

## Traditional methods for vegetable and grain storage in Leh district of trans-Himalayan Ladakh

T Tsewang<sup>a</sup>, S Acharya<sup>b,\*</sup>, A Mishra<sup>a</sup>, K Kumar<sup>a</sup>, V C Verma<sup>a</sup>, V K Tiwari<sup>a</sup> & Avantika<sup>a</sup>

<sup>a</sup>Agriculture Research Unit, Defence Institute of High Altitude Research (DIHAR), DRDO, Union Territory of Ladakh 194 101

<sup>b</sup>Defence Research Laboratory (DRL), DRDO, Tezpur, Assam, India

\*E-mail: someniari@gmail.com

Received 31 March 2021; revised 07 July 2022; accepted 01 August 2023

Cold, arid and high-altitude regions of Ladakh are exceptionally unique in the world and are characterized by extreme temperature variation, thin atmosphere with high UV radiation and less oxygen availability. Cultivation is not viable in Ladakh during the winter due to sub-zero temperatures, resulting in a severe shortage of fresh vegetables and an unbalanced diet. To combat the scarcity of fresh vegetables during the region's harsh winters, farmers have developed low-cost traditional methods for storing vegetables such as potato, cabbage, onion, radish, carrot, and grains such as wheat and barley that are compatible with the region's ecological and socioeconomic conditions. Indigenous knowledge and techniques are extremely valuable in the daily lives of Ladakh natives. In this study every traditional storage method been investigated from Leh district of U.T Ladakh. Hilly areas suffer various climate issues in the present scenario; thus, it is critical to promote the traditional strategy for sustainable agriculture and food security. This study discusses prevalent storage structures of Ladakh region such as *Pang-Nga*, *Sadong*, *Tsodbang* for keeping vegetables like potato, radish, carrot, cabbage, and grains. *Charches*, *Thingches*, and *khygches* method especially designed for winter storage of onions.

**Keywords:** Grains & vegetables, Ladakh, Traditional methods, Winter storage

**IPC Code:** Int Cl.<sup>23</sup>: A01F 25/00

Ladakh, also known as Little Tibet or Red Land (Maryul), is located in the northernmost part of India at an altitude of 3527 m above mean sea level in the Ladakh range between 32°5'- 36°N and 75°5'-80.5°E<sup>1</sup>. Union territory of Ladakh, the territory of the union consists of two districts, Leh and Kargil. The districts are bounded on the west by Pakistan, on the north and east by China, and on the south by Himachal Pradesh<sup>2</sup>. The region is considered to have a cold desert climate, characterized by intense temperature variations from -30 to +30°C, limited precipitation, mostly in the form of snow, high wind strength, and low plant density, a thin atmosphere of 6-7 Kwh/sq m with high UV radiation and a fragile ecosystem<sup>1</sup>. Ladakh faces development challenges that are unique to the region. The mountain walls separate it from the rest of India and its neighbouring territories, allowing access only through challenging passes normally situated around 4400 metres above sea level<sup>3</sup>. The district Leh has a reporting area of 45167 hectares, of which 10542 hectares have been

cultivated according to revenue department village papers (2016-2017)<sup>4</sup>. Because of heavy snowfall, the trans-Himalayan Ladakh area remains cut-off for six months a year. Extreme winter restricts cultivation in an open state all year long. Agriculture production is restricted only during summer season (April to October). In the winter months, the supply of fresh vegetables declines dramatically, resulting in an unbalanced diet. Seasonal shortages and poor diet diversity among the local population contribute to deficiencies in micronutrients, a phenomenon described as 'Hidden Hunger'<sup>5</sup>. Vegetables and grains cultivated during summer season have to be stored for consumption during extreme winters. In early days with its strong social structure to sustain the agriculture system, production in Ladakh was high enough to feed the whole population with its conventional techniques appropriate for local climatic conditions. Local people of an area have unique wisdom and understanding about the consumption and storage of their food products<sup>6</sup>. Since ancient times, people used to rely primarily on crops such as wheat, barley, and potato in Ladakh. Also, for winter

\*Corresponding author

purposes, people often store dried leafy vegetables and dried milk products called "*Churpay*". Vegetable consumption and storage information has been passed down from generation to generation, allowing conventional knowledge to expand<sup>7</sup>. It has been a part of the conventional method to store vegetables such as potato, onion, radish, turnip, carrot, and cabbage for winter use using different local methods; the storage methods include above ground, underground and semi-underground storage<sup>8</sup>. The passive storage facility has been playing an important role in the food chain of Ladakhi farmers. Traditional storage systems for vegetables and grains in and around Ladakh region must be promoted, and they can be enhanced with proper scientific input. In this article various age old traditional vegetables and grain storage structures of Leh district of trans-Himalayan Ladakh region have been explored, studied, analyzed and discussed in details.

### Methodology

The survey was carried out in the Union territory of Ladakh, Leh district (77°45'06.34' E, 34°2'35°.6' N). This survey covers Shey, Thiksay, Nang, Tigger and Sasoma (Nubra) villages of Leh district. Visits were performed based on prior information provided by farmers from several villages, and feedback was recorded from a group of older farmers as well as individual farmers. The purpose of the trips was to understand the age old postharvest management techniques that are prevalent in the region, the technique that has been adjusted with the climatic condition in the region. Special visit to Sasoma area in Nubra was to learn about the *khyg-ches* method of onion storage, which is unique in the world. Traditional vegetable and grain storage systems have proven effective and popular since decades. Farmers used to grow vegetables for both personal and commercial purposes. Ladakhi smallholders described a general improvement over the past decades in terms of food quantity and diversity<sup>9</sup>. During the harsh winter months, the best way to get vegetables is by storing locally farmed surplus vegetables for off-season use (Fig. 1 & 2).

### Results and Discussion

Local farmers use locally grown cereals and vegetables that are stored conventionally during the winter season when the region is cut off due to significant snowfall<sup>10</sup>. Drying, canning, curing, salting, freezing, and conventional storage are the five



Fig. 1 — Taking input from the farmers about various storage methods of vegetables



Fig. 2 — Farmers selling their stored vegetables in the local market of Leh during extreme winter months

methods for storing vegetables and fruits<sup>4</sup>. The method employed is determined by the type of produce and the storage facilities available. The most broadly adopted conventional storage methods for keeping vegetables and cereals in District Leh of U.T Ladakh are explained in detail and depicted in Figure 3.

#### *Pang-Nga* (indoor storage)

*Pang-Nga* used to be the most convenient place to store grains. Barley or Grim, which is locally known as '*nas*' is one of the most important staple crops of Ladakh. The main crops grown in the region in past were barley, wheat, other grains, and nonfood crops,

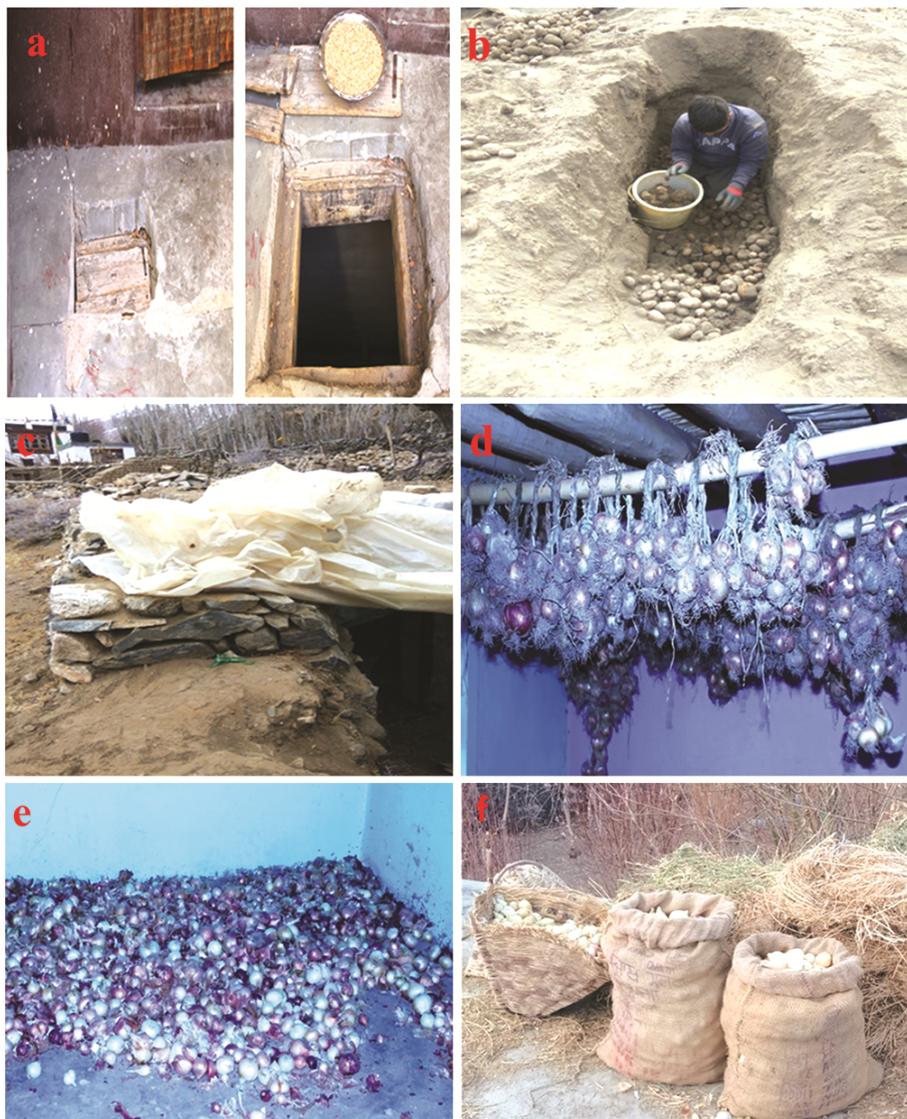


Fig. 3 — Traditional storage structures for winter storage of vegetables and grains (a) *Pang-Nga* (indoor storage); (b) *Sadong* (underground pit); (c) *Tsothbang* (cold cellar); (d) *Charches* (hanging); (e) *Thingches* (spreading) & (f) *Khyg-ches* (freezing) adopted by Ladakhi farmers.

which mainly consist of fodder crops, especially alfalfa. Traditionally, every house in Ladakh has *pang-Nga*, which comprises of a rectangular structure having dimension around 3×2×6 ft. The structure is built in the basement; a small opening is kept for the inlet and outlet of grains as shown in Fig. 3a. Due to its long shelf-life grains can be kept in *pang-Nga* for a longer duration.

#### ***Sadong* (underground pits)**

In this method, a pit is dug in the same field as the vegetables are produced, usually in a well-drained location. This method of creating pits has no costs, requires minimal labour, and is environmentally

friendly. The pits are conical in shape and vary in size depending on the volume of vegetables grown<sup>1</sup>. In the winter, farmers use these structures to store hardy vegetables like cabbage, carrot, turnip, radish, and beet. Because soil temperature does not fluctuate much and remains cold compared to air temperature, keeping the veggies in underground pits and covering them with layers of soil creates favorable conditions for vegetable storage for around 4-5 months in a natural atmosphere (Fig. 3b).

#### ***Tsothbang* (cold cellar)**

The underground or partly underground buildings that are used to store root vegetables are often referred

to as root cellars and they are locally called as 'Tsothbang'. This includes preserving harvested produce in a darkened, underground cold region in a natural state of low temperature and humidity. According to local farmers there is little temperature variations inside the underground structure, thus keeping the temperature ideal for vegetable storage for about 5-6 months. Tsothbang is a multi-sized rectangular structure (Fig. 3c).

Method of construction of *Tsothbang*: Digging the earth with an average dimension of 20×15×5 ft (L×B×H), stacking along walls with rock bricks. Farmers use native dry poplar trees and their twigs as cladding material to erect a shelter over the cellar. The store has narrow entrance doors and lightweight wooden windows for ventilation.

#### ***Phay-Khang or dZod (above ground store)***

*Phay-khang* literally translates to "where farmers store their barley or wheat floor." The store is rendered above ground adjacent with the main rooms or supplementary rooms are utilised. The roof is clad with wood cladding, while the store is composed of mud bricks. Farmers preserve onions for five to six months in such scenarios (Fig. 3d). Farmers keep their onions in the same place where they keep their flour. There are several traditional methods followed for preserving onions in Ladakh, each have their own set of benefits and drawbacks, which have been illustrated and described below

#### ***Charches (hanging)***

The method of hanging is locally called as *Charches* and commonly used to store onions. In this procedure, onion after harvesting cured for 10-15 days in the month of October. A cluster of onions with their semi dried leaflets are hung from the ceiling of the store/basement area (Fig. 3d). For hanging reasons, long wooden poles are connected to the ceiling. The method is a little time-consuming since it takes time to tie each onion leaf into a bunch, and big quantities of surplus cannot be stored because they take up a lot of space in the store.

#### ***Thingches (spreading)***

The mechanism of spreading is known as '*Thingches*' in the Ladakh region. Properly cured onions are distributed on the floor of the basement cold closet called '*Phay-Khang or dZod*' in this ancient way. Spreading of the onion bulb allows appropriate ventilation to each and every onion bulb by reducing contact with each other (Fig. 3e).

According to some farmers, spreading is the safest technique to store onions, without that spoiling or sprouting can happen. The major disadvantage of this storage technique is that onions cannot be preserved in bulk in this condition.

#### ***Khyg-ches (freezing)***

*Khyg-ches* means "freezing." A common and very desirable way to preserve certain types of garden produce is through freezing. One large advantage of freezing is that the nutritional quality remains relatively good, plus food can be kept for many months with little change in colour<sup>11</sup>. The cured onion is placed in Gunny bags and Tse-poo (traditional local straw baskets) (Fig. 3f) and placed on the roof in a shady location, covered with cloths or dried alfa-alfa. The goal of putting onions on the roof could be to provide adequate aeration, as onions require aeration when stored; moreover, when onions are kept open and frozen, the chances of fungal attack are considerably reduced. Farmers place onions in a shaded area to prevent moisture loss because onions contain about 90% water. Farmers consider that touching the onion will spoil it, therefore the onion needed for cooking is withdrawn from the gunny sacks and tse-poo without disturbing it. This type of storage is prevalent in the Nubra valley of Ladakh.

### **Conclusion**

Local farmers in the Ladakh region have been storing vegetables and grains using traditional methods for a very long time. They have devised low-cost indigenous methods for storing vegetables and harvests to meet the demand during winter months. These methods reduce post-harvest losses and meet the demand for vegetables and grains to some extent for locals of Ladakh region during extreme winters. These local storage methods are effective and to make them more efficient, scientific approach is need of the hour for enhancing shelf life, reducing spoilage and long term storage of vegetables and grains.

### **Acknowledgement**

The authors are grateful to the local farmers of Thiksay (Tashi Namgail Shingkhon), Shey (Dorjay Konyak), Nang (Tsering Khangpa-kongma), and Tigger, Nubra (Tashi Hilbee) Ladakh for their assistance in providing relevant knowledge on traditional storage; without their help, the manuscript

would not have been possible. We are grateful to DIHAR-DRDO, Leh, for all the assistance throughout the village survey.

### Conflict of Interest

Authors have no conflict of interest.

### Authors' Contributions

The idea was originally conceptualized and developed by SA. The experiment was conducted by TT with support and assistance from KK, AM, VT in field operations and data collection. The manuscript was skillfully edited and processed by VV and A, who contributed their expertise in refining the content. Throughout the process of writing the manuscript, SA, SK and TT took the lead, incorporating critical feedback and valuable insight from all the contributors involved in the project.

### References

- 1 Raghuvanshi M S, Dorjay N, Singh R K, Manjunatha B L, Moharana P C, *et al.*, Ladakh traditional farming: An approach to resource utilization under changing climate, *Int J Curr Microbiol App Sci*, 8 (9) (2019) 654-666.
- 2 Day S, Himalayan Buddhist villages: environment, resources, society and religious life in Zangskar, Ladakh, (Edited by John Cand Henry O), University of Bristol, *J R Asiat Soc*, 6 (2) (1996) 281-282.
- 3 Singh H, Ladakh: problems of regional development in the context of growth point strategy, Doctoral dissertation, (Jawaharlal Nehru University), 1978.
- 4 Anonymous, Statistical Handbook for the year 2016-17, District statistical and evaluation agency, Ladakh Autonomous Hill development council (LAHDC) Leh, Government of India, 2017.
- 5 Angmo P, Dolma T, Namgail D, Tamchos T, Norbu T, *et al.*, Passive solar greenhouse for round the year vegetable cultivation in trans-Himalayan Ladakh region, India, *Def Life Sci J*, 4 (2) (2019) 103-116.
- 6 Jabeen T, Akhtar A, Shah A H, Khan K R & Farooq M, Qualitative and quantitative ethnobotanical evaluation of plant resources of Kiwai, Kaghan valley, district Mansehra, Pakistan, *Indian J Tradit Know*, 20 (1) (2021) 141-153.
- 7 Kale S J, Nath P, Jalgaonkar K R & Mahawar M K, Low cost storage structures for fruits and vegetables handling in Indian conditions, *Indian J Hort*, 6 (3) (2016) 376-379.
- 8 Ali Z, Yadav A, Stobdan T & Singh S B, Traditional methods for storage of vegetables in cold arid region of Ladakh, India, *Indian J Tradit Know*, 11 (2) (2012) 351-353.
- 9 Dame J & Nüsser M, Food security in high mountain regions: Agricultural production and the impact of food subsidies in Ladakh, Northern India, *Food Secur*, 3 (2) (2011) 179-194.
- 10 Chorol S, Angchok D, Angmo P, Tamchos T & Singh R K, Traditional knowledge and heirloom root vegetables: Food security in trans-Himalayan Ladakh, India, *Indian J Tradit Know*, 17 (1) (2018) 191-197.
- 11 Kumar K, Cold preservation and processing, In: Food Processing and Preservation, Scientific Publisher, 2020, p. 23-35.