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Indigenous methods of grain storage followed by the *Lepcha* and *Limbo* tribes in the Himalayan tract of Sikkim

Amrit Lamichaney*[,1,+], Pradeep Kumar Chettri[2], Anirban Mukherjee[3], Aniruddha Maity[4&5] & Kumari Shubha[6]

[1]ICAR – Indian Institute of Pulses Research, Kanpur 208 024, Uttar Pradesh, India
[2]Government Agriculture Farm, West Sikkim 737 121, India
[3]Social Science Section, ICAR – Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand 263 601, India
[4]Department of Soil and Crop Sciences, Texas A&M University, Texas, USA 77843
[5]Division of Seed Technology, ICAR – Indian Grassland and Fodder Research Institute, Jhansi 284 003, Uttar Pradesh, India
[6]Germplasm Evaluation Division, ICAR – National Bureau of Plant Genetic Resources, New Delhi 110 012, India

E-mail: [+]amritiipr@gmail.com

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Since time immemorial, seed has been stored through indigenous methods as per people's convenience and access to contemporary technologies. Thus, indigenous traditional methods have become essential component of sustainable agriculture and it varies from region to region. However, with modernization, urbanization and the associated technological breakthroughs, the indigenous technologies have been eroded and are not passed on to next generation. In the present study, attempt has been made to identify some of the traditional methods and associated knowledge called Indigenous Traditional Knowledge (ITK), linked to storage of seeds and grains followed by the people of Sikkim, the organic state of North-eastern India. ITKs were collected from 04 villages of east district and 02 villages of west district of Sikkim. Total of 06 (*bhakari, kotha, jhutta, dalo, chindo* and *dhikuti*) traditional storage structures were identified which are commonly used by the people of Sikkim to store grains. Utilizing the locally available materials people has designed their own eco-friendly and safe storage structures for storing grains.

Keywords: Indigenous traditional knowledge, Seed, Sikkim, Storage structures
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In the North Eastern states of India (NE) agriculture is traditional, which depends mainly on ITK that has been acquired by people over time immemorial. ITKs are usually followed by the people of NE in day to day life, may it be in agriculture, animal husbandry, seed/grain conservation or storage, medicines, food, etc. It has been mixed so well with their culture that it has become a culture itself. Among the states, Sikkim has acquired organic state status which would not be possible without the rich traditional knowledge base. In Sikkim, farmers possess very small land holdings. The produce is used mainly for household consumption and planting for next year. Therefore, the role of indigenous storage structures is immense, as most of the farm produce are stored at home. Due to the specific terrain, hilly tracts and characteristic environmental conditions, it is very difficult to cultivate crops and get a profitable yield from these hilly regions. Also due to the slopes and small land holdings, farm mechanization becomes arduous. Owing to the heavy rainfall (2731 mm annually) it becomes difficult to store the grain for a season or two safely. In India, it is estimated that about 60–70% of food grain produced are stored at traditional homemade structures that involves bamboo baskets to mud structures, gunny bags and modern bins[1]. One of the commendable accomplishments achieved by the farmers and farming community over time is the development of innovative structures where the grains/seeds can be successfully stored devoid of the storage pests, insects and rodents. The storage needs of small scale farmers have always been fulfilled by indigenous structures crafted and designed by farmers with easily and cheaply available materials.

Though the mechanized and modern mode of agriculture have occupied most part of India, the ITKs are still playing a pivotal role in promoting the sustainable and low-input agriculture in the resource–poor parts of the country. Seed of acceptable quality is an important input in agriculture, which is not an

*Corresponding author

exception in any system of agriculture worldwide. People of the tribes in Sikkim had felt this need long before and had been instrumental in developing and reshaping indigenous storage structures to maintain good quality seed for years without using pesticides. The detailed information on the storage structures (or of same kind) is a wealth of the tribes and the human kind as well, which needs urgent documentation. Documenting the traditional knowledge, which is sustainable and environment friendly, has gained significant attention in recent years across the world owing to their importance for a community and the people worldwide[2,3]. Managing and documenting indigenous knowledge will not only safeguard but also expose the hidden treasures of the region that the rest of the world might not know before. The indigenous storage structures of other parts of India have been documented earlier[4,5,6,7,8,9,10]. With the inquisition that how in an organic state like Sikkim, people are conserving seed through traditional seed storage structure, we formulated this study. The literature review revealed only a few and scattered information available on the indigenous storage structures that existed in Sikkim. Therefore, the present investigation was conducted to identify and document the existing traditional storage structures available in hilly tracts of Sikkim.

Methodology

Study area

Sikkim, a tiny state of India, which has an area of 7096 sq. km, stretches over 112 and 64 km from north to south and east to west, respectively. This Himalayan state falls between 27.45° N to 28.9° N latitudes and 87.59° E to 88.60° E longitudes. It constitutes about 0.05% and 0.22% of the total population and total geographical area of the country, respectively. Sikkim is situated in a geographically important location where it shares number of international borders, like with Bhutan in the east, China in the north and east & Nepal in the west and the Indian state of West Bengal in the south. Sikkim experiences subtropical climate in the south while north experiences tundra climate. However, the inhabited region experiences a temperate climate, with temperature below 28°C in the summer. Mean annual temperature of Sikkim is around 18°C. Sikkim is a multi-cultural society inhabited by a multiple cultural-linguistic groups of which the *Lepchas* (*Rongs*/*Monpas*/*Rongkup*), the *Bhutias* (*Denzongpas* /*Lhopas*) and the *Nepalis* (*Gorkhas*/*Paharias*) are the prominent communities.

The *Lepchas* also called as '*Monpas*', '*Rongkup*', '*Rong*', which means 'the son of the snowy peak'[11]. The origin of Lepchas are not clear, some believed they have migrated from Assam and Upper Burma[12,13], while others believe that they originated from southern Tibet[14]. Amidst obscurity and contradictory views on their origin and history, *Lepchas* very proudly consider themselves as autochthones of Sikkim. They have their own language and perhaps the oldest among the languages used in hills. However, the origin of this oldest language remains a mystery. The *Limboo* or *Subba* are indigenous to hill or mountain regions. They are the earliest inhabitants of Sikkim[15,16]. It is believed that the state got its name Sikkim from two limbo words, *i.e.,* 'Su' meaning new and 'Khin' meaning a house or a place. Etymologically, the term '*Limboo*' means 'archer' or 'bow shooter'. The Subbas belong to the Kirata tribal family[17]. There are supposed to be originated from Tsang province of Tibet. *Limbo* people have been known for the simple and primitive life. They generally practice subsistence farming, collect edible wild crops from rich biodiversity of Sikkim. Rice and maize are the main crops they grow.

This study was undertaken in 04 villages, *viz.,* Sumik, Badongthangsing, Lingzey and Lindong of east district and 02 villages, *viz.,* Daramdin and Thambong of west district. Mainly *Lepcha* and *Limboo* farmers were interviewed to explore their vast traditional knowledge in seed storage related ITKs.

Methods

The survey was conducted during April-August 2018 by utilizing a semi-structured interview schedule. Participatory Rural Appraisal (PRA) tools were used for the data collection to identify and gather information about the indigenous grain storage methods prevalent in the study area. Key informants belonging to all categories of tribal farmers (small, medium and large categories) were interviewed. During the data collection process mainly personal interview and focused group discussions methods were conducted to get precise information on grain storage linked with their culture. During visit to their house personal observation method was followed to verify the real methods of documented seed storages. During the survey, triangulation exercise was also done to enhance the reliability of information gathered during data collection.

Results and discussion

Most of the storage structures in Sikkim, especially in the rural areas are made entirely of bamboo or in

combination with mud, wood, wheat straw, cow dung, etc. Preference of bamboo over other modern materials may be due to the abundant availability and low cost of these raw materials. India is the second largest bamboo growing country next to China. Out of the total bamboo production, 66% comes from the NE region[18,19] where Sikkim contributes the major part having 82.31% of the total area under vegetation. This tiny state alone has about 30 species of bamboo spread across the state[20]. The main base of economy of the state has been agriculture. The materials and techniques used by farmers are mostly based on the concepts of organic farming. Therefore, people of Sikkim still use various kinds of traditional grain storage methods, without using any chemicals. The details of these traditional grain storage structures are as follow.

***Dhikuti*:** *Dhikuti* means 'storage' (in Nepali). *Dhikuti* is a four-sided box or bin built of wood, which has a wooden lid, built inside the house, often utilizing one or more of the existing walls (Fig. 1). The capacity is variable and can store about 300–400 kg seed or grain. Most households have more than one *dhikuti*. These are commonly used for storing rice, but they are used to store other grains as well. *Dhikuti* is a long term method of storage. It is one of the preferred methods of storage in Sikkim because of few advantages. The humid weather is not suitable for post–harvest storage and *dhikuti* prevents the moisture flux into the seed/grain from the surrounding air. It protects the seeds by maintaining dryness. The lid, additionally, checks the invasion of rodents and insects to the storage.

***Bhakari*:** A woven bamboo mat rolled into a cylinder and placed on one end, on a mat (Fig. 2). The base consists of rice straw smeared with cow dung. *Bhakari* may be large, medium or small depending upon the quantity of the grains to be stored. They may or may not have lids made of straw. They are plastered with cow dung or mud, which not only makes it waterproof but also inaccessible to rodents and insects. It has a durability of about 4 to 5 years with careful maintenance. Paddy seeds are commonly stored in *bhakari*.

***Kotha*/*Kothe*:** *Kotha*/*Kothe* is similar to *bhakari* but with the woven bamboo base. The circumference of this storage unit is plastered with mud lining or cow dung. *Kotha*/*Kothe* can be of various sizes (Fig. 3), usually 3–4 ft in height with a capacity of holding about 1.5–2 q of seeds. It would normally take two to three days to weave a *Kotha*/*Kothe* of above mentioned height. After it is woven, the structure is smeared with cow dung or mud to seal the holes for safe storage of seed/grains. *Kotha*/*Kothe* has a durability of about 3–4 years. Seed/grains of paddy, buckwheat, soybean and urdbean are usually stored in *kotha*/*kothe*.

Chindo: *Chindo* is another indigenous practice of small storage in Sikkim, wherein the seeds are stored

Fig. 2 — Bhakari

Fig. 1 — Dhikuti; closed (A), open (B)

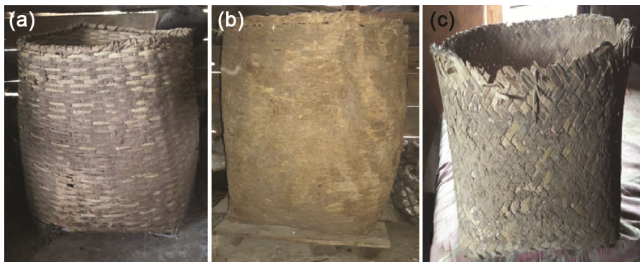

Fig. 3 — Kotha

in dry and emptied shell of gourds (Fig. 4) especially bottle gourds and ash gourds. The process involves harvesting of matured gourds and removing the outer soft parts, cleaning and drying in a well ventilated area to avoid rotting. These are then sundried till it is thoroughly dry. One would know that the gourd is ready to be used as a storage unit, once it feels light and sounds hollow when tapped. It usually takes 06 months to over a year to be completely dry and purposeful. Using a saw, the top of the gourd is chopped and the seeds and the fibrous materials inside the gourd are removed carefully. Thereafter, the seeds to be stored are placed inside the empty gourd and are covered with a lid and are made airtight. The seeds can then be stored successfully for 2–3 years**.** *Chindo* is used to store seed/grains of vegetables, black gram and green gram. Bottle gourd is one of the first cultivated plants in the world, which were primarily grown for use of dry shells as water containers and not for food[21].

***Jhutta*:** *Jhutta* (in Nepali) literally means to tie in bunches. So anything that can be tied in bunches and stored are called Jhutta (Fig. 5). This method of storage is commonly used in Sikkim for storing maize and occasionally garlic. Maize is one of the most important cereal crops of Sikkim. Maize covers an area of about 40,000 ha which constitutes about 40% of total cultivable area[22]. After the maize is harvested and dried, the husk of bunch of maize is shucked and tied together to make a *jhutta*. Traditionally, *jhutta* of 6–7 cobs are placed in an open structure made of bamboo poles and timber for further sundry and storage. Now a day, tin or straw roofs are being made over such structures to safeguard the cobs from rain.

***Dalo*:** *Dalo* is a small conical or circular shaped basket made out of bamboo (Fig. 6). The bamboo is thickly woven to ensure that grains remains intact inside it. Unlike *Bhakari* and *Kotha*/*Kothe*, it doesn't require any plaster or mud/cow dung lining. *Dalo* is commonly found and used in every household of Sikkim. It has the capacity of holding about 10–15 kg of grains/seeds. *Dalo* is often used for holding small quantities of threshed grain for milling or the milled product. *Dalos* are also used for storage of surplus grain when all major structures are filled.

Fig. 4 — Seeds stored inside mature and dry shell of bottlegourd

Additives used in storage structures

It was found that except *Jhutta*, in all other seed storage structures additives were used to enhance the life of seed stored (Table 1). Majority of the seed storage structures were found using neem leaf (*Azadirachta indica*), bakainu leaf (*Melia azedarach*), turmeric (*Curcuma longa*), zinger (*Zingiber officinale*) and other traditional ITKs. Neem contains various alkaloids which have foul odour as well as insecticidal properties that keeps away most of the stored grain pests including weevil and grain moth[23]. The anti-feedant effects of *Melia azedarach* extracts are known for many insects[24,25,26].

In case of *dhikuti*, before and after placing seeds, the structure is fumigated with smoke of dry chilli burned in coal. The reason for doing the same as informed by informants is to scare away any bad spirits as well as the grains or seeds are not attacked by rodents and pests following fumigation. It is felt that the pungent and strong fumes of chilli might mimic the action of fumigation thus the seed or grains are not damaged by rodents. Birds' eggs were placed on the top of the grains to scare rodents from the place. Respondents told that the rat assumes it as snake eggs as an indication of

Fig. 5 — Jhutta

Fig. 6 — Dalo

Table 1 — Different indigenous seed storage structures and their features

S. No.	Parameters of seed storage structures	*Kotha*	*Bhakari*	*Dhikuti*	*Jhutta*	*Chindo*	*Dalo*
1	Dimensions	5×3 sq. ft (common size)	height (3–5 ft.) size varies	6×4 sq. ft (common size)	NA	NA	2×3 sq. ft (size varies)
2	Material used	Bamboo, cow dung, woods	Woven bamboo mat, cow dung	Wooden box	Rope, bamboo	Shell of gourds	bamboo
3	Cost (in Rupee)	1000	800	1500 – 2500	200 – 800	20	300
4	Durability (in Years)	3 – 4	4 – 5	10 – 15	1	1	2 – 3
5	Capacity (in Kg)	100 – 150	200 – 250	400	3 – 4	1 – 2	10 – 15
6	Grains that can be stored	Seeds/grains of paddy, buckwheat, soybean and urdbean	Paddy	Paddy,	Maize cob, garlic	Urdbean, Green gram	Paddy
7	Additives used in storage structures	leaf of neem, bakainu (*Melia azadirach*) dried and burned chilli powder along with charcoal, ash mixed with grain, ginger and turmeric powder	salt, dried zinger powder, dried and burned chilli powder along with charcoal, neem leaf,	neem leaf, dried and burned chilli powder along with charcoal, ash mixed with grain, ginger, eggs are placed on top of grains	NA	dried chilli, neem leafs, turmeric, mustard oil applied in the grains	salt, neem leafs
8	Storage duration (in years)	1	1	1 – 2	0.5– 1	1	0.5 – 1
9	How good it is in protecting from rodents	Average	Average	Good	Good	Average	Good
10	How good it is in maintaining seed viability	Good	Good	Good	Good	Average	Average
11	How good it is in handling	Easy	Easy	Easy	Very Easy	Easy	Easy
12	Level of Satisfaction	Satisfactory	Acceptable	Satisfactory	Satisfactory	Acceptable	Satisfactory

NA= not available

danger near about. Dried and burned chili powder with charcoal and ash are mixed with grains to reduce the attacks of stored grain pests like rice weevil, (*Sitophilus oryzae*), grain moth (*Sitotroga cerealella*) etc. It was also observed that mustard oil is applied in seeds of pulses to reduce the stored pest attacks.

All the structures are made either of bamboo or wood which are locally available so the cost of making such traditional structures are very less and easy to use. The highest cost was found to be Rs. 1500–2500 in case of *dhikuti* and lowest was found in *chindo.* Durability and capacity wise also *dhikuti* was durable upto 10 to 15 years and had the highest storage capacity (400 kg) as compared to others. As for the protection from rodents- *dhikuti*, *jhutta* and *dalo* were good and other was average. *Kotha*, *bhakari, dhikuti* and *jhutta* were found to be good in maintaining the seed viability and handling. All the structures are small in nature, easy to use, easy to construct providing good results and all these culminated in to the high level of satisfaction of the tribes.

Conclusion

Indigenous knowledge plays a major role to help farmers save a large quantity of stored grains and seeds, from 10–20% loss every year from stored grain insect-pest damage, with the available materials. The study documented the 06 very important and widely used storage structures and pointed out that the innovations of storage structures by ancestors were scientifically based and are still being used by *Lepcha* and *Limboo* tribes with satisfaction. Since, these ITKs are eco-friendly and location specific, proper documentation, scientific validation and refinement with modern technical knowledge is essential to conserve this knowledge and effectively used for sustainable crop cultivation. ITKs are cheap, easy to adopt, locally available and are able to reduce the input of chemical pesticides in our food chain and the environment.

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