Learning Brief – March 2022

# How can increased access to solar powered cold storage with in-built dehumidifier, improve efficiency and smallholder income in the pulses value chain?

Insights from Inficold's experience in India

Shell Foundation

Inficold

# Executive Summary

India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world**Error! Bookmark not defined.**. Pulses are an important and affordable source of protein in Indian diets[1]. They can remain in edible condition for several years if properly stored**Error! Bookmark not defined.**, but are more difficult to store than cereals and suffer much greater damage from insects and micro-organisms owing to their high protein content. In India, estimated post-harvest losses account for 9.5% of total pulses production[2]. Among the post-harvest operations, inadequate storage is responsible for the maximum loss (7.5%)[2].

If infested, the whole harvest can be wiped out, so farmers usually sell their produce as soon as it is harvested. Income generation by the farmers is low due to small demand in peak harvest season.

An assessment was conducted to understand the impact of solar cold storage on the pulses value chain and on the farmer household. This report presents the case of Bandal Ghati Sawayat Sahakarita, a Self-Reliant Cooperative (SRC) from Dehradun district, Uttarakhand. The SRC is the aggregator for its farmer members. It stores, packages and sells organic agriculture commodities in large cities. It was earlier drying pulses through a solar heat-based dryer and later storing them in a warehouse. The cooperative was incurring losses due to pest infestation and micro-organisms leading to lower quality of produce and ~15% wastage (weight loss) for the stored pulses.

**Solar cold storage**

A solar cold storage with in-built dehumidifier for 35 MT storage capacity was installed. The system primarily operates on solar energy to maintain temperature and humidity of the product. It also acts an in-situ dryer to remove moisture from the produce. The cooperative can maintain the quality of pulses and was able to reduce wastage of the stored pulses by 95% over the last year of the system operation. It has resulted in increased income at farmer level.

**Impact**

The system was utilised at full capacity for nine months to store pulses and for the remaining three months to store potatoes. The overall losses in pulses during storage were reduced to 2% from 15% before the installation. The in-situ drying resulted in reduced operational expenditure and improved produce quality. Extra income of around 10-15% was realised by the 268 farmers using the cold storage facility. The increase in revenue of the cooperative was 24% year-on-year. Usage of pesticides and rodent killers was eliminated and the pulses were able to achieve the organic nametag.

**Conclusions, recommendations and potential impact**

There is a huge unmet demand for the cold storage solution. The limited storage capacity results in lower participation of additional farmers. In the current case, where there are two levels of aggregation taking place initially at the producer level (which is finally transported to the cold storage), it would be ideal for similar cold storage units to be set up and made available at the village or block level to strengthen the existing value chain and ensure higher returns for all the farmers.

The intervention helped the farmers to reduce post-harvest losses. The improved quality, reduction in post-harvest losses and automated drying and temperature control of the pulses helped the cooperative to manage the operations effectively and led to increase in their overall income. Overall increase in income of the combined cooperatives using the cold storage solution is around INR 3,76,000, translating to system payback of less than three years[10]. The cold storage helped 268 farmers to increase income to around 10-15%, the combined value of which stands at INR 6,70,000. The cold storage solution provides the farmers an opportunity to improve their participation in the pulses value chain, thus augmenting their income by eliminating the middlemen involved in storage and processing. The end user receives benefits in the form of lower retail prices, organic grains free from pesticides and high-quality produce. The situation is a win-win for the entire value chain and most importantly for the farmer households, giving them a motivation to

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[1] https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/131495/filename/131708.pdf

[2] https://www.sciencedirect.com/science/article/pii/S0570178319300375

improve the pulses productivity. With a greater number of such installations throughout the country, India will be able to reduce the import bills of pulses and also cater for the growing demand of pulses.

## Acknowledgement

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## List of Abbreviations

| | |
|---|---|
| ERH | Equilibrium relative humidity |
| MC | Moisture Content |
| kVA | kilo volt ampere |
| TR | Tonnes of Refrigeration |
| SRC | Self-reliant Cooperative |
| CFC | Community Facility Centre |
| Km | Kilometre |
| $CO_2$ | Carbon dioxide |
| INR | Indian Rupee |
| Kg | Kilogram |
| KWp | Kilowatt Peak |
| MT | Metric Tonnes |
| PV | Photovoltaic |
| US$/D | US Dollar |

# 1. Introduction

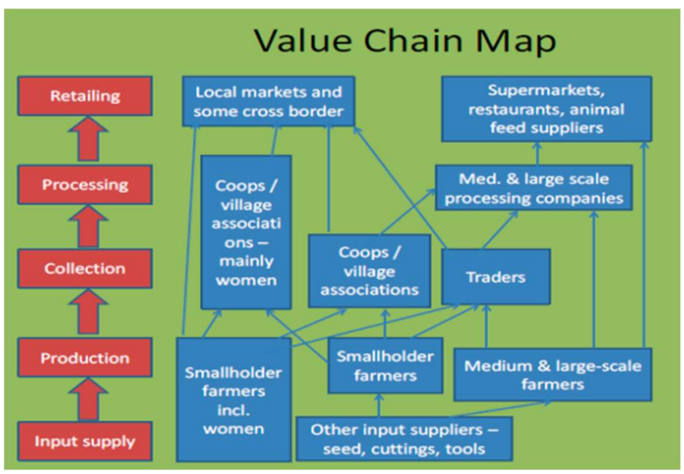
Being a rich source of proteins and other nutrients at an affordable price, pulses not only provide nutritional benefits but also play a significant role in fostering the food and nutritional security of the Indian population. Among protein-rich foods, pulses have the lowest carbon and water footprint[3]. Pulses also improve soil health by naturally balancing atmospheric nitrogen in the soil; thus, growing pulses reduces the need for nitrogenous fertiliser[3].

For rainfed areas and resource poor farmers, pulses are the preferred crops due to low water requirement and ability to sustain in adverse conditions. India ranks first both in area and production of pulses with 35% of global acreage and 25% of world production[4] and produced 23.4m tonnes of pulses during 2018-19 – still short of annual domestic demand of 26-27m tonnes[5]. The gap is met through imports which results in higher prices for the end consumer. To ensure self-sufficiency, an annual growth rate of 2.14%[6] is necessary.

## 1.1 Pulses value chain in India[7]

Figure 1 explains the generic pulse value chain in India. It shows that farmers who produce pulses, usually sell to the cooperatives, local traders or processing companies and various players such as wholesalers and transporters are involved before pulses reach consumers. On the left-hand side of the diagram are the different stages (functions) of the pulses value chain. In blue are the actors in the value chain that are involved at each stage.

Figure 1 – Generic value chain of Pulses in India[7]

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[3] https://www.ifpri.org/publication/pulses-nutrition-india-changing-patterns-farm-fork

[4] http://dpd.gov.in/Technical%20Paper%20on%20Pulses%20JNKVV.pdf

[5] https://economictimes.indiatimes.com/news/economy/agriculture/india-on-track-to-become-self-sufficient-in-pulses-production-agriculture-minister/articleshow/74062730.cms?from=mdr

[6] Indian Institute of Pulse Research Indian Council of Agricultural Research, July 2015. https://iipr.icar.gov.in/pdf/vision_250715.pdf

[7] http://oar.icrisat.org/11707/1/Pandey%20and%20et.%20al._Pulses%20Value%20Chain%20Development%20in%20South%20Asia.pdf

Figure 2, shows that each actor in the value chain adds value and charges an “economic rent”. In most of the cases, the trader sells the farmer’s produce to a processor, who supplies a wholesaler, who supplies a retailer, who supplies a consumer, with transport and other links in between. The amount each actor in the chain receives varies between different products and value chains. But the price the farmer receives for his or her raw goods is only a small fraction of the price paid by the consumer.

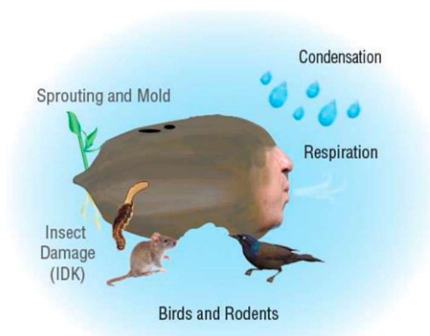
Figure 2: Simple linear value chain in India[7]


*Value added = price received by actor – price paid by actor

## 1.2 Process of drying and storage for harvested pulses

Pulses can remain in edible condition for several years, if properly stored. However, pulses are more difficult to store than cereals and suffer much greater damage from insects and micro-organisms. The storage losses are affected by several factors, which can be classified into two main categories: biotic factors (insect, pest, rodents, fungi) and abiotic factors (temperature, humidity, rain). Figure 3 depicts the various sources of dry matter loss faced by pulses in storage conditions. During 2016-17, the country produced 22.95m M/T of pulses and lost around 3.2m M/T (15% of the total production) in wastage[8]. This required the country to import 6.6m M/T of pulses worth INR 285 billion (US$4bn as per current exchange rate)[8]. Reducing the postharvest losses, especially in developing countries, could be a sustainable solution to increase food availability, reduce pressure on natural resources, eliminate hunger and improve farmers’ livelihoods.

Figure 3:Dry matter loss in pulses




Drying of pulses takes place immediately after harvesting, before threshing (pre-drying) and during storage and/or primary processing. Drying is an important post-harvest operation for safe storage, processing, and grain quality preservation. Inadequate drying results in excess grain moisture, and coupled with temperature favours microbial growth and enzymatic activity leading to degradation of grain quality. Drying and conditioning of pulses are mostly done by artificial methods; however, the most common drying method for pulses in the world is open sun drying, particularly at farm level. The most important advantage of sun drying is the low cost but there are several disadvantages which include prolonged drying time, high labour requirement, weather dependence and potential exposure to environmental contamination. Further, it is not always feasible to reduce the moisture content of grains to safe levels in the field, which necessitates the artificial removal of moisture from grains. In general, sun-dried products do not fulfil the international quality standards and therefore cannot be sold on international markets.

[8] https://agricoop.nic.in/sites/default/files/pocketbook_0.pdf

Figure 4: Relation of ERH or MC on activity of different organisms in stored pulses

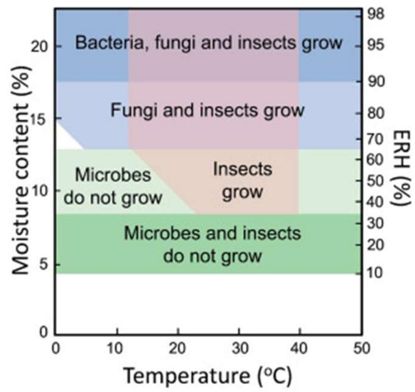


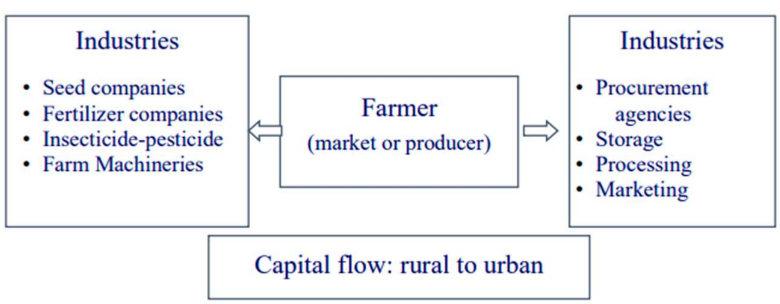

Figure 4 shows the relationship between Equilibrium Relative Humidity (ERH) or Moisture Content (MC) of the pulses and temperature on activity of different organisms[9]. MC and temperature are the most crucial factors affecting storage life. For long term storage ranging from a few months to a year, pulses should be dried to less than 13% moisture content (ERH below 70%) and stored at temperatures of less than 15°C under low relative humidity (less than 70%).

The storage of dried pulses is done in silos/warehouses, which require frequent inspection and insect fumigation to prevent losses due to biological organisms. The whole process is cumbersome and requires constant vigilance. More importantly, the pesticides do not guarantee 100% protection from the infestation if abiotic factors such as temperature and humidity are not controlled. Apart from nutritional and quantitative loss of pulses due to infestation, there is deterioration in quality in the form of discolouration due to high heat, darkening due to oxidation, broken/cracked/split/peeled seeds due to improper handling, sprouting due to high humidity, odour, and heat damage. Pulses respire (breathe) during storage which raises seed moisture and temperature, thus there is a need for automated and continuous control of temperature and moisture to maintain the quality of stored produce for longer durations.

## 1.3 Inefficiencies in the value chain of pulses

The present production scenario of pulses (Figure 5) shows that the farmer has either become a market for costly input or a supplier of cheap raw materials of pulses with monetary flow from rural to urban areas. Most of the time a discussion on doubling farm income ends with doubling production. But surplus production of agricultural commodities usually creates a glut-like situation in a particular season, and the producer does not get the due return for his or her inputs and hard work.

Figure 5: Present monetary flow in pulses production[7]




[9] https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/grain-dryers

Safe storage of pulses or grains can be an enterprising business and is a big part of the pulses value chain as quality is the most important factor that accelerates the competitiveness of pulses in the international, as well as domestic markets. However, penetration of cold storage with temperature and humidity control is low due to limited technology and high operational costs owing to erratic grid supply which requires use of diesel generators. This outweighs the benefits realised in the form of good quality and lower wastage. Traditional drying and storage methods are still extensive throughout the country despite the drawbacks because of lack of awareness about scientific storage techniques.

### 1.3 Hypothesis

To maximise the profit generated by famers, retain product quality and minimise food wastage, it is essential to aggregate and further store the pulses near production level. To enhance the efficiency in the value of pulses, it is important to store the produce that helps to maintain a balance between ideal harvest and marketing. More and more people are demanding organic food products which do not allow usage of fumigants and thus are more attractive to pests. Making pulses safe and suitable for transportation along with conservation of hygiene, quality, and nutritional value is possible only with a temperature and humidity-controlled storage facility.

A solar cold storage coupled with dehumidifier serves to be a one-stop solution to address value chain challenges of pulses at the village level which is predominantly affected by high wastage, inefficient drying and handling, frequent power fluctuations, and higher operational costs. These solutions have the potential to increase smallholder farmer income, improve the quality of grain, reduce post-harvest losses during transportation and storage, and augment value addition to improve the overall value chain.

### 1.4 Objective of the study

Inficold provided solar powered temperature and humidity controlled cold storage solution for the storage of pulses at a cooperative level. They were aggregating, storing, packaging, and marketing the farmer produce for an opportunistic time to get a better price. To understand the impact of having farm gate cold chain for the value chain of pulses, an assessment was conducted to study the following objectives:

- Assess the measurable impact of solar cold storage in reducing post-harvest losses and improving smallholders' income;
- Identify challenges in scaling the technology and provide recommendations for its proliferation.

## 2. Methodology

This report is based on a case study of an installation of a temperature and humidity controlled cold storage facility which is powered by solar photovoltaics panels. The system has the capacity of 35MT. It is owned and operated by Bandhalgati Self Reliant Cooperative in Dehradun district, Uttarakhand, India. A mixed-method approach, using quantitative and qualitative data was used for the study.

- Literature review was carried out to study the status of pulses value chain in India and the role of cold chain in it.
- Semi-structured interviews with three key informants from the cooperative was used to understand the institution level uptake of the cold chain as compared to the traditional solution. Furthermore, data available on energy efficiency, rates provided to farmers, benefits of using the cold storage, challenges, gaps, improvements needed, etc have been collected and documented.
- Semi-structured interviews were done with a smaller group of farmers who are associated with the cooperative to understand the increase in income, and individual-level impact.

## 3. Background

### 3.1 Inficold

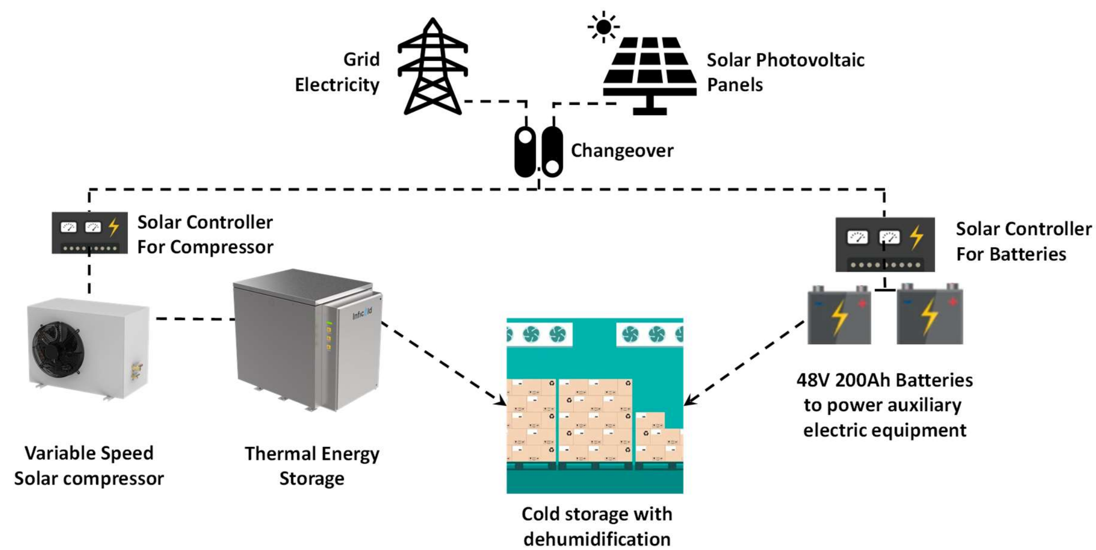
Inficold is a National Technology Award winning company making farm level cold storage efficient and inexpensive to own and operate. The solar cold storage technology is powered through photovoltaic (PV) cells and the generated solar energy is stored in the form of ice.

**Solar Cold storage with inbuilt dehumidifier for pulses**

Inficold's innovative solution uses solar energy to convert water to ice and maintains a temperature of $7^0$-$15^0$C and relative humidity of less than 70% at all hours within the storage room. Using ice to maintain the ideal temperature and humidity required for storage of pulses during non-solar hours eliminates the need to use diesel generator or lead acid batteries as a backup system. Traditional grid powered cold storage facilities on the other hand, require a continuous supply of electricity to maintain the ambient temperature of the cooling chamber. At the farm level, traditional grid based cold storage facility is not practical, mainly because of unreliable grid electricity.

The system installed at Bandalghati cooperative has storage capacity of 35MT and is powered by 7.6 kWp solar photovoltaic panels to operate the 3.5 TR cooling unit, dehumidifier, and other auxiliary electrical components. There is also a 3kVA grid connection provided as backup power and the system automatically switches over from solar to grid electricity in case of low thermal storage backup during non-solar hours. Figure 6 below shows the schematic diagram of the solar cold storage.

Figure 6: Schematic of solar cold storage with in-built dehumidifier




Inficold cold storage facilities provide the option to store produce in either containerised units or indoor cold rooms. The containerised units are quickly deployable, require minimal civil work at the site and can be mobilised and re-installed at other locations during the off-season. The solar integration technology for cold storage was jointly developed in partnership with the National Institute of Solar Energy, the autonomous institute under the Ministry of New and Renewable Energy, Government of India.

The advantages of Inficold solar cold storage include:

- Flexibility of site selection without the need for grid electricity;
- No need for large electric battery banks which have expensive recurring costs and also a challenge to dispose of for environmental reasons;
- Grid electricity or diesel generator can be used as an alternative source of power to operate the solar cold storage in case of prolonged rainy season when sunshine hours are much lower than the average;
- Retrofittable solution for existing cold storage facilities;
- In-built dehumidifier reduces the requirement of external drying in case of pulses, grains and millets;
- Modular design of ice-backed cooling results in system size flexibility in the range of 5-100 MT.

## 3.2 System ownership

Bandalghati Self Reliant Cooperative (SRC) was established in 2019 and has a membership base of 268 entirely women farmers. It is in the Dehradun district of Uttarakhand. The cooperative serves to anchor 12 other self-reliant women cooperatives called sister SRCs. Each of these sister SRCs have around 200 all-women farmer members associated with them. The profile indicates that around 40% of the members are under 35. Bandalghati SRC operates the cold storage as a business model where the farmers sell their crops to the cooperative while it, in turn, does value addition, processing, packaging and sells it during the time when it is likely to get a better price.

Himmotthan society – an associate organisation of Tata Trusts – promoted an active community engagement in Bandalghati SRC through institution building initiatives. A Community Facility Centre (CFC) was established by the cooperative to support smallholders in the production, aggregation and marketing of pulses cultivated in the Raipur region near Dehradun. The collective model supports the pulses value chain for the catchment villages associated with the SRC within a 30km radius. Storage of pulses in ventilated areas was resulting in 15% of the quantity being lost post-harvest. The cooperative also procured a solar dryer two years ago to reduce the moisture content, but it was cumbersome to operate and was not able to address the challenges associated with increased moisture level in the storage facility – especially during the rainy season. The cooperative explored various possible options to maintain cold and dry conditions for storing the produce for 5-6 months after its harvest. The grid based cold storage backed with a diesel generator was not an option owing to high operating costs and maintenance. These traditional systems were also not able to maintain the humidity at less than 60%. Therefore, the cooperative procured Inficold's solar cold storage unit costing INR 11,00,000 (~US$15,000) through a grant supported by Sustain Plus.

# 4 Findings

## 4.1 Profile of farmers

The system is installed at a location where in the nearby region, 2,000-2,500 farmers are directly involved in the farming of pulses. The farming is done in a hilly terrain and the average land holding of farmers is about 1.13 acres. As part of the assessment, 32 farmers associated with the cooperative have been interviewed; all of them women with an average age of 33. The typical landholding of the interviewed farmers is around 1-1.5 acres. The cold storage is 30km away from the farmers' village. While the farmers have multiple income sources, agriculture contributes to 35% of the total income. An average farmer income is INR 20,000 annually from agriculture at baseline.

The average, maximum and minimum production per annum by the group of farmers under assessment is 0.4 tonnes per annum, 0.2 tonnes per annum and 0.5 tonnes per annum respectively.

## 4.2 System usage data

The area of installation faces occasional power outages and low voltage supply issues and a few instances of electricity breakdowns during rainy storms have also been occurred. The nearest storage facility available was 50km from the installation site and was commodity-specific to potatoes. In addition, the facility does not provide humidity control. The cooperative was using closed rooms to store the organic pulses procured from the farmer members.

Inficold dehumidified air cold storage solution was set up at the Dehradun centre of Bandalghati SRC on 21 December 2020. Crops stored are rajma, black soybean, horse gram, red rice, long grain rice, black gram, finger millet (Maduwa), barnyard millet (Jhamgora), pigeon pea, and amaranth millet. The cold storage was 100% in usage for nine months from August-April during which these crops were stored. During the lean season, potatoes were stored on a trial basis. Since the inception of the cold storage, 35MT pulses were stored for an average of 270 days and 1MT of potatoes stored for an average of six weeks.

268 farmers have been able to benefit from the installation based on the limited capacity of the cold storage system. The stored produce is distributed to the bigger cities at a remunerative price after the primary processing like sorting, grading, and packaging of pulses. The cold storage unit was playing a pivotal role to conserve the quality of the organic pulses to proceed further in the value chain to reach the consumers.

## 4.3 Benefits of the solar cold storage

The following advantages have been identified since its usage:

- The wastage of stored pulses has been brought down to 2% (from 15% earlier). Apart from reduction in the crop loss, the quality of the stored pulses does not degrade even after prolonged storage of over nine months. This has helped the cooperative to get better prices for the same produce and a peace of mind for the farmers who are assured of their returns.
- Before cold storage, the average farmer was earning INR 20,000 per annum through pulses. With installation of the solar cold storage facility at the cooperative level, the income of the farmers increased by 10-15% due to reduced losses and better price realisation by improved quality. Value addition at the producer level helped in better price realisation to farmers, elimination of multiple stakeholders and lower wastage of the production. This creates a win-win situation for both the farmers and the consumer, making farming and farmers' growth sustainable.
- With the implementation of the cold storage facility, average annual income of the cooperative has increased by 24% to attain a value of INR 1.9 million. The annual profit realised by the cooperative due to the intervention is INR 2,50,000.
- In addition, the sister SRCs of the cooperative who collect pulses from nearby regions and supply them to the centralised cooperative for value addition, were able to increase their annual revenue by 24% to attain a value of INR 4,00,000. Average annual profit realised due to the intervention, by each of the 12 sister SRCs associated with the Bandalghati cooperative is INR 10,500.
- Combining the overall savings of the centralised and sister cooperatives, the system payback can be achieved within three years[10].
- The annual energy bill of the centralised cooperative has decreased from INR 50,000 to INR 21,000 after the installation of solar powered cold storage solution. Based on weighted average data of grid emission factor for the year 2018-19, 1 kWh of grid electricity in India produces 0.82 kg of $CO_2$[11]. Using these references and the primary data collected on energy usage for a year, the Inficold solar cold storage with dehumidification system has reduced the annual emissions of the facility by 2.9 MT $CO_2$[12].
- With the availability of cold storage, usage of pesticides during storage has been eliminated and the cooperative can now market the produce under the organic category. Organic produce fetches a better price in the market and overall a healthy and quality product reaches the end consumer.
- The reduction in food wastage by 4.55 MT per annum has prevented emission of 8.6 MT $CO_2$ in a year[13].
- A larger number of farmers are now motivated to increase the production of pulses, which is an urgent need for meeting the demand of India, improving national food security and reducing the dependence on imports.

## 4.4 Challenges

Some of the challenges involved with the intervention are:

- The system is currently utilised for about nine months to store pulses. The cooperative is storing potatoes on a trial basis for the other three months. After evaluating the trial results, potatoes may be stored inside the cold storage during the lean season of pulses to increase the system utilisation.

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[10] Payback period = Cost of the system / (Profit of centralised cooperative + Profit of 12 SRCs) = 11,00,000/ (250,000 + 12*10,500) = 2.9 years

[11] https://cea.nic.in/cdm-co2-baseline-database/?lang=en

[12] Energy cost = 8 INR/kWh. Energy usage before cold storage = 50,000/8 = 6,250 kWh. Energy usage after solar powered cold storage = 21,000/8 = 2,625 kWh. Total savings in energy = 3,625 kWh. Savings in emission = 0.82*3,625 = 2972 kg $CO_2$

[13] 1.9MT $CO_2$ emission reduction per ton reduction in food wastage. Reference - https://watchmywaste.com.au/food-waste-greenhouse-gas-calculator/

- The storage capacity limits participation of additional farmers. The ideal scenario is that similar cold storages are set up and made available at the village or block level to strengthen the existing value chain process and ensure higher returns to the producers.
- The system is single chamber design. It is desirable to have multiple chambers at this location to utilise the storage facility for different commodities including fruits and vegetables. Inficold's current design of solar cold storage is available in multi chamber format with individual temperature control for each chamber to enable multicommodity storage.
- There is a lack of financing provisions by banks where the cold storage acts as a collateral. In the current scenario, the end user needs to provide collateral as land and personal guarantee of the board members in the form of cancelled cheques to obtain loans from financing institutions.

# 5. Conclusion and Recommendations

Technology interventions and improved storage structures can play a critical role in reducing postharvest losses and increasing farmers' revenues. Value addition plays an important role in increasing returns from agriculture and farmers can utilise this opportunity with the help of drying and storage of pulses during harvest season. Pulses like other agricultural commodities has high price volatilities, and the price is especially low during the harvest period. Pulses have higher shelf life than fruits and vegetables and can be sold 3-4 months after harvesting by the smallholder farmers to ensure better returns. Unscientific storage practices at households, farms, and warehouses contribute to the losses. Farmers, traders, and processors need to be trained in scientific storage practices, and scientific bulk storage facilities need to be developed.

The storage of pulses in temperature and humidity-controlled environment is quite limited across India. This impact assessment asserts the successful implementation of cold chain for pulses. One of the unique value propositions of the Inficold solution is in-situ drying of the pulses, which eliminates the additional requirement of manual drying and later storing the commodities in the cold storage. Temperature and humidity-controlled storage creates an automatic modified atmosphere which significantly reduces insect infestation losses, rodent losses, quality degradation in the form of discoloration and heat damage etc. The system has been utilised for one year, and the data suggests 95% reduction in wastage from post-harvest losses, 10-15% increase in income of total 268 all women farmers and 24% increase in revenues of the cooperative year-on-year. The total monetary benefit realised by the farmers and cooperative due to implementation of the solution in one year is INR 6,70,000 and INR 3,76,000 respectively.

There exists the primary challenge of financing the cold chain equipment. One possibility is to engage with the bank to provide guarantee on the buyback of the equipment in case of payment default. Another possibility is to build and operate cold chain where farmers can store agriculture commodities via renting and have the freedom of where to sell and to who. Farmers can be connected to the buyers through an online marketplace. This also brings transparency in quality, quantity, and transaction for both the buyers and sellers. However, setting up of rental cold storage facilities is an operationally intensive job which requires daily ledger maintenance, product labelling/tagging for identification, product traceability for efficient operation of storage and food protection from temperature fluctuations or other damages. Inficold, being a manufacturing organisation, lacks the expertise in cold storage operation and marketing of food produce. Inficold has started actively working with companies who are engaged in providing rental services of cold storage at the farm gate. It will enable a wider ecosystem of creating local entrepreneurs who would like to adopt cold storage service as a business across India. Using better agricultural practices and adequate storage technologies can significantly reduce the losses and help in strengthening food security and poverty alleviation, increasing returns of smallholder farmers.