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A Survey on the Indian Storage Methods of Food Grains and Pest Infections

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Abstract:
In the past scenarios across the globe, several tons of grains that are stored after harvest cannot be maintained for very long due to the spoilage caused by various biotic and abiotic factors. To overcome this, over the years several techniques have been administered to improve the storage quality and protect the grains. Started at the traditional level and slowly covering a few technical aspects, the mechanisms have improved. Though not giving cent percent result, the grains can be saved up for a longer term for human consumption. The techniques are being studied on and further changes being made with respect to the many disadvantages of them, providing a wider scope for better ideas to come up letting the harvested grains a longer strike at lasting longer.

Keywords: Kothas, Talab, Kuttar, Beris, Hermetic storage, silos, Rice weviel, Red beetle, Meal moth,Toothed grain beetle.

INTRODUCTION:

To meet the food demand of a fast growing global population is coming up as a big challenge to humans. The population will be growing to 9 billion people by the year 2040, and about 71% more food production will be necessary to feed everyone. However, postharvest loss (PHL), does not receive the needful attention and less than 4% researches has been allocated for the issue in the last many years. About one-third of the food produced is lost around the world during postharvest processes every year. “Food loss” is defined as the food that is available for human consumption but goes unconsumed due to various factors. The losses can be divided as weight loss due to spoilage, quality loss, nutritional loss, seed viability loss and commercial loss. The massiveness of postharvest loss in the food supply chain varies greatly among different crops, areas and economies.

A large amount of produce is lost in postharvest processes due to lack of knowledge, inadequate technology and poor storage conditions. PHL accounts for physical losses and quality losses that reduce the economic value of the crop, or may make it inedible. In certain cases, these losses can be up to 84% of the total produce. It is very important to know the reason and magnitude of these losses and identify its causes and suggest possible solutions. Although losses may occur at each stage of the supply chain from production to consumption, storage losses seemingly the most critical in developing countries. While many parts of the globe are well fed, a majority of humanity is not able to have one square meal a day. The amount of food wasted could be at least one meal to the many that starve. It is time to realize that huge amounts of harvested crops are being wasted and this is affecting a large part of the society. While several methods have been adopted from time to time, the wastage still remains high and discussions to reduce it further with respect to the growing population is of high priority

MATERIAL AND METHODS:

Existing Traditional Methods:

Kothas:

In Rajasthan, grains stores are called Kothas. It is made using Talab (mud mixed with a bit of straw). The external white coating is done using a white mud diluted in water, as shown in fig.1. The main drawback here is that grains cannot be stored for more than 2-3 weeks.

Kaambara:

In Tamil Nadu, a permanent masonry structure called Kaambara is built with bricks pasted with a mixture of diluted lime and sand called lime mortar, as shown in fig.2. There exists no method to control temperature and moisture. Hence, spoilage cannot be detected. In Tamil Nadu, a permanent masonry structure called Kaambara is built with bricks pasted with a mixture of diluted lime and sand called lime mortar, as shown in fig.2. There exists no method to control temperature and moisture. Hence, spoilage cannot be detected.

Fig1: Talab Pots used for Kothas Storage

Fig 2: Lime Mortar Pot

Kuttar:
In Uttarakhand, grain stores are wooden structures looking similar to small temples and called Kuttar, as shown in fig. 3. Every household has their own granary, as the produce is rich in the region. Mites are likely to infest the structure over time.

Beris:
In Champaran, Bihar, the grain stores are called Beris, as shown in fig. 4. An outdoor structure used for storing grains and made with bamboo strips or locally available perennial grass. It is usually circular in shape and plastered with mud. The base on which the structure is constructed is made of grass or in some cases with stone pieces or brick. The platform is raised and protects grain from rat damage and avoids moisture absorption from the ground. The roof of the structure is usually made from coif material.

Fig 3: Wooden Kuttar

Fig 4: Structure of Beris using Bamboo

Existing Commercial Methods:
Grain aeration:
This can be defined as the forced movement of ambient air of suitable quality through a grain bulk for improvement of grain storability, as shown in fig. 5. It is a practice adopted to decrease the material/produce's temperature.

Refrigerated storage:
In this method, ambient air is cooled and then passed over the bulk grains via existing aeration system, as shown in fig. 6. Insects' resistance to chemical products has become a serious problem and the development of direct methods of insect control is a matter of importance. Refrigeration has been used for cooling dry grain in subtropical climates when ambient control by aeration with untreated air. Temperatures are too high for successful insect habitation. To be economic, the storage has to be thermally insulated and the cooled air circulated.

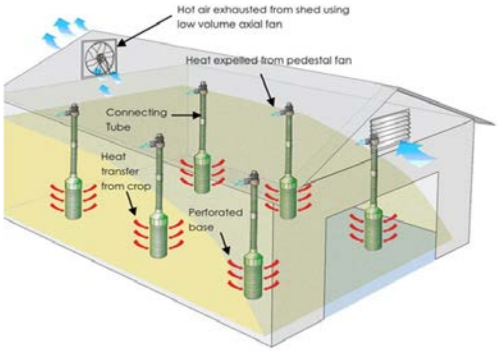

Fig 5: Layout of grain aeration

Fig 6: Refrigeration Area for Aeration

Hermetic storage:
An airtight or sealed storage is termed as "hermetic storage", as shown in fig. 7. The method enables insects and other aerobic organisms in the commodity to generate the modified atmosphere by reducing oxygen. Hermetic storage also allows for organic storage without chemical pesticides, which is an added advantage when compared to many traditional methods. Detecting internal spoilage due to respiration of seeds or fungus is not easy. Rodents and birds are not very attracted as they are unable to smell the grains.

Silos:
A silo is a concrete or metal structure for storing bulk materials, as shown in fig. 8. Silos are used in agriculture to store grains or fermented feed. It is more commonly used for bulk storage of grain, coal, cement carbon, food products and sawdust. Grain storage in silos is vertical while the storage of grain in warehouses is horizontal. One main advantage lies in the ground surface that is occupied. Another advantage is how easy it is to keep constant storage conditions for the grain by controlling the temperature, birds, rodents etc. which in long term storage facilities would result in an important economic loss. The main drawback is the high initial installation costs and maintenance of these vast sized silos.

Fig 7 : Sealed Storage

Fig 8: Metal Structured Silos

Pest Grains:

Rust-Red Flour Beetle:

They have cream colored larvae that feed externally on damaged grain. The beetles, as shown in fig. 9, infest whole grain, but breed more successfully on processed products. (Eg.: Flour). They move quickly and are strong flyers. When in low numbers, sieving and probe traps are used to detect them. Their preferred habitat is around storage areas with poor hygiene, broken grain, grading or bulk cottonseed.

Rice Weevil

The larvae is generally not seen, they feed and develop inside single grains. Life cycle is completed in four weeks at 30 degree Celsius, 15 weeks at 18 degree Celsius and breeding stops below 15 degree Celsius.

Under warm conditions or when grain is moved, Rice Weevil is often observed climbing out of grains up vertical surface, as shown in fig. 10.

Fig 9: Rust-Red Flour Beetle

Fig 10: Rice Weevil

Flat Grain Beetle:

Larvae, with signature tails and horns, feed and develop on damaged grains, externally[7]. Females lay up to 300 eggs loosely in the grain stock. Sieving and probe traps usually required for detection. They have high levels of phosphine resistance. Adults fly readily and can live for several months, as shown in fig. 11.

Saw-Toothed Grain Beetle:

Adults can live for several months, as shown in fig. 12. Females laying 300-400 eggs loosely throughout the grain. White larvae feed and develop externally. Life cycle completed in 3 weeks at 30-33 degree Celsius, 17 weeks at 20 degree Celsius, reproduction stops below 17.5 degree Celsius. Has developed resistance to a number of grain insecticides.

Fig 11:Flat Grain Beetle

Fig 12: Saw –Toothed Grain Beetle

Indian Meal Moth

Larvae create webbing as they feed, as shown in fig. 13. They then develop in several grains webbed together in a clump. In summer, life cycle takes about 4 weeks. Take regular samples from the stock and look for webbing and moths near grain surface, on the top and sides majorly. Also check residues during grain harvesting and handling equipment used during processing.

Fig 13: Indian meal moth

QUALITY MONITORING OF STORED FOODS:

(i) Visual observations involving sampling, sifting and counting.
(ii) Detection of latent infestation through chemical, x-rays and sound amplification
(iii) Use of chemical attractants: Synthetic pheromones and food attractants are valuable where insects are difficult to locate and their population is hard to assess.
(iv) Use bait stations: Attractive sticky food, especially for moth and beetles.
(v) Use of traps: Light traps function as an early warning monitor system nets, aspirators may be used.

TNAU Stack Probe Trap:

TNAU stack probe trap is made of plastic and comprises of main hollow tube, as shown in fig. 14, having a diameter in the range of 1.8-2.0 cm with equi-spaced perforation on its upper portion with a bend at one end that ends in a transparent collection unit to accumulate the insects falling through from the bend, the other end of main tube being closed as a trap. The device is useful in detecting stored grain insects in bag stacks of the food grain warehouses and does not require any bait materials to trap insects.

Fig. 14: Stack probe for detection of spoilage in turmeric

UV Light Trap:

The UV light trap mainly consists of a ultra-violet source (4W germicidal lamp). The lamp UV light rays of peak emission around 250nm, as shown in fig. 15.The UV light trap can be placed in food grain storage godowns at 1.5m above ground level, preferably around warehouse corners as it has been observed that insects tend to move towards these places during the evening hours.

Thermal Imaging:

Thermal imaging[3,2] is technique which converts the invisible radiation emitted by an object into temperature data without making contact with the object, as shown in fig. 16.This method is widely used for determination of surface temperatures, grain quality measurement like infested kernel and presence of foreign bodies (dead insects, stones, rat excreta) in food produces. These images can acquire using portable, handheld or thermal sensors that are coupled with optical systems. In recent years the usage of thermal imaging is gaining popularity in pest detection due to the reduction in the cost of equipment and simple operating procedure.

Fig. 15: UV Light Trap

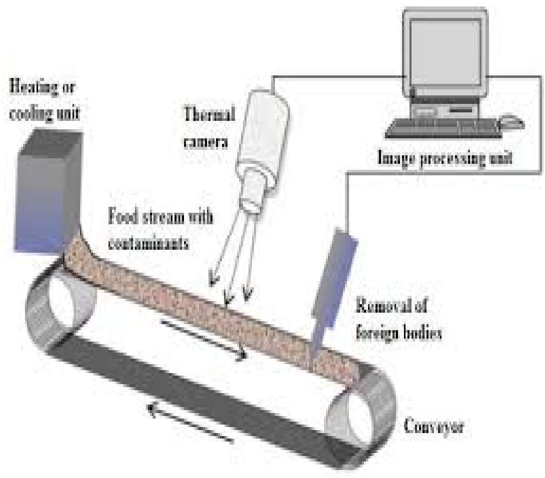

Fig. 16: Temperature in Grains Using Thermal Imaging

Electro-magnetic Grain Bin Monitoring:

Electromagnetic imaging (EMI) system, is capable of detecting spoiled grain regions inside a large scale grain storage bin. Increases in temperature and moisture, both raise the complex permittivity of the grain. EMI system processes a 3D image of the complex permittivity with use of 24 antennas mounted on the side of the bin that will be operating at a frequency of 93MHz, combined with a 3D finite element inversion/imaging code. The antennas are designed to have both desired electrical characteristics as well as withstand the significant forces caused by the loading and unloading of grain.

Acoustic Detection

The activity of insects within a grain bulk produces noises in the audible range of wavelength which can be detected by high performance acoustic sensors[1,4]. A portable probe is built up with three levels acoustical sensors coupled to a computer assisted processing system. The recorded sound signals of the major grain insects species where digitized when stored into a reference database. A classification algorithm was developed for the automatic recognition of recorded insect noise signals by their comparison to the specific spectra of the reference database.

DEEP LEARNING:

A detection and identification method for stored grain insects was developed using deep neural networks. The detection steps for the target object were: acquire the region of the image by RPN, merge these proposals as candidate boxes by NMS, map these candidates boxed by classification network, used the NMS to merge these overlapping candidate boxes[5,6].

The proposal regions are mapped to the output of the inception. This developed method could directly back-propagate the gradient from the deep layers to the shallow layers of the inception network. The method could detect the insects with slight adhesion. An improved inception network was also developed to enhance the accuracy of small insect detection through the deep convolution neural networks.

CONCLUSION:

In older times, simpler and traditional methods to store the grains for longer periods were adopted. When a disadvantage was recognized, improvised methods were found to help overcome them. Technology has shown great help in the field of protection of these grains from the various factors causing spoilage. Silos are an effective method but the initial installation and ground area required is a drawback. As the latest trend, Deep Learning helps in understanding the deeper aspects of studying the spoilage factors and methods can be adopted to rectify them.

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