UNIT 7 STORAGE STRUCTURES

Structure

7.0 OBJECTIVES

After going through this unit, you should be able to:

- explain the merits and demerits of bag and bulk storage;
- describe what are flat godowns, silos and bins;
- know the role of turning and aeration in safe storage of foodgrains;
- explain the importance of static pressure and flow rate in aeration system of foodgrains in a bin;
- understand the moisture migration;
- know the extent of post harvest losses in foodgrains;
- explain the important stored grain insect pests and rodents; and
- understand importance of cleanliness and hygiene in storage of foodgrains.

7.1 INTRODUCTION

In India about 70% of total foodgrains produced are retained at farm level. Remaining 30% of the foodgrains which arrive in the grain markets are being procured by Government procuring agencies viz. Food Corporation of India (FCI), State Governments, their agencies

and traders. Foodgrains retained by farmers are stored in their traditional grain storage structures as well as in bags. The traditional rural storage structures are neither moisture proof nor rodent proof. Therefore, at farm level grain storage, considerable losses are caused due to various physical and biological factors such as moisture, temperature, insects, rodents, birds and microorganisms.

Similarly, the major quantity of foodgrains procured by Government procuring agencies are stored in bags in conventional godowns and warehouses. Some quantity of foodgrains (about 0.5 million tonnes) procured by FCI and State agencies is also stored in bulk (in silos and flat godowns) which are located in different parts of the country. At commercial level storage, scientific code of storage practices are adopted and therefore, the storage losses at commercial level are quite low (about 0.5%).

7.2 BAG AND BULK STORAGE OF FOODGRAINS, THEIR RELATIVE MERITS AND DEMERITS

Although, the unit cost of creation of modern bulk storage which involves use of vertical, cylindrical silos/bins made of either steel or reinforced cement and concrete (RCC) is higher than the unit cost of creation of bag storage godowns, the bulk storage system has several advantages over bag storage system. The merits and demerits of bag storage versus bulk storage of foodgrains are as follows:

Bag storage	Bulk storage
The unit cost for creation of bag storage facilities is less	Unit cost is higher
Land requirement is more	Land requirement is less
Storage and transit losses in foodgrains are higher	These losses are negligible in modern bulk storage system (silos)
The system is not moisture and rodent proof	The system is moisture and rodent proof
Fumigation requires gas proof covers and it is not much effective and efficient	Fumigation does not require gas proof covers and is quite easy, effective and efficient
Labour requirements are more	Labour requirement is very less
Storability of grain is less	Storability of grain is more.

7.3 FLAT STORAGE GODOWN

Low height flat storage godowns and bins are also used for storage of foodgrains in India and other countries. These storage structures were constructed about four decades ago for the storage of wheat by the Food Corporation of India (FCI).The FCI is having flat storage godowns and bins at following locations:

Sl. No.	Location	Capacity of the flat storage structure in metric tonnes
1.	Hapur	5500
2.	Kanpur	72000
3.	Manmad (Maharastra)	84000
4.	Borivili (Maharastra)	1,04,000
5.	Gaya (Bihar)	32000
	Total	**2,97,500**

The grain bags are cut open from the mouth of the bags and poured into the flat storage. The shoveling and leveling of the foodgrains are carried out.

Foodgrains from Flat Storage are normally taken out by evacuators or grain conveyors. The evacuators either discharge the grain into the baby pit or feed the hoppers of the automatic/weighing and filling machines (velosac machines) which are designed to fill the bags upto a prescribed weight. The bags are stitched with at least 16 stitches and stacked in the same or any other godown(s) or loaded into wagons/transport vehicles. The flat storage system is also provided the rail siding facilities.

7.4 SILOS AND BINS

Large scale modern storage structures known as silos and bins are used for bulk storage of foodgrains and oil seeds. These are vertical cylindrical storage structures with in-built facilities for loading, unloading, drying, cleaning and bagging of foodgrains and oil seeds. Aeration, fumigation and temperature recording facilities are also provided. Dust control devices are also provided to minimize the accumulation of dust in the working area. Wheat, paddy, barley and soybean can be safely stored in these structures. These bulk storage structures have following advantages over bag storage:-

(i) the storage and transit losses are negligible

(ii) the silos are rodent and moisture proof.

(iii) land area requirement is less.

(iv) less labour is required to maintain and run the silo storage system.

(v) in-built facilities for cleaning to remove foreign matters and for aeration for reducing the temperature and moisture content of grains.

(vi) storability of grain is more.

(vii) The fumigation system for the control of insect pests is efficient and effective.

The silos are made of either steel or cement concrete. The metal silos are cheaper than the cement concrete silos. The silos are equipped with facilities to receive the grain in bags as well as in bulk. An integrated bulk handling, storage and transportation system consists of silos in producing areas, bulk movement rail wagons with top loading and bottom discharge facilities and silos at consuming areas . The silos at port are useful for export and import of grain and grain can be directly loaded into silos from ships and then to bulk rail wagons from silos and vice versa.

A modern bulk storage complex may consists of silos from 10,000 MTs to 1.00 lakh MTs. .In a 10,000 MTs silo complex (similar to Hapur in U.P) , there are 20 bins, each of 500 MTs capacity and one large service bin /head house.

The Food Corporation of India (FCI) is having steel and RCC silos at different locations in the country viz Hapur, Khurja, Lucknow and Kanpur (U.P.), Kolkata (West Bengal), Mandi Govindgarh, Jagraon and Moga (Punjab), Borivili and Manmad (Maharasrta), Narayana (Delhi), Gaya (Bihar) and Faridabad (Haryana). Integrated bulk grain handling, storage and transportation facilities to the tune of 5.5 lakh MTs are being created first time in India through private sector participation on build-own-operate (BOO) basis. FCI has given long term business guarantee for such facilities.

Check Your Progress 1

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. What are the merits and demerits of bag and bulk storage system?

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2. What do you understand by silos?

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3. What are the advantages of integrated bulk storage system of foodgrains?

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7.5 TURNING AND AERATION

Temperature and moisture are two important physical factors which affect the storability of foodgrains during storage. High temperature and high moisture rapidly deteriorate the foodgrains during the storage. These two parameters attract the insects and moulds to further spoil the grains. On the other hand, grain at moderate temperature and low moisture can be stored safely for a longer period. Thus, effective post harvest grain management involves following three sets of control objectives : -

(i) Drying (initial reduction of moisture content)

(ii) Conditioning (making moisture content uniform)

(iii) Aeration (lowering grain temperature)

Turning and aeration aim at holding the grain temperature as well as moisture at safe level. Aeration is natural or forced movement of ambient air through stored food grains to decrease its moisture and temperature. It is a general practice in the godowns and warehouses that if the grain moisture is high, the gates of the warehouses/godowns are opened from both sides on clear sunny days so that warm air may pass through the stacks and reduce the moisture content as well as grain temperature. Different type of mechanical grain aeration system are also available for the aeration purposes. Silos and flat storage bins are equipped with grain aeration system of the foodgrains.

An aeration system consists of a fan, an air supply duct, aeration ducts and a fan controller. In a typical aeration supply system, the air is distributed into the grain mass through aeration ducts or a perforated floor.

7.6 STATIC PRESSURE AND FLOW RATE FOR AERATION

Aeration is carried out by introducing an air through a grain mass to reduce the temperature as well as moisture during storage. If the bin is filled with a hot or warm grain, the grain may be damaged even if moisture content is low. The difference in the temperature of the grain and outside bin produces an air convection current with air dropping through the cool grain along the outside wells and rises through the hot/warm grain in the centre of the bin. As it rises, it will pick up moisture as well as temperature (heat). When this hot and moist air reaches the upper cool surface of the grain in the bin, it will cooled down and drop its moisture on the upper surface of the grain resulting into total spoilage of top layer of grain in the bin.

DESIGN PROCEDURE

Therefore, in such cases the grain should be immediately and properly aerated. Before proceeding for actual aeration, the following steps should be determined:-

(i) Capacity of the bin and the quantity of grain filled in the bin.

(ii) Air flow rate keeping in view the temperature and moisture content of the grain.

(iii) Total air volume required.

(iv) Selection of fans.

(v) Static pressure required.

AIR FLOW RATE

It is necessary to choose right air flow rate to obtain the desired aeration effect in a grain bin. Generally, aeration air flow rate ranges from 1-2 litres of air per second per cubic meter of grain. Sometimes, lower air flow rate (0.5 litre per second per cubic meter) and higher flow rate (2-6 litres per second per cubic meter) are also used. The total air volume is calculated by computing the air flow rate, capacity of the bin and time required for aeration.

SELECTION OF AERATION FAN

Axial fans are commonly used for aeration purpose in grain storage.

STATIC PRESSURE

Static pressure is the pressure against which the fan must operate and it is expressed as inches of water or Pascal (1 inch of water is equal to 250 Pascals). Static pressure depends upon the desired aeration rate, depth of the grain in the bin, type of grain and type of aeration system (weather perforated floor or duct system). In a bin having perforated floor and having large size grain like corn or maize, the static pressure is about 0.9 inches of water . If there is a duct system in the bin, it is 0.4 inches of water. For smaller grains like wheat, sorghum and barley, the static pressure is about 2.8 inches of water with duct system.

7.7 RURAL STORAGE STRUCTURES

About 70% of total foodgrains produced in India are retained by farmers for their self consumption or meeting their other financial requirements. The food grains at farm level are stored in traditional as well as in modern storage structures. A large

number of traditional rural grain storage structures are found in India. These structures are made of locally available cheaper materials like mud, bamboo, wood, paddy and wheat straw and stones.

The grain in bulk is stored in these storage structures which are neither rodent proof nor moisture proof. These structures can not protect the grain from fungi and insects. Substantial quantity of foodgrains (about 6.0% of total post harvest losses) are damaged in these storage receptacles due to moisture, insects, rodents and fungi.

Some of the commonly used rural grain storage structures are :

A. Traditional Rural Storage Structure

I Mud Bin or Kachcha Kothi

The mud bin or Kachcha kothi with capacity ranging from 2 to 5 quintals are indoor circular storage structures made of mud mixed with wheat or paddy straw.

The bottom portion of the wall section and floor is made in the form of rings which can be put one over the other so as to make the structure of desired capacity. Finally, the top with an inlet is provided to complete the kothi. Both the sides of structures are plastered with mud and cow dung. The thickness of the wall is about 7.5 to 10.00 cms. and an outlet of 10.00 cm diameter is provided at the bottom. These mud bins are available in U.P, Haryana, Bihar and M.P and are used for the storage of wheat, paddy, rice, maize and pulses. The foodgrains stored in such bins are easily damaged by insects, rodents and moisture.

II. Paddy Straw Bins

For storing paddy in eastern humid regions in India , dried paddy plants are used for making temporary structures which after filling the grains are further reinforced from outside by winding paddy straw ropes around the whole structure. These structures generally store 1-6 quintals of paddy grain. Some times, palm leaves are also incorporated in these structures to provide them extra strength and safety from heavy rains which are prevalent in these regions.

B. Improved Structures

I Coal Tar Drum Bin

The structure was developed and recommended by Central Institute of Agricultural Engineering (CIAE), Bhopal for grain storage at farm level . These are the used tar coal or bitumin drums which are discarded after using the material in road construction work. These drums are heated by open fire to remove excess coal tar. A layer of bitumin remains inside the drum which serves as insulator and protects the galvanized iron sheet. A lid is fabricated by local artisan and its capacity is about 1.5 quintals.

II Pusa Bin

The bin which is used for storage of foodgrains at farm level was developed by Indian Agricultural Research Institute(IARI), New Delhi. It is a LDPE (Low density polythene sheet) sandwiched bin. About 10 MTs grain can be safely stored in this bin.

The bin is fabricated on a pucca brick surface to prevent rat damage. A platform of burnt brick is made and LDPE film of 700 guage is spread over the platform extending 6 cm from all sides. An another layer of unburnt bricks is spread over this layer. The inside wall is built to the required height depending upon the capacity of the bin. A wooden frame with an additional pole at a distance of 45 cms from the end of structure is prepared and is placed at the top of the inner wall to support the roof.

A small hole of 9.0 cms diameter is made in the middle of front wall for delivery of the grain. A mud slab of 5.00 cm thick is placed on the roof leaving a manhole of 50 cms at one corner. The structure is plastered with mud on all sides and left to dry.

A LDPE film cover of 700 guage black sheet made in form of a mosquito net is then placed over the dried structure. A 9.00 cm diameter plastic pipe or galvanized iron sheet outlet with cover is fixed at delivery point. The LDPE film is pulled down and sealed with earlier layer of extended sheet. The outer layer is constructed using burnt bricks up to 45 cm and then unburnt bricks. The whole structure is again plastered with mud and allowed to dried before use.

III Domestic Hapur Metal Bins

These domestic grain bins have been developed by Indian Grain Management and Research Institute previously known as Indian Grain Storage Institute (IGSI) Hapur, UP. These are made of galvanized iron sheet or aluminum sheet of 18 gauge and have covered inlet and outlets. Their capacity ranges from 2 to 10 quintals.

In addition to above rural storage structures, outdoor reinforced brick bin (capacity ranging from 3.5 to 10.5 mts.), reinforced cement concrete (RCC) bins (capacity ranging from 1.0 MT to 2.5 MTs) and indoor pucca kothi (capacity 2.0 MTs) developed by IGMRI ,Hapur are also used for storage of food grains by farmers.

The following important points should be kept in mind while constructing rural grain storage structures:

1. The structure should be elevated and away from moist places in houses.
2. The structure should be air tight, rat and moisture proof.
3. The area surrounding a grain storage structure should be clean and dry.
4. The structure may be plastered with an impervious material like shalicoat to make it moisture proof.

Check Your Progress 2

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. What is the aim of aeration of foodgrain?

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2. What is the static pressure in grain storage?

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3. Name some rural tradition storage structures for foodgrains.

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4. What are the defects in the traditional grain storage structures?

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7.8 MOISTURE MIGRATION

Grain moisture is the most important critical grain management factor that regulates the storability of grain. Higher level of moisture attracts the insects and moulds which deteriorate the grain rapidly during storage. Low or safe moisture of foodgrains increases their storability.

Two types of water (moisture) are found in cereals. One is a bound water which is a part & partial of its constituent. Another water is free water which can migrate from grain to atmosphere and atmosphere to grain depending upon the moisture content of grain & relative humidity of atmosphere.

The traditional moisture migration theory states that if the grain is warmer than outside air, the interstitial air near the wall sinks towards the bottom of the silo, circulates in the grain mass along the floor, warms up, and rises through the centre portion of silo or bin . As the air approaches the headspace, the air drops its in moisture in the grain mass at the top surface of the silo, then continues to circulate below the grain surface back to the wall.

Grain is a poor conductor of heat like most other stored products. Therefore, heat does not escape easily or quickly in some portions of the bulk grain. Non-uniformity of temperature keeps warm spots to remain warm and if high temperature differences exist in the bin as induced by solar radiation, air convection currents are generated causing moisture migration. In this phenomenon, the convection air current picks up moisture from warmer grain and transfers this moisture to the cooler grain where condensation of moisture would take place. This results in grain damage which is attributed to molding, caking, rotting, and sprouting. This is considered critical in areas where large seasonal changes in temperature exist. The respiration of insects, moulds and the grain itself also creates localized heating in the grain bulk which could also raise the temperature of the region they occupied. This center of insect activity is known as the "hot spot". The hotspot expands in size because insects migrate because of its high temperature and create identical conditions along side through further respiration. The water produced by respiration tends to rise in the warm air of the hot spot and condenses in the cold grain. Both phenomena can cause damage and loss due to mould infestation.

Some of the benefits of the proper irradiation are as follows:

1. Aeration removes the bad smell from grain after the fumigation.
2. Equalizes the grain moisture in bulk storage.
3. Newly harvested grain can be stored in short periods without appreciable damage using aeration to provide cooling and dissipating heat caused by respiration.
4. It reduces the grain temperature.

7.9 STORAGE LOSSES

Considerable quantity of foodgrains are lost during post harvest handling:; storage and transportation. The losses are caused by moisture, temperature and biological agents during storage viz:- insects rodents, birds and storage fungi. Various estimates have been made to assess the post harvest foodgrain losses.

The Government of India had appointed a Committee to estimate the post harvest losses in 1966 under the chairmanship of Dr V.G. Panse, the then members of Planning Commission. In its interim report the committee reported 9.33% post harvest losses. The break up of these losses is as follows—

(i) Threshing losses 1.68%

(ii) Transport losses..... 0.15 %

(iii) Processing losses..... 0.92%

(iv) Storage losses due to:

(a) Rodents..... 2.50%

(b) Birds 0.85%

(c) Insects..... 2.55%

(d) Moisture.....0.68%

Total Post Harvest Losses.....9.33%

In an another study conducted by Indian Grain Management and Research Institute (IGMRI) Hapur, U.P. during 1998-99 and 1999-2000, **4.75%** post harvest losses have been reported in wheat in major wheat producing states viz. Punjab, Haryana, UP, MP and Rajasthan. The break up of these losses is as follows :

(as %age of production)

(i) Harvesting..... 1.13%

(ii) Threshing yards losses 0.59%

(iii) Transport losses..... 0.14 %

(iv) Processing losses..... 0.99%

(v) Storage losses due to:

(a) Rodents..... 0.59%

(b) Birds 0.05%

(c) Insects..... 1.22%

(d) Moisture..... 0.04%

Total Post Harvest Losses..... 4.75%

The average storage losses in foodgrains at FCI level are about 0.50 % and transit losses are about 1.2 %.

The above data indicate that the post harvest losses in foodgrains have been reduced considerably. This is due to the reason that improved type of rural grain storage structures such as metal bins, Pusa bins and pucca kothis are being used at farm level and farmers are using insecticides, fumigants and rodenticides for the control of insect pests and rodents. Further efforts are still required to minimize these post harvest losses in the foodgrains.

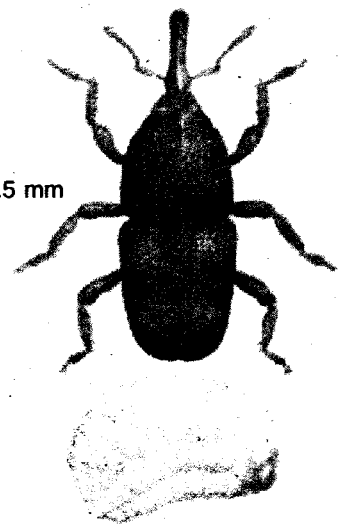
7.10 STORED GRAIN INSECT PEST AND RODENTS

Important stored grain insect pests

Among the pests which degrade and destroy foodgrains, insect of stored foodgrains are most important. These insects cause quantitative as well as qualitative damage to the stored foodgrains and also contaminate them with harmful materials like uric acid. Uric acid causes rheumatic pain in human beings. The brief life history and biology of some of the important and commonly found insect pests is given below:-

(i) **Sitophilus oryzae (Linn)**

Order	Coleoptera
Family	Curculionidae
Species	Sitophilus oryzae (Linn)
Common name	Rice weevil
Hindi name	Sundwali Sursuri



Sitophilus oryzae (L.)
Rice weevil

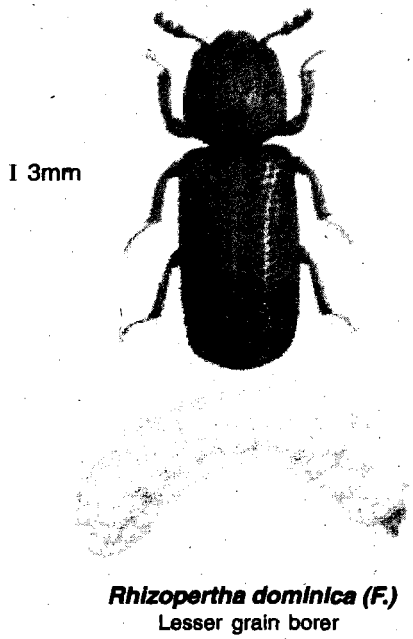
Identification:- The adult weevil is reddish brown in colour, 2.5 to 4.55 mm long having a well defined snout. Antenna is elbowed and clubbed. There are 4 light reddish marks on elytra and round punctures on pro-thorax are very dense.

Commodity damaged: – It is a major pest of all cereals like wheat, paddy, rice, maize, jowar and barley.

Habits and life History: – Under optimum condition of temperature (28 degree C) and relative humidity (70%) about 100-150 eggs are laid inside the grain by a single female weevil. The eggs hatch inside the grain and the tiny larvae begin to feed the grain by remaining inside the grain kernels. The life cycle is completed inside the grain kernel and the adult weevil comes outside the grain by making a round hole. Such type of grain kernels are known as weevilled grain.

(ii) **Rhizopertha dominica (Fab)**

Order	Coleoptera
Family	Bostrychidae
Species	*Rhizopertha dominica* (Fab)
Common name	Lesser Grain borer
Hindi name	Ghun



Rhizopertha dominica (F.)
Lesser grain borer

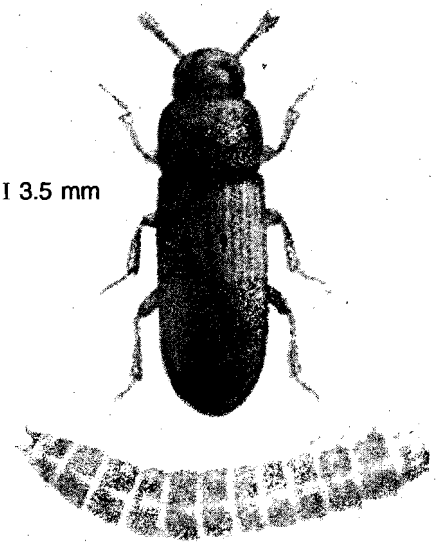
Identification:- Adult beetle is cylindrical in shape and dark brown in colour. Its head is deflected downward. The average length is 3 mm and antenna is 3 segmented club.

Commodity damaged:- It is a serious pest of all cereals like wheat, paddy, rice, maize, jowar and barley. Both, larvae and adult feed on the grain. Atta formation is the main symptom by which its infestation in the godown can be easily detected.

Habits and life History:- The adult are long lived and upto 550 eggs may be laid by a single female on the grain bags or on the surface of grain kernel. The thread life larvae enters the grain kernel where it feeds the endosperm portion of the grain and completes its life cycle. The adult insect comes out of the grain by making a hole. It is responsible for hidden infestation.

(iii) **Tribolium Castaneum (Herbest)**

Order	Coleoptera
Family	Dermestidae
Species	Tribolium castaneum (Herbest)
Common name	Red flour beetle
Hindi name	Ata ki keet.



Tribolium castaneum (Herbst.)
Red flour beetle

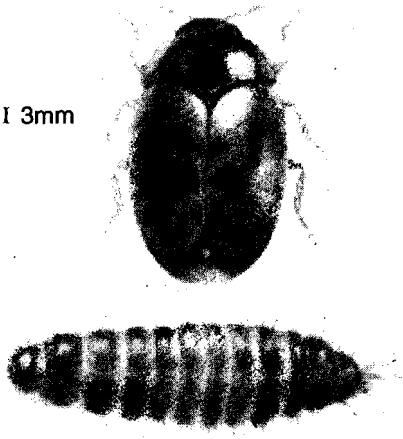
Identification:- Adult beetle is very active, moves fast and reddish brown in colour. Length is about 3-4 mm. Antennae are with distinct 3 segmented club.

Commodity damaged:- It is commonly found in broken cereals and their milled products like atta, maida and suji. It is also found in groundnut and oilseeds.

Habits and History:- About 450 eggs are laid by a female over a period of many months. The larvae are creamy whitish in colour and cylindrical in shape. The egg to adult development is completed within 20 days. Damage is caused both by adult and larva.

(iv) **Trogoderma granarium (Everest)**

Order	Coleoptera
Family	Dermestidae
Species	Trogoderma granarium (Everst)
Common name	Khapra beetle
Hindi name	Pai



Trogoderma granarium (Everts)
Khapra beetle

Identification:- Adult beetle is grey in colour, oval shape , small in size i.e 1.5 to 3.0 mm and brown in colour. Thorax is having 6 teeth like serrations on each side. Adult is harmless and does not consume grain. It is short lived. The larva is wheat straw coloured and has dense hairs on its body.

Commodity damaged:- The larva damages mainly wheat grain .

Habits and History:- Being a primary pest, it starts damage from germ portion of the wheat grain. It reduces the grain into the frass and excessive molting creates contamination and loss of merchantability of the grain. Crowding of larvae create unhygienic conditions in the grain stores.

RODENT

Rodents are vertebrate pests which belong to class Mammalia and have an external covering of hairs. Its Order Rodentia includes a large number of animals ranging in size from the smallest mice to as large as porcupine, squirrels and beavers etc. Rodents are easily distinguished from other mammals by the characteristics arrangement and form of their teeth. They have only one pair of chisel shaped incisor teeth in both the lower and upper jaws and no canines. The rodent incisors grow continuously throughout the animal's life @ 12.5 cms./year. According to Panse Committee's report, about 2.5% losses are caused due to rodents in storage annually. Rodents not only feed on grains but also contaminate 5 times more than what they consume with their droppings, urine, hair and even some times with their own dead bodies.

Some of the important rodents species, found in storage are as under :

HOUSE RAT

Scientific Name	:	**Rattus rattus (Linn.)**
Common Name	:	House Rat, Roof Rat, Black Rat
		(Hindi : Chuha)

NATURE OF DAMAGE

It eats up all food materials and can damage wood, plastic, rubber and even soft metals also. It is responsible for plague.

IDENTIFICATION

The important characteristics of black rat are as follows:

1. Soft grey to black coloured. Dorsal colour rufus; hairs on belly rough with rusty tinge.
2. It has small eyes, large sparsely hairy ears.
3. Snout is pointed.
4. Tail is thin uniformly dark coloured and is equal to the size of the body plus head.
5. Adult weighs from 150 to 200 gms.
6. Generally the droppings are found scattered and banana shaped.
7. Female has 10 mammae.

LIFE HISTORY AND HABITS

It breeds around the year with 5-7 litters per year, each having 6-14 young ones after a gestation period of about 25 days. Being nocturnal in habit, it can be seen rarely during day time. It is a good swimmer and good climber also. Life span is for 2 years in laboratory conditions, probably in field conditions for one year. It prefers to stay in dusty places. It is rarely found in sewers also. It rarely moves out of houses or crosses the big lanes. It can climb high to enter through roofs.

HOUSE MOUSE

Scientific Name : **Mus musculus** (Linn.)

Common Name : House mouse (Hindi : Chuhi or Chuhiya)

NATURE OF DAMAGE

Their infestation imparts a typical smell to store rooms and stocks. They feed on cereals, cereal products, vegetables, meat, fats, carbohydrates etc. and can damage wooden furniture, paper, clothes, rubber, plastic and leather goods etc. They are responsible for contamination of food with hairs, urine, excreta, and also spreading Salmonella organisms responsible for food poisoning. They may cause virus infection not only by faucal infection but also by walking over the foodgrains etc. They are responsible for disease like ringworm.

IDENTIFICATION

1. Colour is dark brown to sandy brown with smooth short hairs and under parts whitish to light grey.
2. Average weight is from 23 to 35 gms.
3. Tail is usually longer than head and body.
4. Rounded ears can be stretched upto eyes.
5. Female has eight mammae.
6. The droppings are scattered and spindle shaped.

LIFE HISTORY AND HABITS

Mating starts after 30-45 days of birth. Breeding is round the year with litters upto 8 per year and gestation period of approximately 19 days. Each litter size may be on an average 5.6 litter. A female may become pregnant only two days after it has given birth. Freshly born young ones are naked and blind and are weaned for 3-4 weeks. It prefers to stay in holes in floors or under the boxes or any other dark place suitable for hiding. It is active during night but can be seen in day time also. Movements are almost like darting. Feeding is confined normally upto 10 meters.

It can penetrate into buildings easily even through holes less than 1.2 cm. size. A mouse consumes 3-4 gms. per day (approx. 22% of the body weight). It can jump upto a height of 25 cms.

NORWAY RAT

Scientific Name : **Rattus norvegicus (Birken)**

Common Name : Brown rat, Sewer rat, Ship rat
(Hindi : Videshi Chuha)

NATURE OF DAMAGE

Feeds on grain. It damages containers i.e. bags/cartons and pollutes grain with excreta, droppings and hairs. It spreads various diseases.

IDENTIFICATION

1. Soft skinned brownish grey with whitish belly.
2. Its weight ranges from 200 to 300 gms.
3. Snout is wide and blunt.
4. Tail not uniformly tapered and shorter than head and body.

5. Ears are small, thick, furred, opaque and do not reach upto eyes when stretched.
6. It has 12 mammae.
7. Droppings are found in groups and spindle shaped.

LIFE HISTORY AND HABITS

It breeds round the year with 6-14 litters per year with a litter size of 5-7 young ones and a gestation period of 4 weeks. In one year 22 litters have been recorded in ideal conditions.

It is habituated of making burrows outside grain stored but often lives in sewers. The burrows are only on surface with two to five openings. Normally it stays within a radius of 25 to 30 meters. It can jump upto 60 cm. and is a good swimmer. Life span is for one year. So far it is confined to port towns mainly in sewers.

RODENTICIDES

Compounds which kill the rats by their chemical action are known as rodenticides. These poisonous rodenticides can be divided into two groups:-

a) Single dose poison

Zinc phosphide, Barium carbonate, Red squill and ANTU are some of the compounds which have been/ are being used as rat poisons. These are also called acute poisons as these are highly toxic in nature i.e. they show immediate fatal results. The defect of acute poisons is that these create poison shyness and bait aversion in rodents. Rodents are very suspicious to new objects (new object reaction) as well as to the new foods. Before the rats are given poisoned bait, plain baits i.e. eatable with some edible oil without poison is fed to rodents, for two days. This makes the rats habituated to feeding on that particular food. This process is known as pre-baiting. Next day the poisoned bait is placed in similar manner and on same locations instead of plain baits. Thus, a good kill is obtained.

Preparation of bait

Zinc Phosphide	-	2 parts
Crushed Foodgrains	-	94 parts
Any edible oil	-	2 parts
Sugar of Jaggery	-	2 parts

About 20 gms of the poisoned bait is kept in paper plate or earthen pot at 4-5 places in a room or godown. Rats consume the poison bait and die immediately. The dead rats should be collected and buried into the earth.

Multiple dose poisons

These rodenticides which are anticoagulant (cause bleeding) in nature are fed to rats in bait material continuously for 5-6 days. The rats are killed due to internal and external hemorrhage.

Bait material:-

(i)	Anticogulant	–	25 gms (5 teaspoon full)
(ii)	Flour (cereal / millet)	–	450 gms (4 teacups full)
(iii)	Sugar or jaggery in powder	-	15 gms (3 teaspoon full)
(iv)	An edible oil	-	10 gms (2 teaspoon full)

The four constituents are mixed thoroughly in a container. There is no need of mixing water. Prepared bait material (approx. 100 gms) is kept in 4 shallow vessels to facilitate rat feeding on rat runs, dark places where rats can consume bait without disturbance even during day time. Consumed baits should be replaced daily. Rats do not die immediately. They start dying after a period 6- 7 days. Dead rats should be buried The baiting should continue for 21 days to get an effective kill.

Phosphine gas fumigation

Aluminium phosphide pellets of 6 gms. are utilized for carrying out burrow fumigation. A simple rod like hollow bamboo or metal applicator is thrusted deep into the burrows and two pellets are put in each borrow. The burrows are sealed with mud. The liberated phosphine gas kills the rats in the burros.

Zinc phosphide poisoning symptoms:- Zinc phosphide poisoning causes nausea vomiting, diarrhea, severe abdominal pain. This is followed by symptom free period of 8 hrs or longer. Symptoms of systemic toxic absorption then begin. There is again nausea and protracted vomiting, diarrhea, hemorrhage in the skin.

Antidotes

1. Gastric lavage using 1 :5000 Potassium permanganate solution.
2. Cupric sulphate (0.2%) solution may act as emetic.
3. Beaten whites of 3 eggs may be given.
4. Fat or oil should be avoided by the victim.

Anti coagulants poisoning symptoms: Inhibits clotting of blood which causes internal and external hemorrhages due to depressed formation of pro-thrombin and other components of the clotting mechanism such as factor VII.

Antidotes: Vitamin K is given orally or intravenous which is available in the market under trade mark Kaplin.

Check Your Progress 3

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. What is moisture migration in a grain bin?

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2. What are the post harvest losses in foodgrains?

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3. Name some important stored grain insect pests and their damaging stages.

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7.11 CONTROLLED AND MODIFIED ATMOSPHERE STORAGE

The atmosphere in an airtight storage system can be altered or modified by using different techniques to the extent that atmosphere is lethal to the pests of the commodity. This is known as modified atmosphere or controlled atmosphere storage. This can be achieved by:

(i) The commodity itself can change the surrounding atmosphere by its respiration in hermetic storage structures.

(ii) By introducing inert gases such as carbon-di-oxide and nitrogen in an airtight storage system

In the hermetic storage system, the respiration of the commodity leads to reduction in oxygen level and thus, controlling the inset pests and fungi. When the oxygen level in an air tight system is reduced below 2% level, all the insect pests are killed. Hermetic storage structures had been used in ancient times for the storage of foodgrains in India and several other countries.

The introduction of carbon-di-oxide and nitrogen, each alone or in combination, in highly air tight bins has been found to be detrimental to stored grain inset pests. The oxygen level should be reduced to less than 2% level and this controlled atmosphere should be maintained upto 10-15 days.

Some of the advantages of using controlled atmosphere technology are:

(i) The insect pests during storage are controlled using non-toxic gases like carbon-di-oxide or Nitrogen which leave no toxic residues in treated commodities.

(ii) It also inhibits the growth of micro-organisms.

(iii) It reduces the grain respiration.

(iv) It reduces the oxidative degradation of commodities.

(v) There is no toxic effect on commodities treated upon.

However, there are some dis-advantages of this technology which are as follows:-

(i) It is costly and highly air tight storage structures/bins are required for this technology.

(ii) The process of dis-infestation is slow and 10-15 days are required for the control of insect pests and moulds. The controlled atmosphere technology has been successfully used for the storage of fresh fruits and vegetables.

7.12 PHYSICAL DISINFESTATION

Physical disinfestations techniques like cold storage, heat treatment and gamma rays irradiation are used as an alternative to chemical control for the storage and preservation of cereals, fruits and vegetables. Irradiation of foodgrains is a process through which food items including foodgrains are exposed to very high level of ionizing radiation. The grain is allowed to pass through a narrow irradiation zone for short time of few milli

seconds. Foodgrains may also be exposed to Gamma rays from radio active source (Cobalt 60 or Cesium 137) or high energy electrons (E-beam). These radiations sterilize the food items as well as kill the insects and moulds.

Wheat, corn and rice grain can be irradiation to low doses of 200 to 500 Gy. to inactivate the adults and larvae of stored grain inset pests. It has been found that shelf life of irradiated food items is increased. It also inhibits the sprouting in vegetables like potato, onion and garlic and extends their shelf life/storability.

Nuclear irradiation has been found to reduce the vitamins and nutrients in food items including fruits and vegetables. The long term effect of such irradiated food items on the health of consumers are not known. More studies and research activities are required before exposing the population to such diet. In India, Gamma rays irradiation of rice, potato, onion and some other spices have been recommended.

7.13 CLEANLINESS AND HYGIENE

Farm and commercial level storage of foodgrains have been practiced since ancient times. During storage, the foodgrains are deteriorated by physical and biological factors. These factors include moisture, temperature, insects, rodents, birds and storage fungi. Losses by these factors may be reduced to minimum level by maintaining cleanliness and hygiene in grain storage premises. The following steps should be taken to ensure cleanliness and hygiene in the godowns/stores:

1. The floor space in the godowns/stores should be cleaned daily.

2. The stacks (foodgrains bags) should be brushed at weekly intervals and after every fumigation.

3. Cleanliness should be maintained in entire storage complex.

4. The sweepings including dead insects after spraying of insecticides should not be left in godowns/stores and should be immediately removed.

5. The waste material and dead stock items including used old gunny bags, wooden crates, polythene sheets etc should not be stored in godowns. These should be stored in separate rooms.

6. Spilled grain should be immediately collected, sieved and filled in grain bags (palla bags).

7. Timely prophylactic and curative treatments (spraying of chemicals and fumigation for insect pest control) should be carried out in godowns. Similarly, rodent control operations should also be carried out as an and when required and dead rats should be collected and buried in the earth.

8. Measures to check birds entry in the godowns should be carried out and these should not be allowed to contaminate the grain with their excreta and dead birds.

9. Godowns can be made bird proof by equipping windows, ventilators and other possible entries by putting meshes size ¼ (0.6 cm). Polythene strips or nylon curtains may be used on doors of godowns/warehouses to check the entry of birds.

10. Proper and timely aeration which reduces the grain temperature and moisture and also eliminates the psocids infestation should be carried.

Check Your Progress 4

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. What do you understand by controlled and modified storage system?

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2. What are the gases which are used in controlled atmosphere technology?

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3. What are the advantages of physical dis-infestation of foodgrains and other items?

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7.14 LET US SUM UP

About 70% of foodgrains produced in the country are stored at farm level. The remaining quantity is procured by Government agencies and private traders. The farmers store their agricultural produce mostly in traditional rural storage structures which are made of locally available cheaper materials such as mud, bamboo, wood, wheat and paddy straw and stones. These storage structures are neither moisture proof nor are able to protect the grain from insects and rodents. Therefore, considerable storage losses in food grains are caused due to moisture, insects, rodents and storage fungi in these structures. Improved rural storage structures like Pusa bin and domestic metal bins are also used by farmers wherein storage losses are minimized.

The foodgrains are stored in bags as well as in bulk. Bulk storage system has several advantages over bag storage system. Although, the unit cost of creating the bulk storage system is higher as compared to bag storage system, the storage and transit losses are minimized in modern bulk storage system.

The silos and bins which are vertical cylindrical storage structures made of either steel or reinforced cement concrete (RCC) are also used to store the grain in bulk. Modern silos are equipped with in - built cleaning, drying, turning, aeration, loading and unloading system.

Moisture and temperature are two important physical factors which affect the storability of foodgrains. Grain stored at high temperature and higher moisture deteriorate very rapidly and these two factors attracts the insects & storage fungi to further spoil the grain. Mould growth in the grain produces mycotoxins in the grain which are poisons to man and animals.

Turning and aeration reduces the temperature as well as moisture content of foodgrains. Forced as well as natural air at ambient temperature is used for aeration purposes. Insects of stored foodgrains and rodents are two biological agents which cause both quantitative and qualitative damages to foodgrains during storage at both, farm and

commercial level. Controlled atmospheric storage system (cold chain) is used to store fresh fruits and vegetables.

Insects and rodents can be controlled by using recommended insecticides and rodenticides in the godowns and grain stores. The proper cleanliness and hygiene should be maintained in the godowns and warehouses to protect the grain from various biological agents like insects, birds, rodents and psocid. The floor of the godowns should be regularly cleaned and grain bags should be brushed after each spraying and fumigation. The sweepings, dead insects and rats should be removed from the godowns and dead rats should be dumped in the earth to avoid secondary poisoning.

7.15 KEY WORDS

Silo/bin : Vertical cylindrical storage structures made of steel or RCC for storage of foodgrains etc.

Aeration : Circulation of natural or forced air of ambient temperature to reduce grain temperature.

Rodent : Rodents are vertebrate pests of mammalia class and Rodentia order including mice, rats, squirrels and porcupines

Prophylactic treatment : Spraying of recommended insecticides in godowns for prevention of insect infestation.

Fumigation : Using of certain recommended toxic gases in a airtight structures to control insect and other pests

Rodenticides : The chemicals which kill the rodents

7.16 SOME USEFUL REFERENCES

1. Handling and storage of foodgrains in Tropical and Sub Tropical Area. FAO Plant Protection and Plant Production Series. 350 pages by **DW Hall**, 1970. Published by FAO Rome Italy.

2. Manual of Fumigation for insect control. FAO Agricultural Studies No.79. FAO Plant Production & Plant Protection Series No. 20. By **HAU Monro**, 1961. Published by FAO Rome Italy.

7.17 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. The bulk storage system has several advantages over the bag storage system. The bulk storage occupies less space, needs less man power and minimizes the storage and transit losses. The fumigation for the control of insect pests is more effective and efficient in bulk storage system than bag storage system.

2. The silos are cylindrical vertical storage structures made of steel or re-inforced cement and concrete (RCC) used for storage of foodgrains, oilseeds and other items in bulk.

3. The integrated bulk storage system consists of silos in the producing areas, specially designed bulk rail wagons with top loading and bottom discharged facilities and silos in consuming areas. The grain like wheat may be procured in bulk, may be filled in silos and can be dispatched in bulk wagons to the silos in consuming areas. The storage and transit losses are minimized and grain quality is maintained.

Check Your Progress 2

1. The main objective of aeration of the foodgrains in bulk is to reduce its temperature as well as moisture. Warm and moist grain deteriorates rapidly during storage. It needs to be aerated immediately.

2. The static pressure is the pressure against which the fan must operate in an aeration system and it is expressed as inches of water or Pascal.

3. The traditional storage structures such as mud bins or kaccha kothi, paddy straw structures, bamboo structures RCC bins are used by the farmers for storage of foodgrains. These structures are neither moisture proof nor rat proof. The fumigation for insect pests control cannot be carried out effectively in these storage structures.

4. The traditional grain storage structures are neither moisture proof nor rodent proof and therefore, heavy losses in foodgrains are caused by moisture, insects, rats and storage fungi.

Check Your Progress 3

1. If a grain bin is having moist grain and there is temperature variation in the inside air and outside air and if outside air is cool, then convection current of air passes from upper side of the bin along with the cooler surface of bin, it reaches to centre and picks up moisture as well as heat and on reaching at the top of surface of grain, the air cools down and drops water on the surface of the grain. This migration of moisture causes condensation and spoilage on the top layer of the grain bin.

2. In a study conducted long back in 1966, the post harvest losses in foodgrains had been estimated to be 9.33. In an another study, conducted during 1998-99 and 1999-2000 in major wheat growing states, about 4.75% post harvest losses have been reported in wheat.

3. Sitophilus oryzae(L.) (Rice weevil), Rhizopertha dominica(F.) (Lesser grain borer), Tribolium castaneum (Herbst.) (Red flour beetle) and Trogoderma granarium(Everts) (Khapra beetle) are the important insect pests of stored foodgrains.

Check Your Progress 4

1. In a controlled atmosphere grain storage system, the oxygen level in a bin is reduced to less than 2% level by introducing gases like Carbon-di-oxide and Nitrogen, alone or in combination. This low oxygen level and high CO2 and N2 concentration is allowed for about 10 to 15 days. All the insect pests including moulds are killed. In a modified storage system the atmosphere inside a hermetical sealed storage bin is modified due to increase in carbon di oxide level and decrease in oxygen level due to respiration of insects and grains.

2. Carbon di-oxide and Nitrogen are the main gases which are used in controlled atmosphere technology.

3. In physical dis-infestation of foodgrains and other food commodities, there is no insecticide residue in treated commodities, shelf life of commodities is increased and time taken in dis-infestation is very less as compared to chemical dis-infestations.