storage products and equipment. However, enterprises have innovative means of collecting their fees, in order to make it affordable for their customers. Enterprises such as Tessol include fees obtained from renting out cold storage products such as portable cold storage and walk-in cold rooms. Ecozen provides on-farm solar-powered cold storage solutions and earns revenues from the sale of its cold storage solution, Ecofrost. A few India based enterprises such as Ergos and Tessol offer service packages that the customers can choose from, as per their requirements. For instance, some farmers may choose to only avail of warehousing solutions, while others may opt for consulting services along with warehousing solutions. Ergos and Inspira Farms provide consulting services to farmers about best practices in agriculture, specifically post-harvest storage; however this is not a major revenue stream for the enterprises.

Some larger enterprises such as India-based StarAgri and SLCM support farmers by facilitating loans. They work with banks to disburse loans and help with documentation, earning a fee on the loan origination and collateral management. Farmers can choose to store agricultural produce in the warehouse for three to four months and sell at better prices later. They receive credit against the warehousing receipts from banks and financial institutions. In 2014, SLCM forayed into warehouse receipt financing through its wholly-owned subsidiary, KissanDhan.[11]

Financial Viability

Post-harvest storage solutions, specifically large warehouses and cold storage units are generally characterized by low margins. For instance, in India, the cost of a 20,000 sq. ft. warehouse is in the range of USD 1.05 million and 1.5 million, and it takes 10-12 years to achieve break-even with a 12-14 percent return on investment, which does not seem profitable in a shorter span of time. A utilization of 70 percent is considered the best possible average in a year. Large warehouses have to incur expenses such as human resources, monthly rental, cleaning and housekeeping, and auditing fees. Maintaining a large warehouse also involves dealing with a number of middlemen, besides building a network of buyers and suppliers. Another critical challenge in the warehousing and storage segment is the domination by unorganized players that operate with low capacities and have inadequate handling, stacking and monitoring facilities. These unorganized enterprises compete with organized players by charging significantly lower prices.[12]

In India, a warehouse costs around USD 1.5 million and takes 10-12 years to achieve break-even with a 12-14 percent return on investment.

To address this situation, post-harvest solution providers have adopted a number of innovative strategies including bundling of various services such as warehousing, logistics, procurement,

collateral management and quality testing, and commodity pest management to build revenues and profit. A majority of the service providers therefore follow an asset-light strategy by leasing out existing warehouses to public and private warehousing companies on a monthly or yearly rental. Some enterprises procure agricultural products directly from farmers on behalf of processors, traders and government bodies, thereby ensuring better prices for farmers and better margins to the company. A few enterprises also take up third party warehouses on rent to extend their reach into villages to maximize business volumes. Some companies establish their own commodity research desk to provide adequate prices to customers and partners, which in turn increases their business volumes and margins.

Enterprises also use mobile and web technology including SAP solutions to make the system more efficient while requiring lesser manpower, which further saves the cost to the companies. Some enterprises have forayed into warehouse receipt financing and added another revenue stream with high margins. Other strategic measures to ensure financial viability of the enterprise include optimum capacity utilization of the warehouse units, and minimum bad debts. Availability of low-cost and long-duration funds is critical for the agri-warehousing sector. Regulatory and financial support from the government could improve the financial sustainability of this model. For instance, measures such as granting infrastructure status[13] and providing viability gap funding to post-harvest agriculture warehouses and cold chains[14] [15]ensure commercial viability, in turn resulting in increased private sector investment to provide a vital service to farmers.

Enterprises are increasingly considering renewable energy to power their storage solutions. The shelf life of solar cold storages is around 15 years, which is comparatively lower than the conventional cold storages which is around 20 years[16]. The cost of conventional cold storages is almost 50 percent lower than solar-powered ones. However, they require grid power for operation, which comprises around 20-30 percent of the running cost. Solar cold storages not only remove this cost, but can also make a key difference in remote rural areas such as Uganda, where 87 percent of the total population lives in rural areas while rural access to electricity is estimated at just 7 percent[17,18]. Currently, Uganda based Baridi Stores earns nearly 12 percent profit on each sale of solar cold storage products. The price of its solar cold storage ranges from USD 50,000 to 200,000. It also deals in large projects that cost nearly USD 500,000 to 1 million to the customers. The current clientele of the enterprise includes large companies. In the near future, Baridi plans to operate large cold storage warehouses, and rent out storage space to agricultural enterprises and smallholder farmers at an affordable rate of 4 cents per kilogram per day.

The price of solar cold storage ranges from USD 50,000- 200,000. Very large projects may have prices in the range USD 500,000- 1 million. Baridi Stores makes a profit of approximately 12 percent by selling solar cold storages at the above rates. (Baridi Stores, Changemakers).

Currently, storage solution providers adopt several measures to ensure financial sustainability. These include steps to ensure lower default, higher uptake and financial liquidity. Ergos, for instance, has an innovative mechanism of providing forward links for the agricultural produce, where buyers pay Ergos an advance for the agricultural output purchased; and the enterprise pays back to the farmers. This allows the enterprise to maintain liquidity for working capital. Ergos also facilitates finances to smallholder farmers through National Collateral Management Service Limited (NCML), which decreases the chances of bad debts or delinquency for the enterprise. On-farm cold storage solution provider, Inspira Farms partners with banks to facilitate consumer financing to farmers, where risk is shared between the enterprise and banks.

Storage solution providers have been able to raise debt and equity capital for long term growth as well. Inspira Farms has raised debt and equity investment in the last two years. Tessol has attracted equity investment, and has also received small amounts of grants to explore opportunities for providing on-farm products. Ecozen is supported financially by various investors and incubation hubs at premier institute such as Indian Institute of Technology Kharagpur. Some enterprises also operate

as part of various programs of development finance institutions such as those by the World Bank to raise debt and equity investment. National Bank for Agriculture and Rural Development (NABARD) plays a critical role to support creations of post-harvest storage infrastructure in India.[19] Several finance institutions in other countries such as the UK also facilitate development of post-harvest infrastructure and solutions. For instance, UK based Inspira farms has also established contact and partnerships with diverse finance institutions including banks that provide asset financing, impact investors that cater to mezzanine finance and equity finance, and impact lenders that lend long-term loans to the customers of the enterprise.

In the last few years, there is a positive trend of investment, both public and private in African agriculture, including development of infrastructure to prevent the significant amount of post-harvest losses. African governments are prioritizing agricultural sectors such as horticulture in Kenya, and value addition to staple food crops in Nigeria. Other public and private organizations, such as the United States Agency for International Development (USAID), the Swiss Agency for Development and Cooperation (SDC), the African Development Bank (AfDB), the Food and Agriculture Organization (FAO), the World Food Program (WFP), and the Gates Foundation, are either already investing or exploring investments in postharvest storage solutions.[20]

Partnerships

A number of post-harvest storage service providers have been established in the past few years in response to the need for curtailing post-harvest losses and ensuring food security. These enterprises depend on strategic partnerships to increase awareness, acceptance, accessibility and affordability of their products and services, thereby creating maximum impact on smallholder farmers. They partner with federal and state governments, financial institutions such as MFIs and banks, industry associations, and development finance institutions' programs such as JEEViKA by the World Bank that supports the Bihar Rural Livelihoods Project. For instance, Ergos works with public sector banks such as IDBI and SBI to facilitate consumer financing. Tessol engages with non-government organizations (NGOs) to reach out to smallholder farmers and farmer collectives. It has also worked with financial institutions to facilitate loans to its customers. Inspira is a part of 'Sustainable Fruit Lab', an industry association in the US that helps increase its outreach.

Implementation: Delivering Value to the Poor

Awareness

Most developing countries are unable to ensure food security, primarily due to lack of appropriate post-harvest storage facilities. Farmers are often unaware of the benefits and availability of post-harvest storage solutions, and the availability of finance to access them. They either do not avail the post-harvest storage services at all, or compromise the quality by using sub-optimal solutions.

Efforts to increase awareness that incorporate essential features of modern storage facilities, including the significance of gently handling fresh fruits and vegetables, and need and importance of cold storage to reduce post-harvest losses, would increase adoption of storage solutions. Enterprises adopt several mechanisms to spread awareness about the significance and long-term benefits of storing agricultural produce. Ergos and Tessol conduct outreach programs such as exhibitions, demonstrations, and roadshows to showcase their solutions. They also establish partnerships with educational institutions, government, and civil society organization for awareness building activities. For instance, Ergos has tied up with Rajendra Central Agriculture University, Pusa for conducting awareness programs. Tessol works in association with ASHRAY and Ministry of Food Processing to spread awareness regarding cold chain application. Tanzania based Kilimo Markets is in partnership with government extension agencies and research institutes, and actively develops potential partnerships with private players and NGOs to spread awareness regarding post-harvest storage solutions.

Acceptance

Storage enterprises have to break age-old practices and habits of farmers and help them understand that modern storage solutions provide them an opportunity to reduce wastage and get better prices for their agricultural produce. For this, the enterprises bank on their local knowledge and contacts to build trust, and engage with smallholder farmers. To ensure adequate marketing and acceptance of its warehousing solutions, Ergos utilizes its local knowledge of the agricultural setting, and farmers' attitude. Similarly, to ensure effective business engagement and development of its on-farm cold storage solutions, Inspira Farms engages marketing executives who have local knowledge and understanding. Farmers are also unaware of convenient solutions such as low cost modular options for cold storage provided by enterprises such as Tessol and Inspira Farms, and the availability of finance for the same, resulting in low adoption of such solutions. Tessol plans to cover the entire value chain from source to-end customer and facilitate the adoption of cold storage facilities at the last mile level.

Accessibility

Enterprises such as Wakati and Promethean Power Systems engage with local farmer leaders and dealers for distribution. Ecozen reaches its customers through in-bound calls and face-to-face meetings, exhibitions, events, seminars and workshops; news-paper articles, and blogs. Its distribution strategy includes both, Business-to-Customer (meeting with customers/ smallholder farmers), and Business-to-Business/ Government (meeting with local governments, CSR departments, and donor agencies). The enterprise is also in discussion with Farmer Producer Organizations (FPOs), Farmer Producer Groups (FPGs), Microfinance Institutions (MFIs), Non-Government Organizations (NGOs), and Energy Saving Companies (ESCOs) to build the market and increase access to its storage solutions.

Affordability

Storage solution enterprises offer significant cost benefits to smallholder farmers, and price their services and products at nearly 35 percent-50 percent lower rate, in comparison to mainstream competitors. A few enterprises have their own research and development (R&D) teams that continuously innovate to make their storage solutions more affordable to the farmers. Ecozen is in discussion with several financial institutions and Corporate Social Responsibility (CSR) departments of corporate firms to help facilitate loans to customers.

Some enterprises leverage renewable energy technologies to provide affordable post-harvest storage solutions to smallholder farmers. For instance, Inspira Farms provides pre-fabricated, standard storage solutions that operate on an automatic mechanism that sources energy first from renewable energy sources. Once the renewable energy is exhausted or is not available, it sources from non-renewable energy sources, thereby reducing electricity bills. In some cases, smallholder farmers get together and buy a cold storage unit with their consolidated funds and mutual understanding to share the storage unit as per their requirement. As these products can serve a number of customers, they are affordable on a per unit basis. Promethean Power Systems provides low-cost energy efficient refrigeration facilities in rural locations. It uses a mix of thermal-power batteries and solar energy, which is inexpensive compared to other diesel powered facilities.

In contrast, Tessol's stationary storage solution is expensive on a capital expenditure basis, and makes a difference when a big customer such as any government agency buys at least 500 units. The price range for its mobile on-farm solutions is 10 percent-20 percent higher than its competitors. The enterprise clarifies the reason for the higher price citing differentiation which includes energy storage and real time performance monitoring. Ergos offers warehousing solutions and collateral management facility to smallholder farmers in India at reasonable rates. It helps farmers in better price discovery, where they become the 'price makers' in the market. It provides loans to the farmers at attractive rates of 10-10.5 percent.

Results and Cost-Effectiveness

Scale and Reach

In most developing countries, agricultural storage facilities are owned, operated and maintained by the public sector. Increasing demand for food coupled with lack of adequate post-harvest storage facilities challenges the government's capacity to sustainably meet the requirement. Private sector enterprises present effective storage solutions and have the potential to expand their scale and reach, considering the burgeoning demand.

Some of the 'reach' indicators include number of warehouse facilities and establishments, capacity of these warehouses, and throughput of the warehouses. Scale of the storage business model is mainly measured in terms of increase in income and profits of farmers. Most of the storage solution providers interviewed for this research needed a minimum of two years to create considerable impact.

Table 2. Examples of companies and their reach

Company	Country of operation	Years of operation	Scale and Reach
Baridi Stores	Uganda	2	Increase in income of agricultural enterprises[21] by at least 30 percent[22]
Ecofrost Technologies	India	6	Increase in the top-line of farmers by over 20-40 percent and profit by 80-100 percent[23]
SCLM	India	8	Technology enabled network of 1303+ warehouses and 19 cold storages across India with a total capacity of over 3.3 million metric tons spread over 18.5 million sq. ft. and a throughput of more than 373 million metric tons[24]
StarAgri Warehousing	India	10	1,200+ warehouses across 300 locations with a total warehousing capacity of over 1.7 million tons[25] Collateral management portfolio increased from USD 75 million in 2012 to USD 1.35 billion in 2014[26]

Currently, Baridi Stores plans to set up a solar—three phase hybrid powered cold storage facility for Mbarara District Farmers' Association of over 10,000 farmers in Western Uganda. The member farmers, after harvesting their fruits and vegetables, will take them to the cold storage facility where they will be stored until they are transported to the airport and then airlifted to buyers in Europe or United States who pay premium prices for them. The incomes of these farmers will increase by at least 20 percent because they do not have to sell to local brokers or middle men at significantly lower prices and risk food spoilage if they delay sale or consumption. In five years, Baridi Stores is planning to own and operate large cold storage warehouses in Uganda where farmers will be able to store their perishables for a handling fee.[27] On-farm post-harvest storage solution providers such as Ergos, Tessol and Ecozen, currently operate in fewer markets, but plan to expand geographically within their countries of operation and beyond in the next couple of years. Most of these enterprises in the last 2-3 years, and have achieved outstanding scale and reach in these years. The enterprises also want to build up their umbrella of services. For instance, Ergos plans to set up its own Non-Banking Financial Company (NBFC) in the future.

Improving Outcomes

Post-harvest storage solutions are very useful to smallholder farmers, who had no option but to sell their agricultural produce immediately after harvest at prevailing local market prices, for fear of it getting spoiled. By offering storage solutions, the enterprises have helped farmers become "price makers" instead of "price takers".

Although not many enterprises have conducted social and environmental impact assessment, most of them aim to reduce post-harvest losses by at least 20-25 percent. Ecozen's solution, for instance, provides direct benefits by preserving the quality of fruits and vegetables until market prices are attractive. It also offers indirect benefits such as savings on electricity bills and diesel costs, as it operates on solar energy. Ecozen's solution results in an increase of farmers' profits by nearly 40 percent. Promethean Power Systems has installed over 100 milk chilling systems across rural India. Each system serves approximately 20-30 farmers who can now deliver more milk to quality conscious dairy processors. The dairies in turn collect more milk and produce higher value and higher quality products for Indian consumers. A number of other enterprises such as Baridi Stores and Tessol also provide affordable energy-efficient refrigeration or cold storage solutions that result in direct and indirect economic impacts.

Availability and reliability of solar cold storage increases the average incomes of agricultural enterprises such as exporters of fruits and vegetables, farmers' associations and large scale farmers especially those with rural operations by at least 30 percent because they can bargain for higher prices from buyers. Cold storage also stabilizes prices for fruits and vegetables across seasons of high and low supply. Fairly moderate prices of foodstuffs ensure Ugandans can afford to buy foodstuffs reducing infant malnutrition.[28] Wakati is located in Haiti, Uganda, Tanzania, Kenia, Benin and Sierra Leone and is setting up new pilot projects in China and India. It has already sold nearly 150 cold storage units that helped the local farmers in the respective countries receive higher prices for the crops, ultimately resulting in higher incomes.[29] Inspira Farms creates at least 28-30 jobs in each of the rural agricultural communities, further increasing their avenues of income. As the direct customers of the enterprise include rural businesses, and small and medium enterprises, and co-operatives such as dairies, horticulture companies and agri-export companies, it focuses is on the jobs created by these clients.

The larger enterprises, particularly those that have scaled significantly focus on technological innovation to increase customer experience and improve their operational efficiency. SLCM, for instance, established a centralized management information system that provides real-time information on the multi-location holdings of customers. It has also devised its own Standard Operating Practices (SOP) called Agrireach, which significantly brings down wastage during storage. The company uses a coded warehouse system wherein customers can track the movement of their products. This process reduces theft, and also checks the quality of the food grains.[30] The product also enables farmers to reduce electricity costs. The cold storage solution leads to over 40 percent increase in the profits of the smallholder farmers, after a 2-year breakeven.

Cost Effectiveness

Post-harvest storage solutions are the responsibility of the public sector in a number of developing countries. With increasing population and growing demand for food, there is excess pressure on agriculture production. In Sub-Saharan Africa (SSA), the amount of food loss exceeds the value of total food aid received, and is equal to the annual value of cereal imports to the region.[31] Reduction in post-harvest losses can help cater to the problem of malnutrition and hunger in most developing countries. However, there has not been any significant improvement in the public storage facilities in these countries in the last few years. Private enterprises offering storage solutions can support public facilities in providing sustainable and cost-effective solutions.

Some storage solution enterprises offer forward linkage services to ensure cost-effectiveness. Ergos currently works with NCDEX e-market Limited (NeML) to provide warehouse receipts to smallholder farmers, but plans to directly issue the receipts going forward, thereby reducing intermediary cost. Tessol also worked with financial institutions and helped facilitate a few loans to the customers. Inspira Farms works on Just-In-Time (JIT) model to lessen its inventory cost and provide customized solutions to the clients. Some enterprises lease, maintain and operate local warehouses in rural areas that are located closer to the farms. This prevents initial capital expenditure on infrastructure and also keeps the operational costs, mainly transportation from farms to warehouse, low. A few enterprises

also adopt the outsourcing and partnership model in areas that are cost-ineffective to serve otherwise. Technologically advanced enterprises deploy automated quality control measures to prevent spoilage of food items and the cost attached to it.

Taking it to Scale

Challenges

Enterprises that plan to provide and expand post-harvest storage solutions face several challenges including that of real estate and access to finance. High cost of real estate, especially in peri urban areas where land is expensive, can make the financial viability of the warehouse low. In Kenya, small and medium enterprises (SMEs) providing post-harvest storage facilities use Savings and Credit Cooperative Organizations (SACCOs) and funds from family and friends to invest in the businesses. The interest rate offered by SACCOs are almost half (around 8 percent per annum) compared to that offered by the banks (around 15.75 percent per annum).[32] These sources of funds, however, will not be able to help enterprises scale rapidly.

Enterprises also face significant challenges that hinder day-to-day business operations such as cash flow maintenance, especially in case of small sized warehouses. They need funds to ensure continuous customer engagement by means of training and awareness building activities, and to attract and retain talent. Other important challenges that restrict expansion include inadequate financing for farmers to avail of storage solutions; and the need for behavior change among smallholder farmers to appreciate the importance of post-harvest storage. Post-harvest storage service providers must also build strong geographical presence and then expand offerings to ensure multi-revenue streams. For instance, in addition to post-harvest storage facilities, enterprises such as Ergos and Inspira Farms are foraying into other associated services such as consulting and advisory support to farmers regarding best practices in agriculture. However, this does not result in significant revenue.

Role of Government and Policy

Government strategies and policies related to post-harvest infrastructure and solutions vary across developing countries. In some countries, such as India and Kenya, the governments are cognizant of the critical issue of post-harvest losses, and hence, are keen to take appropriate steps for the same. They seek to address the issues of access to finance, development of technology, and provision of adequate infrastructure to build robust post-harvest storage systems. However, Governments need to develop specific strategies to prevent food loss and waste reduction in a number of Latin America and Caribbean countries.

In India, the central government has devised several strategies including the Warehousing Development Act and permitting 100 percent FDI investment in the warehousing segment.[33] The segment has grown at a CAGR of over 16 percent from 2012 to 2016.[34] Government investment in infrastructure and the adoption of Public Private Partnerships (PPP) models are considered to be the key drivers for this growth.[35] However, most of these storage capacities are located in states producing majority of the crops. In August 2016, the Ministry of New and Renewable Energy, Government of India, (MNRE, GOI) extended its subsidy scheme to solar refrigeration units to boost the use of solar-powered cold storages.[36] Currently, banks and other financing institutions do not provide priority funding to cold-chain projects as this segment is considered nascent in meeting its operational challenges.[37] The Finance Act of India also does not acknowledge services provided for storage of agricultural produce or any service provided by a cold storage in the definition of 'storage and warehousing service'. However service tax is applicable to various services provided at cold storages, specifically those included in the definition of 'agricultural produce'. This increases costs for the enterprises and prices for farmers.[38]

In Kenya, the agriculture policy, which is determined by the Ministry of Agriculture, Livestock and Fisheries (MALF) has some strategic objectives for the agriculture sector including improved market

access and trade, increase in productivity and outputs of the produce, and hence increase in food security.[39] Further, corruption remains a problem according to Transparency International's Corruption Perception Index, which ranked Kenya 139 out of 168 countries in 2015.[40] In Kenya, there are a few food related regulations that have contributed to the development of the post-harvest storage solution model in general. According to one of these regulations, it is mandatory to pasteurize the raw milk before its sale. In Ghana, the government has made a number of infrastructure and policy interventions to reduce post-harvest losses. These include creating storage facilities and development of a commodity exchange. In Mozambique, although, it is not a policy requirement, farmers are encouraged to produce in quantities as per demand, given the relatively small market for agricultural produce, and lack of post-harvest storage facilities.[41]

In Latin America and the Caribbean, there is no specific strategy to prevent food loss and waste reduction; governments are implementing several measures to address this issue. One such measure is the food banks that collect food for redistribution. Public and private sectors establish alliances in various countries such as Costa Rica, Chile, Guatemala, Argentina, the Dominican Republic, Brazil and Mexico, to tackle the situation. The Association of Food Banks of Mexico, for example, is a non-profit organization which coordinates a network of 61 food banks all over the country to prevent food loss at various stages of the value chain.[42]

Storage enterprises have shared mixed experiences regarding role of government and policies in facilitating the activities of the business. According to the founder of Ergos, the current policies in India do not cater to the requirements of smallholder farmers, who have difficulty accessing storage for a variety of reasons, and appropriate institutional measures are required to address their needs. He also believes that there is a huge gap in terms of awareness regarding government initiatives in the agriculture sector, and farmers do not know of the different programs that they can avail of. On the other hand, enterprises such as Ecozen underscore the inclusion of on-farm cold storage facilities in the subsidy scheme of Ministry of New and Renewable Resources, Government of India (MNRE, GOI). The Ministry of New and Renewable Energy, Government of India (MNRE, GOI) has approved 30 percent subsidy from the central government for micro cold storage (mCS) solution of Ecozen.

Conclusion

There is significant interest in preventing post-harvest losses in developing countries, both from governments and the private sector. Given this interest, this business model (both variants – on-farm modular solutions as well as large facilities for lease) can potentially scale, and build on existing technologies as well as infrastructure.

The model is financially viable as a number of storage enterprises are leveraging strategies such as bundling of services, forward linkages, collateral management, and facilitating consumer financing. Although the payback period is considerably long for storage solutions, a number of financial institutions are actively supporting enterprises in this business model, further contributing to their financial sustainability.

Table 3. SEs: Post Harvest Storage Solution

Company	Country	Solution Description
Baridi Stores	Uganda	Baridi Stores provides low-cost energy efficient storage facilities. It offers solar commercial refrigeration technology solutions for perishable food items. These include solar-three phase hybrid cold storage warehouses and ice plants that help reduce risk and improper management.
Ecozen	India	Ecozen provides on-farm solar-powered cold storage solutions to the rural smallholders farmers in India. The cold storage unit is solar powered, and has a back-up of 30 hours. It can easily be transported from one farm to another, and after a 2-year breakeven, leads to over 40 percent increase in the profits of the farmers.
Ergos	India	Ergos offers warehousing solutions and collateral management facility to smallholder farmers in India at reasonable rates. It helps farmers in better price discovery and makes them 'price makers'. It provides loans to the farmers at attractive rates of 10-10.5 percent.
Inspira Farms	Central America, and East Africa, Southern Africa	Inspira Farms operates on Just-In-Time (JIT) model that designs, develops and supplies affordable small scale cold storage facilities to its customers primarily consisting of including rural businesses, SMEs and co-operatives.
Kilimo Markets Ltd	Tanzania	Kilimo Markets provides a range of agricultural services, including warehouse facilities. It also facilitates production of quality certified seeds, provides agri-training, and market brokerage services to smallholder farmers.
Promethean Power Systems	India	Promethean Power Systems is a provider of low-cost energy efficient refrigeration facilities designed for rural applications in post-harvest functions. This solution uses thermal-power batteries and solar energy to provide energy efficient storage facilities. This technology is low cost compared to other diesel powered facilities used by farmers who have little or no access to grid electricity.
Rebound Technology	Multiple developing countries	Rebound Technologies is an innovator in the refrigeration and storage space for both urban and rural sectors. Its technology is based on a thermally-driven heat pump model that provides practical solutions. It is developing two types of technologies - IcePoint and SunChill to serve the urban and rural markets respectively.
Samriddhii (Kaushalya Foundation)	India	Samriddhii is an integrated vegetable supply chain model that allows farmers and vendors to bypass intermediaries and establish direct market linkages. It sells produce in self branded AC push carts.
StarAgri Warehousing	India	StarAgri provides integrated post-harvest management solutions including warehousing, procurement and collateral management of agricultural commodities. In addition to their management services, StarAgri also provides access to a range of financial services such as risk management, retailing and logistics.
Tessol	India	Tessol is a cold chain equipment provider and deals with both stationary and mobile cold chain solutions, the technology for which is based on energy storage. Stationary cold chain solution is useful in places of irregular power supply; it can work on solar or any other energy source. While the mobile solution offers lesser cost in comparison to its competitors.
Wakati	Haiti, Uganda, Tanzania, Kenia, Benin, Sierra Leone, India, and China	Wakati provides low-cost and energy efficient post-harvest storage solutions to smallholder farmers at the farm level.

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* INR to USD rate conversion = 1 INR = 0.015 USD

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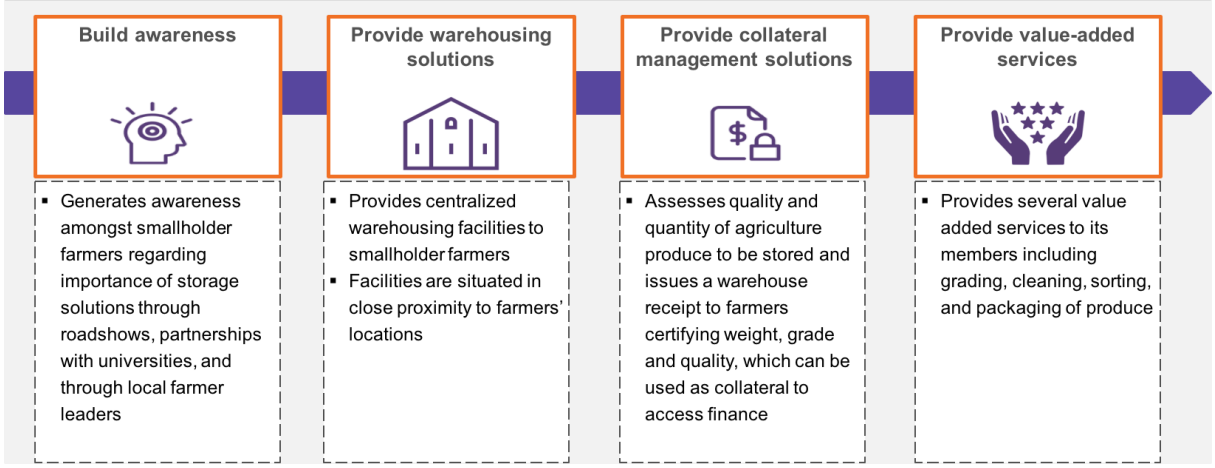
CASE STUDY: ERGOS

ergos
empowering participation

Founding year: 2012
HQ: Bangalore, India
Countries of operation : India
Orientation: For-profit
Employees: 31
Turnover: USD 1.35 million

In India, the government provides for around 72% of agriculture warehousing capacity leaving a gap of 35 million tons of warehousing capacity. The average cost of establishment of a 20,000 sq. ft. warehouse in India ranges between USD 1.05 million to USD 1.5 million, takes 8-10 years to break even with a 12%-14% return on investment, coupled with low levels of awareness amongst the smallholder farmers regarding warehousing and cold storage facilities, there is limited private sector interest to enter this market.

Ergos offers warehousing solutions and collateral management facility to smallholder farmers in India at reasonable rates. It helps farmers in better price discovery and in making them 'price makers'. The enterprise provides continuous access to the farmers to visit the warehouse to check, sell or retain the stored items. Aside, it also connects the farmers to finance providers that could help them with the working capital till they sell the produce.



Operating model

Ergos offers scientific warehousing solutions and collateral management facilities to smallholder farmers in rural districts of Bihar. The enterprise operates a chain of efficient and hygienic warehousing facilities situated within a range of three to four kilometers from the farmers' locations. It provides 24/7 access to farmers to transact, sell or hold the commodities. Farmers can thus track market movements and sell when they can realize better prices.

The enterprise runs a network of micro-warehouse-based "farmer offices" that works in tandem with the retail partners of Ergos to build capacities of smallholder farmers, and to expand the existing user base. At present, there are nearly 21 farmer offices, and the enterprise plans to increase this number to 500 in the next couple of years. The micro-warehouse is a low-cost format that operates at the village level and helps the enterprise to directly bond with the farmers. The enterprise signs agreements with several smallholder farmers who store their agricultural produce in the warehouse. Once farmers deposit stock in the warehouses, Ergos checks the quality and quantity of the items and issues a warehouse receipt to the farmers certifying the weight, grade and quality. The enterprise is able to negotiate better prices on behalf of the farmers,

Ergos operates nearly 20 warehouses in over 20 villages in 6-7 districts, and has over 11,000 farmers on board. The current warehousing capacity of the enterprise is 6,000 tons. Its capacity utilization is 100 percent.

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This series on Inclusive Innovations explores business models that improve the lives of those living in extreme poverty. Editors are Elaine Tinsley and Natalia Agapitova. Researched and developed by Intellecap.

based on this data. The micro warehouse network helps Ergos accomplish business development as well as transaction execution. This arrangement also ensures optimum capacity utilization of the warehouse, and low wastage and higher price realization for the farmers. Ergos is able to achieve higher turnover with limited capital. It has also achieved greater price efficiency in certain crops such as maize, wheat and paddy as these are the major crops cultivated in the region.
Ergos has introduced a unique concept of farmers' portfolio management, wherein its software application captures basic information about all associated farmers. The software captures information related to various business transactions between the farmer and Ergos. The enterprise also provides several value added services including grading, cleaning, sorting, and packaging to its members. It also trains farmers on various in all aspects of financial transactions, contracts and markets.

The enterprise makes use of technology such as SAP and other web applications. It has also developed a mobile app for farmers, end users and internal staff to ensure minimum turnaround time on any service request, and to make the operations easy and transparent. Ergoslive, a webapp for forward link, is a unique portal linked to SAP core database. The application runs on all browsers and can be accessed by users even remotely.

Ergos generates general awareness among smallholder farmers regarding the importance of storage solutions. It showcases the significance of storage solutions through videos, roadshows, and midnight cafes. It works with local farmer leaders to mobilize interest, and has tied up with Rajendra Central Agriculture University, Pusa to conduct awareness programs in its different markets.

Ergos was founded with the support of some donor and government initiatives such as JEEViKA (a World Bank project to support Bihar Rural Livelihoods Project), and NABARD producer groups. National Collateral Management Service Limited (NCML) helped the enterprise to understand warehousing and credit access, and also provided access to finance to Ergos associated smallholder farmers. Ergos collaborated with National Commodity and Derivatives Exchange e-Markets Limited (NeML) for forward linkage to access the national platform. It also partnered with LTC Commercial to adopt better warehousing practices. Ergos received an investment from Aavishkaar, an early-stage investor in March 2015. It works with the government, banks such as Industrial Development Bank of India (IDBI) and State Bank of India (SBI), and World Bank (WB) programs to facilitate consumer financing.

Ergos receives a state government subsidy of 3 percent for timely repayment of loans.

Financial Sustainability

Ergos, being a smallholder farmer focused social enterprise, ensures that the base price charged to the farmers is almost half in comparison to other warehouses. For instance, it charges USD 0.09 to USD 0.18 per quintal as against USD 0.25 to USD 0.27 charged by others. The enterprise also offers various packages that customers can choose according to their requirements. These packages include warehousing, loans and linkages to processors. In addition, the enterprise facilitates loans at 10-10.5 percent as it has access to the collateral stored in its warehouses.

Ergos currently works with NCDEX e-market Limited (NeML) to provide electronic warehouse receipts (e-WHR) that farmers can use as collateral with banks to access credit. Through this platform, it connects the rural warehouses to national market that helps discover better prices for farmers. Going forward, the enterprise will directly issue the warehouse receipt, which will reduce the intermediary cost.

Ergos' micro warehouse network helps to achieve procurement and transaction execution, and ensures maximum capacity utilization of the warehouse. Some of the major costs incurred by the enterprise include warehouse rent, relationship managers' salaries, operations fee, and insurance fee. This amounts to nearly USD 3,000 to USD 3,750 per annum for a 200 metric ton (MT) capacity

warehouse, USD 4,500 to USD 6,000 per annum for a 500 MT capacity warehouse, and USD 7,500 to USD 9,000 per annum for a 2000 MT capacity warehouse. The major revenue streams of the enterprise include warehousing services and advance advisory and processing fee. Ergos plans to achieve break-even by December 2016.

Impact

Ergos' warehousing and collateral management solution has innumerous direct and indirect impacts on the lives of the smallholder farmers. Some of the direct benefits include support in better price discovery. The indirect benefits include providing better access to finance, and inculcating the habit of storing the agricultural produce and not selling immediately after harvest. This reduces post-harvest loses by 20 percent to 25 percent, and prevents a situation of distress sale. Reduction in post-harvest losses increases the disposable income of the smallholder farmers that they can invest in their family's health and education.

Challenges and Lessons

Ergos faces several challenges linked to financing, marketing and distribution. Some of the major financial challenges include maintenance of cash-flow and operational expenses, especially for small-size warehouses. This is due to the gap in the meticulous calculations required while managing the consumables, safety and security of the warehouses. The enterprise also faces marketing and distribution challenges related to customer engagement, awareness and trust building, and the need for behavior change amongst the smallholder farmers to adopt warehousing practices. The enterprise also finds it difficult to attract, train and retain suitable talent, as the concept is new, and people with desired skill-sets are rarely available. The enterprise needs to recruit the right talent, and train them professionally, to obtain the required business outputs.

Road Ahead

By next year, Ergos plans to rent 30-35 additional warehouses; and expand its operations to Karnataka, by replicating the Bihar model. The enterprise wishes to explore various other opportunities under the project JEEViKA, whereby it plans to scale up warehousing capacity to 5000 MT to connect with one lakh farmers by 2017, and subsequently to a capacity of one million MT to connect a million farmers in the next 2-3 years.

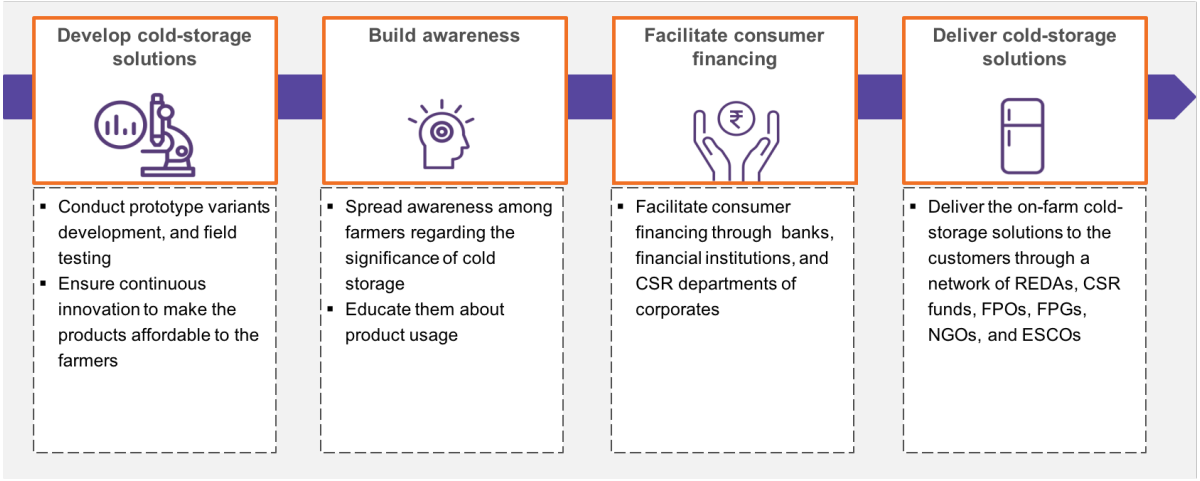
By 2020, Ergos aims to reach 500,000 farmers and 5,000,000 ton warehousing capacity. It plans to establish a unique procurement process in India that can be replicated globally. The enterprise has a long term vision to establish a Non-Banking Financial Company (NBFC) to further support smallholder farmers to have better access to finance. This initiative will impact the farmers who do not comply with banks' norms for access to credit, forbidding them to access finance.

CASE STUDY: ECOZEN

Founding year: 2009
HQ: Pune, India
Countries of operation : India
Orientation: For-profit
Employees: 100
Turnover: USD 1.43 million

India, despite being the second largest horticulture producer in the world, is not able to meet the domestic demands owing to over 35% of total produce, worth USD 2 billion wasted annually due to inadequate infrastructure for storage. The lack of electricity across the major horticulture cultivation areas in India restricts the effective functioning of cold chain facilities .

Ecozen Solutions, a renewable energy company, has developed solar micro cold storage systems for use in agriculture and rural communities. Ecozen's solution is as useful for smallholder farmers as it is for big farmers and agriculture based institutions. The micro cold storage units help in increasing the income of smallholder farmers who previously didn't have access to on-farm storage solutions, leading to huge amount of wastage of perishable agriculture produce. The enterprise has served 400 farmers.



Operating Model

Ecozen manufactures on-farm solar-powered cold storage—micro cold storage (mCS) systems and solar powered irrigation products. Ecofrost can be used by farmers located in remote rural areas.

Smallholder farmers find it difficult to access large cold-storage facilites, thereby increasing the need for on-farm cold-storage solutions such as the one offered by Ecozen.

Farmers can monitor the temperature of the cold storage unit using sensors attached to the unit and regulate the temperature using their mobile phones or any hand-held devices. The unit can be used without a battery and has a back-up capacity of 30 hours It is portable and easy to transfer from one field to another, which enables a group of smallholder farmers to buy the product together, and share it.. The enterprise uses ICT for 'remote monitoring', 'predictive analytics' and 'preventive maintenance metrics'.

In India, 10 million tons of cold storage capacity is required to prevent over 30 percent waste of perishable produce.

Ecozen continuously educates the customers regarding the product, usage models and value-addition because of the solution. The company's personnel provide after-sales support as well. The enterprise leverages corporate social responsibility (CSR) and sustainability initiatives of corporate partners, various programs of municipalities, state government, renewable energy development agencies, community organizations and non-governmental organizations (NGOs) to increase its

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market reach. For donor based initiatives, partners fund the capital cost, while Ecozen covers the operating expenses including installation, commissioning, and maintenance of the product at nominal cost. For community owned initiatives, the capital cost is borne by the partners as per pre-determined installments, and the enterprise undertakes training of the operators or village level entrepreneurs (VLEs) on the usage models.

Ecozen reaches its customers by means of several online and offline modes including articles, blogs, field surveys, exhibitions, seminars and workshops. The sales team of Ecozen also conducts face to face meetings and calls with the customers. Ecozen offers a quarterly lease to farmers, which helps in increasing the affordability of its products among small-scale farmers. Farmers are encouraged to lease the product on a trial basis for a quarter, post which the farmer acquires the product if there is a visible cost-benefit attached.

"Inclusion of the Ecofrost in the existing National Horticulture mission and Jawaharlal Nehru National Solar mission will impact the lives of several farmers and eventually reduce agriculture wastage to a great extent." - Prateek Singhal, Co-founder, Ecozen (Energy Next, November 2014)

Ecozen either distributes its products to farmers directly or through its corporate and institutional buyers. Under the partnership model, the distribution process involves State Renewable Energy Development Agencies (REDAs), CSR funds, local governments, and donor agencies. The enterprise is also in discussion with Farmer Producer Organizations (FPOs), Farmer Producer Groups (FPGs), Microfinance Institutions (MFIs), NGOs, and Energy Saving Companies (ESCOs) to build up the market and increase accessibility to its storage solutions.

Financial Sustainability

Some of the major expenses of the enterprise include those for research and development, prototype variants/version development, field testing, acquiring certifications, marketing and product promotion, vendor development, and client scouting & servicing expenses. Ecozen prices its products based on survey outcomes, price elasticity of clients and product costs involved.

"Omnivore funded Ecozen because it believes that Ecozen has the solution to provide last-mile cold chain to India's farmers and radically reduce losses of fresh produce." - Jinesh Shah, Founding Partner, Omnivore Partners (The Economic Times, April 2015)

In April 2015, Ecozen raised about USD 1 million from Omnivore Partners. With this funding, Villgro, which had invested in Ecozen in March 2014 through a combination of equity and grant, exited the company with a profitable return. Ecozen planned to utilize the funding from Omnivore Partners to strengthen the business structure and supply chain including logistics and production, increase the production capacity, and widen the market reach.

The enterprise is an approved supplier for Chhattisgarh state government and it receives a subsidy of 40 percent each from the state and central governments respectively. It is also an approved supplier under National Bank for Agriculture and Rural Development (NABARD) supported subsidy scheme for solar pumps in Madhya Pradesh, Chhattisgarh, Maharashtra and Bihar, and it receives 40 percent subsidy from the state governments. The subsidy for micro cold storage (mCS) from Ministry of New and Renewable Energy, Government of India (MNRE, GOI) is approved for 30 percent central assistance. Ecozen's revenues have quadrupled from USD 360,000 in financial year 2015 to USD 1.43 million in financial year 2016.

Impact

The enterprise's micro cold storage units help in increasing the income of smallholder farmers who previously didn't have access to on-farm storage solutions. A group of smallholder farmers collate funds to buy the storage unit to store perishable fruits and vegetables instead of being forced to sell their produce at low prices in the market. The product also enables farmers to reduce electricity costs.

The cold storage solution leads to over 40 percent increase in the profits of the smallholder farmers, after a 2-year breakeven.

Ecozen Solutions has won several awards and recognitions including the Dow Sustainability Innovation Challenge at California Institute of Technology, Pasadena Ecozen Solutions received Economic Times-Power of Ideas award from DST, Government of India. Ecozen Solutions' idea was ranked among the world's top 30 business ideas at Stanford's E-bootcamp. Ecozen Solutions was awarded the Technology and Sustainable Development Award 2011 at Eureka IIT Bombay and was covered as a Pioneering Product by CNBC TV18.

Challenges and Lessons

The company's primary challenges relate to the high upfront cost of the system to smallholder farmers. The enterprise faces difficulties in ensuring end user financing for its smallholder farmer customer base. Ecozen also finds it challenging to make the products affordable to the lower income consumers; however the in-house R&D team is focusing its efforts to devise cost-effective technology solutions that it can leverage to decrease the price of the product.

Road Ahead

Ecozen targets to expand its reach in Maharashtra, and surrounding areas, while exploring the opportunity to make direct sales to big farmers and agriculture based institutions. It aims to reach a revenue scale of USD 3 million by the end of 2016. By 2017, Ecozen plans to complete nearly 500 installations in India. It targets to reach a turnover of USD 11.7 million by the end of financial year 2018. It also wishes to expand geographically, into Africa and East Asia. The enterprise targets to achieve break-even by mid-2017. The enterprise is in discussion with banks, financial institutions, and CSR departments to facilitate financing options for its customers.