Chapter V

FOOD GRAIN MANAGEMENT PRACTICES FOR PEST CONTROL

The World food production in agricultural sector is damaged or destroyed by several insects-pests during growth, harvest and storage. The monetary loss due to store grain insects-pests amount millions of rupees each year. Use of chemical pesticides on large scale which are persistent and non bio-degradable in the environment should be avoided. These insecticides have a wide range of toxic biochemical action on plants and animals, hence, they are known as ‘dirty dozens’.

Our ancient literature like Atharvaveda, Kallavagga, and Rigveda mentioned protection of crops from locusts, mice, borers, mildews, blights, birds, etc. by using plant resources or by performing ceremonies, by making noise or din, by setting traps, etc. In ‘Vrikshayurveda’ the ‘science of medicine for plants’ had relevant mantras to mutter one hundred and eight times and write them down on the leaf of the tree affected by locusts, rats, birds, ants, etc. In Visva-vallabha, vermin and rats can also be destroyed by medicines that emit offensive smell or have acrid taste. Fumigation with the fumes of white mustard, Ramava, Vidanga, Vaca, black pepper, beef, Ambu, horn of buffalo and flesh of pigeon mixed with the powder of Lodhra, at once destroys the colonies of insects infesting the trees. White mustard, Sesamum, Vidanga mixed with ghee, irrigation with diluted milk for seven days are effective in destroying insects like Kandara. All these practices of insect control were used in ancient India (Raychaudhuri, 1964). Nene (1999) reported pests that are named in Sanskrit and which affect crops during the time of Sage Parashara. These are Gandhi, Shankhi, dhuli, etc. Gandhi (offensive odour) is from Gandhi bug (Leptocorisa varicornis F.), Shankhi must be a snail (Pila sp.) and Dhuli meaning powdery mildew.

Farmers store perishable bulbs and root crops by covering it with dung paste or kept in ash. In rural area grain storage is prevalent in Kothal (mud bins) or bins prepared by using dried twigs of Clerodendrum spp., Bamboo (Bambusa arundinacea Willd.), Nirgudi (Vitex negundo L.) etc. Skilled persons from villages are preparing conical structure called as Kanagi. This
structure is kept in house on a stone base at least 9 inch above ground level. Traditional practice of plastering of bins with cow-dung and then white washing with slaked lime or covering the surface with gypsum is known to keep the pests away (Kulkarni and Kumbhojkar, 2003). Verma et al. (2007) recorded eco-friendly grain storage structures in India. It includes indoor grain storage structures made from Bamboo containers, wooden boxes, mud structures and earthen containers. Some outdoor structures prepared from Bamboo, Straw/stalk, wooden structures. Kacheri is a traditional storage structure using paddy or wheat straw, woven as rope. It is made from either paddy straw alone or paddy straw mixed with mud. Hagevu is an underground structure that is used to store grains. It is a simple pit lined with straw ropes to prevent damage from moisture. In some cases, Hagevu is constructed as an indoor structure (with stones). After filling the structure fully, the paddy straw is spread on top as a thick layer and the structure is sealed with mud plaster. In some cases a small square or circular opening is provided at the top. The inlet opening is above the ground level. The advantage of this structure is that fumigation is not required for disinfections. Grain can be stored for a longer period. This storage method is suitable for dry agro-climatic zones (Channal et al., 2004).

Control of grain quality before storage or to minimize the intake of heavily infested and badly damaged or uncleaned grain is feasible and commonly practiced to a considerable extent. Even at the small farm level it is possible to segregate the crop at harvest, especially with maize on the cob and unthreshed sorghum and millet, selecting relatively undamaged material with good storage potential and setting aside the more evidently infested or otherwise damaged material. If there is no other option then can at least be used first. The rate of deterioration due to insect infestation can be considerably retarded in the main stock of stored grain. There is little doubt that some subsistence farmers use this form of commodity management fairly effectively. One can sometimes observe on farm grain stocks that have received no special insecticidal treatment, with relatively little insect damage after several months of storage at an ambient temperature that would permit the rapid increase of any well-established initial insect population.

According to World Bank report (1999) post harvest losses in India amount to 12-16 million metric tons of food grains each year. The monetary values of these losses amount to more than Rs. 50,000 crores per year (Singh, 2010). Scientific approaches to grain storage pest management, having regard to grain storage as a part of the food production and distribution
management system, have sometimes referred to the biological ecosystem concept as a means of comprehending grain storage processes and problems. Dunkel (1992) has applied ecosystem principles in a broad analysis directed towards an improved understanding of physical and biological interactions including socio-economic factors. The purpose was to generate improved understanding of the stored grain ecosystem and to identify objectives for future postharvest research. This treatment of the subject should serve to enhance the growing awareness of storage as a system within a system and to stimulate systematic and objective analysis of grain storage problems. The need to minimize the cost of insect pest control is a major factor militating against the extensive use of some of the more 'environmentally friendly' measures.

Agricultural production today is dependent on commercially available synthetic chemical pesticides to combat a variety of weeds, insects, fungi and other agricultural pests. Some of these pesticides are considered to be acutely or chronically toxic to human and other segments of the environment and pose potentially serious health risks to non-target organisms and species. They occur in the mother’s milk and probably in the tissues of the unborn child (Singh et al., 1996). These hazardous chemicals formulated as synthetic pesticides need to be replaced by plant based products. According to the published reports plants like Mentha piperita L., Acorus calamus L., Piper nigrum L., Pongamia pinnata Poirr. and Azadirachta indica A. Juss. have been evaluated for their insecticidal properties and found satisfactory (Tripathi et al., 2001). Neem tree has attracted global attention in finding new chemicals for control of locusts, gypsy moths, cockroaches and other insects. Such plant resources have been receiving attention in recent years. Neem leaves and neem cake are commonly used against storage pests, soil born fungal pathogens and nematodes, respectively. Treating of seeds with ash before storage is an age-old practice used by farmers. By this practice, larvae and adults of storage pests that attack the grain at the time of storage can be killed. It is specifically used in storage. The ash is mixed with grains based on the extent of infestation, quantity of grains and storage structure. The method is very economic and made up of locally available materials. The seeds and grains do not chemically contaminated and the ash can be easily separated from grains by sieving. It is good for small capacity storage as quantity of fuel wood required is not too much.

Farmers from hilly regions of Arunachal Pradesh have developed traditional package of storage. Cereals and other food grains are stored in places where the smoke of burning firewood
penetrates. This smoke produces carbon dioxide (CO$_2$) and carbon monoxide (CO) gases that suppress the infestation of insects/pests in the seeds. Farmers experience is that the places where these gases do not penetrate are vulnerable to pest infestation. Practices like hanging maize cobs from kitchen roof for seed storage, used of ash to control Pumpkin beetles and aphids, birds catching using jackfruit latex were of much interest and great practical value (Ramanamurthy et al., 2003)

Pigeon pea seeds are coated with red earth before storage. The notorious pulse beetle lays eggs in mature grains in the field. The harvested grains contain the grubs inside. The red earth coating prevents the emergence of adults from such grains. This way the adults die-inside the grains and thus the infestation does not spread (Choudhary and Saxena, 2007).

Castor oil 10 ml/kg seed gives complete protection to mung bean seeds against the bruchids for 18 months without impairing germination. Oils like Sesamum, Peanut and Sunflower had no deleterious effects on viability, palatability, cooking quality or physical appearance of pulse legume seeds. Mauha (*Madhuca longifolia* Mac. Brid.) seed oil at 5 ml/kg applied on cowpea seeds had shown the similar results (Raja and Ignacimuthu, 2001, Verm, 2006). Some tribal people Muster oil (*Brassica* sp.) at 4-5 ml/kg seed of wheat for protection against rice weevil (*Sitophilus oryzae*) and other pests. Satisfactory results are obtained in controlling the storage grain pests. Singh (1999) reported certain essential oils used for biocidal activity. The essential oils have been successfully used against insect infestation of various food commodities. Chandar (1986) used volatile oils of *Pongamia glabra* and *Acorus calamus* for control of pulse beetle *Callosobruchus maculatus* Fab. on green gram. *Seseli indicum* oil has been reported to check infestation on *Cajanus cajan* and *Cicer arietium* from store grain insect. Essential oils and their constituents have varying degree of pest controlling activities and a potent source of environmentally and ecologically safe biocides and could be exploited for commercialization.

The farmers use dry chillies (*Capsicum annum* L.) against storage pests of mung been (*Vigna radiata*L.) Wilezek and black gram (*Vigna mungo* (L.) Hepper). They placed 4 to 5 chillies in one kg of seed for effective control of storage pests. 2-3 Kg of common salt and 4 kg onion (*Allium cepa* L) is mixed with 100 kg chickpea (*Cicer arietinum* L) seed in storage. Farmers reported that this technique is effective against store grain pest. Traditional knowledge

Chemicals present in plant resources have different properties like attractants, ovicides, insecticides, anti-feedants (Muruganam et al., 1998), etc. Majority of insects are having particular semi-chemicals hence different insecticidal properties of plants need to be studied. Salvakumari (2009) reported insecticidal activity of *Typhonium roxburghii* Schott. belongs to family Araceae was tested on *Tribolium castaneum* Herbst. The plant has repellent activity for its petroleum ether fraction of the benzene extract and corn oil. Much of the insect’s behaviour is mediated by chemicals in its environment. By turning these chemicals to our own advantage, it is possible to attract pests to traps or baits or repels them from our homes, our crops or our domestic animals (Singh and Upadhyay, 1993, Singh, 1999, Sharma et al., 2000).

Farm storage systems must provide maximum protection against deterioration of the commodity by inclement weather and pests, and also to deter theft. Traditional farm storage systems have been evolved over long periods to satisfy these requirements. Most are well adapted to their environment and losses are generally low, often below 5 percent of grain weight over a storage season. However, for poor farmers living at or near subsistence even losses of this magnitude have important implications for food security. Rectifying these losses can only be achieved by subsistence farmers if changes are made to the traditional system of storage which bear no cost (other than of the farmers own labour), such as improving the design of the storage structure and using grain protectants which occur naturally in the local environment. Traditionally, protectants against insect infestation fall into two groups: those materials such as ashes, minerals and oils, in which physical barrier effects are responsible for the control of insects; and the use of whole plants, or parts of plants where there may be some chemicals with
insecticidal or repellent effect. In the present study management of store grain pests by local or tribal people from Bhor region of Pune district of Maharashtra State is discussed.

**Storage structures**

Food grains like maize, wheat and paddy are stored in special structures made of bamboo called *Kanagi*. Prior to use, these structures are plastered from inside with a mixture of cow dung and clay. These containers are placed on the ground floor and grain is loaded into them from a hole made on the top of the structure. Grains for daily use were collected from a special opening provided near the bottom of Kanagi. Another type of bamboo structure locally known as Hatari is preferred by the traditional farmers to store large quantity of food grain especially for paddy. Interestingly, these structures are invariably kept in a separate room is known as Kotharand access to such room is allowed only to very few persons from the family. (Plate – V.1)

The use of bamboo (*Bambusa arundinacea* (Retz.) Willd. containers allow the free exchange of gases inside the grain and keeping containers on the ground floor ensures cool temperature for storage. Loading from top and unloading from bottom offers easy material handling. Keeping storage structures away from main living room protects grain from fire etc. Apart from bamboo sometimes sticks of Nirgudi (*Vitex negundo* L.) and Tantani (*Lantana camara* L. var. *aculeata*) are also used to prepare Kanagi.

*Tectona grandis* Leaves: Grain is mixed with leaves of (*Tectona grandis* L.) and then stored in bins. About 100 gms of leaves are sufficient to preserve one quintal of food grains. Leaves of Nirgudi (*Vitex negundo* L.) mixed with common salt used for 100 gm/quintal in case of rice. Leaves of Nilgiri (*Eucalyptus globulus* Labills) mixed with common salt used for 100 gm/quintal in case of rice.

Similarly leaves of neem tree, *Azadirachta indica* L. are also used by the local people to preserve the grain in bins. Generally, in ground layer of leaves, second layer of grain again layer of leaves and then layer of grain. Finally the top of the bin is covered with basket and plastered with cow dung and mud. Infestation of store grain pests is controlled by this method.

**Pasting of seeds:** Seeds of cucurbits – *Cucumis sativus*, (Kakadi), *Cucumis melo* var. *reticulate* (Chibud), *Bennicasa hispída* (Kohala), *Momordica charantia* (Karle), *Momordica
dioica (Kartoli), Randia uligenosa (Pendhar) are mixed in ash and pasted on mud walls plaster with cow dung mixed with mud.

Seed kept in wood ash: Tribal people from Bhor and Mahad region use wood ash for storage of seeds. The special woods used as fuel are Catunaregam spinosa (Gelphal), Gnidia glauca (Rametha), Mangifera indica (Amba) Carya arborea (Kumbha). Cow pea, ginger and black gram etc. seeds kept in ash during storage. By this practice, larvae and adults of storage pests that attack the grain at the time of storage can be killed. It is specifically used in storage. The ash is mixed with grains based on the extent of infestation, quantity of grains and storage structure. The method is very economic and made up of locally available materials. The seeds and grains do not get chemically contaminated and the ash can be easily separated from grains by sieving. It is good for small capacity storage as quantity of fuel wood required is not too much.

Table V.1: Traditional method for store pest management

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Family</th>
<th>Local name</th>
<th>Application</th>
<th>Part used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melia dubia Cav.</td>
<td>Meliaceae</td>
<td>Nimbara,</td>
<td>Dried leaves are kept in the bins.</td>
<td>Leaves</td>
</tr>
<tr>
<td>Pongamia pinnata Poir.</td>
<td>Leguminaceae</td>
<td>Karanj</td>
<td>Dried leaves</td>
<td>Leaves</td>
</tr>
<tr>
<td>Catunaregam spinosa (Thunb.)Tirveng.</td>
<td>Rubiaceae</td>
<td>Gela</td>
<td>Fruits kept in bins</td>
<td>Fruits</td>
</tr>
<tr>
<td>Madhuca longifolia Mac. Brid.</td>
<td>Sapotaceae</td>
<td>Mahua</td>
<td>Leaves</td>
<td>Leaves</td>
</tr>
<tr>
<td>Eucalyptus globulus Labillis</td>
<td>Myrtaceae</td>
<td>Nilgiri</td>
<td>Leaves kept in bin</td>
<td>Leaves</td>
</tr>
<tr>
<td>Gnidia glauca (Fresen.)Gilg.</td>
<td>Thymalaceae</td>
<td>Rametha</td>
<td>Leaves kept in bin</td>
<td>Leaves</td>
</tr>
<tr>
<td>Tectona grandis L.</td>
<td>Verbenaceae</td>
<td>Sag</td>
<td>Leaves inside the bin</td>
<td>Leaves</td>
</tr>
<tr>
<td>Pogostemon benghalensis O. Ktze.</td>
<td>Lamiaceae</td>
<td>Phangali</td>
<td>Seeds and leaves kept in bin</td>
<td>Seed and leaves</td>
</tr>
<tr>
<td>Vitex negundo L.</td>
<td>Verbenaceae</td>
<td>Nirgudi</td>
<td>Leaves kept in bin</td>
<td>Leaves</td>
</tr>
<tr>
<td>Azadirachta indica A.Juss</td>
<td>Meliaceae</td>
<td>Nimb</td>
<td>Leaves kept in bin</td>
<td>Leaves</td>
</tr>
</tbody>
</table>

Laboratory testing leaf powders of 10 plant species have been done against common store grain insect-pest of pulses viz. Pulse beetle Callosobruchus maculatus Fab. on cowpea is presented in next chapter. (Plate – V.2, V.3)