POST HARVEST MANAGEMENT OF WHEAT

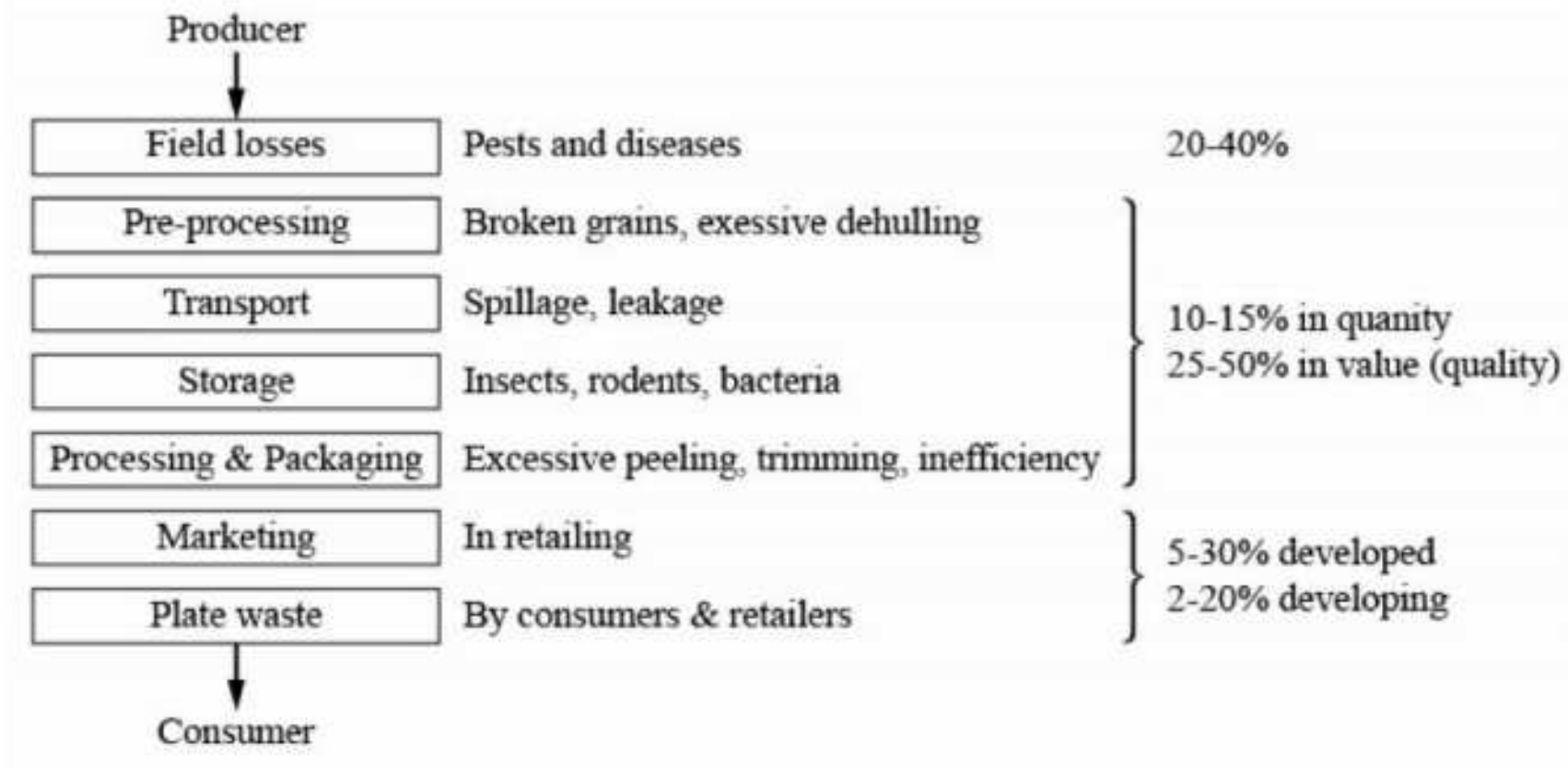
Storage & Processing

MANAGEMENT OF POST HARVEST LOSSES IN WHEAT
(Storage Component)

AGENDA

- **Post Harvest Losses**
- **Insect pests of stored Grains**
- **Non Insect Pests of Stored Grains**
- **Role of Abiotic Factors**
- **Management of Stored Grain Pests**

Losses along the Grain Chain



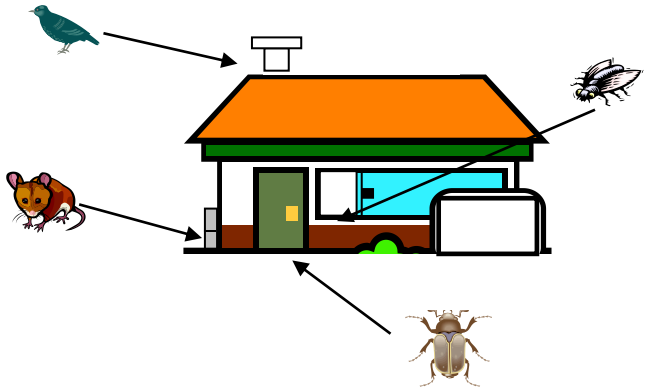
Why is Post-Harvest Management Important?

- Food Safety
- Quality assurance
- Better storage
- Better protection from pests
- Reduce losses (quantity & quality)
- Better marketing opportunities

Factors Influencing Grain Loss During Storage

- **Biotic**
  - Insects
  - Fungi
  - Bacteria
  - Mites
  - Rodents
  - Birds
- **Abiotic**
  - Grain Moisture
  - Relative Humidity
  - Temperature

All provide conducive environment to insect pests



All affect quality, seed viability as well as quantity of grains

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Types of Losses due to Pests

- **Direct**
- **Indirect**

Direct Losses

- Actual consumption
  - loss of weight,
  - loss of nutrients,
  - lower germination,
  - reduced grade
  - lower market value
- Contamination
- Damage to structures or containers

Indirect Losses

- Bacteria
- Fungi
- Aflatoxins
- Control and application costs
- Pesticide residues
- Loss of consumer confidence

Ideal Conditions for Pests

Environment Conditions

Temperature 20 - 40°C

Relative humidity 60-70%

Mixing grain lots

Old and new

Two Pest Categories

- **Primary** – Cause initial injury.
- **Secondary** – Take advantage of injury.

Major Insect Pests of Stored Grains

a) **Khapra Beetle** (*Trogoderma granarium)*

b) **Lesser Grain Borer** (*Rhyzopertha dominica*)

c) **Red Flour Beetle** (*Tribolium castaneum*)

d) **Saw Toothed Grain Beetle** (*Oryzophilus surinamensis)*

e) **Maize Weevil** (*Sitophilus zeamais*)

f) **Grain Weevil** (*Sitophilus granarius)*

g) **Rice Weevil** *(Sitophilus oryzae)*

h) **Flat Grain Beetle** *(Cryptolestes Furrigenius)*

i) **Pulse beetles** (*Callosobruchus chinesis,* C. *maculatus*)

Major Insect Pests of Stored Grains

j) **Angoumois Grain Moth** *(Sitotroga cerealella)*

k) **Rice Moth** *(*Corcyra cephalonica*)*

l) **Indian Meal Moth** *(Plodia interpunctella)*

Lifecycle

Beetles 15-18 days

Moths 28 - 35 days

Khapra Beetle: *Trogoderma granarium*

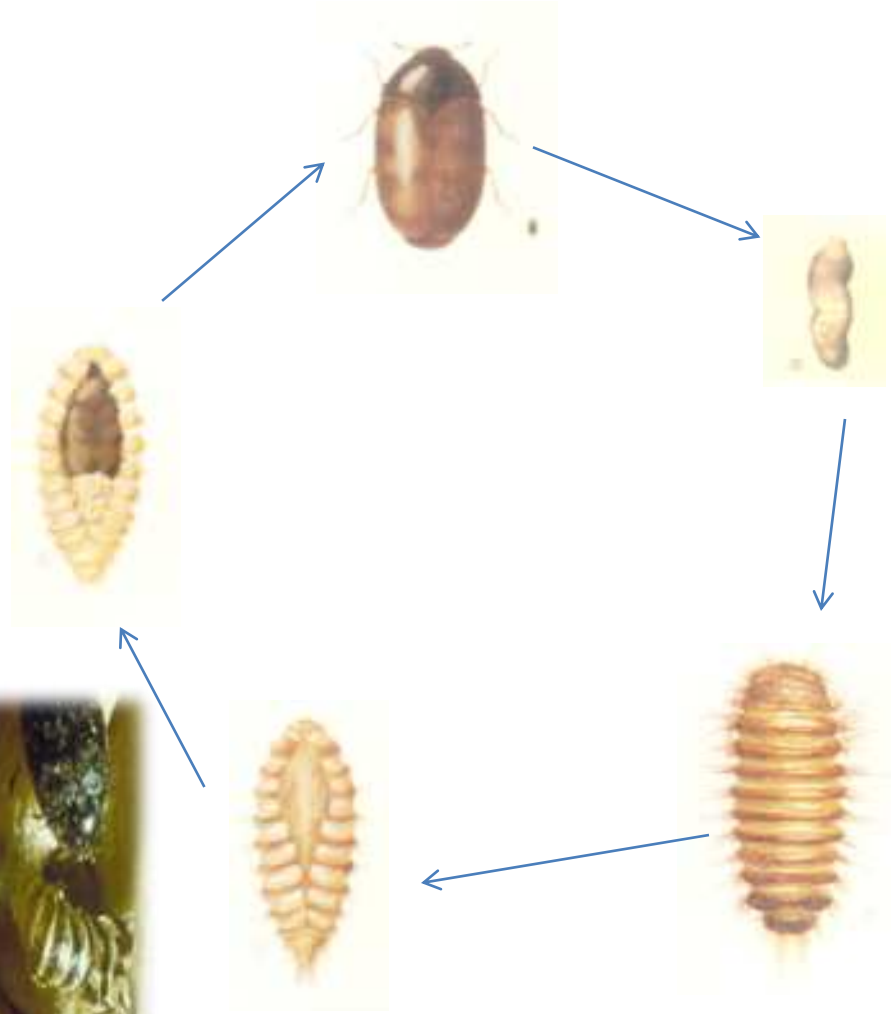
Host range:

Wheat, maize, jowar, rice, pulses, oil seeds and their cakes.

Damage

- ✓ Adults are harmless. Grub damages the grain starting with germ portion, surface scratching and devouring the grain.
- ✓ It reduces the grain into frass.
- ✓ Excessive moulting results in loss of market value due to insanitation caused by the cast skin, frass and hair.
- ✓ Crowding of larvae leads to unhygienic conditions in warehouses.
- ✓ Damage is confined to peripheral layers of bags in bulk storage.

Khapra Beetle Life Cycle



Lesser Grain Borer: *Rhyzopertha dominica*

Host range:

Paddy, rice, wheat, maize.

Damage

- ✓ Grubs and adults cause damage and are voracious feeders.
- ✓ Adults reduce the grain kernels to mere frass.
- ✓ Grubs eat their way into the grain or feed on the grain dust and are capable of attacking grain externally.

Lesser Grain Borer Life Cycle

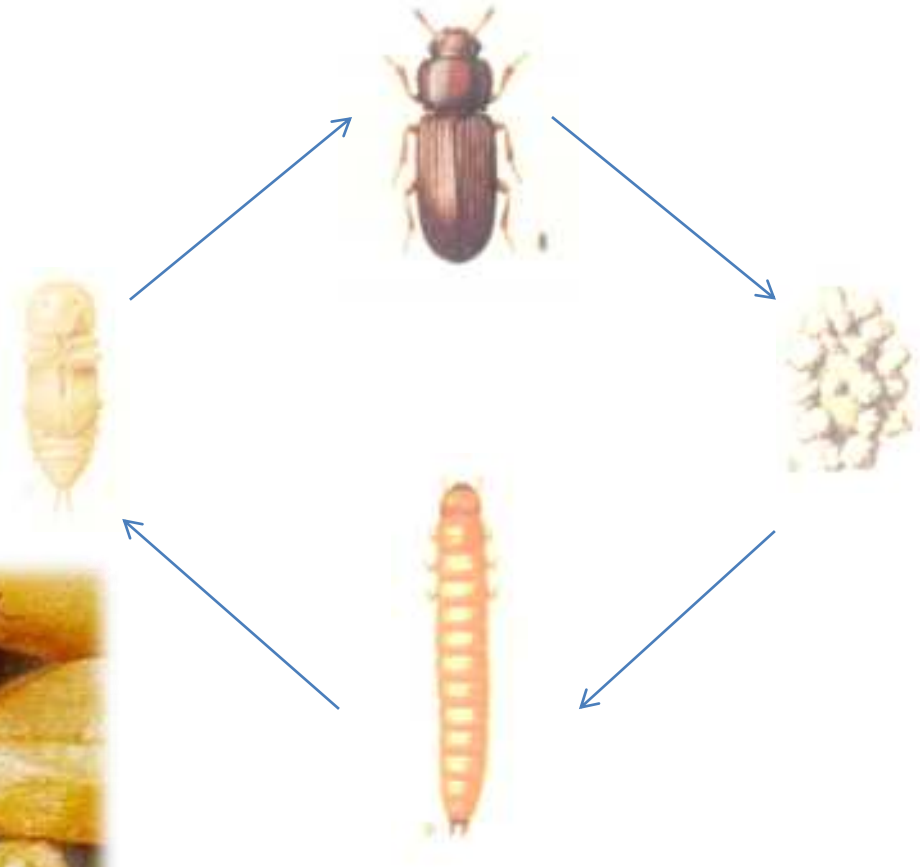
Red Flour Beetle: *Tribolium castaneum*

Host range: Broken grains/ mechanically damaged grains, germ portion and milled products. Heavy infestation causes stinking odour in flour, adversely affecting the dough quality. It is an important pest for mill machinery.

Damage

- ✓ Grubs feed on milled products.
- ✓ Flour beetles are secondary pests of all grains and primary pests of flour and other milled products.
- ✓ In grains, embryo or germ portion is preferred.
- ✓ They construct tunnels as they move through flour and other granular food products.
- ✓ In addition they release gaseous quinines to the medium, which may produce a readily identifiable acid odour in heavy infestations.

Red Flour Beetle Life Cycle



Grainary Weevil: *Sitophilus granarius*

Host range:

Wheat, rice, maize, jowar, paddy.

Damage

- ✓Both grub and adults cause the damage.
- ✓Grains are hollowed out; kernels are reduced to mere powder.
- ✓Adults cut circular holes. Heating takes place during heavy infestation, which is known as ‘dry heating

Grainary Weevil Life Cycle

Flat Grain Beetle Life Cycle

Host range:

Rice, maize, wheat with excessive brokens, different flours, groundnut particularly with high moisture and mouldy grain.

Damage

- ✓ Both adults and grubs feed on stored products and are important pests of mills.
- ✓ Grubs feed on germ portion and even on dead insects.
- ✓ Adults are only scavengers, cause heating in grain and flour in case of heavy infestation.

Flat Grain Beetle Life Cycle

Saw Toothed Beetle:*Oryzaephilus surinamensis*

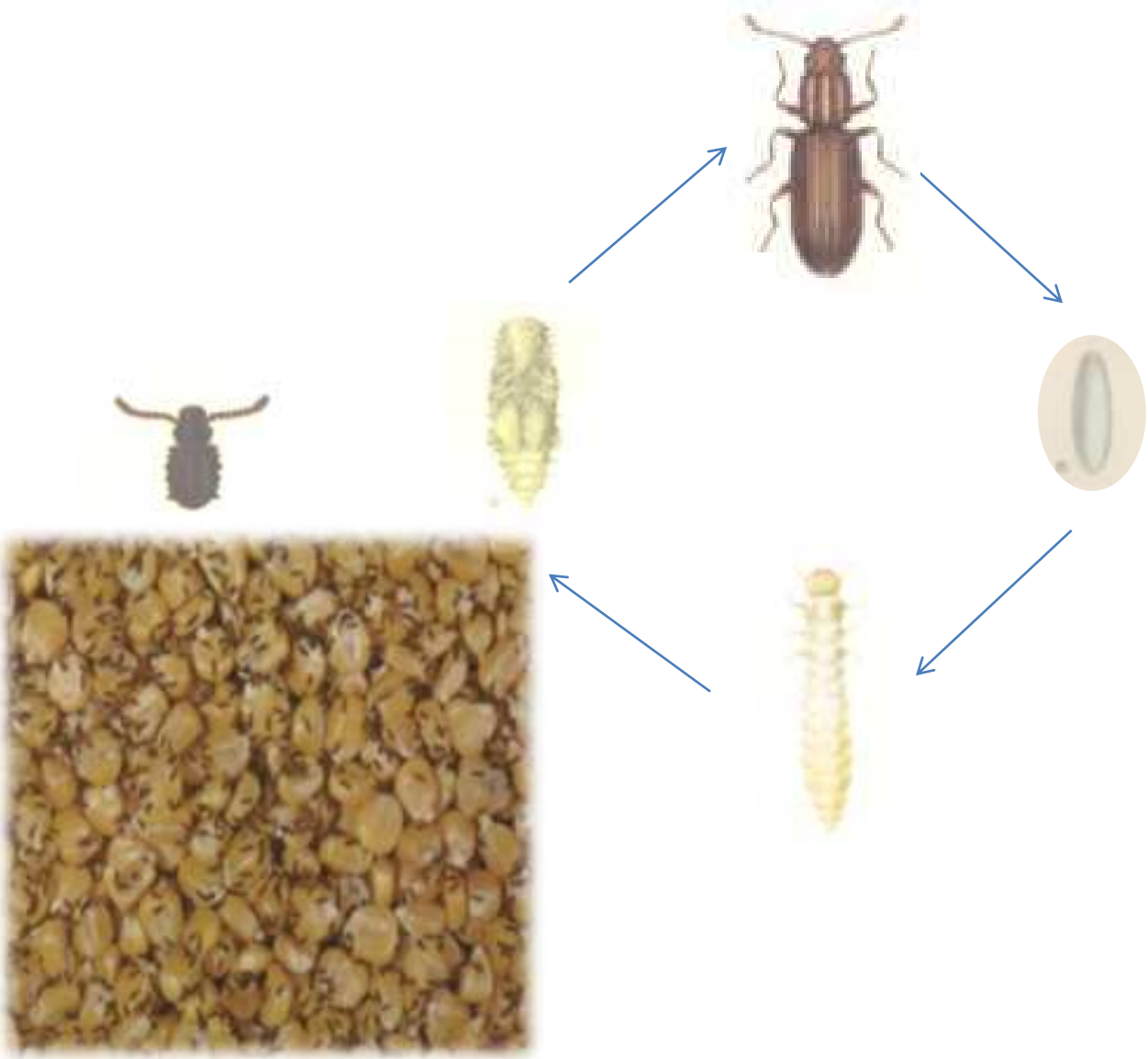
Host range:

Paddy, maize, wheat, jowar and barley.

Damage

- ✓ Common in grocery stores, storage warehouses, homes
- ✓ Adults penetrate packaged products
- ✓ Rapid lifecycle of 3 to 4 wk
- ✓ Larvae do not enter seed, feed externally as they go (secondary pest?)
- ✓ Serious heating of stored grain

Saw Toothed Beetle Life Cycle



Angoumois Grain Moth: *Sitotroga cerealella*

Host range:

Paddy, maize, jowar, barley and wheat .

Damage

✓Larvae damage grains, adults being harmless.

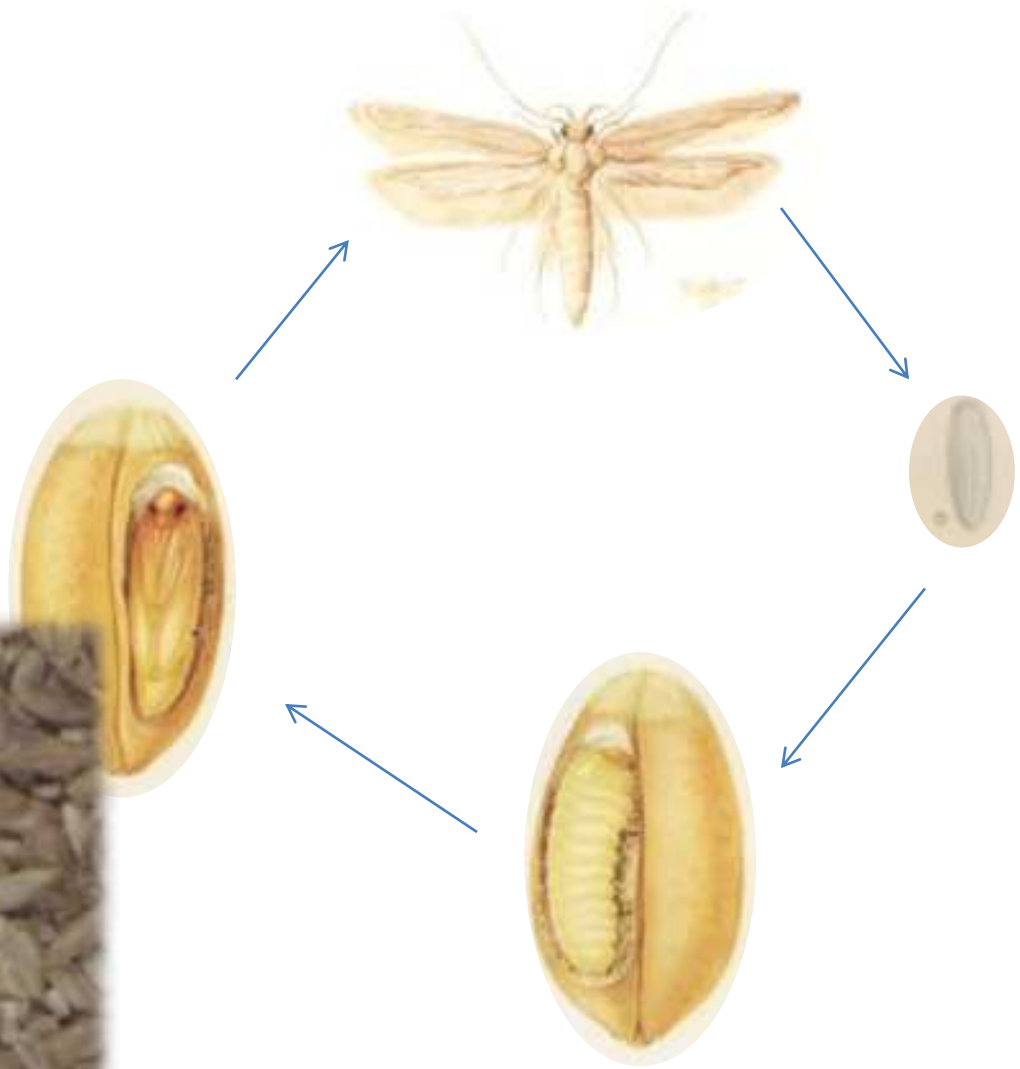
✓Grains are hollowed out.

✓It attacks both in fields and stores.

✓In stored bulk grain, infestation remains confined to upper 30 cms depth only.

✓Caterpillar enters the grain through crack or abrasion on grain.

Angoumois Grain Moth Life Cycle



Rice Moth: *Corcyra cephalonica*

Host range:

Rice, jowar, other millets, whole cereals, cereal products, pulses, processed products of cereals, pulses, oil seeds, nuts, dry fruits and milled spices.

Damage

- ✓ Larva is only responsible for damage.
- ✓ It contaminates food grains with frass, moults and dense webbing.
- ✓ In whole grains, kernels are bound into lumps upto 2 kg.

Rice Moth Life Cycle

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Non Insect Pests

- Rodents
- Mites
- Microorganisms
- Birds

What is a Rodent ?

Rodents are gnawing animals. They

- gnaw to wear down their teeth and get where they want to go (can cut anything softer than steel);
- are most active at night;
- make lots of babies fast;
- travel the same paths nightly, staying close to walls.

Rodents Associated with Stored Grains

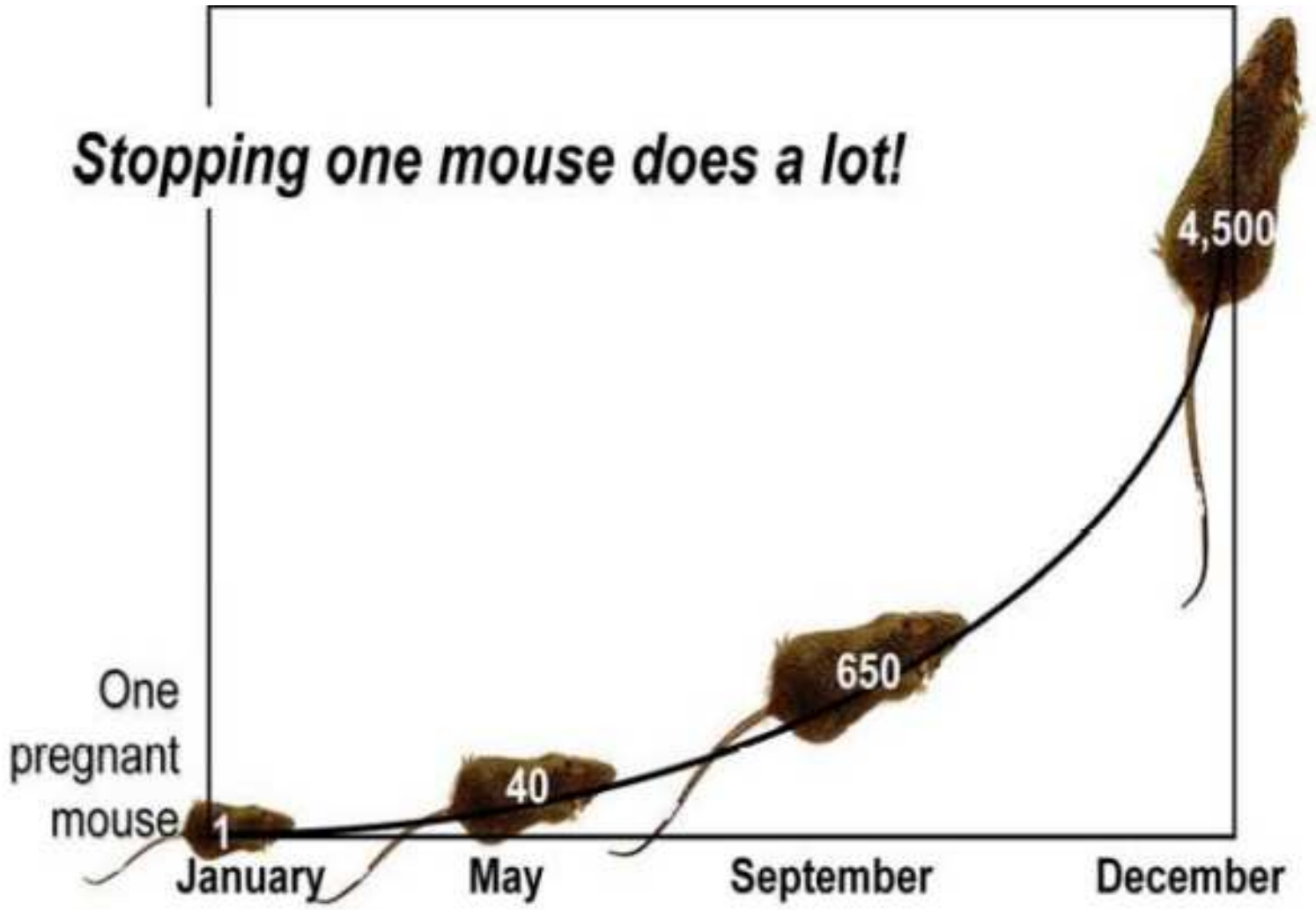
Three Species

- **Black rat or Roof Rat *(Rattus rattus)***

- **Norway rat or Common rat (*Rattus norvegicus*)**

- **House mouse (*Mus musculus*)**

One Mouse, One Year…..



Mite Pests

- Mostly occur in damp or moist grain.
- Mites are not insects.
- *Chiloglyphus and Acarus species* are considered most important mites of stored cereals.
- Mites multiply under high humidity conditions (over 65% relative humidity).

Mite Damage

- Direct damage by eating the germ of the grain.
- Infested commodity becomes tainted with off-flavours
- Affect the Seed Viability.
- Straw-itch mite´ can cause severe dermatitis and allergic conditions in people handling infested commodities.

Fungi Associated with Stored Grains

Most common

- **Aspergillus, Penicillium** and **Rhizopus**
- Grain spoilage and mycotoxins (poisonous)

Development of Fungi is influenced by

- Moisture content of the stored grain
- Temperature
- Condition of the grain going into storage
- Length of time the is grain stored and
- Amount of insect and mite activity in the grain.

Effects of Fungi on Food Grains

- Reduction of viability.
- Discolouration of embryos.
- Increase of free fatty acids.
- Production of toxins.
- Heating moulding and rotting.
- Mustiness of bad odour.

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Effect of Moisture Content in Food Grains

- The storage life of the grain is closely related to its moisture content.

- For safe storage, the moisture content in the food grains should be less than 10 per cent.

- The moisture content in a mature grain is about 16 to 18 per cent.

Moisture & Storage Span of Wheat

•If wheat grain broke with a typical sound of "**Karak"** under teeth, then moisture content is ok

Seed Moisture Content (%)	Storage Life
11-13	Six months
10-12	One year
9-11	Two years
8-10	Four years

Wheat grains stored for one year

Effect of Moisture Content…

Below 5% seed moisture,

- Breakdown of membrane structure.
- Hastens seed deterioration.
- **For every decrease of 1 per cent seed moisture content, the life of the seed is doubled.**
- (Applies only when the moisture content is between 5 to 14%)

Effect of Temperature

- It affects the growth of insects and microorganisms. which attack the stored food materials.

Insects (maximum growth rate)	30` C and 32`C
Micro-organisms and **enzymes** (most Active)	30`C and 40`C.

- Damage to the stored food materials can be significantly reduced by storing them at lower temperatures.
- **A 10 °F decrease in temperature nearly doubles storage potential of seed.**
- The sum of the **temperature in °F** and the **percent relative humidity** should not exceed 100.

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Principles of Safe Storage

Three Principle,

- As dry as possible
- As cool as possible
- Regular inspection

Management of Pests of Stored Grains

1. Sanitation of stores

2. Chemical control

3. Biological control

4. Controlled Atmosphere (Hermetic Storage)

5. Resistant varieties

6. Use of heat and cold environments

STORAGE OF WHEAT

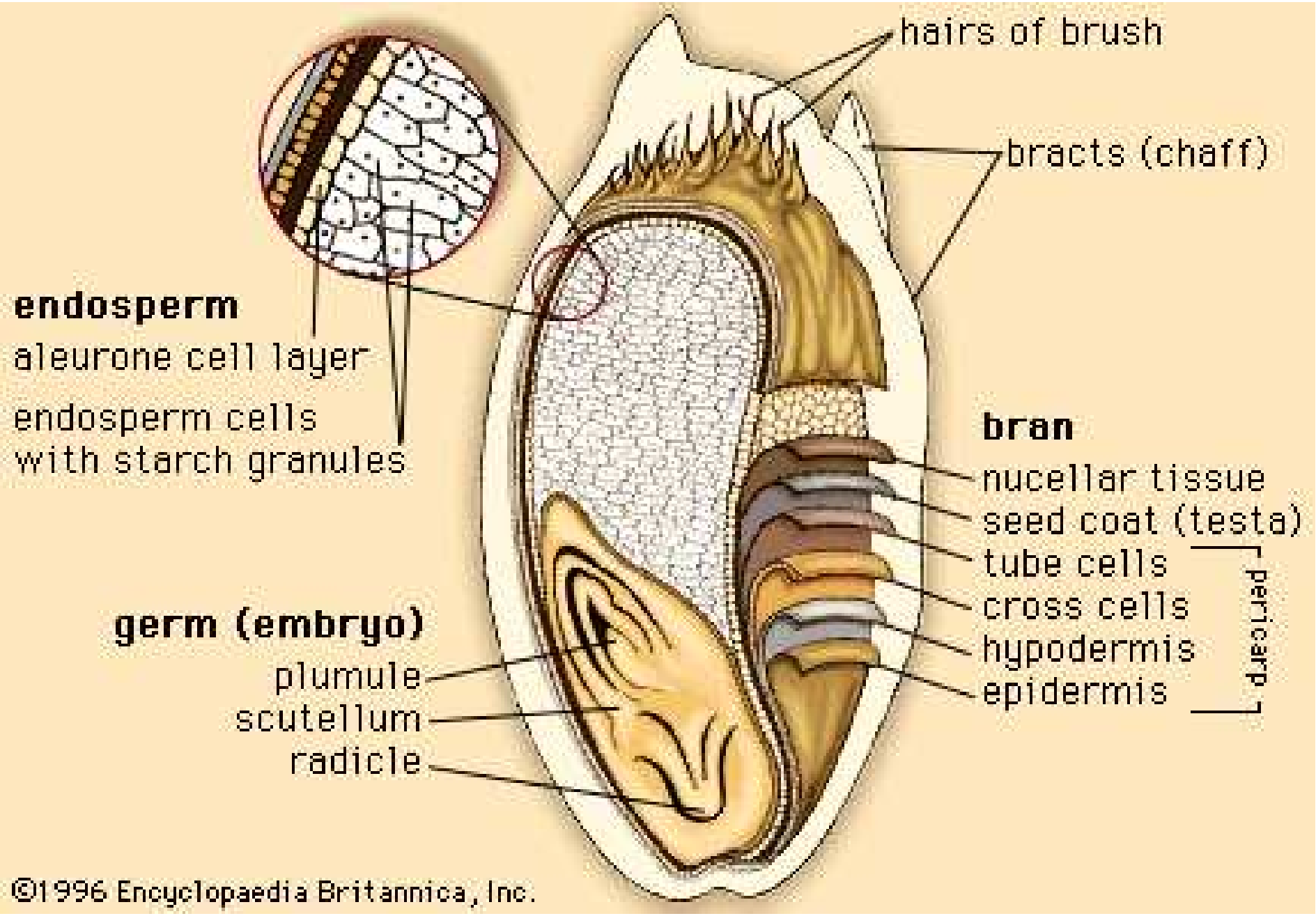
- Proper threshing to avoid seed breakage (Broken seeds are more susceptible to pest attack)
- Seed moisture should be <10% for storage
- Use new seed bags or spray old bags with proper pesticide
- **Fumigation of stores** with Aluminum phosphide (30-35 Tablets/1000 cubic feet)
- Store complete airtight
- Close for seven days after fumigation
- When open no entry 4-6 hours
- Suitable measures to avoid rats and ants

Post Harvest (Processing)

The wheat grain consists of four major parts. Their weight is expressed as a% of the total seed as follows:

- Seed Coat (Bran): 10%
- Aleurone layer (Bran): 2%
- Endosperm: 83%
- Germ: 5%
- **Total** **100%**

- In the industrialized world, wheat milling yields **flour and mill feed.**
- The milling process yields generally **72 to 74% flour**. The rest is mill feed.
- If only excessively coarse bran is removed to produce whole-wheat flour, recovery runs as high as **90%**
- In South Asia, the whole grain is milled and the flour recovery is **99%** or more.



- **The commercial important wheat belong to:**

- *Triticum aestivum* (common hard wheat)
- *Triticum dicoccum* (hard wheat)
- *Triticum durum* (durum wheat)
- *Triticum compactum* (soft white wheat)

❖ Wheat Milling:

The quality of wheat flour determines the suitability for a particular end-use. Therefore, milling plays an important role in the utilization of wheat for various products. Products made from wheat include bread, cakes, cookies, biscuits, pretzels, doughnuts, muffins, pasta, gruels, breakfast cereals, semolina etc.

Each of the above could be subdivided into many forms. Therefore, different operations are included in the wheat milling process.

Wheat Products

❖Wheat-based breakfast cereals:

♠ **Bran:** Bran contains a relatively high lipid content and this unsaturated lipid rapidly becomes rancid unless the bran is stabilized by heat to inactive the lipases. It is used as an additive to increase dietary fiber, particularly in breakfast cereals.

♠ **Isolated wheat products:** Wheat is used as a source of starch and gluten. The starch is separated by fractionating the flour, either by wet or dry air classification methods. Gluten is prepared by washing the soluble components from the flour. The gluten may be used as an additive to low protein flours to improve their bread-making qualities.

Methods to be used for checking the wheat quality

- **Physical methods:**
  - **Grain appearance,**
  - **Vitreous kernel,**
  - **Damaged and infected kernels,**
  - **Kernel weight (1000 grain weight),**
  - **Test weight,**
  - **Grain hardness,**
  - **Flour/Semolina recovery,**

Chemical methods

- Moisture,
- Ash,
- Crude protein,
- Crude fiber,
- Starch,
- Sugars,
- Damaged starch,
- Falling number,
- Lipids,
- Fat activity,
- Sedimentation,
- β-Carotene,
- Gluten,
- Acid insoluble protein,
- Lysine,
- Gliadin,
- Glutenin,
- Friabilin,

❖Rheological methods:

♣ Mixograph

The mixograph is a dough testing equipment used to assess the baking quality of flours from soft, hard and durum wheat. It provides information on the mixing and absorption characteristics of flour.

♣ Alveograph,

It is based on injecting air into a thinly stretched sheet of dough to form a bubble, simulating gas/carbon dioxide release and retention during dough fermentation and oven spring during baking.

♣ Farinograph

The Farinograph is used to determine flour strength and to predict processing characteristics like water absorption and mixing time. The instrument works by measuring the resistance to mixing of a flour and water dough.

➢ Pre-milling operations:

1. Cleaning

1. **Wheat washing:** Removing dirt
2. **Screens:** Separation of impurities based on size and shape
3. **Milling separators:** Separates dust, stones, sands etc.
4. **Magnetic separators:** Metal pieces separated on electromagnetic properties
5. **Aspirations:** Light materials such as chaff, straw, small seeds by terminal velocity
6. **Specific gravity separators:** Using air separate the suitable material.
7. **Dry scourers:** Used machine to removes hair and dirt adherent to the grain

2. Tempering

Water is added to the grain to raise the moisture content of grain upto 15-19% in hard wheat and to 14.5 to 17% in soft wheat. Keep the grain in bins for 18-72 hrs.

3. Conditioning / Hydrothermal Treatment:

This involves use of heat for quick diffusion of water into endosperm and bran. It improves milling properties with saving of time. It can be used for improving shelling efficiency, nutritional quality and milling quality and for facilitating degermination and dehulling of corn and wheat

1. **Warm conditioning: For 60-90 min at 46 ^{0}C and allowed for 24 h before milling**
2. **Hot conditioning: Similar to warm conditioning but the temp. raises to 60 ^{0}C or higher.**
3. **Steam conditioning: Steam heating, it requires less power and gives higher yield of flour.**

Parboiling of Wheat

- Debranned and cracked parboiled wheat is known as **bulgur**.
- Bulgur is one of the special products of wheat. Various cooked foods, quick cooking products, breakfast cereals can be prepared using bulgur.
- The process of bulgur wheat production consists of soaking followed by steaming, drying and milling.
- **Principle of parboiling of wheat:** For complete gelatinization of starchy endosperm by open steaming, the moisture content of raw wheat has to be raised to the level of 80% by soaking prior to steaming.
- **Soaking:** 75 ^{0}C for 25 h;
- **Steaming:** open steaming for 15-20 min;
- **Drying:** at 75 ^{0}C for 3 h to get cracks

Methods of parboiling and production of Bulgur

- **Traditional batch method:** Soaking, open steaming, drying, partial debranning in a polisher, cracking by disc type cracking machine.
- **Modern method:** Soaking, pressure cooking (steaming) in modern parboiling units, drying in dryer, debranning and cracking in modern milling machines.
- **Chemical lye peeling method:** Continuous soaking and pressure cooking, lye peeling (NaOH), drying and cracking.

Milling Operations of Wheat Grains

➢1. Breaking

Grains are passed through break rolls. Four or five sets of rolls are employed for breaking grains, a mixture of bran, free endosperm and bran containing endosperm goes to next breaking roll. Horizontal rolls are faster and gives higher production.

➢ 2. Sifting

Sifting or scalping machine. It is a combination of sieving operations (plan sifters) and air aspirations (purifier). The resulting flour and endosperm chunks (middling) which still contain bran particles are transferred to purifier.

➢ 3. Purifying

It consists of a long-oscillating sieve inclined downward, through which air current is passed in the direction of floor to ceiling. The number of purifiers may be up to 12 for a system with 4 break rolls.

➢ 4. Reduction

These reduce the endosperm middling to flour size.

➢ 5. Scratching

A scratch system is sometimes used as a standby to maintain proper release of endosperm from bran (standby to break and reduction system).

➢ 6. Entoleter

It acts like a detacher and increases the yield of flour. The machine consists of a disc with concentric rings rotating at high speed. If any living matter (insects, fungi) is present, it gets killed because of the centrifugal force. This machine avoids the use of chemicals to control the organisms.

➢ 7. Air classification

The product is separated in air classifiers into their constituent fractions varying in protein content. Air classification is relatively inexpensive and has certain advantages.

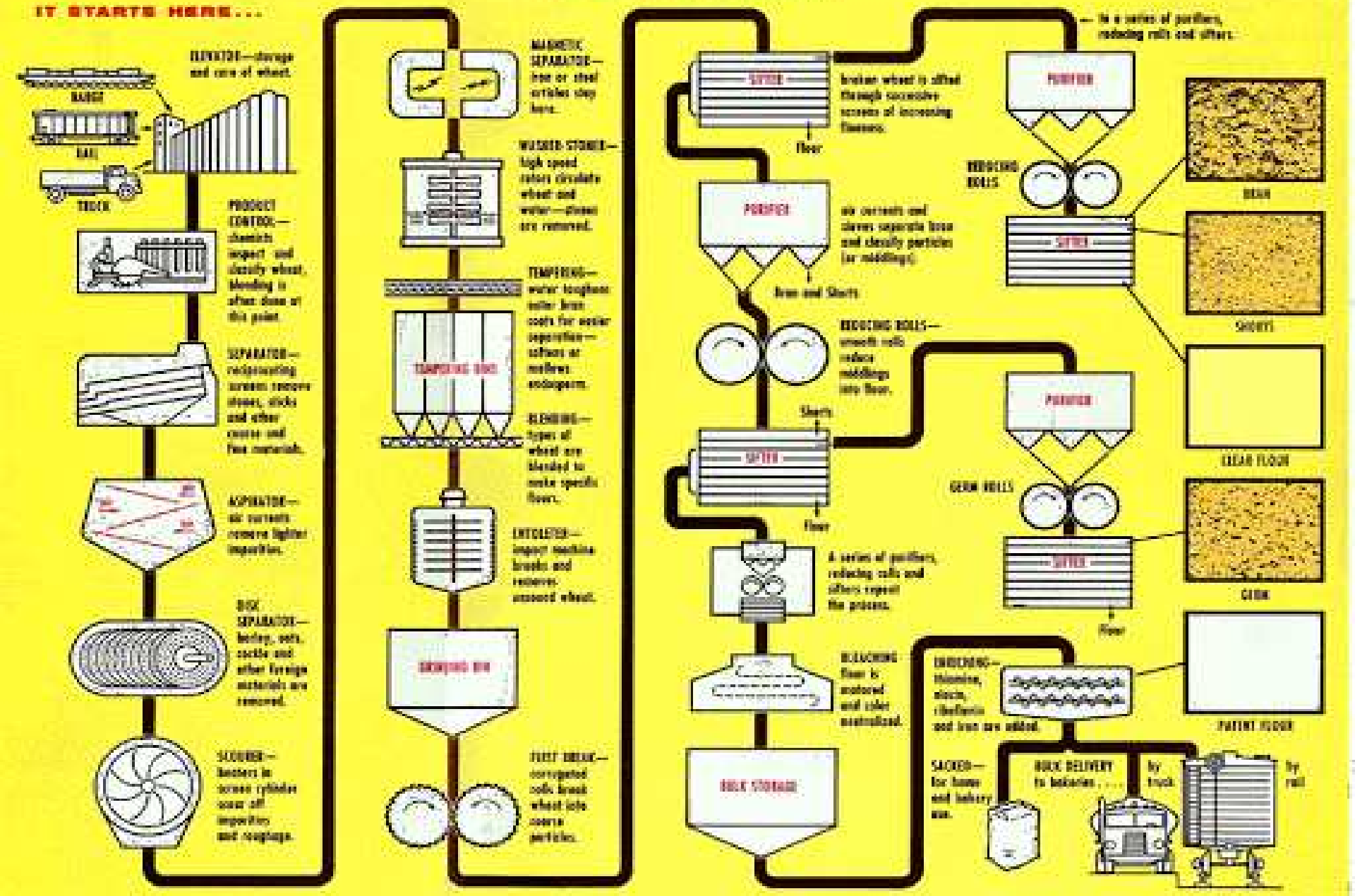
* Manufacture of more uniform flours from different wheat.
* Increase of protein content in break flours and decrease of protein in cake and cookie flours.
* Controlled particle size and chemical composition.
* Production of special flours for special uses.

➢8. Conveying system

Development of pneumatic conveying was an important advantage for the milling industry. Vacuum is applied using pumps or fans. Besides transportation an intake through roller mills keeps rolls and flour cool during grinding. This milling process is applied for hard wheat.

HOW FLOUR IS MILLED

(A SIMPLIFIED DIAGRAM)



Chemical additives to wheat flour

❖ In the milling of wheat in many countries, minute quantity of certain chemical substances are added to the flour to improve it in various ways-such as ageing (maturity), bleaching or enriching.

❖ **Ageing:** Bread made from freshly-milled flour is usually inferior in loaf-volume, texture and colour to bread made from flour of the same source after it has been stored for several months. The gluten is in some way improved by a natural 'ageing' or maturity process. By addition of potassium bromate the flour is satisfactory matured in a few hours.

❖ **Bleaching:** Untreated flour is often of a yellowish colour and produces yellowish bread-primarily because of a pigment known as xanthophylls, which is present in varying amounts in flour made from wheat of different varieties or produced under different conditions. Therefore, many countries the flour is bleached by the addition of minute quantities of bleaching agent such as nitrogen peroxide, chlorine etc.

❖**Combined Ageing and Bleaching:** **The simultaneous ageing and bleaching of a flour has been achieved by the addition of an improving agent together with a bleaching agent (Nitrogen trichloride (Agene), Chlorine dioxide, Benzoyl peroxide etc.)**

♣**Enriching:** **In various countries certain vitamins (thiamine, riboflavin, niacin), minerals (iron) or other (vitamin D) chemical substances of nutritional value are bleached with the flour at the end of the milling process to increase its nutritional value.**

THANK YOU