

## **Stored Product Pests:**

Stored Product Pests can refer to any organism that infests and damages stored products such as cereal, seeds, spices, dried fruit and nuts, books, fabrics, leather, carpets, libraries, and museums, and any other dried or preserved item that is not used shortly after it is delivered to a location, or moved regularly. These pests cause significant quantitative and qualitative losses.

### **Product pests include:**

- 1- Microorganisms such as fungi and bacteria.
- 2- Arthropods such as insects and mites.
- 3- Vertebrates such as rodents and birds.

Grains and legume products are vital food sources for humans universally. High proportions of produce may be lost due to agricultural pests, both pre- and post-harvest in stores and, problems of environmental and food hygiene mean that food systems continue to be stressed. Stored food products are important economically because they will be available throughout the year for consumption and not restricted to a specific time during the season. In addition to their nutritional values, they are rich sources of vitamins, minerals, carbohydrates, fats, oils, and protein.

### **Various pests such as insects, mites, fungi, and rodents were considered to be major problems associated with**

- 1- Food quantity, it is estimated that around 15% of total food products might be lost during storage processes due to pests.
- 2- Food quality, the food quality includes some invisible changes in the nutritive value or visible changes in grain properties such as appearance, color, and texture.

- 3- Reduces the rate of seed germination.
- 4- Besides, many species of stored product insects might cause allergies in humans due to transmitting toxins that are produced by some fungi, bacteria, or other types of toxins such as quinines which also might be considered carcinogenic substances.

Crop production in Kurdistan is in continuous decline owing to drought, lack of financial support to farmers and thus importing most commodities from abroad rather than encouraging local production. Further, the current losses due to stored pests, besides other factors, are considered a major constraint in increasing crop production both quantitatively and qualitatively in our country. We aim to better understand the sources of infestation and how to minimize the loss by finding suitable solutions. The ability to identify the different species of pests directly associated with stored products, together with access to information about their biology and pest status, is important to be able to support effective control measures against them.

### **What are grains?**

Grains are the products of plants belonging to Gramineae family which are mainly cultivated for feeding purposes. The word cereal is used as an indicator for plants in this family while grains are an indicator of fruits and seeds.

**Food grains:** grains used as food for humans such as wheat and rice.

**Feed grain:** grains used for animal feeds such as barley and oats.

**Legume pulses:** grains (seeds) that belong to plants of the Poaceae family which are considered an important source of proteins such as cowpeas and lentils.

### **Factors affecting grain storage**

#### **1- A biological agents**

- Storage temperature
- Moisture content of grains

- Properties of grains

## **2-Biological agents**

- Insects
  - Fungi
- Rodents
- Mites
- Birds

## **1- A biological agents**

### **Storage temperature**

Most grains stop breathing and consequently die when storage temperature reaches above 50 Celsius which also affects gluten contents in breads, though some kind of bacteria and fungus continue breeding till 80°C. Insect reproduction will increase with the increase of temperature to 40°C. While temperature below 15°C can influence insect development stages and eventually cause death when exposed to 10 °C. for a long period. The increase in grain temperature is usually accompanied by increased CO<sub>2</sub> production due to: grain respiration, insects, bacteria, or fungi activity.

### **The moisture content of grains:**

Factors that might influence the rising moisture content of grains:

- Harvest before complete maturation of product or after rainy days
- Grains exposure to dew, rain, or fogs
- Sea transportation of seeds
- Transferring grains from the dry area to the damp area
- Lack of homogeneity in grains (e.g. mixing early and late ripening crops) 8

## **The standard properties of grains and stored products:**

Stored products used for human consumption should have below properties:

1. pesticide residuals or other harmful chemicals should not be detected on grains.
2. Foreign substances such as (stone, sand, soil, weed, grass, stem, and seeds of other plants should be no more than 4% .
3. The percentages of damaged seeds by fungus, humidity & temp should not exceed 5% .
4. The waste product uric acids that result from insect's activity should not be more than 10g /100g seed sample
5. The moisture content should not be more than 13%
6. Living organisms such as rodents and insects (different stages) should not be present.

Federal Grain Inspection Service (FGIS) helps with sampling, inspection, process verification, weighing, and storage examination services that accurately and consistently describe the quality and quantity of the commodities being bought and sold

## **2-Biological agents**

### **1-Stored product losses due to mites:**

Mites are important pests of stored grains and other stored commodities. They are responsible for both the qualitative and quantitative losses in stored grains. Mites feed on embryos thus resulting in germination losses of up to 50% and consume up to 3% by weight of the grain, total losses by mites might reach 7%.

Further, the flour prepared from infested grains makes it unsuitable for milling and undesirable for live stocks. They also cause allergenic reactions including asthma, rhinitis, and eczema.

The flour mite, *Acarus siro*, a pest of stored grains is one of many species of grain and flour mites. The flour mite, which is pale

greyish-white in color with pink legs, is the most common species of mite in foodstuffs. The males are from 0.33–0.43mm and the females are from 0.36–0.66 mm. Flour mites contaminate grain and flour and they transfer pathogenic microorganisms. Foodstuffs acquire a sickly-sweet smell due secretion of certain lipids and eating only the germ portion leaving an unpleasant taste. If an infested sample is kept in hand, an itching sensation is a sign of the presence of mites.

Flour or grain mite

Kingdom: Animalia

Subkingdom: Invertebrata

Phylum: Arthropoda

Subphylum: Chelicerata

Class: Arachnida

Subclass :Acari

Order Sarcoptiformes

Family Acaridae

Genus *Acarus*

Species *siro*



### Life cycle:

Females can lay 1-24 eggs/ day after one day of their emergence and mating and continue till death. About 250 eggs can be laid by a female in her lifetime but might reach 600 eggs if the feeding is on dried milk & cheese. The population of mites is very sensitive to moisture, thus less than 12% moisture in the seeds causes death to the population. The optimum temperature for mite development is 20-25°C and optimum moisture is 15-18%. The female life cycle can be completed between 50-100 days depending on moisture, temperature, food availability, and mating status.

### Chemical Control

• Pirimiphos-Methyl/ Actellic • Chlorpyrifos-Methyl/Dursban • Malathion • Aluminium phosphide

### Stored product losses due to Fungi:

Is a member of a large group of eukaryotic organisms that includes microorganisms such as yeasts (single cell) and molds (multiple cell), as well as the more familiar mushrooms. These organisms are classified as kingdom Fungi, which are separate from plants. The major difference is that fungal cells have a cell wall that contains chitin, unlike the cell walls of plants, which contain cellulose but not chitin. Most fungi grow as hyphae, which are cylindrical, thread-like structures 2–10 µm in diameter and up to several centimeters in length. Hypha is a long, branching filamentous structure of a fungus. In most fungi, hyphae are collectively called mycelium; yeasts are unicellular fungi that do not grow as hyphae. All types of stored grains are susceptible to attack by microorganisms. Store fungi species of *Aspergillus* and *Penicillium* are mainly the most common storage fungi. High relative humidity and high temperature favor their development. Hyphae of *Penicillium* Hyphae of *Aspergillus*

*Penicillium* is important in food and drug production. Members of the genus produce penicillin, a molecule that is used as an antibiotic, which kills or stops the growth of certain kinds of bacteria inside the body. *Penicillium* can contaminate grains and produce toxins.

*Aspergillus* species are common contaminants of starchy foods (such as bread and potatoes). In stored products can cause disease on many grains, especially maize, and synthesize mycotoxins including aflatoxin which is both a toxin and a carcinogen.

Contamination of seed and grain with fungal organisms may result in the presence of a stink odor, kernel discoloration, loss of nutritive value, and loss in grain viability which has poor germination quality.

Storage fungi usually invade grain or seed during storage and are generally not present in large quantities before harvest in the field.

Contamination occurs through small quantities of spores contaminating the grain as it is going into storage from the harvest, in handling and storage equipment, or from spores already in the storage structures. Under high temperatures and moisture, this small amount of inoculum can increase rapidly.

**The development of fungi is influenced by the:**

- 1- Moisture content of the stored grain
- 2- Temperature,
- 3- Length of time stored,
- 4- Amount of insect and mite activity in the grain.

• **Fungi cause two distinct problems in storage grains.** These are grain spoilage from fungal growth or molds and the production of poisonous mycotoxins.

**A-Grain spoilage causes**

- 1- poor germination.

2-loss of weight, loss of nutritive value.

3-poor milling quality, and deterioration in the flavor and color of the grain

### **B -production of poisonous mycotoxins.**

.Mycotoxins are poisonous chemical compounds produced by certain fungal species that infect crops. Mycotoxin is harmful and may be fatal to human beings, and animals.

### **The best way to avoid damage by fungi during storage of food grains are:**

1-The grain should be properly cleaned and dried to a safe level of moisture content before storage below %12.

2-The temperature in the storage structure should be maintained. below 23°C to avoid moisture migration and reduce fungal activity.

3-Turn over the grains whenever possible.

4-The storage structure should be without leaks and free from dampness.

Storage losses due to rodents:

Rodents belong to class Mammalia and have an external covering hair. Its order Rodentia includes a large number of animals including rats and mice. Rodents inflict serious losses on different food grains in stores and warehouses. Rodents not only feed on grains but also contaminate 20 times more than what they consume with their dropping, urine, hair, and even sometimes with their dead bodies. According to WHO, rats and mice cause losses of 33 million tons of food each year, which is enough to feed 130 million people in the world.

Kingdom: Animalia



Subkingdom: Vertebrata

Phylum: Chordata

Class: Mammalia

Order: Rodentia

Family: Muridae

Some of the important rodent species found in storage are:

House rat / *Rattus rattus*. It eats up all food materials and can damage wood, plastic, and even soft metals. This species is responsible for spreading the plague. It feeds on cereals, vegetables, meats, fats, and carbohydrates and can also damage wood, plastic, paper, rubber, and leather. This species is responsible for contaminating food with hairs, and urine and also for spreading Salmonella bacteria. It feeds on grains, damages containers like bags, and cartons, pollutes grain with hairs, and spreads various diseases.

### **Detection of Rodent infestation:**

Visual sightings and typical noise, rats burrows, rats dropping and urine marks, feet and tail marks on dusty floors, torn bags, spilled grains, the disappearance of bait, and typical smell in a store room and stocks.

### **Signs of rodent infestation:**

When there are signs of rodent infestation, it is necessary to conduct a thorough investigation of the store, and its immediate surrounding area. There are a large number of clear signs of rodent infestation:

**1-Live animals:** Rodents are mainly active at night. If animals are nonetheless seen during the daytime, this is a sign of an already advanced stage of infestation.

**2-Droppings:** The shape, size, and appearance of droppings can provide information as to the species of rodent and the degree of infestation. The droppings of Norway rats are around 20mm in length and are found along their runs. The droppings of Black rats are around 15mm long and are spindle-shaped. Mouse droppings are between 3 and 8mm in length and irregular in shape. Droppings are soft and shiny when fresh, becoming black or grey after 2 - 3 days.

**3-Footprints and tail marks:** Rats and mice leave footprints and tail marks in the dust. If you suspect there might be rodent infestation, scatter some sort of powder (talcum powder or flour) on the floor at several places in the store and later check for traces.

**4-Tell-tale damage:** Rats leave relatively large fragments of grain they have nibbled at (concern marks). They generally only eat the embryo of maize. Sharp and small leftovers are typical for mice. Damaged sacks where grain is spilled and scattered can be a further sign of rodent attack. Attention should be paid to damaged doors, cables, and other materials.

**5-Urine:** Urine traces are fluorescent in ultraviolet light. Where available, ultraviolet lamps can be used to look for traces of urine.

**6-Burrows and nests:** Depending on their habits, rodents either build nests inside the store in corners as well as in the roof area or burrows outside the store. Rat holes have a diameter of between 6 and 8cm, whereas mice holes are around 2cm in diameter. These holes can be found particularly in overgrown areas or close to the foundations of a store.

## **Rodent Management;**

Several methods of rodent management need to be integrated in a manner to manage the rodent population, as a single method may not achieve success. The following methods can be used to control rodents in store:

1-Habitat manipulation: Availability of food, shelter, and water are main affecting rodent population. Thus, removing garbage and maintaining good hygiene conditions with sanitary practices will minimize rodent infestation.

2-Repelling: various chemicals have been considered rodent repellent such as laurontirate, actidione and analine but disappear quickly. Sound waves emitted by ultrasonic devices are unbeatable by rats but are unheard of by humans thus without any harm to human beings.

3-Poisoning: The most popular and effective method of controlling rats is the use of poison baits. The poisons used in the baits are of two types: **1-Acute poisons:** which are used in a single dose, i.e. zinc phosphide, thallium sulphate & strychnine hydrochloride. Rodents are very suspicious of new objects as well as new foods. Before rats are given poison baits, plain baits, i.e. eatable with some edible oil without poison are fed to rodents for 2-3 days. This makes the rat habituated to feeding on that particular food. This process is called pre-baiting. Then the poison bait is placed similarly in the same location to obtain a good killing result. If pre-baiting is not used because of fast poisons symptoms the rodent will develop bait shyness so that other rodents avoid feeding on the bait.

**2-Chronic poisons:** These act as blood anticoagulants and are used in multiple doses, i.e. warfarin, fumaric, recumin. These poisons are lethal when consumed for several days, as they cause external and internal

hemorrhage and make the blood vessels more permeable. This substance will replace vitamin K in thrombokinase enzyme which is found in platelets. Therefore another enzyme will be produced rather than prothrombin which helps blood clotting. Thus, hemorrhage will occur in blood vessels found on the nose, eyes, and urinary system till the death of the animal. Using multiple-dose poison baits, pre-baiting is not required and bait shyness will not happen in this case, but baiting should be continued for 21 days to get an effective kill. Extreme care must be taken when using rat poisons (read instructions carefully) to prevent the danger of children or pets being accidentally poisoned.

4-Chemo-sterilization: The chemical that makes the rodents sterile is called chemosterilants such as furadantine and colchicine. These are generally used as a mixture of one tablet of furadantine and half of colchicine to make both sexes sterile.

5-Fumigation: The use of fumigation like cyano gas and phosphine would give quick results without problems. In cyano gas calcium cyanide is used as a fumigant and for phosphine gas aluminum phosphide is utilized. Two tablets are put per hole and should be immediately closed tightly after fumigation by wet soil. The process should repeat twice in the following days on noticing any new burrows.