A Case Study :

Stored grain pests and traditional techniques of their control measures

D.R. THAKUR AND DAMITA AND PRITI

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See end of the article for authors' affiliations

Correspondence to :
D.R. THAKUR
Department of Biosciences, Himachal Pradesh University, SHIMLA (H.P.) INDIA
Email : drdr4@rediffmail.com

SUMMARY

Traditional agricultural practices and cultivars have profound effect on modern day agricultural and plant materials. Use of broad spectrum insecticides have lead to eliminate the eco-friendly species of commercially and economically important insects and thus resulted in the unbalancing of natural food chain. The increasing public awareness of the environmental contamination by toxic chemical residues has necessitated the research and development of non-chemical methods. In the present study, different agricultural insect pests and relevant Indigenous Technical Knowledge (ITK) belonging to the different agro-ecological zones of Chopal subdivision of Shimla district, Himachal Pradesh, India have been studied. Rural folk designed their structures and methods for storing grains with locally available materials were unveiled. Various storage yarns like Kuthar, Kothi, Bara, Dobli, Khalda, Matka, Bijdi, Peru etc. used for safer storage of agricultural produce and various traditional techniques including some plant products used by the local people as an additive for prolonged storage of seed grain were explored.

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Indian society is amongst the oldest societies of the world, having rich social, cultural and agricultural traditional knowledge and practices. More than 75% people in India are directly and indirectly depend upon the agriculture for their livelihood. The main challenge is to produce enough food for increasing population. Although, we have achieved the green revolution and increased the food grain production by four folds by using inorganic chemicals but production at the cost of inorganic chemicals have disturbed the natural ecological balance.

Cereals and pulses are the staple food of India and these are stored by the farmers in homes, traders in stores and by government agencies in godowns and warehouses for future years. Crop losses due to insect pests are quite high and vary in developed and developing countries. Significant losses of crop occur even after their harvest by pest attack, particularly in the tropics. After harvesting, grain is dried until their moisture contents are less than 9%, which is considered ideal for storage. Warm and humid environment are highly conductive for fast growth and rapid multiplication of insect pests of stored grain. Almost all the insect pests of stored grain have a remarkably high biotic potential and within one season, they may destroy 7-10% of the grain and contaminate the rest with undesirable odour and residue. Dampness of the receptacles as well as seed grain also promote the growth of certain fungi on cereals and other grains. Therefore, use of proper receptacles, such as metal bins and improved godowns, can save the stores products from fungus and insect pests both.

In India, there are about a dozen of species of insect pests of stored grains. Our efforts to combat these pests by indiscriminate use of the pesticides have created several environmental hazards and these necessitated the reorientation of our strategies to pests and disease management in an eco-friendly manner. The increasing public awareness of the environmental contamination by toxic chemical residues and public perception about the use of eco-friendly methods in agricultural and public health care programmes have

necessitated the research and development of non-chemical methods. Modern scientific agriculture is committed to cater the need of global market but agricultural practice of traditional farmers if also taken in account would synergize the productive goal of present day agro-ecosystem.

Traditional agricultural practices and cultivars have profound effect on modern day agricultural and plant materials. It is of prime importance to know and understand the Indigenous Technical Knowledge (ITK) available with the farming community in the country. ITK may be defined as a means by which the inputs are transformed into outputs (Fresco, 1986). Indigenous knowledge contains ideas, beliefs, values, norms and rituals, which are native and embedded in the mind of people. ITK refers to the unique traditional local knowledge existing within and developed around the specific conditions by women and men indigenous to particular geographic areas (Lal, 2004). ITK has gained through a series of observations and they are passed generation to generation orally and keep on changing after receiving constant stimuli from outside (Camber *et al*., 1989). ITK is developed by people of a particular region through their own experience (Gadgil *et al*., 1993). Farmers have tested these traditional technologies in their own fields and developed them in such a way that they are totally self-reliant and sustained with these technologies. Over the ages farmers of Himachal Pradesh have evolved and perfected a number of sanitary methods of cultivation and storage suitable for different agro-climatic conditions of the state.

The present study, was therefore, initiated to document the relevant Indigenous Technical Knowledge belonging to the different agro-ecological zones of Chopal subdivision of Shimla district.

The present investigation has been carried out from Chopal Tehsil of Shimla District in Himachal Pradesh. Studied area is situated at 30^0 56' 55.73" N latitude and 77^0 35' 21.14" E longitude at an altitude of 2830m above the mean sea level and comprises 584.30 sq. km and composed of 417 villages under 54 Panchayats. The demographic profile of 74903 individuals comprising 38435 male and 36460 female according to 2001 census has reached about ninety thousand during the period (2007 and 2008) when this endeavor was carried out. Information about the different indigenous techniques used for storage of grains and to protect them from pests was collected. The Interactive Participatory Rural Appraisal (PRA) techniques were used to assemble the required information by using the format approved by the Indian Council of Agricultural Research (Anonymous, 2000).

– Title of the ITK.

– General description of the ITK practice.

– Users of the technology with details about location, address, education and economic status.

– Purpose for which the ITK is in use.

– Rational and hypothetical detail of the ITK.

– Appropriate season for using the ITK.

– Indigenous grain/seed storage system along with photographs.

– The structure, its capacity and material used for its construction.

– The pests along with photographs.

– The resources required for the practices of ITK.

– Compatibility of the ITK with the internal resources, technically feasible, socio-cultural compatibilities etc.

– The benefits of the ITK also enumerating cost and benefit.

Under the present study, different cereals and pulses, their insect pests and traditional innovative technology employed for their safe storage in Chopal subdivision of Shimla District in Himachal Pradesh has been investigated.

In the studied area, main cereals were *Triticum aestivum* L. cultivar Aradhana (HPW-42), Sartaj cultivar of *Zea mays* L., Bhrigu dhan cultivar HPR-1179 of *Oryza sativa* L., *Amaranthus dubidus* L. (Amaranth), *Eleusine coracana* L. (finger millet), *Setaria italica* L. (Italian millet) and Dolma cultivar of *Hordeum vulgare* L. (barley/jau).

Major pulses grown by local people in the studied area were *Phaseolus mungo* urd (cultivar T-9), *Phaseolus vulgaris* kidney beans (cultivar HPR-12), *Glycine max* (soybean), *Lens esculenta* (lentil), *Dolichos biflorus* L. (kulth) etc. These cereals and pulses were infested by insect pests belong to orders Coleoptera and Lepidoptera during storage (Table 1).

Indigenous technical knowledge for safe storage of cereals and pulses:

In Chopal subdivision, different indigenous techniques were in use for safe storage of cereals and pulses. Rural folk have designed structures and methods for storing grains with locally available materials. These structures have been identified by comprehensive survey of the studied area. Cereals and legumes were main source of food and constitute an important part of people's diet. In studied area, a few crops of food grains

Table 1 : Major storage insect pests and cereals and pulses recorded from different agro-ecological zones of Chopal subdivision of Shimla (H.P.)

Sr. No.	Name of insect pests	Pulses and cereals attacked
1.	*Sitotroga cerelalla* (Olivier)	*Oryza sativa*, *Triticum aestivum*, *Hordeum vulgare*
2.	*Sitophilus oryzae* (L.)	*Oryza sativa, Triticum aestivum*, *Zea mays*
3.	*Tribolium castaneum* (Harbst.)	*Triticum aestivum*
4.	*Acanthoscelides obtectus* (Say)	*Phaseolus vulgaris*
5.	*Callosobruchus chinensis* (F.)	*Psaseolus mungo*., *P. aureus*, *Dolichos biflorus*
6.	*Callosobruchus maculatus* (F.)	*P. aureus, D. biflorus*
7.	*Zabrotus subfasciatus* (Boh.)	*P. vulgaris*
8.	*Bruchus lentis* (Froel)	*Lens esculenta*

were grown and were found infested by some storage insect pests. Farmers of Shimla area have evolved and perfected the number of post harvest and sowing techniques suitable for different agro-climatic conditions of the state over a period of time. These are storage devices and additives.

Storage devices:

Kuthar:

It is a small hut type structure mainly made up of *Cedrus deodara* (Devdar), *Pinus* sp. (Kail, Chid etc.). For its construction a wooden platform nearly one meter above the ground level was formed and 7-9 wooden boxes were made above it to protect the stored seed grain from ground moisture. The boxes in kuthar were used for individual grain items. Wood of kuthar contains resin which acts as the insect repellant. It was used for storing both *Rabi* and *Kharif* crops. Kuthar was about 10-12 feet in height, 8-10 feet in width and 9-10 feet in length. Its capacity of storage was 2200-2500 kilograms (Fig.1 A). Farmers practiced an indigenous storage method using a traditional wooden outdoor structure locally called kuthar was used for the storage of multiple crops at a time from different parts. But similar outdoor grain storage structure called 'gummi' has been reported from Karnataka by Kanwar and Sharma (2006).

Kothi:

Kothi is almost box type and made up of wood of *Cedrus deodara* and *Pinus* sp. Kothi was movable structure and partitioned into 2-3 small boxes inside but lid was common. It was sealed by mixture of cow dung and cow urine. Resin of the wood and cow urine were used for sealing the crevices of the kothi which synergize the insecticidal and antimicrobial effect of the storage structure. It was used for the storage of *Rabi* and *Kharif* crops. Its height was about 2-3 feet, width 2-2.5 feet, length 6-7 feet and capacity was about 300-600 kilograms (Fig.1 B). A small rectangular wooden structure commonly called kothi or kotha, generally covered with single lid and open from top was found in some other parts of the state (Kanwar and Sharma, 2006).

Bara:

It is also box type and made up of *Cedrus deodara* and *Pinus* sp. It was partitioned into 2-3 boxes but each small box has its own lid. Bara was fixed to the wall of the room and crevices were sealed by mixture of cow dung and cow urine. It was used for the storage of both *Rabi* and *Kharif* crops. Its height was about 2-3 feet, width 2-2.5 feet and length 8-10 feet. The capacity of bara was about 650 kilograms (Fig.1 C). A wooden box called 'peti' was used for the storage of grain. These wooden boxes were made up of locally available wood such as *Cedrus deodara* and *Pinus* sp. A similar structure but locally known by different names like 'tanki' in district Hamirpur, sandook in Kullu and Bilaspur, Kotha in Solan and Mandi, 'bara' in Shimla, 'datha' in Lahul and Spiti and 'yangadup' and 'coff' in Kinnaur has been reported. Variations in size of this structure was found in every district but basic material used for its construction was wood except in Lahul and Spiti where 'datha' was prepared with wood along with slates. The frames of 'datha' were made up of locally available wood with slates panels and lids were also made up of wood and slates both (Kanwar and Sharma, 2006).

Khalda:

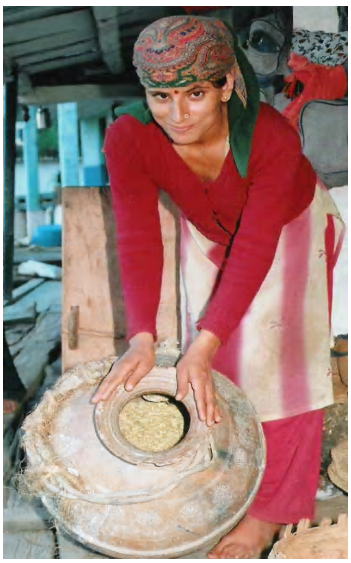
Khalda is a bag like structure formed of turnover stitched skin of slaughtered goat or sheep. This was treated with the salt and dried in air and then filled with straw and dry grasses for 20-30 days. A bag like structure formed and was used to carry the grain to mill for grinding and to store grain for even longer period of time. It was

A

B

C

D



E

F

G

Fig. 1 : Kuthar in front view (A), dorsolateral view of kothi (B), bara in front view (C), khalda under preparation (D), a rural woman showing mataka used for storing seed grain (E), inside view of dobli showing stored seed grain (F) and a grand old lady operating the bijdi for storing her agricultural produce (G)

used for the safer storage of both *Rabi* and *Kharif* crops. Its capacity was about 15-25 kilograms (Fig.1 D). Khalda is a bag like structure made up of turnover stitched skin of sheep or goat and in tribal belts of Himachal Pradesh similar bags were used for storage and to carry grain to mill for grinding and thrashing (Kanwar and Sharma, 2006).

Matka:

It is an earthen pot used to store legumes especially *Lens esculenta* (lentil) and cereals especially *Hordeum vulgare* (barley). In this practice, storage grains were treated with the cow urine and then dried in sun and then stored in earthen pot. Opening of matka was sealed with cow dung, cow urine and clay to make it air tight. It was used for the storage of *Rabi* and *Kharif* crops also. The matka was made up of clay and its capacity was about 15-20 kilograms (Fig.1 E). The grains to be stored in this practice were sun dried before storage to reduce the moisture contents. Use of similar structure for safe storage of lentil in southern parts of India has been advocated by Reddy (2006).

Dobli:

It is ground floor room of the house. This room was mainly made up of *Cedrus deodara* and *Pinus* sp. But dobli of devdar has longer life than other. In dobli 7-8 wooden boxes were made and each box was used for individual item. Dobli was opened from the top and each box has individual lid. It was used for the storage of *Rabi* and *Kharif* crops. Its height was about 10-12 feet, width 8-10 feet and length 9-10 feet. Its storage capacity was 2200-2500 kilograms (Fig.1 F). Dobli was an underground room used to store the grain without damage from insects and moulds for a longer period of time and it saves space for storage (Nagnur *et al*.**,** 2006).

Bijdi and Peru:

Bijdi was formed of bamboos sticks and its inner sides were sealed by mixture of cow dung and urine to make it air tight. It was used for storage of paddy, wheat and maize (both *Rabi* and *Kharif* crops). Since it has been formed of bamboo sticks its capacity varies from 15-20 kilograms or even more (Fig.1 G). Peru was identical to bijdi, made up of splited bamboo sticks but its capacity varied from 300 - 400 kilograms. It was cylindrical or oval in shape and plastered with cow dung and urine before use. Use of bamboo containers for storage has also been reported from different areas of Himachal Pradesh like Mandi, Bilaspur, Hamirpur but called peru (Bharwal, 2000; Lal, 2004). Bijdi like yarn was also used in Dharwad in Karnataka for storing paddy but called kanaja or galagi (Nagnur *et al*., 2006).

Additives:

Use of different leaves:

Different leaves having insecticidal and fungicidal properties were used as additives in different storage structures for better and prolonged storage of grain. These leaves belong to *Eucalyptus, Juglans regia, Azadirachta indica,* mint etc. These leaves were placed in storage yarns (Kuthar, kothi, dobli, bara, bijdi and peru) at different depths and this practice was in use since hundreds of years. Farmers used neem leaves in the gunny bags to control the pests like pulses beetles, pod borers etc. Neem leaves are known to have insecticidal property and when added with grains during storage, repel storage pests effectively. Such practice of adding leaves of neem, walnut and safeda etc. have been observed from areas (Nagnur *et al*., 2006; Karthikeyan *et al*., 2006). Walnut, safeda and mint leaves have also been reported to possess certain antimicrobial and pesticide properties, which protect the grain during storage.

Use of ash:

Ash is commonly obtained by burning the wood and cow dung etc. It was mixed with storage grains. The ash has crystalline property and may cause wounds in insects body, which leads to dehydration and ultimately insects die after some time. To control the storage pests of harvested grams were mixed with ash in 1:1 ratio. Ash treatment during storage was found effective for controlling the storage losses up to 80% (Karthikeyan *et al*., 2006).

Turmeric powder and chilli:

These were used by mixing with storage grains for protection against insect pests. Turmeric powder paste prepared by mixing with mustard oil used to control the stored seed grain pests. Pulse crops after harvesting were sun dried, cleaned and packed in jute gunny bags for safe storage. To repel the storage pests, farmers used chilli (*Capsicum annuum*) fruits with pulse grain. The astringent smell of chilli fruits control the storage pests like pulse beetle, lesser grain borer, floor beetles etc. Similar practice of insect pests control by various additives has also been recorded by Nagnur *et al*. (2006). These substances act as insect repellent, antifeedant and oviposition deterrents. This practice protects the grain

from insect pests up to few months (Reddy, 2006).

Mustard oil:

It was applied on storage grain especially pulses. This was also used as paste with turmeric powder. It has antimicrobial substance, allyl isothideyanate and provided better protection. Farmers of Chopal district drew a line of turmeric powder and mustard oil mixture around store grain to repel ants. Such practices have also been reported for safe storage of pulses (Atwal and Dhaliwal, 2005).

Use of table salt:

Table salt was used for storage of rice grain. Salt was mixed with rice during storage and after sun drying. It was used for the storage of *kharif* crops. Similar practice of using table salt for protection of storage grains has been reported by Bharwal (2000).

Sun drying:

In this practice, seeds (grains) were sun dried by spreading them on floors after harvesting. It killed both juveniles and adult insect pests. It was used for storage of *Kharif* and *Rabi* crops. It was in use since hundred of decades. Farmers sun dried the seeds of maize, wheat, pulses and rice after harvesting. Exposing infested grains to sun during the months of May and June kills stored grain pests (Atwal and Dhaliwal, 2005) and periodic sun drying of pulses suppresses the internal infestation (Reddy, 2006).

Cow dung and urine:

In this practice a thin paste by mixing cow dung, clay and cow urine was formed. This paste was applied on storage yarns to make them air tight. Cow dung and urine have antimicrobial and insecticidal properties and provid better results for the storage of both *Kharif* and *Rabi* crops. Cow urine was especially used for the storage of *Lens esculenta* (lentil). In this practices, the grains to be stored were firstly sun dried then mixed with cow urine and agains were sun dried before storing in Matka. Cow urine has antimicrobial and insecticidal property. Mixture of cow dung and urine were used to seal the crevices of the storage yarns. Antimicrobial and insecticidal properties of cow dung and urine and their use in agro-ecosystem and forest ecosystem have been worked out by various workers (Bharwal, 2000; Lal, 2004; Kanwar and Sharma, 2006 and Thakur and Singh 2009).

By frying:

In this practice, the storage grains especially green and black grams were fried in iron pan for three to four minutes. With this practice seed coat of grain becomes hard and reduces the chance of infestation of seed borers. Farmers evolved another storage technique to get rid of storage pests like pulse beetles by frying pulses in iron pan (Nagnur *et al*., 2006 and Karthikeyan *et al*., 2006).

Use of ginger and clove pieces:

This technique was especially used for storage of rice grain. Ginger was cut into pieces and put into storage yarns along with rice grain. Clove either fried or un-fried were put into storage yarns to check the insect pests. The grains to be used in next season were stored in special way by adding chilli powder, salt, edible oils, condiments etc. to keep them fresh and in good conditions (Rao and Hetta, 2006).

All these techniques were cheap, technically feasible, compatible with components of the existing farming system and internal resources of household, eco-friendly, avoiding spoilage of stored grain, check insect pests, simple and easy to apply.

Conclusion:

It is now well documented that ITK methods for insect control are eco-friendly, less expensive, easy to apply, need no formal training, have no adverse effect on human health and helps in strengthening the socio-cultural and environmental aspects among the farming community. On the other hand, use of chemical pesticides leads to increased environmental pollution, damage the soil texture, impart adverse effects on the human health and insects also develop resistance to pesticides. Keeping in view the advantages of ITK, the agricultural extension workers should encourage and disseminate the use of indigenous technical knowledge methods on target scale in farming community.

Authors' affiliations:
DHAMITA AND PRITI, Department of Biosciences, Himachal Pradesh University, SHIMLA (H.P.) INDIA

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