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Indigenous agricultural storage and pest management of Northeast India

Lilika K Zhimomi* • Papiya Dutta

Department of Rural Development, University of Science and Technology Meghalaya

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ABSTRACT

Since time immemorial, the indigenous method of pest and storage management has been regarded as one of the most essential traditional methods for many indigenous communities all over. Traditional methods for food grain production and conservation have been successfully used by indigenous populations using locally accessible resources. This review study thus highlights 30 such traditional practices adopted by indigenous communities in the north-eastern part of India gathered from diverse secondary sources. These traditions have highlighted the indigenous people's enormous inventiveness in a very simple way, as demonstrated by their excellent usage of natural resources.

1. Introduction

Food remains the most significant human need around the world, attracting the attention of people around the world and prompting the development of methods to address the issue of food security. Before reaching the consumer, food grains go through a number of processes including planting, harvesting, threshing, bagging, transportation, storage, and processing. Farmers are battling to protect their crops from harm owing to a variety of factors, even after a laborious effort of cultivating and producing the harvest (Sundaramari et al. 2011). As a result, ensuring food sufficiency and quality necessitates effective operation at every stage, as there are significant losses in agricultural output at all of these processes (Sharon et al. 2014). Post-harvest losses are enormous at the farm and trade level, where approximately 70% of the produce is held for food, feed, or seed (Mandali & Kosnam 2015). Food grains are produced seasonally but used all year, therefore having an effective pest management and storage system is critical for securing food requirements all year. Proper food grain storage is essential to avoid spoilage, improve keeping quality, and thus save cost (Karthikeyen et al. 2009). Losses due to storage pests are said to be in the 10 - 20% range on average, with losses reaching up to 30% at times (Mandali & Kosnam 2015). Although chemical pest management methods are accessible and widely used, indigenous pest control methods predominate in rural regions. Because the vast majority of farmers in India are small-scale farmers, 60–70% of food grains are kept in indigenous knowledge frameworks at the home level (Prakash et al. 2016). Indigenous structures are not only less expensive, more environmentally friendly, and locally available, but they also safeguard the grain and pose no health risks (Sundaramari et al. 2011). The intoxication of farmed and endangered animals has created severe issues due to either direct consumption or secondary hazard caused by non-targeted predators or scavengers consuming poisoned rodents (B. Sinha 2014). Due to the sheer dangers associated with chemical pest control procedures, there has been a surge in interest in eco-friendly, long-term pest control alternatives. Rodents do far more economic damage than any other pest, wreaking havoc on all crop types at all stages, from plantation through harvest and storage (B. Sinha 2014). The usage of various synthetic pesticides has had a negative impact on the environment and remains in the form of residue for a longer amount of time, inevitably infiltrating the food chain. As a result, safer, more sustainable, and environmentally friendly options are required. Since time immemorial, the indigenous method of food preservation and conservation in India has been regarded as one of the most essential traditional approaches (Sundaramari et al. 2011). Working to develop and promote knowledge and practises would thus contribute to the country's goal of long-term food security by increasing storage capacity, reducing losses, and increasing purchasing and distribution efficiency.

*Corresponding author: lilikazhimomi@gmail.com

As a result of the lack of supportive and extension services in the majority of communities, the rural highland parts of the northeast India rely heavily on indigenous storage and pest management practises. Furthermore, even in regions where services are available, the rural poor lack the means to access them (Bikramjit Sinha et al. 2011). The North-eastern region is believed to be home to over 100 diverse indigenous communities; yet, investigations on indigenous methods of storage and pest management are limited. Because of the lack of formal recording, traditional know-how is passed down orally from generation to generation, resulting in the dilution of vital components of the knowledge with each passing generation. The linkages between indigenous people and nature, as well as traditional practises, have been established through experience but have not been formally documented (Nakro 2011). If this tendency continues, the efficacy of the practices will be reduced, eventually leading to the system's extinction.

2. Result

Agriculture system of the region

The region is rich in biodiversity and agricultural crops. Multiple cropping and mixed cropping are popular in the region. The diversity is aided by favourable weather conditions as well as varying food patterns among different communities. The region's most popular traditional agricultural technique is '*Jhum*' cultivation, often known as 'slash and burn' or 'Swidden' agriculture, which sustains the majority of the inhabitants. Because of the region's different socioeconomic, sociocultural, and socio religious practises, the *Jhum* cultivation system is also more diverse in this region. Agroforestry has a long tradition in the North east, where trees are incorporated into crop and livestock production systems based on agro-climatic and other environmental factors. These systems are administered on an indigenous level, with farmers evolving practises through time through trial and error (Deb et al. 2009). Other type of cultivation such as Terrace Rice Cultivation, Wetland Cultivation, Home garden, etc. may also be found in the region. Despite the large population absorption in agriculture, the region remains deficient in food grain production for a variety of reasons, including the ruggedness of the hilly terrain, dry terraces, high rainfall, humidity, and low temperature at a higher altitude, not to mention socioeconomic and socio-cultural factors (Bikramjit Sinha et al. 2011). In the absence of current sophisticated services, or when access to modern techniques is limited or constrained, communities turn to local solutions to deal with day-to-day challenges.

Indigenous pest and storage management

Among the different indigenous pest management approaches described in secondary literature, the following are some of the pest control measures employed by farmers in the north east that contribute to the safe growing and storage of food grains in the north east. As per the literature, these have been created and validated through many years of experience, which is inherent in the justification for each approach proposed.

Sl.no.		Method
1.	Leaves of Dendrocnide sinusta (B1.) Chew (*Urticaceae*)	The leaves are sandwiched between hot rice to allow the poison to pass to the rice, which is then ingested by the rat. The Garo farmers of Meghalaya practise this.
2.	Seeds of Entada purseatha DC, (*Mimosaceae*)	The Garo and Poumai farmers combine an adequate proportion of ground kernel and rice grains, which they lay in the paths of the rats, killing them as they eat it.
3.	Fused electric bulb	Mao farmers blend finely powdered fused electric bulbs with rice and place it on potential rat pathways, killing the rats as they eat it.
4.	Peels of Citrus grandis L. (*Rutaceae*) fruit	Pomelo is used as a pest repellent by Mao and Assamese farmers. The slices or peels are strewn in the field to keep rodents away.
5.	Fresh and/or dried branches of Artemisia Vulgaris L. (*Asteraceae*)	Since the smell repels rodents, farmers from the Mao tribe plant the branch in paddy fields and around granaries.
6.	Innovative granaries	The structure is built one metre off the ground and is supported by wooden or stone posts. The barrier, made of aluminium sheets, wooden plates, or 20 litres of mustard oil tins inverted, is erected around the poles, leaving no room between the post and the barrier, making it hard for the rats to cross over.
7.	Scarecrows	Scarecrows, other sound-producing devices, both manual and wind-powered, are placed in the field to frighten away predators. Almost all farmers in the North East employ this strategy.

8.	Attracting Owl	Plant branches, particularly bamboo, are placed on terraces to attract Owls, which are excellent predators of rats.
9.	Sapium baccatum Roxb (*Euphorbiaceae*)	To attract predatory birds, it is planted in or near the *jhum* field, kitchen garden, and terraces. This is something that the Garos practice.
10.	Dendrophthoe falcate (L) Spreng. (*Loranthaceae*)	To attract predatory birds, Garo farmers grow this tree in or near *jhum* fields, kitchen gardens, and terrace fields.
11.	Morus macroura Mig. (*Moraceae)*	To attract predatory birds, Garo farmers place trees in or near *jhum* fields, kitchen gardens, and terrace fields.
12.	Bridelia retusa Spreng (*Phyllanthaceae*)	To attract predatory birds, Garo farmers place trees in or near *jhum* fields, kitchen gardens, and terrace fields.
13.	Fruit of epiphyte Scurrula parasite L. (*Loranthaceae*)	Mao farmers attach the fruit on a bamboo stick and place it near potential rat tracks. The gum catches the rat, which is subsequently caught and killed, as it becomes stuck in it.
14.	Inflorescence of Cyathula tomentosa Moq. (*Amaranthaceae*)	It is placed in and around granaries and other potential rat tracks by adhering it to a cloth or any rough surface. When the rat comes into contact, it adheres to its body, making it heavy and slowing its mobility. These are then readily caught and killed. The inflorescence also induces infighting among the attached rats, resulting in injury and even death in certain cases. The Mao farmers practice this.
15.	Rat traps	Trapping with various types of indigenous traps is one of the most important and widely used methods of rodent management. These are often made of bamboo strips; cane, iron wires, satin-umbrella sticks, and other materials are employed in various ways depending on the application. Almost all farmers in the North East employ trapping.
16.	Crab	Crabs are smashed and placed in the middle of a paddy field on top of a bamboo stick. This attracts gundhi bugs, which are then smashed or burned once they have accumulated. The Garo farmers practise this.
17.	Curry leaves and neem leaves	To combat rice weevil and grain moth in the granary, Garo farmers mix dried curry leaves and neem leaves with grain during storage. The stench of the leaves is repulsive.
18.	Bamboo branches	The heavily branched tip of a bamboo stick is raised in the field for birds to sit on, acting as a predator for foliage-feeding insects. This is practiced by the Garo and Assamese farmers.
19.	Cow dung	In Assam, farmers use raw cow dung combined with water to make a suspended solution that is sprayed in the rice field which has an odour that repels bugs.
20.	Cow dung, ghee, and honey	To combat bug infestation, Garo farmers sprinkle a mixture of cow dung, ghee, and honey with water on their crops.
21.	Cow urine, neem leaf, custard apple leaf, dry tobacco leaf, datura leaf	This concoction is used as a bug repellant by Garo farmers.
22.	Branch of bitter oleander	The Garo farmers lay a branch of bitter oleander in the corner and centre of the paddy field to keep the rice hispa, gundhi insect, and grasshopper at bay.
23.	Cycle tyre	Farmers in Assam use cycle tyres to control rodents in rice fields. A rat is scared away by the cycling tube, which resembles a snake which has been placed near the mouth of the burrow.
24.	Vermillion	In Assam, farmers throw vermillion water on captured rats and release them in the field, scaring away the other rats.
25.	Toko palm	The Adi tribes of Arunachal Pradesh construct storage structures out of locally available materials and toko palm, which has been found to preserve grains from storage pests to the greatest extent possible.
26.	Bamboo string/steel wire	To catch rats in the field, the Ao-Naga farmers utilise a locally manufactured

		trap. The trap is coated in leaves and hung from the runways. One end of the bamboo string/steel wire is tied to the tip of a bamboo plant or tree limb, while the other end is formed into a noose with a trigger that is placed using a small twig or a thin bamboo split.
27.	Bamboo	It functions much like a scissor in that two bamboo splits are linked together at one end and the other end of the lower bamboo split is tied to another bamboo while the higher split remains loose. Another bamboo split, which works as a spring, is linked to the higher loose split. Tong is activated by a trigger and placed on the runways. This is employed by Nagaland's Ao-Naga farmers.
28.	Smoking	Farmers in almost every North Eastern state store food grains in the kitchen, allowing the smoke from the firewood to penetrate and prevent insects from infesting the grains.
29.	Rearing duck	Ducks are kept near paddy fields in Assam to help control rice hispa due to duck nibbling on them.
30.	Fern	In Assam, fern branches are planted in fields because they have insecticidal capabilities.

3. Discussion

In recent years, there has been a paradigm shift in grain protection from conventional approaches to the use of natural, dependable, and sustainable alternatives (Bikramjit Sinha 2010). These traditions have exposed, in a relatively straightforward way, the indigenous people's enormous inventiveness, as reflected in their excellent usage of natural resources. These studies show that the practises have long contributed to the social and economic security of communities by providing a stable foundation at the grass-roots level. According to the study, despite all obstacles, indigenous farmers have successfully demonstrated their cognitive abilities by skillfully employing the available natural resources to effectively handle the storage problem. The impact of modernisation on Indian agriculture is causing the extinction of many indigenous agricultural methods that have played an important part in food security (Sundaramari et al. 2011). Further, transfer of long-tested nature-friendly agriculture knowledge and practises has only been accomplished through oral tradition until now, and unless documented, these methods will perish over time (Nakro 2011).

4. Conclusion

These techniques show that indigenous tribes have an excellent understanding of crop management, which is becoming more widely recognised around the world. Continuous use enables the practice to evolve and fine-tune over time, while also ensuring efficiency through continuous tabs and modifications. As a result, including indigenous knowledge systems into the research would result in the development of a suitable new modern technique for proper food grain management. To make the job of strengthening the indigenous knowledge system effective and meaningful, it is absolutely necessary to capture the indigenous system as well as ensure its sustainable use at peak efficacies; thus documentation must be accomplished sincerely and meticulously with urgency (Bikramjit Sinha et al. 2011), which may exert pressure on policymakers to pay due respect for people's knowledge and to incorporate the knowledge in rural development planning (Dhaliwal & Singh 2010). Even after many decades of education reform in the northeast, the region is yet to see its all-round implication especially in retrieving and documenting the various indigenous knowledge systems. Therefore, more investigative and exploratory studies must be initiated for the safeguard of the knowledge as well as for the continued benefit to the indigenous communities.

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